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TOWEF0

(Toward Effluent Zero)

EVALUATION OF THE EFFECT OF THE IPPC APPLICATION ON THE SUSTAINABLE WASTE MANAGEMENT IN TEXTILE INDUSTRIES

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*Authors
S. Scalbi ENEA
M. Tarantini ENEA
S. Verità Bologna University

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1 Introduction

The work documented in this report is part of the project "Evaluation of the effect of the IPPC application on the sustainable waste water management in textile industries (Towef0)" funded by European Commission as a shared cost RTD project in the 5th Framework Research program, Energy, Environment and Sustainable Development, Key action 1 Sustainable Management and Quality of Water, Treatment and purification technologies, Waste water treatment and reuse.

The project objective is to establish a multicriteria integrated and coherent implementation of Good Environmental Practices (GEP) and to promote the efficient use of resources within textile finishing industries characterised by large use of water, taking into account the treatment of industrial waste water effluent (Urban Waste Water Treatment Directive 91/271 EEC) and the impact of the final discharge to the water recipient bodies (Water Framework Directive COM (98)).

Within this framework ENEA-PROT-INN conducted detailed LCA studies on selected Italian and Belgian industries in order to estimate the overall impact of the companies on the environment and to evaluate the environmental effects of alternative water management scenarios.

Partners of the project were: ENEA, the Italian National Agency for New Technologies, Energy and the Environment, Vito, a Belgian research center for the industry, Centexbel, a research center for the Belgian textile federation, the Joint research Centers of Siviglia and Ispra, Lariana Depur S.p.A., a private Italian company, Ecobilan, a private French company and Lettinga Associates Foundation (LeAF), a Dutch foundation for environmental protection and resource conservation.

The purpose of this report is to present in a consistent and usable form the Life Cycle Inventories (LCI) of textile wet processes and general facilities developed in Work Package 8 of the Towef0 project (see [1-7]). The database, which has been built on the PIDACS data gathered in Italy by Lariana Depur and in Belgium by Centexbel, can be used by LCA experts to perform LCA studies on textile products and processes.

This document contains a short summary of a literature survey performed to evaluate the public availability of LCA studies on textile products and of specific LCI data.

In the Towef0 project, an effort has been made to collect data on LCI of textile chemicals by means of direct contacts with chemical producers and of a detailed check of the commercial LCA databases: the results are summarized in chapter 3.

The data on energy consumption and materials flows gathered by means of membrane treatment tests performed by ENEA in Work package 6 have been elaborated and included in Annex 8.

2 Literature review of LCA studies of textile products

During the first six months of the project the work focused on a literature survey of LCA case studies on textile products, with the double aim of defining the state of application of LCA methodology to textile sector and of checking the availability of detailed data on textile processes, chemicals and wastewater treatments.
The research was performed:

- By means of the ISI Web of Science and SwetsWise servers for bibliographic research;
- In the packages of international journals and reviews accessible by internet by ENEA library: Academic Press (600 titles), Blackwell Science (600 titles), Elsevier (1800 titles), IEEE , Kluwer (750 titles), Springer (513 titles), Wiley (520 titles) and so on;
- By personal contact with APAT (Italian Environmental Agency) and textile manufactures, associations, ……
- In Internet with several search engines as Google, Altavista with key word as LCA textile, LCA water treatment, ecc;

Abstracts and articles in full text were then selected and divided in three types:

1. Reports and articles on the environmental impacts of textile processes and wastewater treatments;
2. Reports and articles on specific LCA case studies on textile products;
3. Reports and articles on LCA on the treatment of wastewater.

Where relevant, the authors were contacted to have more specific information. Anyway for chemicals ecoprofiles often the data couldn't be disclosed to the public because they contained confidential information.
The most interesting and documented research projects on textile sector were Tex-change net and the Cost Action 628.

TEX CHANGE NET Expert Network for the Effects of the European Textile Industry on Global Change http://www.tex-change-net.org/ is a research network of textile and environmental experts. The network was formed in January 1999 by four leading textile institutes in Europe. The overall project aim was to provide European policy makers and textile industry with packaged information about:

- the environmental impact of the actual industrial activities and its contribution to global change (e.g. ozone depletion, climate change);
- the state of the actual utilisation of specific BAT (Best Available Technologies) in Europe considering local and regional aspects;
- cleaner technologies for preventing or minimising the environmental impact of textile products and processes regarding the overall effects on the environment and global change

The involved institutions in the Tex-change net project were:

- ITV-Institut für Textil- und Verfahrenstechnik, Denkendorf;
- Centro Tessile Cotoniero e Abbigliamento Busto Arsizio (VA);
- DTI-Danish Technological Institute Clothing and Textile, Taastrup;
- IFP-The Swedish Institute for Fibre and Polymer Research, Moelndal;

The internet site has a link to a knowledge database which contains, among other, some inventories of specific textile processes.

COST Action 628 is an European project on Life Cycle Assessment of Textile Products, Eco-efficiency and Definition of Best Available Technology of Textile Processing
COST 628 objectives are:

- Propose methods and guidelines for a simplified and balanced LCA for textile products
- Propose methods to compare textile products with environmental criteria
- Consider dematerialisation methods and practices
- Define BAT system boundaries for cleaner processing
- Suggest criteria for ISO environmental declaration
- Propose calculation and allocation rules for dematerialisation, recycling, energy generation and disposal

In this project there were several involved institutes from Belgium, Czech Republic, Denmark, Finland, Germany, Greece, Poland, Romania, Spain, Sweden, Switzerland and United Kingdom.

The articles found by this literature survey were organized in a database with bibliographic references and contact persons details with the format of Figure 1.
In the database were reported also the answers to our questions of several authors and institutes. The database is accessible on the Towef0 internet site http://spring.bologna.enea.it/towefo/ip_default.asp

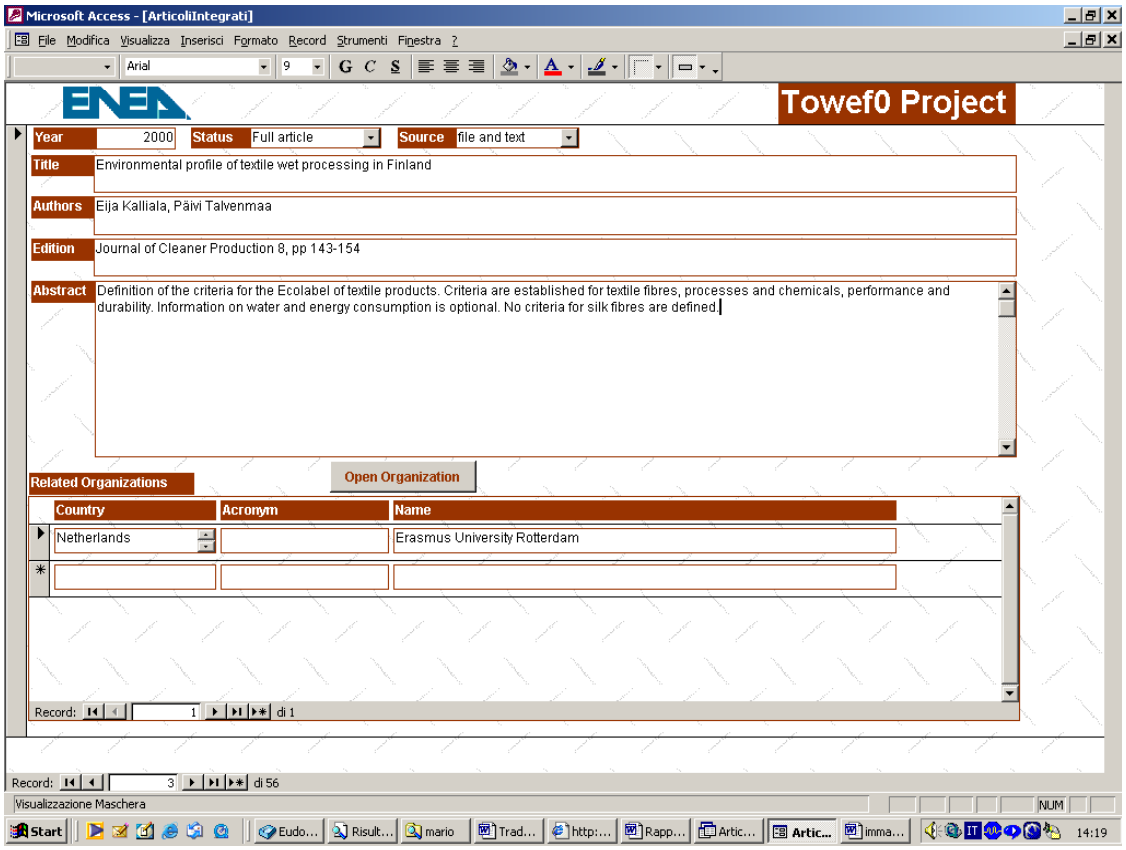

Fig 1 Format of database interface.

3 Textile chemicals inventories

The ecoprofiles of the production of the textile chemicals used within the selected Italian companies were searched within the main commercial LCA databases. The results of this survey, together with a short description of the databases contents and structure are reported in the following paragraph. The results of the contacts with the main chemicals manufacturers are reported in paragraph 3.2. Both surveys highlighted a lack of LCI data on textile chemical production. Anyway this lack did not influence the results of LCA analysis on innovative water management scenarios, because the selected scenarios did not imply any change in the chemicals use.

3.1 Textile chemicals inventories in LCA commercial databases

To perform all the LCA studies of Towef0 project, TEAM software, developed by Ecobilan, a partner of the project, was used. The TEAM software comes with a Starter Kit database of over 300 modules which range from fuel production to car and truck transport and from chemical production to plastic moulding. Anyway only a small percentage of textile chemicals was found within TEAM database, mainly the base chemicals, of common use in several industrial processes and not only in textile ones.
In order to verify if missed chemicals ecoprofiles were available in other databases, a survey of the main commercial products was performed. The checked databases were:

- SimaPro,
- IVAM,
- GABI,
- KCL
- Boustead model
- ECOINVENT

The result of this survey is reported in the following table. The only chemical not available in TEAM database was sodium dithionite; this ecoprofile has been buyed by KCL Ecodata and has been included in ourLCA studies.

Database / Product	Team 3.0	Boustead	GaBi	SimaPro	Ecoinvent	KCL EcoData	Ivam
Acetic acid	×	×	×		×		×
Acid buffer							
Acid dyestuff							
Acid hydrochloric	×	×	×		×		
Ammonia	×		×	×	×	×	×
Ammonium persulphate	×	×					
Antifoaming agent							
Antioxidizing agent							
Antireducing agent							
Antistatic agent							
Carrier							
Cationic acid							
Caustic soda	×	×	×		×	×	×
Deoxigenatic agent							
Detergent	×	×					×
Dispersant agent							
Equalising agent							
Equalizing agent							
Formic acid							
Lubricating agent							
Metacrylamide							
Non ionic surfactant							
Reactive dye							
Reducing agent							
Regenerating agent							
Sequestering agent							
Soaping agent							
Soda solvay	×	×	×	×	×	×	×
Sodium Chloride	×	×	×	×	×	×	×
Sodium Hydrosulphite					×	×	
Sodium Hydroxide	×	×	×		×	×	×
Sodium sulphate	×	×		×	×	×	
Softener							
Solubilizing agent							
Tickening agent							
Urea	×	×	×	×	×		×

Table 1 Textile chemicals ecoprofiles included in LCA commercial databases

In the following tables the main information included in the databases providers documentation is summarized.

Name	**DEAM**
Reference	
Organization	PricewaterhouseCoopers / Ecobilan Tour AIG G.E.S. Ecobilan SA 34, Place des Corolles 92908 La Défense cedex FRANCE tel. 33 (0) 1 56 57 58 59 fax 33 (0) 1 56 57 16 36 http://www.ecobilan.com register@ecobilan.com
Database contents	The DEAM™ Database includes thousands of datasets, most of which have been gathered through on-site visits and detailed questionnaires. Each DEAM™ module provides data for the consumption of raw materials and energy as well as releases to air, water and land for a discrete process or activity. All DEAM™ modules are supported by explanatory notes documenting the origins, age, representativeness, etc of the data. The Starter kit consists of about 360 processes, divided in ten category: paper, plastic and petrol chemical matters, inorganic compounds, steel, aluminium, other metals, glass, energy, transport, waste treatment. Modules can represent both "cradle to gate" and "gate to gate" data. The main sources of data are APME, BUWAL, ETH. The TEAM software is compatible with Ecoinvent data It is possible to consult on-line DEAM catalogue and ask for the modules you need by clicking on the SEARCH ENGINE link
Database format	Database for TEAM software

Table 2 Short description of DEAM database.

Name	**SimaPro**
Reference	
Organization	12 Plotterweg, Amersfoort 3821 BB, The Netherlands Phone +31 33 4555022 - Fax: +31 33 4555024 http://www.pre.nl/index.html e-mail: info@pre.nl
Database contents	The processes are separated in 7 categories: Material, energy, transport, processing, use, waste scenario, waste treatment. Each category has its own sub-category, for further separation in useful groupings. Processes are grouped in libraries or projects. Libraries contain processes for general use that can be used in all projects. The processes in projects are specific for that project and cannot be used in any other project. The standards SimaPro database contains the following library: • ETH-ESU96 Inventory data of energy. This a sub set of the most important processes • BUWAL 250 this database developed by EMPA St. Gallen in Switzerland, for study commissioned by Swiss Ministry of the Environmental (BUWAL) • Data archive, this is a renamed version of Pre4 database. Although if contains old data, like the previous BUWAL 132 database, it still may contain valuable data • Industry data, here data of industry associations such as APME and other are made available • The IDEMAT 2001, an updated version of IDEMAT96 database has been developed by the faculty of Industrial Design Engineering of Deft University of Technology • Franklin USA 98, inventory data for North American materials, energy and

	transport • Dutch Concrete database and scripts, Dutch data related to all aspects of concrete production and use. • IVAM 4.0 database, materials, transport, energy and waste treatments. Mostly focused on Dutch data (see table below). • FEFCO database and scripts, European data on corrugated board production, partially based on BUWAL 250. Includes scripts to model the production and life cycle of corrugated board.
Database format	In SimaPro 5.1 is used a SPOLD simplify format

Table 3 Short description of SimaPro database.

Name	**IVAM**
Reference	
Organization	Postbus 18180 1001 ZB Amsterdam The Netherlands Telephone: +31 (0)20 - 525 5080 Fax: +31 (0)20 - 525 5850 E-mail: office@ivam.uva.nl
Database contents	The IVAM database consists of about 1350 process leading to more than 350 materials. The data can be used for LCA applications in various sectors: construction materials, plastics, metals and others, especially processes from agriculture (e.g. milk, fish, chicken, beef, pork, feed, fertilizer and pesticide), electrical industries (e.g. PV-panels) and waste treatment (23 waste types with about six processing alternatives each) are included. Material production is split into individual process sub-steps as far as possible. Many production processes have been updated, relying on comments of the industry, database users and new LCA studies. The methods for the aggregation of data and impact assessment are updated, including new Dutch and European normalisation data.
Database format	The nomenclature of IVAM LCA Data 4 is adapted to SimaPro's Standard database. This makes it easy to use both processes from IVAM LCA Data 4 and the Standard database.

Table 4 Short description of IVAM database.

Name	**GABI**
Reference	Daniel Coen, PE Europe Phone: (+49) 711 / 34 18 17 – 54 d.coen@pe-europe.com
Organization	IKP University of Stuttgart Institut für Kunststoffkunde und Kunststoffprüfung Universität Stuttgart Life Cycle Engineering Dept. Hauptstr.113, D-70771 Leinfelden-Echterdingen, Germany Tel.: (+49) 711 / 48 99 99 - 29 Fax: (+49) 711 / 48 99 99 - 11 E-mail: gabi@ikp2.uni-stuttgart.de www.pe-product.de/englisch/frame_htm
Database contents	GaBi 3 software and data base for Life Cycle Engineering contains: • Lean database • Professional database • Extension databases The “lean” and “professional” databases contain processes of the next product//function groups and sub-groups: Energy conversion, Production, Parts and components production, transport, recovery of materials, Disposal. The “extension” databases contain processes of the next product//function groups: Organic intermediates (country specific), Inorganic intermediates (country specific), Energy (country specific power stations, dynamic power plant model), Steel Sheets (alloyed steel, alloying elements), Aluminium (profiles, sheets, castings, alloying elements), Non-ferrous metals (primary, secondary, alloying elements), Precious metals (primary), Plastics (high performance plastics, compounds), Coatings (automobile) (painting processes, paint, solvents, pigments, fillers for automobile applications), Coatings (industry) (painting

	processes, paint, solvents, pigments, fillers for industrial applications), End of life (disposal, recycling, dynamic process models), Manufacturing (single processes, material specific processes, dynamic processes), Electronic (average and specific components, PWBs, solder paste and wire, assembly lines and parametric populated PWB). Inventory data of GaBi databases are taken from investigations conducted by the IKP University of Stuttgart and PE Europe GmbH, as well as from literature and model calculations. In addition data sets generally used and published for users are supplied, which have been taken from other sources (only in the "lean" and "professional" databases): • Federal Office for the Environment, Forests and Countryside (BUWAL):Eco-inventories for packaging volume I and II, journal set Environment No. 250, Bern 1996, • Association of Plastics Manufacturers in Europe (APME): Eco-profiles of the European plastics industry: Report 1 - 15, Brussels, October 1997.
Database format	Database for GABI software

Table 5 Short description of GABI database.

Name	**KCL**
Reference	Catharina Hohenthal M.Sc. (eng), Application Spezialist – Life Cycle Assessment, tel +358943711, fax +3589464305, e_mail catharina.hohenthal@kcl.fi
Organization	KCL, (the Finnish Pulp and Paper Research Institute), Tekniikantie 2, P.O. BOX 70, FIN-02151 Espoo, Finland http://wwwkcl.fi/eco/syst.html
Database contents	KCL EcoData is a continuously updated LCI database primarily intended for life-cycle inventory calculations related to forest products. The data has been collected by using experts from various branches of industry together with publications and questionnaires. EcoData contains nearly 300 data modules covering the following sectors: • energy production: back-pressure and condensation power plants using different fuels (BAT, average or low technology) • chemicals manufacturing (pulp and paper chemicals) • wood growth and harvesting operations for spruce, pine and birch • pulp, paper and board mills (typical product specific processes based on Finnish/Nordic production technology) • deinking processes for different printing papers and tissue papers • printing • waste management operations (paper incineration, landfill) • plastics • transport data for trucks, trains and ships, covering the transport of both raw materials and product
Database format	KCL EcoData is a separate database in a KCL-ECO compatible format

Table 6 Short description of KCL-ECO database.

Name	**Boustead Model**
Reference	For General Information, Sales or Customer Support Please Contact Us At: sales@boustead-consulting.co.uk
Organization	Boustead Consulting Ltd., Black Cottage, West Grinstead, HORSHAM, West Sussex, RH13 8GH, UK
Database contents	In the supplied databases there are nearly 13 000 individual unit operations, covering a vast number of materials processing and fuel production processes. The records in this file contain fuel production data for almost all of the countries around the world as well as data for the different regions of the USA and Canada.
Database format	Database for Boustead model

Table 7 Short description of Boustead database.

Name	**Ecoinvent v1.0**
Reference	
Organization	Swiss Centre for Life Cycle Inventories http://www.ecoinvent.ch/en/index.htm support@ecoinvent.ch
Database contents	Several different databases for Life Cycle Assessment (LCA) have been developed in Switzerland within the ETH domain and other Swiss Federal institutions. The ETH Zürich and PSI together from 1992 to 1996 established a Life cycle inventory (LCI) database including data on current energy supply systems, on transport and waste treatment services, and on material supply (the Ökoinventare von Energiesystemen). EMPA has experience in compiling LCI's for building materials, components, and construction, as well as consumer goods such as detergents, papers, information technologies and packaging. Finally, FAL has performed various LCI studies in the agricultural sector. Ecoinvent database includes all these studies resulting in more than 2500 datasets.
Database format	Ecoinvent is available in several LCA software formats

Table 8 Short description of Ecoinvent database.

3.2 Results of the survey with textile chemical producers

The main chemicals manufactures of textile products were contacted to verify the availability of ecoprofiles of textile chemicals. ETAD (Ecological and Toxicological Association of Dyes and Organic Pigments Manufacturers), initially contacted for ecoprofile information, gave us a great help, giving a list of companies with the references of the contact persons.
The contacted companies were:

- BASF Aktiengesellschaft
- Bayer S.p.a, SP-TPC
- Ciba Specialty Chemicals SpA
- Clariant
- DyStar Italia s.r.l.
- Mitsubishi Chemical Corporation
- Sanyo Color Works Ltd
- CHT R. Beitlich Gmb
- Govi nv
- Pymag Italia s.r.l.
- ROTTA GmbH
- Virkler

A simplified specific questionnaire (Annex 9) for data request on chemicals production was sent to them with a short presentation of Towef0 project. An ecoprofile of Indigo dye was available in BASF but the data were confidential and could not be disclosed to ENEA.
More important was the answer of CIBA that gave us detailed LCA inventories of CIBACRON ROT C-2G and CIBACRON ROT FN-3G, two red reactive dyes. This information was used in TEAM database and included in our LCA studies.
In the same way we searched information on the availability of ecoprofiles of chemicals for wastewater treatment but the survey did not gave any result.

4 Textile wet processes and general facilities inventories

4.1 Main assumption adopted for the Italian companies

The Italian companies selected for this study were I06, I02, I04, I09 and I15, all located in the Como area. A detailed description of each company is available in the related Process Identification and Data Collection Sheet (PIDACS). In each company different products were analysed, as shown in the table below:

Company	Fabric/yarn	Textile products	LCA Report
I06	Flax/Pes fabric	Sized Flax/Pes fabric dyed with dark colours	TM-108-002 Rev. 1
		Sized Flax/Pes fabric dyed with light colours	
		Non sized Flax/Pes fabric dyed with light colours	
I02	Viscose fabric	Electronic table reactive printing of viscose fabric	TM-108-003 Rev. 0
		Rotary machine reactive printing of viscose fabric	
I04	Viscose fabric	Viscose fabric dyed in Jigger with dark colours	TM-108-005 Rev. 0
I09	Silk yarn	Silk yarn dyed with dark colours	TM-108-004 Rev. 1
I15	Silk fabric	Acid dyeing of silk fabric	TM-108-006 Rev. 0

Table 9 Summary of case studies of textile products in the Italian companies

LCA reports describe in detail the work performed in each company. They contain all the information for an optimal understanding of the inventories included in this report. Nevertheless, because the data gathered by Lariana Depur in the Italian companies were pretty homogenous, a summary of the main common hypotheses adopted for the studies is reported hereafter.

- **System Boundaries:**

The system boundaries are depicted in Figure 2.

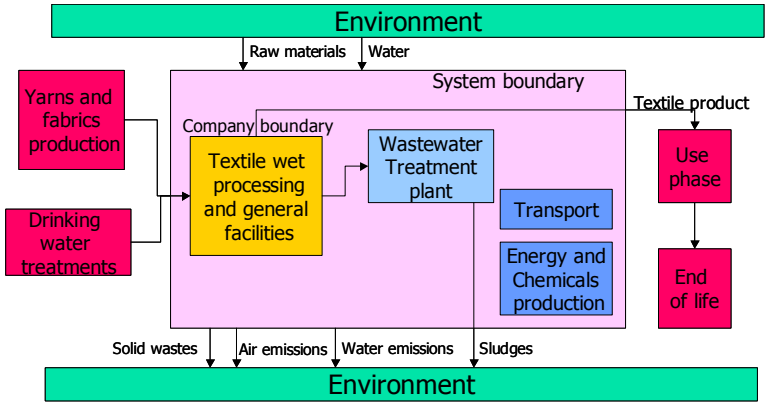

Figure 2 System boundaries of the LCA case studies.

The process excluded from the system boundaries are:

- All the product life cycle phases external to the company gate including yarn and fabric production processes and the relative transports;
- The production and manufacturing of all equipment, machinery and capital goods used in the industrial processes, as commonly accepted in LCA.

- **Data categories:**

The choice of data categories has been made in relation to impact categories and characterization factors adopted. They include the macro categories of energy, raw materials, chemicals and emissions in air, water, and soil. Different data sources were used in this study:

- Company specific data (from PIDACS);
- TEAM 3.0/Ecobilan data (production of energy, production of methane, transport processes, production of chemicals);
- Lariana Depur (all the centralised Waste Water Treatment Plant data);
- For some chemical, data included in other LCA commercial databases or data collected from manufacturers were used)

- **Steam production:**

The annual company methane consumption as well as the annual steam consumption are metered and reported on the PIDACS. The 95% of the methane is used for production processes described in the PIDACS, the remaining part is used for heating the factory shed (estimation of the company technicians). To evaluate the methane consumption for each process, the required heating energy for each process has been calculated first. The calculation took in account the volume of water to be heated up and the bath temperature:

"required heating energy"[kJ] = volume of heated water [m^3] x (bath temperature – initial water temperature) [°C] x density of water [kg/m^3] x specific heat of water [kJ/kg x °C]

Then the specific consumption of methane [m^3/kJ] has been calculated as:

"total consumption of methane in the company" [m^3/year] /"total required heating energy in the company" [m^3/year].

The methane consumption for each process [m^3] was so calculated as:

"specific consumption of methane" [m^3/kJ]/"process specific required heating energy" [kJ]

To calculate the emissions of methane burning and the natural resources consumption, the TEAM 3.0 model developed by Ecobilan was used, adjusting the water inlet and the steam outlet temperatures on the actual company data and calibrating the steam generator efficiency to meet 95% of the metered company methane consumption.

- **Process specific wastewater effluent:**

The wastewater effluent from the specific processes of the selected product has been characterized only with measured COD and TSS concentration, due to unavailability of specific contaminant concentration. For the same reason it was not possible to take in account the effect on the aquatic ecotoxicity of the effluent release to the environment.

- **Electricity consumption:**

The electricity consumption of specific processes has been calculated as [equipment absorbed power] x [run time].

- **Main assumptions for production of chemicals:**

The inventories available in the TEAM 3.0 database have been included in the study; the following databases were checked in addition to the TEAM 3.0 one:

- SimaPro,
- IVAM,
- GABI,
- KCL
- Boustead model
- ECOINVENT

- **Water pre-treatment:**

The potential impact of the production of the ionic exchange resins has been neglected, due to the small quantities used. Only the potential impact of the salt production (used for resin regeneration) has been included in the study.

- **Solid waste:**

The annual solid waste production is specified for each company in the PIDACS. The waste has been classified in three main fluxes: recycled waste (divided in packaging, iron and steel, plastic waste), special waste and special dangerous waste. The total waste quantity has been allocated to the analyzed product systems on a mass basis. The solid waste treatment has not been included in the systems, because of lack of specific data and the difficulty to identify reference treatment scenarios.

- **Airborne emissions:**

PIDACS specifies for each emission source, typically a specific machinery, the chimney flow rate and the contaminants concentration. For LCA purposes the contaminants emissions in the environment have been calculated as: [emission source flow rate] x [machinery run time] x [contaminant concentration]. If the concentration has been indicated as < limit value, the specific limit value has been assumed.

- **Lariana waste water treatment plant (WWTP):**

We assumed that the potential environmental impacts of WWTP processes are mainly due to the production of the energy needed in the plant and to the emission of the treated effluent into the environment; the impact of chemicals production has been neglected. These hypotheses were based on results of previous LCA studies of ENEA.

The potential environmental impacts for treating the waste water of the studied product systems have been considered proportional to effluent mass.

Direct CO2 emissions in the environment from Lariana WWTP processes have not been considered (according to IPPC guidelines).

Because it was not possible to have information on the specific contaminants of the product systems water effluents, the evaluation of the potential impact connected to the release to the environment of the treated water effluent has been calculated considering the effluent mass of

the specific analyzed processes and the contaminant concentration of the treated WWTP effluent (allocation by mass).

Information on reference flow, time related coverage, geographical and technology coverage is included in the specific database modules, as well as a short description of the characteristic of the used equipment.

4.2 Main assumptions adopted for the Belgian companies

The Belgian companies selected for this study were B02 and B05. A detailed description of each company is available in the related Process Identification and Data Collection Sheet (PIDACS). Table below shows the products analysed.

Company	Fabric/yarn	Textile products	LCA Report
I09	Silk yarn	Silk yarn dyed with dark colours	TM-108-004 Rev. 1
I15	Silk fabric	Acid dyeing of silk fabric	TM-108-006 Rev. 0

Table 10 Summary of studied textile products in Belgian companies

LCA reports describe in detail the work performed in each company. They contain all the information for an optimal understanding of the inventories included in this report.
In Belgian companies we tried to maintain the same hypotheses and assumptions adopted for the Italian ones, but, because less detailed primary data were available, it was necessary to modify them as reported hereafter.

- **System Boundaries, Data categories, Process specific wastewater effluent:** Same as in the Italian companies;

- **Data characteristics:** Time and Geographical related coverage are specified in the database modules

- **Steam production:**

The annual company steam consumption is measured and reported on PIDACS reports as well as the annual production of processed fabric. Lacking process specific data on PIDACS, the steam consumption was allocated to the references flow on a mass basis.

- **Electricity consumption:** Same as in the Italian companies for B05; allocated to the reference flow on a mass basis for B02 because of lack of data in PIDACS;

- **Main assumptions for production of chemicals:**
  - Same as in Italian companies;

- **Solid waste, Airborne emissions, Transport of chemicals:**

Due to data unavailability in PIDACS transport processes are not included.

- **Lariana waste water treatment plant (WWTP):**

Same assumptions as in the Italian companies, but the Belgian electricity mix has been used to model the electricity production processes.

References

[1] Towef0 report TM-108-002 “Life cycle assessment of Flax-Pes Fabric in I06 company Rev. 1 July 2003
[2] Towef0 report TM-108-003 “Life cycle assessment of Viscose Fabric in I02 company Rev. 0 November 2003.
[3] Towef0 report TM-108-004 “Life Cycle Assessment of silk- and charged silk yarn in I09 company”, Rev. 1 July 2003.
[4] Towef0 report TM-108-005 “Life Cycle Assessment of viscose fabric in I04 company” Rev 0 July 2003.
[5] Towef0 report TM-108-006 “Life Cycle Assessment of silk fabric in I15 company” Rev 0 February 2004.
[6] Towef0 report TM-108-007 “Life Cycle Assessment of cotton fabric in B02 company” Rev. 0 November 2003
[7] Towef0 report TM-108-008 “Life Cycle Assessment of cotton/polyester fabric in B05 company” Rev. 0 November 2003
[8] European Commission: Integrated Product Prevention and Control – Reference document on Best Available Techniques for the textile industry, November 2002.