Worldwide environmental impacts of consumption and production in Flanders: feasibility of an environmental input-output model for Flanders

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Woord vooraf

Om haar productie en consumptie te ondersteunen, onttrekt Vlaanderen wereldwijd grondstoffen aan het milieu. Deze ontginningen en de daaropvolgende productie- en consumptieprocessen leiden tot allerhande milieuverstoringen, gaande van verontreiniging door afval en emissies, over verlies van land en ecosytemen, tot uitputting van schaarse grondstoffen. Die milieuverstoringen situeren zich niet alleen in Vlaanderen zelf, maar ook in de landen waar die grondstoffen worden ontgonnen en verwerkt tot materialen en producten bestemd voor productie en consumptie in Vlaanderen.

Duurzaam gebruik van grondstoffen en andere natuurlijke hulpbronnen krijgt dan ook veel aandacht op de verschillende beleidsniveaus. ‘Voorraden/natuurlijke hulpbronnen’ is zowel in het zesde milieuactieprogramma van de Europese Gemeenschap als in het Federaal Plan Duurzame Ontwikkeling 2004-2008 en het Vlaamse Mina-plan 3 één van de inhoudelijke prioriteiten. Op Europees niveau wordt dit vertaald in de uitwerking van een thematische strategie aangaande het duurzaam gebruik van natuurlijke hulpbronnen, op federaal niveau in een aantal acties, onder meer minder gebruik van natuurlijke hulpbronnen en een strategie voor duurzame producten, en op Vlaams niveau in een project ‘beleid gericht op voorraden’.

Eén van de sleutelindicatoren in het MINA-plan 3 om het duurzaam gebruik van natuurlijke hulpbronnen op lange termijn te evalueren is de Totale Materialen Behoefte (TMB). Deze indicator, die sinds 2001 jaarlijks werd gerapporteerd in MIRA-T, geeft aan hoeveel primaire grondstoffen Vlaanderen jaarlijks in beweging zet. De TMB geeft echter geen beeld van de milieuverstoringen gekoppeld aan dat gebruik van grondstoffen. In MIRA-T 2004 werd ook gerapporteerd hoeveel afval en emissies in Vlaanderen zelf ontstaan door ontginningen en door gebruik van grondstoffen in productie- en consumptieprocessen. Deze laatste indicator geeft echter geen beeld van de milieuverstoringen die we veroorzaken in het buitenland. Ook de verdeling van het grondstofgebruik en de milieuverstoringen over de verschillende productie- en consumptiedomeinen was niet in beeld te brengen met deze indicatoren. In het streven naar een duurzaam gebruik van natuurlijke hulpbronnen is het belangrijk om de totale milieuverstoringen ten gevolge van de Vlaamse productie en consumptie te verminderen. Dit vereist de ontwikkeling van indicatoren die de totale milieuverstoringen ten gevolge van ontginning en gebruik van grondstoffen in beeld brengen, ook de milieuverstoringen buiten Vlaanderen. Deze indicatoren moeten het beleid bovendien aangeven bij welke productiesectoren en/of consumptiedomeinen de prioritaire knelpunten zitten.

Om milieuverstoringen te linken aan productiesectoren en consumptiedomeinen bestaan er internationaal gehanteerde methodes[1]. Deze methodes steunen onder meer op input-output analyse. Voorliggend onderzoek heeft tot doel de mogelijkheden en beperkingen van een Vlaams input-output model met milieuextensies gedetailleerd in kaart brengen, knelpunten en suggesties op te lijsten voor verdere ontwikkeling van het ‘Vlaamse’ model, en indicatoren voor materiaalgebruik, emissies en milieu-impact per productiesector en/of consumptiedomein te bepalen.

[1] Europese Commissie (2004) Environmental impact of the use of natural resources (EIRES). IPTS/ESTO project by DTU, TNO-STB, 2.-0 LCA consultants. ftp://ftp.jrc.es/pub/EURdoc/eur21485en.pdf
Europese Commissie (2005) Environmental impact of products (EIPRO). IPTS/ESTO project by TNO-STB, CML, VITO, DTU. http://ec.europa.eu/environment/ipp/pdf/eipro_report.pdf (last consulted 29/08/2006)
Weidema et al. (2005) Prioritisation within the integrated product policy. Danish Environmental Protection Agency. http://www.mst.dk/homepage/default.asp?Sub=http://www.mst.dk/udgiv/Publications/2005/87-7614-517-4/html/default_eng.htm

Overzicht

De hoofddoelstelling van het project was het in kaart brengen van de mogelijkheden en beperkingen van een model voor een Vlaamse Input-Output studie.

In hoofdstuk 1 wordt kort uitgelegd wat Input-Output Analyse (IOA) is. De nationale en internationale toestand inzake het gebruik van IOA wordt geschetst. Verder komt ook het beleidsnut van IOA en haar relatie tot andere economische modellen aan bod.

In hoofdstuk 2 wordt stilgestaan bij de afbakening van de systeemgrenzen en de economische activiteit. De functionele specificaties waaraan het model zou moeten voldoen staan daar neergeschreven. Welke outputs worden verwacht en waar moet idealiter rekening mee gehouden worden? Deze doelstellingen van het model werden afgebakend in overleg met de begeleidingsgroep.

In hoofdstuk 3 worden enkele bestaande IO-modellen onderzocht. Rekening houdend met de doelstellingen bepaald in de eerste stap werd een literatuurreview van EIPRO (Evaluation of the Environmental Impact of Products, IPTS/ESTO project), EIRES (Environmental Impact of the Use of Natural Resources, Europese Commissie, Technical report series EUR 21485 EN) en Deense studie (Prioritisation within the Integrated Product Policy, Deens Ministerie van Milieu, Environmental Project Nr. 980 2005) gemaakt. De modellen en de gebruikte statistieken werden geïnventariseerd en grondig geanalyseerd. Besluiten staan in hoofdstuk 3.4.

In hoofdstuk 4 wordt de beschikbaarheid van gegevens voor Vlaanderen onderzocht. De beschikbare statistische gegevens voor de specifieke situatie in Vlaanderen worden geïnventariseerd. De voor de modellen vereiste Vlaamse data worden beschreven naar beschikbaarheid, gebruikte classificaties en onzekerheid. Besluiten staan in hoofdstuk 4.5.

In hoofdstuk 5 staat de neerslag van de uitgevoerde haalbaarheidsanalyse voor het opstellen van een Vlaams IO model. In de haalbaarheidsanalyse worden de mogelijkheden en beperkingen van een aan de Vlaamse situatie aangepast model aangegeven. Deze zullen in grote mate berusten op de eerdere analyse van de beschikbaarheid van regionale statistieken. Er wordt ingegaan op het bereikbare niveau van detail, de definitie van productgroepen, de conversie van verschillende classificaties, methodische correctheid en coherentie… . Er wordt aangegeven wat er met de bestaande statistieken mogelijk is en wat er nodig is om de statistieken te verruimen voor dit type studies op regionaal en nationaal niveau. Verder wordt ingegaan op te maken keuzen voor een Vlaams model inzake methodologie en consequenties hiervan. Het gaat hier bijvoorbeeld om conversiefactoren tussen verschillende tabellen en andere methodische 'randaspecten'… . Er wordt een overzicht gemaakt van de onzekerheden/vervormingen die deze methodische beslissingen in het resultaat geven. Dit zijn belangrijke nuances ter interpretatie van de gegevens. In principe wordt er van uitgegaan dat deze aspecten kunnen overgenomen worden van het bestaande model, voor de regionaal-specifieke onderdelen moeten deze echter ontwikkeld worden.

In hoofdstuk 6 worden de voornaamste eindbesluiten getrokken. Knelpunten en suggesties voor de verdere ontwikkeling van het Vlaamse model staan daar opgelijst.

List of abbreviations used in the report

eIOA	Extended Input-Output Analysis or Environmental Input-Output Analysis
eIOT	Extended Input-Output Table
IPTS	Institute for Prospective Technological Studies (department of the Directorate-General Joint Research Centre, DG JRC)
IPP	Integrated Product Policy
NAMEA	National Accounting Matrix including Environmental Accounts

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Steering committee

A steering committee has been composed of relevant policy stakeholders: these are the potential users or essential contributors to a future Flemish extended Input-Output model. A listing of the members of the steering committee is shown in the following table.

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1. eIOA principles and model outlines

1.1 Environmentally extended input-output analysis (eIOA)

Input-Output tables (IOT) provide a complete picture of the flows of products and services in the economy for a given year, illustrating the relationship between producers and consumers and the interdependencies of industries. It is a formalized way to describe the relationships between an “economic structure” and “economic actions” and finds its origin in the work of Wassily Leontief (1961). In this context, economic structure refers to the sectoral composition of an economy (as share of sectors to GDP). An input-output table describes how industries are interrelated through producing and consuming “intermediate” industry outputs as represented by monetary transactions between industries, i.e. the purchase and sale of products. “Final” industry outputs are deliveries to final users; domestic private consumption and export products. Economic actions refers to private and public consumption of products, including both goods and services and also comprising capital goods.

In input-output modeling it is assumed that each industry consumes outputs of various other industries in fixed ratios in order to produce its own unique and distinct output. Under this assumption of linear technology, an n x n input-output table **X** is defined such that each column of X shows the domestic intermediate industry output (in monetary terms) that is required to produce one unit of output of the sector that corresponds to the column.

Due to this linearity, an input-output model is capable and suitable for predicting the economic (and environmental) impacts of mainly ‘substantial’ and ‘temporary’ economic actions, i.e. organizing the Olympic Games in 2016 in Flanders, public environmental investment programs, a relighting program for more energy-efficient street lighting, etcetera. Because the calculated impacts include the interdependencies of all sectors; all direct and indirect downstream effects are accounted for, i.e. more activity in construction sector will lead to more activity in building material sectors, will lead to more activity in… When after the economic action, the equilibrium will come close again to what is was before this action, input-output analysis is an appropriate tool for such purposes. In case of long term or even enduring measures (i.e. introduction of a carbon tax) where the economic structure will find a new equilibrium: general equilibrium models (GEM) are found more suitable. But, also for GEM, input-output tables are at its basis (see chapter 1.4 explaining in more detail the differences between IOA and GEM). Also, for predicting or evaluating the impacts of other types of “shocks” IOA is suitable, i.e. for evaluating the effects of the dioxin crisis on production sectors and consumption in Flanders (Buyst E., 2001).

In the figure below, an overview is given of an input-output model, extended with environmental data:

- The n x n “Input-Output” matrix **X** is symmetric where rows represent the outputs of different sectors and columns the inputs from different sectors. In the figure, we read in the first row that agriculture delivers to itself at the value of a_{11}€, of a_{12}€ to the chemicals sector, etc. In the first column, we read that agriculture uses inputs from its own sector at the value of a_{11}€, inputs from the chemicals sector at the value of a_{21}€, etc. The level of detail of input-output matrices can be low or high, i.e. the input-output tables reported by the OECD have a typical resolution of 35 sectors, the Belgian reported IOTs have a resolution of 60 sectors, while the background (not reported) IOTs have a resolution of 120 sectors, the US (CEDA) IOT even has a resolution higher than 450 sectors.

- The “Production Factors” (or “Primary Inputs”) m x n matrix **Z** describes the inputs for each sector such as compensation of employees, profit margins, taxes and subsidies. In the first row, we read that agriculture uses labour at the value of f_{11}€, the chemicals sector at the value of f_{12}€, etc.

- The “Final Demand” n x l matrix **Y** distinguishes l categories of final consumption, i.e. expenditure by households (of agricultural products c_{11}, of chemicals c_{12}), expenditure by government, exports, capital formation, etc…

- The “Environmental accounts” q x n matrix **E** can conceptually be compared with the Production Factors. They describe, usually in physical quantities, the amount of CO2 is produced by the agricultural sector (m_{11}), the amount of waste by the chemicals sector (m_{22}), etc.

	Input-Output table X (technology matrix)					**Final demand Y**				
	Production Sectors	Agriculture	Chemicals	...	**n**	Households	Fixed capital	...	**q**	
	Agriculture	a11	a12	...	...	c11	c12	...	...	**Σ**
	Chemicals	a21	a22	...	...	c21	c22	...	...	=
	...	...	...	...	...	...	...	...	...	**Xi**
	n	...	...	...	...	...	...	...	...	
Production factors Z	labour	f11	f12	...	...					
	...	...	...	...	...					
	m	...	...	...	...					
Environmental Accounts E	CO2	m11	m12	...	...					
	waste	m21	m22	...	...					
	...	...	...	...	...					
	l	...	...	...	...					
		Σ = Xj								

By providing organized economic information, IOTs constitute a tool to analyse the inter- and intra-sectoral impacts as regards the supply and demand of commodities and capital goods, as a consequence of growth and decline and as an effect of subsidies and levies.

Based on the economical equality of supply and demand the following equation holds:

$x_i = \Sigma_k (X_{ki} + Z_{ki}) = \Sigma_k (X_{ik} + Y_{ik})$.

The vector k of total final demand is defined as $y_i = \Sigma_k Y_{ik}$. This vector basically distributes the total available income in a region over products used for final consumption. This final demand for products drives all production activities (and their related environmental effects).

The “Technology Matrix A” is defined as $A_{ik} = X_{ik}/x_i$. This matrix gives the interrelations of production activities in monetary terms. This is a symmetric n x n (sectors) matrix and shows per sector the monetary value of goods delivered to each other sector, and purchased from each other sector, necessary for the production of 1 EURO value of that product unit (so-called “multipliers”). Note that the number of products described in vector k must be lesser or equal to the number of sectors m, since not all sectors deliver goods or services for final consumption.

Then the previous equality of supply and use can be rewritten as:

$x = A*x + y \quad = (I-A)^{-1} * y$ with I : identity matrix
$= L * y$ with L: Leontief-inverse

If the Leontief inverse is expandable as a Taylor series, the following equation holds:
$(I-A)^{-1} = I + A + A2 + A3 + \ldots$
This explains the meaning of the Leontief inverse (see figure): by multiplying with the Leontief inverse, direct (stage 1) and indirect (following stages) effects linked to a change in consumption or production are measured as a whole. The element on row i and column j expresses how much direct and indirect input from industry i is required for producing one output of industry j for final demand.

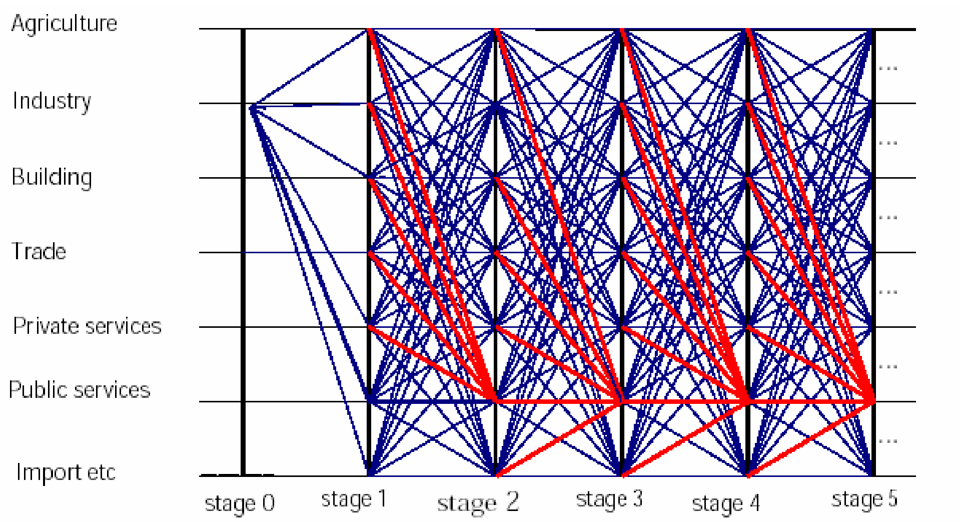

Figure from Treloar (1998)

Extended Input-Output Analysis (e-IOA) broadens the field of application of IOA. So-called ‘satellite accounts’ relate economic activities to indicators on i.e. employment or environmental pressures. The latter finds important applications in the field of environmental systems analysis and industrial ecology, eco-efficiency etc.

Environmental extensions of IOA can easily be made by assuming that the amount of environmental impacts generated by industry is proportional to the amount of output of the industry.

For environmental IOA an inventory of q different environmental interventions (such as CO2, resources use, water pollution etc…) for each individual sector is connected to the input-output system. This is done with the environmental/emissions/impact q x n matrix E, giving the environmental interventions per monetary unit of production of each industry, i.e. as Euro turnover.

The total life cycle environmental impact of each sector can then be attributed to final demanded products and services or to categories of final demand. This is done by calculating:

Products: $M = E * L * \langle y \rangle$ with $\langle y \rangle$ = diagonal n final demand vector
Final demand: $M = E * L * Y$

The matrix product E * L gives the (life-cycle) environmental impact intensity of each industry. The environmental impact intensity of each industry is then multiplied by the monetary requirement for final consumption, resulting in the total environmental impact from each product group, household activity or export item.

Though this suggests that the principle of e-IOA is mathematically straightforward, getting the data right is the main problem. Also, IOA is based on records accounting for financial transactions between productive sectors and to final consumers, and the use and disposal phase are generally not accounted for. These need to be covered by adopting specific solutions. In the reviews of the Danish e-IOA study (Weidema et al, 2005) and the European 'EIPRO' e-IOA study (Tukker et al, 2005), the solutions adopted in these are discussed in some more detail (see Chapter 3).

A good methodological introduction to the use of IOT, extended with environmental indicators can among others be found in: Van Humbeeck (1996) and Duchin en Steenge (1999). Regarding the application of the IOA methodology in Flanders, see MIRA-S 2000 (Van Steertegem, 2000, "Een input-outputmodel met milieumodule toegepast op afvalproductie en CO_2"). Finally, in Van Zeebroeck, Vandille (2003) a state-of-art is outlined regarding environmental accounts that can be integrated with a Belgian IOA model.

1.2 Overview of State of the Art in e-IOA

About 10 EU countries publish monetary IOTs. Detailed IOTs are also available from U.S. and other global economies (Australia, Japan…). In Belgium, input-output tables are published by the Federal Planning Bureau as part of the national accounts (each 5 year period; IOTs for 1995 and 2000 are currently available). When comparing different national IOTs, they are generally not mutually compatible, as national statistical offices traditionally work with their own classification systems and accounting methods resulting in significant inconsistencies in the classification systems, in the level of resolution (from a few tens to several hundred sectors/commodities) and as regards the harmonization of import-export figures.

Currently, several countries, such as the Netherlands and Denmark, publish environmentally extended Input-Output tables (eIOTs or often called NAMEAs). Also here, the same problem of inconsistency occurs: mapping from a few types of air pollutants to several hundred emissions to different media as well as extraction of primary resources and energy use. In Belgium, available NAMEAs are limited to air emissions, water use and emissions to water.

So far, the most relevant step towards the harmonization of IOTs is represented by the activities conducted by Eurostat. Also in Belgium, since 1995, the IOTs are developed according to the rules of the ESA-95 framework (European System of National Accounts). According to this system, input-output tables should be submitted with a resolution of 60 sectors and conformant wit set specifications. Every 3 years countries need to submit make-supply tables, and every 5 years the ensuing symmetric input/output table (expressed in the products-by-products formalism). It should be noticed however, that the degree of harmonization of these tables is not yet as such as to allow for the straightforward comparison or – by simple summation – the production of an EU-wide IOT.
The ESA-95 framework only concerns economic accounts; however, in recent years Eurostat has endorsed pilot NAMEA studies conducted in many European countries, mostly with the focus of air emissions. This can be of interest for the current study given that a Flemish e-IOT or NAMEA should be, as far as possible, compatible with NAMEAs reported by other countries according to the ESA-harmonization principles.
OECD also publishes Input-Output tables for the largest EU-countries[2]; most recent data are based on 1995 data and have a resolution of 35 sectors. Environmental accounts are outside the scope of the IOTs reported by OECD. As such, the OECD IOTs are of less interest to this study compared to the Eurostat references.

Apart from the official publications of national an international statistical bureaus, several independent research projects have made exercises to produce unofficial harmonized IOTs for Europe and beyond. An example of such project is GTAP (Global Trade Analysis Project) but is of less interest to this project since it deals with how to aggregate (or summate) national tables to produce an average IOT for EU15. With it's 57 sectors it has a different resolution than prescribed by ESA-95 and also doesn't consider environmental extensions. Another example is the GINFORS study (the Global INterindustry

[2] http://www.oecd.org/document/1/0,2340,en_2649_34445_34062721_1_1_1_1,00.html

FORecasting System), which is an economy-energy-environment model with global coverage comprising a world model for bilateral trade. GINFORS contains individual, harmonized IOTs for all EU25 countries with a resolution of 25 commodity groups and services, and is extended with energy and environmental accounts.

Of particular interest to this study are considered the European EIRES (Environmental Impact of RESources use), and EIPRO (Environmental Impact of PROducts) projects, both commissioned by DG JRC/IPTS and conducted by research members of the ESTO network (European Science and Technology Observatory). VITO, as a member of ESTO, has actively participated in the latter and conducted a scientific review of the first. Both studies conclude that for the areas of product and resource policies, the top-down e-IOA method is preferred over other plausible methodologies such as bottom-up LCA[3]. A more detailed review of both finished studies, within the framework of this project is conducted (see chapter 2).

Currently ongoing research on environmental-IOT is mainly in the policy areas of IPP (Integrated Product Policy) and the thematic strategy on Natural Resources (NATRES), one of the seven strategies outlined in the sixth EU Environmental Action Plan. The strategy is based on three core tasks: to gather and update information, to assess policies that directly or indirectly affect resources, and to identify appropriate measures to integrate into to other policies. Mainly with regard to the first, e-IOT is seen as an opportunity since it builds on existing national accounts and environmental statistics. A Working Group on IOA, shared by both the Society of Environmental Toxicology and Chemistry (SETAC) and the International Society of Industrial Ecology (ISIE), and launched in 2002, is an international collaborative effort to collect and disseminate state-of-the art knowledge on IOA. Two meetings have been held so far and the Working Group has now decided to work on two books; one about hybrid LCA and the other on e-IOA.

The above collection of examples is not meant as an exhaustive list of state of the art research in the field of e-IOA but can generally be considered as those of most interest to the scope of this study. Already, this brief overview of official reporting and research initiatives leads to the conclusion that e-IOA is taking root in many policy applications and has substantial prospects in improving our view on, and better integrating the economy- and environmental components of sustainable production and consumption. While few EU-countries (NL, DK,etc.) are obviously leaders in the development of e-IOA and e-IOTs, other member states are taking part in these developments and at the EU-level (more in particular DG JRC, together with DG ENV and DG ENT) are taking the necessary initiatives to harmonize these methods and reporting of extended input-output tables. An example of this is the IPTS-study, launched in 2006, on the development of software and a preliminary input-output table for the EU25. In relation to these current developments, other aspects considered of great relevance are; the development of more detailed input-output tables (comparable to existing US and Japanese IOTs with a resolution of several hundred sectors/commodities) and finally, the inclusion of -more- environmental interventions, also those generated downward in the supply chain (cradle-to-gate perspective, including 'imported' impacts) and upward in the product chain (gate-to-grave perspective, including the use- and disposal phase). The fact that e-IOA, at least at EU member states level, still lacks the required level of harmonization and accuracy, and that these efforts are 'currently' ongoing with presumably still a long way to go, certainly adds a level of difficulty to the Flemish initiative of developing its own extended input-output table and model. On the other hand, the advantage is that for several aspects of e-IOA, quite a detailed framework with model- and database requirement are already outlined. It is important that the Flemish model is developed consistent within this framework and is adequately flexible to ensure necessary future adaptations. The development of a high-quality e-IOT for Flanders (according to harmonized approach, accurate, up-to-date and fully based on best primary sources) is certainly a multi-year task requiring large effort and should be seen objective for the longer term. A more realistic objective for the mid-long term is a first generation of Flemish e-IOA, including a preliminary e-IOT, based on best readily-available sources and reasonable assumptions, and consistent with available and ongoing projects at the Belgian federal and EU level. The shortcomings of e-IOA for the purpose of policy support, given an overview above, will be gradually overcome. For the scope of this and future projects in Flanders, it is too ambitious, and also waste of research budgets, to include issues that will eventually be dealt with in EU-research programmes and standardisation. Therefore, it is advisable that this study focuses on aspects relating to the availability

[3] Results of product Life Cycle Analysis (LCA), extrapolated with market sales data to estimate the total impacts of national consumption.

and structure of the data that will be required for the modelling of a Flemish e-IOA, so that the necessary steps can be taken and budgeted accordingly.

1.3 Potential of using e-IOA for policy support

The development of a Flemish extended input-output model is deemed beneficial for support to a number of policy areas of immediate relevance, for which the application of input-output methods is particularly well-suited, such as:

- **Economic analysis :** Input-Output techniques are used to address questions such as comparing the competitiveness of industrial sectors, calculating the multiplier effects of investment programmes, assessing how environmental restrictions impact on prices etc.

Of interest are:

BE/FPB	Published IOTs (1995, 2000) and several related publications by FPB

- **Natural Resources and Waste** : the sustainable use of natural resources aims at ensuring that the consumption of resources and their associated impacts do not exceed the carrying capacity of the environment and breaking the linkages between economic growth and resource use. Prevention and recycling of waste aims at the one hand at avoiding environmental impacts from the extraction of primary raw materials by meeting demand with recycled rather than primary resources, on the other hand at avoiding environmental impacts from the transformation of primary raw materials in production processes. IO techniques are well suited for identifying those materials and resources whose use has the greatest environmental impacts. In particular, input-output techniques can provide a kernel for the coherent development and calculation of de-coupling and dematerialization indicators (the previously mentioned EIRES and NATRES study reports are guiding documents on this issue).

Of interest are:

EC/DG ENV	Thematic strategy on the sustainable use of NATural RESources (NATRES) *(More information, see: latest press release[4] with links to relevant studies such as EIPRO, studies on decoupling indicators, etc.)*
EC/DG JRC/IPTS	EIRES study[5]
EC/DG ENV	The other thematic strategies (EU 6th framework) on prevention and recycling of waste, production and consumption patterns

- **Integrated Product Policy** : while the previous mentioned resources and waste policy areas put the focus more on (raw and transformed) materials, the focus of integrated product policy is somewhat different. IPP aims at the reduction of the environmental impacts from products throughout their life-cycle. In this context products, including services, relate to the fulfilment of functional needs of the domestic and non-domestic markets and by using a broad range of policy instruments and harnessing whenever possible market-based instruments, consumption patterns could be changed (i.e. filling in those needs differently by product-service systems and let consumers make well-informed and conscious choices). Input-Output techniques, due to their capability to give a complete account of the economy, have already been used by several studies, both at national and European level, to identify priority product groups for IPP (referring mainly to previously mentioned EIPRO study).

Of interest are:

EC/DG ENV	Green paper Integrated Product Policy (IPP)

[4] http://www.europa.eu.int/rapid/pressReleasesAction.do?reference=MEMO/05/497&format=HTML&aged=0&language=EN&guiLanguage=en (last consulted 29/08/2006).
[5] ftp://ftp.jrc.es/pub/EURdoc/eur21485en.pdf (last consulted 29/08/2006)

EC/DG JRC/IPTS	EIPRO study on priority product groups (ESTO)
BE/FGOV ENV	Ongoing working groups on product measures for packaging, building materials, passenger transport, detergents and electrical products
BE/FGOV ENV	Market-LCA study on priority product groups (VITO, ICEDD)
BE/FGOV	Product Standards Law of 21 December 1998
VL/OVAM	Prevention and recycling of waste, Eco-design, Eco-Efficiency, etc…

- **Sustainable Production and Consumption :** can be considered a general overarching programme, aimed at making a step change towards sustainability in the production and consumption patterns by means of getting consumer prices to reflect more closely the actual ecological footprints on the products consumed, by investing in science and technology to exploit new opportunities as consumption patterns change, and by improving information in order to allow consumers to make informed and responsible choices. A somewhat justified comment is to what the added value could be of this program complementary to the previously mentioned policy programs due to the obvious identical objectives. It is rather vague in how this programme can put different accents.

Of interest are:

EC/DG ENV	Sustainable Production and Consumption programme

It is useful to note that different policy applications might well have different requirements in terms of needed specifications of the supporting input-output models; for instance environmental assessment of products and eco-design in the context of IPP requires a high level of detail as regards to both product definitions and accounted types of environmental impacts; conversely, dematerialization indicators could be constructed with relatively low detail mapping of productive sectors but require time series. It is therefore an overarching constraint of this project that the development of the e-IO model proceed keeping in mind the high level of flexibility required to take into account diverse future applicative needs.

1.4 Comparing IOA with other modeling approaches

There are five basic approaches to evaluating the effect of a policy action on environment and economy:

1. supply and demand analysis of the affected sector
2. partial equilibrium analysis of multiple markets (i.e. MARKAL for the energy sector)
3. fixed-price, general equilibrium simulations such as Input-Output Analysis (IOA)[6]
4. non-linear, general equilibrium models (GEM)

In theory, all these models are *"complementary"* as they each have their advantages and drawbacks as "models of reality" and where the choice among these alternatives should be based on the type and scale of the policy action evaluated or policy question posed.

As a practical matter, the cost of the evaluation, the time available to complete the analysis, the convenience and knowledge acquired by the expert for using the tools at hand often dictate the method used. Maybe as a "reputation" matter when there are different scientists involved, there is a tendency that the ones involved in one type of modeling begin to think that their model is the only right one, so it is also not incorrect to say that there is some *"competition".*

The five above mentioned modeling approaches mainly differ in the way they capture adjustment and economy-wide interactions. By definition, single and multi-market analysis (1 and 2) do not access economy-wide impacts and will underestimate effects if used in situations where sectors other than those modeled are affected.

[6] In Dutch: algemeen evenwichtsmodel

The purpose of this chapter is to compare mainly two (much spoken off) modeling techniques that can be used to evaluate the effects of policy actions on directly affected sectors ánd also the effects on interrelated sectors and markets, thus economy-wide assessments, which are basically GEM and IOA (3 and 4). The purpose is not to conclude that IOA would be "better" than GEM, but rather to pinpoint for which reasons IOA is more suitable for policy questions regarding resources use and integrated product policy.

Fist one should consider the following type of policy question posed:
"Ex ante", question could be "has an (environmental) policy action been effective?"
"Ex post", question could be "to what extent will an (environmental) policy be effective?"

IOA are fixed-price, fixed-coefficient, demand-driven, economy-wide simulation models. It provides projections for industry, government and households that can be highly disaggregated (high level of detail). IOA is capable of evaluation ex ante and ex post the effects of an obvious "shock" or change in final demand (consumption, investments, export), for example the investment in a network of water treatment infrastructure, investment in an eco-efficient street lighting (replacing installed base), organization of Olympic Games in 2016, etc… With the "effects" we mean on production activity, added value, demand for production factors (capital and labor) and environmental effects. All interdependencies of all sectors are taken into account. Another example of "shock" are the effects of reduced demand by households for poultry and derived products as result of the dioxin crisis (Buyst E., 2001).

The advantage of IO modeling are:

- it is generally more simple compared to GEM and therefore more transparent,
- a high level of detail is possible (app. 120 sectors or product categories),
- consistent data, derived from official national accounts and environmental agencies,
- internal model consistency

The disadvantages are:

- it imposes a fixed linearity on all parts of the economy, and consequently
- it tends to overestimate the response to a change because it does not take into account the interplay and price elasticities (i.e. it assumes full elasticity of supply).
- it assumes a static economic structure, but input-output models with dynamic structures are also implemented nowadays
- no links with well-founded micro-economic behavior, technology aspects…

IOA can be used for:

- ex ante evaluation, with high level of detail
- ex post evaluation, simulating very short-run adjustment
- temporary and "chock" changes in final demand (after the event, an equilibrium as before the event is again the case)
- local changes (where local is considered that an event or a measure affects or is particularly implemented in Flanders)
- evaluation of

In the case of policies that have large, widespread impacts, like carbon taxes to address global warming, the exogeneity of prices implicit in the linear IOA model can lead to significant inaccuracy in policy analysis. To achieve a greater detail of reality in these cases, one must accept a more complicated level of modeling, such as GEM with endogenously set relative prices.

Just like IOA, a GE model is a general equilibrium model of an economy. It uses the IO tables and the other matrices of the IOA model (primary inputs, final demand…) as its database, and represents the same transactions. But unlike the IOA mode, GEM permits non-linear relationships between actors in the economy and adjust through changes in relative prices rather than quantity. As a result, the GEM allows for substitution among inputs in production and goods in consumption. This permits a more realistic representation of the adjustment process and results in less extreme assessments of impacts. However, this potentially more realistic representation of relationships in the economy comes at the cost of significantly greater data and modeling requirements. Each relationship in the economy must be modeled. Use of non-linear relationships also means more decisions must be made about functional form and choice of parameter values. In practice, while these choices are sometimes based on estimated relationships, they more often draw on the modeler's judgment and a stylized understanding of the economy being examined. This has been a major criticism of GEM models (Abler et al. 1999). Before deciding to embark on GEM analysis for some policy question, one needs to examine the scale of the economy. A product policy that changes the cost of a product by 10% will make no noticeable difference in the results from such a model. Only policies that are large-scale (millions of Euros) have a change of having effects larger than rounding errors. The investment, migration and trade equations that specify the closure of the economy to the rest of the world receive particular attention in GE models.

The advantages of GEM are:
- that it allows modeling of the relationships and feedback loops between the different changes introduced (because it uses assumptions of price elasticities).
- GEM allows for factor substitution in response to changes in relative price and can be used for long-run equilibrium.

The disadvantage are;
- that the empirical basis for this is complex and weak and that it is practically impossible to make the model transparent so that one can see what assumptions influence the results in what way.
- GEM modeling requires considerably more effort to built or customize (but advantage is that it permits an almost unlimited amount of flexibility in structuring the analysis).

GEM can be used for:
- Ideal for ex post simulations and answering questions on whether a policy action causing a structural change (thus not a temporary event, but of more lasting nature) will be effective
- Mainly for large-scale policy actions / changes; for small changes the model is too generic
- simulating long-run adjustment

Currently ongoing and important work is the GEM-3 model (among others KUL in the consortium). For more information I refer to the website: http://www.gem-e3.net

As mentioned in the introduction of this chapter, IOA and GEM are complementary and it depends on the questions asked whether GEM or IO modeling is the best to provide the answer. If we discuss International trade and the responses to International legislation (such as CO2 quotas) GEM is likely to provide more correct results, but if we discuss small and local changes IO models will be adequate and much more transparent and thus less prone to (political) manipulation and controversy. In any case, IOA and GEM are closely related models and *the IO matrices are also the underlying basis of any GE model.*

2. Flemish eIOA model requirements

2.1 System definitions and indicators

The resulting output of the Flemish Input-Output model will be indicators for reporting under MIRA-T. These indicators have to reflect the impact of material flows that are the result of production and consumption processes in Flanders. Besides the direct impacts caused by processes in Flanders, also the indirect or worldwide impacts of production and consumption in Flanders have to be indicated.

In this chapter, we define in more detail the system that will have to be examined in order to calculate the direct and indirect impacts of material flows in Flanders. In 2000, Eurostat published a methodological guide to conduct Material Flow Accounting for national economies (Eurostat, 2000). This guide treats definitions, system boundaries, relations with other types of accounts such as the Input-Output Tables, and indicators that can be composed out of the Material Flow Account such as the TMR, Total Material Requirement, the DPO, the Domestic Processed Outputs, etcetera. According to this methodological framework, indicators are already constructed and reported in MIRA-T. From the existing Eurostat model, we developed three more specific system descriptions that approach the problem of environmental impacts of material flows in an economic region (~i.e. Flanders) from different perspectives. These approaches are:

- Regional approach
- Functional approach
- Dematerialisation approach

2.1.1 Regional approach

The regional approach takes the geographic area of Flanders as the starting point. The impacts considered cover the environmental impacts that occur within Flanders. Environmental impacts that occur outside the country, such as cradle effect of imports and grave effects of the exports, are excluded.

The main advantage of this approach is that it accounts for the environmental impacts caused by environmental interventions taking place within the region, and therefore can be easily related to the Flemish environmental policy. However, the materials life cycles rarely are limited to the regional boundaries. By ignoring the cradle- and grave-effects in other countries, one would underestimate the impact that Flanders is having on the environment if it imports materials that have a particularly damaging extraction and production phase, or export materials that have a very damaging use and disposal phase.

A schematic system, corresponding to the regional approach, is presented below:

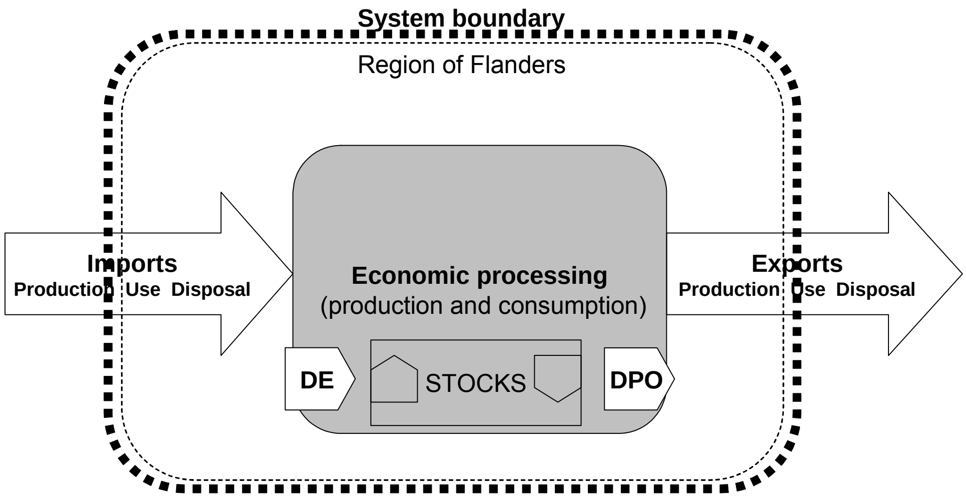

Figure 1 : Imports + Local Production + Exports – $\text{Imports}_{\text{production}}$ –$\text{Exports}_{\text{Use, Disposal}}$

DE and DPO are Domestic extractions and Domestic Processed Outputs (being emissions and landfill of final waste) (Eurostat, 2000). The thin dotted line represent the Flemish region, the thick dotted line represents the system boundary. The above depicted system scope thus not include: the 'cradle' impacts of imported materials of products (mining, processing steps prior to processing in Flanders); the impacts of export goods, except their production processing in Flanders. This scope best reflects sectoral impacts and impacts from the use and disposal of final products (including services) by households and governments.

2.1.2 Functional approach

The second possibility is to take a functional approach to measuring the environmental impact of Flanders. Starting point are the impacts caused by final expenditures, or in other words product purchases (including services) by Flemish households and governments in order to satisfy consumptive needs and functions (food, housing, healthcare, mobility, communication, leisure…). Determinants for these impacts are the amount of purchases, product selection, product use and disposal patterns, etcetera. Note that expenditures for materials, products, investments in fixed capital etcetera by sectors are not included in this perspective. These are however considered as process inputs and are taken into account for the environmental impact calculation; at least for the part that is required for the production of these final products (outputs from sectors as inputs to other sectors, after consequent processing steps resulting in final products for Flemish households, governments). This system definition is similar to this from i.e. the Ecological Footprint system, or the system definitions used for Integrated Product Policy, IPP-studies (i.e., see EIPRO study in chapter 3).

This approach enables to see, in a way, the total global impact of Flemish consumption. On the other side it masks the local impacts of exports. A schematic system belonging to the functional approach is presented below:

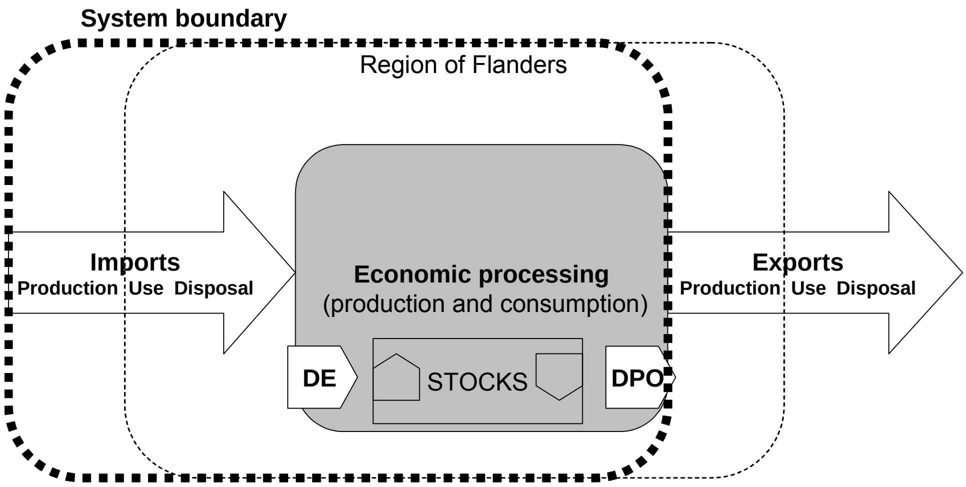

Figure 2 : Consumption = Imports + Local Production - Exports

2.1.3 Suggested Dematerialisation Approach and resulting indicators

Besides the above approaches, and using the components of material flow accounting, various other system boundaries can be defined. While the regional approach is best appropriate for sectoral indicators and the functional approach for indicators on integrated product policy, strategies regarding production & consumption, ecological footprint, etcetera, these are not necessarily best applicable for strategies regarding dematerialisation and resources use. The basic concept of dematerialisation and the strategy on resources use is that the economy (of Flanders) should reduce its use of resources and reduce the impacts related to this resources use without compromising future economic growth, welfare, world trade. In this sense, the regional approach is too limited since it only copes with local impacts. Also the functional approach is too limited since it does not take into account the local impacts of product (processes) that are exported.

For the system boundary in the framework of a Flemish resources policy, we recommend the following 2 approaches, presented below:

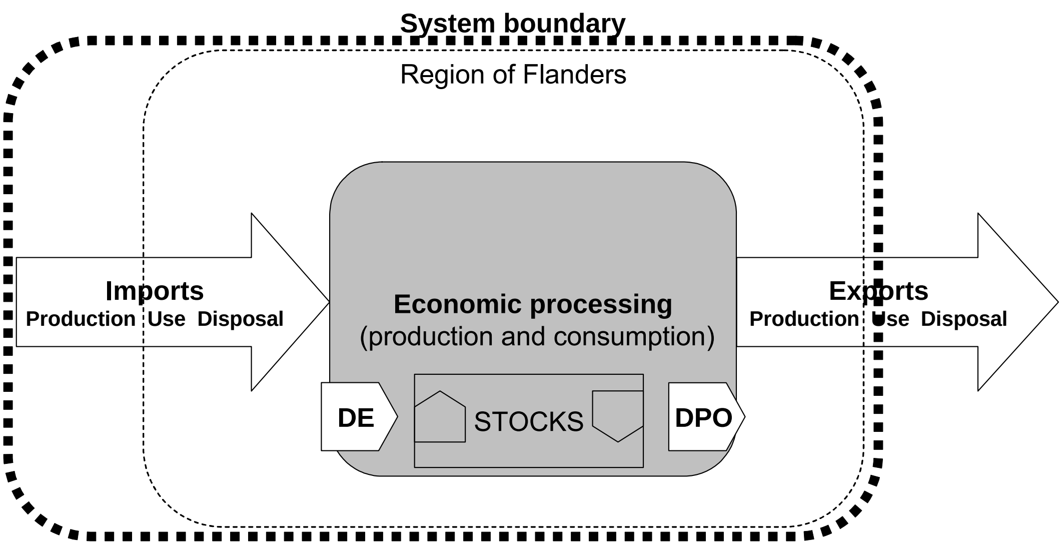

Figure 3 : Alternative 1 = Imports + Local Production + Exports - –Exports $_{\text{Use, Disposal}}$

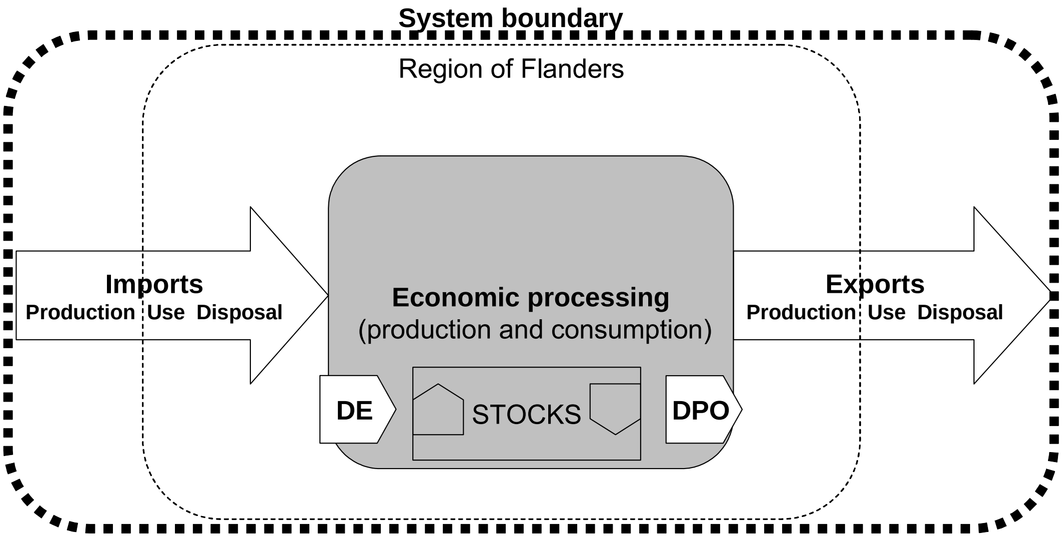

Figure 4: Alternative 2 = Imports + Local Production + Exports

To cover all worldwide impacts caused by material uses in Flanders, alternative 2 would logically cover best this principle. There are however two basic arguments to decrease this system boundary to a more modest and more feasible one (alternative 1):

1. First of all, Flanders (policy or sectors) cannot be held responsible for the way products are being marketed, used, or disposed off in trade partner countries. No measures on this can be proposed since they potentially cause trade barriers and endanger the market position of local sectors, i.e. the export of very low energy-efficient products cannot be restricted even if EU, national, Flemish legislation would prohibit bringing it on the market locally.
2. The second basic reason is of more practical nature: data on how materials and products are used, disposed off in all these foreign countries is impossible to retrieve. For the impacts of imported materials, products, the same argument is true but in much less extent. “Cradle to gate” LCIA (Life Cycle Inventory, Life Cycle Assessment) data; this is from mining processes up to where the material or product leaves the company are better available compared to these “gate to grave” data i.e. various sector organisations compile such data, generate EU-averages, and make these available for researchers. Examples are the APME (Association of Plastic Manufacturers Europe), The Copper Institute, the International Iron and Steel Institute (IISI), etcetera. For the U.S. an eIOT, or input-output table extended with environmental data is available (the so-called U.S. CEDA database), and quite recently, from this U.S. CEDA an EU25-CEDA has been derived in the EIPRO study (see chapter 3). Also for other big economies such as Japan, such eIOTs are available. In other words, for worldwide impacts relating to “cradle to gate” impacts there is no problem, but “gate to grave” is considered not feasible due to lack of structural data availability.

As result, the following indicators result from the model (system boundary, alternative 2):

- Impact(1 to x), Sector(1 to n), domestic < this is for local consumption and export
- Impact(1 to x), Sector(1 to n), import < this is for local consumption and production
- Impact(1 to x), Consumption(1 to q), domestic < this is for local consumption and production
- Impact(1 to x), Disposal(1 to z), domestic < this is for local consumption and production

“1 to x”, “1 to n”, “1 to z”… indicate the resolution or level of detail at which these resulting indicators should be distinguished (number of impact categories considered, number of sectors, number of consumption categories…). This discussion is part of the following chapters on functional requirements and is also mainly determined by data availability (chapter 4).

2.1.4 Other important considerations

For better understanding of the indicators resulting from the model, here are some substantial explanatory notes to consider:

1. The indicators reflect a regionally and temporary situation, e.g. the impacts caused by product consumption by Flanders residents in 2005.
2. However, the impacts caused by these products reflect a non-time-and-location specific life cycle approach, i.e. the mining and production impacts caused by mobile phones sold in 2005 actually happen year(s) before, the use and disposal impacts the actual and consequent years after date of purchase.
3. The model cannot give "real" impacts, but only indicators on "potential" impacts, because the actual impacts depend on many variables such as exposure, and sensitivity of the receiving environment (ecosystems, humans etc.) in the area affected. An example is the emission of CFC gases, which causes a depletion of the ozone layer in the stratosphere (this is a so-called 'mid-point' indicator), which results in increased levels of radiation (also 'mid-point') that eventually cause a certain number of people to die from skin cancer ('end-point' indicators) depending on exposure and sensitivity on receiving environment (dark versus light skin color, amount of sun block etc.). In relation to 'mid-' or 'end-point' indicators, it is worth to note that the effectiveness of communication of messages is higher when using 'end-point' indicators. However, the level of uncertainty is lower with 'mid-point' indicators.
4. To be in line with the system boundary of economic input-output tables, all indicators should reflect the "residential" scope and not the "geographical" scope. This means that Flemish economic activities include all those of Flemish residents, whether they actually perform these activities locally or abroad (i.e. tourism, transport outside region of Flanders). On the opposite, activities of non-Flemish residents are not accounted for in this system boundary (activities of foreign tourists, foreign transit traffic in Flanders…). These indicators can be presented as "per capita" principle. It is often difficult to draw an exact line of residential versus geographical impacts i.e. foreign companies or foreign residents domiciled in Flanders are most logically still accounted for. Mostly for passenger- and goods- 'transport' and 'tourism' this should be considered.

2.2 Functional Requirements of the Flemish e-IOA and e-IOT

Met opmaak: opsommingstekens en nummering

The following sections present technical and functional specifications for the development of the model and of the complementing database. Such specifications contain both minimum and optional requirements. The starting point for the setting of these requirements was asking potential policy users what they want the model to be able to support. Subsequently the model should be developed as according to these 'desires' (instead of developing a model first and then telling users what it can and cannot do). During the first steering committee of the project, several options were discussed and some clear preferences were given on what the essential requirements are.

Aim of this feasibility study is to trace the significant gaps in data availability and make justified suggestions towards future developments and research. As mentioned before, it must also be borne in mind that e-IOT and e-IOA standards are evolving and improving as regards to harmonization, data quality and accuracy. A progressive release of methodology and data updates, mainly from Eurostat, can be expected. For Flanders, this leaves several options with regard to the development of its own model and dataset:

- *"Take initiative towards standardization"* is the most ambitious option by proposing and developing methods to fill in these data and knowledge gaps, likely in cooperation with other member state organizations (and Eurostat), and/or in the framework of existing European research programmes. This is however unlikely given the strong existing network of e-IO researchers being pulled by leading countries such as the Netherlands and Denmark.

- *"Develop specific approach"* (for Flanders, or combined effort with federal authorities) is a valid option for aspects where Eurostat (or other) is not likely to produce a harmonized approach or for aspects where no initiative at all is taken at EU level. It is not advisable to produce an own highly-accurate system for certain aspects of IOA where it is likely that harmonization will eventually take place.
- *"Await standard"* (Eurostat, or other) is the most plausible option when the aim is to make a Flemish IOT and IOA operational in the mid-long term. Inherent to this option is the development of a *"preliminary solution"* (methodology and datasets), based on best readily available sources and reasonable estimates / adaptations, required for proper functioning of the model. These can be used for the time being and when a standardized method becomes available, the model will be adapted. Easy database updatability and adaptability is therefore anyway a highly desirable functional requirement.
- *"Leave blank"* is the least desirable option, but could be the case for aspects unfeasible with regard to time and budgetary constraints, aspects not considered of immediate priority, or for aspects where a harmonized standard is expected to come out and for which preliminary solutions are not worth it or necessary. Of course, this is only true for components of the model that can be considered optional, and are not mandatory for its proper functioning.

In the chapters following this listing of functional requirements, the steps and options that can be undertaken to develop the model and database according to these functional requirements are elaborated in much more detail. In the tables listing the requirements, it are the table cells indicated in grey that require specific attention.

2.2.1 Database: e-IOT Flanders

Met opmaak: opsommingstekens en nummering

Description : a preliminary extended input-output database with geographical coverage Flanders. The objective for the database that should be achieved in the mid-long term is based on best readily-available sources and reasonable adaptations/assumptions to fill in the data gaps. As result of this, the model should be able to produce results that are at least qualitatively correct for most policy-relevant indicators.

Structure : the database should include the following separate matrices:

1. Core system (technology matrix, consumption vectors)
2. Partitioning matrices (classification conversions, allocation)
3. Economic inputs
4. Satellite accounts (Environmental Interventions)
5. Imports matrices

Specifications for core system (technology matrix, use matrix, disposal matrix and consumption vectors)

Met opmaak: opsommingstekens en nummering

Description : this is the kernel of the database, describing the monetary exchanges between sectors of the economy, including final consumption.

Feature ID	**Specifications**	**Suggested Action**
T1. Classification system / Lowest Level of Resolution (mandatory)	Proposal 1 : resolution of 60 sectors, according to the classification systems of the tables published by Federal Planning Bureau (consistent to Eurostat / ESA-95 framework) Proposal 2 (preferred) : 120 sectors CPA/PRODCOM classification or according to SUT, Supply Use Tables (as agreed on first working meeting)	Tables for BE available and published Tables for BE available (constructed by INR) but not published due to confidentiality. This availability is critical and without these data,

		constructing a 120-resolution table is not feasible.
T2. Classification system / Highest Level of Resolution (optional)	A high resolution classification; ideally 400-600 sectors-product groups. The selected classification system should be one compliant and highly relevant to the official national and EU statistics, such as CPA for products or NACE for sectors.	Await EU standardization [7]
T3. Age and reliability of data	Applies to the entire database, including satellite systems. An estimate of the age of all data to be utilized should be indicated in the database.	Available. IOT for Belgium is periodically updated (every 5 yrs).
T4. Flemish IOT	Development of Flemish IOT, based on best readily available data and justified assumptions. Option 1 (preferred): top-down approach where Belgian IOT is regionalized to cover Flanders Region according to a specific approach (this can be a combined federal-regional task, i.e. APS/INR) Option 2 : bottom-up approach where Flanders constructs its own IOT, based on retrievable economic and trade statistics for Flanders. This requires the setup of new/adapted statistical accounts.	Develop a specific approach for regionalizing Belgian IOT. Specific methods are available.
T5. Link to Belgian IOT (mandatory) Link to 'future' EU25 IOT (optional)	The Flemish IOT should be linked through a transparent and fully traceable (reversible) procedure to the series of 60 sector (NACE-CPA) input-output tables published by Federal Planning Bureau for Belgium and Eurostat in the ESA-95 framework.	Given that the Flemish IOT is derived by regionalizing the Belgian IOT (option 1, T4), the link remains.
T6. Use and Disposal Phase Extension	Use and disposal phase extensions are required for capturing the entire volume of impacts generated in the life-cycle of products. Note that these extensions are not relevant for all product categories (distinction not applicable to many services, many products devoid of significant use-phase related impacts). See satellite table specifications for required satellite environmental data on product use and disposal.	Develop specific approach. The demand for outputs from sector/product categories concerning production and distribution of electricity, gas, steam and tap water. The sector/product categories concerning sewage removal and waste treatment (incineration, landfill, recycling processes)
T7. Final Demand Consumption (mandatory)	Option 1 : Final Demand Consumption vectors, separately accounting for at least: -Household expenditure -Government expenditure	Option 1 vectors are available for BE IOT (INR). Regional data on household expenditure, government expenditure are available from national/regional accounts.

[7] A HREC (High Resolution European Classification) will be developed in the scope of a current ongoing European Project. The problem with lower aggregation levels in CPA or NACE are acknowledged gaps of data availability. For the HREC, a solution should be found on how to fill up these data gaps, i.e. by means of different, non-EU-specific classification systems.

	(vectors=totals per sector, 1 column) Option 2 (preferred): Final Demand Consumption matrices, accounting for at least: -Household expenses distributed over various consumptive needs (i.e. level 1 categories of COICOP) -Government expenses, similar to previous (i.e. level 1 categories of COFOG)	Option 2 matrices should be developed. These can be partly derived from detailed SUT-tables (available but not published due to confidentiality) and requires additional data retrieval from other statistics, inventories, scientific studies, … particularly for specific product categories such as cars: ‘transport for leisure’, ‘transport for traveling’, ‘transport for work’, etcetera. Also, a specific approach is required to disaggregate Belgian export statistics for Flanders (and particular approach for inter-regional trade flows[8]).
T8. Final Demand Export	Option 1 (mandatory): One export vector. Option 2 (optional, but preferred): Separate vectors for: -Exports to EU25, non-EU25, or -Exports to OECD, non-OECD	Export vector (option 1) for Flanders available from regional accounts. With regard to option 2, separate export vectors can be estimated based on BE export statistics.
T9. Fixed Capital Formation	Option 1 : One vector on fixed capital formation. Option 2 (preferred): since fixed capital is also a form of material required for the production of output materials / products (plant, machinery, vehicles, the value of land…); it should also be considered as an input for the impact assessment. For this purpose, an investment matrix should be constructed showing the supply-use relations between the sectors of fixed capital.	Capital Formation vector (option 1) for Flanders is available from regional accounts. Option 2 matrices should be developed. These can be partly derived from detailed SUT-tables (available but not published due to confidentiality) and requires additional data retrieval from other statistics, inventories, scientific studies, …

Specifications for partitioning matrices (classification conversions, allocation procedures)

Met opmaak: opsommingstekens en nummering

Description : the model brings together information from different classification systems:

- the ESA-95 60 sectors resolution table;
- the higher resolution products/sectors table (CPA, at a resolution of about 120 sectors, Supply Use Tables, at a resolution of 122 products);
- consumption vectors expressed according to different systems for different consumption entities (such as UNSD’s 1993 SNA classifications COICOP for household consumption, COFOG for government consumption, etc.)
- Satellite accounts on environmental interventions (mainly from VMM / MIRA reporting), are according to NACE classification, although for certain environmental interventions, they are often aggregated or adapted to non-standardized classifications. Additionally, conversion matrices (vectors) must be included because environmental statistics for Flanders are (mostly) reported according to the territorial principle (environmental impact on the territory by both Flemish and

[8] Difficulty when IOT Belgium is disaggregated to Regions is that trade between Regions is treated as (Belgian) domestic consumption.

foreigners), and not according to the resident principle (environmental impact in Flanders and abroad by Flemish residents) used in the national (regional) accounts.

The model should foresee in conversion (allocation) matrices between these different classifications utilized wherever necessary.

All procedures should be explicit and transparent in order to allow to carry out future updating and further refinement of the database (also taking into account the possible shortage of sufficient reliable data at present).

With regard to feasibility, this task is almost entirely a 'data retrieval' effort, presuming that this information is already available from national statistics organizations and existing e-IO studies (i.e. EIPRO), etc.

Feature ID	**Specifications**	**Suggested Position**
P1. High resolution level to ESA-95 conversion	The model should allow performing the analysis not only at high resolution level (preferred 120) but also at the level of the official ESA-95 60 sectors classification.	Available (at INR) for conversion of 120 SUT or NACEBEL to 60 ESA95.
P2. High resolution to UNSD conversion	This conversion is needed in order to link the input-output model to final demand expressed in UNSD's 1993 SNA classifications (COICOP, COFOG…)	The development of a SUT-COICOP conversion table is ongoing at INR.
P3. Producer to consumer prices conversion	Conversion from consumer to producer (basic) prices needed for consistency between the high resolution technology matrix expressed in basic prices and final demand expressed in consumer prices.	Available. The conversion is readily obtained through the economic input entries of the input-output table.
P4. COICOP aggregation	COICOP can be used to distinguish consumption needs from households (see T7, option 2). The COICOP classification is known at three levels of aggregation, with a resolution of 14, 58 and 156 categories. It is desirable that aggregation of results be implemented in the model.	Available. Suggestion: distinguish consumption needs only at the highest level (14 domains), and optionally at the second highest level of 58 categories.

<u>Specifications for economic inputs and satellite accounts</u>

Met opmaak: opsommingstekens en nummering

The required technical specifications concerning economic inputs and satellite accounts are summarized jointly in the following table:

Feature ID	**Specifications**	**Suggested Position**
S1. Economic Primary Inputs (mandatory)	This is strictly limited to inputs required for the proper functioning of the economic input-output table and depends on data availability. Other economic inputs are considered optional. Mandatory are the primary inputs (matrix Z in figure) already accounted	Primary inputs are available for Belgium (as constructed by FPB/INR) from national accounts and are also available from regional accounts for Flanders.

Met opmaak: opsommingstekens en nummering

	for in the ESA95 input-output tables.	
S2. Social and economic Satellite Accounts (optional)	The same remark as previous for economic inputs. • Employment (1000 persons) • Tourism accounts • …	Not mandatory and can be added later on for specific case studies.
S3. Environmental interventions (mandatory)	The environmental interventions matrix should be as detailed as feasible without losing data accuracy. At least the following aspects covered in MIRA-reporting, should also be covered in the environmental matrices: *Emissions to air:* The following MIRA-themes should be covered: • Greenhouse gas emissions • Acidifying emissions • Emissions of ozone forming substances • Eutrophicating emissions • Non-Methane Volatile Organic Compounds (NMVOC) • Persisting Organic Pollutants (POP) • Particulate Mattter (PM) • Ozone Depleting Substances (ODS) • Heavy metals *Emissions to water and soil:* The following MIRA-themes should be covered: • heavy metals • nutrients • pesticides • POPs • BOD and/or COD *Energy, water and land use:* The following MIRA-themes should be covered: • Water use (ground-, surface-,…) • Energy use (green vs. non-green, or renewable vs. non-renewable) • Land occupation and transformation *Waste and material flows* The following MIRA-themes should be covered: • Material use and consumption (including at least energy carriers, metal and non-metal ores, renewable resources) • Waste generation *Ionizing radiation* Which indicators should be used?	A specific approach should be developed for converting data from 'territorial' to 'resident' (per capita) scope. Practically, most work will be to convert these indicators from their existing classification to a harmonized sector/products classification for use in the eIOA (preferably 120 sectors NACEBEL of SUT). Besides this, the NACE-code under which environmental interventions are reported by industries to VMM are often not the same as the NACE-code under which they declare their economic entries (taxes, production volume, turnover, trade, etcetera should only be declared under the 'main' activity of that company. Also subsidiary companies declare under the main activity of the parent company). However, to link the data from the environmental satellite accounts to the monetary input-output tables, the NACE codes should correspond. A specific approach in statistical data collection should be foreseen to overcome this problem (i.e. for environmental reporting, ask for both NACE-codes when different).

	Impact assessment? The following environmental interventions are considered optional: • Physical hinder such as light pollution, noise, etc… • Further disaggregation of emission categories (POPs, NMVOCs, ODS etc…)	
S4. Data sources impacts (Flanders)	Ideally, this environmental interventions matrix should be based as much as possible on data that is directly linked to authoritative and regularly updated sources. This environmental interventions matrix is based on the Flemish statistical sources: • VMM, OVAM, … • Energy accounts	Generally available, but see remarks S3.
S5. Data sources imported impacts	This is required to estimate the 'imported' hidden impacts of resources and products used in Flanders. Environmental interventions associated with economic activities occurring outside Flanders are in principle different from domestic ones, both quantitatively (environmental standards, cost structures) and qualitatively (i.e. many mining activities take place in developing countries). Ideally, for each trade partner specified separately in the model, a different environmental interventions matrix should be used. However, since these are non-existent and data collection would be sheer drudgery, a more generic approach with (estimated) 'global' averages should be pursued. The principle is that the regional scope of this datasource should be as 'global' and as representative as possible for the entire diversity of resources extraction and processing activities that exist. In other words, the bigger the regional scope of this datasource, the better (i.e. OECD, EU, US…).	Await EU-based database. For now use preliminary tables for imported impacts. Currently, EU-based environmental matrices are being set up, based on data sources, such as: • The European Pollutant Emission Register (EPER) and the proposed UN-ECE Protocol compliant European Pollutant Release and Transfer Register (PRTR) • The CO-oRdinated INformation on the Environment in the European Community (CORINE) including the CORINE land cover database NATure/LANd (NATLAN) and CORINAIR • The IPCC National Greenhouse Gas Inventories Programme (IPCC-NGGIP) and the Emission Factor Database therein (EFDB) • The Long-Range Transboundary Air Pollution protocol and the EMEP database • The Emission Database for Global Atmospheric Research (EDGAR), RIVM-MNP Bilthoven (NL), TNO-MEP Apeldoorn (NL), JRC-IES Ispra (IT) and MPIC-AC Mainz (D) • The Eurostat Waste Database In the EIPRO-project, preliminary tables have been composed for EU25, based on and adapted from

		the American CEDA-data tables. More highly accurate and representative EU-tables are currently being developed, but are only expected to be published in at least 5 years from now.
S6. Number of supported regions	In addition to the previous requirement, ideally, at least 2 distinctive 'generic' foreign environmental interventions matrices should be available and used; one representing the developed countries (OECD) and one representing the developing countries (non-OECD).	Leave blank, but foresee in model. This differentiation is difficult to make (now) since this data does not exist. Feasibility is doubtful and large effort is anyway required to make such distinction. Given that it is not a high priority for this project, the calculation model should foresee such differentiated tables, but for now the developed- and developing countries environmental matrices are assumed identical (=preliminary 'generic' EU data). Once these knowledge and data become available, these tables can be updated.
S7. Compatibility of environmental interventions	As much as possible, emission factors and all other environmental interventions indicators should be based on data specific to the considered regions. Also, comparability requires that the list of environmental interventions considered for imports matches with that for Flanders; fulfilling this condition is expected to require further estimation.	Where this data is not available, or the used impact indicators do not match: leave blank and report results only on direct impacts in Flanders (not taking imported impact-share into account).
S8. Compatibility IOTs	The trade partner IOT should be compatible with the one used at a certain aggregation level of the domestic (Flanders) IOT. It should generally be at least according to the ESA-95 60 sectors resolution and preferably at 120 sectors resolution.	A conversion table needs to be developed, i.e. 550 US CEDA categories (taken for imported impacts) to SUT or NACEBEL 120 categories.

Met opmaak: opsommingstekens en nummering

2.2.2 Model: e-IOA Flanders

Met opmaak: opsommingstekens en nummering

We can already set some essential requirements that we desire the final calculation model to meet. Calculation software is available commercially (e.g. SimaPro). The user interfaces are for experts only. Simpler interfaces can be developed on top of this commercial software. All issues that need 'to be developed' can be split up in mandatory and optional requirements. A listing of these is given in the following table.

Feature ID	**Specifications**	**Suggested Position**
M1. Adaptable and updatable	A flexible model that should allow to incorporate future refinements in the database and to accommodate future and evolving application needs. All data should be easily adaptable following straightforward and well-documented	Mandatory

	procedures. Data adaptability should also be understood as ease of construction of sub-variants and scenarios for analysis of technology and policy change.	
M2. Programming (language, computational capacity	Given the large number of matrix operations, and the ability to perform all needed computational functions on large matrices, Matlab would for instance be considered suitable.	Mandatory
M3. Accessibility of code	The source code must be readily available, to allow for the program to be modified at will.	Mandatory
M4. Simple interfacing	The software should feature simple interfacing with at least Microsoft Excel.	Mandatory
M5. Basic Analytical Tools	The calculation routines must be based on the matrix inversion method; the software must allow • Calculating direct and indirect effects resolved by sector/product and by environmental intervention • Calculating type I multipliers Calculation routines (using information on physical and monetary input/output flows) for • Indicators for resource efficiency, eco-efficiency and decoupling of resource use and environmental pressures • MFA-based input and output indicators • Equivalents (residential calculation) of environmental impact potential indicators used in MIRA-T	Mandatory
M6. Additional Analytical Tools	It is desirable that the software support: • Aggregating/disaggregating results • Possibility to operate closure with respect to households and calculation of type II multipliers • Dynamic (time series) analysis; with: o Decoupling indicators; o Structural decomposition	Optional
M7. Impact Assessment (IA)	Impact assessment methods should be widely used and accepted, comprising at least the categories Global Warming Potential, Acidification Potentials, Ozone Layer Depletion Potentials, Photochemical Oxidation Potentials and Eutrophication Potentials. Optionally, other impact assessment methods such as abiotic depletion potentials, human toxicity potentials, eco-toxicity potentials etcetera can be foreseen later on in the model.	Mandatory
M8. Uncertainty and Sensitivity	It should be possible to give uncertainty and probability intervals for all relevant	Mandatory

Analysis	input parameters. It should be possible to perform sensitivity analysis to ascertain how given model outputs depend upon the input parameters, to check the quality of the model and the robustness and reliability of results.	

3. Study of studies

In trying to catch up with state-of-the-art in environmental input-output analysis (eIOA) and examining how particular problems are dealt with in ‘total life cycle’ eIOA, two international projects were reviewed. First a Danish eIOA project commissioned by the Danish Environmental Protection Agency was studied: “Prioritisation within integrated product policy” (Weidema et al. 2005), later referred to as “Danish study”. Second two European projects financed by the European Commission’s Institute of Prospective Technological Studies (IPTS) of the DG Joint Research Centre (JRC) were studied: “Environmental Impact of the Use of Natural Resources” (IPTS/ESTO, 2004) and “Evaluation of the Environmental Impact of Products” (IPTS/ESTO, 2006). Later referred to as “EIRES” and “EIPRO”.

3.1 Danish study

3.1.1 Main objectives

The main objective of this project was to establish a method for prioritising product areas/groups concerning environmental improvement measures. Besides the assessment of the environmental impact of Danish production and consumption, the project also provided some further analysis. Prioritised product groups were analysed in search of new product groups for environmental labelling. Four product groups (agriculture/foods, electronics, retail trade and textiles) were analysed in greater detail. Resource and waste flows were also calculated for all product groups. Furthermore the database of the project is developed in such manner that its applicability as a Danish reference-database for life cycle assessment is possible.

3.1.2 Main conclusions

Environmental measures should first target food, housing, ships and electricity. For the Danish industry food, housing, transport by ship and electricity are the areas with the highest (direct and indirect) environmental impacts. For the Danish private consumption priority areas are housing, food, tourism, clothes, personal hygiene and car driving. Public consumption generally has less impact on the environment than private consumption.

3.1.3 Short method description

The expanded NAMEA method is based on a combination of environmental statistics and the Danish national accounts of the economic flows between Danish enterprises and institutions, imports and exports, and of supply to final consumptions. The traditional eIOA-method is used (see chapter 1). To include use phase emissions the transaction matrix of the Danish monetary IOT is supplemented with consumption services. For validation purposes the matrix calculation was performed in parallel in three different programmes (MatLab, SimaPro and Analytica).
The environmental statistics are adjusted to the same level of detail as the industries and product groups of the national accounts. The fact that this method is based on detailed commodity statistics and local environmental statistics is a big difference with the later discussed EIPRO method, which is produced by forcing the American NAMEA matrix on the EU-25 overall production, consumption and emissions vectors.
In the Danish study the American NAMEA was used to estimate indirect flows and emissions associated with imports. This is a second big difference with the EIPRO-study, which does not account for imports and exports, assuming the EU25 is a closed economy where imports are more or less cancelled out by the exports. In the calculation routine of the Danish study imports and exports are separate matrices linked to the transactions matrix (in effect an expansion of the transaction matrix).
In standard IOA, the supply and use of industries are assumed to be in a fixed relation to each other. Such a calculation is not “market-based” however. In reality not all industries will be able to change their supply chain in the same proportion to the demand. The expanded NAMEA has been adapted to account for constrained industries to allow more realistic modelling. Thus the Danish model is

available both as a traditional, attributional matrix and a market-adjusted, consequential version more suitable for policy support.
In a first step prioritisation was done based on the impact intensity (environmental impacts per DKK) of the product groups. Only in a second step considerations on the size of the environmental impacts of the product groups were included.
The data tables largely follow EU statistical classification of activities and products (NACE, CPA and PRODCOM).

3.1.4 System definition

The system components are the Danish economy and the foreign trade partner economy. Both are embedded in the natural environment. Financial exchanges between the different components of the economies and specific environmental exchanges between economy and nature are considered. Only activities and environmental exchanges that are life-cycle related to production or consumption activities of Danish residents are considered.
The environmental impacts were analysed from different perspectives. The first one is the supply or net production perspective. In this perspective only the net supply of products for final consumption or export, produced by Danish enterprises or institutions is considered. This is a cradle-to-gate perspective. The second one is the use or consumption perspective. In this perspective private and public consumption in Denmark, of both domestically produced or imported products, are considered. This is a cradle-to-grave perspective. The last one is the process perspective. Here processes in both Danish and foreign production and in Danish households, caused by Danish consumption or export are considered. This is a gate-to-gate perspective for Danish processes and a cradle-to-gate perspective for the foreign supply-chain. Impacts caused abroad by foreign consumption of products produced in Denmark are excluded.
The Danish economic supply is divided in intermediate production and final use. In conventional IO-tables investments in capital goods and financial intermediation services indirectly measured (FISIM) are included in final use. To be able to link these investments and this FISIM expenditure as inputs to other items of final use, they were respectively redistributed as inputs to the industries supplying the investment goods and to the financial industries supplying the loans. New household consumption services are defined as an ‘intermediate consumption’ category to include use phase emissions. Exogenous emissions to the natural environment are endogenised (compared to the Danish national account system).

3.1.5 Choice and detail of product- and material groupings

The Danish national accounts are divided in 130 product groups and 107 categories of final use.
The classification of the Danish production follows EU statistical classification of activities and products (NACE, CPA and PRODCOM). Modifications have been made in order to target product groups which were assessed as regulatory meaningful:

- “Steam and hot water” and “Electricity” were aggregated,
- “Agriculture” and “Horticulture” were disaggregated into 28 different farm types,
- “Textile industry” was disaggregated
- The meat industry was disaggregated into three industries (Pork, Beef and Chicken),
- “Manufacture of starch, chocolate and cocoa products” was disaggregated into nine industries,
- “Manufacture of industrial cooling equipment” was split out of “Manufacture of other general purpose machinery”

This added up to a total of 197 different products and services that were analysed (annex B).

The consumption part is composed of private consumption and government consumption (Annex B). Private household functions were defined by rearranging product groups of final consumption in relation to the functions of the products in their use in the households:

- major household appliances (and their repair) were disaggregated into groups of household activities (Cooking, Personal hygiene,...). The items of “Appliances, articles and products of personal care” and “Toilet paper” were allocated to the new household activities.
- “Purchase of vehicles”, “Repair and maintenance of motor vehicles” and “Fuels and lubricants” were regrouped according to the purpose of trip (work, shopping or leisure). “Car driving for

holiday abroad" was disaggregated from "Consumption of residents in the ROW" and the emissions added.
- "Detergents, prepared for use" and "Candles" were split out of "Non-durable household goods".
- "Toys", "Pet food and veterinarian services", Christmas trees", "tools and equipment for recreation" "household textiles" and "fireworks" were split out of "Other recreational items and equipment".

For the classification of the Danish consumption, final uses for which the distinction does not have environmental relevance were aggregated:
- Two types of out-patient services by medical doctors and dentists (market and non-market government consumption)
- "Recreational and cultural services" and "Recreational, Cultural and religious affairs and services"
- "Education" and "Education and Research Affairs and services"

The groups of final consumption were also grouped according to product functions, relating to the satisfaction of human needs. Ten big basic need groups were defined by aggregating the products and services for consumption: housing, food, leisure, social care, education, health care, security, communication, clothing and hygiene.

3.1.6 Environmental impact assessment

Impact potentials instead of real impacts are measured. All applied characterisation factors are site-generic. For impact assessment the Danish EDIP-method for the external environment (Wenzel et al. 1997) was applied.

Inventory at substances-, emissions levels

All exchanges that contribute significantly (more than 1.5%) to the EDIP impact categories in the updated EDIP normalisation reference for Denmark for 1994 (Stranddorf et al. 2001) were included. The EDIP normalisation data do however not cover all toxic substances. The toxic release data from the U.S. Toxic Release Inventory (TRI 1998) was used to check the completeness of the environmental exchanges that were accounted for. The TRI 1998 data was scored using available EDIP characterisation factors to check for important substances, additional to these already covered.

Characterization

The project aimed at including all substances that contribute significantly to the environmental impacts that are normally included in product life cycle assessments: global warming, ozone depletion, acidification, nutrient enrichment, photochemical ozone formation, ecotoxicity, human toxicity and nature occupation. The used Danish EDIP-method for the external environment had to be supplemented with an impact category for nature occupation (focused on biodiversity impacts).
Not covered issues are species dispersal, poverty-related health issues, accidents, occupational health and noise. The EDIP characterisation factors were compared with factors of other LCA-methodologies (i.e. SimaPro) during the project and some were updated (i.e. photochemical ozone formation). All toxicity factors were updated with the most recent information available (Olsen 2003).

Normalisation

The impact scores for each product are expressed (normalised) as share in the Danish totals. A Danish normalisation reference for 1999 relating to the total environmental impact caused by Danish production and consumption was produced and applied for this purpose.

Weighting

The subcategories of the categories ecotoxicity and human toxicity are aggregated into one, based on their normalised values. Each of the subcategories receive equal weight within the overal categories ecotoxicity and human toxicity. The eight impact categories in their turn have also been weighted equally based on their normalised totals. Thus each category contributes with 1/8 to the reported total environmental impact of Danish production and consumption. The results are also reported per impact category and not just as weighted results.

3.1.7 Data requirements

The following detailed table gives an overview of the data that was required for setting up the IOT (data inputs) and the model used in the Danish study. In the last column, this data availability for Flanders is indicated.

Table 1 : data requirements Danish Study and availability in Flanders Accounts

Monetary supply-use tables (SUT)	The monetary SUT from the Danish national accounts were used for disaggregation of product groups and for distribution of emissions over industries.	Available for Belgium (but not public) Not available for Flanders
Monetary input-output tables (IOT)	The Danish IOT provided by Statistics Denmark are based on reports on bought and sold products received from the individual industries. The full IOT for Denmark is published every year and has 130 industries and 107 types of final use.	Belgian IOT is published every 5 years at a resolution of 60 sectors (is available in the 122 SUT format, but not published) Not available for Flanders.
Investment matrices	The Danish investment matrices of Statistics Denmark were used to redistribute the investments (which is a ‘final use’ category in a traditional IOT) as inputs to the industries supplying the investment goods. This way investments can be linked to other final use categories. The Danish investment matrices provide investment data aggregated on 57 supplying industries. These were further disaggregated to the level of the 130 industries in the IO-table.	This data (redistribution investment matrices) is not available for Belgium, nor Flanders. They are not part of national or regional accounts.
National NAMEA	The extended NAMEA was based on the Danish NAMEA for the year 1999 for specific air emissions.	NAMEA for air emissions was calculated for Flanders in the context of the production of such NAMEA for Belgium.
NAMEA’s for imports	The NAMEA for the USA (Suh 2003) was used for estimating the “cradle-to-wholesale” emissions of imports. Other NAMEA’s were used for estimating the coefficients of variance of IO-data and foreign emission data (for the uncertainty assessment).	Available (if identical approach pursued for Flanders)
Energy matrices	The Danish energy matrices are provided by Statistics Denmark in physical and monetary units. The physical flows were used to map the energetic relation between industries.	NAMEA for energy use was calculated for Flanders in the context of the production of such NAMEA for Belgium.
Tourism expenditure	Tourism Satellite Accounts (TSA) are used to estimate the expenditure of residents travelling abroad (tourism imports) and tourists (tourism exports). There exist no Danish TSA, so general assumptions on how tourism expenditure is distributed over industries had to be made. First a distribution over the general groups was estimated based on TSA’s from Australia, Canada, Norway and USA. Further distribution over the supplying	No tourism accounts are available for Flanders or Belgium (that contain data on how to distribute expenditure over sectors).

	industries was made in the same proportion as in the Danish private consumption or Danish imports.	
Industry foreign expenditure	The US-American Water transport expenditures were used (proportionally) as an estimation of the unclassified expenses of Danish ships abroad.	Not available for Flanders? The same approach/sources can be used.
Data sources for the domestic environmental exchanges	Emissions included in the extended NAMEA were estimated using a variety of sources. The most important emissions to air (CO2, SO2, Nox, NH3, NMVOC, CO, CH4, N2O) were reported in the official Danish NAMEA. Some sources of emissions that were not allocated (i.e. some solvents) in the official Danish NAMEA were distributed based on own estimations, general CORINAIR emission factors, available specific Danish studies (Illerup et al., 2002) and mass flow analysis based on the Danish SUT. Other emissions: • emissions to air of PAK's and heavy metals for the year 1998 (Pedersen 2003) • emissions of methane, nitrogen and phosphorous for Danish agriculture (Dalgaard & Halberg 2004) • Point sources of N and P (Laursen et al. 2000, Wrisberg et al. 2000) • Mass Flow Analyses of cadmium (Drivsholm et al. 2000), mercury (Skarup et al. 2003), zinc (Stranddorf et al. 2001, Hansen 1995b), lead (Lassen et al. 2003), copper (Lassen et al. 1996) and tributyltinoxyde (TBTO) (Lassen et al. 1997) for estimation of emissions to water. • Emissions of HCFC's for the year 1999 (Poulson 2001) • PM10 emissions for the year 2000 (NERI 2003) • Emissions of active ingredient of pesticides applied (DEPA 2000) A few additions or corrections for emissions in the use phase had to be made: • combustion of vehicle fuels for gardening (Bak et al. 2003) • car driving for holiday abroad was estimated based on the emissions from Danish private car driving • emission data of minor sources that were not covered by Statistic Denmark or NERI (i.e.fireworks) were drawn from a Dutch research project (Goedkoop et al. 2003) • Private consumption of water, gas,.. and associated emissions were distributed over the new household activities (Dall et al. 2002). For resource extraction; Statistics Denmark delivered statistics concerning energy, resource extraction and agricultural production. Material density conversion factors as applied in the calculation of material flow accounts by Statistics Denmark were used (Pedersen 2002). Waste statistics for the year 2000 were delivered by the Danish Environment Protection Agency (DEPA 2002). These were used to correct the information provided in a later study (Dall et al. 2003), where deposited waste is specified for 27 material groups. Land use (Dalgaard & Halberg 2004, NERI-AIS/Madsen 2003)	Data availability on regional (Flemish) environmental exchanges discussed in detail, chapter 5.

Investigation on transport habits	Transport related final use was regrouped according to the purpose of trip based on the Danish investigation on transport habits (Bach et al. 2002)	Studies / statistics on transport generally available, also on transport habits.

3.1.8 Handling of foreign impacts

The foreign upstream environmental impacts associated with imports are accounted for in the Danish study. For most foreign industries emission factors (environmental exchanges per monetary unit) for the USA were used. These were obtained from the US NAMEA (Suh 2003). The US tables have a very low level of aggregation (493 industries), include a high number of emissions and are relatively complete in terms of industries covered. Because the biggest part of Danish imports come from European countries, the emission factors were adjusted. For this purpose, the US emission factors were compared to the emission factors of the closest corresponding Danish industries (this is called a 'minimum-procedure', but better would be to compare with different EU countries). The US NAMEA with adjusted emission factors was then used to calculate the "cradle-to-wholesale" emissions per product from each industry. Later the resulting 493 products were aggregated to the industry levels of the Danish NAMEA.
For estimating foreign resource extraction a similar procedure was used. The US NAMEA was supplemented with resource extraction data based on the USGS data (USGS 2001) and FAOSTAT data. This resulted in resource consumption intensities for each imported product group.

3.1.9 Calculated indicators

The calculated environmental impacts per DKK can be used as a decoupling (welfare from environmental impact) indicator. Environmental impact potential indicators can be calculated for the included environmental impacts (global warming, ozone depletion, acidification, nutrient enrichment, photochemical ozone formation, ecotoxicity, human toxicity and nature occupation). The indicators depend on the selected view (consumption, production or process) and on the selected grouping (product grouping, functional grouping or total economy).
Besides the environmental impact indicators Material Flow Account (MFA) indicators were calculated: Total Material Requirement (TMR). Contrary to traditional MFA-indicators, complete "indirect flows" (compared to the traditionally calculated "hidden flows") associated with imports were calculated. Also the contribution of product groups to the amount of deposited and hazardous waste in Denmark is estimated.

3.1.10 Uncertainty and robustness of the results

Uncertainty can be arising from the used model (structure and parameters) and from the inserted empirical data. Only the data uncertainty of the extended NAMEA was analysed in a quantitative uncertainty assessment. The uncertainty of the main model inputs is estimated (coefficients of variance) and propagated to the results using a probabilistic simulation analysis. The uncertainties on the output results are presented as coefficients of variance and as graphical plots with confidence intervals. The prioritisation results are provided with 95%-confidence intervals. The conclusion is that the difference between product groups are so large that their position in the prioritisation is rather stable.
Two of the main sources of uncertainties in economic input-output data (aggregation and allocation error, geographical coverage) and uncertainties of the emission data (final use excluded) were quantified in a probabilistic uncertainty analysis. The IO-data sources are considered in detail because of the often appearing choice between the use of highly aggregated geographically relevant data and less aggregated data of another region. The conclusion is that it appears preferable to use a foreign table with a low level of aggregation rather than using a more geographically relevant data at a high level of aggregation (see figure below).

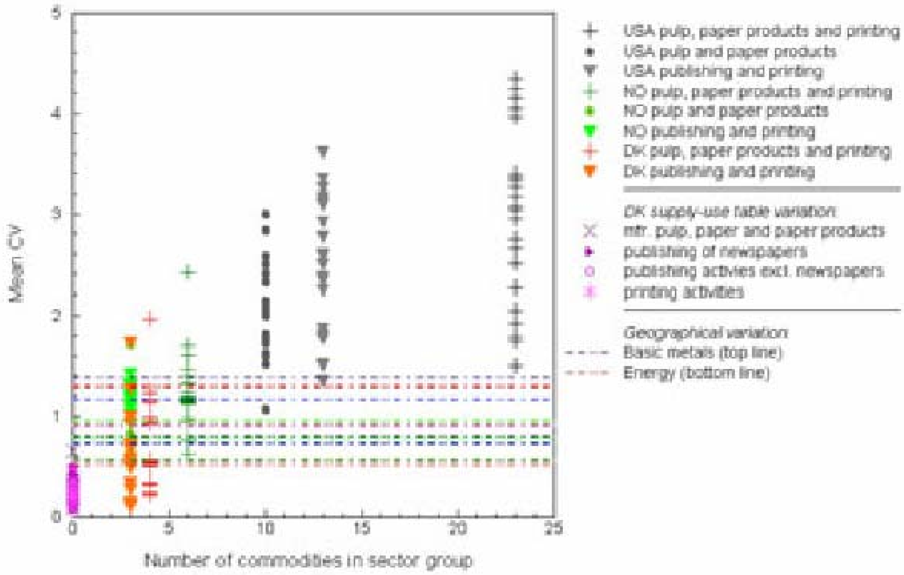

Figure from Weidema et al. (2005)*: Coefficient of variance (CV) within industry groups as a function of the aggregation level, with the geographical variation superimposed as horizontal lines, showing highest variation for Basic metals and lowest variation for Energy inputs.*

The analysis does not include uncertainty of characterisation parameters for the impact assessment, uncertainty due to the age of the data or uncertainty for the final use data and emissions.
The coefficients of variance of the results were calculated with the Analytica software, using a probabilistic simulation with Median Latin Hypercube sampling (sampling size 200) of the input distributions.

3.1.11 Scalability to Flemish situation

In principle the method can be perfectly used for the Flemish situation. It also meets the minimum requirements posed to the Flemish model, as generally agreed upon by the user committee of this project. All depends on the availability of the necessary data (see chapter 2). The biggest drawback for the set up of Flemish environmental IOTs is the lack of Flemish monetary input-output tables (IOT). This is essential for the production of environmental IOTs for Flanders. In chapter 5, an approach is proposed to set up such a Flemish IOT.

A Flanders prototype version could be constructed in the following way:

- take the Belgian 120x120 intermediary products table in NACE or SUT format (with possible changes to adjust it to Flemish situation),
- add consumption processes using Danish emission coefficients (assuming these are not available for Belgium or Flanders),
- add those emissions for which you have data for the same 120 sectors (or distribute over the 120 by using the turnover or energy input if the emission data are more aggregated),
- add missing emission coefficients from the Danish data,
- link imports to the same foreign data as used for Denmark,
- import all into the software “SimaPro” for presentation purposes,
- provide a list of things that need to be checked and/or improved for a full model.

3.1.12 Estimation of budget for setting up Flemish eIOT, using the Danish model as a start

Total costs of the Danish project was 270.000 EUR. Re-using some of the methodology, about half of that amount can probably be saved. The model structure, foreign emissions etc. can all be used in a Flanders eIOT-project. Cost savings will be substantial (several months of work). Regarding software Simapro: an indefinite licence costs about 3600€, annual service contract 1200€. This estimation assumes that Danish data can be used to fill in Flemish data-gaps. The set up of a Flemish IOT is not yet taken into account and is estimated to take several months of work. In chapter 5, a budget estimation is more elaborated.

3.2 EIPRO

3.2.1 Main objectives

Similar to the Danish study, it's main objective was also to establish a method for prioritising product groups that have the greatest environmental impact from a life-cycle perspective, but then on a EU25-level and with focus on consumption by private households and government expenditures. Note already the difference of focus with the Danish study where both consumption ánd production of an economic region are the scope of the study. The identification of the priority product groups had to allow the European Commission to select products that qualify for an assessment of their improvement potential and, depending on the outcome of such assessment, for being addressed with the European IPP. Up to this moment (August, 2006) the Commission has launched three such 'improvement potential' studies, one dealing with the product category 'meat and dairy' that was identified as the main priority product category in the EIPRO study. The 2nd study is dealing with housing and the 3rd is on passenger cars.

Another objective of the study was to evaluate existing modelling approaches and propose a final methodology for setting priority product groups in the framework of IPP. The EIPRO-study used two different approaches for identifying the priority product categories. The first approach was based on a study-of-studies. The second approach was based on a preliminary operational eIOA model for the EU25. The study goes quite in-depth in how to outline the eIOA model, based on different available data sources and how to develop the model to analyse the impacts for the total life-cycle of final product commodities, which goes beyond the complexity of lets say more conventional NAMEA's.
The study acknowledges that the current results are too uncertain for setting specific product policies, but that its value is in helping to gain perspective on IPP policy in a more generic way, and in helping to set priorities. For actual policies, substantial additional and robust information will have to be acquired (thus not so much additional methodological developments).

3.2.2 Main conclusions

In the 'study-of-studies' approach, all existing studies that were executed for several EU Member States (among others a Belgian study) were compared on used methodology and final results. Overall, two different used methodologies could be distinguished: the bottom-up market-LCA approach and the top-down environmental input-output analysis. Because this topic, and the arguments why the top-down approach is superior for this purposes, is discussed in much more detail in the review of the EIRES study, it is not further discussed in the following chapters on EIPRO. The comparison of final results on priority product categories from the different studies revealed no big surprises and across all studies a limited number of similar priorities arose and these are: housing (heating, energy-using household products, residential building materials), transport (car and air transport) and food (meat and dairy). The second approach was based on a preliminary operational eIOA model for the EU25. Because the background data and structure is based on the US CEDA database, subsequently 'Europeanized' by forcing upon it limited available EU input-output and environmental data, it is referred to as analysis with CEDA EU25. With regard to results on priority product categories, the same 3 major categories are defined (Food, Transport and Housing) and tend together to be responsible for 70-80% of the life cycle environmental impact (at 60-70% of the total expenditure). The main difference with the results of the other existing studies is that the impact scores for food are on average one third higher in the EIPRO study (as 'impact per EURO'). This has the consequence that, while some existing studies pointed out food as second or third top ranking category, in the EIPRO study it is the highest ranking category.

3.2.3 Short method description

In addition to the description of the two approaches used in the previous chapter, briefly some more 'critical' information is given on the eIOA model, or also named the CEDA EU25 model (second approach used in EIPRO).

Generally the same principles of eIOA are used as described for the Danish study. The main differences are that another product classification or aggregation principle has been used ('as high as possible' resolution) and that the model allows for distinguishing input data and outcome results per life-cycle stage of the product (in the Danish study, they are always added). It includes a specific approach for dealing with the use and disposal phase of products. The full mathematical structure of the model and data therefore becomes more complex compared to 'normal' eIOAs (see chapter 1) and is as follows:

$$M = (B_1\ B_2\ B_3)\left(I - \begin{pmatrix} A_{11} & A_{12} & A_{13} \\ A_{21} & A_{22} & A_{23} \\ A_{31} & A_{32} & A_{33} \end{pmatrix} \right)^{-1} \begin{pmatrix} k_1 \\ k_2 \\ k_3 \end{pmatrix}$$

The full environmental matrix B has 3 sub-matrices (respectively impacts from production, use, disposal activities) and the full technology matrix has 9 sub-matrices (read rows as "sales from" and columns as "to", for instance A_{11} is sales from production sectors to production sectors, A_{12} is sales from production sectors to households, A_{33} is sales from disposal services sectors to disposal services sectors etcetera…). The full consumption vector k has in theory also 3 sub-vectors, but in practice vectors k_1 and k_3 are empty because of the assumption that the (economic) system is driven by the private/public part of final consumption only.

Because for EU25 (nor EU15) no monetary input-output tables are available with an adequately high level of sector resolution, the US "CEDA 3.0" input-output model has been used, also because the US is an economy similar by level of development to that of EU. The CEDA-IOT has a resolution of 480 x 480 sectors and is for 2003. This CEDA-IOT was Europeanised, by first forcing on it the European production structure, available from OECD country IOTs (for 1995, 5 countries representing 72% of EU25 economy in 1990) but which have a very high level of aggregation, namely 35 x 35 sectors. For this purpose, the RAS-method was applied. This is a mathematical technique, used in economic IOA for estimation purposes (Stone, 1963 and Lecomber, 1975). In a next step, the energy sector has been Europeanised, by adapting the energy resource mix to the European situation. In a last step, the sector technology matrix is split-up in a production and a disposal technology matrix.

The US emissions data in the CEDA-IOT have been Europeanised by forcing on them the European totals, as have been established by "van Oers et al" for EU15 (2001) and were adapted to EU25 (2003).

The resulting CEDA-EU25 Products and Environmental model provides complete coverage of resource use and emissions in the production, use and disposal phase of the life cycle of all products consumed in the EU25.

3.2.4 System definition

In the EIPRO study, an operational eIOA model is elaborated in detail that allows analysing the environmental effects of the consumption of products in EU25. The functional unit and related system boundaries of the analysis are defined as follows:

- The functional unit is the total domestic final demand for each of the products (including services), together covering the total consumption of EU25. The model hence covers both final private household consumption and final government consumption, both in terms of their expenditure of the products involved.
- The system boundaries are set to cover all cradle-to-grave life cycle chains related to products consumed in Europe. The model thus covers impacts related to the production of imported goods, production of goods in Europe, and the use and waste management of products – all for products consumed in EU25.
- Residential approach for IOA

To conclude on aspects not covered in the scope of the study:

- Production in EU25 for exports
- Consequently, neither product use and waste management aspects in export regions
- The study does not explicitly address the environmental scores of intermediate process outputs that undergo several further processing steps prior to final consumption by households or for government use. Examples of such intermediate process outputs include the major part of natural resources, materials, chemical substances and preparations etc… because they have 'as such' no functional value for consumers. Note that these intermediate outputs however can also be defined as 'products' according to legal definitions ("…all moveable goods brought on market…"). The EIPRO study does not address this category for two 'technical' reasons: first, the nature of the products sold in the production chain is mostly very different from those sold to private households and second, these environmental scores of intermediate sales would not be cradle-to-grave scores but cradle-to-gate scores only. Comparing simultaneously the environmental scores of final and intermediate products in a hierarchic listing would be inconsistent and would lead to substantial double counting of impacts.
- The import of products into EU25 and export from EU25 are assumed to outweigh each other.

3.2.5 Choice and detail of product- and material groupings

- The lowest aggregation level (or the highest level of detail) in the EU25 input-output table comprises 478 categories. The classification follows the US CEDA database and also a conversion matrix is provided to convert these data and results to the EU COICOP classification on household expenditure.
- Of the 478 categories; 255 correspond to products purchased by private consumers. The other 223 products are sold as intermediates to other sectors or to government.
- Typical material and energy carrier groupings can be found in the 223 intermediate categories.
- Services are also included in this detailed listing. Results on top ranking (=highest impacts) categories demonstrate that some services belong to the highest scoring 35 products and confirm that there is no general rule that services are environmentally superior to goods.
- Note that the original CEDA database consisted of 480 x 480 categories. Two of these categories were typical use- and waste management categories and have been separated from this production technology matrix to two separate use- and disposal technology matrices. In addition to the two CEDA -use and –disposal categories, some other relevant categories have been added in these matrices, stemming from a variety of sources such as Oeko-Invent and other regular LCA-databases.
- The CEDA EU25 model allows for combining different categories to define general consumption activities. This is a separate matrix in the model. Simply said: this matrix allows to make combinations such as the purchase of water, electricity and washing machines into the consumption activity 'laundry washing'. For most products there is no need to produce such combinations (for instance, newspapers have no link to other product categories). For some other (relevant) products, it is essential to make this inherent link in the model, as in gasoline for driving a car, or all energy-using appliances (electricity used by…, residential heating). This does not go this far that combinations are detailed according to functional purposes, for instance driving a car for shopping, for leisure or commuter driving.

3.2.6 Environmental impact assessment

Inventory at substances-, emissions levels
CEDA comprises more than 1000 individual interventions per product (i.e. CO2, CH4 etc…).

Characterization
For interpretation of the results, the interventions have been related to impact categories by means of characterisation factors (i.e. GWP 100). This impact assessment factors are taken from Guinée et al. (2002) and are the following:

- Abiotic Depletion (Guinée et al.,2002)
- Global Warming, timeframe 100 yrs (Houghton et al., 2001)
- Ozone Depletion, steady state (WMO, 1992, '95, '99)
- Human Toxicity (Huijbregts, 1999, 2000)
- Eco-Toxicity, average over 3 ecotox themes
- Photochemical Oxidation (Jenkin & Hayman, 1999; Derwent et al., 1998)
- Acidification (Huijbregts, 1999)
- Eutrophication (Heijungs et al, 1992)

Normalization
The impact scores for each product are expressed as share in the "van Oers" EU25 totals. In LCA terminology that is called 'normalized' results. This gives an indication of the relevance of a product impact within the bigger picture of the total of that impact in the EU25.

Weighting
Sometimes, for some forms of presentation, the calculation of a single weighted score over the various impact categories can have added value. A weighting scheme is presented in the study, but such scheme is 'scientifically' and 'objectively' hard to justify. For this reason and merely for auxiliary or secondary use, a weighted one-point score is 'also' presented and calculated.

The proposed weighting factors were those used in the Dutch environmental policy for the oil and gas producing industry (NOGEPA).[9] For the other impact categories, an average over all impact categories has been used.

3.2.7 Data requirements

Data requirements are discussed in much detail in the EIPRO report. The amount of required data is very extensive and the use of them in the model is rather complex. In fact, there are 11 matrices and 2 vectors that have to be constructed. An overview of these are given in Table 2 and the resolution and used unit is given correspondingly.

3.2.8 Handling of foreign impacts

This is not considered an issue in the EIPRO study, given the assumption that imported goods and exported goods from the EU25 outweigh each other. In this 'theoretical' model all processes are assumed to occur in the EU25 itself.

3.2.9 Calculated indicators

The resulting indicators are very similar to the ones from the Danish study, with the following exception that in the Danish study, the indicators could be calculated depending on the selected view (consumption, production or process). In the EIPRO model, only the consumption 'cradle to grave' perspective is possible.

[9] Abiotic Depletion Potential 5%, Global Warming Potential 100 35%, Ozone Depleting Potential 5%, Human Toxicity Potential 17%, Eco-Toxicity Potential 7%, Photochemical Oxidation Potential 9%, Acidification Potential 7%, Eutrophication Potential 15%.

Also in the EIPRO-model, resulting indicators can be calculated for specific selected grouping (product grouping according to CEDA, combined functional 'activity' grouping according to COICOP classifications and aggregations, or total for the economy).

3.2.10 Uncertainty and robustness of the results

No specific 'statistical' or other 'academic' approach was used for uncertainty analysis. In general the study underlines that highly uncertain relations exist. The uncertainty has been looked at practically by thoroughly analysing the reliability of the inputs and the model and by involving judgement of external specialists.

The reliability of input data

Others have used part of the input data in different contexts, with much statistical analysis on underlying partial data sets there. This already gives some partial support to the data used. For the environmental data, the background is less well developed and fewer methods specifications have been developed, except for energy related emissions. However, the confidence comes from the fact that independent US and EU emission data applied at the same technology system give the same ratio between totals per substance.

Alternative input data are not available at the level of the EU. All data which can be found have been used in this study. Only new studies on data can improve on this situation. For the purpose of this study, and in the modal as being applied, the data is evaluated as 'adequate'.

The validity of the model

The detailed IO model used seems most adequate for the purpose. Its representativeness for Europe seems reasonably safeguarded. The extension of EU15 to EU25 is well justified. The validity pertains to the products as analysed at this level of 255 product covering the total of consumption, not to more specific product types and ultimately brands. The problem oriented indicators used have a most direct policy relevance.

The major weakness in the results does not lie in the general model and the input data and partial models being used, but in the lack of clear correspondence between on the one hand consumption activity classifications of the EU COICOP and on the other hand the make-and-use product categories which lie at the heart of the CEDA categories.

The reliance on US data for detailing resource use and emissions over larger numbers of sectors is a particular feature of the approach. The method of technology transfer as has been applied seems adequate for general EU policy support. For specific environmental policies such as in IPP or resources use strategies, more detailed European analysis is welcomed but is basically unavailable. From a comparative point of view, the mixed EU25-US model seems the most valid approach for policy support.

3.2.11 Scalability to Flemish situation

Due to high complexity and mainly due to detailed and high data requirements, it is very unlikely this eIOA approach is feasible for the Region of Flanders. Although such high level of detail is desirable for policy purposes, the base statistical system is not yet in place: nor in the EU, nor in individual Member States and we assume there is still a long way to go before such new detailed statistical system is agreed upon, harmonized (i.e. by Eurostat) and applied within the EU regions. Related to the further development of this eIOA for the EU, the JRC-IPTS initiated a study named 'Environmentally Extended Input-Output Tables and Models for Europe'. This study explores how methodologies based on analysis of eIOT can be further developed and applied in policy making. This study was completed in 2006 and is available on the website of the JRC[10].

There is also one major weakness to the model and that is the exclusion of imported (into EU) impacts. They are assumed outweighed in this model, but for the Flemish situation this cannot be

[10] www.jrc.es/home/pages/detail.cfm?prs=1366 (last consulted, 29/08/2006)

assumed. Flanders is, for one, very export-oriented and secondly, regions as EU25 or US cover the entire range of material extraction and production processes existent, while in Flanders only a very small part of these production activities are covered. This is an important extension that should be developed for a Flemish model (as done in Danish study). The same is true for export-related products and activities (i.e. waste treatments of Flemish-consumed products abroad), but this is to a lesser extent relevant from a consumption perspective, assuming that most waste treatment activities for Flemish-consumed products take place in Flanders or as according to ‘Flanders standards’.

The results of the EIPRO study itself (different impact indicators per Euro, given for about 250 product categories) can be used as an important data input into the Flemish model, representing the impacts for products imported into Flanders. This can be justified because most relevant trade partners of Flanders are still within the EU25.

The following table gives an overview of the data requirements for the core system of the EIPRO model. As mentioned, this kind of detailed data is not available for Flanders therefore it’s feasibility is not further discussed.

Table 2 : data requirements EIPRO study

Symbol	Resolution	Unit	Meaning
A11	478 x 478	Euro/euro	Technology matrix for production sectors
A21	478 x 478	=0	Sales from private/public consumers to production sectors
A31	5 x 478	Euro/euro	Sales from disposal services sectors to production sectors (=secondary materials, recuperated energy etc…)
A12	478 x 478	Euro/Euro	Sales from production sectors to private/public consumers
A22	478 x 478	Euro/Euro	Technology matrix for final consumption activities (zero matrix)
A32	1 x 478	Euro/Euro	Sales from disposal services sectors to private/public consumers
A13	478 x 5	Euro/Euro	Sales from production sectors to disposal service sectors
A23	478 x 4	=0	Sales from private/public consumers to disposal services sectors
A33	9 x 9	Euro/Euro	Technology matrix for disposal services sectors
B1	1344 x 478	EI/Euro	Environmental impacts from production sectors
B2	1344 x 478	EI/Euro	Environmental impacts from consumption activities
B3	1344 x 9	EI/Euro	Environmental impacts from disposal sectors
k1	478 (x 1)	Euro	k1 are the actual purchases of individual products. Precursor of k2.
k2	478 (x 1)	Euro	Final demand: consumption *activity* expenditures by private/public consumers (combined expenditure on items consumed together, like cars and gasoline make up ‘car driving’). Each consumption activity expenditure is linked to its main product
k3	9 (x 1)	=0	Purchases by disposal sectors from private/public consumers
M	1344 (x 1)	EI	Total life-cycle environmental impact for each consumption activity

EI= Can be both characterized environmental indicators or inventories of specific substance, for instance, kg CO2/Euro of kg CO2equivalents/Euro.

3.3 EIRES

3.3.1 Main objectives

The EIRES study is in itself a study of studies and has a somewhat different scope compared to the two previous discussed studies (Danish and EIPRO). The main objective was to support the development of the European resources strategy by extracting and assessing the science-based evidence from eight studies that were identified as relevant for understanding the environmental implications of resource use:

- Labouze E, Monier V, Puyou J-B (2003). Study on external environmental effects related to the life cycle of products and services. BIO Intelligence Service and O2 France for the European Commission, Directorate General Environment.
- Moll S, Acosta J, Villanueva A (2004). Environmental implications of resource use – insights from inputoutput analyses. Copenhagen: European Topic Centre on Waste and Material Flows. Draft manuscript, January 2004.
- van der Voet E, van Oers L, Nikolic I (2004). Dematerialisation: not just a matter of weight – Development and application of a methodology to rank materials based on their environmental impacts. Leiden: Centre for Environmental Studies at Leiden University. CML report no. 160.
- Phylipsen D, Kerssemeeckers M, Blok K, Patel M, de Beer J (2002). Assessing the environmental potential of clean material technologies. Institute for Prospective Technological Studies, Joint Research Centre (DG JRC), European Commission. Report EUR 20515 EN.
- Nemry F, Thollier K, Jansen B, Theunis J (2002). Identifying key products for the federal product and environment policy. Final report. Institut Wallon de développement économique et social et d'aménagement du territoire ASBL and Vlaamse Instelling voor Technologisch Onderzoek (VITO) for the Belgian Federal Services of Environment, Department on Product Policy.
- Dall O, Toft J, Andersen TT (2002). Danske husholdningers miljøbelastning (Environmental impacts of Danish households). Danish Environmental Protection Agency. (Arbejdsrappport 13). In Danish.
- Nijdam DS, Wilting H (2003). Milieudruk consumptie in beeld (A view on environmental pressure on consumption) RIVM report 7714040004). In Dutch.
- Rixt K, Falkena H-J, Benders R, Moll HC, Noorman KJ (2003). Household metabolism in European countries and cities - Comparing and evaluating the results of the cities Fredrikstad (Norway), Groningen (The Netherlands), Guildford (UK), and Stockholm (Sweden). Toolsust Deliverable No. 9. Groningen: Center for Energy and Environmental Studies, University of Groningen.

The objectives of the study were to analyze and evaluate this existing body of research with a view to identifying those materials and resources whose use has the greatest environmental impacts; conclude on the present state of knowledge about the relationships between resource use, material flows and environmental impacts; and propose on how to approach future research in support of developing the environmental aspects of the EU resources strategy.

3.3.2 Identification of existing studies relevant in the context of the EU resources strategy

The common feature of the eight considered studies is that they aim at determining the driving forces behind environmental impacts and resource consumption in the European Union or parts of it. The considered studies cover a range of methodological approaches, ranging from "top-down approaches" where impacts are determined from National Accounts input-output tables (IOT) extended by Environmental Accounts (NAMEA) to "bottom-up-approaches" where environmental impacts are determined from Life Cycle Assessments (LCAs). While all studies have been made with other purposes than supporting the EU's resources strategy, it has been analyzed in the study to what extent the results of the studies can be applied in the EU's resources strategy. It turns out that all of the considered studies do contribute to the understanding of what are the environmentally most relevant types of resource use, through identifying relationships between environmental impacts and specific material flows or product groups within the production and consumption realms. The immediate possibilities the studies offer to establish direct links between indicators of resource use and indicators of environmental impact were concluded 'limited' and additional research would be required to explore such links.

3.3.3 Priority Environmental Impacts

Environmental impacts are typically classified in a number of impact categories of which the following are covered by most of the 8 considered studies:

- Acidification
- Climate change (global warming)
- Ecotoxicity
- Human toxicity
- Nutrient enrichment (eutrophication)
- Photochemical ozone formation (smog)
- Stratospheric ozone depletion

This set of well-established impact categories is commonly used and spans the main part of the environmental concerns that are presently generally considered important.

3.3.4 Conclusions on the core and second order activities at the origin of environmental impacts

From analyzing the data and models applied in the considered studies, it has been found that the by far largest share of the major environmental pressures affecting those environmental impact categories originate from a limited number of human activities referred to as "core activities":

- Combustion processes
- Solvent use
- Agriculture
- Metal extraction and refining
- Dissipative uses of heavy metals
- Housing and infrastructure
- Marine activities
- Chemical industry

The core activities can be seen as first order driving forces for the environmental impacts, themselves driven by second order driving forces largely in the form of market forces, ultimately reflecting human demands. The second order driving forces are the main focus of the considered studies, which look at products or product groups, sometimes aggregated in need groups, or material flows induced by these products. Due to the great variation in applied methods and scopes, the results show a complex picture at the detailed level. However, at the more general level the studies reinforce each other in pointing to:

- housing ((construction and heating),
- transportation and,
- food consumption

as covering a large part of the most important consumption domains driving the environmental impacts and resource use in Europe.

3.3.5 Correlation and causal relationships between resource use and environmental impacts

With the exception of Moll et al. (2004), the considered studies do not analyze explicitly the correlation or causal relationships between indicators of resource use and indicators of environmental impact. However, from the underlying data and models it appears that, apart from environmental impacts directly related to resource *extraction*, there are only few instances where the relationship between resource use and environmental impacts are straightforward, and thus a more obvious target for policies aiming to reduce the environmental impacts from resource use:

- The use of fossil fuels and "global warming potential" and "potential acidifying effect".

- Use of specific metals, where there is a clear and linear relationship to environmental impacts from metal extraction and refining. A reduction in use of these metals will lead to a direct reduction in the associated impacts.
- Area occupation, where it is the resource use itself that is of environmental concern. A reduction in area occupation will reduce the pressure on biodiversity.
- Construction materials, where the resource use drives the waste stream, albeit mostly with a significant delay corresponding to the lifetime of the constructions.

This list is, however, only indicative at this stage of research knowledge, and further systematic analysis would be needed to consolidate it (see ‘identified gaps’). It should be noted, furthermore, that even in those cases where causal relationships may be established it is unlikely that these relationships will be linear, especially at the aggregated level.

3.3.6. Evaluation of methodologies

Two main approaches have been applied in the 8 studies considered: “bottom-up” and “top-down”, each with specific advantages and disadvantages. The main advantage of the process-based “bottom-up” approach is its ability to treat each product or material separately in great detail. However, at the same time, it is notoriously incomplete when it comes to covering all activities involved in the production processes.
In contrast, the main advantage of the input-output based “top-down” approach is its completeness. Since it takes its starting point in the national accounting matrices, it includes by definition all activities, materials and products in the economy. Its main disadvantage is the implicit assumption of homogeneity of the industries, i.e. that all products from an industry are assigned the same environmental impact per monetary unit.

3.3.7 Identified knowledge gaps and suggested future research

Based on the information and experience gathered from the eight studies and the critical assessment hereof, the following knowledge gaps with respect to development of the resources strategy have been identified:

- Lack of systematic insights into the causal relationships between resource use and environmental impacts, and therefore of possibilities to give consolidated advice on priority needs in policy development.
- Persisting weaknesses in environmental impact assessment models.

Three different strategies for closing these knowledge gaps and developing further the scientific input to the resources strategy are proposed.

1. Exploit more thoroughly the models behind the existing studies with a focus on the relation between resources and environmental impacts. It gives, however, not a structural information basis that can be easily updated.
2. Make a selection of the resources a priori seen as most relevant, and perform for each of them Substance Flow Analyses[11] or other adequate resource-specific analyses.
3. Set up and use for the analysis a detailed European NAMEA (National Accounting Matrix including Environmental Accounts), specified from the outset in a way that takes into account the information needs of the EU’s resources strategy (European top-down approach).

The investment in the last two strategies is probably of a similar order of magnitude (some two million Euros each alternative). Strategy 3 actually covers similar research as Strategy 2, but it is more systematic with the advantage that a structure is built that lasts and allows for regular and relatively cost-effective upgrading and updating. If a major investment will be made, the authors of the EIRES study express a clear preference for Strategy 3.

Improved and more comprehensive scientific input to the resources strategy following such lines is clearly recommended, but for effective policy development, it should be provided in close relation to

[11] Nederlands: stofstroomanalyse.

parallel research and dialogue on:

- A precaution-based approach to a resources strategy building on existing knowledge.
- An approach based on the scarcity of resources in Europe and globally.
- An approach building on equality among the different parts of the world.
- The requirements of different methods of linking the state of the environment to resource consumption (through materials, product groups, consumption areas etc.).
- The abatement strategies used in cases of resources where policies are already in place.

3.4. General conclusions from review of existing studies

In the past, different methodologies for assessing the environmental impacts of resources use have been investigated. The EIRES study, which is in itself a study of eight existing studies, concluded that the top-down approach, using environmentally extended input-output tables from national accounts is preferred over a bottom-up approach where LCA's (Life Cycle Assessments) are conducted for a whole range of individual resources or products that are extrapolated with market data to cover the whole EU25 region. This is also concluded in the EIPRO study, which context is more in the field of integrated product policy rather than the resources strategy (mainly chapter 4 of this study dealing on the comparison of methods and results of different existing studies).

Towards feasibility of the model and data retrieval; the very detailed and rather complex eIOA suggested in the EIPRO study (chapter 5 of this report) is unlikely to be feasible for setting up and implementation in Flanders. Also, because it lacks a method for taking into account imports and consequent impacts outside the considered economic region. Since Flanders has a very open economic structure, this is a major drawback. The eIOA suggested in the Danish study on the other hand is more feasible, but there are some critical drawbacks and data gaps that should be dealt with. These will be the subject of the following chapters. The main data gap for Flanders is the existence of a monetary Input-Output tables for Flanders. These can be derived from the national IOTs but; the national IOTs are very aggregated (resolution of 60 sectors). Compared to the IOTs used in the Danish study, a resolution of at least 120 different product and material groupings (or sector groupings) should be aimed for. This was also concluded during the meetings with the user committee where the advantages and the drawbacks of EIPRO and the Danish Study were compared and discussed.

4. Data availability

In this chapter, the general inventory of the data that is required to set up the Flemish eIOT (referring to the specifications set in chapter 2) is discussed in more detail on aspects such as (non-)immediate availability and usability.

4.1 Economic inputs (specifications S1, S2)

4.1.1 National Accounts

The Belgian national accounts are set up by the Institute of National Accounts (INR). In this institute, Statistics Belgium (NIS), the National Bank of Belgium (NBB) and the Federal Planning Bureau (FPB) are represented. Following European regulation of 1996, since 1998 the national accounts have to be set up according to the European System of National and Regional Accounts 1995 (ESA95). Belgium had previously (1994) regulated the construction of the national accounts and has up until now published definitive accounts following ESA 95 for the period 1995-2003. Historical time series are published for the period 1970-2000 (since 1995 following ESA 95).
The national accounts reflect the economic reality from three perspectives: value added, income and spending. They include accounts of the different sectors (households, firms and government), with yearly aggregates calculated at a NACE-BEL level of 120 activities (combination of NACE levels 3 and 4 digits), and the input-output system. The sector accounts systematically describe the different phases (production, income generation, income division, income spending and financial and non-financial accumulation) of the economic process for the different institutional sectors. The accounts in the three perspectives are integrated in supply-use tables, out of which the input output-tables are created.

4.1.2 Regional Accounts

The first regional accounts for Belgium were published in 1962. From the reference year 1995 on the regional accounts (following ESA95) include aggregates by branch of industry (gross value added, wages of employees, number of employees and gross investment in fixed capital) and the income accounts of the households (accounts on destination of primary incomes and secondary income division) for the Flanders region. These are published at the level of the first 2 digits in the NACE nomenclature, this is a level of 60 activities. For earlier years homogenised series (1975-1997) exist based on ESER79. One of the main problems for regional accounting is the lack of information on interregional flows.

In the following chapters we will further comment on the availability of some of the information used in the national accounts.

4.1.3 Foreign trade statistics

Since 1993 The National Bank of Belgium (NBB) collects statistics of Belgian international trade (specified by trade partner) in monetary and physical units following the ESER79 system. Since 2004 the ESR95 system is used. For the period before 1993 only statistics for the Belgian-Luxemburg Economic Union (BLEU) are available. The Belgian statistics are completely published at the 2-digit level in the harmonised nomenclature (HN) for the period 1993-2005. Upon request more detailed statistics can be obtained. The background data of the NBB is detailed to the 8-digit level of the combined nomenclature (10400 product codes).
The (private) database of the NBB yields the 5-digit NACE-BEL activity code (a one-digit Belgian extension of the four-digit NACE code) of the importing/exporting industry or trader, the type of transaction involved (sale, returned goods, subcontracting etc.) and the distinction between imports and exports within and outside the European Union.

Regional international export statistics for Flanders are calculated since 1997 by the NBB, as a part of the Belgian Institute of the National Accounts (INR), following the community[12] concept. These statistics are build based on the location of the administrative or social seat of the companies. This leads to a so called 'seat-effect': the international trade of companies is allocated to the region where the administrative centre is seated. There is also a 'gate-effect' when the community concept is followed: declarations made by fiscal representatives of non residents are also taken into account. Regional export statistics following the community concept are only made available at the 2-digit HN-level (due to privacy considerations) for the period 1995-2005.
Since 2004 the INR also calculates regional international import statistics. Furthermore regional statistics are now calculated following the national concept (based on residential principle). They are based on the Intrastat (intra-community trade) and Extrastat (extra-community trade) declarations, which hold region of origin and destination. Flanders international import and export statistics following the national concept are available at 2-digit level (due to privacy considerations) in the HN for the period 2002-2005.
The Belgian national, regional export figures calculated by the INR are lower than those calculated by the NIS (based on VAT, see below) because:

- trade with Luxemburg is not taken into account
- only trade of physical goods is accounted for (no bank-services etc.)
- transit is eliminated

It needs to be stressed that these statistics only include international trade. Interregional trade statistics are not available.

4.1.5 Household and government expenditure

Since 1995-1996 the NIS performs a yearly survey of the budget spending of Belgian households. Surveys have been performed before (as early as 1854, since 1978 by the NIS), but not on a yearly basis. A continuous time series is available from 1997 to 2004. Nowadays the survey is performed monthly on 300 households. National and regional household expenditure statistics are published every year at the level of 4-digit COICOP classes. The survey delivers information on the spending on each product, specified in a detail of 6 digits product level extension of the 4 digit classes in the COICOP nomenclature. On demand the 6-digit information is available.

The NBB publishes statistics on the Belgian government accounts split up by functional class and by economic component (fiscal and parafiscal revenues, splitting of the social benefits). Time series are available starting from 1990. For the functional statistics in the past the Benelux classification was used. Since 2005 COFOG-nomenclature is used. The basis sources for the statistics are functional expenditure tables built by the federal and regional government.

4.1.6 Tourism expenditure

Statistics Belgium (NIS) yearly publishes statistics concerning tourism since 1975. In 1992 the methodology has changed so continuous time series are available for 1992-2005. These statistics are based on reports (forced by law) from licensed tourist establishments. The statistics count the number of arrivals and nights spent by national and international tourists. The data are split up by accommodation type, purpose of trip and by nationality of the tourists. The published figures relate to tourism accommodation with four chambers or more (no Bed & Breakfast). They are freely available on a regional level.
The time accounts of the NIS also include statistics on the number of nights spent by Belgians in other countries.
The Flemish 'Support group on Tourism and Recreation' (Catholic University of Leuven) is trying to create tourism accounts for Belgium and its regions. By the end of the summer of 2006 they will publish transport accounts of tourists.

[12] In Dutch: communautair

4.1.7 Structural statistics of companies

Since 1996 (reference year 1995) the NIS yearly conducts a survey of the structure of Belgian companies. The survey is directed to companies with VAT- or/and social security number. The sample survey is taken in the sectors industry, construction and trade and services. Agriculture and public services are not included. This gives information on the activity, profits, costs, employment and investment of companies/activities at 4-digit NACE level. The statistics are published in the detail requested by Eurostat, which is a detail of 3 digits of the NACE-code. The latest year available is 2003. Exceptionally no statistics are available for 2002. The structural information is used as a base for the set up of the national and regional accounts and input-output tables following the ESR 1995 system. From 1999 on the results are published in € (before 1999 they were only published in Belgian francs).
The yearly structural statistics of companies use 25 variables amongst which turnover, value of production, value added, purchase of goods and services, stock changes, material investment (in grounds, infrastructure and machines/equipment), non-material investment and purchases of energy and energy carriers.
At the regional level the only statistics available (because of the limited survey) are those on wages, material investment and number of employees. These are transferred to Eurostat, but not published.

4.1.7 Investments

Turnover, export and investments (in billion €) of Belgian companies are calculated by the NIS based on the VAT-declarations of the companies. They are calculated on national and regional level. The regional statistics are produced in two ways: by means of the location of the head seat of the company and by means of social security figures on the branches (this leads to statistics on municipality level). The companies are grouped by NACE (1971 to 2001) and NACEBEL (1995 to 2005) activity codes. For the yearly statistics the grouping is at the 5-digit level in the NACE nomenclature. Monthly and half-yearly statistics are produced at 4-digit level. The statistics are available on demand at a level (mostly lower) depending on the demanded NACE code, period and area. These investment statistics are based on section 83 in the VAT-declaration and concern the total invested amount (in monetary terms). No further detail on the investments is available.
The NBB makes investment matrices for constructing supply-use tables. These investment matrices are based on the structural statistics of companies, which contain information on investments at product level. They are constructed at the same level as the supply-use tables, this is 321 products and 122 branches of industry. They are however restricted to a lot of suppositions at this level and are not very reliable. These investment matrices are not published. On official demand they can possibly be obtained at the level of 60 products and 60 branches of industry. The investment matrices are not constructed at the regional level.

4.1.8 Monetary supply-use tables (SUT) and input-output tables (IOT)

The Belgian supply-use tables are made by the NBB (with the aid of FPB). They are constructed in a dimension of 321 products and 122 branches of industry. The categories of final use are classified following general COICOP nomenclature. The use table is valued in purchase prices and the supply table is valued in basic prices. For the construction of the monetary input-output tables the FPB constructs a use table in basic prices. The FPB also constructs separate use tables for imports and for domestic production. Belgian supply-use tables are published for the years 95, 97, 99, 2000, 2001 and 2002 in a detail of 60 products and industries. Regional supply-use tables do not exist for Belgium.

The company information used for the construction of the supply table comes from the surveys on the structure of companies and the Prodcom. The side activities of companies are not split from main activities into different local kind of activity units (as prescribed by ESA 95). The total production is allocated to the NACE-code corresponding to the main activity of the company. The constructed supply table is not homogeneous in its branches.

The first Belgian (monetary) input-output table (IOT) was constructed in 1958 for the year 1953. Since 1994 the FPB, as part of the INR, is responsible for the construction of the IOTs. From 1980 on, IOTs are made available every 5 years. From reference year 1995 on, tables following ESR95 are constructed. The tables for 2000 are the most recent available up till now. The tables are published at the 60 x 60 level and is in basic prices, as demanded by Eurostat. The calculation is performed at the more detailed level of 120 activities (combination of NACE levels 3 and 4 digits). These background tables are not freely available however. Regional input-output tables do not exist for Belgium.

In the Belgian input-output tables side activities are split from main activities for a certain branch of industry when negative input coefficients emerge in the calculation of the tables. Then atypical inputs are lifted out of the concerned branch of industry and a separate branch is created. These analytical splits can be performed at company level or at branch of industry level. Again company information comes from the surveys on the structure of companies and the Prodcom.

4.2 Environmental satellite accounts for Flanders (specifications S3, S4)

4.2.1 MIRA core data set

The Flemish Environment Agency (VMM) makes use of extended statistical data in making the environmental reports (MIRA). Some of these background data are collected in the MIRA core data set. This set will provide the basis for the environmental accounts necessary in an environmental input-output model. The MIRA core data set contains data on: the use of energy, water and space; emissions to air; discharging to surface water and waste production. Unfortunately it is not sufficiently detailed for the envisaged sectoral division of the IOT (resolution of at least 120 sectors). In some cases more detailed background data can be obtained from the data providers. In the next chapters we will describe the detail in which environmental data are available.

4.2.2 Emissions to air

Emissions to air in Flanders are recorded in the emission inventory air (EIL) by the Flemish Environment Agency (VMM). Data are available for emissions of pollutants coming from industry, heating of buildings, traffic, agriculture (and horticulture) and other important sources. Due to legislative and methodological changes reliable time series can only be given for the period 1990-2004, but this is sufficient for the setting up of the Flemish eIOT.

Error margins are available for the emissions of greenhouse gasses. These were based on uncertainty estimations of the activity data made by VITO and estimations on the uncertainty of emission factors. Uncertainties for other pollutants are not available but can possibly be estimated based on literature (e.g. EMEP/Corinair emission inventory guidelines).

For industry the data are based on the annual emission reports, which Flemish companies that exceed a threshold value for a specific emission are obliged to make. For the most important companies emission data are available for specific contaminants at the most detailed level, and some in aggregated form, e.g. NMVOC. At the level of a sector, for the companies that do not have to report, supplementary estimations for combustion processes are made based on sectoral information on energy use. Estimations were also made for the emission of pollutants in some specific processes: smoking of fish, smoking of meat, preparation of bread and biscuits, preparation of beer and spirits, preservation of wood, production of chipboards, polyester processing industry, production of concrete, production of asphalt, foundries, thermal galvanisation, petrol stations, storage and transfer of volatile fuels, management of cemeteries and crematoria. Due to these estimations the sectoral detail of the complete industry data depends on the detail of the Flanders energy balance (see Annex Energy) and the analysed industrial processes.

Emissions for the heating of buildings are estimated in a collective way. They are based on the Flanders energy balances and split up into emissions for heating of households and emissions for heating of the tertiary sector. The tertiary sector is further split up into hotels and restaurants, health services, education, offices and administrations, trade, other services and CHP (Combined Heat and

Power) in the tertiary sector. Emissions of CO_2, CO, SO_2, $NO_X(NO_2)$, NMVOC, Pb, As, Cd, Cr, Cu, Hg, Ni, Se, Zn, PM10, N_2O and CH_4 are accounted for.

The traffic emissions were estimated by use of the MIMOSA model. Emissions are split up by fuel type and vehicle category. The used vehicle categories are: motor cars, light delivery vans, heavy lorries, buses and motor cycles. Based on the Flanders energy balance and/or transport technology data, emissions of transport by plain, train and ship were calculated. Emissions of CO_2, CO, SO_2, $NO_X(NO_2)$, NMVOC, Pb, Cd, Ni, Zn, Cr, Cu, Se, dust (total), NH_3, N_2O and CH_4 are accounted for.

EIL has models for the calculation of agricultural emissions of ammonia (NH_3), laughing gas (N_2O) and methane (CH_4). The N_2O emissions are split up between stock breeding and arable farming. The NH_3 emissions are split up between stock breeding and fertiliser use. These emissions due to stock breeding were specified by emission locations (viz. sheds, storage, pasture and application) and by animal species. Methane emissions from stock breeding are further split up into manure and enteric fermentation.

Based on these data sets, sectoral emission data are estimated for agriculture, industry, services, households, among others... For example, besides the modelled agriculture emissions of ammonia (NH_3), laughing gas (N_2O) and methane (CH_4), also other emissions are calculated for the agricultural sector. Fuel combustion emissions (CO_2, CO, SO_2, NO_X, NMVOC, Pb, As, Cd, Cr, Cu, Hg, Ni, Se, Zn, dust, N_2O and CH_4) are allocated to arable farming, permanent cultivation, pastured stock breeding, factory farming, greenhouses, open air horticulture, offshore fishing and CHP (in greenhouses). Sectoral emission data are published in a detail that corresponds more or less to the general MIRA industry division of **Fout! Verwijzingsbron niet gevonden.** (however, some sector estimations are based on non-published estimations at more disaggregated sub-sector level).

The sectoral reporting on air emissions by MIRA is based on the air emission inventory of the VMM. Some additional sources have been taken into account by MIRA: e.g. NH3-emission from septic tanks from households, NO-emission from arable soil due to manure and fertiliser use.

The minimal requirement for a Flemish eIOT (see specifications) was to include all emissions of the MIRA core dataset. The following emissions are covered by the MIRA core dataset: CO_2, CH_4, N_2O, HFC's (total), SF6, PFC's (total), CFC's (total), HCFC's (total), Halons (total), CH_3Br, CCl_4, As, Cd, Co, Cr, Cu, Hg, Mn, Ni, Pb, Sb, Tl, V, Zn, CO, NMVOC (total), 1,2-dichloroethane, Benzene, formaldehyde, monovinylchloride, Tetrachloroethene of PER, Toluene, Xylene-isomers, NOx (NO_2) , NH_3, SO_X (SO_2) , PM10, PM2,5, dust (total), POP's (total), PAH's (total), Dioxins (total), Carbon disulfide, Asbestos, Be, Se, H_2S. This list covers all the emissions (even more) that were taken into account in the Danish study.

Flemish air emission accounts (following the NAMEA framework) have been constructed by the Federal Planning Bureau for the period 1990/1994-2002. The air emissions included are greenhouse gas emissions, acidifying emissions, ozone depleting substances, dust and lead. These emissions were calculated up to a detail of 60 NACE NAMEA-Air sectors.

4.2.3 Emissions to water and soil

Emissions to water

The MIRA core data set contains data on emissions to water for the period 1992-2004 of the following substances: BOD,COD, floating dust, N (total), P (total), Ag, As, Cd, Cr, Cu, Hg, Ni, Pb, Sb, Zn. The sectoral division is at a very aggregated level (Annex Water), even less detailed than the general division of **Fout! Verwijzingsbron niet gevonden.**.

The dataset is based on the VMM water emission inventory. This inventory holds data of emissions by industry and trade & services, households, agriculture, transport and infrastructure. The VMM inventory contains data on emissions to water of numerous substances which are considered in regional and European regulation and guidelines. Results of analysis are available for over 100 substances. Unfortunately the measurements series only started in 2002. The dataset of companies where water samples were taken differs from year to year and data for non-sampled companies are not yet available. Thus the completeness of the data can not be guaranteed for all pollutants. There are generally no uncertainty estimations available for these emission data.

The emissions of industry and trade & services are based on the measuring-net operated by the Flemish Environmental Agency (VMM). This measuring-net aims at describing point sources of water pollutants in Flanders. Data are available for the period 1996-2004. These are based on measurements at about 1500 companies and yearly emission reports of about 1000 companies. These emissions represent 80% of the total volume of released water pollutants of industry and trade& services. In principle, data on emissions by point sources are publicly available at the most detailed level. The VMM databases used for the yearly emission reporting and levy taxing contain aggregated sectoral data at a level of more than 120 activities. This aggregation is done by levy parameter, and not by NACE sector. Supplementary estimations (20%) of released pollutants are made (for a total of approximately 15.000 companies) at this levy sector detail. NACE codes were related to levy parameters by the VMM, making use of the KBO-database. There is no one to one correspondence however between levy parameters and NACE codes. Aggregation by NACE code could only be made at a level of 14 sectors and 38 sub-sectors. In addition to this, pollutants released by a company are not necessarily allocated to the main NACE code of this company (activity-based economic NACE code).

Emissions of households are estimated based on EPAS values. These are concentrations (mg/l) based on analysis in residential areas. Pollutants due to corrosion of buildings are subtracted from the household emissions and added in the category infrastructure. Also the emissions of pollutants by road furniture are estimated in this category. Pollutants (heavy metals) coming from transport are estimated based on air emissions. These emissions from diffuse sources are only available for the year 2002. A time series will be started from 2005 on. Diffuse emissions from agriculture are estimated by means of the SENTWA (for nutrients) and SEPTWA (for pesticides) models. The SENTWA model of the VMM estimates the flows of nutrients to water. It uses the NIS statistics on animal numbers as primary input. These NIS statistics are based on a survey of the animal numbers at a specific moment in time (15th of May). Calculated emissions are available for the period 1990-2004. The model does not allow to allocate the emissions to different agricultural sub-sectors. The SEPTWA model of the VMM estimates the flows of pesticides to water. It considers pesticide use for agriculture, public services and private consumers. The problem with the latter model is that necessary input data are lacking. Data are needed on the effective use of specific pesticides for each culture. Also public data are lacking on the sales of pesticides to private consumers in small sale. Estimations were made for one year (in the mid 1990's) based on surveys. No actualisation has been done since. For the SENTWA and SEPTWA models uncertainty estimates were made.

Data necessary to construct Flemish water emission accounts (following the NAMEA framework) are available at the Federal Planning Bureau for the period 1997-1999. The water emissions included are BOD, COD, floating dust, nutrients (N and P) and some heavy metals. These emissions were calculated up to a detail of 60 NACE NAMEA-water sectors.

Pesticide use

The MIRA core data set contains data on the use of pesticides for the period 1990-2005. The amount of active substance in the pesticide is accounted for. The pesticide use is divided in use in agriculture (potatoes, beet, grain, maize, industrial crops, fodder crops, pasture), horticulture (open air fruit, open air vegetable, open air ornamental plant, glasshouse fruit, glasshouse vegetable, glasshouse flower) and other use. The other use (e.g. on public gardens,…) is estimated based on socio-economic parameters (e.g. population). The data are delivered to the MIRA data set by the department 'crop protection' of Ghent University.

Nutrients

Nutrient flows can be estimated with the MIRANDA model. Starting from the livestock and the area of land used for agriculture, MIRANDA calculates the produced and processed manure (per animal specie). By means of the MIRANDA model, the spread manure and industrial fertilizers are estimated for the MIRA-T environmental report for the period 1990-2005. MIRANDA was designed at the Centre for Agricultural Economics (CLE) and was updated and now managed by the Institute for Agricultural and Fishing Research (ILVO). The model is designed for the determination of components of the nutrient flows and manuring possibilities in Flanders. Nutrient balances are calculated. Inputs are nutrients from artificial fertilizers, animal manure, diverse remnants, seeds and young plants, atmospheric deposition and biological nitrogen oxidation. Outputs are harvested or pastured plants, ammoniac emission and the surplus on the balance, resulting in nutrient emissions to air and water. MIRANDA only calculates the surplus on the balance, emissions are not calculated. Supplementary calculation methods (with specified emission factors) can be coupled to MIRANDA for the calculation of other flows (e.g. methane emissions). The same categorisation as the agriculture accounting of the NIS is used. Thus, for manure production, distinction can be made by animal specie and type (and even age, race, sex,..). The main difference with the SENTWA model (see above) for the calculation of emissions to water is that the MIRANDA model uses yearly average animal numbers (given by the VLM 'Mestbank') as an input.

Landfilled waste
See later (generated waste)

4.2.4 Water, energy and land use

Water and groundwater use
The 2005 MIRA core data set contains data on water use (Annex Water) from 1991 up to 2003. It was first calculated in 2002, for earlier years a quantitative analysis was made. Water use is split up into use of cooling-water, tap water, ground water, rain water, surface water and other water. The water use is split up by MIRA-sector (excluding transport). However, the specified sub-sectors are less detailed than the earlier given reference list (**Fout! Verwijzingsbron niet gevonden.**). Industry NACE sector 26 is not given as a separate sector. For energy only the water use of NACE sectors 23 and 40 as a whole are reported as separate sectors. For trade and services only NACE sector 55 is reported separately. The water use of agriculture has the categories stock breeding and arable farming (and horticulture). Stock breeding is further divided in poultry, pigs, cattle and other livestock.

The MIRA statistic are based on three sources: the VMM database for levying on water pollution of large-scale consumers, the VMM database for levying on water pollution of small-scale consumers and the AMINAL (environmental administration) database on tap-water.

Individual company information is gathered by the VMM for levying on water use and waste water. These company data are not linked to NACE activity codes but to VMM internal levy sectors. There is no one on one correspondence between NACE codes and levy sectors. The available data do not allow to calculate the complete sectoral water use (only the reported fraction), which is higher than the given figures.

The regional NIS statistics of water use are based on the information of the VMM and only cover a limited number of sectors.

Energy use (energy matrices)
Energy matrices are produced by VITO for the years 1991 and 1994-2004. These matrices are constructed at a (approximately) 34 sector detail (Annex Energy). Data at individual company level exist however (collected by VITO by surveys and with help of sector federations), but they are confidential and only cover big energy users. Estimations for complete NACE-sectors are made at the published aggregated level. Since 2005, companies with an energy use of more than 0.1 PJ have to report their (primary) energy consumption to the VMM in their yearly environmental report. These reports are publicly available.

An uncertainty estimation of the energy use data is available at the VITO and the VMM. This uncertainty estimation of activity data was used to estimate uncertainties of greenhouse gas emissions.

The MIRA core data set on energy (1990, 1995-2004) is based on the VITO energy balance and has the same aggregated categories. This is more or less the detail of the general MIRA division specified in **Fout! Verwijzingsbron niet gevonden.**. The energy use of the agricultural sector however is split up in the following categories: arable farming, pastured stock breeding, factory farming, heating glasshouse horticulture, open air horticulture, permanent cultures and offshore fishing.

Since 2005 energy and gas netmanagers and operators of energy plants have to report to the Flanders Energy Agency (VEA) on sectoral consumption and production of electricity and gas. This reporting is at a 60-sector level (Annex Energy). The accuracy of the data is questioned however, because not all companies obliged to report have reliable data on the NACE codes of their clients. Sectoral deliveries of heating oil are not included in this reporting. These (confidential) data are used by VITO for constructing the energy matrices. The data are only published at the more aggregated level of the energy matrices.

The national survey on the structure of companies (performed by the NIS) asks for data on the companies expenditure on energy and energy carriers (only for industry and construction). The structural statistics are generally published at a level of 3 NACE-digits.

The NIS and the federal government department of Economy and Energy also publish statistics on energy use, but also at an aggregated level (comparable to general division of MIRA core data set). These are based on the above regional information. Studies on sectoral energy use are performed at regional level.

Occupation and transformation of land

The MIRA core data set contains data on land occupation for the years 1990 and 2000 to 2004. The land occupation data is not divided in the same components as other MIRA data sets. The division is by type of land occupation rather than by sub-sector. Seven sectors are distinguished: households (apartments, buildings, (farm-)houses), industry & energy (trade and industrial buildings), agriculture (temporary pastures, permanent pastures, fodder plants, arable farming, horticulture, fallow land and other), transport (roads, railways, waterways, airports), trade & services (storage spaces, office buildings, trade buildings, public buildings, utility services, social security and health service buildings, buildings for education and research and culture, worship buildings), tourism & recreation (buildings sports and recreation, recreation parks) and nature (acidic grassland, neutral-acidic grassland, chalk grassland, wet heathland, dry heathland, deciduous forest, coniferous forest).
The background information for the sectors households, industry & energy, trade & services and tourism & recreation came out of the land register (AAPD). For land occupation by agriculture (yearly agriculture accounts of the National Institute of Statistics (NIS)), transport (2005 MIRA background document Transport) and nature (2001 forest map of the Flanders Agency for Nature and Forest (ANB) and 1997 biological marking map of the Flanders Research Institute for Nature and Forests (INBO)) supplementary information was used.
Land occupation by agriculture can be further disaggregated based on the agriculture accounts of the NIS. These accounts contain the use of agricultural area split up by specific culture.

The documentation of the land register is built following division of municipality, section and parcel number. The NACE activity code is unknown to the land register. The nature of a parcel in the land register (see Annex Land) is determined by its (often original) destination (from fiscal viewpoint). If changes in exploitation, location,… are not reported by the owner, the nature will not be adapted. Unfortunately this is often the case. At present databases kept by the local governments for registration (juridical) and by the federal land register (fiscal) are being integrated. In the future also the nature of the parcel as indicated in the notarial act will be considered in the land register. This should lead to higher accuracy. The AAPD (land register) at present cannot deliver information on land use by NACE-code. The plan of parcels of the land register is at present being made available in digital form (so called KADVEC) by the Flemish agency for geographic information (AGIV). No uncertainty information is available for the data of the land register.

The Flemish environmental administration has integrated the databases with company information of different environmental institutions in one central database (CBB). This database links among others company names (incl. VAT number, if existing), addresses (social seats and exploitations) and NACE-codes. With help of the central reference address file (CRAB) of the AGIV, that links house numbers to land register parcel numbers, the CBB is now also being updated with KADVEC id's (parcel numbers). This should allow the linking of activities to land use in the future.

The NIS has also published figures on land occupation per region and municipality (based on the land register) for the period 1980-2005. The occupation is divided in land for agriculture, forests, built up area (further divided in residential, industry, mining, trade, public, mixed, transport and telecommunication, technical services, recreation) and other (dunes, water,…). These statistics are also based on the information of the land register. In 2007 the NIS is planning a NAMEA on land use. A correspondence table will be made, to link the approximately 200 parcel types to (lower number of) groups of NACE-codes. A further problem is that at the level of individual parcel types the figures of the land register are subject to big errors.

4.2.5 Waste and material flows

Resource use
Material Flow Accounts have been published in MIRA-T from 2002 on. A time series is available covering the period 1993-2004. These accounts are based on resource extraction (agriculture, forestry, mineral extraction and fishing) data sources of different regional and federal administrations and were built following Eurostat methodology (see MIRA background document at www.milieurapport.be). Up until now, no central database exists on the use of materials by different sectors or societal actors. The NIS will start compiling Material Flow Accounts from 2006 on. The NIS keeps yearly statistics on agricultural production. The Department of Natural Resources and Energy (ANRE) of the Flemish government keeps records of mineral extraction in Flanders over the years. The Flemish administrations responsible for fishing and forests keep data on yearly fish catch and wood harvest. No information on uncertainty is available.

Generated waste

The Public Waste Agency of Flanders (OVAM) is responsible for waste management and soil remediation in Flanders. The OVAM waste statistics since 2004 distinguish incineration, landfilling, sorting, other pre-treatment, reuse, composting, recycling and use as secondary raw material. They are available split up by economic sector (60 sub-sectors: households, mining, meat, …, laundries, personal hygiene, other) or by waste category (60 categories). The OVAM waste statistics are based upon a sample survey of approximately 15.000 companies. The companies are initially divided by 5-digit NACE-BEL code (more than 800 categories) and later aggregated to the 60 sub-sectors. Data are for the moment available for the period 1992-2003. Since 1998 the same methodology is used. The statistics are freely available.

The surveyed companies are grouped by self allocated NACE code. In most cases the chosen NACE code is this of the federal KBO-database. In this database all exploitation activities falling under a specific administrative seat are given the same NACE-code. But in some cases corrections are made based on own (OVAM) information on the different exploitations (and their environmental impacts). For example: transport companies collecting and transporting waste are allocated to the sector of collection and processing of waste (NACE 90) instead of to the NACE sector of transport of goods (as done in the KBO-database).

4.2.6 Ionizing radiation

There are many indicators in use to describe the environmental implications of ionizing radiation. Possibilities are the generated total amount of radiation (Bq), the average exposed effective dose of radiation (Sv, manSv, E), the amount of radioactive discharges to air and water (Bq), grounds/buildings contaminated with radioactivity (Bq/m^2, Bq/kg…) and the produced amount of radioactive waste (Bq/kg,…).

For the effective dose of ionizing radiation MIRA has data (gathered by the SCK, the Belgian Nuclear Research Centre) for the period 1990-2004, covering the following 4-sector division: Households (radioactive substances as body), Industry & Energy (industrial products, nuclear energy, military applications), Trade & Services (medical applications) and Other (natural sources and buildings). The accounted sources of radiation are limited in number and can mostly be allocated to the more detailed sub-defined MIRA sub-sectors. The sectoral allocation of ionizing radiation from buildings is less straightforward.

For similarity with the other environmental themes (which also describe flows at DPSI-R ‘pressure’ level) however, it seems most appropriate to include in the eIOT the generated total amount of radiation (Bq), the amount of radioactive discharges to air and water (Bq) and the produced amount (Bq/kg,…) of radioactive waste as indicators for ionizing radiation.

The national institute for radioactive waste and enriched nuclear fuel (NIRAS) has the task to manage the Belgian nuclear waste. The NIRAS has the necessary information to make the detailed sectoral allocation of radioactive waste.

Data concerning radioactive discharges are managed by the Federal Agency of Nuclear Control (FANC). Non-natural emissions can be divided in emissions from medical practices, industry and energy production (minor importance). The SCK made a study for the FANC on the nuclear emissions by industry due to the concentration of natural radioactivity in production processes. The emission of radioactive substances is however a less important topic and emissions are not calculated on yearly basis.

4.2.7 Completeness (for impact assessment) of the environmental data

The objective of the Flemish eIOT (see specifications set in chapter 2) was to include the most important environmental flows, indicators that are reported in the MIRA-T Flanders environmental report. These flows, although numerous, do not guarantee a complete impact assessment. Flows with large contributions to some impact categories are possibly not included.

We illustrate this in the case of the toxicity assessment of emissions to air. In the Danish study the U.S. Toxic Release Inventory (TRI) was used for a first check on the completeness of the toxicity assessment. The TRI 1998 data was scored using available EDIP characterisation factors (available for 230 of 630 TRI substances). Based on this (minimal) assessment we conclude that the following additional substances (emissions to air) that scored in the top 10 of a specific impact category could possibly be of high importance:

- 1,3-butadiene or vinyl ethylene or erythrene (human toxicity via air)
- n-butyl alcohol or n-butanol (human toxicity via air)
- (n-)hexane (human toxicity via water; chronic ecotoxicity water; chronic ecotoxicity soil)
- chlorine or hydrogene chloride (human toxicity via soil)
- propionaldehyde or methylacetaldehyde(human toxicity via soil)
- hydrogen cyanide or formonitrile (chronic ecotoxicity water; chronic ecotoxicity soil)
- ethylene or ethene (chronic ecotoxicity soil)
- chloroform or trichloromethane or methylenechloride (chronic ecotoxicity soil)

Some of these emissions are included in the total of NMVOC. However, they are not always taken up as a separate contaminant because of the incompleteness (only available from emission reports of limited number of companies) of the data. Because not all NMVOC have an equal impact potential, it is clear that a further improvement of the data on the different NMVOC can largely improve impact assessment.

For the moment the feasibility of the Flemish eIOT is limited to a limited number of environmental flows. The completeness of the impact assessment is to be analysed. Furthermore, calculated impacts should be interpreted as (minimal) impact potentials instead of real impacts for which the calculation would need more local and contextual information than only regional environmental pressures.

4.3 Environmental satellite accounts for imported impacts (specification S5)

Towards data availability, this is not so much an issue. In the Danish study, the U.S. CEDA database has been used for this purpose. Alternatives are the use of the preliminary compiled EIPRO EU25 CEDA, that would be more representative for processes and activities taking place at our main trade partners (still mainly EU25 member states). Or both databases can be combined (although this would not make much sense).

Environmental accounts distinguishing the developing countries (non-OECD) from the OECD countries are non-existent. Some detailed studies on particular impacts or particular activities (i.e. mining) can provide some basic information for this purpose, but are relatively scarce.

Another relevant issue when taking into account imported (hidden) impacts is the compatibility of sector classifications used by the Flemish environmental accounts versus foreign accounts. The U.S. and preliminary EU25 CEDA accounts are very detailed (>300 sectors). A conversion table will have to be set up by consequence. Also in relation to this, the environmental indicators used by these foreign accounts have to be compatible with the Flemish inventories and indicators. As already mentioned in the paragraphs above on the various environmental themes, for some themes these foreign accounts are more detailed compared to the MIRA indicators (i.e. NMVOS substances), for some other themes data in the foreign accounts is missing or not compatible in use (different definition or unknown, but a significant difference in figures indicates this). From the Danish study however, the use of the CEDA accounts demonstrate that this source can be used and covers the most relevant environmental pressures.

4.4 Compatibility of sector classifications used in environmental accounts and economic accounts

The sector divisions to be used for the environmental matrices should correspond with the sector divisions which are used in the input-output tables of the Belgian national accounts (Annex Accounts).

Based on the division made in the Danish study and on the sectoral divisions used by the VMM (**Fout! Verwijzingsbron niet gevonden.**), additional environmentally relevant divisions can be defined. It should be noted however that for relevance to the eIOT a similar split of the input-output tables then will be necessary.

If we compare the 122 sector division of the background tables of the Belgian IOT with the MIRA core data set divisions, we see that the NACE sectors 23 ‘Mfr. of refined petroleum products etc’ and 40 ‘Production and distribution of electricity, gas, steam and hot water’ of the NACE-BEL 60 division could be supplemented with the following activity groups:

- 23.1 Manufacture of cokes oven products
- 23.2 Manufacture of refined petroleum products: petroleum refineries
- 23.3 Manufacture of refined petroleum products: other companies
- 23.4 Manufacture of nuclear fuels
- 40.1 Production, transport and distribution of electricity
- 40.2 Production, transport and distribution of gas
- 40.3 Steam and hot water supply

We also compared the 122 sector division with the 198 production groupings used in the Danish expanded NAMEA (table B.1, Annex B). Considering their high (Danish) environmental impacts (>1% for specific impact potential) in the Danish study, supplementary disaggregation into the following production groupings could be useful:

- For agriculture and food products: livestock and meat products by animal type (pork, beef, chicken,…); cattle and diary products; seeds and grains; plant products by culture (potatoes, other vegetables, barley and rye, tobacco,…).
- For the chemical industry: fertilizers; pesticides and other products for agriculture
- For the metals industry: basic non-ferrous metals
- For ‘Sewage and refuse disposal, sanitation and similar activities’ (NACE 90): sewage removal and disposal; refuse collection etc.
- For ‘Wholesale, retail trade and repair of motor vehicles, motorcycles’ (NACE 50): sale of motor vehicles, motorcycles etc.; repair and maintenance of motor vehicles; service stations
- For ‘Manufacture of machinery and equipment n.e.c.’ (NACE 29): industrial cooling equipment; domestic cooling equipment

Looking at the specific situation of Flanders other groupings may be more relevant. For example, in the air emission inventory the steel industry is further disaggregated.

If we also want to analyse from the viewpoint of consumption then we will also need consumption statistics. We compared the consumption classification used in the Belgian household expenditure statistics with the one used by the Danish study. The following private consumption groupings which were not mentioned in the Belgian household expenditure statistics were seen to have big environmental impacts:

- fireworks
- toilet flush in households

A working group made up of members of the environmental administrations and the INR should examine which environmentally relevant division of production and consumption will be possible in the near future. For the moment the feasibility is limited to the (122 sector) division of production used by the INR in the calculation of the input-output tables and the division of consumption used by the NIS for household consumption statistics.

4.5 General conclusions on data availability

Data are generally not published at the desired level of detail.

For economic data there are two big problems. The first is the absence of Flemish input-output tables. The construction of Flemish input-output tables starting from the Belgian input-output tables is an option, but requires a great deal of effort. This is discussed in more detail in the feasibility study, chapter 5. The second is the confidentiality of data. Data (foreign trade statistics, national and regional accounts, input-output tables, supply-use tables, investment matrices) that are available at the INR are not published in the desired detail of >120 sectors. The access to economic data in the desired detail (A120) is a prerequisite for the feasibility of the study.

For environmental data the main problem is that the calculation of the data is not made at the desired level of detail. Sometimes the statistical system of the data providers is not built to deliver the requested detail. For example, the sample size of surveys etcetera, mostly does not allow to extrapolate company data to the required sectoral detail in a statistically sound way. Supplementary actions (see feasibility study, chapter 5) will be needed to disaggregate the sectoral environmental information to the desired level. In the feasibility study an estimation of the supplementary costs for a one-time calculation/estimation of detailed sectoral data will be made. In a first phase of putting into operation a Flemish eIOT, it seems not reasonable to already adapt the statistical system of the data providers. In a later phase, if the development of the eIOT is to be further continued, it can be investigated how the existing statistical system of the data providers can be adjusted to a new eIOT-compatible statistical system (adaptation of sample survey, calculation routines, etcetera). Because this is expected to take some time, this approach in two phases is suggested. Also, maybe harmonization with a new EUROSTAT eIOT-format can be expected for the mid long term[13].

Another problem relates to the completeness of the environmental data. Only the most important flows (relating to specific problems) are monitored separately. This will certainly influence the results of the impact assessment. Furthermore, given the fact that the necessary environmental data are not readily available, it seems appropriate to limit the eIOT-model in a first phase to air emissions, water emissions, waste and material flows, energy use, water use and ionising radiation (radioactive waste). Land use (on which the NIS plans a NAMEA study in 2007) and pesticide use (lack of reliable yearly updated data) can be added in a later phase.

In a limited number of cases (e.g. surveys directed to specific companies or sectors concerning energy use) confidentiality agreements can also be a problem. However, this does not seem to endanger the feasibility of the eIOT.

[13] Referring to study report “Environmentally extended input-output tables and models for Europe” (DG JRC / IPTS, 2006)

Another general problem is that NACE-codes are differently allocated to companies in the different datasets. Sometimes all exploitations get the NACE-code of the economic head-activity of the social seat. In other cases corrections to the NACE code are made based on the specific activities at the exploitations. Example given: in the federal datasets the whole of BELGACOM resides under the sector ‘telecommunication’, but OVAM allocated the BELGACOM exploitation where the car fleet is maintained and repaired to the sector ‘garages’. Different data-providers make different corrections. Thus errors are introduced when linking the different datasets. We suggest to start a working group (including all data providers) concerning this topic in the first phase of putting into operation the Flemish eIOT (see feasibility study, chapter 5). In this working group it should be checked which sectors are most affected by the different NACE codes and how this effect can be minimized. Another task of this working group will be the development of a disaggregated sector and product consumption classification, with relevance for material and product policy.

For most data, error margins are not available. The adding of uncertainty information will require a great deal of effort (see feasibility study, chapter 5).

5. Feasibility study

In this part of the study, we will investigate some particular issues that deal with constructing the Flemish IOTs and the environmental satellite accounts. Feasible aspects versus drawbacks will be outlined and options for closing the model- and data gaps will be evaluated. Based on existing work done (mainly Danish eIOT study abroad and experiences from the EIPRO project) and from communications with experts, an indicative budget is estimated for setting up the first Flemish eIOT.

5.1 Constructing the Flemish monetary IOTs.

5.1.1 Definition / classification of sectors for the Flemish IOTs (specifications T1, T2)

According to the ESA95 accounting framework, the input-output tables are constructed at a resolution of 60 sectors, according to a symmetric sector-to-sector format. The Belgian IOT is publicly available at this level of detail. However, to be useful for policy studies on resources use, product policy, production and consumption; a resolution of at least 120 sectors is required and even more disaggregated when the effect of particular measures at “material”-, or “product”-level should be investigated. A resolution of 60 sectors is however adequate for general sector studies. For example, in the Danish study, a resolution of about 330 sectors is used. The input-output tables at a level of 120 sectors exists in Belgium (INR), but is not published and cannot be obtained for constructing the Flemish IOTs at 120 sectors level. For constructing a resolution 120 table, or at more disaggregated level, the detailed data from supply-use tables is required. This exists, but is also not publicly available. ***It should be noted that this is a critical drawback for constructing reliable and adequately detailed IOTs! Options should be evaluated to obtain and or to construct the detailed IOTs.***

To have an idea on the lowest level of aggregation possible, the example of “copper” is shown in the following table.

Table 3 (in Dutch): example of sector resolutions, demonstration for copper.

NACE, resolution 60	27 – “Basic Metals”
NACE, resolution 120 (aggregation of NACE, level 4 for MIOT)	27B1 – “Eerste verwerking van staal, productie van niet-EGKS-ferrolegeringen en non-ferro metalen, en gieten van metalen”
NACE, resolution 223 (level 4)	27.4 – “Basic iron and steel and ferro-alloys”
NACE, resolution 502 (level 5)	27.44 – “Copper products”
SUT, resolution 330	27B05 – “Aluminium, lood, zink, tin en werken daarvan, evenals werken van koper en andere non-ferrometalen”

<u>Feasible</u>
- Available at CPA60 for Belgium, but is generally too aggregated for material- and product policy fields.

<u>Not feasible / Drawbacks</u>
- Monetary IOTs are currently available at a resolution of 120 sectors for Belgium, but not published (due to confidentiality). At the moment it is thus not feasible to derive the Flemish IOTs from these detailed national IOTs.
- Same is true for the required detailed supply-use (SUT) tables, required for constructing the more disaggregated IOTs, and also required for constructing the more detailed consumption matrix and investment matrix, see later.

<u>Option(s)</u>
There is no other option than to use the detailed IOT and SUT data for Belgium, hence to derive the detailed Flemish monetary IOTs. This would mean, the confidentiality over the detailed data has to be

lifted. We have to note that, even at a level of 120 sectors, data is still very aggregated and would not pose any risk towards revealing confidential (company) information (i.e. when a sector aggregate covers only 2 companies, this data should be hidden in statistics).

Other, “mathematical” options to disaggregate the 60 sectors national IOTs, such as the RAS method, would still require a one-time insight in the detailed tables or as an alternative; detailed tables from foreign IOTs. The same problem of unavailability exists and in case of using foreign data, would inhibit substantial uncertainties, making the IOT-model less reliable to mirror the typical Flemish sectoral and make-use relationships.

The previous chapters on existing studies and data availability have pointed out that it can be of interest towards a resources use strategy, integrated product policy, sustainable production-consumption strategy, … to include more detailed sectors or product categories. In other words, to disaggregate some sectors of the 120 resolution a bit more. Detailing the sector classifications in later phases, following the initial set-up of the Flemish IOTs, will be very difficult because by consequence all the accounts have to be adjusted accordingly. Our recommendation would be to strive for a “first time right” sector definition, classification. This should be the first task of a working group existing of different representatives (national accounts, regional accounts, environmental agencies, experts…). In the context of this task, also the now ongoing developments at the EU-level should be monitored. A recent study (IPTS, 2006) advises the set up of an IOT for the EU with a detailed resolution of several hundreds of sectors. However, it also states “It goes without saying that the first step in any development strategy should be to use what there is: combining the national ESA95 tables and NAMEA’s, complemented with other environmental data, …”. The EU study also, comparable to our proposal for the Flemish eIOT, recommends to set up “Medium resolution eIO tables : IO/NAMEA++” with a resolution of 100-150 sectors as one of three most feasible approaches.

Estimated Budget

Task	Estimated Man Months
Develop sector classification, with relevance for macro-economic analyses, material-, product policy, … (recommended resolution 100 – 150)	2

5.1.2 Set-up of monetary IOTs for Flanders and required economic inputs (specifications T4, T5, S1)

The feasibility of constructing regional IOTs for Flanders has been elaborated by Buyst et al (2000). At the time of this study, data from national and regional accounts were only available according to the ESER79 system, i.e. no data were available on intermediary use and total production (codes P20 and P10 of national accounts) and also sectors were defined differently (so-called “R25”). Today data are available according to ESA95 system, so in principle more is possible (i.e. the “RAS-method” for more accurate periodic actualization of existing older IOTs), but the general conclusions of this feasibility study remain the same and are briefly discussed in the following.

2 general strategies can be followed to construct the IOTs for Flanders; a top-down and a bottom-up approach. In the first approach, the Flemish IOTs are derived from the national IOTs by means of partitioning procedures. In the second approach, the Flemish IOTs are calculated ‘bottom-up’ from statistical Flemish base data (i.e. assembled by APS). Both approaches have advantages and disadvantages. The advantage of the last is that it is more precise and better reflects reality, but the disadvantage is that it requires substantially more work. The top-down approach is less resource- and cost intensive but is strongly dependent on the reliability of the underlying hypotheses. These hypotheses on its turn depend strongly on the reliability and availability of regional data that are required for these partitioning procedures. “Initialization” is the construction of the IOTs with corresponding technology matrix A (see 2.3), while “actualization” is the periodic updating of the IOTs and assuming an unchanged technology matrix A (the interrelations between sectors remain the same).

Figuur 1: Overzicht en samenhang van constructiemethoden voor input-outputtabellen over tijd en geografisch niveau.

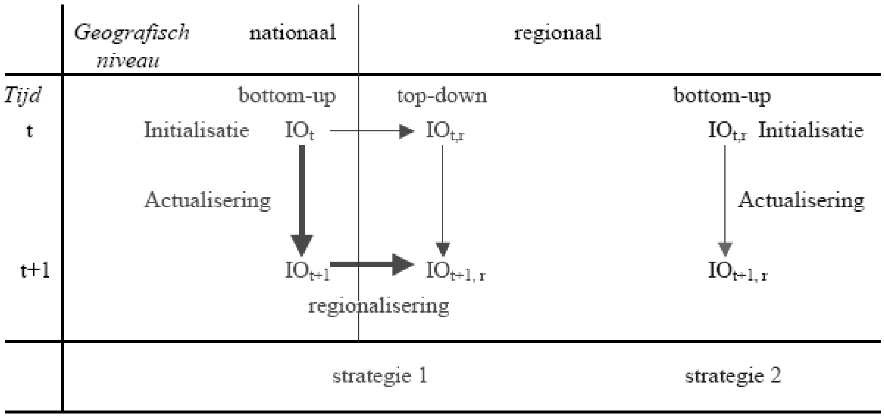

Figure by Buyst et al (2001)

The core issue for regionalizing the IOTs applicable for Flanders is to adjust the national technology matrix A (the technical coefficients in the rows of the matrix for the corresponding sectors) according to the realistic regional situation. Suppose α is the interregional trade coefficient and β is the technical coefficient that reflects the differences between the national and the regional input-output relations. In a non-realistic case where $\alpha = 1$ (no interregional import or export) and $\beta=1$, there is no difference between the technology matrix A for the regions and the country and the same technology matrix can be used for the regional IOTs. Where $\beta<1$ means that the regional production by this sector cannot cope with the regional demand and consequently the corresponding regional technical coefficients should decrease. Where $\beta>1$ means that the regional production exceeds regional demand and exports the difference and in this case the regional technical coefficients should increase. Two methods exist for determining β: the “Supply and Demand Pool” or SDP-method and the “Simple Location Quotient” or SLQ-method. In the study by Buyst et al., the SDP and SLQ-methods were compared and the SLQ is perceived as more appropriate and logical but the differences between the results of both methods are substantial. The reliability over all of this “top-down” approach, certainly if regional IOTs are to be used as statistical reference material, should be investigated in more detail. In the exercise by Buyst et al. (2001), mainly the technical coefficients on the sectors of tradable services are overestimated for Flanders and should be imported from other regions in Belgium (assuming mainly Brussels) and this is also the case for sectors on mineral extraction and mineral products. For most of the other R25-sectors evaluated, the technical coefficients for Flanders seem underestimated. With regard to policy measures, the multiplicator effect is larger for local sectors where $\beta>1$, so it is very important to do this estimation as correct as possible.

Tabel 3: Een vergelijking van de interregionale handelspatronen volgens de SDP en de SLQ methode

		Demand and Supply Pool methode				SLQ methode		
Code	Sector	Regionale output	Regionale behoeften	Output - behoeften	Beta	SLQ	beta	Overeen-komst ?
1	Landbouw, bosbouw, visserij	195954	280167	-84213	0.699	1.10524	1.000	0
6	Energetische producten	511615	596680	-85065	0.857	1.17723	1.000	0
13	Ijzerertsen, non-ferrometalen,...	356176	440635	-84459	0.808	1.11834	1.000	0
15	Mineralen en producten...	116176	123221	-7045	0.943	0.70583	0.706	1
17	Chemische producten	563348	691500	-128152	0.815	1.26391	1.000	0
19	Metaalproducten	183295	183806	-511	0.997	1.22918	1.000	0
21	Landbouw- en industriemachines	214747	200164	14582	1.000	1.22036	1.000	1
23	Bureaumachines	27252	39563	-12311	0.689	1.47114	1.000	0
25	Elektronische installaties	198846	193602	5244	1.000	1.21717	1.000	1
28	Transportmiddelen	532770	533489	-718	0.999	1.22602	1.000	0
36	Voeding, dranken, tabak	682190	609945	72245	1.000	1.20024	1.000	1
42	Textiel, leder, schoeisel, kleding	301690	270313	31377	1.000	1.41236	1.000	1
47	Papier en drukerk	191870	210043	-18174	0.913	1.09040	1.000	0
48	Overige industrieproducten	177980	200286	-22306	0.889	1.40474	1.000	0
49	Rubber en plastiekartikelen	168263	192141	-23878	0.876	1.33523	1.000	0
53	Gebouwen, wegen en waterwegen	537019	421087	115933	1.000	1.00342	1.000	1
56	Reparatie, recycling, handel	957948	943817	14132	1.000	0.97175	0.972	0
59	Diensten hotels, cafes, restaurants	284335	264672	19662	1.000	1.00318	1.000	1
61	Vervoer te land, binnenscheepvaart	174280	168141	6139	1.000	1.07552	1.000	1
63	Diensten zee- luchtvaart	98391	68254	30137	1.000	1.58199	1.000	1
65	Aan vervoer verwante activiteiten	299198	344971	-45774	0.867	1.52955	1.000	0
67	Communicatiediensten	105390	88512	16878	1.000	0.77189	0.772	0
69	Bank- en verzekeringswezen	788662	695177	93485	1.000	0.67638	0.676	0
74	Andere verhandelbare diensten	1478084	1456460	21624	1.000	0.91532	0.915	0
86	Niet-verhandelbare diensten	621816	588778	33038	1.000	0.79033	0.790	0

Figure by Buyst et al (2001)

The top-down method for deriving the Flemish IOTs from the national IOTs, requires the following detailed national and regional data to be available to the research team (detailed at the level of defined sector classes):

Necessary economic inputs for the construction of Flemish IO tables (regionalisation)

- Top-down 'Location Quotient' or 'Supply and Demand Pool' method (low accuracy):
    - total supply (production)
    - total use (for SDP)
    - gross value added at factor cost
    - fixed capital formation (investments)
    - government and household accounts

Necessary economic inputs for the actualisation of input-output tables

- RAS method:
    - gross value added at factor cost
    - total output
    - intermediate use
    - intermediate supply
    - diagonal matrix of relative prices

Necessary economic inputs for the disaggregation of input-output tables

- Location Quotient method
    - gross value added at factor cost
    - total output

<u>Feasible</u>

Regional IOTs for Flanders by means of SLQ method. KUL (department of dr. Buyst) can do this on condition they get access to all required detailed data from INR, or INR can do this. However, the reliability of the SQL-method should be investigated (i.e. a sensitivity analysis by comparing with the other "top down" methods using most current and detailed datasets), primarily because the Flemish monetary IOTs would be used as statistical reference material (for various other policy oriented studies).

Not Feasible / Drawbacks
The same as with previous task: access to detailed data is a critical condition (regional accounts, national accounts, supply-use tables, etcetera)

Options
KUL[14] estimates that when access to detailed tables of INR is guaranteed, reliable regional IOTs, compatible with national IOTs can be constructed. However, based on their previous experiences, they estimate this would take more than one man-year of work. For the initial set up of the Flemish monetary IOTs, all depends on the chosen level of detail (sector resolution, therefore estimated budget given as option A and B).

Estimated Budget

Task	Estimated Man Months
Option A) Develop Regional IOTs (ESA95, 60 sectors) by means of SQL-method + sector verifications, uncertainty analysis	3 – 5
Option B) Develop Regional IOTs (>120 sectors) level by means of SQL-, or other method + sector verifications, uncertainty analysis	8 – 12

Option B is recommended due to its more appropriate applicability in various policy areas. Eight to twelve man months are estimated as the initial cost for setting up the preliminary Flemish IOTs, but it should be noted that (taking the remarks of KUL into account) additional work in the order of one extra man year should be accounted for optimizing this method resulting in a more reliable model.

5.2 Development of consumption matrices and use- and disposal phase extensions (specifications T6, T7 & P2)

Sectors deliver - besides intermediate deliveries to sectors, export and capital formation - final products and services to households and governments. In the Belgian IOTs (at resolution 60), consumption vectors (=total for each sector) are given for household-, government- and NPISH[15] expenditure. Note that the vector Gross Fixed Capital Formation has to be re-allocated as intermediate inputs to the sectors. In other impact assessment methods such as LCA (Life Cycle Assessment), infrastructure is considered as an indirect input into the system.

Purchases by households and governments are reflected in COICOP and COFOG statistics, which are also used to develop the monetary IOT consumption vectors. Statistics on household and government expenditure are part of the regional accounts following ESA 95. They are available at a 4-digit (and more on demand) COICOP-level. Government expenditure is available following COFOG nomenclature. These statistics are also available for Flanders and the other Belgian regions, so the Flemish consumption vectors are available and can be calculated from these.

For policy studies, mainly when thinking of product and production-consumption oriented policies, it is useful to detail these consumption vectors, resulting in consumption matrices as shown in the table below.

Sector	Total consumption by households	COICOP cat 1	COICOP cat 2	COICOP cat …
Sector 1 to n	total for sector	a	b	c

[14] Catholic Universtiy of Leuven, communications with authors of study on regional input-output table.
[15] in Dutch : IZW

	split over >			
				…

Sector	Total consumption by government	COFOG cat 1	COFOG cat 2	COFOG cat …
Sector 1 to n	total for sector split over >	d	e	f
				…

For the national IOTs, this partitioning matrix can be developed by first constructing a SUT-COICOP conversion table. This table can then be used to develop the partitioning matrix sector outputs to COICOP household products. An incomplete SUT-COICOP conversion table has been developed by INR (National Bank and Federal Planning Bureau). Once this table is constructed, it is estimated relatively easy to construct the partitioning matrix from the national SUT accounts. Detailed SUT data are not available however for the region of Flanders and no known method is at hand for applying a top-down approach on this matter. On the other hand, it can be assumed that this partitioning matrix will be rather alike for all regions in Belgium, inhibiting (?) no substantial uncertainty if the partitioning factors from Belgium are assumed identical for Flanders.

Another problem is that some COICOP categories do not reflect certain consumption categories by their function, and also taking into account the whole range of products involved in the life cycle of certain products. In the Danish study, the following consumption activities and consequent partitioning matrices were introduced:

- COICOP categories “Major household appliances” and “Repair of major household appliances” were split up in the following consumption activities:

CAT.	Activity	Dom	Imp
FOOD	Storage of food in household	4%	6%
FOOD	Cooking in household	4%	5%
FOOD	Dishwashing in household	4%	2%
CLOTHING	Clothes washing (private)	6%	5%
HYGIENE	Personal hygiene	25%	26%
HYGIENE	Toilet flush in household	3%	3%
HYGIENE	Cleaning of household	3%	0%
LEISURE	Television, computer etc., incl. use	2%	44%
HOUSING	Lighting in household	3%	2%
HOUSING	Heating in households, incl. combustion	28%	6%
HOUSING	Household activities using electricity n.e.c.	2%	1%
	Total “Major Household Appliances”	100%	100%

The items of "Appliances, articles and products for personal care” were taken from the category “Major household appliances” and were allocated to the new activity “Personal hygiene”, and the commodity “Toilet paper” to the new activity “Toilet flush”.

Then, COICCOP categories on private consumption of water, electricity, gas, liquid fuel, hot water, etc… were distributed over these household activities.

	Storage of food	Cooking	Dishwashing	Clothes washing	Personal hygiene	Toilet flush in household	Cleaning of household	Television, computer etc.	Lighting in household	Heating in households	Household activities using electricity n.e.c.	TOTAL (%)
Forestry products, domestic			2		13		2			48		64
Pulp, paper and paper products,					36	31						67

import												
Refined petroleum products etc., domestic			1		5		1			20		26
Refined petroleum products etc., import			<1		3		<1			12		16
Detergents & other chemical products, domestic			<1		21		<1	<1		<1		21
Detergents & other chemical products, import			<1		87		<1	<1		<1		87
Electricity, domestic	7	3	3	4	15		2	4	6	52	5	100
Electricity, import	18	7	4	11	7			10	16	15	13	100
Gas, domestic			3		20		3			75		100
Gas, import			3		20		3			75		100
Water supply, domestic		5	11	16	37	21	11					100
Sewage removal and disposal, domestic		5	11	16	37	21	11					100
Wholesale trade, domestic	<1	<1	<1	<1	8		<1	10	<1	2	<1	22
Retail sale & repair work n.e.c., domestic	2	2	1	1	3		<1	15	<1	1	<1	24
ETC…												

- COICOP categories “Purchase of new vehicles” and “Repair and maintenance of motor vehicles” were split up in the following consumption categories:

CAT	Activity	**Dom**	**Imp**
TRANSPORT	Car purchase and driving to/from work	31%	31%
TRANSPORT	Car purchase and driving for shopping	27%	27%
TRANSPORT	Car purchase and driving for leisure	42%	42%

Car driving for holiday abroad was split from tourist expenditure abroad and emissions were added.

Then, COICOP categories fuels and lubricants were then (partly) distributed over these private transport activities.

	Car purchase and driving to/from work, domestic	Car purchase and driving for shopping, domestic	Car purchase and driving for leisure, domestic	TOTAL
Refined petroleum products etc., domestic	20	17	27	65%
Refined petroleum products etc., import	9	8	12	30%
ETC…				

These partitioning matrices are as such available from the Danish study and also from the European EIPRO study (in more detail, but according to the U.S. CEDA classification). The Danish partitioning matrices can be used as a guideline for defining and determining consumption activities and their use- and disposal- phase extensions in Flanders. However, the split up of energy carriers, water use etcetera, should be verified with detailed available data for the region of Flanders to increase the reliability of these partitioning matrices. This data availability is discussed in chapter 4. Also, these data need to be actualized periodically to take into account certain shifts in consumption patterns and/or certain shifts in the energy-/water- use efficiency of appliances.

Tourist accounts are necessary inputs for the distribution of tourist expenditures abroad. Given that IOTs use the “residential” approach (not territorial), impacts from Flemish people abroad are to be accounted for and on the other hand, impacts from foreign tourist expenditures are to be deducted. Complete tourist accounts do not exist in Belgium or Flanders. The methodology of the Danish study can be used however. Tourism expenditure is distributed over industries based on Tourism Satellite Accounts of Australia, Canada, Norway and the USA and general assumptions.

Feasible

- Developing a partitioning matrix to cover for different consumption categories and consumption activities of households and government, using the Danish study as a base and refined by available research on consumption activities in Flanders (note: multiplication of available consumption vector x to be developed partitioning matrix results in consumption matrix).
- For the consumption matrix, modelling of the use- and waste phase detailed expenditure statistics are available.
- The distribution of tourist expenditure can be estimated following the Danish methodology.

Estimated Budget

Task	Estimated Man Months
Continue development SUT-COICOP conversion table (work ongoing)	1
Develop Partitioning Matrix NACE-COICOP based on detailed SUT-data	1
Expand this COICOP Partitioning Matrix by introducing some function- oriented “Consumption Activities” (using Danish Study as a base + additional statistics and literature research)	1
Inventory of typical use- and disposal phase emissions / impact indicators from environmental statistics and energy accounts.	1
Allocation of these use- and disposal phase emissions / impact indicators to the consumption matrix (using Danish Study as a base + additional statistics and literature research)	1
Include tourist accounts	1

5.3 Calculating the indirect impacts of imported goods and fixed capital (investments in infrastructure)

For the determination of the worldwide impacts, caused by production and consumption in Flanders, also the (hidden or indirect) impacts of imported goods have to be taken into account. Ideally, input statistics on imports by country, or at least at OECD and non-OECD, are necessary. Import statistics are available for international imports to Flanders at the level of 2 digits in the combined nomenclature. INR has more detailed data but does not publish these because of confidentiality considerations.

If we want to describe the environmental pressures associated with our production and consumption from a life time perspective, we also need data on foreign environmental impacts. As much as possible, emission factors and all other environmental interventions indicators should be based on data specific to the considered regions. Ideally, at least 2 distinctive ‘generic’ foreign environmental interventions matrices should be available and used; one representing the developed countries (OECD) and one representing the developing countries (non-OECD). However, international environmental matrices of the OECD and non-OECD countries do not exist up until now. Input-output tables for OECD and non-OECD countries only exist at a detail of 30 industries. Given that it is not a high priority for this project, the calculation model should foresee such differentiated tables, but for now the developed- and developing countries environmental matrices are assumed identical.
Following the Danish methodology, we recommend to use the U.S. sectoral emission data for estimating ‘imported’ impacts.

Fixed capital formation (or investments) are in conventional IOTs and NAMEAs not considered an input but an output, since they are a lower order of (indirect) inputs required for production and consumption activities. In common impact assessment methods such as LCA (Life Cycle Assessment) however, they are (mostly) included in the scope of the studied system. In order to re-allocate the vector on fixed capital formation as inputs into the technology matrix, an investment matrix is required. Investment statistics (vector, or total per sector) are part of the regional accounts following ESA 95. They are constructed at 5-digit level in the NACE-nomenclature and available at lower level (depending on sector, down to 2-digit level). Investment matrices are constructed for the Belgian SUT at a P321xA122 level. They are publicly available at 60 sector level. In order to derive the Flemish investment matrix, condition is that all these detailed data should become available to the research team.

Feasible

- The U.S. tables are integrated in software SimaPro 7 and as such readily available (note: licensed software).
- The Belgian imports (available at 4 digit level in the combined nomenclature) and Flemish imports (available at lower level) can be split up by trade partner (OECD or non-OECD).

Not feasible / Drawbacks

- For the determination of foreign impacts the import data are needed in a detail of 4 figures in the combined nomenclature.
- For the determination of foreign impacts, environmental data are needed in the same detail. This is feasible for average EU25 or US activities, not feasible for developing countries. No division can be made yet between the OECD and non-OECD countries.
- For the redistribution of investment access to the investment matrices at the desired 120-level is needed.

Estimated Budget

Further study is required on how to apply a top-down approach for deriving a Flemish investment matrix from the Belgian investment matrix and investigate to which detailed extent this is possible and reliable. It is very difficult to give an indicative workload on this task. This can be 2 to 3 man months or more, depending on complexity and data input requirements.

Task	Estimated Man Months
Construction of investment matrix for Flanders	2-3
Expand technology matrix (rows) with input data on imports for each sector	2-3

5.4 Environmental indicators and impact assessment (specification S3, S4)

5.4.1 The extent of indicators and environmental pressures included in the model

The objective of the eIO-model (see specifications) was to include the most important environmental flows / indicators that are reported in the MIRA-T Flanders environmental report. These flows, although numerous, do not guarantee a complete impact assessment. Flows with large contributions to some impact categories are possibly not included. The completeness of the impact assessment is to be analysed. Furthermore, the resulting impacts should be interpreted as (minimal) impact potentials instead of real impacts (the calculation of which would need more local and contextual information than only regional environmental pressures).

As inputs in the model, substance emission data instead of thematic indicators should be used as much as possible. Emission categories (NMVOCs, ODS etc…) will have to be disaggregated where possible. The environmental interventions matrices should be based on authoritative and regularly updated statistical sources.

To allow the coupling of environmental data and monetary IO-data the used divisions of products (sectors) must be the same. The environmental interventions matrix should have a sectoral detail of (at least) 120 branches of industry, the same as used in the construction of the IO-tables (Annex

Accounts). Top-down disaggregation of the environmental data will give rise to higher uncertainty of the resulting data. Uncertainty estimations are generally difficult to make.
It would be better if, when possible, the emissions were allocated to the NACE code of the effectively polluting activity (e.g. side activity of company). Economic input output tables also split some (only those that are necessary for meaningful results) monetary flows of side-activities and main activities. The different data providers allocate company flows to NACE codes in different ways. A consistency check seems necessary. It needs to be investigated what impact these differences would have on the generated results.

The environmental data are collected using a 'territorial' scope. All emissions inside the territory of Flanders are measured. National accounts are constructed with a 'residential' scope, meaning that only economic flows of entities resident in a country are considered. A transformation of the environmental data from 'territorial' to 'residential' scope is needed. This can be done by correcting for emissions associated to tourist expenditure (car driving,…) and international transport.

Additional data for use and waste phase modelling is needed. Private consumption of water, gas,.. and associated emissions need to be distributed over the new household activities. This will be done using the Danish distributive code.

Emissions to air:

The following substances/categories that are included in the MIRA core data set should be included:

CO2, CH4, N2O, HFC's (total), SF6, PFC's (total), CFC's (total), HCFC's (total), Halons (total), CH3Br, CCl4, As, Cd, Co, Cr, Cu, Hg, Mn, Ni, Pb, Sb, Tl, V, Zn, CO, NMVOC (total), 1,2-dichloroethane, Benzene, formaldehyde, monovinylchloride, Tetrachloroethene of PER, Toluene, Xyleen-isomeren, NOx (NO2) (total), NH3, SOX (SO2) (total), PM10, PM2,5, dust (total), POP's (total), PAH's (total), Dioxins (total), Carbon disulfide, Asbestos, Be, Se, H2S

Feasible
Emissions to air in Flanders are recorded in the emission inventory air (EIL) by the Flemish Environment Agency (VMM). Regularly updated sources exist. Sectoral disaggregation can be done based on activity data (e.g. number of companies (KBO), total production (INR), energy use (VITO - when available) and foreign sectoral emission profiles (USA, Denmark,…).

Not feasible / Drawbacks
The sources do not publish sectoral emission data in the needed 120 sectors detail. Error margins on the published data are not available (except for greenhouse gasses). In the methodology used by EIL air emissions are allocated to the main activity (NACE code) of the polluting company.

Emissions to water and soil:

The following substances/categories that are included in the MIRA core data set on emissions to water should be included: BOD, COD, floating dust, N (total), P (total), Ag, As, Cd, Cr, Cu, Hg, Ni, Pb, Sb, Zn, pesticides.

For emissions to soil only nutrients by agriculture are considered.

Feasible
Emissions to water and soil are recorded in the water emission inventory water of the VMM, which is a regularly updated source. Sectoral data can be disaggregated to the desired level of detail based on (if available, see below) data on sectoral water use and the individual and aggregated company reports (available by levy parameter).
The MIRANDA model produces yearly data on nutrient flows from agriculture.

Not feasible / Drawbacks
Sectoral emission data are not available at the desired level of detail (A120). Due to the incompleteness of the data, water emissions should better be limited to BOD, COD, N, P and heavy metals.

Energy, water and land use:

Feasible
VITO is responsible for the construction of yearly Flemish energy matrices. Energy matrices at the desired A120 level can be constructed top down starting from the 30 sector VITO matrices based on energy use of companies bounded to yearly reporting on energy use (> 0.1 PJ), activity data (number of employees, number of companies, production,…) and foreign high detail sectoral energy use profiles.

Statistics on water use are published in the MIRA core data set and by the NIS. They are based on company specific information gathered by the VMM. The company information has to be grouped by NACE code. This can be done in two ways. The first method is top down allocation of the water use by levy sector to NACE codes (there is no 1-1 correspondence between levy sectors and NACE codes). This is the cheapest but least accurate solution. The second method is by bottom up linking of the individual company information to NACE codes. This would give more accurate data but demands a bigger effort.

Not feasible / Drawbacks
Sectoral emission data are not available at the desired level of detail (A120). Detailed data gathered by the INR (production,…) and the VITO (energy use) are confidential and not publicly available.

Statistics on land use are published in the MIRA core data set and by the NIS. They are mainly based on the information in the land register (AAPD), agriculture accounts (NIS) and transport statistics (VMM). For the moment all the parcel numbers of the land register cannot be linked to NACE codes. This might become possible in the near future when the land register information is digitalised and linked to the CBB-database. For the moment a one-time calculation of land use by NACE sector at the A120 level was ruled out by the AAPD (land register) due to organisational reasons. The NIS will start compiling a NAMEA Land in 2007. They estimate the effort to be spent on 6 man months. It is advised to wait for the outcome of these projects.

Options
The construction of a data set on water use in the desired sectoral detail can be made top down or bottom up. The top down solution is cheaper (0.2 MM) but less accurate, the bottom up solution is more expensive (1MM) but also more accurate.

Waste and material flows

Feasible
The waste statistics of OVAM and resource extraction databases of public administrations and institutions (NIS agricultural data, ANRE mineral extraction,…) are regularly updated sources. Material flow accounts can be constructed based on the Eurostat MFA methodology.

Not feasible / Drawbacks
Sectoral waste statistics are not available at the desired level of detail (A120). For the calculation of material flow indicators the main problems are the confidentiality of data on international trade and the lack of data on interregional flows. Access to the 4-digit international trade data is needed. Interregional flows can be estimated upon constructing a Flemish input output table.

Options
The first option to produce waste statistics in the desired level of detail is to divide the NACE-codes in a different way (the way of the FPB) into sectors and to extrapolate the taken sample for the new sectors. The problem is that the sample will not be optimal for the new sector division. This could lead to poor quality of the estimated waste production. The statistical system of OVAM does not support this option and costs may rise to allow high-quality waste production estimations. No cost estimation is made.

In the second (OVAM-favoured) option the present OVAM sector division is kept for the calculation of the average waste production of a company in a sector. When extrapolating for the present sectors, a separate extrapolation could be made for each NACE-code in the sector. This will lead to an estimation of the total waste production for each NACE code, including a confidence interval. This method seems sound presuming the homogeneity of the waste production in the present categories. A one-time calculation of these sectoral statistics represents a workload of approximately one man month.

Ionising radiation

For ionising radiation the availability of data on radio-active waste and radio-active emissions to water and air were investigated.

Feasible
The NIRAS manages the flows of radio-active waste. Yearly sectoral information is available up to the most detailed company level. NACE-codes are not yet allocated however. Given the limited number of companies and sectors producing radio-active waste this will not cause a big problem.

Not feasible / Drawbacks
Data on radio-active emissions to water and air are available at the Federal Agency for Nuclear Control (FANC). These emissions are assessed to be of minor importance. The data are largely based on a one-time study performed by the Study Centre on Nuclear Energy (SCK). Yearly emission figures do not exist.

Estimated Budget

Task	Estimated Man Months
Consistency check (with other environmental and economic data, e.g. EIW, OVAM, Federal Planning Bureau) of NACE codes allocated to companies (splitting of side activities etc.).	1
Sectoral disaggregation of water use data up to A120 level.	0,2-1
Sectoral disaggregation of water emission data up to A120 level based on sectoral data on water use and sectoral emission data aggregated by levy parameter.	0,2
Sectoral disaggregation of energy use data as close as possible to A120 level based on existing VITO data not bounded by privacy considerations.	0,2
Sectoral disaggregation of energy use data up to A120 level based on activity information (KBO, …) and foreign sectoral energy use profiles.	1
Sectoral disaggregation of air emission data up to A120 level based on energy use (for combustion gasses) and foreign environmental sector profiles.	1
Sectoral disaggregation of waste production data up to A120 level	1
Sectoral disaggregation of environmental data (ionising radiation, resource extraction, nutrients to land) as close as possible to A120 level.	1
Adding material flow information to the model	1
Inventory use and disposal phase emissions. Distribution of emissions over household functions.	0,5
Converting data from ‘territorial’ to ‘residential’(correction for tourism and	0,5

international transport) scope	
Adding environmental data to the model.	0,5
Adding uncertainty data to the model (rough estimations)	0,5
Total "Inventory sector environmental data (from MIRA-data, etc…), incl. converting to agreed sector resolution, converting from territorial to residential scope, etcetera"	**9,5**

5.4.2 Compatibility of environmental interventions and IOTs (specifications S7, S8)

Comparability requires that the list of environmental interventions considered for imports (indicators) matches with that for Flanders. The trade partner IOTs should be compatible with the ones used at a certain aggregation level of the domestic (Flanders) IOTs.
We recommend that the IOTs (480 commodities) and environmental matrices (1344 interventions) of the USA (available data in software SimaPro 7) will be used following the Danish methodology. All interventions mentioned previously are included. In the Danish project conversion matrices were constructed for linking the USA classification to the ESA95 system.

Feasible
Conversion matrices need to be constructed to link the USA classification to the NACEBEL 120 level.

Not feasible / Drawbacks

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Options

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Estimated Budget

Task	Estimated Man Months
Conversion of the USA classification to the NACE-BEL A120 level	1

5.5 OVERVIEW PROJECT TASKS

The following approximation of working group man hours is based on communications with representatives from the related institutes and the experience of the author of the Danish study. The table summarizes the tasks mentioned in the previous paragraphs (in italic) and additional tasks, mainly related to communications with experts, user committee, and other.

Task	Person-hours
Model phase	
Set-up of a working group during one expert/user committee meeting	40
Developing a detailed proposal for a eIOT and -model	250
Develop sector classification, with relevance for macro-economic analyses, material-, product policy, … (resolution 100 – 150 sectors)	*250*
Expert panel comments the proposal	40
User committee meets and comments the proposal	40
Working group finalises model description and work plan	40
Finishing report on eIOT-model	40
TOTAL PHASE	**700**
Data and calculation phase	
Develop Regional IOT (>120 sectors) level by means of SQL-, or other method + sector verifications, uncertainty analysis	*1250*
Continue development SUT-COICOP conversion table (work ongoing)	*125*
Develop Partitioning Matrix NACE-COICOP based on detailed SUT-data	*125*
Expand this COICOP Partitioning Matrix by introducing some function- oriented "Consumption Activities" (using Danish Study as a base + additional statistics and literature research)	*125*
Inventory of typical use- and disposal phase emissions / impact indicators from environmental statistics and energy accounts.	*125*
Allocation of these use- and disposal phase emissions / impact indicators to the consumption matrix (using Danish Study as a base + additional statistics and literature research)	*125*
Include tourist accounts	*125*
Construction of investment matrix for Flanders	*250*
Expand technology matrix (rows) with input data on imports for each sector	*250*
Total Inventory sector environmental data (from MIRA-data, etc…), incl. converting to agreed sector resolution, converting from territorial to residential scope, etcetera	*1200*
Conversion tables US NAMEA to NACEBEL A120 level (for imported materials, products)	*125*
Adding further environmental data to the model, incl. uncertainty analysis	125
Dialogue with the user committee	40
The Flemish eIOT is transferred to calculation software SimaPro	30
Simulations & Results	60
Two-day workshop for the user committee	40
Adjustments and supplementing simulations	80
Finalizing documentation in report form	40

TOTAL PHASE	**4200**
TOTAL PROJECT	**4900**

Excluding expenses and at a day rate of app. 650-800 €/day (7,6 hrs), total indicative budget amounts up to approximately 420.000-500.000 € in case a Flemish eIOT with a resolution of 100-150 sectors is targeted.

For the minimum option where only Flemish IOTs are constructed according to ESA95 at a resolution of 60 sectors, and extended with Flemish green accounts (NAMEAs), the budget would amount to approximately 220.000-300.000 €. Note that in this option no additional work is done towards adding use and disposal phase data, indirect impacts of imports or infrastructure etc.

6. Conclusions and recommendations

Environmentally extended input-output models can be used in support of sustainable development policy. The sectoral accounting framework allows environmental pressures to be related to economic parameters. Thus eco-efficiëncy indicators can be built and the consequences of policy measures can be analysed. Direct and indirect environmental pressures associated with the production and use of envisaged products and materials can be estimated based on the monetary interactions between the different components (industries, households,...) of our economy. The 'imported' and 'exported' environmental pressures related to national/regional production and consumption can be estimated based on foreign trade statistics and foreign environmental information (or foreign environmentally extended input-output tables).

In recent years several environmentally extended input-output models have been constructed in Europe and the rest of the world. The models used by the Danish ministry of the environment and the proposed European model were compared in function of the specified requirements (see Chapter 2) of the Flemish model. It was chosen tot do a feasability study for a Flanders model following the Danish methodology. This because the Danish NAMEA methodology makes use of local environmental data, deals with exports and imports and is less complex and more feasible than the other model.

To be useful for general product and material policy the industry branches of the extended input-output model should be sufficiently detailed. In the Danish model approximately 120 branches of industry are determined. This seems to be a minimal requirement. The biggest problem for the realisation of the model is the availability of detailed environmental and economic data and the general lack of a harmonized mutually compatible structure across all these data.

A NAMEA (National Accounting Matrix including Environmental Accounts) can be seen as consisting out of a NAM-part and an EA-part . We will comment on both parts seperately.

In the complete version of the NAMEA, the NAM-part consists of the input-output tables[16]. The main drawbacks here are related to the fact that the NAMEA is to be constructed at the regional level. Data on interregional flows (and thus 'complete' regional imports and exports) do not exist. This is also one of the reasons why reliable high-detail input-output tables have not yet been compiled for Flanders. Belgian input-output tables in a detail of 60 branches of industry are published by the Federal Planning Bureau (FPB) every five years. For the construction of these Belgian input-output tables a background table with 122-branches of industry is used. This table is not published however. Flemish input-output tables can be constructed by regionalisation of this background table. A prerequisite for this is that access to the not published detailed economy information of the Institute of National Accounts (INR) is granted. Approximating Flemish input-output tables could be constructed in a relatively short time-span (one man year or more) by using Flanders output data (production,...). This task can be realised within a one- to two-year project on the construction of an operational Flemish NAMEA. As a by-product of the regionalisation (with the RAS or SLQ method) imports and exports including interregional trade can be estimated. The construction of reliable tables is a multy-year effort. On this matter we refer to the FPB.
The detail of the 122 branches of industry is the highest detail that is possible for the moment. The economic information required to produce more detailed input-output tables does not exist so far.

The EA-part are the sectoral environmental accounts. Because the environment is a regional responsability in the Belgian state, regional environmental information is widely available. However, the necessary detail of approximately 120 industries is seldom reached. The production of information in this detail seems in the short term only feasible for the following environmental pressures: emissions to air, emissions to water, water use, energy use, nutrient flows, waste and material flows and radio-active waste. The sectoral disaggregation would lead to a combined effort of about 10 man months. It needs to be stressed that an environmental database is needed that is 'residence' rather than 'territory' based. This to be compliant with the national accounts. The first (and most difficult) step in the construction of this high-detail 'residence'-based database however, will be the construction of a

[16] The NAMEA's developed for practical use by Eurostat incorporate economic data on e.g. value added, intermediate consumption, output and employment, but do not contain the input-output tables. The latter have been shown to be a useful tool of analysis, though, in combination with the existing NAMEA data.

high-detail ‘territory’-based database. Such a database will certainly be a great help in classical environmental reporting (e.g. MIRA-reports).

We conclude that the construction of a NAMEA for Flanders is feasible within a reasonable time span (2 to 3 years). Given the detail of 122 industry branches that seems feasible, its policy use will mainly lie in the fields of sector policy and product policy. For material policy more detailed models are desirable. Prerequisite however is the access to detailed economy data of the INR. The environmentally extended input-output model will depend strongly on rather unreliable Flemish input-output tables and estimated detailed sectoral environmental data. A sensitivity analysis will have to determine the restrictions on its use for policy.

Although a Flemish environmentally extended input-output model will in the beginning certainly have its restrictions, we advise to start with the operationalisation in a pragmatic way. In a first (one year) poject the preliminary model as described above can be operationalised. This preliminary model will at least have an exemplary value. It will be a firm basis for continuous improvement. The Flemish environmental accounts following the NAMEA formalism will also seriously facilitate the construction of NAMEAs at the federal level. Further the preliminary model will probably be suited for use at the strategic policy level (analysis of the state of things, problem screening, broad target setting...). Its results should be interpreted as indicative. This will probably make them less useful as reference indicators. At operational level more detailed and reliable sectoral/product information is desirable. One of the advantages of NAMEAs is that it is a well defined methodology with broad use in different countries. This gives the opportunity to compare between sectors and countries. Given the expected big uncertainties in the model data (and the limited number of environmental flows included), one should be cautious in using the preliminary model for benchmarking. In following projects the number of environmental flows can be increased, sectors can be further divided and uncertainties can be decreased. If a further deepening of the NAMEA project is desirable, which extensions to be made (in view of policy use) can be analysed at the end of each project. A further extension of the model could be the coupling with Social Accounting Matrices (SAM) to produce an integrated analysis tool for sustainable development policy.

We advice to divide a first project into different phases. In a first phase (+- 700 hrs) a detailed model proposal needs to be made. We suggest this to be done in a working group consisting out of all data providers and possible model users. Topics to be tackled are e.g. environmental impacts to include, detail sectordivision, linking of activities to NACE codes,... In following phases the Flemish input output tables (+- 1750 hrs) and the detailed environmental accounts (+- 2000 hrs) need to be constructed. These two phases can be done in parallel. In a last phase (+- 450 hrs) the two building blocks need to be integrated and a sensitivity analysis should be made. This leads to an indicative total cost of about 350-400 k€.

For an efficient use of resources the regional efforts should be tuned with the activities at the federal level. The National Institute of Statistics (NIS) will start a NAMEA on land use in 2007. The Federal Planning Bureau (FPB) has already made NAMEAs for air and water emissions in the past. Furthermore the FPB has been investigating the feasibility of the construction of reliable regional input-output tables. For the consistency of the regional and federal NAMEAs, and the necessary access to confidential data, close co-operation with the INR (in which NIS and FPB are seated) seems necessary.

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ANNEX A: Activities on Extended Input-Output modeling at EU level

DG JRC (Joint Research Centre) / IPTS (Institute for Prospective Technological Studies)

FP6 - WP2005 - Action n° 4113 - CLEANTECH (Clean technologies: prospective techno-economic analyses and scenarios)

The following is an extract of full project description with relevance to thematic topic of sustainable use of resources. The full project description can be seen on the JRC's Project Knowledge Management site (http://projects-2005.jrc.cec.eu.int/).

The purpose of this action is to support the policy making process related to specific priority issues identified in the Sustainable Development Strategy (SDS) and the Environment Action Program (EAP): the sustainable use of resources and environment and health. It contributes to policy developments in these fields by analysing the inter-relations between technological change, scientific developments, environment, economy and policies approaches. The activities of the action related to the sustainable use of resources are concentrated around the Thematic Strategy on Resource Management, the Integrated Product Policy, the Thematic Strategy on Recycling.

Objectives :

2. **IPP**. To support DG ENV and DG ENTR in the development and implementation of Integrated Product Policy: methodology development and product identification; assessment of the potential for improvement of selected products under different regulatory scenarios.
3. **EU RESOURCES STRATEGY**. To support DG ENV in the development of the European Strategy for the sustainable management and use of natural resources, by analyzing the relationship between resources/materials flows and environmental impact.
4. **WASTE AND RECYCLING POLICY**. To contribute to the development and review of waste management and recycling policies developed by DG ENV, in cooperation as appropriate, with actions 2131 and 2321 of the IES.

Deliverables :

2.1 IPP. Assessment of the environmental and sustainability improvement potential for a number of selected product groups with the greatest environmental impact. (**31/12/2005**)
3.1 EU RESOURCES STRATEGY. Technical analyses on policy measures regarding the sustainable production and consumption of natural resources and materials, as required by DG ENV, in the context of IPTS support to the development of the EU Resources Strategy (**31/12/2005**)
3.2 EU RESOURCES STRATEGY. Report on "Environmentally Extended Input-Output Tables and Models for Europe". Assessment of application areas of IO tables with environmental extensions in EU policy making and evaluating the feasibility of producing and using (**31/12/2005**)
4.1 EU RESOURCES STRATEGY. Report on "Environmentally Extended Input-Output Tables and Models for Europe". Assessment of application areas of IO tables with environmental extensions in EU policy making and evaluating the feasibility of producing and using (**31/12/2005**)
4.4 WASTE AND RECYCLING POLICY. Identification of the wastes whose prevention would have a high potential to reduce the overall environmental impacts of resource use in the context of the development of national waste prevention programmes. (**31/12/2005**)

IPTS study "Tools for Environmentally Extended Input-Output Analysis" (2006-2007)

End 2005, IPTS has launced a call for tender for a one year contract study on the development of software tools intended for e-IOA, including a preliminary e-IOT with the geographical scope of the entire EU25. The contractor will be required to produce a preliminary database, as much as feasible within the one year project, on best readily-available sources and reasonable assumptions. The study will be concluded by end 2006, beginning of 2007. IPTS understands well that the development of a high-quality (accurate, up-to-date and fuly based on best primary sources) e-IOT for the entire EU is certainly a multi-year task requiring large effort and that it should be seen as an objective for the (mid-) long term.

Of interest for this Flemish feasibility study on e-IOA are: potential use of the (preliminary) e-IOT EU25 for imported impacts in the Flemish model. Of importance is mainly to assure consistency of the EU25 model with the proposed Flemish model.

DG JRC/IPTS and DG ENV (Environment)

Studies related to Integrated Product Policy

The Commission has as announced in the Communication on Integrated Product Policy (COM(2003) 302 final) to launch a work with the purpose of identifying products with the greatest potential for environmental improvement from a life-cycle perspective. This work started in 2004 and is being led by the Institute for Prospective Technological Studies (IPTS) in Seville, which is part of the DG Joint Research Centre. This work is carried out in two phases:

The **first phase** is to identify products with the greatest environmental impact from a life cycle perspective. For this purpose a methodology for identifying the products needs to be developed and applied. This is done in a study named Evaluation of the Environmental Impacts of Products (**EIPRO**). This study is carried out for the IPTS by partner institutions of the European Science and Technology Observatory (ESTO). This project is finished (draft version, review ongoing, final version expected to be published beginning of 2006). An objective of this study was to develop an operational methodology to identify the products with the greatest environmental impacts. This resulted in a transparent methodology that allows building on the methods and results of previous research as far as possible and complementing this with a new systematic analysis of the environmental impacts of products for the EU-25. A top-down oriented approach based on environmental input/output analysis (IOA) was identified as most suitable for the new analysis. This methodology has been refined and applied. A full draft report and annexes of the study are now available presenting the analysis of the life cycle environmental impacts of products related to the final consumption of the EU-25. These documents and further information on the topic are available at the IPTS website (http://cleantech.jrc.es/pages/r4.htm).

The **second phase** is to identify products with the greatest potential for environmental improvement based on the results delivered in phase one. This project will have the objective to focus on some of the products with the greatest environmental impacts and examine the ways in which their environmental impacts can be reduced. This will include examining the socio-economic impacts of each measure. The second phase will only start when the first phase has been concluded. Following this, the Commission will seek to address some of the products with the greatest potential for environmental improvement at least socio-economic cost. The second phase of the project was planned to end in 2007 (although end 2008 is probably more realistic given that to date, february 2006, this study has not yet been launced

Related to and based on the first phase of the project IPTS has started a study named **Environmentally Extended Input-Output Tables and Models for Europe**. This study will explore how methodologies based on analysis of environmentally extended input/output tables can be further developed and applied in policy making. This study will end in 2006. Contact with the project manager of the study has been established and will inform us on (preliminary) results when these become available.

European Network of Environmental Input-Output Analysis

(http://www.leidenuniv.nl/cml/ssp/projects/envioa/index.html)

ANNEX B: Production and consumption in Danish study

Production

	Code	product/activity
	11009	Agriculture
1		Part time farms on clay soil
2		Sugar beet farms
3		Seed crop farms
4		Dairy farms on clay soil, low animal density
5		Dairy farms on clay soil, medium animal density
6		Dairy farms on clay soil, high animal density
7		Dairy farms on clay soil, ecological
8		Pig farms on clay soil, low animal density
9		Pig farms on clay soil, medium animal density
10		Pig farms on clay soil, high animal density
11		Grain farms on clay soil
12		Residual farms on clay soil
13		Horticulture on clay soil
14		Part time farms on sandy soil
15		Potato farms
16		Dairy farms on sandy soil, low animal density
17		Dairy farms on sandy soil, medium animal density
18		Dairy farms on sandy soil, high animal density
19		Dairy farms on sandy soil, ecological
20		Pig farms on sandy soil, low animal density
21		Pig farms on sandy soil, medium animal density
22		Pig farms on sandy soil, high animal density
23		Meat cattle farms
24		Grain farms on sandy soil
25		Fur farms
26		Horticulture on sandy soil
27		Chicken farms
28		Poultry farms
	11209	
29	14000	Agricultural services and landscape gardeners
30	20000	Forestry products
31	50000	Fish & seafood
32	110000	Crude petroleum, natural gas etc.
33	140009	Gravel, clay, stone and salt etc.
	151000	
34		Pork and pork products
35		Beef and beef products
36		Chicken meat products
37	152000	Fish products
38	153000	Processed fruits and vegetables
39	154000	Vegetable and animal oils and fats
40	155000	Dairy products
41		Dog and cat food
42		Animal feeds

43		Cocoa products
44		Candy and other confectionery products
45		Flavoring extracts and syrups
46		Roasted coffee
47		Food preparations, n.e.c.
48		Flour
49		Oatflakes
50	158109	Bread, cakes and biscuits
51	158120	Bakers' shops
52	158300	Sugar
53	159000	Beverages
54	160000	Tobacco products
55	170000	Textile industry inputs not alloc. to specific outputs
56		Carpets, wool
57		Sweaters, wool
58		Knitware, cotton
59		Knitware n.e.c.
60		Broadwoven, wool
61		Broadwoven, cotton
62		Bed linen etc., cotton
63		Duvets
64		Broadwoven, synt.
65		Nonwoven synthetic
66		Tents, tarpaulins, awnings
67		Textile goods n.e.c.
68		Yarn, cotton
69		Yarn, synt.
70		Yarn, wool
71		Curtains, household textiles
72		Glass fibre based textiles
73		Fish net, other nets
74		Embroideries
75		Mattresses
76		Plast-coated textiles
77		Rope, synt.
78		Cotton wadding
79		Accessories to textiles
80		Textiles for technical use
81		Textile industry inputs not alloc. to specific outputs
82		Apparel industry inputs not allocated to specific outputs
83	180000	Wearing apparel; dressing etc. of fur
84	190000	Leather and leather products
85	200000	Wood products
86	210000	Pulp, paper and paper products
87	221200	Publishing of newspapers
88	221309	Publishing activities, excluding newspapers
89	222009	Printing activities etc.
90	230000	Refined petroleum products etc.
91	241109	Industrial gases & inorganic basic chemicals
92	241209	Dyes, pigments, organic basic chemicals
93	241500	Fertilizers etc.

94	241617	Basic plastics and syntethic rubber
95	242000	Agro-chemical products
96	243000	Paints and printing ink
97	244000	Pharmaceuticals etc.
98	245070	Detergents & other chemical products
99	251122	Rubber products, plastic packing etc.
100	252300	Builders' ware of plastic
101	252400	Plastic products n.e.c.
102	261126	Glass and ceramic goods etc.
103	263053	Cement, bricks, tiles, flags etc.
104	266080	Concrete, asphalt and rockwool products
105	271000	Basic ferrous metals
106	272030	Iron and steel after first processing
107	274000	Basic non-ferrous metals
108	275000	Cast metal products
109	281009	Construction materials of metal etc.
110	286009	Hand tools, metal packaging etc.
111	291000	Marine engines, compressors etc.
112		Industrial cooling equipment
113	292000	General purpose machinery
114	293000	Agricultural and forestry machinery
115	294009	Machinery for industries etc.
116		Domestic cooling equipment
117	297000	Domestic appliances n.e.c.
118	300000	Office machinery and computers
119	310000	Electrical machinery n.e.c.
120	320000	Radio and communication equipment
121	330000	Medical & optical instruments etc.
122	340000	Motor vehicles parts and trailers
123	351000	Ships and boats
124	352050	Transport equipment n.e.c.
125	361000	Furniture
126	362060	Toys, gold & silver articles etc.
127	370000	Recycling of waste and scrap
128	401000	Electricity and heat
129	402000	Gas
130	403000	Steam and hot water supply
131	410000	Water supply
132	450001	Construction of new buildings
133	450002	Repair and maintenance of buildings
134	450003	Civil engineering
135	450004	Construction materials
136	501009	Sale of motor vehicles, motorcycles etc.
137	502000	Repair and maintenance of motor vehicles
138	505000	Service stations
139	510000	Wholesale trade
140	521090	Retail trade of food etc.
141	522990	Retail sale in department stores
142	523000	Retail sale of pharmaceuticals and cosmetics

143	524190	Retail sale of clothing, footwear etc.
144	524490	Retail sale & repair work n.e.c.
145	551009	Hotels etc.
146	553009	Restaurants and other catering
147	601000	Transport via railways
148	602100	Scheduled passenger land transport n.e.c.
149	602223	Taxi operation and coach services
150	602409	Freight transport by road
151	610000	Transport by ship
152	620000	Air transport
153	631130	Cargo handling, harbours; travel agencies
154	634000	Transport agencies n.e.c.
155	640000	Telecommunications and postal services
156	651000	Monetary intermediation
157	652000	Financial intermediation n.e.c.
158	660102	Life insurance and pension funding
159	660300	Non-life insurance
160	670000	Activities aux. to financial intermediation
161	701109	Real estate agents etc.
162	702009	Dwellings
163	702040	Letting of non-residential buildings
164	710000	Renting of machinery and equipment etc.
165	721009	Computer activities excl. software consultancy and supply
166	722000	Software consultancy and supply
167	730001	Research and development (market)
168	730002	Research and development (non-market)
169	741100	Legal services
170	741200	Accounting, book-keeping, auditing etc.
171	742009	Consulting engineers, architects etc.
172	744000	Advertising
173	747000	Industrial cleaning
174	748009	Business activities n.e.c.
175	751100	General public service activities
176	751209	Public service, excl. for business
177	751300	Public service for business
178	752000	Defence, justice, public security etc.
179	801000	Primary education
180	802000	Secondary education
181	803000	Higher education
182	804001	Adult and other education (market)
183	804002	Adult and other education (non-market)
184	851100	Hospital activities
185	851209	Medical, dental, veterinary services etc.
186	853109	Social institutions etc. for children
187	853209	Social institutions etc. for adults
188	900010	Sewage removal and disposal
189	900020	Refuse collection and sanitation
190	900030	Waste incineration
191	910000	Activities of membership organisations

192	920001	Recreational & cultural activities, market
193	920002	Recreational & cultural activities, non-market
194		Hairdressing and other beauty shops
195		Laundries and dry cleaners
196		Funeral services
197	930009	Service activities n.e.c

Consumption

	final use	need group	code (COICOP,…?)	product/service
1	Private consumption	Food	1110	Bread and cereals
2		Food	1120	Meat
3		Food	1130	Fish
4		Food	1141	Eggs
5		Food	1142	Milk, cream, yoghurt etc.
6		Food	1143	Cheese
7		Food	1150	Butter, oils and fats
8		Food	1160	Fruit and vegetables, except potatoes
9		Food	1171	Potatoes etc.
10		Food	1181	Sugar
11		Food	1182	Ice cream, chocolate and sugar products
12		Food	1190	Salt, spices, soups etc.
13		Food	1210	Coffee, tea and cocoa
14		Food	1220	Mineral waters, soft drinks and juices
15		Food	2110	Wine and spirits
16		Food	2130	Beer
17		Leisure	2210	Tobacco
18		Clothing	3110	Clothing purchase
19		Clothing	3140	Laundering, dry cleaning etc.
20		Clothing	3200	Footwear
21		Housing		Dwelling, use and maintenance
22			4100	Actual rentals for housing
23			4200	Imputed rentals for housing
24			4300	Regular maintenance and repair of the dwelling
25		Hygiene	4410	Refuse collection, other services n.e.c.
26		Clothing		Collection of old jewellery
27			4430	Water supply and sewerage services
28			4510	Electricity
29			4520	Gas
30			4530	Liquid fuels
31			4540	Hot water, steam etc.
32		Food	Activity	Storage of food in households
33		Food	Activity	Cooking in households
34		Food	Activity	Dishwashing in household
35		Clothing	Activity	Clothes washing (private)
36		Hygiene	Activity	Personal hygiene
37		Hygiene	Activity	Toilet flush in household
38		Hygiene	Activity	Cleaning of household
39		Leisure	Activity	Television, computer etc., incl. use
40		Housing	Activity	Lighting in households
41		Housing	Activity	Heating in households, incl. combustion
42		Other consumption n.e.c.	Activity	Household activities using electricity n.e.c.
43		Housing	5100	Furniture & furnishing
44		Housing	5200	Household textiles
45			5310	Major household appliances
46			5330	Repair of major household appliances
47		Food	5400	Glass, tableware and household utensils
48		Housing	5500	Tools & equipment for house and garden

49		Clothing		Detergents prepared for use
50		Leisure		Candles
51		Hygiene		Brooms and brushes
52		Housing		Matches
53		Housing		Carbondioxide cartridges
54		Housing		Metal articles n.e.c.
55		Housing		Paper articles n.e.c.
56		Housing		Pesticides
57		Housing		Plastic articles n.e.c.
58		Housing		Polishes
59		Housing		Solvents
60		Housing		Textile articles n.e.c.
61		Housing	5610	Non-durable household goods n.e.c.
62		Social care	5620	Domestic services and home care services
63		Health	6111	Medical and pharmaceutical products
64		Health	6112	Therapeutic equipment
65		Health	6200	Medical doctors and dentists
66		Health	6300	Hospital services
67			7100	Purchase of vehicles
68			7210	Maintenance and repairs of motor vehicles
69			7220	Fuels and lubricants
70		Communication		Car purchase and driving to/from work
71		Food		Car purchase and driving for shopping
72		Leisure		Car purchase and driving for leisure
73		Leisure		Car driving for holiday abroad
74		Communication	7240	Car driving, fringe benefits and services
75		Communication	7300	Transport services
76		Communication	8100	Communications
77		Leisure	9120	Photographic equipment etc.
78			9130	Data processing equipment
79			9140	Recording media for pictures and sound
80			9150	Repair of a/v and data processing equipment
81		Leisure	9200	Major durables f. recreation & culture n.e.c.
82		Leisure	9300	Recreational items n.e.c.
83		Leisure		Toys
84		Leisure		Petfood and veterinarian services
85		Leisure		Christmas trees
86		Leisure		Plants and flowers
87		Housing		Tools & equipment for recreation
88		Housing		Tents and outdoor equipment
89		Leisure		Fireworks
90		Leisure	9400	Recreational and cultural services
91		Leisure	9510	Books, newspapers etc.
92		Leisure	9530	Stationery and drawing materials etc.
93		Leisure	9600	Package holidays
94		Education	9700	Schools and other education
95		Food	9810	Catering
96		Leisure	9820	Accommodation services
97		Hygieine	9911	Hairdressing salons etc.
98			9912	Appliances, articles and products for personal care
99		Clothing	9921	Jewellery, clocks and watches
100		Clothing	9922	Personal effects n.e.c.

101		Social care	9931	Social care for the elderly
102		Social care	9932	Kindergartens, creches etc.
103		Security	9940	Insurance
104		Other consumption n.e.c.	9950	Financial services n.e.c.
105		Other consumption n.e.c.	9960	Services n.e.c.
106			9980	Consumption of non-residents on the economic territory
107		Leisure	9990	Consumption of residents in the ROW
1		Social care	73	Consumption by private non-profit institutions
1	Public consumption	Health	2- 6111	Medical and pharmaceutical products, public cons.
2		Health	3- 6112	Therapeutic equipment, public cons.
3		Health	4- 6200	Out-patient services
4		Health	5- 7300	Transport services, public cons.
5		Social care	6- 9960	Services n.e.c., public cons.
6		Housing	7- 4100	Dwellings, use of (rented), public
7		Health	8- 6200	Medical doctors and dentists, public cons.
8		Health	9- 6300	Hospital services, public cons.
9		Leisure	10- 9400	Recreational and cultural services
10		Education	11- 9700	Education
11		Social care	12- 9931	Social care for the elderly, public cons.
12		Social care	13- 9932	Kindergartens, creches etc., public cons.
13		Security	14- 9940	Insurance, public cons.
1		Security	15 CG 981	General public services, public order and safety affairs
2		Security	16 CG 982	Defence, affairs and services
3		Education	17 CG 983	Education and research affairs and services
4		Health	18 CG 984	Health affairs and services
5		Social care	19 CG 985	Social security and welfare affairs and services
6		Social care	20 CG 986	Housing and community affairs
7		Leisure	21 CG 987	Recreational services
8		Other consumption n.e.c.	22 CG 988	Economic affairs and services

ANNEX Accounts

CPA	product
01A1	Landbouw, jacht en aanverwante diensten
02A1	Bosbouw, bosexploitatie en aanverwante diensten
05A1	Visserij en het kweken van vis en schaal- en schelpdieren
10A1	Winning van steenkool, bruinkool en turf
13A1	Winning van metaalertsen
14A1	Overige winning van delfstoffen
15A1	Produktie en verwerking van vlees en vleesprodukten
15B1	Verwerking en conservering van vis en vervaardiging van visprodukten
15C1	Verwerking en conservering van groenten en fruit
15D1	Vervaardiging van plantaardige en dierlijke oliën en vetten
15E1	Zuivelnijverheid
15F1	Maalderijen en vervaardiging van zetmeel en zetmeelprodukten
15G1	Vervaardiging van diervoeders
15H1	Vervaardiging van brood, vers banketbakkerswerk, beschuit en koekjes
15I1	Vervaardiging van suiker, chocolade en suikerwerk
15J1	Vervaardiging van deegwaren, koffie en thee, en overige voedingsmiddelen -
15K1	Vervaardiging van dranken, excl. mineraalwater en frisdrankenissantes
15L1	Vervaardiging van mineraalwater en frisdranken
16A1	Vervaardiging van tabaksprodukten
17A1	Bewerken en spinnen van textielvezels, weven van textiel en textielveredeling -
17B1	Vervaardiging van geconfectioneerde artikelen van textiel excl. kleding, overige textielprodukten, gebreide en gehaakte stoffen en artikelen
18A1	Vervaardiging van kleding en bontnijverheid
19A1	Leernijverheid en vervaardiging van schoeisel
20A1	Houtindustrie en vervaardiging van artikelen van hout, kurk, riet en vlechtwerk -
21A1	Papier- en kartonnijverheid
22A1	Uitgeverijen
22B1	Drukkerijen en aanverwante diensten en reproduktie van opgenomen media
23A1	Vervaardiging van cokes, geraffineerde aardolieproducten en splijt- en kweekstoffen
24A1	Vervaardiging van chemische basisprodukten
24B1	Vervaardiging van verdelgingsmiddelen en van chemische produkten voor de landbouw
24C1	Vervaardiging van verf, vernis en drukinkt
24D1	Farmaceutische nijverheid
24E1	Vervaardiging van zeep, was- en poetsmiddelen, parfums en kosmetische artikelen
24F1	Vervaardiging van overige chemische produkten
24G1	Vervaardiging van synthetische en kunstmatige vezels
25A1	Rubbernijverheid
25B1	Vervaardiging van produkten van kunststof
26A1	Vervaardiging van glas en glaswerk
26B1	Vervaardiging van keramische produkten
26C1	Vervaardiging van cement, kalk en gips -
26D1	Vervaardiging van artikelen van beton, gips en cement, natuursteen en overige niet-metaalhoudende produkten
27A1	Vervaardiging van ijzer en staal, ferro-legeringen (EGKS), en buizen
27B1	Eerste verwerking van staal, productie van niet-EGKS-ferrolegeringen en non-ferro metalen, en gieten van metalen
28A1	Vervaardiging van metalen constructiewerken, metalen recipiënten, radiatoren en kelels voor centrale verwarming, stoomketels; smeden, persen, stampen en profielwalsen van metaal
28B1	Oppervlaktebehandeling en bekleding van metaal; algemene metaalbewerking -

28C1	Vervaardiging van scharen, messen, bestekken, gereedschap en ijzerwaren, en overige produkten van metaal
29A1	Vervaardiging van motoren en mechanisch drijfwerk, exclusief motoren voor luchtvaartuigen, motorvoertuigen en -rijwielen
29B1	Vervaardiging van machines voor algemeen gebruik
29C1	Vervaardiging van machines voor de landbouw en de bosbouw, en gereedschapswerktuigen
29D1	Vervaardiging van huishoudapparaten
30A1	Vervaardiging van kantoormachines en computers
31A1	Vervaardiging van electromotoren en electrische generatoren en transformatoren, schakel- en verdeelinrichtingen, en geïsoleerde kabels en draad
31B1	Vervaardiging van accumulatoren en elektrische batterijen, elektrische lampen en verlichtingsapparaten, en elektrische benodigdheden
32A1	Vervaardiging van audio-, video- en telecommunicatieapparatuur
33A1	Vervaardiging van medische apparatuur, van precisie- en optische instrumenten en van uurwerken
34A1	Vervaardiging en assemblage van auto's
34B1	Vervaardiging van carrosserieën, aanhangwagens en caravans, en van onderdelen en accessoires voor auto's
35A1	Vervaardiging van overige transportmiddelen
35B1	Vervaardiging van motorrijwielen en rijwielen, en overige transportmiddelen, n.e.g
36A1	Vervaardiging van meubels
36B1	Bewerking van edelstenen en vervaardiging van juwelen
36C1	Vervaardiging van muziekinstrumenten, sportartikelen, spellen en speelgoed, en overige industrie
37A1	Recuperatie
40A1	Produktie en distributie van elektriciteit, gas, stoom en warm water
41A1	Winning, zuivering en distributie van water
45A1	Het bouwrijp maken van terreinen
45B1	Algemene bouwkundige en civieltechnische werken, dakbedekking en bouw van dakconstructies
45C1	Aanleg van spoorwegen, wegen, straten, vliegvelden en sportaccomodaties, waterbouw, en overige werkzaamheden in de bouw
45D1	Bouwinstallatie
45E1	Afwerking van gebouwen, en verhuur van machines voor de bouwnijverheid met bedieningspersoneel
50A1	Handel in auto's, onderhoud en reparatie van auto's, handel in onderdelen en accessoires van auto's, handel in en reparatie van motorrijwielen
50B1	Kleinhandel in motorbrandstoffen
51A1	Groothandel en handelsbemiddeling
52A1	Kleinhandel, reparatie van consumentenartikelen
55A1	Hotels en overige accomodaties voor kortstondig verblijf, markt
55B1	Restaurants, drankgelegenheden, kantines en catering
60A1	Vervoer per spoor
60B1	Personenvervoer te land volgens een dienstregeling, taxis, en overig vervoer van personen te land
60C1	Goederenvervoer over de weg en verhuisdiensten, en vervoer via pijpleidingen -
61A1	Zee- en kustvaart
61B1	Binnenvaart
62A1	Luchtvaart
63A1	Reisbureaus en touroperators
63B1	Vrachtbehandeling en opslag, overige vervoerondersteunende activiteiten, organisatie van het vrachtvervoer
64A1	Postactiviteiten
64B1	Telecommunicatie
65A2	Financiële instellingen
66A2	Verzekeringswezen
67A1	Hulpbedrijven i.v.m. financiële instellingen en het verzekeringswezen
70A1	Verhuur en handel in onroerende goederen
71A1	Verhuur van auto's en overige transportmiddelen
71B1	Verhuur van machines en werktuigen, en overige roerende goederen
72A1	Informatica en aanverwante activiteiten
73A1	Speur- en ontwikkelingswerk, markt

73A5	Speur- en ontwikkelingswerk, niet-markt
74A1	Rechtskundige dienstverlening, en accountants, boekhouders en belastingconsulenten, markt- en opinieonderzoekbureau's
74B1	Adviesbureaus op het gebied van bedrijfsvoering en beheer, managementactiviteiten van holdings en coördinatiecentra
74C1	Technisch advies, architecten en ingenieurs, technische testen en analyses -
74D1	Reclamewezen
74E1	Selectie en terbeschikkingstelling van personeel
74F1	Opsporings- en beveiligingsdiensten, industriële reiniging, en diverse dienstverlening aan bedrijven
75A3	Openbaar bestuur, excl. defensie en verplichte sociale verzekering
75B3	Defensie
75C3	Verplichte sociale verzekering
80A1	Onderwijs, markt
80A3	Openbaar onderwijs
80A5	Onderwijs, ander niet-markt
85A1	Gezondheidszorg
85B1	Veterinaire diensten
85C1	Maatschappelijke dienstverlening, markt
85C5	Maatschappelijke dienstverlening, niet-markt
90A1	Afvalwater- en afvalverzameling; straatreiniging
91A1	Diverse verenigingen, markt
91A5	Diverse verenigingen, niet-markt
92A1	Activiteiten op het gebied van film en video, radio en televisie
92B1	Overige activiteiten op het gebied van amusement, markt
92C1	Persagentschappen, en overige culturele activiteiten, markt
92D1	Sport en overige recreatie, markt
92B5	Overige activiteiten op het gebied van amusement, niet markt
92C5	Overige culturele activiteiten, niet markt
92D5	Sport, niet markt
93A1	Overige diensten
95A4	Particuliere huishoudens met werknemers

ANNEX Energy

The sectoral detail of the Flanders energy balance

IndustryIron and steel
- Non-ferro
- Chemistry
- Food, drinks and tobacco
- Paper and publishing
- Mineral non-metallic products
- Metal processing industry
- Textile, leather and clothing
- Building industry
- Wood and furniture industry
- Rubber and synthetics industry
- Waste recuperation
- Other industries

Division for energy use in MIRA core data set

Bevolking	
Industrie	Chemie
	IJzer en staal
	Metaalverwerkende nijverheid
	Minerale niet-metaalprodukten
	Non-ferro
	Papier en uitgeverijen
	Textiel, leder en kleding
	Voeding, dranken en tabak
	diverse deelsectoren (o.a. niet verder toewijsbare warmte en elektriciteit)
	Andere industrieën
Energie	Cokesfabrieken
	Distributie en transport van elektriciteit
	Productie van elektriciteit en warmte
	Raffinaderijen
	Transport en distributie van gas
	Andere (o.a. steenkoolmijnen)
Landbouw	Akkerbouw
	Graasdierhouderij
	Intensieve veehouderij
	Glastuinbouw
	Vollegrondstuinbouw
	Blijvende teelten
	Zeevisserij
Verkeer & vervoer	Binnenscheepvaart
	Luchtvaart
	Spoorvervoer
	Wegvervoer
Handel & diensten	Handel
	Hotels en restaurants
	Kantoren en administratie
	Onderwijs
	Gezondheidszorg en maatschappelijke dienstverlening
	Gemeenschapsvoorzieningen, sociaal-culturele en persoonlijke diensten

NACE-codes for reporting on energy use

De codes in de tweede kolom van de onderstaande tabel zijn de NACE codes (Rev.1), die als bijlage zijn opgenomen bij de Verordening (EEG) Nr. 761/93 van de Commissie van 24 maart 1993 tot wijziging van de Verordening (EEG) nr. 3037/90 van de Raad betreffende de statistische nomenclatuur van de economische activiteiten in de Europese Gemeenschap (PB nr. L 83 van 3.4.1993, blz. 1 en rectificaties, PB nr. L 159 van 11.7.1995, blz. 31).

1. Energiesector	**NACE-codes**
1.1 Winning van steenkool, bruinkool en turf	10
1.2 Vervaardiging van cokesovenproducten	23.1
1.3 Vervaardiging van geraffineerde aardolieproducten	23.2
1.4 Bewerking van splijt- en kweekstoffen	23.3
1.5 Productie en distributie van elektriciteit, gas, stoom en warm water	40
1.6 Overige	11; 12
2. Industriële sector	
2.1 IJzer- en staalnijverheid	27.1; 27.2; 27.3; 27.50; 27.51; 27.52
2.2 Non-ferro	27.4; 27.53; 27.54
2.3 Chemie	24
2.4 Voeding, dranken en tabak	15; 16
2.5 Papier en uitgeverijen	21; 22
2.6 Minerale niet-metaalproducten	26
2.7 Metaalverwerkende nijverheid	
2.7.1 Transportmiddelen	34; 35
2.7.2 Overige	28; 29; 30; 31; 32
2.8 Niet-energiehoudende delfstoffen	13; 14
2.9 Textiel, leder en kleding	17; 18; 19
2.10 Houtindustrie en vervaardiging van artikelen van hout	20
2.11 Bouwnijverheid	45
2.12 Overige	25; 36; 37, 33
3. Vervoer	
3.1 Vervoer per spoor	60.1
3.2 Overig vervoer te land	60.2
3.3 Vervoer via pijpleidingen	60.3
3.4 Vervoer over water	61
3.5 Luchtvaart	62
4. Tertiaire sector	
4.1 Horeca	55
4.1.2 Hotels	55.1
4.1.3 Restaurants, drankgelegenheden, kantines en catering	55.3 - 55.5
4.1.4 Kampeerterreinen en overige accommodaties voor kortstondig verblijf	55.2
4.2 Gezondheidszorg en maatschappelijke dienstverlening	85
4.2.1 Ziekenhuizen	85.11
4.2.2 Maatschappelijke dienstverlening waarbij onderdak wordt verschaft (rusthuizen etc.)	85.31
4.2.3 Overige	85.12 tem 85.14; 85.2; 85.32
4.3 Onderwijs	80
4.3.1 Kleuter- en basisonderwijs	80.1
4.3.2 Secundair onderwijs	80.2
4.3.3 Hoger onderwijs	80.3
4.3.4 Volwasseneneducatie en overige vormen van onderwijs	80.4
4.4 Andere gemeenschaps-, sociale en persoonlijke dienstverlening	
4.4.1 Winning en distributie van water; zuivering van zeewater	41
4.4.2 Afvalwater- en afvalverzameling	90
4.4.3 Sport, cultuur en recreatie	92
4.4.3.1 Sport	92.6
4.4.3.2 Cultuur en recreatie	92 met uitz. van 92.6
4.4.4 Wassen en chemisch reinigen van textiel en bontproducten	93.01
4.4.5 Overige	93.02 tem 93.05;91
4.5. Kantoren en administratie	
4.5.1 Vervoersondersteunende activiteiten; reisbureaus	63
4.5.2 Post en telecommunicatie	64
4.5.3 Financiële instellingen en zakelijke dienstverlening	65 - 67, 70, 71, 72,74
4.5.4 Speur- en ontwikkelingswerk	73
4.5.5 Openbaar bestuur en defensie, verplichte sociale verzekeringen	75
4.5.6 Overige	99
4.6 Handel	
4.6.1Verkoop, onderhoud en herstelling van auto's en motorrijwielen; kleinhandel in brandstoffen	50
4.6.2 Groothandel en handelsbemiddeling met uitzondering van handel in auto's en motorrijwielen	51

4.6.2.1 Groothandel in voedings- en genotsmiddelen	51.3
4.6.2.2 Overige	51.1; 51.2; 51.4 tem 51.9
4.6.3 Kleinhandel met uitzondering van kleinhandel in auto's en motorrijwielen; reparatie van consumentenartikelen	52
4.6.3.1 Kleinhandel in niet-gespecialiseerde winkels waarbij voedings- en genotmiddelen overheersen	52.11
4.6.3.2 Overige	52 met uitz. van 52.11
5. Openbare verlichting	**Enkel voor elektriciteit**
6. Landbouw, jacht, bosbouw, visserij	
6.1 Teelt van groenten, tuinbouw- en kwekerijproducten	01.12
6.2 Veeteelt	01.2
6.3 Overige landbouw, bosbouw en visserij	01.1 (met uitz. van 01.12), 01.3 tem 01.5, 02, 05
7. Huishoudens	95 tem 98

ANNEX Land

001BOUWLAND
002WEILAND
003HOOILAND
004TUIN
005WARMOESGR.
006SCH.HOOIL.
007VETWEIDE
008SCHAAPSWEI
009BOS
010BOOMG.HOOG
011BOOMG.LAAG
013BOOMKWEK.
014KERSTBOMEN
017PARK
018SPORTTERR.
020SPEELTERR.
021KAMPEERT.
022ZWEMBAD
024WELWATER
025POEL
026VIJVER
027MEER
028GRACHT
029SLOOT
030VISKWEKER.
033WEG
034PLEIN
035WOESTE GR.
036HEIDE
038MOERAS
039VEEN
041AANSPOEL.
042DUIN
043WAL
044DIJK
045STEENB.WGR
046STORT.WGR.
049STORT.EXP.
050NIJV/GROND
051WERF
052KAAI
054BASSIN N/V
055SPOORWEG
056STEENB.EXP
057GROEVE
059KANAAL
062GRAFHEUVEL
063MERKSTEEN
067BEB.OPP.G
068BEB.OPP.U
069BEB.OPP.N
070GROND
071PARKING
072VLIEGVELD
073MILIT.TERR
074KERKHOF
075WIJMLAND
076BASSIN GEW
077KOER
078BOUWGROND
079D.PARKING#
164OPP.&& G.D
165G.D.AP.GEB
166BEB.OPP.A
200HUIS
201NOODWONING
202KROTWONING
203BERGPLAATS
204GARAGE
205AFDAK
206LAVATORY
220D.AP.GEB.#

221M.D.AP.GEB
222BUILDING
223HUIS#
240HOEVE
241PAARDESTAL
242DUIVENTIL
243K.VEETEELT
244G.VEETEELT
245SERRE
246PADDEST/KW
247LANDGEBOUW
260DRUKKERIJ
261GAR.WERKPL
262SMIDSE
263SCHRIJNW.
264WASSERIJ
265WERKPLAATS
280ZUIVELFAB.
281BAKKERIJ
282VLEESW/FAB
283SLACHTERIJ
284VEEVOE/FAB
285KOFFIEFAB.
286BROUWERIJ
287DRANKFABR.
288TABAKFABR.
289MAALDERIJ
290VOEDINGS/F
300KLEDINGFAB
301TEXTIELFAB
302LEDERWAR/F
303MEUBELFAB.
304SPEELG/FAB
305PAPIERFAB.
306GEBRUIKS/F
320STEENBAKK.
321CEMENTFAB.
322ZAGERIJ
323VERFFABR.
324BOUWMAT/F.
340METAALNIJV
341HOOGOVEN
342KALKOVEN
343CONSTR/WPL
344ELEK.MAT.F
345PETROL/RAF
346CHEMIC/FAB
347RUBBERFAB.
348IJSFABRIEK
349GLASFABR.
350PLAST/FAB.
351AARDEW/FAB
352KOLENMIJN
353ELEK.CENTR
354GASFABRIEK
355GAZOMETER
356COKESFABR.
357NIJV/GEB.
370HANGAR
371MAGAZIJN
372ELEK.CABIN
373PYLOON
374GASCABINE
375CABINE
376RESERVOIR
377SILO
378ONDERZOEKC
379DROOGINST.
380KOELINR.
381MAT.&& OUT
382BEDRIJFSC#
400BANK
401BEURS
402KANTOORGEB
403DRANKHUIS
404HOTEL

405RESTAURANT
406FEESTZAAL
407HAND/HUIS
408GR.WARENH.
409GAR.STELPL
410PARKEERGEB
411SERV.STAT.
412OVER.MARKT
413TOONZAAL
414KIOSK
415DIERENGEB.
420GEM/HUIS
421GOUVER/GEB
422K.PALEIS
423GERECHTSH.
424STRAFINR.
425GEZANTSCH.
426GENDARMER.
427MILIT.GEB.
428STATION
429WACHTHUIS
430TEL/CEL
431TELECOM/G.
432LUCHTHAVEN
433LIJKENHUIS
434ADMIN.GEB.
440WEESHUIS
441KINDERBEW.
442BESCHER/W.
443RUSTHUIS
444VERPL/INR.
445KUURINR.
446WELZIJNSG.
460SCHOOLGEB.
461UNIVERSIT.
462MUSEUM
463BIBLIOTH.
480KERK
481KAPEL
482KLOOSTER
483PASTORIE
484SEMINARIE
485BISDOM
486SYNAGOGE
487MOSKEE
488TEMPEL
489GEB.ERED.
500BADINRICHT
501SPORTGEB.
502VAKAN/TEH.
503VAKAN/VERB
504JEUGDHEEM
505THEATER
506SPEKT/ZAAL
507KULT.CENTR
508BIOSCOOP
509CASINO
510UITKIJK
520PUIN
521ONDERGR.R.
522PAVILJOEN
523KASTEEL
524HISTOR.GEB
525MONUMENT
526WINDMOLEN
527WATERMOLEN
528WATERTOREN
529WATERWINN.
530ZUIVER/INS
531AFVALVERW.

ANNEX Water

Sectoral division of emissions (Ag, As, BZV, Cd, Cr, Cu, CZV, Hg, N, Ni, P, Pb, Zn and floating dust) to surfacewater in the MIRA core data set:

- Bevolking (incl. een groot deel van Handel & diensten)
- Industrie (enkel data beschikbaar voor bedrijven bemonsterd door VMM, ≠ totaal van deze sector)
- Energie (enkel data beschikbaar voor bedrijven bemonsterd door VMM, ≠ totaal van deze sector)
- Landbouw: N en P voor totale landbouw. Daarnaast zijn ook emissies gekend van enkele bedrijven die door de VMM bemonsterd worden, ≠ totaal van deze sector)
- Handel & diensten (zit deels bij Bevolking. Daarnaast zijn ook data beschikbaar voor bedrijven die bemonsterd worden door VMM, ≠ totaal van deze sector)

1 Huishoudens	
2 Industrie	2.1 chemie
	2.2 metaal
	2.3 voeding
	2.4 textiel
	2.5 papier
	2.6 andere industrieën
3 Energie	3.1 & 3.3 produktie en distributie van elektriciteit, gas, stoom en warm water
	3.2 petroleumraffinaderijen
	3.4 overige energiebedrijven
4 Landbouw	4.1 akkerbouw, tuinbouw, veeteelt, jacht
	4.2 visserij en visteelt
6 Handel & diensten	6.1 handel
	6.2 hotels en restaurants
	6.3 kantoren en administratie
	6.4 onderwijs
	6.5 gezondheidszorg en maatschappelijke dienstverlening
	6.6 gemeenschapsvoorzieningen, sociaalculturele en persoonlijke diensten
	6.7 overige dienstverlening

Sectoral division of water use in the MIRA core data set:

Huishoudens

Industrie	Voeding
	Textiel
	Hout etc.
	Papier
	Chemie
	Metaal
	Waterwinning
	Overige
Energie	Raffinaderijen
	Elektriciteit & gas
Landbouw	Pluimvee
	Varkens
	Rundvee
	Ander vee
	Landbouw overige
	Landbouw niet onderverdeeld
Handel & diensten	Hotels & restaurants
Overige	

Different divisions used for MIRA, VMM-levying and annual emission reports

The table below gives an indication of the conversion possibilities of the different classifications in use.

MIRA		NACE		VMM-heffingen				VMM-emissiejaarverslag	
Mira sector	**sub-groep MIRA**	NACE-afdeling	NACE-Bel = activiteit	betreffende nace	heffingssector		heffingssector	EJV water 2000	naam EJV water
Industrie	vervaardiging van machines, apparaten en werktuigen	29	29	290	32		metaalindustrie	280	metaalnijverheid
Industrie	bouwnijverheid	45	45					240	hout+overige industrie
Industrie	chemische industrie	24	24	24	8	a	minerale chemie	260	chemie
Industrie	chemische industrie	24	24	24	8	b	organische chemie	260	chemie
Industrie	chemische industrie	24	24	2430	27		lak en verf	260	chemie
Industrie	chemische industrie	24	24	2451	40		poets en smeermiddelen	260	chemie
Industrie	chemische industrie	24	24	2451	52		zeepfabrieken	260	chemie
Industrie	chemische industrie	24	24	2452	36		parfum en cosmetica	260	chemie
Industrie	houtindustrie	20	20					240	hout+overige industrie
Industrie	leernijverheid en schoeisel	19	19	19	22	a	chroomleerlooierijen	230	textiel
Industrie	leernijverheid en schoeisel	19	19	19	22	b	plantaard. Leerlooierij	230	textiel
Industrie	leernijverheid en schoeisel	19	19	19	22	c	witleerlooi	230	textiel

Industrie	leernijverheid en schoeisel	19	19	19	22	e	zeemleerlooi	230	textiel
Industrie	metallurgie	27	27	270	33		metallurgie	280	metaalnijverheid
Industrie	overige winning delfstoffen	14	14					210	mijnbouw
Industrie	papier- en kartonnijverheid + uitgeverijen, drukkerijen	21	21	21	35		papierindustrie	250	papier
Industrie	papier- en kartonnijverheid + uitgeverijen, drukkerijen	22	22	22	18		grafisch en papier	250	papier
Industrie	prod. v. metaal	28	28	280	32		metaalindustrie	280	metaalnijverheid
Industrie	prod. v. metaal	28	28	285	15		galvanisatie	280	metaalnijverheid
Industrie	recyclage van afval	37	37					290	afvalverwerking en recyclage
Industrie	rubber en kunststofnijverheid	25	25	2510	50		vulkanisering en rubber	260	chemie
Industrie	rubber en kunststofnijverheid	25	25	2520	38		plastiekverwerking	260	chemie
Industrie	vervaardiging audio,vodeo,telecom	32	32					280	metaalnijverheid
Industrie	vervaardiging electrische en electronische apparaten en instrumenten	31	31					280	metaalnijverheid
Industrie	vervaardiging kantootmach. en computers	30	30					280	metaalnijverheid
Industrie	vervaardiging med.app.,precisie app.	33	33					280	metaalnijverheid
Industrie	vervaardiging transportmiddelen	34	34					280	metaalnijverheid
Industrie	vervaardiging transportmiddelen	35	35					280	metaalnijverheid
Industrie	vervaardiging van meubels	36	36	36	24		kaarsen	240	hout+overige industrie
Industrie	vervaardiging van overige niet-metaalhoudende minerale producten	26	26	261			vervaardiging glas	240	hout+overige industrie
Industrie	vervaardiging van overige niet-metaalhoudende minerale producten	26	26	262	13		emailleerderijen	240	hout+overige industrie
Industrie	vervaardiging van overige niet-metaalhoudende minerale producten	26	26	263	13		emailleerderijen	240	hout+overige industrie
Industrie	vervaardiging van overige niet-metaalhoudende minerale producten	26	26	263	25		keramiek	240	hout+overige industrie
Industrie	vervaardiging van overige niet-metaalhoudende minerale producten	26	26	264	3		aardewerk en cement	240	hout+overige industrie
Industrie	vervaardiging van overige niet-metaalhoudende minerale producten	26	26	265	3		aardewerk en cement	240	hout+overige industrie
Industrie	vervaardiging van overige niet-metaalhoudende minerale producten	26	26	266	3		aardewerk en cement	240	hout+overige industrie
Industrie	vervaardiging van overige niet-metaalhoudende minerale producten	26	26	267			natuursteen	240	hout+overige industrie
Industrie	vervaardiging van textiel en kleding + ledernijverheid en vervaardiging van schoeisel	17	17	171	45	a	spinnerij	230	textiel
Industrie	vervaardiging van textiel en kleding + ledernijverheid en vervaardiging van schoeisel	17	17	172	45	b	weverij	230	textiel
Industrie	vervaardiging van textiel en kleding + ledernijverheid en vervaardiging van schoeisel	17	17	173	45	c	textielveredeling	230	textiel
Industrie	vervaardiging van textiel en kleding + ledernijverheid en vervaardiging van schoeisel	17	17	173	45	d	wolwasserij	230	textiel
Industrie	vervaardiging van textiel en kleding + ledernijverheid en vervaardiging van schoeisel	18	18					230	textiel
Industrie	vervaardiging van voedings- en genotmiddelen	15	15	1511	10		destructiebedrijven	220	voeding+voedingindustrie

Industrie	vervaardiging van voedings- en genotmiddelen	15	15	1511	41	a	varkensslachthuizen	220	afvalverwerking en recyclage
Industrie	vervaardiging van voedings- en genotmiddelen	15	15	1511	41	b	andere slachthuizen	220	voedingindustrie
Industrie	vervaardiging van voedings- en genotmiddelen	15	15	1512	39	a	pluimveeslachterijen1	220	voeding+voedingindustrie
Industrie	vervaardiging van voedings- en genotmiddelen	15	15	1512	39	b	pluimveeslachterijen2	220	voeding+voedingindustrie
Industrie	vervaardiging van voedings- en genotmiddelen	15	15	1512	39	c	pluimveeslachterijen3	220	voeding+voedingindustrie
Industrie	vervaardiging van voedings- en genotmiddelen	15	15	1513	49	a	worst en ham	220	voeding+voedingindustrie
Industrie	vervaardiging van voedings- en genotmiddelen	15	15	1513	49	b	andere vleeswaren	220	voeding+voedingindustrie
Industrie	vervaardiging van voedings- en genotmiddelen	15	15	1520	47		visconserven	220	voeding+voedingindustrie
Industrie	vervaardiging van voedings- en genotmiddelen	15	15	1530	2		aardappelverwerking	220	voeding+voedingindustrie
Industrie	vervaardiging van voedings- en genotmiddelen	15	15	1530	14		fruitconserven	220	voeding+voedingindustrie
Industrie	vervaardiging van voedings- en genotmiddelen	15	15	1530	19		groentconserven	220	voeding+voedingindustrie
Industrie	vervaardiging van voedings- en genotmiddelen	15	15	1530	20		groentwasserijen	220	voeding+voedingindustrie
Industrie	vervaardiging van voedings- en genotmiddelen	15	15	1540	31		margarine en olie	220	voeding+voedingindustrie
Industrie	vervaardiging van voedings- en genotmiddelen	15	15	1550	53	a	zuivelindustrie nt gesan.	220	voeding+voedingindustrie
Industrie	vervaardiging van voedings- en genotmiddelen	15	15	1550	53	b	zuivelindustrie wel gesan.	220	voeding+voedingindustrie
Industrie	vervaardiging van voedings- en genotmiddelen	15	15	1562	42		stijfsel en zetmeel	220	voeding+voedingindustrie
Industrie	vervaardiging van voedings- en genotmiddelen	15	15	1570	6		diervoeders	220	voeding+voedingindustrie
Industrie	vervaardiging van voedings- en genotmiddelen	15	15	1580	6		andere voeding	220	voeding+voedingindustrie
Industrie	vervaardiging van voedings- en genotmiddelen	15	15	1583	44		suikerfabrieken	220	voeding+voedingindustrie
Industrie	vervaardiging van voedings- en genotmiddelen	15	15	1584	7		chocolade en suikerwerk	220	voeding+voedingindustrie
Industrie	vervaardiging van voedings- en genotmiddelen	15	15	1589	17		gist en spiritus	220	voeding+voedingindustrie
Industrie	vervaardiging van voedings- en genotmiddelen	15	15	1591	9		destilleerderijen	220	voeding+voedingindustrie
Industrie	vervaardiging van voedings- en genotmiddelen	15	15	1592	17		gist en spiritus	220	voeding+voedingindustrie
Industrie	vervaardiging van voedings- en genotmiddelen	15	15	1596	5	a	brouwerijen	220	voeding+voedingindustrie
Industrie	vervaardiging van voedings- en genotmiddelen	15	15	1596	5	b	brouwerijen	220	voeding+voedingindus

									trie
Industrie	vervaardiging van voedings- en genotmiddelen	15	15	1597	34		mouterijen	220	voeding+voedingindustrie
Industrie	vervaardiging van voedings- en genotmiddelen	15	15	1598	30		limonades	220	voeding+voedingindustrie
Industrie	vervaardiging van voedings- en genotmiddelen	16	16				tabaksprod.	220	voeding+voedingindustrie
Industrie	winning van metaalertsen	13	13					210	mijnbouw
Industrie	winning, zuivering en distributie van water	41	41					270	waterwinning&distr.
Energie	productie en distributie van elektriciteit, gas, stoom en warm water	40	40	401	12		electriciteitscentrales	310	Energie
Energie	vervaardiging van cokesovenproducten	23	231					310	Energie
Energie	vervaardiging van geraffineerde aardolieproducten	23	232					310	Energie
Energie	vervaardiging van splijt- en kweekstoffen	23	233					310	Energie
Energie	winning van steenkool,bruinkool en turf + winning van aardolie en aardgas en aanverwante diensten+ winning van uranium- en thoriumerts	10	10					310	Energie
Energie	winning van steenkool,bruinkool en turf + winning van aardolie en aardgas en aanverwante diensten+ winning van uranium- en thoriumerts	11	11					310	Energie
Energie	winning van steenkool,bruinkool en turf + winning van aardolie en aardgas en aanverwante diensten+ winning van uranium- en thoriumerts	12	12					310	Energie
landbouw	akkerbouw, tuinbouw en veeteelt	01	1	1	28	a	pluimvee	220	voeding+voedingindustrie
landbouw	akkerbouw, tuinbouw en veeteelt	01	1	1	28	b	varkens	220	voeding+voedingindustrie
landbouw	akkerbouw, tuinbouw en veeteelt	01	1	1	28	c	rundvee	220	voeding+voedingindustrie
landbouw	akkerbouw, tuinbouw en veeteelt	01	1	1	28	d	ander vee	220	voeding+voedingindustrie
landbouw	akkerbouw, tuinbouw en veeteelt	01	1	1	28	e	landbouw overige	220	voeding+voedingindustrie
landbouw	bosbouw	02	2					220	voeding+voedingindustrie
landbouw	visteelt	05	5					220	voeding+voedingindustrie
Handel & diensten	afvalverwerking	90	90002					290	afvalverwerking en recyclage
Handel & diensten	afvalverwerking	90	90003					290	afvalverwerking en recyclage
Handel & diensten	afvalverwerking	90	90004					290	afvalverwerking en recyclage
Handel & diensten	benzinetankstations	50	505	500	4		garages,transportwerkplaatsen	610	Handel & diensten
Handel & diensten	financiële instellingen	65	65					610	Handel & diensten
Handel &	financiële instellingen	66	66					610	Handel & diensten

diensten									
Handel & diensten	financiële instellingen	67	67					610	Handel & diensten
Handel & diensten	gezondheidszorg en maatschappelijke dienstverlening	85	85	85141	26		laboratoria	610	Handel & diensten
Handel & diensten	gezondheidszorg en maatschappelijke dienstverlening	93	9302					610	Handel & diensten
Handel & diensten	gezondheidszorg en maatschappelijke dienstverlening	93	9303					610	Handel & diensten
Handel & diensten	gezondheidszorg en maatschappelijke dienstverlening	93	9304					610	Handel & diensten
Handel & diensten	gezondheidszorg en maatschappelijke dienstverlening	93	9305					610	Handel & diensten
Handel & diensten	groot- en kleinhandel, reparaties auto's en huishoudartikelen	51	51					610	Handel & diensten
Handel & diensten	groot- en kleinhandel, reparaties auto's en huishoudartikelen	52	52					610	Handel & diensten
Handel & diensten	groot- en kleinhandel, reparaties auto's en huishoudartikelen	50	500	500	4		garages,transportwerk plaatsen	610	Handel & diensten
Handel & diensten	groot- en kleinhandel, reparaties auto's en huishoudartikelen	50	501	501	4		garages,transportwerk plaatsen	610	Handel & diensten
Handel & diensten	groot- en kleinhandel, reparaties auto's en huishoudartikelen	50	502	502	4		garages,transportwerk plaatsen	610	Handel & diensten
Handel & diensten	groot- en kleinhandel, reparaties auto's en huishoudartikelen	50	503	503	4		garages,transportwerk plaatsen	610	Handel & diensten
Handel & diensten	groot- en kleinhandel, reparaties auto's en huishoudartikelen	50	504	504	4		garages,transportwerk plaatsen	610	Handel & diensten
Handel & diensten	hotels en restaurants	55	55	55	21	a	hotels,rest,café	610	Handel & diensten
Handel & diensten	hotels en restaurants	55	55	55	21	b	pensions,campings,pr etparken	610	Handel & diensten
Handel & diensten	industriële reiniging	74	747	747	46		vatenreiniging	290	afvalverwerking en recyclage
Handel & diensten	o.a. onroerende goederen, gemeenschapsvoorzieningen, sociaal-culturele diensten	70	70					610	Handel & diensten
Handel & diensten	o.a. onroerende goederen, gemeenschapsvoorzieningen, sociaal-culturele diensten	71	71					610	Handel & diensten
Handel & diensten	o.a. onroerende goederen, gemeenschapsvoorzieningen, sociaal-culturele diensten	72	72					610	Handel & diensten
Handel & diensten	o.a. onroerende goederen, gemeenschapsvoorzieningen, sociaal-culturele diensten	73	73					610	Handel & diensten
Handel & diensten	o.a. onroerende goederen, gemeenschapsvoorzieningen, sociaal-culturele diensten	91	91					610	Handel & diensten

Handel & diensten	o.a. onroerende goederen, gemeenschapsvoorzieningen, sociaal-culturele diensten	92	92	9261	54		zwembaden	610	Handel & diensten
Handel & diensten	o.a. onroerende goederen, gemeenschapsvoorzieningen, sociaal-culturele diensten	99	99					610	Handel & diensten
Handel & diensten	onderwijs	80	80					610	Handel & diensten
Handel & diensten	openbaar bestuur	75	75					610	Handel & diensten
Handel & diensten	overige zakelijke dienstvetlening	74	741					610	Handel & diensten
Handel & diensten	overige zakelijke dienstvetlening	74	742					610	Handel & diensten
Handel & diensten	overige zakelijke dienstvetlening	74	743	743	26		laboratoria	610	Handel & diensten
Handel & diensten	overige zakelijke dienstvetlening	74	744					610	Handel & diensten
Handel & diensten	overige zakelijke dienstvetlening	74	745					610	Handel & diensten
Handel & diensten	overige zakelijke dienstvetlening	74	746					610	Handel & diensten
Handel & diensten	overige zakelijke dienstvetlening	74	748					610	Handel & diensten
Handel & diensten	RWZI's	90	90001					110	RWZI's
Handel & diensten	vervoer, opslag, communicatie, zonder tankstation	60	60					610	Handel & diensten
Handel & diensten	vervoer, opslag, communicatie, zonder tankstation	61	61					610	Handel & diensten
Handel & diensten	vervoer, opslag, communicatie, zonder tankstation	62	62					610	Handel & diensten
Handel & diensten	vervoer, opslag, communicatie, zonder tankstation	63	63					610	Handel & diensten
Handel & diensten	vervoer, opslag, communicatie, zonder tankstation	64	64					610	Handel & diensten
Handel & diensten	wassen en chemisch reinigen	93	9301	9301	51	a	natwasserijen	610	Handel & diensten
Handel & diensten	wassen en chemisch reinigen	93	9301	9301	51	b	droogkuis	610	Handel & diensten
					55		andere		