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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Report Chapter:

Report chapter describing potentials and difficulties for completing data collection

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1 Introduction

This subreport describes potentials and difficulties for completing data within work package 3. The objective of WP3 is to obtain detailed, validated data for four specific countries. Germany, Austria, Denmark and France. The data mining in WP3 contains the following steps:

- Definition of the operational data structure in relation to WP1 und WP2.
- Collection of statistics and other data in Germany, Denmark, Austria and France.
- Comparison and verification of the acquired data.
- Identification of missing data.
- Collection / substitution of missing data for individual sectors.
- Check for plausibility and perform data reconciliation.
- Elaboration of coefficients and indicators for subsequent working packages (esp. WPs investigating scenarios and forecastings).
- Identification of potentials and difficulties for completing the data collection.

The deliverables within WP 3 are:

- D3-1: Report chapter describing data processing and validation.
- D3-2: Databases of material flows and stocks for the four countries.
- D3-3: Report chapter containing indirect procedures for estimations of transfer coefficients.
- D3-4: Report chapter describing potentials and difficulties for completing the data collection.

2 Context within FORWAST

As mentioned in the previous chapter, the objective of WP3 is to obtain detailed, validated data for the specific countries: Austria, Denmark, France and Germany. The ambition is to create a core of data which will be more detailed than for the EU 27. Within the project structure of FORWAST, WP3 interacts with the other working packages as shown in Figure 1.

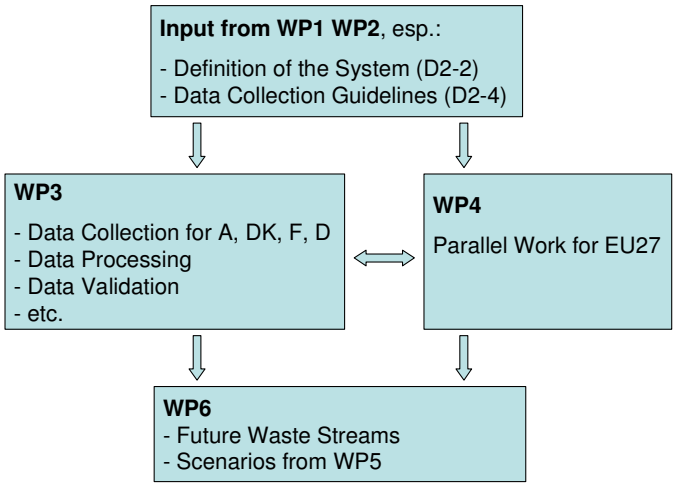

Figure 1: Project Structure

Relevant outcomes for WP3 (and WP4 as well) - resulting from WP1 and WP2 – are, among others:

- Overall Calculation Model
- Identification of relevant Materials and Products
- Definition of Terms
- Definition of Data Structure
- Definition of System Boundaries
- Harmonisation of Data

Interaction between WP3 and WP4 is necessary in order to ensure a congruent and coherent data base for EU27. Therefore partners of WP3 and WP4 exchange experiences within periodical project meetings and data mining-workshops. Exchange of experiences and

synergetic effects result from the interaction not only within WP3 and WP4 but also by giving feedback to WP2.

Outcome of WP3 is a verified and coherent data base for the above mentioned four countries suitable to be used for the estimation of future waste streams (WP6) within scenarios elaborated in WP5.

2.1 Limitations in Data Collection

The countries which were observed countries in work package 3 (France, Germany, Denmark and Austria) cover 41 percent of the European Union's GDP. Compared to the countries of work package 4, France, Germany, Denmark and Austria provide detailed data. Nevertheless Also among these 4 countries we find different levels of statistical precision. Each country has its own local particularities in the handling of national data. There are different ways of detail and different philosophies concerning the level of confidentiality. E.g. the Scandinavian countries are on a high level of detail and provide each statistical without confidential barriers. There are no existing boundaries which hamper the data collection. In Austria exists a different understanding of confidential data. If there are less than 4 companies working in a sector the statistical bureau is requested to keep this data confidential to respect the internal security of these companies. In Scandinavian countries this transparency is state of the art and no one bothers about this issue.

There are different issues to provide statistical data in Europe. These issues and other problems constrict or support data collection within FORWAST. Not surprisingly, each country has its own problems and barriers which impede data collection.

This chapter is an attempt to identify these barriers and differences in order to deviate policies according the handling of statistical data.

2.1.1 Denmark

In general, data quality in Denmark is at a very high level. The Danish data is first processed into a square 134x134 table by using categorisation provided by Statistics Denmark for the 2000 products. The monetary supply-use table can directly be extracted. Before the physical (by mass) supply-use table can be created, it has to be ensured that all physical products are assigned a physical weight. The procedure for this is to calculate the average price (monetary transactions divided by physical transactions) for the products where physical information is available, and then use this price for those products for which no physical information is available.

2.1.2 Austria

The MSUTs from EUROSTAT are the starting point to fill the FORWAST model with information. The difficult part is to obtain additional data for the FORWAST-specific disaggregated categories. Most of the categories are disaggregated by using NACE 4-digit

codes, but there are some cases, where a FORWAST-specific redistribution is required. It is very difficult to obtain information according to those disaggregated categories.

Data quality in Austria generally is found on a high level. The core database (structural business accounts; short term statistics), provided by Statistics Austria, are highly reliable and of statistical depth. But there is a serious problem with confidential data. In Austrian statistics it is usual to keep data confidential, if there are less than 4 enterprises within one economic category. Unfortunately there are lots of confidential data, because of the fact, that Austria has a small scaled economy. After consultation with Statistics Austria there is no way of getting this information. Hence, research has to be done by using other sources or by making own assumptions, which comprises a certain potential of inaccuracies.

In recent years it has become standard to provide Austrian data only at a monetary level. Consequently, there is a lack of information regarding physical data of used and supplied goods. As a result additional data and knowledge is needed to obtain information regarding the targets of FORWAST.

Another problem with data mining in Austria is that information is often not available based on NACE categorisation. Some sources use national codes and others use international codes that are not compatible with NACE (e.g. UN-codes). Thus, it is necessary to convert the data, which comprises a high potential of inaccuracies.

A further problem is the comparability of statistical data, i.e. even the most reliable data, which are used for calculations or comparisons, do not necessarily fit. This leads to the problem that even data sets from the same statistical bureau, which are obviously produced under special preconditions and objectives, are not a priori compatible. This inconsistency even increases, when trying to connect data sets of different statistical units.

If data from different sources do not match, the decision has to be made, which data are more reliable. The other data have then to be adjusted manually. This procedure seems questionable and favours a calculated loss of information.

2.1.3 France

Like in the other countries in this work package, French monetary supply and use tables exist at a level of 59 activities per 59 commodities, available at EUROSTAT. Data Quality in France in general is at a very high level. Uncertainties may occur due to the fact that a huge number of references and sources were used to reach the goals of FORWAST. Similar to Austria, France has the same problems regarding physical data. Predominantly, databases and statistical sources only provide data in monetary terms. There is lack of information regarding physical information. To deal with this lack of information additional price information is needed to calculate physical values.

Similar to the other countries in this work package France used databases on a European and/or worldwide level. These databases are serviced by national or supranational statistical bureaus and institutions or market based groups of interest.

2.1.4 Germany

In general, data quality in Germany is also at a very high level. Uncertainties may occur during the data processing as the data available fit only partly into the FORWAST scheme. The monetary SUT available from EUROSTAT (59 activities/goods) has a direct correspondent monetary SUT in the macroeconomic accounting of the Federal Statistical Office of Germany. These SUT have a disaggregation level of 79 activities/goods. The target disaggregation level within FORWAST is 119 macro-economic groups. These 79 activities/goods had been aggregated by the Federal Statistical Agency to 59 activities/goods for creating the EUROSTAT-tables. By using the national macroeconomic accounting as primary dataset (instead of the EUROSTAT-tables) a higher level of monetary disaggregation could be used as starting point for data processing (however the 79 categories are not completely coherent with the FORWAST-scheme).

2.2 National Monetary Supply-Use Tables

2.2.1 Denmark

The basis for data collection is provided by the original supply and use tables from EUROSTAT. These tables are at the level of 60 products per 60 activities. Regarding the original Danish supply and use table, a few activities are missing:

- NACE 10 – Mining of coal and lignite extraction of peat
- NACE 12 – Mining of uranium and thorium ores
- NACE 13 – Mining of metal ores (not observed within FORWAST)

Nevertheless 2.0-LCA-consultants were able to generate more detailed supply and use tables originating from the Danish statistical bureau. The new supply and use tables are disaggregated at a level of 154 products per 154 activities. It should be mentioned that Denmark is not a member of the Euro-Zone. For that reason, the monetary supply and use tables are provided at national currencies. The reference year of the tables used is 2003.

2.2.2 Austria

The basis for data collection is the original supply and use tables from EUROSTAT. These tables are at the level of 60 products x 60 activities. Regarding the original Austrian supply and use table, a few activities are missing:

- NACE 12 – Mining of uranium and thorium ores
- NACE 13 – Mining of metal ores (not observed within FORWAST)
- NACE 95 – Private households with employed persons (not observed within FORWAST)

Statistic Austria provides monetary supply and use tables on a high level. Data concerning uranium and thorium ores is missing because no such mining existing in Austria. Data concerning the mining of metal ores is missing due to confidential aspects. There are less than 4 companies in Austria which extract mining ores.

Austrian supply and use tables are provided in Euro. The reference year of the used tables is 2003.

2.2.3 France

The basis for the data collection is the original supply and use tables from EUROSTAT. These tables are at the level of 60 products x 60 activities. Regarding the original French supply and use table, only one activity is missing:

- NACE 95 – Private households with employed persons (not observed within FORWAST)

French statistics provide monetary supply and use tables on a high level. Although France is a member of the Euro-zone the matrices are provided in national currencies. The reference year of the used tables is 2003.

2.2.4 Germany

The basis for the data collection is the original supply and use tables from EUROSTAT. These tables are at the level of 60 products x 60 activities. Regarding the original German supply and use table, only two activities are missing:

- NACE 12 – Mining of uranium and thorium ores
- NACE 13 – Mining of metal ores (not observed within FORWAST)

German statistics provide monetary supply and use tables on a high level. The monetary supply and use tables are provided in Euro. The reference year of the used tables is 2003.

2.3 Conversion to Basic Prices

The procedure for converting the use table in purchasers' prices to basic prices is described in deliverable D6-4. The procedure is a generalized method which does not take into account that margins and taxes may be different over activities. Therefore, uncertainties in the transactions in the monetary use table may occur. This may affect the use of service products (monetary). Also, the use of physical products may be affected indirectly because the monetary uses are to some extent used to distribute the physical use into the physical use table. In this respect it should be noted that uncertainties in the use of service products only have an effect on the environmental impacts, not the generation of waste and accumulated stocks. The use of physical products is further adjusted as part of ensuring consistency in physical SUTs. The uncertainties related to the conversion to basic prices are assessed as not being significant.

Due to the fact that purchasers' prices were converted into basic prices by using a standardized tool provided by 2.0-LCA-consultants, no differences between the countries in work package 3 are expected. A detailed observation of the differences between the countries can be neglected.

2.4 Disaggregation of Monetary Supply and Use Tables

One major procedure within the data collection and data preparation was the disaggregation procedure of the original supply and use tables from EUROSTAT. The main goal was to disaggregate the original tables (60 activities x 60 commodities) into 117 activities x 117 commodities used in FORWAST.

To alleviate this procedure and prevent failures, instead of manual disaggregation, a semi-automatic procedure was developed. 2.0LCA-consultants provided the so-called “Matrix Expander”. This tool was filled with the result matrix of the “basic price converter”. The output of this tool is a disaggregated and balanced 117x117 table of a national economy. Additional information on the following activities/commodities is needed to accomplish the disaggregation procedure:

Table 1: disaggregated activities/commodities

NACE	ESA 95 Nomenclature
01	Products of agriculture, hunting and related services
02	Products of forestry, logging and related services
13	Metal ores
14	Other mining and quarrying products
15	Food products and beverages
21	Pulp, paper and paper products
23	Coke, refined petroleum products and nuclear fuels
24	Chemicals, chemical products and man-made fibres
26	Other non-metallic mineral products
27	Basic metals
40	Electrical energy, gas, steam and hot water
45	Construction work
90	Sewage and refuse disposal services, sanitation and similar services

This means, that additional information is needed to disaggregate one activity/commodity into several sub-activities/sub-commodities. E.g. the agricultural sector is disaggregated into six categories. This information was derived by filling in data into the “split screen”.

Additional information concerning the proportion between these six categories would be of great value. Furthermore, additional information concerning the supply and use of products is needed. Per default the “matrix expander” uses the same proportions within the supplied

products and the used products. This is not a realistic assumption due to the fact, that single activities use or produce goods non-proportionally.

> *E.g. The activity "Bovine meat and milk" produces 35 percent of the NACE 01 group "Agriculture" in monetary values. Regarding the use of intermediate goods this proportion is critical. Using the same proportion within the use of products this would lead to the fact, that the activity "Bovine meat and milk" uses 35 percent of all of the fossil fuels within the agricultural sector, 35 percent of all used animal feeds, and so on. That's no reflection of the reality. But due to lack of information this is the best way to reach the recommendations of the FORWAST model.*

The following table shows the level of disaggregation within the FORWAST model. Thirteen sectors are disaggregated, two sectors are neglected. The competition is to obtain data for the subcategories of each activity. E.g. additional data concerning the ratio between the single sub-activities is needed. This information can be obtained from different national and international statistics.

Table 2: Level of disaggregation (FORWAST)

NACE Code	ESA 95 nomenclature		Level of Disaggregation
01	**Products of agriculture, hunting and related services**		
		1	Bovine meat and milk
		2	Pigs
		3	Poultry and animals n.e.c.
		4	Grain crops
		5	Crops n.e.c.
		6	Agricultural services n.e.c.
02	**Products of forestry, logging and related services**		
		1	Forest products
		2	Recycling of waste wood
12	Uranium and thorium ores	0	not observed within FORWAST
13	**Metal ores**		
		1	Iron ores from mine
		2	Bauxite from mine
		3	Copper from mine
		4	Metals from mine n.e.c.

14	**Other mining and quarrying products**		
		1	Sand, gravel and stone from quarry
		2	Clay and soil from quarry
		3	Minerals from mine n.e.c.
15	**Food products and beverages**		
		1	Meat and fish products
		2	Dairy products
		3	Fruits and vegetables, processed
		4	Vegetable and animal oils and fats
		5	Flour
		6	Sugar
		7	Animal feeds
		8	Food preparations n.e.c.
		9	Beverages
21	**Pulp, paper and paper products**		
		1	Pulp, virgin
		2	Pulp, recycled
		3	Paper and paper products
23	**Coke, refined petroleum products and nuclear fuels**		
		1	Refined petroleum products and fuels
		2	Recycling of waste oil
24	**Chemicals, chemical products and man-made fibres**		
		1	Fertiliser, N
		2	Fertiliser, other than N
		3	Plastics basic, virgin
		4	Plastics basic, recycled
		5	Chemicals n.e.c.
26	**Other non-metallic mineral products**		
		1	Glass, mineral wool and ceramic goods, virgin
		2	Glass, mineral wool and ceramic goods, recycled
		3	Cement, virgin

		4	Recycling of slags and ashes
		5	Concrete, asphalt and other mineral products
		6	Recycling of concrete, asphalt and other mineral products
		7	Bricks
		8	Recycling of bricks
27	**Basic metals**		
		1	Iron basic, virgin
		2	Recycling of iron basic
		3	Aluminium basic, virgin
		4	Recycling of aluminium basic
		5	Copper basic, virgin
		6	Recycling of copper basic
		7	Metals basic, n.e.c., virgin
		8	Recycling of metals basic, n.e.c.
		9	Iron, after first processing
		10	Aluminium, after first processing
		11	Copper, after first processing
		12	Metals n.e.c., after first processing
40	**Electrical energy, gas, steam and hot water**		
		1	Electricity, steam and hot water
		2	Gas
45	**Construction work**		
		1	Buildings, residential
		2	Buildings, non-residential
		3	Infrastructure, excluding buildings
90	**Sewage and refuse disposal services, sanitation and similar services**		
		1	Incineration of waste
		2	Manure treatment
		3	Biogasification of waste
		4	Composting of food waste
		5	Waste water treatment
		6	Landfill of waste

		7	Land application of waste
		8	Unexpected waste
95	**Private households with employed persons**	0	not observed within FORWAST

In some cases this lack of data has been compensated for by assuming a similar distribution of the total supply of products within the category to be disaggregated as for other countries. In other cases, physical data have been identified, and this has then been converted to monetary supplies using price information. The uncertainties related to the lack of data and estimates described above are generally not significant; uncertainties in the total supply will only move some products from one activity to another, and the production functions (inputs and outputs per supply of an activity) is not affected by this.

The second type of data input to the disaggregation are the coefficients specifying the distribution of supplies. The major role of these data are 1) within the disaggregated products, to distinguish between domestically produced products and imported products, and 2) to distinguish virgin production (diagonal supply) from recycled supply (off-diagonal supply of a product from a recycling activity). The data sources used for specifying the import of products are trade data. These data are generally of a good quality. The data sources used to distinguish virgin from recycled production are typically production statistics and waste statistics.

The preferable data source is production statistics because this directly specifies the split between virgin and recycled. These data are typically available for pulp, but for other materials which are supplied both from virgin production and recycling, such data are generally not available. In these cases, data on the amount collected for recycling in waste statistics have been used. These data are then multiplied with a factor representing the efficiency of the recycling process, e.g. 0.9 means than 90% of the recycled iron scrap becomes supply of new iron. Data on collected waste for recycling is available for some waste flows in most countries; typically glass waste, plastic waste, and metal waste. Very little information exists on the recycling of wood and demolition waste as well as slag and ash waste. Hence, the latter is estimated for some countries. The uncertainties described above influences the split between recycling and virgin product, and also indirectly how much waste is sent to other waste treatment activities (if iron waste is recycled, than it is not sent to e.g. landfill). Therefore, these uncertainties have a significant effect on the quantity of waste sent to recycling, incineration, landfill, and the derived effects of this on the environmental impacts. In traditional IOanalysis, the overall impact should not be affected, but in the FORWAST project, the waste treatment activities (incineration, landfill, biogas) are created as normalised modules, meaning that a full coherence with national emissions accounts are not ensured. However, as in the case of the first type of disaggregation data, this does not affect the production functions of the activities (inputs and outputs per supply of an activity).

The third type of data input to the disaggregation are the coefficients specifying the distribution of uses. The major role of these data is to specify the production function of the activities, i.e. the inputs and outputs per unit of supply. The main adjustments are carried out for the use of different feedstock, e.g. when agriculture is disaggregated, it is ensured that 'pigs' use animal feed, and 'grain crops' do not. Also the uses of fuels and electricity are specified, e.g. when the activity virgin production of aluminium uses more electricity per unit of supply of aluminium than recycling of aluminium waste. This type of input data to the disaggregation is based on engineering/chemical/agronomic knowledge on different manufacturing processes (often obtained from life cycle assessments). The physical information obtained from engineering/chemical/agronomic knowledge is converted to monetary units using price information. The uncertainties related to the determination of coefficients specifying the distribution of uses are significant. The data sources are seldom country specific, e.g. data on fuel uses in cement production in an LCA may not correspond to the specific mix of fuels used in the different countries for which monetary SUTs are disaggregated. However, it should be noted, that the uncertainty only concerns the distribution of products within the disaggregated product categories, therefore, an underestimated use of coal in cement production will then result in an overestimation of the use of coal for glass, concrete, and bricks. Thus, the overall waste generation and environmental impacts of the model is not affected by this – the uncertainty only concerns which activities are contributing with waste generation and emissions.

2.5 Disaggregation of Physical Supply and Use Tables

Data on physical domestic supply and trade can be obtained via two issues. One possibility is to obtain data directly from physical supply and use tables. The other possibility is the indirect procedure by using price information to calculate physical supply and use tables. The great difference between these sources is the level of uncertainty. The indirect procedure bares a huge potential of inaccuracies.

In recent years it becomes more and more standard in European statistics to provide data only in monetary units. This leads to a lack in information on physical data. To obtain physical data price information are needed to run this calculation. Unfortunately the price information usually and accordingly is not user-friendly. In most cases only index-based price information are provided. This data are not feasible to calculate physical data via price information. Furthermore categories consisting of more than one product/good do have the problem of the necessity of an average price. By using a weighted mean possible inconsistencies can be left on an acceptable level. The assumption that every good produced or used by an activity has the same price level leads to inconsistencies due to the fact that a price is nothing more than a variable influenced by many factors. Summing up, the calculation of physical values by using price information is a quite poor way of data generation as it bares a high potential of inaccuracies. The data would be more consistent and reliable if primary physical data are provided by the statistical units.

The conversion of supplied goods from monetary to physical units is straight forward. In terms of the market it makes no difference, if the supplied good is produced by activity A or activity B. The supplied good has a market price.

The conversion of used good is more difficult. It makes a great difference if good A is used in activity A or B. E.g. “chemical n.e.c.” used in the agricultural sector have another composition (and price) like the chemical used in the chemical sector. But we can use only average price information of a high aggregated level. Therefore the conversion via price information is afflicted with a high level of inaccuracies.

Generally, data on the use of products are not available or they are of poor quality. Monetary uses have to some extent been used to distribute the total physical domestic use over activities in economy. The uncertainty related to this does not differ from an ordinary monetary input-output based life cycle analysis, which by definition does not take into account differences in prices over activities. Differences in prices become an issue when dealing with supply-use tables in physical units. This uncertainty is eliminated/minimised for all uses of feedstock products since the accounting framework described in deliverable 6-4 allows for the calculation of feedstock efficiencies (the D table) and the calculation of the supply of residuals (WV table). For all feedstock it is ensured that 1) no negative waste occurs, and 2) the feedstock efficiency lies within normal range, e.g. approx 10% of the feed

input to bovines become bovine meat and milk. Further, it is checked whether the fuel uses and electricity uses lies within normal ranges. Normal ranges for feedstock efficiencies, fuel uses, and electricity uses are identified based on general experiences, and in various life cycle assessment studies, mainly in the ecoinvent database.

In most cases, the use of feedstock and energy contributes to the most significant environmental impacts. The uncertainties related to these issues are minimised through the above mentioned procedure. Still some uncertainties may be present for environmental impacts. For waste generation, the uncertainties relating to the distribution of physical use of products only affect where in economy the waste is generated – not the total quantity

A further problem regarding the conversion from monetary to physical units is the fact that a lot of commodities are given in non-weight units (e.g. square meters, cubic meters, pairs, pieces and so on). Conversion factors are needed to calculate the physical output of an activity. Mainly in inhomogeneous activities (e.g. machinery n.e.c.) this procedure is linked to inconsistencies of the result. Hence this procedure bares a high potential of inaccuracies as well.

2.6 Internal Flows

With the introduction of the “internal flows” the FORWAST model is able to picture unrecorded production. (e.g. home grown forage crops). The national account only records the amount of products or services, which leave the self-contained system of the producer – from the producer to market economy. Products, which stay in the system of the producer are not recorded, but are physically and monetary remarkable.

To illustrate this assumption, the example “forage crops” is shown: A farmer produces a part of the forage crops by him. This amount is not recorded in the MSUT, but is important in reference to the advance performance. If you leave this amount the advance performance will be underestimated. The part of home grown forage will be evaluated with the same value (“shadow price”) like the purchased goods, i.e. industrial produced feed. Hence home grown forage could be interpreted as substitute for industrial feed.

The added “internal flow” raises the total value of the agricultural production and leads to another distribution over all categories, because the amount directly flows into the diagonal cell “grain crops”, as the internal flow increases the actual production of the activity “grain crops”. In the use-table this redistribution will take place in another way.

The problem of the “internal flows” occurs due to the system boundaries of a census, i.e. only flows from one enterprise to another are detected. The goods and activities that appear within an enterprise are out of sight. Due to that, the total monetary turnover is underestimated. Therefore the “internal flow” has to be taken into account to picture the reality in a better and entire way. It needs more additional information to calculate this “internal flow” and add it to the original value of the MSUT (the procedure is explained in D2-4 [Daxbeck et al., 2008]). This procedure bares a high potential of inaccuracies.

2.7 Emissions

Within FORWAST 2 different types of emission tables are implemented.

1) The "Emissions Matrix (B)", which is includes the total emissions per activity (117 activities x 53 emissions)

2) The Emissions distribution matrices (G_c, G_w, and G_r), which specify the origin of the emissions. These matrices specify if the emitted emissions originates from the use of products (G_c), use of residuals (G_w) or from the use of resources (G_r).

The NAMEA (National Accounting Matrix including Environmental) is also a good starting point to obtain data concerning air emissions for B-Matrix and G-Matrix. The tables are NACE-based and because of that easy to connect to the activities in the FORWAST project. This benefit occurs only regarding the aggregated activities (e.g. rubber and plastic production). For the user-defined FORWAST categories a disaggregation based on additional information has to be done. In Austria the use of energy carriers from energy statistics is taken into account. That is suitable within the industry, but there is no information concerning agriculture and services. The other way of obtaining emissions for the aggregated activities by using emission factors is even difficult. It is most likely that the calculated result and the aggregated sum obtained from the NAMEA do not match, because they are probably generated under different preconditions. Furthermore the NAMEA includes no information concerning emissions to water or soil. Additional information is needed to obtain the recommended 53 emissions within the FORWAST project. To prevent such unreliability an additional tool was provided by 2.0LCA-consultants. This tool is able to balance the use of (fossil) fuels and the related emissions. The respiratory of humans and animals is also taken into account.

Table 3: Selected National Air Emissions and their availability {EUROSTAT, 2008 #2563}

	CO2				CH4				SOx			
	AUT	GER	DEN	FRA	AUT	GER	DEN	FRA	AUT	GER	DEN	FRA
Agriculture, hunting and related service activities	n.a.	x	x	x	n.a.	x	x	x	n.a.	x	x	x
Forestry, logging and related service activities	n.a.	x	x	x	n.a.	x	x	x	n.a.	x	x	x
Fishing, fish farming and related service activities	n.a.	x	x	x	n.a.	x	x	x	n.a.	x	x	x
Mining of coal and lignite; extraction of peat	n.a.	x	x	x	n.a.	x	x	x	n.a.	x	x	x
Extraction of crude petroleum and natural gas; service activities incidental to oil and gas extraction	n.a.	x	x	x	n.a.	x	x	x	n.a.	x	x	x

excluding surveying												
Mining of uranium and thorium ores	n.a.	x	x	n.a.	n.a.	x	x	n.a.	n.a.	x	x	n.a.
Mining of metal ores	n.a.	x	x	n.a.	n.a.	x	x	n.a.	n.a.	x	x	n.a.
Other mining and quarrying	n.a.	x	x	n.a.	n.a.	x	x	n.a.	n.a.	x	x	n.a.
Manufacture of food products and beverages	n.a.	x	x	n.a.	n.a.	x	x	n.a.	n.a.	x	x	n.a.
Manufacture of tobacco products	n.a.	x	x	n.a.	n.a.	x	x	n.a.	n.a.	x	x	n.a.
Manufacture of textiles	n.a.	x	x	n.a.	n.a.	x	x	n.a.	n.a.	x	x	n.a.
Manufacture of wearing apparel; dressing; dyeing of fur	n.a.	x	x	n.a.	n.a.	x	x	n.a.	n.a.	x	x	n.a.
Tanning, dressing of leather; manufacture of luggage	n.a.	x	x	n.a.	n.a.	x	x	n.a.	n.a.	x	x	n.a.
Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials	x	x	x	x	x	x	x	x	n.a.	x	x	x
Manufacture of pulp, paper and paper products	n.a.	x	x	x	n.a.	x	x	x	n.a.	x	x	x
Publishing, printing, reproduction of recorded media	n.a.	x	x	x	n.a.	x	x	x	n.a.	x	x	x
Manufacture of coke, refined petroleum products and nuclear fuel	n.a.	x	x	x	n.a.	x	x	x	n.a.	x	x	x
Manufacture of chemicals and chemical products	n.a.	x	x	x	n.a.	x	x	x	n.a.	x	x	x
Manufacture of rubber and plastic products	n.a.	x	x	x	n.a.	x	x	x	n.a.	x	x	x
Manufacture of other non-metallic mineral products	x	x	x	x	x	x	x	x	n.a.	x	x	x
Manufacture of basic metals	x	x	x	x	x	x	x	x	n.a.	x	x	x
Manufacture of fabricated metal products, except machinery and equipment	n.a.	x	x	x	n.a.	x	x	x	n.a.	x	x	x
Manufacture of machinery and equipment n.e.c.	x	x	x	x	x	x	x	x	n.a.	x	x	x
Manufacture of office machinery and computers	n.a.	x	x	n.a.	n.a.	x	x	n.a.	n.a.	x	x	n.a.
Manufacture of electrical machinery and apparatus n.e.c.	n.a.	x	x	n.a.	n.a.	x	x	n.a.	n.a.	x	x	n.a.
Manufacture of radio, television and communication equipment and apparatus	n.a.	x	x	n.a.	n.a.	x	x	n.a.	n.a.	x	x	n.a.

Emissions

Manufacture of medical, precision and optical instruments, watches and clocks	n.a.	x	x	n.a.	n.a.	x	x	n.a.	n.a.	x	x	n.a.
Manufacture of motor vehicles, trailers and semi-trailers	n.a.	x	x	x	n.a.	x	x	x	n.a.	x	x	x
Manufacture of other transport equipment	n.a.	x	x	x	n.a.	x	x	x	n.a.	x	x	x
Manufacture of furniture; manufacturing n.e.c.	n.a.	x	x	n.a.	n.a.	x	x	n.a.	n.a.	x	x	n.a.
Recycling	n.a.	x	x	n.a.	n.a.	x	x	n.a.	n.a.	x	x	n.a.
Electricity, gas, steam and hot water supply	x	x	x	x	x	x	x	x	n.a.	x	x	x
Collection, purification and distribution of water	n.a.	x	x	x	n.a.	x	x	x	n.a.	x	x	x
Construction	x	x	x	x	x	x	x	x	n.a.	x	x	x
Sale, maintenance and repair of motor vehicles and motorcycles; retail sale of automotive fuel	n.a.	x	x	n.a.	n.a.	x	x	n.a.	n.a.	x	x	n.a.
Wholesale trade and commission trade, except of motor vehicles and motorcycles	n.a.	x	x	n.a.	n.a.	x	x	n.a.	n.a.	x	x	n.a.
Retail trade, except of motor vehicles and motorcycles; repair of personal and household goods	n.a.	x	x	n.a.	n.a.	x	x	n.a.	n.a.	x	x	n.a.
Hotels and restaurants	n.a.	x	x	x	n.a.	x	x	x	n.a.	x	x	x
Land transport; transport via pipelines	x	x	x	x	x	x	x	x	n.a.	x	x	x
Water transport	x	x	x	x	x	x	x	x	n.a.	x	x	x
Air transport	x	x	x	x	x	x	x	x	n.a.	x	x	x
Supporting and auxiliary transport activities; activities of travel agencies	n.a.	x	x	n.a.	n.a.	x	x	n.a.	n.a.	x	x	n.a.
Post and telecommunications	n.a.	x	x	n.a.	n.a.	x	x	n.a.	n.a.	x	x	n.a.
Financial intermediation, except insurance and pension funding	n.a.	x	x	n.a.	n.a.	x	x	n.a.	n.a.	x	x	n.a.
Insurance and pension funding, except compulsory social security	n.a.	x	x	n.a.	n.a.	x	x	n.a.	n.a.	x	x	n.a.
Activities auxiliary to financial intermediation	n.a.	x	x	n.a.	n.a.	x	x	n.a.	n.a.	x	x	n.a.
Real estate activities	n.a.	x	x	n.a.	n.a.	x	x	n.a.	n.a.	x	x	n.a.
Renting of machinery and equipment without operator and of personal and household goods	n.a.	x	x	n.a.	n.a.	x	x	n.a.	n.a.	x	x	n.a.
Computer and related activities	n.a.	x	x	n.a.	n.a.	x	x	n.a.	n.a.	x	x	n.a.
Research and development	n.a.	x	x	n.a.	n.a.	x	x	n.a.	n.a.	x	x	n.a.
Other business activities	n.a.	x	x	n.a.	n.a.	x	x	n.a.	n.a.	x	x	n.a.

Public administration and defence; compulsory social security	n.a.	x	x	n.a.	n.a.	x	x	n.a.	n.a.	x	x	n.a.
Education	n.a.	x	x	x	n.a.	x	x	x	n.a.	x	x	x
Health and social work	n.a.	x	x	x	n.a.	x	x	x	n.a.	x	x	x
Sewage and refuse disposal, sanitation and similar activities	n.a.	x	x	x	n.a.	x	x	x	n.a.	x	x	x
Activities of membership organization n.e.c.	n.a.	x	x	x	n.a.	x	x	x	n.a.	x	x	x
Recreational, cultural and sporting activities	n.a.	x	x	x	n.a.	x	x	x	n.a.	x	x	x
Other service activities	n.a.	x	x	x	n.a.	x	x	x	n.a.	x	x	x
Activities of households as employers of domestic staff	n.a.	x	x	n.a.	n.a.	x	x	n.a.	n.a.	x	x	n.a.
Extra-territorial organizations and bodies	n.a.	x	x	n.a.	n.a.	x	x	n.a.	n.a.	x	x	n.a.
Households	x	x	x	x	x	x	x	x	n.a.	x	x	x
Transport	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Heating	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Other	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.

Regarding Table 3 it is obvious the level of detail between the observed countries is different. Denmark and Germany provide detailed tables. The provided emissions data of France and Austria are not on this high level.

The second emissions table is used for the calculation of specific waste outputs from activities, e.g. input of 1 kg feed to the 'bovine meat and milk' activity leads to approx 0.08 kg product output and 0.71 kg emission. Now, the waste originating from feed (this is manure) can be calculated as 1 – 0.08 – 0.71 = 0.21 kg manure. If no detailed NAMEA is available, the two emissions tables above are created from UNFCCC country submissions (UNFCCC 2009). For this purpose an 'emissions machine' (Excel based tool) have been developed as part of the project. The physical use table is used for distribution of emissions, when data are not at the desired level of detail in the UNFCCC data.

For most countries, the national emissions tables are created based on country submissions to the UNFCCC. The activities for which emissions data are specified in the UNFCCC national accounts are more aggregated than the FORWAST activity categories. Therefore, data on emissions within a certain aggregated activity, e.g. agriculture, have been disaggregated in to the FORWAST categories of agriculture using animal metabolism for respiratory emissions (e.g. enteric fermentation), physical uses of fuels for emissions originating from coal, refined petroleum, and gas etc. Thus, uncertainties in emissions are related to the same uncertainties as the UNFCCC emissions inventories, the physical uses of

fuels in the physical use tables, as well as animal metabolism balances. Therefore, emissions data does not add new uncertainties into the model – it is rather the physical data in the model (supply-use), which determines the uncertainties in emissions.

A good example for this malfunction is the use of emission factors within FORWAST. The total supply of emission produced by one activity is calculated by using emission factors in connection with the use of fuels of any given activity. It would be not surprising if the values of the calculation and the data from NAMEA do not match, although the sources are basically reliable.

2.8 Resources

Data concerning the input of resources is obtained from production statistics and resource statistics, and resource inputs are aligned with the supply from resource extracting activities, e.g. a mining activity supplies the same amount of mining products as the activity extracts (when not taking into account the loss of resource inputs as emissions and waste).

Table 4: Allocation of Resources

	Activity No.	1	4	5	7	8	9	10	11	12	13	14	15	16	17	39
Resource No.		Bovine meat and milk	Grain crops	Crops n.e.c.	Forest products	Fish	Coal, lignite, peat	Crude petroleum and natural gas	Iron ores from mine	Bauxite from mine	Copper from mine	Metals from mine n.e.c.	Sand, gravel and stone from quarry	Clay and soil from quarry	Minerals from mine n.e.c.	Fertilizer, N
1	Aluminium									x						
2	Fibre biomass				x											
3	Food biomass, (including tobacco)	x	x	x	x	x										
4	Coal						x									
5	Crude oil and natural gas							x								
6	Carbonate carbon								x							
7	Copper										x					
8	Iron								x							
9	Metals, n.e.c.											x				
10	Minerals, n.e.c. (including nitrogen)	x	x	x	x	x	x	x	x	x	x	x			x	x
11	Oxygen (in water content and in oxidised products)	x	x	x	x	x	x		x	x	x	x				
12	Clay and soil													x		

Resources

13	Sand, gravel and stone												x			
14	Total material															

There are several sources to obtain information concerning the data basis of resources. The British Geological Survey (BGS) and the United States Geological Survey (USGS) provide annual data for each European country regarding the production, import and export of resources. As well there are huge numbers of national sources and data bases. The data collection of resource data is not the problem which we faced in FORWAST. The great competition was the selection of data to reach the goals of the model.

During the phases of data collection 2.0LCA-consultants provided a helping tool to obtain reliable and model conform data. The so-called “emission’s machine” balances the input and output of an economy. Besides the emissions, generated from data from the national UNFCCC reports, the “emission’s machine” provides a validated resource table via using the supply of goods.

The allocation and the distribution between the materials are based on the so-called Product Composition Matrix (K_c), which was developed by the FORWAST members. This matrix provides the split of the material composition of each product including the content of water. This was to be done to create default and that fore comparable values. It was in the hands of each partner to adjust these values regarding national specialities.

2.9 Waste Treatment Mix for Different Waste Fractions

Waste generation is a model output. All generated waste per activity is categorised into waste fractions, and the waste fractions are directed to different waste treatments; recycling, incineration landfill etc. The direction of the waste fractions is based on information in the so-called residuals distribution table (J-table) which is created as part of the data collection exercise for each country. For each type of waste in the model, the J-table specifies the waste treatment, e.g. 30% to recycling, 40% to incineration, 10% to landfill, and 20% exported for recycling. The sum is 100%. The creation of the J-table is based on information in national waste statistics. For many waste fractions, national waste statistics are incomplete, i.e. less waste than actual flows is reported. Especially, non registered landfill of construction materials, and unauthorized disposal of food waste (home composting, and other unauthorised disposal) is lacking in national waste statistics. This means that when national statistics report that X tonne of food waste is incinerated, and that the total quantity of food waste is Y, then the percentage directed to waste incineration in the J-table will be too large because the denominator (Y) is underestimated. Since it is most often unauthorised landfill that is lacking in the waste statistics, then it is likely, that other waste treatment options than landfill will be overestimated, and landfill will be underestimated.

2.10 Level of Aggregation

The FORWAST model includes 145 product categories of which 59 are measured in physical mass, i.e. these products are sources of waste. Given the high number of waste fractions, especially for hazardous wastes, it is clear that the FORWAST categories for these wastes are not sufficient for a good description. Therefore, the FORWAST model, at the current level of detail, is only sufficient in providing information on bulk wastes (non-hazardous). And still within these bulk wastes, there are special fractions that are not described in the model, e.g. different qualities of wastes and scrap from recycling.

2.11 Conclusion on the Data Quality Assessment

Regarding the countries within work package 3 following barriers, potentials were detected

Based on the description of difficulties and potentials presented in this section, the following uncertainties are regarded as the most significant:

• Uncertainties relating to the split between EU-27 domestic production and import to the EU-27 causes uncertainties relating to figures on waste generation occurring within the EU-27 versus waste generation occurring outside the EU-27

• Uncertainties relating to disaggregation of monetary supply-use tables and data on physical uses causes uncertainties in waste and emissions per unit of supply for the product categories in the FORWAST model

• Applied waste treatment mix overestimates to share of waste sent to waste incineration (especially food and construction)

• Scenario implementation leads to overestimation of emissions related to coal based electricity in future scenarios

• Uncertainties in waste module causes overestimated emissions from manure treatment and uncertain modelling relating to energy recovery of waste incineration (large variability depending on country)

• Underestimated product life times (especially construction materials) causes overestimation of waste quantities

• The level of aggregation of the FORWAST model prevents the approach for being used for providing data on special waste fractions and hazardous waste

Significant difficulties and potentials have been identified, which lead to significant inaccuracies. Nevertheless model results on future scenarios can be used for obtaining

information on the developments in waste flows and environmental impacts given different macroeconomic developments and different waste treatment strategies. Especially, the relative differences between scenarios are not affected by the major sources of uncertainties. Also information on the environmental impacts per product for year 2003 is appropriate for use in input-output and hybrid LCA. In this respect, it should be noted that the uncertainties in the FORWAST model are estimated as being less significant than in traditional economic input-output tables because the FORWAST model takes into account differences in prices over activities as well as physical inconsistencies are eliminated.