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FLAINOX
Quaregna (BI), Italy

Life Cycle Assessment

D4 LCA of FLAINOX Organisation Quaregna (BI) – Executive Summary

D'APPOLONIA
consulting, design, operation & maintenance engineering

FLAINOX
Quaregna (BI), Italy

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1 INTRODUCTION

The present document constitutes Deliverable D4 "LCA of FLAINOX Organisation – Quaregna (BI) – Executive Summary" in the framework of the project entitled "Life Cycle Assessment" (Doc.No. 13-409 D1).

1.1 LCA METHODOLOGY

In the present Report a resume of the results of the LCA (Life Cycle Assessment) carried out for the organisational systems is documented.

A life-cycle approach takes into consideration the spectrum of resource flows and environmental interventions associated with a product or organisation from a supply-chain perspective. It includes all stages from raw material acquisition through processing, distribution, use, and end-of-life processes, and all relevant related environmental impacts, health effects, resource-related threats, burdens to society, and trade-offs. Such an approach is essential to effective management because important environmental effects may occur "upstream" or "downstream", and hence may not be immediately evident. This approach is also essential for making transparent any potential trade-offs between different types of environmental impacts associated with specific policy and management decisions and to help avoid unintended shifting of burdens.

Life Cycle Assessment is therefore a vital and powerful decision support tool, complementing other methods, which are equally necessary to help effectively and efficiently make consumptions and production more sustainable.

This LCA study has been performed in accordance with internationally recognized guidelines (see e.g. ILCD Handbook: General guide for Life Cycle Assessment - Detailed guidance") and standard (ISO 14044:2006) main requirements.

In addition the Recommendations 2013/179/EU "Commission Recommendation of 9 April 2013 on the use of common methods to measure and communicate the life cycle environmental performance of products and organisations" has been used as further reference in developing the assessment for Organisation Environmental Footprint (OEF).

The Organisation Environmental Footprint (OEF) is a multi-criteria measure of the environmental performance of a goods/services-providing Organisation from a life cycle perspective. OEF studies are produced for the overarching purpose of seeking to reduce the environmental impacts associated with organisational activities, taking into account supply chain (1) activities (from extraction of raw materials, through production and use, to final waste management). The Organisations involved include companies, public administrative entities, non-profit organisations and other bodies. OEFs are complimentary to other instruments that focus on specific sites and thresholds.

The LCA of Flainox plant has been conducted and here an executive summary is presented.

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2 DESCRIPTION OF THE ORGANISATION (FOREGROUND)

Founded in 1968, Flainox S.r.l. has been operating in the dyeing/finishing plant and machinery construction sector for over 40 years.

Flainox is a textile machine manufacturer company specialized in the construction of rotary dye machines suitable for all types of garments. Today they present themselves to the worldwide textile market with the sustainability mission, which involves the whole organisation for the construction of more efficient and environmentally friendly machinery. This concept is extended to the complete range of products manufactured and marketed by Flainox, including yarn dyeing and special finishing machines for woven and knitted fabrics.

The assessment conducted here, is referred to the entire Flainox Plant, for the years 2011, 2012 and 2013.

Flainox plant has a surface of 4830 square meters of which:

- 4250 sqm dedicated to the production;
- 580 sqm (distributed on two floors) for the offices.

In these three years, 33 people were employed:

- 20 workers in the production site;
- 13 employees in the offices.

Data on machine produced (also partially) and working hours for the three years have been used in the analysis for quantifying environmental performances of the organisation.

The machines manufactured are:

- in 2011, 27,2 machines;
- in 2012, 28,6 machines;
- in 2013, 37,7 machines.

Table 2.1: Organisation Requirements

Aspect	Detail
Organisation	Flainox S.r.l.
Goods/Service Sector	Textile machine manufacturer
Location	Quaregna (BI) - Italy
NACE code1	28.94.2 "Other machinery for textile and apparel production, including sewing machines"

[1] http://ec.europa.eu/competition/mergers/cases/index/nace_all.html

3 GOAL OF THE STUDY

3.1 INTENDED APPLICATION(S)

The application is to assess the energetic and environmental impacts of FLAINOX production unit along the entire life cycle, considering all the materials and energy sources in input involved directly or not in the manufacturing processes which take place inside the facilities. Goal of this study is to assess and to compare the environmental impacts of the chosen system, considering the CO_2, the embodied energy and other impacts as described in LCIA scope settings, across the three years.

3.2 REASONS FOR CARRYING OUT THE STUDY AND DECISION-CONTEXT

The intended application is to provide information about environmental performances to Flainox. The study wants to demonstrate commitment to and practice of continuous improvement..

	YES	NOT
This LCI/LCA study is utilized to support a decision by the Client	X	
The LCI / LCA study is interested in the potential changes of this decision		X

3.3 DECISION SUPPORT

<table>
<tr><td rowspan="4">Decision support?</td><td rowspan="3">Yes</td><td colspan="2">Kind of process-changes in background system / other systems</td></tr>
<tr><td>None or small-scale</td><td>Large-scale</td></tr>
<tr><td>Situation A
"Micro-level decision support"</td><td>Situation B
"Meso/macro-level decision support"</td></tr>
<tr><td>No</td><td colspan="2">Situation C
"Accounting"
(with C1: including interactions with other systems, C2: excluding interactions with other systems)</td></tr>
</table>

Situation A	
Situation B	
Situation C1	
Situation C2	X

3.4 TARGET AUDIENCES AND COMMISSIONER OF THE STUDY

The target audience of this study is FLAINOX personnel (mainly technical personnel, such R&D personnel); Flainox management is the Commissioner of the Study.

4 SCOPE OF THE STUDY

Several considerations and assumptions were made in order to define the details of the model to be developed. The scope of this study is to provide data to evaluate sustainability performances of Flainox, as organisation, in an **cradle to grave analysis**.

4.1 FUNCTIONAL UNIT

The entire organisation has been adopted as functional unit: one solar year (2011, 2012 and 2013) is the reference year for the assessment. The choice is useful for simplifying data elaboration and the understanding of the different involved processes.

In a second step, the results referred to each year have been normalized to worked hours per year, in order to allow the comparison of results between the three reference years.

The whole manufacturing steps occur in the Quaregna plant, where materials come into for being shaped and constitute the machines. Data have been provided directly from FLAINOX, due to its previous experience in LCA methodology application.

Any other assumption is justified inside the report, when present.

4.2 SYSTEM BOUNDARIES

Processes in the background system have not been inventoried with actual data from suppliers but included and evaluated on the basis of data taken from dedicated databases. Waste flows belonging to such processes have been connected to disposal management processes according to the cut-off rule.

Processes in the foreground system have been instead inventoried based on data from the owner of the technology, i.e. FLAINOX and its suppliers. All the manufacturing processes which take place inside FLAINOX, the identification of manufactured models across the period 2011 - 2013, dismantling options of rejected parts belong to foreground system.

Moreover for the definition of geographic borders it is important to notice that it covers all Europe, considering that suppliers are located across Europe.

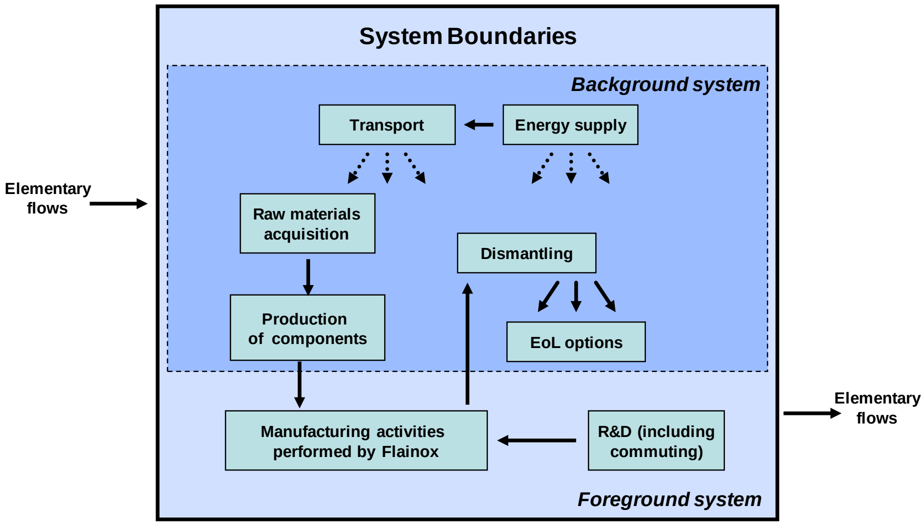

Figure 4.1: LCA General Model with Boundaries and Flows

4.3 LCIA SCOPE SETTINGS

The corresponding impact categories to be considered are in the following Table, according the recommendations of Product Environmental Footprint (2013/179/EU). In addition also the flow "Primary energy demand from renewable and non renewable resources (gross cal. value)" measured in MJ has been evaluated.

Impact category	Recommended Indicator mid-point	Chosen Indicator mid point
Acidification	The accumulated exceedence method of Seppälä et al. (Seppala, Posch et al. 2006) is recommended	(Acidification, accumulated exceedance) Mole H+ eq.
Climate Change	Global Warming Potential (IPCC 2007), 100 year perspective (IPCC 2007)	Climate Change (IPCC 2007, GWP100a) - kg CO2 eq.
Ecotoxicity	The USEtox model is the most advanced and complete indicator (Rosenbaum, Bachmann et al. 2008). However toxicity results are still highly uncertain.	USEtox 2008, Ecotoxicity – PAF (Potentially Affected Fraction) CTUe
Eutrophication	The ReCiPe method is most advanced with respect to aquatic fate modeling and therefore recommended	Recipe – Freshwater/ Marine eutrophication, Eutrend Model - kg P/N eq.
Human Toxicity	The USEtox model is the most advanced and complete indicator (Rosenbaum, Bachmann et al. 2008). However toxicity results are still highly uncertain and indoor toxicity (at the production site) is not considered	Human Toxicity (USEtox, Human toxicity – carcinogenic and non-carginogenic) - CTUh
Ionizing radiation	The method of Frischknecht et al. (Frischknecht 2000) includes all vital model elements in sound way and is well documented	Ionizing Radiation (ILCD 2011 midpoint, Ionizing radiation - human health) kg U235 eq.
Land Use	The midpoint method implemented in ReCiPe simply adds up all land occupation and transformation. It is simple and robust, but misses environmental relevance (De Schryver and Goedkoop 2009)	Terrestrial eutrophication, accumulated exceedance [Mole of N eq.]
Resource depletion, fossil and mineral	This indicator expresses the cumulated non-renewable energy demanded to fulfill a certain function plus mineral depletion (Van Oers et al., 2002)	CML 2002 Resources Depletion, kg antimony-Eq
Ozone depletion	Latest WMO published ODP equivalents (currently WMO, 1999)	Ozone depletion (ILCD 2011 midpoint, Ozone depletion) - kg R11 eq.
Particulate matter/Respiratory inorganics	Risk Poll model (Humbert 2009)	Particulate matter/respiratory inorganics (kg PM2,5 eq.)
Photochemical ozone formation	The LOTOS-EUROS model as applied in the ReCiPe method for photochemical ozone formation (van Zelm, Huijbregts et al. 2008), consists of a detailed fate and exposure model for human health impacts and is developed in a form which makes it readily adaptable	Recipe – LOTUS-Euros model kg NMVOC
Water depletion	Several methods exist, ranging from inventory methods, scarcity indexes and mid-point indicators. Most approaches are still under development.	Total freshwater consumption, including rainwater, Swiss Ecoscarcity [kg]

5 LIFE CYCLE INVENTORY ANALYSIS

The Inventory analysis is the LCA phase that involves the compilation and qualitative/quantitative identification of inputs and outputs for a given product system throughout its life cycle or for a single processes. The inventory analysis includes iterative data collection and the compilation of the data in a Life Cycle Inventory (LCI) table.

The Life Cycle Inventory model has been implemented through dedicated software, namely GaBi 6.

Processes in the background system have not been inventoried with actual data from suppliers but included and evaluated on the basis of data taken from the dedicated database of the software GaBi (PE, Ecoinvent mainly).

Processes in the foreground system have been instead inventoried based on data from the owner of the plant, i.e., Flainox. Data have been collected thanks to wide availability shown by the Flainox management:

- directly measured by Flainox in the course of the years – this procedure mostly refers to data linked to processes performed inside Flainox facilities and applies to most of the data in the foreground system;
- extracted from data sheets provided by suppliers – this procedure mostly refers to parts under purchase;
- extracted from literature;
- calculated based on specific formulas taken from literature – this procedure mostly refers to data conversion;
- estimated, based on experience of technicians – this procedure has been used when none of previous procedures was applicable and only applies to not relevant data.

The entire annual Flainox life cycle is articulated in three main phases: Materials incoming in the plant, Use (production and office) and Exit of finished machines plus scraps/wastes.

For each phase resuming tables with indication of main inputs (mass, energy, etc.) and outputs (products, waste, emissions, etc.), reference source, and geographical and time representativeness have been created. Moreover for each activity the several subsystems constituting them have been identified and analyzed.

For each category, a plan on GaBi 6 has been created: considering three years, for each category three models are present.

5.1.1 FLAINOX Facilities– LCI Model

The LCI model has been schematically represented by block flow diagrams where each block represents either a gate to gate process or a cradle to gate process or a partly linked/terminated process and is connected to upstream and/or downstream blocks by means of arrows representing input and/or output flows, respectively. Schematic representations of the Flainox plant in 2011, 2012 and 2013 have been created and reported in full version of report.

Calculation procedures are embedded in the GaBi6 software and in calculation sheet developed by D’Appolonia. They are available on request in case of LCA review.

6 LIFE CYCLE IMPACT ASSESSMENT

The Life Cycle Impact Assessment (LCIA) identifies and evaluates the amount and significance of the potential environmental impacts arising from the LCI. Inputs and outputs are assigned to impact categories and their potential impacts quantified according to characterization factors.

6.1 GLOBAL RESULTS

In Table 6.1 a normalization of LCIA results, based on number of worked hours per year has been conducted; the 2011 is the reference year and the worked hours are:

- 31869 hours in 2011;
- 32744 hours in 2012 (normalization factor = 0,96778);
- 34457 hours in 2013 (normalization factor = 0,919668).

Table 6.1: Global Impact Indicators – Normalized Values

INDICATOR	Total 2011	Total 2012	Var. [%]	Total 2013	Var. [%]	Reference Unit
Acidification, accumulated exceedance	6,77E+03	4,29E+03	-36,59%	5,48E+03	-19,12%	[Moles of H+-Equiv.]
Ecotoxicity for aquatic fresh water, USEtox	5,36E+07	3,01E+07	-43,81%	3,56E+07	-33,56%	[CTUe]
Freshwater eutrophication, EUTREND model, ReCiPe	1,59E+03	8,93E+02	-43,79%	1,06E+03	-33,39%	[kg P eq]
Human toxicity cancer effects, USEtox	1,79E-01	9,61E-02	-46,32%	1,21E-01	-32,26%	[CTUh]
Human toxicity non-canc. effects, USEtox	2,50E+00	1,43E+00	-42,99%	1,71E+00	-31,65%	[CTUh]
Ionising radiation, human health effect model, ReCiPe	1,36E+08	7,76E+07	-42,84%	9,22E+07	-32,14%	[kg U235 eq]
IPCC global warming, incl biogenic carbon	1,06E+06	7,07E+05	-33,60%	9,27E+05	-12,87%	[kg CO2-Equiv.]
Marine eutrophication, EUTREND model, ReCiPe	3,04E+02	2,01E+02	-33,75%	2,60E+02	-14,51%	[kg N-Equiv.]
Ozone depletion, WMO model, ReCiPe	6,15E-02	3,82E-02	-37,89%	4,72E-02	-23,27%	[kg CFC-11 eq]
Particulate matter/Respiratory inorganics, RiskPoll	8,17E+02	5,01E+02	-38,70%	6,70E+02	-17,99%	[kg PM2,5-Equiv.]
Photochemical ozone formation, LOTOS-EUROS model, ReCiPe	3,84E+03	2,45E+03	-36,13%	3,13E+03	-18,48%	[kg NMVOC]
Resource Depletion, fossil and mineral, reserve Based,	8,17E+02	4,59E+02	-43,77%	5,40E+02	-33,93%	[kg Sb-Equiv.]

INDICATOR	Total 2011	Total 2012	Var. [%]	Total 2013	Var. [%]	Reference Unit
CML2002						
Terrestrial eutrophication, accumulated exceedance	1,32E+04	8,63E+03	-34,57%	1,08E+04	-18,12%	[Mole of N eq.]
Total freshwater consumption, including rainwater, Swiss Ecoscarcity	9,97E+05	7,94E+05	-20,34%	1,02E+06	2,13%	[kg]
Primary energy demand from ren. and non ren. resources (gross cal. value)	1,81E+07	1,25E+07	-31,28%	1,58E+07	-12,94%	[MJ]

The impacts are decreased from 2011 until 2013. Flainox has been able to reduce environmental burdens of its plants, although the working hours increase, due to greater amount of manufactured machines.

The reductions do not overcome the 50% and they are almost global; considering as baseline the 2011, the 2012 is "greener" than 2013 and of course 2011 itself.

The unique increase is the water footprint value in 2013.

In the complete report an analysis per phase has been conducted. Here a focus on phases contribution for Direct contribution and referred to five selected impact categories, considered of particular interest for the study, is presented:

- Ecotoxicity (Figure 6.1);
- Global Warming potential (Figure 6.2);
- Ozone Depletion (Figure 6.3);
- Water Depletion (Figure 6.4);
- Gross Energy Requirement (Figure 6.5).

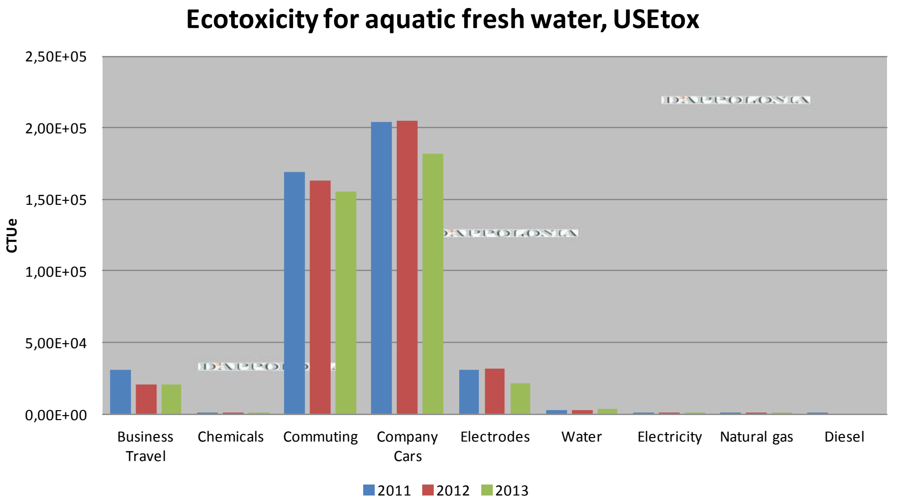

Figure 6.1: Ecotoxicity - Direct Impacts

As regards Ecotoxicity impact, Commuting and Company Cars are the main responsible, followed by business travels and also electrodes consumption. In particular for road transports the hot spots are constituted by construction and disposal of cars: automotive sector generate noticeable impacts on fresh water toxicity. In the three years there is a steady reduction of all contributions.

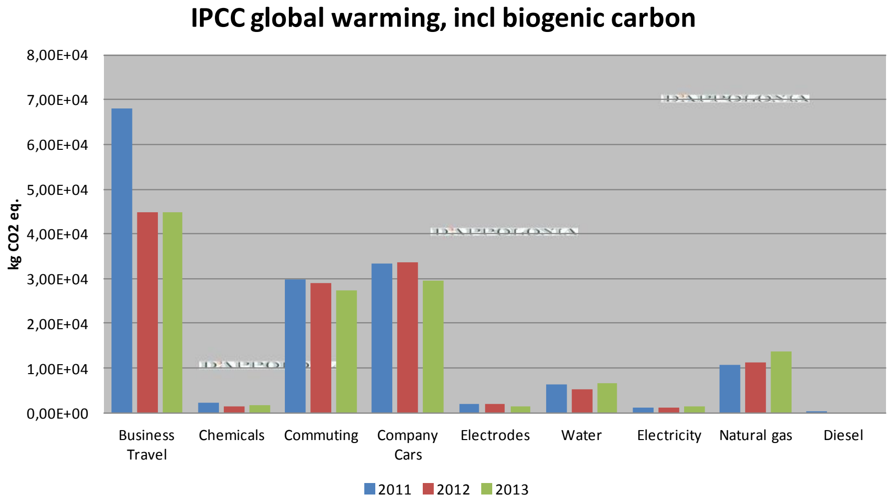

Figure 6.2: Global Warming Potential – Direct Impacts

The main contributors of CFP are related to transport (in particular business travel – intercontinental flights and diesel consumptions for road transports), natural gas consumptions and waste water treatment operations (due to the high amount of water required for manufacturing operations).

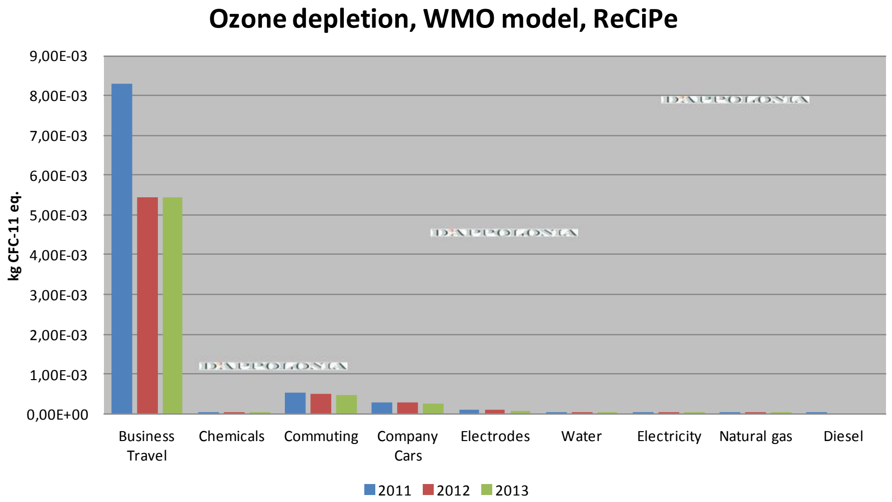

Figure 6.3: Ozone Depletion – Direct Impacts

The intercontinental flights are also main responsible for ozone depletion. They cover more than 90% of total value. Appreciable is also the contribution of road transports due to diesel consumption.

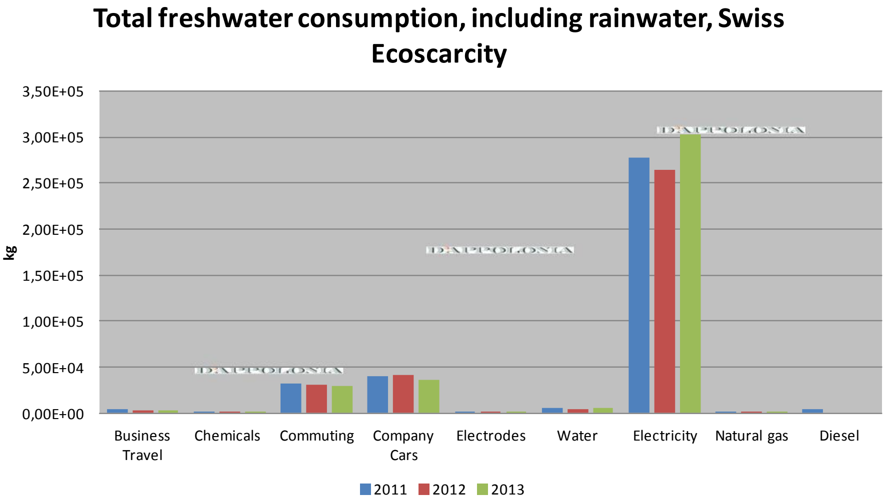

Figure 6.4: Freshwater Consumption – Direct Impacts

For water footprint, the main responsible of the indicator is the electricity, taking into account that energy source is hydropower. Second contributors are commuting and company cars: in detail the diesel consumption.

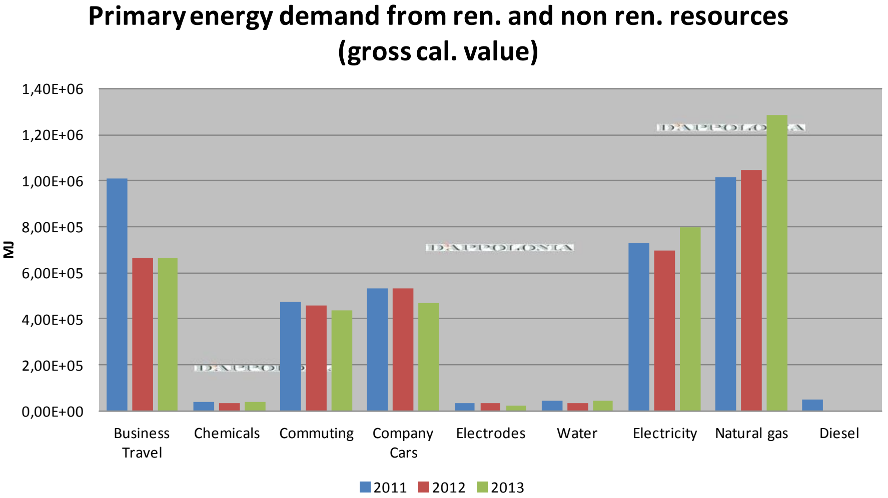

Figure 6.5: Primary Energy Demand – Direct Impacts

Finally for Energy demand, the major responsible for the indicators is the natural gas consumption, followed by electricity demand and business travels (aircraft operations are highly energy intensive). Also diesel requests for road transports affects the indicator value.

Unless increase of natural gas consumptions (and correspondent impacts) along the three years, the other impacts reduce their values from 2011 until 2013.

7 CONCLUSIONS

This LCA study has been performed by D'Appolonia in accordance with main requirements of international standards (ISO 14040:2006 and 14044:2006) and internationally recognized guidelines (i.e., ILCD Handbook: General guide for Life Cycle Assessment - Detailed guidance).

The report provides indications on the environmental footprint of Flainox, as organization, across three years (2011 – 2013). Starting from information collected by Flainox, results have been furnished, split between upstream, downstream and direct activities and normalized to worked hours of 2011, in order to cancel misrepresentations and have a same reference.

The direct activities have the following shares on total (used as examples in Table 7.1).

Table 7.1: Direct Impact Shares for Selected Indicators

Impact categories	2011	2012	2013
Primary Energy Demand	22%	28%	24%
Global Warming Potential	15%	18%	13%

In second instance also providers of components, materials and all incoming shipments should be contacted in order to find out the best solutions in terms of environmental performances.

Recommendations:

In case some actions are considered to be taken by FLAINOX, the Hot Spot Analysis performed in the Impact categories highlights the targets:

Table 7.2: Direct Impact Shares for Selected Indicators

	Direct impacts					Upstream Impacts				
	Ecotoxicity	IPCC GWP	Ozone Depletion	Total freshwater Consumpt.	Primary Energy Demand	Ecotoxicity	IPCC GWP	Ozone Depletion	Total freshwater Consumpt.	Primary Energy Demand
Business trips		X	X		X					
Commuting	X	X	X		X					
Company cars	X	X			X					
Natural gas		X			X					
Electricity				X	X					

	Direct impacts					Upstream Impacts				
	Ecotoxicity	IPCC GWP	Ozone Depletion	Total freshwater Consumpt.	Primary Energy Demand	Ecotoxicity	IPCC GWP	Ozone Depletion	Total freshwater Consumpt.	Primary Energy Demand
Equipment (electronic)						X	X	X	X	X
Equipment (steel)							X		X	

Table 7.2 shows the main impacts and are a starting point for further actions in the evaluation of environmental improvements of FLAINOX facility.

MDS/GGU/PSA/RDL/DMZ:plp

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