An LCA Study Comparing E-books Read on an Apple Air iPad to Printed Books in South Africa

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Summary

A number of studies assessing the environmental impacts of print media systems in comparison to digital media systems offering the same services have been conducted in United States of America (USA) or Sweden. The most notable are studies done by Kozak (2003), Gard & Keoleian (2003), Enroth (2009), Moberg *et al.* (2011) and Achachlouei *et al.* (2013).

However, no studies have been conducted in South Africa. The main purpose of this study was to compare environmental impacts and cumulative energy demand of electronic books (e-books)read from a Tablet personal computer (PC) or Apple Air iPad, the digital system, with the equivalent printed paper books (print system) in South Africa, and establish which of two systems has less of an environmental and energy demand impact. The study was aimed at creating awareness amongst consumers and producers about the environmental and energy impacts of both systems.

The study also included scenarios which investigated the effect that changing the energy mix as planned in the 2010 Integrated Resource Plan (IRP) has on the environmental impacts and cumulative energy demand of both systems, and the effect of multiple users per system.

The initial hypothesis of this study was that reading 21 e-books from a Tablet PC would have a lower environmental impact and cumulative energy demand than reading 21 printed books.

The time period of the study is four years, the length of time for completing a commerce university degree. During this period each learner will purchase 21 books, either in the form of printed paper books or as e-books that can be read using a Tablet PC.

The books to be read are obtained from the commerce degree booklist at the University of Cape Town (UCT)[1,2]. The functional unit of this study is thus the “reading of 21 textbooks over a four year period by a single user”.

The digital and print systems will be compared for all stages in the lifecycle and are assumed to be used and kept by a single user during the four years.[3] The system boundary of the print system included the stages of pulp wood production, pulp wood transportation, pulp and paper production, paper transportation, printing, distribution transportation, personal transportation, printed paper book use, and waste management. The system boundary of

[1]University of Cape Town. 2014. Available: http://www.booklists.uct.ac.za/commerce/recommended/ [2014, July 6]

[2]University of Cape Town. 2014. http://www.booklists.uct.ac.za/commerce/recommended/ [2014, July 6]

[3] It is understood that printed books could have multiple users as they can be sold to other users whilst an e-book is non-transferrable because each e-book has a user licence. The effects of multiple users for printed books will be examined during the multiple user scenario discussed later in this study.

the digital system included the stages of Apple Air iPad production, e-book formatting, e-book downloading, distribution transportation of Apple Air iPad, personal transportation, e-books reading and Apple Air iPad, and waste management.

The reference flow for the print system was the mass of the 21 books in paper (25.4kg) whilst the digital system used a reference flow of energy used in reading and downloading (13,951 Wh).

The Apple Air iPad is a multifunctional device so a reading allocation was allocated to the Apple Air iPad production and Apple Air iPad distribution stages of the digital system. The allocation was calculated as64.5%, based on two hours daily use for reading out of a total daily usage of 3.1 hours (salesforce.com, 2014; SABDC, 2001).

The models for both system lifecycles, print and digital, were configured in SimaPro 8. The data used in the models was gathered from a variety of literature sources and used to supplement and amend the Ecoinvent 3.01 database. The production and distribution stages of the digital system were based on an average global mix data but all other stages for both the print and digital systems were amended by changing the electricity mix, coal, water and transportation distances to South African values.

The results of the analysis indicate that the digital system has a lower environmental impact compared to the print system, for all impact categories except freshwater eutrophication, freshwater ecotoxicity, marine ecotoxicity and metal depletion. In terms of cumulative energy demand, print was approximately three times greater than that of the digital system. Therefore the initial hypothesis assumed in this study was partially correct as the digital system did not have lower impacts than the print system for all environmental impact categories. The stages of printing, and paper production were the largest contributing stages for the print system in most of the environmental impact categories as well as the cumulative energy demand. For the digital system, the production of the Apple Air iPad and the e-book reading stages were the major contributing stages in most of the environmental impact categories as well as the cumulative energy demand. A major finding was that both systems are dependent on the coal related processes as coal related processes are a substantial contributor in most of the impact categories.

The results of the IRP electricity mix scenario indicated that the change in electricity mix reduces the environmental impacts and the cumulative energy demand for both the print and digital system. However, the digital system has a greater decrease in energy demand compared to the print system is greater as the e-book stage has a greater dependency on electricity.

In terms of the multiple user scenario, the print system becomes more environmentally preffered for approximately four users. The re-use and resale of printed books should thus be encouraged as it is can reduce the environmental impacts of existing books.

Reading e-books from an Apple Air iPad could be implemented in universities because the findings of this study suggest that the environmental benefits of e-books read from an Apple Air iPad outweigh those of reading printed books. However, this will depend to an extent on the amount of reading material and whether the re-use of books is actively promoted at the university.

Declaration

I, ……, hereby declare that the work on which this dissertation/thesis is based is my original work (except where acknowledgements indicate otherwise) and that neither the whole work nor any part of it has been, is being, or is to be submitted for another degree in this or any other university.

I empower the university to reproduce for the purpose of research either the whole or any portion of the contents in any manner whatsoever.

Signature: ……

Date: ……

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I would like to thank my family and friends for their emotional support throughout this process. I would like to thank my supervisor Dr Brett Cohen and his work colleague Ilhaam Patel for their guidance and support with the technical issues of this report. Once again thank you all!

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List of Acronyms

ABS	Acrylonitrile-butadiene-styrene
CCGT	Closed cycle gas turbine
CED	Cumulative Energy Demand
CN	China
CSP	Concentrated solar power
DAFF	Department of Agriculture, Forestry and Fisheries
DEA	Department of Environmental Affairs
DOE	Department of Energy
DSLAM	Digital subscriber line access multiplexer
EIA	Environmental Impact Assessments
GLO	Global database source
IRP	Integrated Resource Plan
ISO	International Standards Organisation
LCA	Life cycle assessment
LCC	Life Cycle Costing
LCD	Liquid crystal display
MFA	Material Flow Analysis
MIPS	Material Input Per Unit Service
NAAMSA	National Association of Automobile Manufacturers of South Africa
NCT	NCT Forestry Co-operative Limited
NMVOC	Non methane volatile organic carbon compound
OCGT	Open cycle gas turbine
PC	Personal computer
PM	Particulate matter
PRASA	Paper Recycling Association of South Africa
PV	Photovoltaic
RA	Risk Assessments

RER	Europe database source (average of data from European countries only)
RoW	Rest of the world database source (average of data excluding data from European countries)
Sappi	South African Pulp and Paper Industries
SEA	Strategic Environmental Assessments
UCT	University of Cape Town
UK	United Kingdom
ZA	South Africa

1 INTRODUCTION

1.1 BACKGROUND

Paper has been used for centuries as a medium for storing information and for communication. However, with modern advancements in technology, electronic devices such as electronic-readers (e-readers), Smartphones and Tablet personal computers (PCs) are able to provide consumers with multimedia entertainment such as the ability to view and read electronic books (e-books), newspapers and magazines, record videos, take photographs and access social and lifestyle orientated applications.

The idea of moving away from physical paper resources towards a paperless society has been discussed in Davidson (2005) amongst others. Davidson (2005) discusses the potential benefits that electronic media have over paper (print media) and which favour the uptake of electronic media. The benefits that electronic media have over paper include improved search capabilities, reduction in physical storage space, linkage of texts to other sources of information and allowing for global sharing of information in real time. Davidson (2005) reasons that younger generations in society will become accustomed to using electronic media in their everyday lives, favouring the use of electronic media over printed media.

Davidson (2005) might not be too far off as electronic media is becoming increasingly popular in academic and professional institutions. Twining *et al.* (2005) recommended Tablet PCs as a teaching aid in schools because younger audiences feel more engaged through interactive multimedia and learner applications. In addition, studies conducted by Chiong *et al.* (2012) and Kozminsky & Asher-Sadon (2013) support this notion and show that e-books promote better engagement of young learners.

The growing interest in electronic media was also illustrated in a study conducted by Accenture in 2012 on the electronic media market in countries including USA, Brazil and South Africa (Accenture, 2012). The study found that the South African tablet PC market experienced positive growth and that the popularity and demand for Tablet PCs is increasing in comparison to laptop PCs (Accenture, 2012). The main reason is that Tablet PCs have increased mobility amongst other reasons (Accenture, 2012). The study also indicated that 60% of South Africans who own tablet PCs use the device for both personal and professional applications (Accenture, 2012). The interest in purchasing Tablet PCs was most pronounced in younger age groups surveyed. Approximately 23% of persons in the age group 18 to 34 years old expressed an interest in purchasing a Tablet PC within the following year (Accenture, 2012).

The use of electronic media for reading applications is further supported by a survey conducted by the Pew Research Centre in 2012. The study found that the reading of e-books increased between 2011 and 2012 by 7% in readers 16 years and older; and that printed books readership had declined within the same period by 5%.

However, printed media is still dominant in sales and production throughout the world. Reasons why print media is preferred to electronic media were identified in a survey by Yalman (2014) as follows:

- Printed books cause less strain to the eyes and are perceived to be healthier,
- Books are more natural and traditional to readers,
- Readers prefer the feel of a textbook,
- A printed book has a long lifetime,
- Reading printed books is a habit to which readers have become accustomed to,
- Printed books are easier to understand and use,
- Printed books are better for reading material that requires concentration, and
- The availability and number of printed books is greater than that of e-books.

Shibata *et al.* (2011) showed that reading from paper is still easier to comprehend and that it is still 24% faster to read from in comparison to reading from a display on an electronic device.

The findings of Yalman (2014) and Shibata *et al.* (2011)suggest that print media still has its place in an ever technologically advancing society and that it comes down to the consumer preference.

In deciding on which medium to use consumers may wonder whether reading print or electronic media is more environmentally sustainable. Various international studies such as Kozak (2003) and Enroth (2009) have attempted to answer this question using life cycle impact assessments. Currently there is no publicly available study for the South African consumer on the topic of environmental sustainability of reading electronic media in comparison to print media. This study will attempt to quantify and compare the environmental and energy impacts of both electronic media (digital system) and print media (print system), and hence aid consumers on choosing an environmentally preferable system for reading purposes.

1.2 Environmental Impact Quantification

The environmental impact that systems can cause can be quantified using a variety of tools. These include Life Cycle Assessments (LCAs), Life Cycle Costing (LCC), Material Input Per

Unit Service (MIPS), Bulk Material Flow Analysis (MFA), Risk Assessments (RA), Strategic Environmental Assessments (SEA) and Environmental Impact Assessments (EIA) . A brief explanation of the use of these tools is given below (Moberg, 2006):

- LCA – Assesses the potential environmental impacts of all stages and activities within a defined product or service system. This encompasses production, use, transportation and waste management.
- LCC – Assesses the cost of providing a product or service. This can also be used to attribute environmental and social costs.
- MIPS – Assesses the potential environmental impacts of a product or service but only based on material inputs.
- Bulk MFA – analysis of the relationship of used materials and processes within a system
- RA – Used to determine the probability and risk of an incident or accident
- SEA – Used as a decision making tool for developing and planning policies and programs using sustainability criteria.
- EIA – Environmental impact assessment are used for construction projects to identify and mitigate impacts triggered according to environmental legislation.

This thesis study is only concerned with assessing and comparing the potential life cycle environmental impacts of the print and digital systems. Therefore LCA was chosen as the preferred tool to meet the objectives of this study, which are defined in the next subsection. Cumulative energy demand (CED), although not an environmental damage quantification tool, it has been included to establishing the link between energy and environmental impacts.

1.3 AIMS AND OBJECTIVES

The main aim and objectives of this study are as follows:

- Determine which system, print or digital, is more environmentally sustainable using LCA and hence help the consumer to make an informed decision about which system to use for reading purposes.
- Determine and compare the cumulative energy demand of the print and digital system and to identify the main processes and stages which contribute to energy demand for each system.
- Compare the findings of this study to previous LCA studies in order to understand if the results obtained in this study are plausible.
- Determine the effect of changing the electricity mix to that of the Policy Adjusted 2030 electricity mix as per the Integrated Resource Plan (IRP) on the print and digital system and how they change in comparison to the base case.
- Determine the effect of multiple readers per book on the environmental impact and cumulative energy demand gap between the print and digital systems.

1.4 THESIS STRUCTURE

The thesis has been structured as follows:

- Chapter 1 – Introduction
  The introduction chapter gives the reader a brief overview on the background to the study, the main types of assessment methods for environmental impacts, the aims and objectives of the study and the structure of the thesis.
- Chapter 2 – Methodology
  Chapter 2 gives an overview of the life-cycle process followed which includes the goal and scope, the impact assessment method and the inventory analysis.
- Chapter 3 – Findings and Discussion: Previous Studies
  The results of the LCA and the CED of previous studies comparing the digital system with the print system, are discussed to give the reader context to the methodology used in each study, previous findings and an indication of what to expect in terms of results for this study.
- Chapter 4 – Results and Discussion
  The results of the LCA and the CED for each scenario are compared to the findings mentioned in the previous chapter and any unique findings to this study are also discussed.

- Chapter 5 – Conclusions and Recommendations
  This section concludes how the objectives of the study were met and the major findings of the study.

2 METHODOLOGY

2.1 INTRODUCTION

The section will discuss the methodology followed in this study and begins with the goal definition, which defines what the purpose of the study is, the intended application of the study, intended audience and the additional scenarios to be assessed in this study. Following the goal section is the scope which outlines the product systems, system functions, functional units, reference flows, system boundaries, impact indicators, impact assessment and the compilation of the inventory analysis and associated data assumptions thereof.

The print and digital systems are different in terms of their input materials, processes and the products and waste produced. Therefore they need a common ground for comparing them in terms of environmental impacts. The comparison as previously mentioned in Chapter 1, can be done using LCA.

LCA is defined as “an objective process to evaluate the environmental burdens associated with a product, process, or activity by identifying energy and materials used and wastes released to the environment, and to evaluate and implement opportunities to affect environmental improvements” (ISO, 2006).

The definition of LCA above, originates from the LCA standards which have been developed by the International Standards Organisation (ISO). The ISO standards define and discuss the assessment procedure of LCA. The first standard published was ISO 14040 (1997) and since then subsequent revisions have been published. The most recent and important of these is ISO 14040:2006 (Environmental Management) which focuses on LCA principles and the framework and ISO 14044:2006 (Environmental Management) which addresses LCA requirements and provides guidelines for performing an LCA.

. The main characteristics of a Life Cycle Assessment are as follows (Wolf *et al.*, 2012):

1. Integration of environmental impacts such as toxicity, resource depletion and climate change.
2. Quantification of environmental impacts through the use of factors and linking of resources.
3. Impacts from environmental problems can be linked to a system irrespective of the field, sector, type and location of the system under analysis.
4. A system can be analysed for impacts over the defined lifetime (cradle to the grave) and for each stage within the lifetime.

5. Scenarios can be developed by making changes to components or processes of a defined system. The scenarios can then be compared against the original or base case to determine the effects of the changes made in the system with respect to resources, impacts and goods or services.

Once the impacts are understood LCAs can be used for the following (Wolf *et al.*, 2012):

- Increasing environmental awareness.
- Marketing and enabling companies to set environmental benchmarks and demonstrate their environmental impacts to the public.
- Informing companies of where best to invest money to make the largest environmental impacts.
- Inspiring the innovation of new methods and technologies.

2.2 LCA METHODOLOGY

An LCA methodology is built around four major components (Wolf *et al.*, 2012):

1. Goal definition and scope–The goal definition addresses the reason for the study, intended application, questions to be answered and the intended audience. The scope covers the products systems, function of the systems, functional units, system boundaries and allocation procedures.
2. Inventory analysis – The inventory analysis is the collection, verification and assimilation of data from existing databases or gathered from literature sources for the purposes of quantifying the inputs, processes and outputs for the system or systems being assessed.
3. Impact assessment– This section explains which indicators are to be assessed, the impact assessment method, the impact assessment tool to be used, and also the reasons why.
4. Interpretation of results – Definition and explanation of the LCA results, how these compare to previous studies, the major processes, findings and the associated implications on the systems being studied.

The methodology is illustrated in Figure 2-1 and is an iterative process as indicated by the bi-directional arrows in the figure.

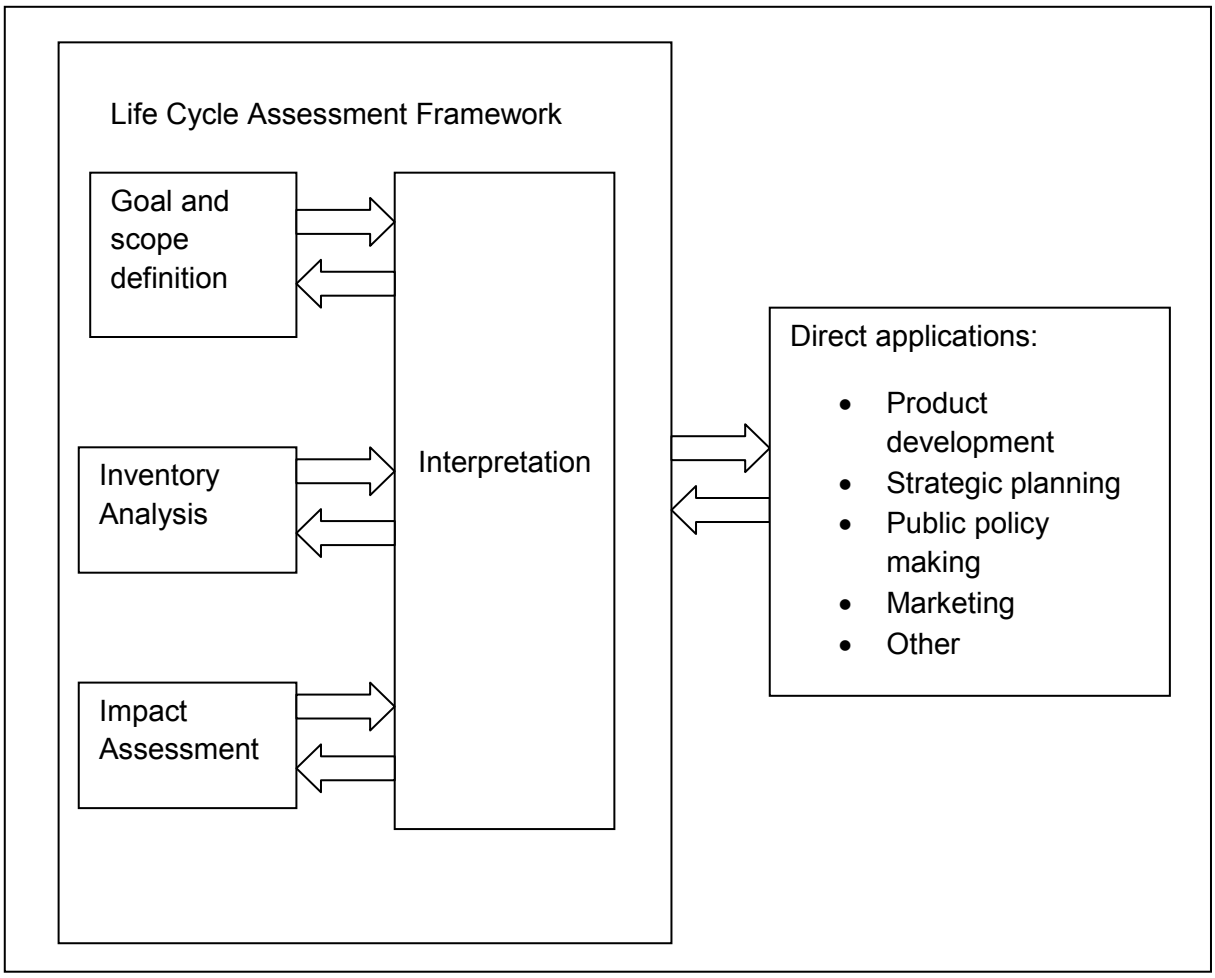

Figure 2-1: Life cycle assessment phases (ISO 14040, 2006)

2.3 GOAL DEFINITION

The main purpose of this study is to compare the environmental impacts and cumulative energy demand of 21 e-books read from an Apple Air iPad (digital system) with 21 printed paper books (print system) in South Africa.

The intended application of this study is to directly compare the printed paper book with that of reading e-books from an Apple Air iPad. The comparison is being performed to create an understanding of the environmental and energy impacts and sustainability of buying either product. If consumers have greater awareness it empowers consumers to make sustainable choices and also to demand more sustainable products. As a result of consumer pressure, companies will respond by reducing the environmental impacts of their products by focusing on the processes and stages causing the greatest impacts. All impacts were assessed because the interest in impacts of the consumer, and the companies which produce the products, might be different. Therefore this study is aimed at consumers and producers of both types of products. Therefore this study is aimed at consumers and producers of both

types of products. The comparative assertions of this study are intended to be disclosed to the public at the discretion of the University of Cape Town.

This study will also investigate the effect that changing the energy mix as planned in the 2010 Integrated Resource Plan (IRP) has on the environmental impacts and cumulative energy demand of both systems.

The main questions to be answered by this study are as follows:

1. Is it more sustainable to read 21 e-books from a Tablet PC or to read 21 printed books?
2. If the electricity mix of the national grid in 2014 is equivalent to the planned Policy Adjusted 2030 electricity mix as detailed in the Integrated Resource Plan, what would the impact be on both systems, in terms of environmental impacts and cumulative energy demand?
3. What is the effect of multiple users on the environmental impact and cumulative energy demand of a printed book?
4. What is the effect of multiple users on the environmental impact and cumulative energy demand of a printed book?

The initial hypothesis of this study is that reading 21 e-books from a Tablet PC has a smaller environmental impact and cumulative energy demand than reading 21 printed books. It is assumed that for the IRP electricity change, and multiple users, that the impacts of the print system in relation to the digital system in all the impact categories, will improve.

This report will serve as academic interest within South Africa and may be used as an information source for future electronic device related studies. It also will help South African consumers who wish to understand the environmental impacts and cumulative energy demand of purchasing either e-books to be read from a Tablet PC or reading printed paper books and which system is the most sustainable. It could also serve as information to the industries namely electronics and paper, which wish to understand the environmental impact contribution of processes and stages in the products lifecycle,

This study will use LCA to make a direct comparison between reading a printed paper book and reading an e-book from a Tablet PC in terms of environmental impacts and cumulative energy demand and determine which system, digital or print, is more environmentally sustainable.

The above is the goal definition for the base case. In addition to the base case two other scenarios will be investigated:

1. IRP electrical energy mix

2. Multiple users

2.3.1.1 IRP Electrical Energy Mix

The Integrated Resource Plan (IRP) developed in 2010 by the Department of Energy (DOE) forms the planning framework for the installed power production plant capacity in South Africa (DOE, 2011). Several scenarios were developed for the period between 2010 and 2030 which assess the impact of installing renewable and energy technologies on the price of electricity and the associated carbon emissions. The "*Policy-Adjusted IRP*" scenario is the current government policy position and assumes the following electrical energy contribution in 2030:

Table 2-1: Electrical Energy Mix for the IRP policy in 2030 in MWh (DOE, 2011)

Electrical energy source	Electrical Energy Share in MWh (%)
Coal	65%
Open Cycle Gas Turbine (OCGT)	0.1%
Closed Cycle Gas Turbine (CCGT)	1%
Nuclear	20%
Hydro	5%
Wind	4%
Concentrated Solar Power (CSP)	1%
Solar Photovoltaic (PV)	4%
Total	**100%**

The "*Policy-Adjusted IRP*" scenario will be used to determine how the digital and print are impacted by a change in of the electrical energy grid mix.

The electricity mix is matched to the Ecoinvent v3.01 database as follows:

- Coal is assumed to be high voltage electricity using hard coal in South Africa.

- OCGT and CCGT were combined and assumed to be high voltage electricity production from natural gas based on a rest of the world mix.
- Nuclear energy is based on high voltage electricity produced in a nuclear pressure water reactor in South Africa.
- Hydro electricity is based on high voltage hydro non-alpine region electricity
- Wind electricity is based on high voltage wind electricity from onshore wind turbines greater than 3MW.
- Solar energy for PV and CSP is grouped together and modelled as low voltage electricity production using a 570kWp open ground installation of PV.

Print system

The electricity mix has been changed to reflect the electricity grid energy mix indicated in the revised scenario of the 2010 IRP. The book is partially recovered with 40% of the paper being recycled and the remainder being disposed of at landfill. The IRP 2010 revised scenario has a greater dependency on nuclear and renewable energy technologies than the current scenario and so lower impacts are expected due to this change. In addition to the change of electricity mix the impacts are expected to be even lower due to the recovery of 40% of the paper material used in the production of the book.

Digital system

The electrical energy mix used in the use phase including the e-book downloading and e-book reading processes is based on the IRP 2010 revised scenario which has a lesser dependency on coal fired power stations. Since coal fired power stations are deemed to be less environmentally sustainable it is expected that this scenario will cause an improvement in the impacts during the usage phase of the lifecycle of the Apple Air iPad. It is assumed that all materials including the packaging associated that the Apple Air iPad is and that the battery are disposed to landfill.

2.3.1.2 Multiple Users

The study is based over a four year period and so there is opportunity for the products being assessed in this life cycle impact to be used by multiple users. If the number of readers per product increases, impacts could either increase or decrease as a multiple of the number of users. This change in magnitude may apply to either, stages of the life-cycle, or the entire lifecycle depending on the exchange between users. This will become clearer in the number

of users discussed in the printed book and Apple Air iPad scenarios below. The functional unit for this scenario is the number of users.

Print System

As mentioned previously, the study is being conducted over a four year period. The booklist used in this study is for half yearly courses. After a course is complete a book could be sold to another student. In a given year this is a possible two applications for the book or two lifetimes. Therefore over a four year a period a book could potentially be used up to eight times. For this scenario it is assumed that the book will be used eight times. A major assumption is that the printed books are still applicable for course work after four years and have not undergone subsequent revision publications.

Digital System

Similar to the print system, the Apple Air iPad is assumed to be shared by a maximum of eight users over the 4 year period. Assuming that the e-books are downloaded by the first user the subsequent users will only need to read the e-books. Therefore all impacts of digital system, except the e-book reading stage, are divided by the number of users. The e-book stage, unlike the other digital stages, will multiply with each new user.

2.4 SCOPE

The scope consists of the product systems, system functions, functional units, reference flows, system boundaries, impact indicators, impact assessment and the compilation of the inventory analysis and associated data assumptions thereof.

2.4.1 PRODUCT SYSTEMS

The two product systems being studied are the print system which consists of a printed textbook and the digital system which consists of an Apple Air iPad and e-books. Both systems will be used for the purposes of reading. The printed books can be read after production but the e-books require the use of an e-device such as the Apple Air iPad to be read.

2.4.2 FUNCTION, FUNCTIONAL UNIT AND REFERENCE FLOW

As mentioned previously, function of both systems is the reading of books. For purposes of comparison a book list from the Commerce degree at the University of Cape Town (UCT), was chosen[4][5]. The degree lasts a period of four years over which each learner will purchase 21 books, either in the form of printed paper books or as e-books that can be read using an Apple Air iPad.

In order to properly define the functional unit, the duration and extent needs to be known. According to South African reading statistics, the average reading time is two hours per day (SABDC, 2001).

Therefore the functional unit can be described as “the reading of 21 books by a single user two hours per day over a four period”.

The reference flow used for the print system was done using the mass of paper required for 21 books, approximately 25.4kg. The 25.4kg was calculated using information on the books from the book list as obtained from Kalahari.com. Using the number of pages and mass of the books an average number of pages per printed book and the average weight per book, was calculated. The average book was found to be 694 pages with each page weight 1.74 grams. For 21 books with an average size of 694 pages, the total weight of all the books is calculated to be 25.416 kg.

The reference flow for the digital system is energy required to download and read 21 e-books is 13,951 Wh. Based on the same reading statistics of the printed book, it is assumed that the e-books are read for two hours per day for four years. Statistics show that the average Tablet PC user uses their tablet for 3.1 hours a day for reading purposes (salesforce.com, 2014). Based on the Apple Air iPad power consumption ratings in the Apple Air Environmental Report, if the Apple Air is used 3.1 hours per day, the battery will require charging every 2.25 days. Over a period of four years this equates to approximately 656Wh per e-book or a total of 21,348 Wh for all 21 e-books. However, only two out of the 3.1 hours is used for reading, a reading allocation of 64.5% (two hours divided by 3.1 hours). Therefore the total energy used for reading is 13,733 Wh.

The energy expended to download a gigabyte of data from the internet is approximately 0.922kWh (Taylor & Koomey, 2008). The estimated average download size of the e-books was obtained from Kalahri.com. The average e-book download size per page was calculated as 13.23 kB. Assuming that there are 21 books that will be downloaded with an average of 694 pages each, the total download size is 192,848 kB. The energy required to download

[4]Available: http://www.booklists.uct.ac.za/commerce/recommended/ [2014, July 6]
[5]Available: http://www.booklists.uct.ac.za/commerce/recommended/?sm=f&id=1 [2014, July 6]

this equates to 178Wh. The total energy to download and read the 21 e-books is thus the 13,951 Wh.

It must be noted that not all books are available online and the site did not have mass, number of pages and download sizes for some of the books. Therefore there is a possibility that the weight and download size might be incorrectly estimated. However, for the purposes of this study it has been assumed that all 21 books were represented by the calculated averages. Please refer to Appendix B for the calculations.

The Tablet PC that the e-book will be read from is an Apple Air iPad. However, since the Apple Air iPad is a multimedia device and can be used for applications besides reading such as video, photography and social networking, the use for reading must be isolated and allocated for all stages of the Apple Air iPad LCA in this study.

2.4.3 SYSTEM BOUNDARY

The system boundaries of each system are discussed in detail in the sections that follow.

2.4.3.1 Print System

The print system involves the forestry, pulp, paper and the publishing industry. The life cycle of the paper book includes the following stages:

- Pulp wood production,
- Pulp wood transportation,
- Pulp and paper production,
- Paper transportation,
- Printing,
- Distribution transportation,
- Personal transportation
- Printed paper book use, and
- Waste management.

The pulp wood production marks the “cradle” of the system and the waste management stage marks the “grave” of the cycle. The printed textbooks are assumed to be part of a closed loop as recycling of paper produces other paper products other than textbooks. The system boundary is illustrated in Figure 2-2. Thereafter, explanations of each stage and the processes that each entails are given.

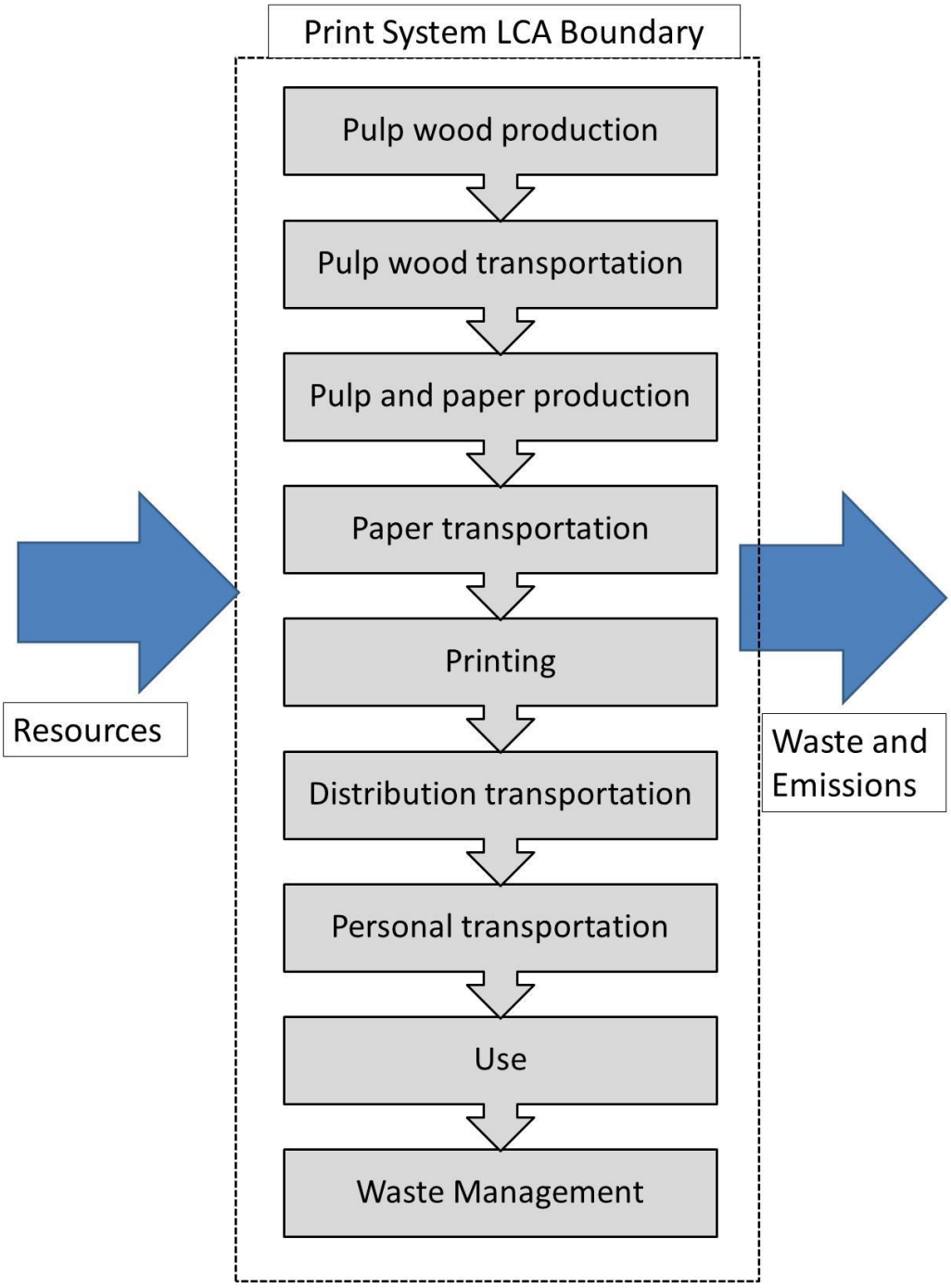

Figure 2-2: Print System Boundary Diagram

The stages of the print system and associated processes will now be discussed in greater detail.

Pulp Wood Production

Eucalyptus is a hardwood tree grown in South Africa primarily for the production of pulpwood which is used in the manufacturing of printing and writing paper grades (DAFF, 2011).

All trees in South Africa are grown in special dedicated nurseries before being transported to the plantations (Sappi, 2011a).Before a tree can be planted the land needs to be cleared by physical, chemical or mechanical means (Sappi, 2011a). The land preparation is important as it affects the survival, growth and yield of the trees (Sappi, 2011a).

Virgin land is prepared by ploughing (Sappi, 2011a). The main aim of the ploughing is to break the dense root networks and allow the tree roots to make optimum use of the nutrients in the soil (Sappi, 2011a). Re-establishment on existing land as is the case with most plantations in South Africa requires a shallow ripping of the soil to remove surface plants (Sappi, 2011a).

The number of trees planted per hectare of land depends on the species of the tree which is important as it affects the nutrient uptake of the plant and in turn the wood yield per tree (Sappi, 2011a).

Fertilisers are added to the plants to increase the turnaround or cycle growth times and also the production of the plantation (Sappi, 2011a). The main fertiliser minerals are Potassium, Nitrogen and Phosphorus (Sappi, 2011a).

In addition to fertiliser the land needs to be maintained regularly through weeding, pruning and thinning (Sappi, 2011a).

Pruning is carried out to correct the growth of trees by removing dead parts (Sappi, 2011a). Thinning removes parts of the tree to improve the growth in size and increase tolerance to external stresses (Sappi, 2011a). This helps plantations maximise yield of pulpwood trees (Sappi, 2011a). Thinning reduces the density of trees per stand from 2,222 to 2,000 in the first round of thinning and to 1,500 trees per hectare after a second round (Sappi, 2011a).

Once the tree has reached maturity at approximately 10 years of age the tree is harvested (Sappi, 2011b). The tree felling is mainly done by mechanised methods such as chainsaw. The tree is then debarked and debranched (Sappi, 2011b). This process involves the removal of tree bark using axes or hatchets and the removal of branches using chainsaws (Sappi, 2011b).

Pulp Wood Transportation

The logs of wood are then stacked and bundled and loaded onto a skidder vehicle or three wheeler vehicles (Sappi, 2011b. The wood is then transported on long haul vehicle trucks of standard 38 ton payloads to the pulp and paper mills[6].

Pulp Production

Once the pulpwood from the plantations arrives at the pulp mill it is converted from pulpwood into pulp (Sappi, 2003a). The pulp process is dependent on the type of wood being used and the application of the pulp to be produced (Sappi, 2003a). Chemical pulping is the process used to make writing grade paper pulp (Sappi, 2003a).

Chemical pulping involves the boiling of wood chips in a chemical solution such as sulphates or sulphites to remove the lignin from the wood (Sappi, 2003a). The sulphite process is an aggressive alkaline process used for strongly bonded wood (Sappi, 2003a). Sulphites use strong acids like sulphuric acid and magnesium bisulphite liquid to penetrate the wood in the direction of the fibres and decompose the lignin (Sappi, 2003a). The lignin can then be washed out (Sappi, 2003a).Carbohydrates that are leached out of the wood are converted to alcohol and ethanoic acid. The chemicals are then re-used (Sappi, 2003a).

Sulphite pulp is then bleached from a slightly brown colour or a base colour for white paper (Sappi, 2003a). The brown colour of the pulp is turned white by bleaching the pulp (Sappi, 2003a). Pulp bleaching is a process where the pulp is put through cycles of washing and chemical treatment to remove lignin (Sappi, 2003a). Common oxidising chemicals are chlorine, oxygen compounds, ozone and hydrogen peroxide (Sappi, 2003a).

Chemical pulping is suitable for making fine paper and writing grade products because it is and has a pulp yield of 60% (Sappi, 2012). The remaining 40% is black liquor (Sappi, 2012). Black liquor is the left over cooking oil from the kraft process (process where wood is broken down into pulp by removal of woody lignin) (Sappi, 2012). The black liquor contains lignin, hemicellulose and inorganic chemicals but retains a lot of energy (Sappi, 2012). The high energy equivalent to more than half of the input wood energy is used as a fuel to create additional heat (Sappi, 2012). The black liquor is burnt as a fuel source to create heat energy and electricity.

[6]Available: http://www.saforestrymag.co.za/articles/detail/smart_trucks_improve_efficiencies [2014, August 9]

Most pulp mills are integrated with paper mills as this decreases the cost of transportation (The Timber Watch Coalition, 2009). The finished bleached chemical pulp is then sent straight into the papermaking process (Sappi, 2003a).

Paper Production

The process of making paper is described below and follows on from the production of pulp containing pulp fibres. The paper making process consists of the following steps (Sappi, 2003a):

1. **Refining**- The pulp is fed into the refiner machine for refining. The machine contains rotating parts called rotors and stationary parts which are fixed relative to the casing called stators. These parts can be varied in position to either cut or bleed the fibres (drain excess water). Bleeding allows the fibre ends to form into stronger connections.
2. **Filling**-The production of paper from pulp requires several raw materials. These include but are not limited to additives, dyes, fillers, sizing substances and water. Fillers are used to create uniform surfaces, increase opacity of the paper, improve the brightness of the papers appearance, soften the papers texture and also add flexural strength. Common fillers include kaolin, china clay, and calcium carbonate. Calcium carbonate is the most popular as it increases the longevity of the paper. Water is an important additive as for every kilogram of paper produced approximately 100 litres of water is consumed. The water used is recycled and re-used in other processes. The water, fillers and other ingredients are mixed together in mix-tubs. The paper is then also cleaned of impurities before heading to the headbox.
3. **Forming**-Afterwards the paper is slowly fed onto a wire. The paper fibres form layers upon the wire and the suspension is drained away. The paper sheet is then formed through filtration and thickening processes. The sheet formation is controlled using running, rotating, stationary and mechanical elements. Sheet formation can be done using twin or gapformers. Twinformers allows the suspension to drain from both the top and the bottom which leads to good process efficiencies. Gap formers drain from both sides and simultaneously inject the suspension between the two wires. This action prevents the particles from moving and allows the sheet to form on the wire without any disturbances.
4. **Pressing** – The paper is then dewatered using a pressing process. The process involves mechanical compression to remove water via a system of rolls. The rolls have been replaced by shoes which attain greater efficiencies.

5. **Drying** - After pressing the paper has a water content of approximately 50 to 55%. The remaining water is vaporised though contact drying. Contact drying is a process where paper is passed over steaming hot cylinders.
6. **Glazing** - The paper is then glazed in machine calendars which use steel and plastic rolls to apply the glazing to the papers surface.
7. **Surface Treatment** -The surface is then treated by size or film dressing which applies starch to the paper surface to prevent the paper collecting dust or causing printing problems. This process like the previous processes is also done using a series of rollers.
8. **Coating** - The paper is then coated to improve visibility and the texture smoothness of the paper for images. It also improves the papers quality for printing ink and the papers image contrast. The paper is coated and then dried using infrared dryers.
9. **Finishing** - Pigments such as chalk and talcum re then added to the paper using binding agents. Commonly used binding agents are casein, starch and synthetics. The process is fully automated using specified mix proportions to achieve specific output requirements such as the brightness. A material which could be added to such a mix is optical whitener. Optical whitener is used to increase the brightness of paper by giving the paper a light blue glow.

   The properties of paper can be adjusted to suit the specific application of the paper. The basic properties of the paper which are optimised during the paper process are the following (Sappi, 2007):

   - Paper weight which depends on fillers and constituent materials,
   - Brightness is measured against magnesium oxide,
   - Gloss which is measured using reflective light of the papers surface as an indicator,
   - Paper surface roughness which is how smooth the papers surface is measured by passing air between a flat surface and paper and calculating the voids from the volume of air passing by per given time,
   - Opacity which is how much light passes through and how much is reflected,
   - Humidity which is the ability of the paper to absorb water from the air, and
   - The pH should be neutral and specific volume which is used as a comparison between different grades of paper.

   The paper is then passed through another series of calendars which apply pressure and heat to the paper for glossing purposes. The paper is then moved via rewinders cut into paper reels with knives on slitter rewinders and then further cut, if needed,

into smaller pieces by a guillotine. The guillotine is used for special sizes but a cross cutter can also be used for standard paper sizes. The paper is packed and stored for transport in reams of 100, 250 or 500 sheets of paper.

Paper transportation

The paper is then transported to the printing houses from the integrated paper and pulp mill via truck.

Printing

Before a book can be created it needs to be printed and bound. The book printing process consists of the following steps (Sappi, 2003b):

1. **Prepress -** The images of the books are loaded as files onto the server for the printer.

2. **Preparing the print plate -** The preparation of the print plate involves setting ink composition and supply.

3. **Printing -** The sheets are fed into the printer and the rollers apply water to the non-ink parts of the paper. Ink is applied to the water resistant parts of the paper. The paper is then airbrushed to ensure that the sheets remain separate. Sheet detectors detect the thickness of the paper and prevent jamming. The paper is coloured in a step wise process first in black followed by cyan magenta and yellow.

4. **Finishing and folding -** After printing the paper is stacked and sprayed with set-off powder to prevent smudging of the ink. The sheets are then folded and bound to a hardcover. In addition to this varnish and melting glue are used to bind and prepare the surfaces. These have been assumed to form minor quantities and left out of the analysis.

Distribution Transportation

The book is then transported from the printing house to the book store.

Personal transportation

The consumer travels to the book store to purchase the book and then travels home. It is assumed that this trip is made each year.

Paper book use

The reading of a printed book is assumed to consume no additional energy such as lighting for reading.

Waste Management

Almost 40% of writing grade paper in South Africa is recycled (PRASA, 2012). However, bleached paper used for printing and writing grade paper relies on a high percentage of virgin fibres (Sappi, 2003a). Friedrich & Trois *(*2013) found that writing and printing grade paper are not recycled into new writing or print grade products but are rather used in the creation of tissue paper products. The implication of this is that a book in South Africa can only be used as a book for one life cycle. The majority of paper (60%) is disposed of in landfill (PRASA, 2012).

2.4.3.2 Digital System

A Tablet PC is a multimedia device that uses a touch screen as its primary user interface. Modern Tablet PCs rival the specifications found on medium range computers offering fast processors, excellent audio and visual displays and a variety of applications all whilst offering greater mobility to users. The system boundary of the Tablet PC the following stages:

- Apple Air iPad production,
- E-book formatting,
- E-book downloading,
- Distribution transportation of Apple Air iPad,
- Personal transportation,
- Use of e-books and Apple Air iPad, and
- Waste management.

The Apple Air iPad production and the e-book formatting stages marks the “cradle” of the digital system as both the e-books and Apple Air iPad are created in these stages. The waste management stage marks the “grave” of the cycle. The Apple Air iPad and e-books are part of a closed loop system as the components of the Apple Air iPad are used in other electronic products with different functionality. E-books are assumed to be copyrighted and cannot be transferred to another user. The digital system boundary is illustrated in Figure 2-3. Thereafter, explanations of each stage and the processes that each entails are given.

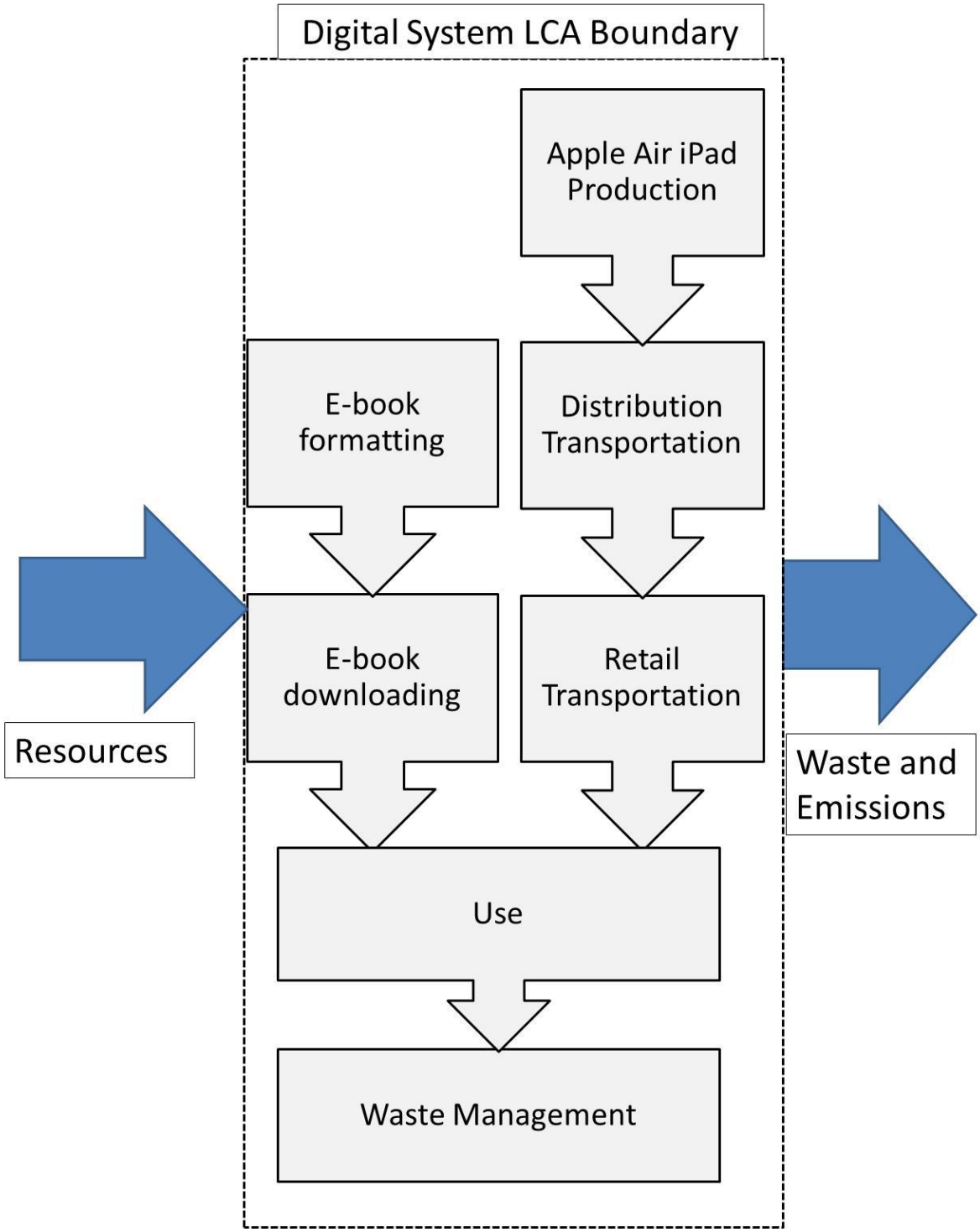

Figure 2-3: Digital system boundary diagram

The digital system stages and associated processes will now be discussed in greater detail.

Apple Air iPad Production

The main minerals and metals used in electronics include Steel, Magnesium, Molybdenum, Rare Earth Metals, Silver, Tin, Tungsten, Vanadium, Yttrium, Indium, Bismuth, Gold, Lithium and Copper(Prakash *et al.*, 2011). Most of these minerals and metals can be found in abundance in China with the exception of Copper, Lithium and Silver (Prakash *et al.*, 2011).

Once the minerals and metal ores are extracted from mines, they are sent to refineries (Faulkner, 1986). The refineries produce minerals and metals from the ore and sell the metals to metal traders and sell the minerals to salt producers (Faulkner, 1986). The metals and minerals are then used to form and assemble electronic components such as transistors, resistors, connectors and integrated circuits (Prakash *et al.*, 2011).

The components are created in different parts of the world such as China, Taiwan, USA, South Korea and Japan but are ultimately assembled into the final product by FoxConn in China[7]. It is assumed that the product is packaged and manufactured in China.

Apple Air iPad Distribution Transportation

The packages are shipped from China to regional distribution centres across the globe. South Africa receives its products from the European distribution centre in the UK[8]. Once in South Africa, the official Apple distributor, Core Group, distributes the products to retailers[9].

Personal transportation

The consumer travels to the store to buy the Apple Air iPad from an electronics store.

E-book formatting

The e-book undergoes a formatting and editing process before being uploaded onto a server for storage and management purposes (Oghajafor, 2005). Whilst all books would be typed up on a computer before being published as a printed book, the e-book formatting refers to published printed books being scanned and formatted for use as an e-book (Oghajafor, 2005). Since the typing up of the books is common to both printed and e-books its effect has been excluded from the LCA of both print and digital systems.

[7]Available: http://forwardthinking.pcmag.com/apple/282348-ipad-2-designed-in-california-manufactured-everywhere [2014, August 9]
[8]Available: https://www.apple.com/za/contact/ [2014, August 9]
[9]Available: https://www.apple.com/za/contact/ [2014, August 9]

E-book downloading

The e-book is then downloaded from the server by the user using modems, routers and the Apple Air iPad[10].

Use

The use phase consists of reading e-books off an Apple Air iPad. Apple Air iPad use consists of cumulative energy demand for reading of e-books which is a function of charging the battery. The battery power and usage of power quantities have been estimated from Apple's product information report for the Apple Air iPad (Apple, 2013).

Waste disposal and recovery

It is assumed that the Apple Air iPad will be recovered by Apple. Currently Apple is offering a free electronics recycling recovery programme[11]. Apple product owners wishing to return old products simply fill in an online form and the products are collected from their door and returned to Apple[12]. The service is available to 48 countries including South Africa[13]. Some countries such as those in Europe have the option of returning undamaged batteries and can also make use of recycling collection points[14]. These options are still not available in South Africa and therefore the whole product is returned to Apple[15].

However, it is assumed that not all materials once returned to Apple will avoid landfill. It is assumed that all components except the battery and packaging material will be recovered (DEA, 2012). This assumption is from the fact that Apple uses components from older devices in newer products. An example is the Apple Air iPad which comprises components from the older iPhone 5.[16].

The waste management process adopts the cut-off approach. It has been assumed that the environmental benefits of recycling will be credited to the life of the products and only one life cycle is considered as a product made from the recycled material will be a different

[10]Internet equipment used to download was assumed as per Taylor &Koomey (2008)
[11]Available: https://www.apple.com/recycling/nationalservices/europe.html[2014, October 13]
[12]Available: https://www.apple.com/recycling/nationalservices/europe.html[2014, October 13]
[13]Available: https://www.apple.com/recycling/nationalservices/europe.html[2014, October 13]
[14]Available: https://www.apple.com/recycling/nationalservices/europe.html[2014, October 13]
[15]Available: https://www.apple.com/recycling/nationalservices/europe.html[2014, October 13]

[16]Available: http://www.chipworks.com/en/technical-competitive-analysis/resources/blog/inside-the-ipad-air/[2014, October 13]

product to the original and have different properties and applications (Nicholson *et al.*, 2009). The waste management stage only considers materials going to landfill or avoiding landfill by being recovered for re-use but does not include the re-use.

2.4.4 ALLOCATION PROCEDURE

Whilst there is no allocation procedures applied to the printed system the digital system does have an applied allocation based on use. The Apple Air iPad is a multifunctional device but is used for reading for two out of 3.1 hours per day, or 64.5% of the time that the Apple Air iPad is in use. The allocation percentage was applied to the production, distribution and retail transportation associated with the Apple Air iPad to reflect the potential impacts due to just reading.

2.4.5 IMPACT ASSESSMENT

2.4.5.1 SimaPro version 8.1

SimaPro is a LCA tool developed by PRé-Consultants. The software has 14 different impact assessment methods including Recipe and Cumulative Energy Demand. Each impact assessment method assesses different impacts and makes reference to libraries of information pertaining to processes and associated impacts. The impacts of the processes can be quantified physically or financially. Previous studies including Moberg et al (2011) and Achachlouei *et al.* (2013) have used SimaPro. Since this study is concerned with just the environmental impacts and the energy demands of the print and digital system, two methods have been selected, namely Recipe 1.09 midpoint heirarchist method for the environmental impacts and the Cumulative Energy Demand method for the energy demand. The LCA and CED methods were chosen because consumers need to be made aware of all the impacts of a given product over its lifecycle, cradle to grave, and the processes and stages which contribute to these. All impacts were assessed as each consumer and the companies which produce the products might be interested in different impacts.

2.4.5.2 RECIPE 1.09 Midpoint (Heirarchist)

The Recipe method is described as a modelling method that is “harmonised in terms of modelling principles and choices, but which offers results at both the midpoint and endpoint level” (Goedkoop *et al.*, 2009).

There are two main types of impact indicators that can be used, namely midpoint and endpoint. The Midpoint characterisation method was developed by Guinée *et al.* (2002). It can be described as "a parameter in the cause-effect chain that or network (environmental mechanism) that is between the inventory data and the category endpoints" (Bare et. al, 2000) and endpoint characterisations factors are computed to indicate "differences between the stressors at an end-point at a cause effect-chain and may be of direct relevance to society's understanding of the final effect" (Bare et. al, 2000).

An example of a midpoint category indicator would be global warming potential in terms of CO_2 equivalents for the impact category for climate change whilst for the same impact category the endpoint is damage to human health and ecosystems.

In this study midpoint impact category indicators are being used to characterise the environmental impact results. The eighteen impact categories being used in this study are shown in Table 2-2. All impacts are assessed because consumers need to be made aware of all the impacts of a given product over its lifecycle and the processes and stages which contribute to these. If consumers have greater awareness it empowers consumers to make sustainable choices and also to demand more sustainable products. Companies will respond to the consumer demand by reducing the environmental impacts of their products as identified through the LCA. All impacts were assessed as each consumer might be interested in different impacts.

2.4.5.3 Cumulative Energy Demand

Cumulative energy demand (CED) is described as "the entire demand, valued as primary energy, which arises in connection with the production, use and disposal of economic goods (product or service) or which may be attributed to it respectively in a casual relation" (Frischknecht *et al.*, 2003).

The CED is categorised into the following five impact categories:

1. Fossil
2. Nuclear
3. Water
4. Wind, Solar, Geothermal, and
5. Biomass

Fossil and nuclear energy are considered to be non-renewable energy whilst water, wind, solar, geothermal and biomass are considered to be renewable sources of energy.

Table 2-2: Environmental Impacts (Goedkoop et al., 2009)

Impact Category	Unit	Description	Characterisation Factor Name
Climate Change	kg	CO_2equivalent to air	Global Warming Potential
Ozone Depletion	kg	Chlorofluorocarbon to air	Ozone Depletion Potential
Terrestrial Acidification	kg	SO_2 to air	Terrestrial Acidification Potential
Freshwater Eutrophication	kg	P to freshwater	Freshwater Eutrophication Potential
Marine Eutrophication	kg	N to freshwater	Marine Eutrophication Potential
Human Toxicity	kg	1,4 Dichlorobenzene to urban air	Human Toxicity Potential
Photochemical Oxidant Formation	kg	Non Methane Volatile Organic Carbon Compound (NMVOC)	Photochemical Oxidant Formation Potential
Particulate Matter Formation	kg	PM_{10} to air	Particulate Matter Formation Potential
Terrestrial Ecotoxicity	kg	1,4 Dichlorobenzene to industrial soil	Terrestrial Ecotoxicity Potential
Freshwater Ecotoxicity	kg	1,4 Dichlorobenzene to freshwater	Freshwater Ecotoxicity Potential
Marine Ecotoxicity	kg	1,4 Dichlorobenzene to marine water	Marine Ecotoxicity Potential
Ionising Radiation	kg	U^{235} to air	Ionising Radiation Potential
Agricultural Land Occupation	m^2.yr	agricultural land	Agricultural Land Occupation Potential
Urban Land Occupation	m^2.yr	urban land	Urban Land Occupation Potential
Natural land Transformation	m^2	natural land	Natural land Transformation Potential
Water Depletion	m^3	water	Water Depletion Potential
Mineral Resource Depletion	kg	Fe	Mineral Resource Depletion Potential
Fossil Resource Depletion	kg	oil	Fossil Resource Depletion Potential

2.4.6 DATA REQUIREMENTS

The impacts for each method will be filtered to cut off processes with less than 1% contribution to the impact being assessed.

The inventory analysis is the construction of the LCA input and output data and the associated assumptions that will be used in the LCA calculations.

The inventory is built through the collection of quantitative, numerical and descriptive qualitative data (Baumann and Tillman, 2004). The numerical data is used to quantify inputs, materials, processes, relationships between material flows, outputs and be used to determine allocation (Baumann and Tillman, 2004). Qualitative data can be used to describe processes, the geographical location and define system boundaries (Baumann and Tillman, 2004).

The LCA data can be sourced as primary data or from LCA software databases or a mix of both. Primary data can be sourced from a literature review of previous studies, scientific reports, producers and organizations and government databases (Baumann and Tillman, 2004).

In contrast to the user gathering data like in the case of primary data, LCA software databases such as Ecoinvent are compiled by expert researchers and from industrial and scientific studies. The databases contain all inputs and outputs associated with the product concerned.

Both primary data and or LCA databases can be used in LCA software packages such SimaPro to construct the processes for a system being assessed in an LCA. Where the product is available, the user can use the database product as is or amend the values to suit the study. Primary data is used when the product being assessed in the LCA, does not exist on the database or requires changes to the input materials, processes or the waste flows and by-products, to suit the study.

When building the inventories for the system it is important to understand the limitations of the assumptions made for the data selected. LCA data is geographic specific but not site specific (Wolf *et al.*, 2012). Geographic specific data refers to data applicable to a geographical region. For instance paper produced in South Africa will use database information from South Africa. Using an energy mix from another country would be inaccurate as the types of resources and associated impacts would differ. However, the energy data is for the whole country and does not vary locally. A new development in South Africa may be sourcing its power from an energy mix, other than the national grid, but if no data is available for the development energy mix, the South African energy mix would be

used. Therefore LCA is considered to not be site specific. If the user wishes to make it site specific the user will have to gather the data and amend the database accordingly.

The inventory data in this study has been built to mitigate the limitations and consists of a combination of both primary data and databases. The primary data has been gathered from a variety of literature and used to supplement and amend the Ecoinvent 3.01 database to suit the South African situation. Data for a process or material can be based on average global data, data from a country or a geographical region. Where there is limited South African data regional data is used. Examples of geographical regions being used are:

- Rest of the world (RoW)- Average of all countries in the world with available data for the process or material excluding those in Europe
- Global (GLO) which uses an average of all the countries with available data.
- Europe (RER) which uses an average of European countries with available data.
- Data for South Africa (ZA)
- Data for China (CN).

2.4.7 Critical Review Considerations

The study will only be critically reviewed by the thesis supervisor followed by internal and external examiner modelling and LCA experts.

2.4.8 Type and Format of Report

The report is intended to be disclosed to the public as it compares two different products. This report is a comparative report and hence will be a full report including the methodology, discussions and finding, an appendix of inputs, outputs and calculations and also have a non-technical executive summary or abstract. In terms of ISO 14044 the report shall include material flow analysis, data completeness and representativeness, critical review process, evaluation of the completeness of the LCIA, use and justification of category indicators, scientific and technical validity and environmental relevance of indicators used, results of the uncertainty and evaluation of the significance of differences found.

2.4.9 Inventory Analysis and Data Assumptions

The inventories of data and assumptions for each system are discussed in the sections that follow.

2.4.10 PRINT SYSTEM INVENTORY AND DATA ASSUMPTIONS

This subsection discusses the data assumptions used in building the inventory of the print system. The data inputs per process for the print system is tabulated in terms of stage, process, input, value, unit and data regional source (Table 2-3). The assumptions should be read in conjunction with Table 2-3. Please refer to Appendix B and C for the data inputs and database edits mentioned in this section.

Pulpwood

Hardwood is used for writing and printing paper grade in South Africa (Sappi, 2012). It is realised that some other types of woods such as softwood may be added into the mix to achieve specific properties but this is not considered in this study.

Once the wood is harvested it is transported to the pulp and paper mill. The average distance between plantations and pulp and paper mills has been calculated by Chamberlain *et al.* (2005) to be approximately 108 km. The density of Eucalyptus wood is approximately 440 $kg.m^{-3}$ (NCT, 2004). Therefore to transport $1m^3$ of pulpwood 47.52 ton.km of transport via truck is required[17]. The vehicles used to transport the timber have payloads of 38 tons (Chamberlain *et al.*, 2005). Therefore trucks dealing with timber transportation are assumed to be the same as trucks that have a payload greater than 32 tonnes as per the Ecoinvent database. EURO III emissions were assumed although South Africa's vehicle parc is a mixture of different EURO emission standards. South Africa is currently using EURO II emission standards but has a mix of mostly EURO III and IV vehicles (NAAMSA, 2012).

All the processes in this stage are based on average global data from the Ecoinvent v 3.01 database with the exception of the input values for ton.km.

Pulp

It is assumed that all printed books are made using paper made entirely from sulfite pulp.

Other edits include the electricity and water input which have been changed from RoW data to South African data and the pulpwood which has changed to be only hardwood as mentioned in the pulpwood stage.

[17] The $1m^3$ is a reference value but not the actual amount of paper needed. The 25.4kg of paper is used as the input for paper, which is then referenced to pulpwood transport $1m^3$ reference and prorated for the corresponding wood volume and hence corresponding truck transportation value.

Paper

It is assumed that once the pulp is made that no transport is needed since the paper is made at an integrated paper and pulp mill (The Timber Watch Coalition. 2009).

All paper in the book is deemed to be made from wood-free uncoated paper. Wood-free refers to paper which is made from pulp which is free of the woody substance known as lignin. This assumption includes the book covers. The weight of the book includes the cover of the book and weight of the paper within. This approach disregards the type of cover of each textbook in the model.

The Ecoinvent database edits include the electricity, coal and water input which have been changed from RoW data to South African data and the pulpwood which has changed to be only hardwood as mentioned in the pulpwood stage.

Paper Transportation

Five of six of South Africa's printing houses are located in Cape Town and its surrounding areas (Genesis Analytics (Pty) Ltd, 2005). Therefore it was assumed that the paper would be transported for 1,635 km between Durban and Cape Town (Google Maps, 2014). It is assumed that 32 ton payload truck with global Euro III standard emissions from the Ecoinvent v3.01 database would be used for the transportation of the paper. Assuming that the truck transports the 25.4kg of paper for a distance of 1,635km then the paper transportation input for the SimaPro model is 41.6 km.ton.

Printing

The publishing and printing data is assumed to be similar to international procedures and therefore a global mix is assumed for the input materials such as ink, solvent, glue etc.

The only to edits the Ecoinvent database for the printing stage is the input of paper produced in the previous stage and the electricity which is based on the South African electricity mix.

The distance travelled by the distribution transportation is made under the assumption that the books are distributed to Cape Town University and is assumed to be close enough to the Cape Town based printing house and can be excluded from the analysis.

Kozak (2003) went to great lengths to calculate the impacts of storing books in a book store. This has been left out as it was found to have a negligible contribution to impacts in that study.

Personal transportation

The personal transportation is assumed to be a car with Euro III emission standards. Small regional shopping centres have an approximate distance of 3-5 km from households (Prinsloo, 2010). Using this information a one way trip is assumed to be 5 km and a round trip assumed to be 10 km. However, it is recognised that trip distances may vary.

It is assumed that four trips will be required i.e. five books are purchased per trip. This assumption follows that the student will need approximately five books per year.

Reading

No impacts have been assumed with the reading of books. This includes the use of reading lights. It is assumed that all books are read once. Although books can be read multiple times it is not considered in the main scenario.

Waste Management

It is assumed that 40% of paper is recovered and avoids being sent to landfill based on recycling statistics from South Africa (PRASA, 2012). The modelling inputs for both recycling and waste sent to landfill are based on the Ecoinvent v3.01 database average global parameters for waste management because there is no waste management data for South Africa in the database.

The recycling of paper or use of recovered paper is not considered as South Africa uses only virgin fibres in the production of writing paper grades (Sappi, 2003a). Any recycled paper from the waste of writing grade paper materials will most likely not be reused in writing grade materials again but lower grade papers such as tissue papers. Since lower grade papers do not produce the same product and hence the same function and essentially represent a new life cycle the issue of recycling paper has been ignored.

Textbooks can be kept for long periods of time or sold to another user. Kozak (2003) discusses the lifetime of books from previous studies and states that books can be kept for indefinite amounts of time. However, since the period of this study is over a four year period the book is also assumed to have a lifetime of four years.

Table 2-3: Print System Inventory Data

Stage	Process	Input	Value	Unit	Data Regional Source
Pulpwood	Pulpwood	Pulpwood, hardwood, measured as solid wood under bark	1.000	m^3	GLO
	Pulp Wood Transportation	Pulp wood Transport, freight, lorry >32 metric ton	47.520	ton.km	GLO
Pulp Production	Pulp Production	Electricity, medium voltage	0.140	kWh	ZA
		Pulpwood, hardwood, measured as solid wood under bark	0.003	m^3	ZA
		Water, cooling, unspecified natural origin	0.017	m^3	ZA
		Water, unspecified natural origin	0.072	m^3	ZA
Paper	Paper Production	Pulpwood, hardwood, measured as solid wood under bark	0.003	m^3	ZA
		Sulfite pulp, bleached	0.030	m^3	ZA
		Hard coal	0.008	kg	ZA
		Electricity, medium voltage	0.350	kWh	ZA
		Water, unspecified natural origin	0.052	m^3	ZA
		Water, cooling, unspecified natural origin	0.056	m^3	ZA
Paper Distribution Transport	Paper Distribution Transport	Transport, freight, lorry 16-32 metric ton, EURO3	41.561	ton.km	GLO
Printed Paper	Printed Paper	Paper, woodfree, coated	1.385	kWh	ZA
		Electricity, low voltage	0.717	kWh	ZA
Personal Transportation	Personal Transportation	Transport, passenger car, medium size, petrol, EURO 3	1.905	km	GLO
Waste Management	Waste Management	Treatment of municipal solid waste, landfill	1.000	kg	GLO

2.4.11 DIGITAL SYSTEM INVENTORY, ASSUMPTIONS AND LIMITATIONS

This subsection discusses the data assumptions used in building the inventory of the digital system. The data inputs per process for the digital system is tabulated in terms of stage, process, input, value, unit and data regional source (Table 2-4). The assumptions should be read in conjunction with the Table 2-4. Please refer to Appendix B and C for the data inputs and database edits mentioned in this section.

Production of Apple Air iPad

The Apple Air iPad is assembled in Foxconn's Chinese factories therefore Chinese mixes from the Ecoinvent v3.01 database were used for all materials where available. Where Chinese data is not available a global mix is used.

The mass of the Apple Air iPad was estimated using the mass as given by the Apple Air iPad Environmental Report (Apple, 2013). The masses of the materials were matched to the Ecoinvent database using the following assumptions:

- The 161 gram Lithium ion battery was assumed to be from a rest of the world production.
- The type of plastics (22g) used in the Apple Air iPad is assumed to be Acrylonitrile-butadiene-styrene (ABS) copolymer. This is based on a computer electronic product material characterisation conducted by Headley Pratt Consulting for the American Plastics Council in 2000, which found that 57% and 36% of plastics in computers were ABS and Polyethylene blend. It is recognised that computers consist of many types of plastics but these were assumed to be solely ABS. The other plastics (11g) were also included as ABS.
- It is assumed that there is an even split in the circuit boards between integrated circuits with memory (16g) and those with logic (16g).Achachlouei *et al.* (2013) measured the components by disassembling the components but the masses were not listed.
- The corrugated cardboard (166g) for packaging is assumed to be corrugated board found in the database.
- The polystyrene (66g) used in the packaging is assumed to be for general purpose use. Although general purpose and high impact polystyrene are different types of polystyrene they both share similar inputs and outputs and the differences between the impacts have been assumed to be negligible. (Plastics Europe Association of Plastics Manufacturers, 2009).

- The glass (61g) is assumed to be flat coated glass.
- The display (109g) is assumed to be the same as un-mounted liquid crystal display (LCD) in the database.
- Aluminium (86g) is modelled as aluminium alloy.

The energy and materials associated with the assembly of the Apple Air iPad were not included as processes in this stage.

Apple Air iPad Distribution

The distribution stage only contains the transportation process of the Apple Air iPad. It excludes processes associated with storing and placing the products in boxes for distribution.

The Apple Air iPad with packaging weighs approximately 714 g (Apple, 2013). This is shipped from China to regional distribution centres across the globe. South Africa receives its products from the European distribution centre in the United Kingdom (UK). The shipping distances are 20,500 km between China and Europe and 12,000 km between Europe and Africa[18]. Therefore the total distance is 32,500 km.

It is also assumed that the Apple Air iPad will be transported from Durban to Cape Town as Durban is the busiest harbour in South Africa (Maharaj, 2013). The distance between Durban and Cape Town via truck is 1,635 km (Google Maps, 2014).

Personal transportation

This stage refers to the trip the consumer makes from the household to the shop, using personal transportation, to purchase the Apple Air iPad. The personal transportation is assumed to have Euro III emissions and the round trip distance between the household and shop is assumed to be 10 km (Prinsloo, 2010).

E-book Formatting

It is assumed that each e-book is formatted for 50 hours using a computer as per Achachlouei *et al.* (2013). A further assumption is that one e-book is formatted for a 1,000 readers i.e. 250 scholars per year for four years. It is assumed that the e-book will be used over the four year period and won't undergo subsequent revisions.

[18] Available: http://www.searates.com/reference/portdistance/ [2014, October 13]

E-book Downloading

The e-book downloading is based on energy use to download the book by the user modem and router, a digital subscriber line access multiplexer (DSLAM) access network, internet, data centre, cables and operational activities as per Malmodin *et al.* (2011).Although the aforementioned is a Swedish study it is used for this study since no LCA data for telecommunications information downloading impacts exists for South African conditions.

It is also recognised that the internet operations and connections are faster and more advance in Europe compared to South Africa but this is overlooked since it is assumed that this study looks at middle and high income households which can afford high internet bandwidth speed connections.

Only the energy usage is modelled. No telecommunications infrastructure associated with the downloading is included.

E-book Reading

The e-book reading in South Africa is based on reading times for printed books as no information exists for e-book reading times in South Africa.

Waste Management

After use most of the Apple Air iPad components avoid landfill. It is assumed that only the battery and packaging of the Apple Air iPad is sent to landfill (DEA, 2012).

Whilst previous studies indicate that up to 80% of the electronic devices can be recovered and recycled (Achachlouei *et al.*, 2013), this study does not calculate these effects.

This study overlooks recovery because recovered materials will be used in the creation of another product which is most likely to be of a different function and used for different applications. Since this study only deals with the Apple Air iPad and the reading of e-books it would not make sense to include a lifecycle of another product.

Table 2-4: Digital System Inventory Data

Stage	Process	Input	Value	Unit	Data Regional Source
Apple Air iPad Production	Apple Air iPad	Flat glass, coated	61	g	RER
		LCD unmounted	109	g	GLO
		Aluminium, wrought alloy	86	g	RoW
		Battery cell, Li-ion	161	g	CN
		Acrylonitrile-butadiene-styrene copolymer	33	g	RoW
		Polystyrene, general purpose	66	g	RoW
		Corrugated board box	166	g	RoW
		Integrated circuit, logic type	24	g	GLO
		Integrated circuit, memory type	8	g	GLO
Apple Air iPad Distribution Transportation	Apple Air iPad Distribution Transportation	Transport, freight, sea, transoceanic ship	5.73	ton.km	GLO
		Transport, freight, lorry 16-32 metric ton, EURO3	0.24	ton.km	GLO
Personal Transportation	Personal Transportation	Transport, passenger car, medium size, petrol	10	km	GLO
Use	e-book formatting	Operation, computer, desktop, office use	0.05	hr	GLO
	e-book download	Electricity, low voltage	8.47	Wh	ZA
	e-book reading	Electricity, low voltage	19.9	Wh	ZA
Waste Management	Waste Management	Municipal solid waste (waste scenario)	100	%	GLO

3 FINDINGS AND DISCUSSION: PREVIOUS STUDIES

A number of studies assessing the environmental impacts of print media systems in comparison to digital media systems offering the same services have been conducted Sweden and the USA. The most notable are studies were done by Kozak (2003), Gard & Keoleian (2003), Enroth (2009), Moberg *et al.* (2011) and Achachlouei *et al.* (2013).The previous literature will serve as a basis for comparison of the results to be produced in this study.

3.1 COMPARISON OF PREVIOUS LITERATURE

The previous literature is compared in terms of the following aspects:

- The functional unit
- System boundary
- Spatial boundary
- Methodology, and
- Findings

A conclusion will then be made about the literature. In order to aid the comparison process and guide the reader a table depicting the different parameters, assumptions and outcomes of the LCAs has been developed (please refer to Appendix A).

3.2 FUNCTIONAL UNIT

Previous studies have had different functional units because the studies assessed and compared different print and digital products with each other. The variance of products is listed below:

- Newspapers - (Hischier & Reichart,2003; Toffel & Hovarth, 2004),
- Office paper- (Deetman & Odegard, 2009)
- Magazines - (Achachlouei et al, 2013),
- Journals- (Gard & Keoleian, 2003), and
- Books (Kozak, 2003, Enroth, 2009; Moberg, 2011).

All these print materials differ in terms of the quantity and type of material inputs such as pulp, energy requirements, chemicals and use of virgin fibres or recycled fibres.

The material being read and the electronic device used for reading in the digital systems also varied in terms of properties and use in the following ways:

- The quality and download size of reading material was different between studies. The electronic journal in Gard & Keoleian (2003) was estimated to be approximately 1.5 MB for a journal of 11.7 pages yet a 500 page novel was estimated to be approximately 1.4 MB by Kozak (2003). The journal was of a higher quality so despite having almost 20 times less pages than the book, the download size was almost the same.
- The type of reading material influences reading times and thus use of electronic devices and the associated environmental burdens. For instance teaching aids in Enroth (2009) are read for approximately 8 hours whilst a newspaper in Hischier& Reichart (2003) requires only 10 minutes of reading.

The electronic devices assessed in the studies also differed between studies:

- e-readers (Kozak, 2003; Deetman & Odegard, 2009; Moberg *et al.* 2011);
- PDA (Toffel & Hovarth,2004);
- desktop computers (Hischier & Reichart, 2003; Gard & Keoleian, 2003; Enroth, 2009), and
- Tablet PC (Achachlouei *et al.*, 2013).

Since different electronic devices were assessed, no direct comparison can be made between them i.e. e-readers are different to desktop computers in terms of size, logic and memory components, material composition, operational power consumption etc. This also implies that the associated lifecycle impacts would differ and be difficult to directly compare.

The electronic devices from previous literature were assessed over different lifetimes. The studies range from two years to ten years. However, the most common period assumed for electronic devices was three years. All studies fit the lifetime of the electronic device to suit the assumed period of study.

It was realised that electronic devices such as computers have more applications than just reading and therefore to correctly assess the environmental burdens of reading using electronic devices, the reading time as a proportion of the lifetime was allocated to the impacts.

All the studies have different functional units in terms of products, quantity of product and lifetime usage. However, all studies have chosen the functional unit as the quantity of paper product used and have compared this to reading the electronic version of the print product from an electronic device.

3.3 SYSTEM BOUNDARIES

The most common system boundary for printed products was the production of the paper, distribution, personal transportation, use and waste management whilst forestry, editorial work and book storage were excluded in most cases.

The most comprehensive print system was Enroth (2009) which included book storage and packaging processes in the lifecycle whilst Gard & Keoleian (2003) only had formatting, use, transportation and disposal in their lifecycle.

The digital system boundary in most studies included the production of the electronic media in addition to the electronic devices used for reading. Also included were the usage of network and telecommunications such as the internet and disposal of the electronic devices.

Kozak (2003) was the only study to consider the effects of book storage in a bookstore. Kozak considered the energy used by the store and allocated this according to the number of books in a bookstore.

The transport distribution distances of the print systems studied differ as the geographical locations and intended users are different. Toffel & Hovarth (2004) assumed that the distribution distance travelled to deliver newspaper from newspaper house was 64 km based on distances in the New York City whilst Kozak (2003) assumed the transportation distance between the printing facility and Michigan University was 1,200 km.

Personal transportation was not included in some of the studies because not all products require personal transportation. Users may need to travel to the bookstore using personal transportation to buy a book but a newspaper might be delivered to their household and this transportation would be treated as distribution transportation.

The distances for personal transportation differed between studies with Kozak (2003) assuming 10 miles (16 km) for the distance travelled between household and book store to purchase five books (3.2 km per book) compared to Moberg *et al.* (2011) which uses 2 km per book. This implies that between these two studies personal transportation could have almost a 50% greater impact in Kozak (2003) and highlights the sensitivity to transportation distance.

The approach to the waste management of the print and digital systems also differs between studies.

Hischier & Reichart (2003) assumed that paper products were recycled 2.3 times whilst Deetman & Odegard (2004) assumed that 90% of the paper was made from recovered paper and or made from recycled paper, 8% landfilled and 2% was incinerated.

The digital systems devices were assumed to be either incinerated (Hischier & Reichart, 2003) or recovered and landfilled (Enroth, 2009; Achachlouei *et al.* 2013). Achachlouei *et al.* (2013) assumed that 80% of the Apple Air iPad was recovered and 20% was landfilled. These figures were based on discussions held with a Swedish electronics recycling company.

3.4 SPATIAL BOUNDARIES

An interesting point to note is that the print systems were based entirely in the country of the study but the digital systems production was either global or based in China. For example Achachlouei *et al.* (2013) assumed that the magazines were produced in Sweden and used in Sweden whilst the Tablet PCs were made in China and used in Sweden.

Most of the studies have been conducted in either USA or Scandinavia. The printed products are assumed to be produced in the country of the study but the source of information is sometimes from other countries. For instance Kozak (2003) used Finnish data for printing although the study was based in the USA. This highlights that industry data for the paper industry is not always readily available in the country of study.

3.5 METHODOLOGY

The main differences in methodology between the studies are the approaches to modelling the electronic devices and the impacts assessed and the corresponding databases and impact calculation methods used.

3.6 MODELLING APPROACH OF ELECTRONIC DEVICES

Although all the studies include the environmental burdens of the electronic devices being used for reading, the modelling approach for the devices differed between studies. In some studies the electronic devices were disassembled into components and the components were linked with existing LCA databases, whilst in other studies the electronic device (say an e-reader) was modelled as another electronic device (personal computer).

Examples of these are Moberg *et al.* (2011) and Kozak (2003). Moberg *et al.* was able to match the component (printed wiring board) of the e-reading device to the printed wiring board component in the Ecoinvent database because the data for printing wiring boards was available. However, Kozak (2003) was unable to find the exact product (e-readers) and therefore used database information from a previous study on computers. Recognising that

the e-reader is smaller than the computer but similar in material composition and components, Kozak (2003) scaled down the inputs and outputs associated with computers, by the ratio of the e-reader mass to the computer mass. The scaled down inputs and outputs were then used in the modelling of the production of the e-reader.

The e-reader and personal computer are different devices with different inputs, processes and outputs. The use of personal computer production data for the e-reader could produce impact results that do not reflect the actual impacts of an e-reader.

3.7 Impacts and Impact Calculation Methods

The most noticeable difference between the studies is the impacts investigated. Whilst some such as Moberg *et al*. (2011) assessed energy, toxicity potentials, ecotoxicity potentials and global warming potentials, others such as Enroth (2009) and Achachlouei *et al.* (2013) assessed only global warming potential.

Based on the impacts being assessed the modellers chose databases and calculation methods. Here are a few examples:

- Hischier & Reichart (2003) used the Swiss method of environmental scarcity and the European Eco-Indicator 99 method as they were only interested in assessing an overall environmental impact,
- Toffel & Hovarth (2004) used the Economic Input Output LCA method to assess the impacts of water and ink consumption, and
- Kozak (2003) used the Ecobalance DEAM database to assess the impacts on global warming, ozone depletion and acidification.

The methods used to quantify impacts vary depending on the database of information it uses. This implies that results for these studies will be different too as these databases are based on different data sets of information and also have different characterisation factors for impacts. This makes it difficult to directly compare a given environmental impact between studies.

3.8 Findings

The major findings of the past studies were discussed and compared in terms of the impacts assessed and the major contributing stages:

In the print system Kozak (2003) found that the most stage with the greatest energy demand in the lifecycle of the print system was paper production. This finding was further supported

by Enroth (2009) which found that approximately half of the lifetime energy of printed textbooks was within the paper and pulp processes and a further 35% was consumed in printing.

In the digital system the majority of studies found that the manufacturing of the electronic device and the use of the electronic device had the greatest environmental impacts and energy consumption (Hischier & Reichart, 2003; Enroth, 2009). Enroth (2009) found that the use and production of the e-reader contributed to 44% and 38% of the total lifecycle energy consumption, respectively.

The number of readers has a large influence on the environmental sustainability of the products. Kozak (2003) illustrated through a sensitivity analysis that as the number of readers per product increase, the associated environmental impacts decrease. Gard & Keoleian (2003) also highlighted this and attributed it to the fact that the impacts would be shared amongst users and could potentially make print products more environmentally sustainable than digital products. The main reason for this is that the printed book requires no additional energy in the use phase and so the impacts are split amongst the users whilst each e-book read requires each user to download and read the e-book from an electronic device, adding additional energy requirements. This finding was further supported by Toffel & Hovarth (2004).

Another influential parameter is the reading time. The greater the number of pages, the longer the amount of time a consumer needs to read the medium. The longer reading time for an electronic device, the greater the energy demand and associated environmental impacts. However, reading printed material has no associated impacts.

The reading time and amount of paper read has been investigated by Gard & Keoleian (2003), Hischier & Reichart (2003) and Deetman & Odegard (2009), amongst others.

Gard & Keoleian (2003) found that browsing through e-journals in comparison to reading printed journals was more sustainable, but that intensive long reading favoured printed journals. Deetman & Odegard (2009) also seemed to agree with these findings. Deetman and Odegard (2009) compared printing office documents with viewing the documents on an e-reader and also found that the digital system was more sustainable with an increase in the number of pages to be read. Hischier & Reichart (2003) found that the energy consumed for reading a digital news article was less sustainable than the print equivalent but that the complete digital newspaper was more environmentally sustainable than the complete print newspaper.

The above studies concluded that the use phase of the electronic devices had a significant impact on environmental burdens. However, even with the increases in environmental

burdens the digital systems outperform the paper equivalents. This is because the paper production stage is prominent contributor of environmental impacts and as the quantity of paper increases the print system becomes less sustainable than the digital equivalent.

All studies concluded that the electricity mix has a large influence on the environmental impacts of electronic media (Hischier & Reichart, 2003). This was further supported by Kozak (2003) who suggested that future improvements to the efficiency of the electricity could influence the environmental impacts associated with the use of electronics (Kozak, 2003). Achachlouei *et al.* (2013) studied the effects of a different electricity energy mix. The introduction of an energy mix with a greater share of renewable energy and less dependence on fossil fuel energy caused an improvement in the environmental impacts of the digital system studied.

Personal transportation used to travel to the retail store to buy books or electronic devices can have a major influence on energy consumption. The energy for personal transportation was73% for the digital system and 83% for the printed journal system and is sensitive to changes in trip distance and vehicle fuel efficiency (Gard & Keoleian, 2003). Moberg *et al.* (2011) also found that distribution and personal transportation had the largest energy impacts in the print system.

The impact of waste management with respect to print products was discussed in Gard & Keoleian (2003) and Toffel & Hovarth (2004). The former assumed used a cut off approach for waste management of paper by assuming that no credits were given for paper used in recycling as it would be attributed to the next product iteration. The only benefits considered were those of landfill burdens foregone (Gard & Keoleian, 2003). Toffel & Hovarth (2004) found that doubling the input recycling material as input material in the creation of newspapers had a significant effect on the overall environmental impact by almost halving the greenhouse gas emissions.

Most studies indicate that the digital systems have less of an environmental impact compared to the print system counterparts (Hischier & Reichart, 2003; Toffel & Hovarth, 2004, Moberg *et al.*, 2011). The digital system was found to be more environmentally sustainable than the print system in the land use competition, eutrophication and terrestrial ecotoxicity (Deetman & Odegard, 2009). Enroth (2009) found that the printed teaching aid had a global warming potential approximately ten times greater than of a desktop computer and approximately thirty times greater than a laptop computer. The results from Moberg *et al.* (2011) suggest that the digital e-book system with a lifetime of 2 years was preferred to the print book system in terms of energy, abiotic depletion, global warming potential, eutrophication, human toxicity, marine toxicity and terrestrial toxicity (Moberg *et al.* , 2010).

3.9 CONCLUSIONS

Previous studies have assumed different functional units, system boundaries, temporal boundaries and systems and environmental impact categories to assess. In addition to these differences various sources of data, software and methodologies have been adopted in assessing the impacts. The variability in the assumptions for each assessment makes it difficult to compare and draw clear concise conclusions on which system (print or digital) has lower impacts for the different impact categories.

However, the previous studies have indicated the following:

- Printing and paper and pulp production are the most environmentally intensive processes in the print system,
- The manufacture of electronics devices and the usage thereof are considered to have the greatest environmental impacts in the digital system,
- The greater the number of readers per product, the smaller the environmental impact of that product. This applies to the print system but not necessarily digital system,
- The length of time a product is used has an influence on the environmental impacts of the digital system,
- Digital systems seem to outperform print systems in terms of environmental impacts as the quantity of paper increases,
- The electricity mix has a large effect on the environmental impacts of the digital system especially in the use stage,
- Assumptions such as vehicle trip distance and fuel efficiency may have large environmental impacts on personal transportation used to travel to retail shops to buy printed material or electronic devices, and
- Recycling and recovery of paper appear to have little effect on environmental impacts of print systems.

The next section discusses the methodology followed for this LCA study.

4 RESULTS AND DISCUSSION

This chapter discusses the base case scenario followed by the IRP electrical energy mix scenario and finally the multiple users scenario. Each will be discussed in terms of the environmental impact assessment results of Recipe and then in terms of the cumulative energy demand results.

4.1 BASE CASE

4.1.1 ENVIRONMENTAL IMPACT ASSESSMENT

The results for the life cycle impact assessments using the Recipe Midpoint Method are shown in Table 4-1. The results indicate that the digital system is more environmentally sustainable than print system. The print system has lower impacts than the digital system in the impact categories of freshwater eutrophication, freshwater ecotoxicity, marine ecotoxicity and metal depletion.

The global warming potential result for the digital system is contrary to Enroth (2009 The results of this study indicate that the print system's global warming potential is approximately 251% greater than the digital system whilst the results of Enroth (2009) found that the global warming potential of the digital system, is 10 times greater than the global warming potential of the print system. . An increase in the amount of paper per book would decrease this gap. This study used an average book weight of 1.2kg whilst Enroth (2009) used an average book weight of 0.8kg and can be seen as the main factor for the difference. Another factor is the difference in the energy mix between the two systems. South Africa's energy mix is more dependent on fossil fuel compared to that of Sweden where Enroth (2009) was conducted. The findings of this study are aligned with those of Moberg et al. (2011) which indicated that the digital e-book system with a lifetime of 2 years was preferred to the print system in terms of energy, abiotic depletion potential, global warming potential, terrestrial ecotoxicity potential, human toxicity potential and terrestrial toxicity potential.

The land use impacts for the print system are also much larger than those of the digital system. The print system is approximately 827 times greater for agricultural land occupation, 17 times greater for urban land occupation and 29 times greater for natural land transformation. This is discussed in greater detail later in this study.

The stages of the print system and their contributions to each impact category have been summarised in Table 4-1. The impacts of each stage can summarised as follows:

- Paper production featured as a prominent stage in all categories except in agricultural land occupation and urban land occupation.
- Printing is also prominent featuring in all categories except in agricultural Land occupation, urban land occupation and natural land transformation.
- Pulpwood is the major contributing stage in the impact categories concerning land use such as agricultural land occupation and urban land occupation.
- Personal transportation is a major contributor in ozone depletion, marine ecotoxicity, ionising radiation and fossil depletion.
- Waste Management is the most prominent in marine eutrophication and global warming contributing to 46% and 15% of the total potential, respectively.

The results from Table 4-2 are also shown in in Figure 4-1 which graphically displays the contribution of each print system process to the impacts. It is quite evident that print and paper are the major stages for most of the impacts.

Table 4-1: Results of Recipe LCA

Impact Category	Characterisation Factor Name	Unit	Print System	Digital System	Difference (Print compared to Digital)
Climate change	Global Warming Potential	kg CO_2 eq	1.32E+02	3.75E+01	251%
Ozone depletion	Ozone Depletion Potential	kg CFC-11 eq	5.12E-06	1.18E-06	334%
Terrestrial acidification	Terrestrial Acidification Potential	kg SO_2 eq	7.24E-01	2.89E-01	151%
Freshwater eutrophication	Freshwater Eutrophication Potential	kg P eq	9.35E-03	2.10E-02	-56%
Marine eutrophication	Marine Eutrophication Potential	kg N eq	9.51E-02	2.44E-02	289%
Human toxicity	Human Toxicity Potential	kg 1,4-DB eq	8.38E+00	5.21E+00	61%
Photochemical oxidant formation	Photochemical Oxidant Formation Potential	kg NMVOC	6.29E-01	1.66E-01	279%
Particulate matter formation	Particulate Matter Formation Potential	kg PM10 eq	2.76E-01	8.92E-02	210%
Terrestrial ecotoxicity	Terrestrial Ecotoxicity Potential	kg 1,4-DB eq	1.99E-02	2.46E-03	708%
Freshwater ecotoxicity	Freshwater Ecotoxicity Potential	kg 1,4-DB eq	6.29E-02	2.06E-01	-69%
Marine ecotoxicity	Marine Ecotoxicity Potential	kg 1,4-DB eq	8.29E-02	2.72E-01	-70%
Ionising radiation	Ionising Radiation Potential	kBq U^{235} eq	3.27E+00	1.36E+00	141%
Agricultural land occupation	Agricultural Land Occupation Potential	m^2a	4.62E+02	5.57E-01	82742%
Urban land occupation	Urban Land Occupation Potential	m^2a	4.50E+00	2.49E-01	1708%
Natural land transformation	Natural land Transformation Potential	m^2	3.47E-02	1.17E-03	2862%
Water depletion	Water Depletion Potential	m^3	1.93E+02	8.62E+01	124%
Metal depletion	Mineral Resource Depletion Potential	kg Fe eq	4.65E-01	1.52E+01	-97%
Fossil depletion	Fossil Resource Depletion Potential	kg oil eq	3.22E+01	9.58E+00	236%

Table 4-2: Contribution of Print System Stages to Impact Potential

Impact category	Characterisation Factor Name	Pulpwood	Pulp	Paper	Paper Distribution Transportation	Printing	Personal Transportation	Waste Management
Climate change	Global Warming Potential	2%	1%	32%	5%	36%	9%	15%
Ozone depletion	Ozone Depletion Potential	3%	1%	31%	8%	43%	14%	0%
Terrestrial acidification	Terrestrial Acidification Potential	5%	2%	38%	4%	47%	2%	0%
Freshwater eutrophication	Freshwater Eutrophication Potential	9%	4%	46%	0%	41%	0%	1%
Marine eutrophication	Marine Eutrophication Potential	3%	1%	19%	2%	29%	0%	46%
Human toxicity	Human Toxicity Potential	9%	2%	42%	1%	38%	6%	2%
Photochemical oxidant formation	Photochemical Oxidant Formation Potential	15%	1%	33%	9%	36%	4%	2%
Particulate matter formation	Particulate Matter Formation Potential	12%	2%	40%	5%	40%	2%	0%
Terrestrial ecotoxicity	Terrestrial Ecotoxicity Potential	6%	1%	51%	3%	33%	6%	0%
Freshwater ecotoxicity	Freshwater Ecotoxicity Potential	2%	1%	47%	2%	42%	3%	4%
Marine ecotoxicity	Marine Ecotoxicity Potential	7%	1%	44%	6%	28%	12%	2%
Ionising radiation	Ionising Radiation Potential	4%	1%	27%	10%	41%	17%	1%
Agricultural land occupation	Agricultural Land Occupation Potential	97%	0%	0%	0%	2%	0%	0%
Urban land occupation	Urban Land Occupation Potential	92%	0%	2%	0%	6%	0%	0%
Natural land transformation	Natural land Transformation Potential	80%	0%	13%	0%	7%	0%	0%
Water depletion	Water Depletion Potential	1%	0%	22%	0%	75%	1%	1%
Metal depletion	Mineral Resource Depletion Potential	1%	1%	23%	0%	73%	2%	0%
Fossil depletion	Fossil Resource Depletion Potential	2%	1%	40%	7%	38%	11%	0%

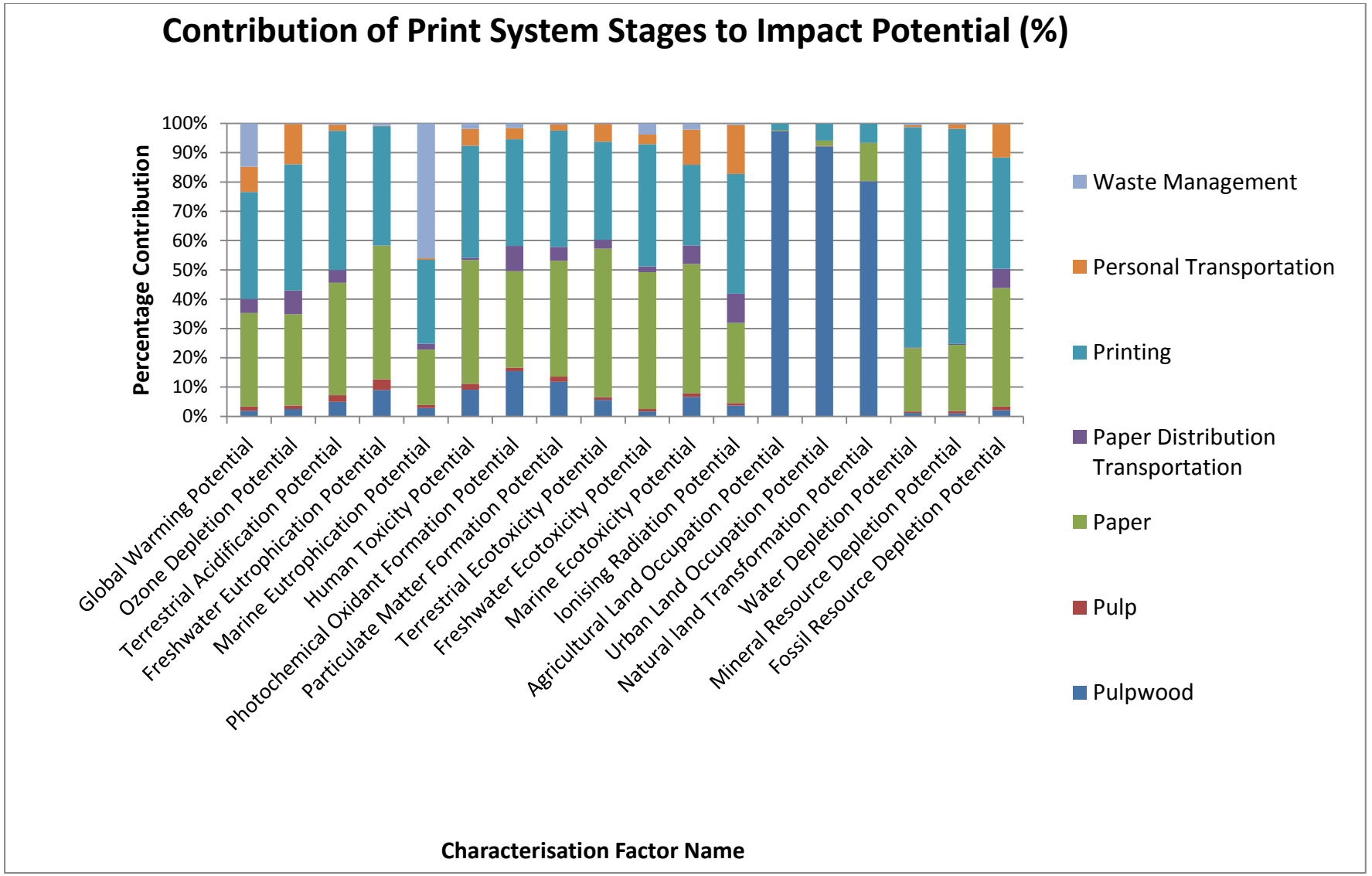

Figure 4-1: Contribution of Print System Stages to Impact Potential

The stages of the digital system and their contributions to each impact category have been summarised (Table 4-3). The following trends can be seen in Table 4-3:

- The production of the Apple Air iPad features in most impact categories as the major impact potential contribution. Impact categories almost entirely attributed to the Apple Air production stage are metal depletion potential, freshwater eutrophication potential, marine ecotoxicity, freshwater ecotoxicity and agricultural land occupation.
- E-book reading features as the second greatest stage in terms of impact potential contributions. It has a large impact in global warming potential, terrestrial acidification potential, photochemical oxidation formation potential, particulate matter formation potential and fossil resource depletion potential.
- Personal transportation has a notable impact in the global warming potential, ozone depletion, terrestrial ecotoxicity, ionising radiation and fossil depletion, and
- In comparison to the above stages, e-book formatting and downloading contribute little or nothing to any of the impact potentials.

The results from Table 4-3 are also represented in Figure 4-2 which displays the contribution of each digital system process to the impacts. It is quite evident that for the digital system that the Apple Air iPad production and the e-book reading stages have the largest effect on most of the impacts.

Table 4-3: Contribution of Digital System Stages to Impact Potential

Impact category	Characterisation Factor Name	Apple Air iPad Production	Apple Air iPad distribution transportation	Personal Transportation	E-book formatting	E-book downloading	E-book reading	Waste Management
Climate change	Global Warming Potential	50%	0%	8%	0%	1%	41%	1%
Ozone depletion	Ozone Depletion Potential	75%	1%	15%	0%	0%	9%	0%
Terrestrial acidification	Terrestrial Acidification Potential	49%	0%	1%	0%	1%	49%	0%
Freshwater eutrophication	Freshwater Eutrophication Potential	94%	0%	0%	0%	0%	6%	0%
Marine eutrophication	Marine Eutrophication Potential	87%	0%	0%	0%	0%	10%	2%
Human toxicity	Human Toxicity Potential	91%	0%	2%	0%	0%	6%	0%
Photochemical oxidant formation	Photochemical Oxidant Formation Potential	52%	1%	4%	0%	1%	43%	0%
Particulate matter formation	Particulate Matter Formation Potential	57%	0%	2%	0%	1%	41%	0%
Terrestrial ecotoxicity	Terrestrial Ecotoxicity Potential	80%	0%	12%	0%	0%	7%	0%
Freshwater ecotoxicity	Freshwater Ecotoxicity Potential	99%	0%	0%	0%	0%	0%	0%
Marine ecotoxicity	Marine Ecotoxicity Potential	98%	0%	1%	0%	0%	1%	0%
Ionising radiation	Ionising Radiation Potential	75%	0%	10%	0%	0%	14%	0%
Agricultural land occupation	Agricultural Land Occupation Potential	96%	0%	0%	0%	0%	3%	0%
Urban land occupation	Urban Land Occupation Potential	83%	1%	0%	0%	0%	16%	0%
Natural land transformation	Natural land Transformation Potential	80%	1%	0%	0%	0%	18%	0%
Water depletion	Water Depletion Potential	91%	0%	0%	0%	0%	8%	0%
Metal depletion	Mineral Resource Depletion Potential	100%	0%	0%	0%	0%	0%	0%
Fossil depletion	Fossil Resource Depletion Potential	50%	0%	10%	0%	1%	40%	0%

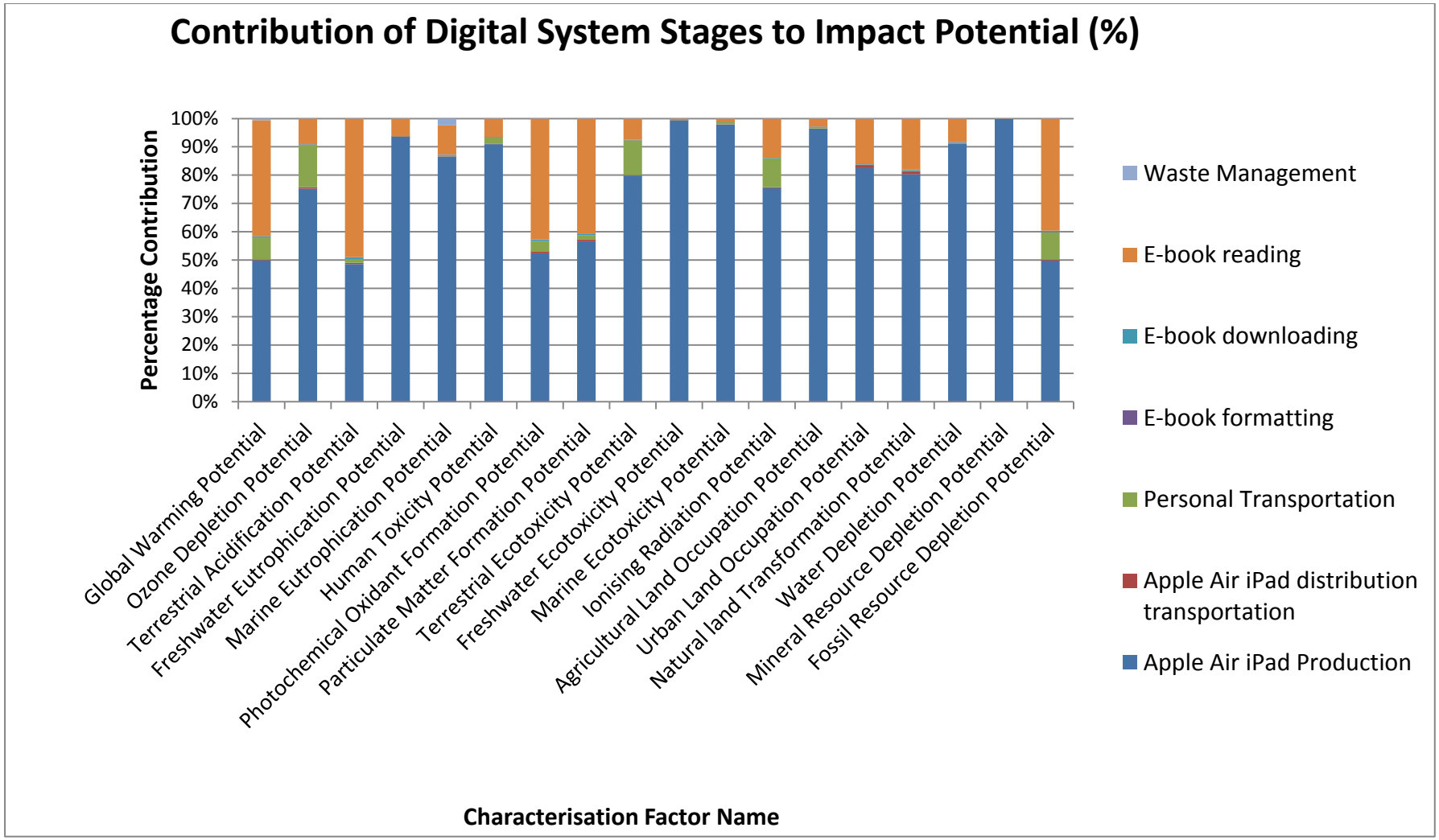

Figure 4-2: Contribution of Digital System Stages to Impact Potential

The top three processes per impact category were identified for each system. The digital system is based overseas with the production of the Apple Air iPad and its distribution and in South Africa with respect to the personal transportation, download of e-books, use of the Apple Air iPad and waste management. The implications are that the processes are a mix of both average global and South African resources. The digital system is largely based on average RoW data but the electrical energy mix, coal and water have been changed to South African data for the e-book related stages. This is different to the print system which has South African data for the electrical energy mix, coal and water in all the stages. The major processes of the print system and their associated contribution to the impacts are described below:

- Marine ecotoxicity potential is caused mainly by waste paper produced in the paper production and the metal depletion potential is due to iron, bauxite and copper mining.
- • Categories involving the use of land such as agricultural land occupation, urban land occupation and natural land transformation are dominated by the pulpwood forestry activities
- Petroleum production is the major contributor to ozone depletion and together with hard coal mining contributes significantly to fossil depletion potential.
- Electricity production in South Africa using coal was the largest process contributor for global warming potential, terrestrial acidification potential, photochemical oxidant formation potential and particulate matter formation potential.
- Freshwater eutrophication is impacted by the disposal of spoils from coal mining and the coal mining process has the largest impact on fossil depletion.
- Ionising radiation potential is most adversely affected by spent nuclear fuel from nuclear power plants.

The main processes for the digital system were as follows:

- Electricity production in South Africa using coal was the largest process contributor for global warming potential, terrestrial acidification potential, photochemical oxidant formation potential and particulate matter formation potential.
- Electricity production in China using coal as a fuel source was second to electricity production in South Africa using coal, in the categories of climate change, terrestrial acidification and particulate matter formation.
- Gold used in silver mining operations had the greatest impact on freshwater and marine ecotoxicity as well as metal depletion.

- The production of LCDs impacted human toxicity the most whilst the waste water generated from LCD disposal had the most severe marine eutrophication impact.
- Sulfidic tailings were the most prominent process contributing to the impact categories of freshwater eutrophication and natural land transformation.
- Ionising radiation potential is most adversely affected by spent nuclear fuel from nuclear power plants.

In almost all of the impact categories for the print system the use of South African electricity featured within the top 1% of contributing processes. These include the impact potentials of climate change, ozone depletion, terrestrial acidification, marine eutrophication, human toxicity, photochemical oxidant formation, particulate matter formation and marine ecotoxicity. The mining of hard coal in South Africa is a major process in climate change, ozone depletion, urban land occupation, natural land transformation and fossil fuel depletion whilst the treatment of the discards from coal mining features prominently in freshwater eutrophication.

Similarly coal based electricity generated in South Africa is a dominant process in all the categories mentioned above in the print system in addition to terrestrial ecotoxicity. The mining of hard coal and the treatment of coal mining is also prominent in the same impact categories as the print system.

This indicates that the environmental impacts are largely influenced by the coal supply chain from the mining operations to the use of coal in electricity generation and also with the treatment of coal.

This explains the prominence of the coal mining and coal based electricity as the major processes in the print system. Similarly the digital system is influenced by coal based electricity and coal mining processes based in China.

Since the print system is influenced by the energy processes in South Africa it makes sense that the print system has greater environmental impacts in most of the impact categories. In addition to this the print system also has an energy demand that is approximately five times greater than that of the digital system. These reasons explain why there is a large difference between the two systems as shown earlier in Figure 4 4.

Essentially choosing the system boundary and what processes to include and what processes to edit is a trade-off.

The systems are both dependent on coal based electricity and therefore moving towards cleaner renewable energy should improve the impacts of both systems. This is explored in the next section.

4.1.2 CUMULATIVE ENERGY DEMAND

The results from the cumulative energy demand for the print and digital systems are shown in Table 4-4. As can be seen from Table 4-4, the print system requires approximately three times more energy (1,525 MJ) to offer the same service as the digital system (473 MJ). This result is similar to Moberg *et al.* (2011) which found a difference of approximately 3.5 times.

The paper and printing processes are the processes responsible for the greatest energy demand contributing 41% and 39% of the total life cycle energy demand, respectively (Figure 4-3). These results are in line with those found by Enroth (2009) which found that half the energy demand for printed textbooks was within the paper and pulp production stage and a further 35% was consumed in printing.

In the digital system the production of the Apple Air iPad in China is the most prominent process contributing 53% of the total cumulative energy demand followed by e-book reading which is 37% (Figure 4-4). These results also seem to agree with the findings of Moberg *et al.* (2011) which also indicated that the production stage of the electronic device is the most prominent in energy consumption.

Table 4-4: Cumulative Energy Demand Results

Print System		Digital System	
Activity	Energy (MJ)	Activity	Energy (MJ)
Pulpwood	31	Apple Air iPad Production	251
Pulp	19	Apple Air iPad distribution transportation	1
Paper	617	Personal Transportation	41
Paper Distribution Transportation	96	E-book formatting	0
Printing	594	E-book downloading	2
Personal Transportation	166	E-book reading	176
Waste Management	4	Waste Management	0
Total	1525	Total	473

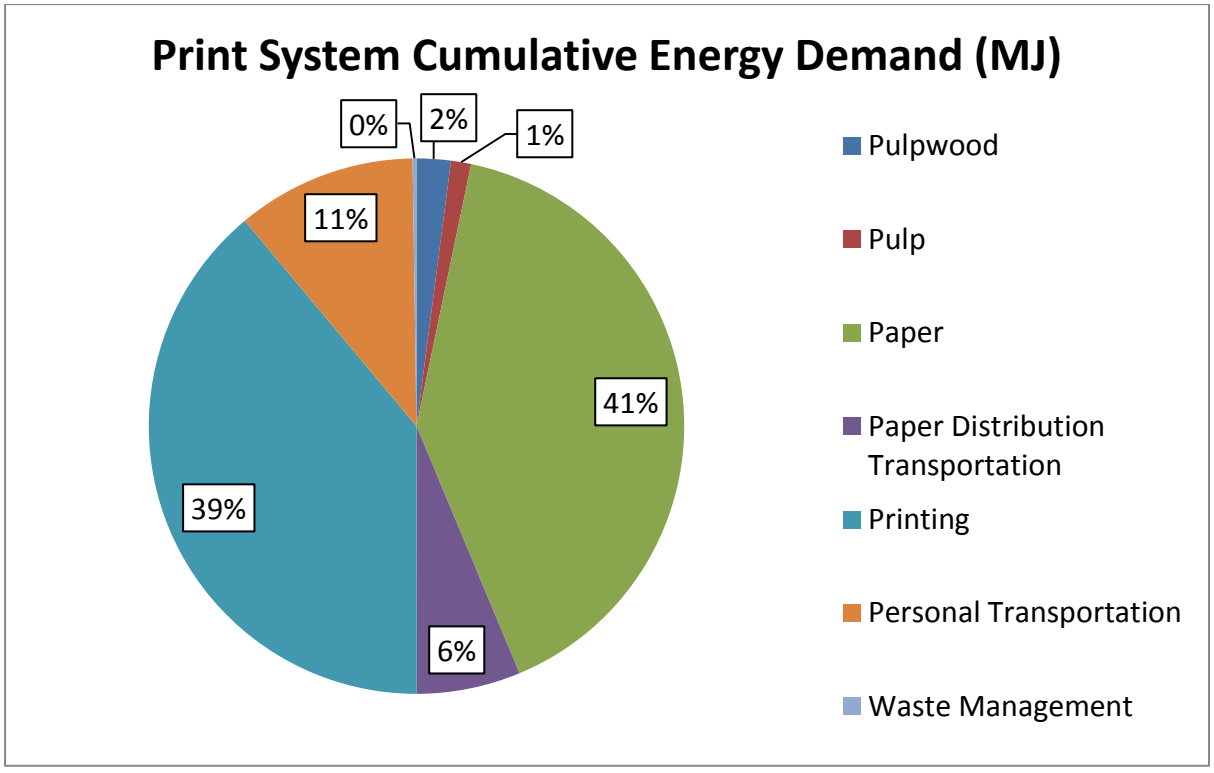

Figure 4-3: Print System Cumulative Energy Demand Distribution

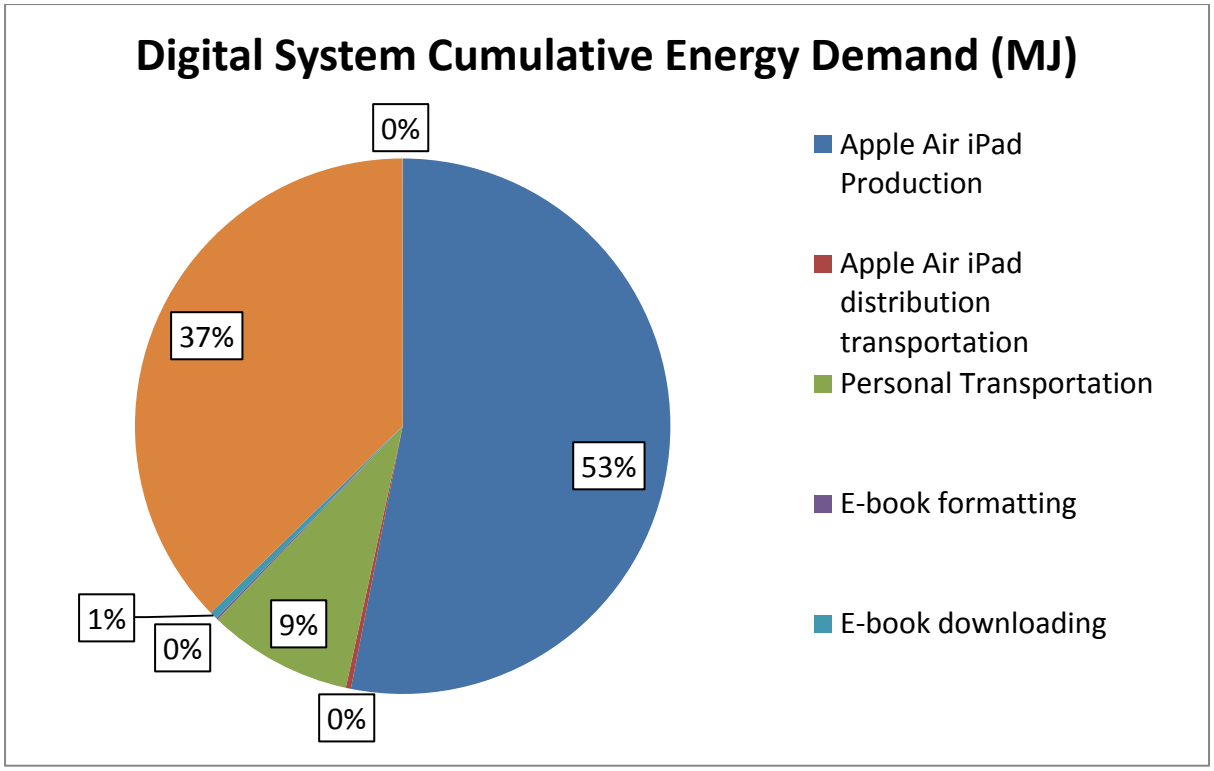

Figure 4-4: Digital System Cumulative Energy Demand Distribution

According to the CED calculations 94% of the print system energy is fuelled by fossil fuels and approximately 6% is made up of nuclear energy whilst the digital system is 87% fossil fuel and 13% nuclear fuel dependent. Since the print system is largely dependent on the South African electricity mix and the digital system is dependent on a global and to some extent a Chinese electricity mix, the CED results indicate that South Africa has a greater fossil fuel dependency compared to the average global energy mix.

4.2 IRP ELECTRICAL ENERGY MIX

The IRP Electrical Energy Mix scenario analysis investigates effect of changing the electrical energy mix in South Africa to the electrical energy mix proposed in the "*Policy-Adjusted IRP*" on the environmental impacts and cumulative energy demand impacts of the print and digital systems. The "*Policy-Adjusted IRP*" scenario has a greater dependency on renewable energy sources.

4.2.1 ENVIRONMENTAL IMPACT ASSESSMENT

The introduction of the energy mix as proposed in the "*Policy-Adjusted IRP*" scenario has reduced the relative difference of the impacts between the digital and print systems, in most impact categories (Table 4-5).

The print system has improved relative to the digital system when compared to the relative differences between the two systems in the base case, but only for certain impact categories. These impact categories include ozone depletion and agricultural land occupation whilst there is little or no change to terrestrial acidification, metal depletion, water depletion, marine ecotoxicity, freshwater ecotoxicity and ionising radiation. The impact categories which realised relative increases between print and the digital system, with the digital system used as the base reference, are global warming, fossil depletion, urban land occupation, photochemical oxidation formation, freshwater eutrophication and terrestrial acidification, The changes in the results can be attributed to the increase in the use of petroleum for proposed gas power plants and also from the nuclear fuel, energy production and waste which comes with the increased use of nuclear power, as proposed in the IRP electricity energy mix.

However, it must be noted that the change to the 2030 IRP electricity energy mix has a positive impact on both systems. However, the digital has larger reductions (Table 4-5).

Table 4-5: Results for IRP electrical energy mix scenario

Impact Category	Characterisation Factor Name	Unit	Base Case Print System	IRP Print System	Base Case Digital System	IRP Digital System	IRP Difference (Print compared to Digital)	Base Case (Print compared to Digital)
Climate change	Global Warming Potential	kg CO_2 eq	1.32E+02	1.22E+02	3.75E+01	3.31E+01	270%	251%
Ozone depletion	Ozone Depletion Potential	kg CFC-11 eq	5.12E-06	5.57E-06	1.18E-06	1.39E-06	301%	334%
Terrestrial acidification	Terrestrial Acidification Potential	kg SO_2 eq	7.24E-01	6.33E-01	2.89E-01	2.47E-01	157%	151%
Freshwater eutrophication	Freshwater Eutrophication Potential	kg P eq	9.35E-03	8.47E-03	2.10E-02	2.06E-02	-59%	-56%
Marine eutrophication	Marine Eutrophication Potential	kg N eq	9.51E-02	9.35E-02	2.44E-02	2.37E-02	295%	289%
Human toxicity	Human Toxicity Potential	kg 1,4-DB eq	8.38E+00	8.19E+00	5.21E+00	5.12E+00	60%	61%
Photochemical oxidant formation	Photochemical Oxidant Formation Potential	kg NMVOC	6.29E-01	5.84E-01	1.66E-01	1.45E-01	302%	279%
Particulate matter formation	Particulate Matter Formation Potential	kg PM10 eq	2.76E-01	2.53E-01	8.92E-02	7.84E-02	223%	210%
Terrestrial ecotoxicity	Terrestrial Ecotoxicity Potential	kg 1,4-DB eq	1.99E-02	1.98E-02	2.46E-03	2.42E-03	717%	708%
Freshwater ecotoxicity	Freshwater Ecotoxicity Potential	kg 1,4-DB eq	6.29E-02	6.26E-02	2.06E-01	2.06E-01	-70%	-69%
Marine ecotoxicity	Marine Ecotoxicity Potential	kg 1,4-DB eq	8.29E-02	8.16E-02	2.72E-01	2.71E-01	-70%	-70%
Ionising radiation	Ionising Radiation Potential	kBq U^{235} eq	3.27E+00	4.23E+00	1.36E+00	1.80E+00	135%	141%
Agricultural land occupation	Agricultural Land Occupation Potential	m^2a	4.62E+02	4.62E+02	5.57E-01	5.47E-01	84220%	82742%

Impact Category	Characterisation Factor Name	Unit	Base Case Print System	IRP Print System	Base Case Digital System	IRP Digital System	IRP Difference (Print compared to Digital)	Base Case (Print compared to Digital)
Urban land occupation	Urban Land Occupation Potential	m^2a	4.50E+00	4.47E+00	2.49E-01	2.37E-01	1787%	1708%
Natural land transformation	Natural land Transformation Potential	m^2	3.47E-02	3.46E-02	1.17E-03	1.13E-03	2974%	2862%
Water depletion	Water Depletion Potential	m^3	1.93E+02	1.92E+02	8.62E+01	8.57E+01	124%	124%
Metal depletion	Mineral Resource Depletion Potential	kg Fe eq	4.65E-01	4.77E-01	1.52E+01	1.52E+01	-97%	-97%
Fossil depletion	Fossil Resource Depletion Potential	kg oil eq	3.22E+01	2.98E+01	9.58E+00	8.47E+00	252%	236%

4.2.2 CUMULATIVE ENERGY DEMAND

The cumulative energy demand for both systems is represented in Table 4-6. The print system has a total reduced cumulative energy demand of 3% whilst the digital system has a total cumulative energy demand reduction of 5%. The main reason is that the digital system e-book reading is impacted by a change in the South African electricity mix and has a substantial energy demand.

The 2030 IRP mix assumes a greater reliance on nuclear energy and renewable energy and a reduced reliance on coal energy. As seen in the original analysis coal mining, disposal of coal and electricity generation using coal, featured in most of the impact categories as a significant process contributor to the impact potentials. The cumulative energy demand for renewable energy sources is less than that of fossil fuels because of the less energy intensive processes upstream. By changing the electricity mix, the way in which the demand is met also changes, and hence the cumulative energy demand changes.

Since the cumulative energy demand is met with less primary energy commodities, the stages which are most dependent on electricity in the print system, paper and printed paper, have reduced cumulative energy demands. The pulpwood, book distribution transportation, personal transportation and waste management are not affected. The digital system is influenced by the IRP electricity energy mix in the use stages of e-book download and e-book reading stages decreasing by 13% relative to the original energy demand of these stages, and since the e-book reading has a large energy demand, the digital system experiences a reduction of 5%.

Table 4-6: Cumulative Energy Results for both Systems with IRP Electricity Energy Mix

Print System				Digital System			
Process	IRP Energy (MJ)	Original Energy (MJ)	Difference (%)	Process	IRP Energy (MJ)	Original Energy (MJ)	Difference (%)
Pulpwood	31	31	0%	Apple Air iPad Production	251	251	0%
Pulp	18	19	-1%	Apple Air iPad distribution transportation	1	1	0%
Paper	597	617	-3%	Personal Transportation	41	41	0%
Paper Distribution Transportation	96	96	0%	E-book formatting	0	0	0%
Printing	563	594	-5%	E-book downloading	2	2	-13%
Personal Transportation	166	166	0%	E-book reading	153	176	-13%
Waste Management	4	4	0%	Waste Management	0	0	0%
Total	1474	1525	-3%	Total	450	473	-5%

4.3 MULTIPLE USERS PER BOOK

The Multiple Users per Book scenario analysis investigates the effect of changing the number of users per book, on the environmental impacts and cumulative energy demand impacts of the print and digital systems. The analysis assumes a maximum of eight users for each system.

4.3.1 ENVIRONMENTAL IMPACT ASSESSMENT

The break-even point is the point at which the number of users sharing causes the print system to have lower impact than the digital system. This point differs between the different impact categories (Table 4-7).

One user per system is needed for the impact categories of freshwater eutrophication, freshwater ecotoxicity, marine ecotoxicity and metal depletion, to make the digital system impacts greater than those of the print system. Similarly, two users per system is the break-even point for the impact categories of terrestrial acidification requires; three users per system is the break-even point for climate change, photochemical oxidant formation, particulate matter formation, ionising radiation and fossil depletion require four users per system is the break-even point for water depletion and human toxicity potential, six users per system is the break-even point for ; marine eutrophication and seven users per system is the break-even point for ozone depletion.

The impact categories associated with land cannot reach the break-even point within the maximum of eight users. This can be explained by the print system using a large amount of wood and hence the impacts associated with land use for the forest wood plantations are far greater than the digital system which is more metal and mineral resource dependent.

The results suggest that a book used in a library could also prove environmentally beneficial rather than reading an e-book on iPads for the same number of users. The greater the number of users per book, the more beneficial books become in comparison to reading of an Apple Air iPad. This result confirms the findings of Kozak (2003), Gard & Keoleian (2003) and Toffel & Hovarth (2004).

Table 4-7: Comparison of Results for Multiple Users per Book

Impact Category	Characterisation Factor Name	Break-even point for Print to equal or better (
Climate change	Global Warming Potential	3
Ozone depletion	Ozone Depletion Potential	7
Terrestrial acidification	Terrestrial Acidification Potential	2
Freshwater eutrophication	Freshwater Eutrophication Potential	1
Marine eutrophication	Marine Eutrophication Potential	6
Human toxicity	Human Toxicity Potential	4
Photochemical oxidant formation	Photochemical Oxidant Formation Potential	3
Particulate matter formation	Particulate Matter Formation Potential	3
Terrestrial ecotoxicity	Terrestrial Ecotoxicity Potential	>8
Freshwater ecotoxicity	Freshwater Ecotoxicity Potential	1
Marine ecotoxicity	Marine Ecotoxicity Potential	1
Ionising radiation	Ionising Radiation Potential	3
Agricultural land occupation	Agricultural Land Occupation Potential	>8
Urban land occupation	Urban Land Occupation Potential	>8
Natural land transformation	Natural land Transformation Potential	>8
Water depletion	Water Depletion Potential	4
Metal depletion	Mineral Resource Depletion Potential	1
Fossil depletion	Fossil Resource Depletion Potential	3

4.3.2 CUMULATIVE ENERGY DEMAND

The cumulative energy results indicate that the print system is increasingly favoured as the number of users increase (Figure 4-5). In contrast, the digital system energy demand increases almost linearly with each additional user. The break-even point for the number of users seems to be approximately three users sharing their books. The results indicate that reading a printed book in a library could, for a large number of users, prove more environmentally beneficial and be less energy demanding than reading e-books from an Apple Air iPad.

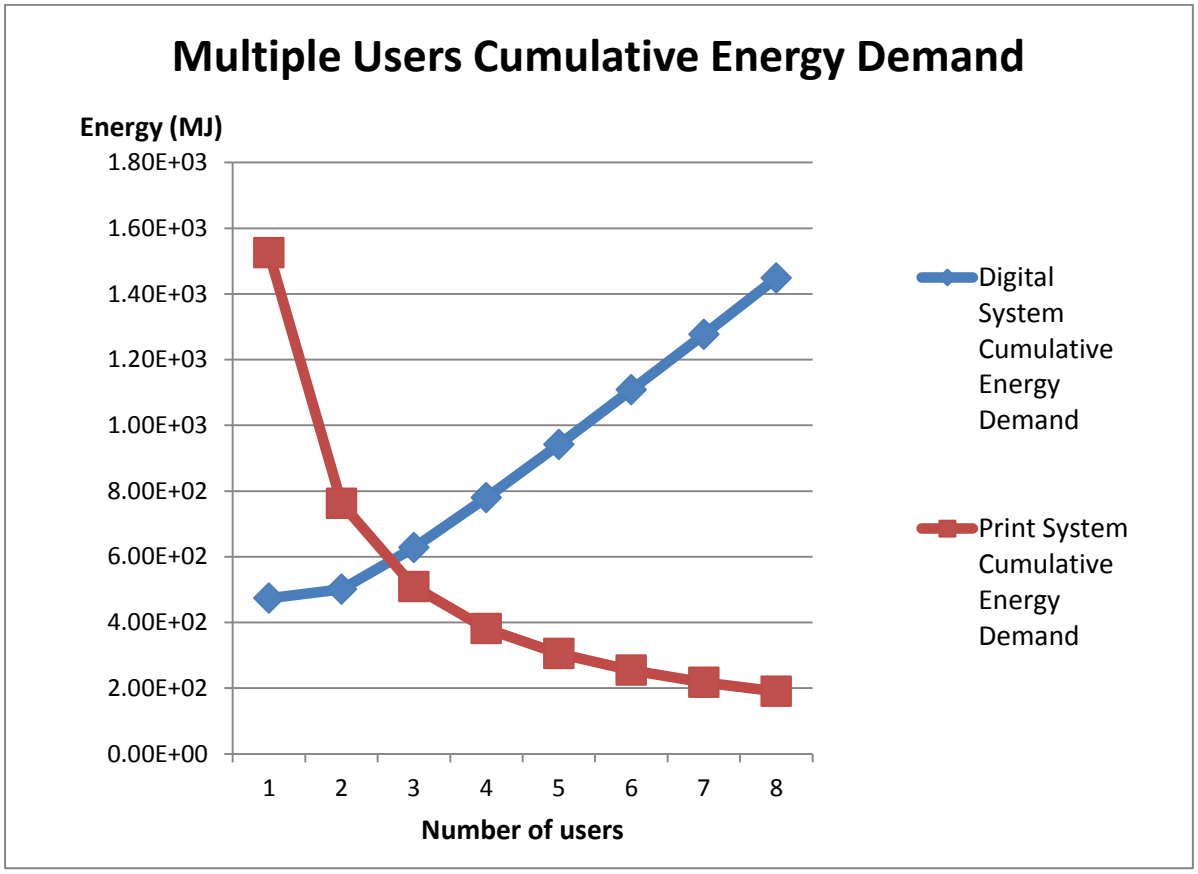

Figure 4-5: Multiple Users Cumulative Energy Demand

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5 CONCLUSIONS AND RECOMMENDATIONS

The objective of the study was to establish which of the systems, digital or print, had less of an environmental and energy demand impact. The initial hypothesis of this study was that reading twenty one e-books from a Tablet PC would have a smaller environmental impact and energy consumption than reading twenty one printed books.

When the two systems print and digital are compared to each in terms of impact potentials, the digital system emerges as the more sustainable system for all impacts. Therefore the initial hypothesis assumed in this study is partially correct as each system is beneficial in terms of certain impacts.

The stages which contributed the most to the impact potentials for the print system are the print and paper stages. Electricity produced in South Africa using hard coal also featured as a one of the main contributing processes in these stages. This indicates that there is a strong correlation between the electricity produced by coal, and the paper and print stages. This is further confirmed by the results of the cumulative energy demand which indicate that print and paper have the greatest energy demand.

However, it is not just the production of electricity using coal that features in the impact potentials. In addition to electricity using coal, the mining features prominently in fossil depletion potential and urban land occupation and the disposal of coal mining waste is the main contributing process for freshwater eutrophication potential.

The other major finding is that the print system has much larger land based impacts compared to the digital system, because of the large amount of wood needed to produce the books. When compared to the digital system it is much larger for the impact potentials for agricultural land occupation, urban land occupation, and natural land transformation.

The digital system is influenced by both local and international processes. The Apple Air iPad production stage is the prominent contributor in most impact categories. E-book reading features as the second greatest stage in terms of impact potential contributions. It had a large impact in global warming potential, terrestrial acidification potential, photochemical oxidation formation potential, particulate matter formation potential and fossil resource depletion potential. The main processes are the production of electricity using coal, coal mining and coal waste disposal. The digital system is also dependent on coal processes because it is based on the Chinese electricity mix which has a large dependency on coal. In the digital system, the production of the Apple Air iPad in China has the greatest energy demand and is responsible for 53% of the total cumulative energy demand, followed by e-book reading (37%).

A scenario to investigate the effect of the electricity mix was conducted. The electricity mix was changed from South African to the Policy Adjusted 2030 electricity mix as detailed in the Integrated Resource Plan. The results of the scenario reveal that the IRP electricity mix change reduces the environmental impacts from electricity produced in South Africa. The 2030 IRP electricity energy mix has a positive impact on both systems.

The other scenario assessed the effects of multiple users per book. The break-even point was reached for most impact categories at four users whilst impact categories with land use associated impacts could not be reached within eight users. This was because the print system has a much greater reliance on wooden sourced products compared to the digital system and even with multiple users this gap cannot be overcome. Reading e-books from an Apple Air iPad could be implemented in universities because the findings of this study suggest that the environmental benefits of e-books read of Apple Air iPads outweigh those of reading printed books. However, this will depend to an extent on the amount of reading material and whether the re-use of books is actively promoted at the university.

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APPENDICES

APPENDIX A: LITERATURE REVIEW COMPARISON TABLE

Table 1: Literature Review Comparison

	Kozak (2003)	Gand and Keoleian (2003)	Hischier Reichert 2003	Toffel and Hovarth (2004)	Deetman & Odegard 2009	Enroth (2009)	Moberg A. (2010)	Acahaclouei et al. (2013)
Impacts assessed	• global warming • ozone depletion and • acidification	energy consumption	Environmental impact	CO2, SO2 and N2O	•global warming potential • land use , • eutrophication potential, • resources depletion (abiotic), • acidification potential, • photochemical oxidation (summer smog), • terrestrial ecotoxicity, • ionising radiation, • marine aquatic ecotoxicity, • freshwater aquatic ecotoxicity, • stratospheric ozone depletion, and • human toxicity	global warming potential	•Global Warming Potential •Ozone Depletion Potential •Terrestrial Acidification Potential •Freshwater Eutrophication Potential •Marine Eutrophication Potential •Human Toxicity Potential •Photochemical Oxidant Formation •Potential Particulate Matter Formation •Potential Terestrial Ecotoxicity •Potential Freshwater Ecotoxicity •Potential Marine Ecotoxicity •Potential Ionising Radiation •Potential Agricultural Land Occupation •Potential Urban Land Occupation •Potential Natural land Transformation •Potential Water Depletion Potential •Mineral Resource Depletion Potential •Fossil Resource Depletion Potential	GHG emissions
Digital medium	scholarly e-book	digital journal collections	Digital newspaper	Digital newspaper	e-paper	electronic teaching aids	electronic newspaper and e-book read off e-reader	electronic magazine read of electronic tablet
Print medium	scholarly printed book	printed journal collections	Printed newspaper	Printed newspaper	office paper	Printed teaching aids	newspaper and novel	printed magazine
Lifetime and size of digital	4 yeas e-book which was estimated at approximately 1372kB	11.7 pages and when scanned in portable document format the document was approximately 1524kB over ten years	10 minutes of reading	• The PDA has a useful life of 3 years • Readers read 1 hour per day on their PDA	e-reader 2 years charged once a day	5 years reading off desktop computer with LCD screen for 2 hours 40 weeks per year	2 years e-reader 2.2MB in size and account for both the e-book (1.5MB) and the website (0.7MB).	3 years 14 hours use per week; 14 issues per year each 163MB
Lifetime of print	0.86kg or 500 pages	11.7 pages over ten years	10 minutes of reading	years worth 250kg			woodfree uncoated 360 pages/book paper, 80 g/m2	3 years
Functional unit	forty, five hundred page scholarly books	contents of one scientific journal	reading one newspaper	a years worth of newspaper	use of office paper in one year	using a teaching aid for 5000 students per year over five years (25000 in total) for two hours per week for a period of 40weeks	One newspaper read by one user One book was one book read by one person	one reader's use of one copy of the tablet edition of a magazine
Year of study	2003	2000-2010	2003	2004	2009	2009	2010	2013
Location	USA	USA	Switzerland Germany	USA	USA	Norway	Sweden	Sweden

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	Kozak (2003)	Gand and Keoleian (2003)	Hischier Reichert 2003	Toffel and Hovarth (2004)	Deetman & Odegard 2009	Enroth (2009)	Moberg A. (2010)	Acahaclouei et al. (2013)
System Boundary	• All product stages. • Digital and print in USA • Mineral extraction and electronics production - global mix	Formatting, transport, use and disposal Excludes document creation and publishing	all life cycle processes for the media including transportation and infrastructure	printed newspaper - production, printing and delivery of the newspaper. The PDA system- manufacturing, usage, uploading via a pc, telecommunications infrastructure and internet operations	e-reader - manufacture, use, packaging and transportation and disposal. Printed paper - paper manufacturing, printing and disposal	Printed book - paper production, paper publishing distribution, use and waste management but excluded the forestry and editorial work stages. Electronic teaching aid - formatting, downloading, production of the computers, distribution of the computers, reading use and waste management but excluded the editorial work of an e-book	Paper - production, editorial work, consumer transport, distribution transport, the book store, storage, use and waste management. e-reader - manufacture, use, packaging and transportation and disposal.	Print - content production, distribution of products and reading of the magazines , Digital - content production, distribution of products, reading of the magazines, and use of network and server Swedish magazines were produced in Swedenand used in Sweden whilst the tablets were made in China and used in Sweden
Assumptions	•average book weight was measured to be 0.86kg or 500 pages. Books could vary in material composition and size. • A distance of 500 miles between the paper production site to the printing house. • Large diesel truck used for distribution transportation. It was realised that there are many modes of transportations which could cause differences in results. • Impacts associated with ink production were excluded. • Printing data was based on Finnish data. A key note is that the energy mixes have a large influence on the impacts. • No storage of books in warehouses was included • Facility infrastructure impacts for the bookstore were included • Average retail transportation trip was assumed to be 10 miles for five books. • Books are kept for a four year period and no end of life burdens were included in the study. • Digital reader use based on desktop computer for material composition and material processing. • Batteries are based on lead acid batteries since Lithium Ion battery information was unavailable. • Swedish data used for e-reader manufacturing. • Delivery transportation is based on 500 mile distance between the e-reader production site to the users home. • Network server, data storage and production were included • Electricity usage was allocated as being in the NERC ECAR region. 10 mile personal transportation	• It was assumed that desktop computers were used for reading. • Printed scientific journals were assumed to have a life of ten years. • A reading time of 0.97hours was assumed per journal.	• The electronic based products were assumed to be used for a certain time for the application of reading newspaper. This time was used as a factor in multiplication in the production, transport and disposal stages. • Electronic goods were incinerated • Paper was recycled an average of 2.3 times	• The PDA has a useful life of 3 years • Readers read 1 hour per day on their PDA • The whole life cycle of the PC was included • Newspaper is assumed to 50% recycled • Distribution of newspaper is 64km from the production line	• The e-reader the iRex DR was assumed to be two years • The DR is charged once a day • Disposal of the e-reader was assumed to be similar to an LCD screen. • Printed paper is based on light weight coated paper from Ecoinvents database • One DR per office worker whilst printed paper shared amongst 30 office workers • 90% of office paper recycled, 8% landfiled and 2% incinerated	• Based on Swedish pulp and paper data • Transportation of paper 400km • Book weighs 0.8kg. • An energy input value of 610kWh/tonne of printed product • Printing and finishing is only based on inputs for office energy, printing plates and ink • Books are transported 1600km for distribution. • 80% fibre recovery and 20% incineration of waste paper from books • Energy recovery from waste incinerated at landfills and from methane gas was adopted in the life cycle impact assessment. • Formatting of books based on 50 hours using a computer • Distribution distances are via ship from China to Norway • e-books are read off a desktop computer with an LCD screen • 95% of electronics are recovered for re-use in other products and energy recovery and 5% is sent to landfill.	• The main processes that had environmental large impacts was distribution and personal transportation in the print production whilst production, waste management and editorial work formed the largest contributors for the electronic versions. • The e-book for a duration of 1 year was preferred in terms of energy, abiotic depletion, global warming potential, eutrophication, human toxicity, marine toxicity and terrestrial toxicity. • The electricity mix is important to the energy consumption of electronics in the use phase and can have large effects on the environmental impacts. • It is difficult to compare the findings to similar studies because the models and assumptions adopted in other studies are different and have impacts on the outcomes. 2 km by car/book	• The energy input was allocated between print and electronic media production using sales figures. • Electricity for operations was used for the network and server components. • Emissions of the production of the network components were included in the study. • The system boundaries were the content production, distribution of products and reading of the magazines for both the digital and print systems. • The assembly of the products was assumed to be in China. • The electronic devices were disassembled and the components were modelled accordingly. • The magazines were based on Swedish magazines produced in Sweden that are used in Sweden whilst the tablets were made in China and used in Sweden.

Table 1: Literature Review Comparison

	Kozak (2003)	Gand and Keoleian (2003)	Hischier Reichert 2003	Toffel and Hovarth (2004)	Deetman & Odegard 2009	Enroth (2009)	Moberg A. (2010)	Acahaclouei et al. (2013)
Findings	• Energy required for books stores less than e-books storage on network server. • The consumption of energy for paper production consumed most energy and had the greatest impact. • Electronic books require less energy in the production stages. • An increase in readers per book decreasing the environmental impact per book. • Improvements in the efficiency of the electricity grid important influence on use of electronics	• Network infrastructure has a small effect on energy consumption. • Waste paper disposed to landfill compared to paper recovered but not recycled had little effect on the energy consumption. • The energy for personal transportation as large as 73% for the digital system and 83% for the printed journal system and largely influenced by changes to the trip distance and the vehicle fuel efficiency. • The energy consumption per product is dependent on the readings per journal article. • Digital products were found to be more suitable for seldom read journals or browsing.	• Digital medium worse for reading news item • Manufacturing of the electronics and the use phase are major impacts • Printed newspaper worse than digital. • The electricity mix has a large influence on the environmental impacts of electronic media	• Reading printed newspaper was less environmentally friendly. • Recycling did not improve the environmental impact much. • The magnitude of the impacts is subject to the number of readers.	• iRex e-reader became more environmentally friendly than printed paper after 3000 prints per worker. • e-reader was environmentally friendlier than the prints in the land use competition, eutrophication and terrestrial ecotoxicity. • At 10000 prints the e-reader was environmentally friendlier in all of the impact categories.	• The production of electronic devices and the usage were the main processes in terms of energy consumption, consuming 38% and 44% respectively. • The main limitation of the Enroth (2009) study was that it only focused on global warming potential. • The printed teaching aid was found to have a global warming potential of approximately ten times greater than a desktop computer and thirty times greater than a laptop computer.	• Distribution and personal transportation in the print system had the largest impacts, waste management and editorial work formed the largest contributors for the electronic versions. • The e-book for a duration of 1 year was preferred in terms of energy, abiotic depletion, global warming potential, eutrophication, human toxicity, marine toxicity and terrestrial toxicity. • The electricity mix is important to the energy consumption of electronics in the use phase. • It is difficult to compare the findings to similar studies because the models and assumptions adopted in other studies are different and have impacts on the outcomes.	• The production of the input materials for the print magazine was a major contributor to environmental impacts. • The electricity mix has a significant impact on the climate change for both mature and emerging tablet devices of more than 100%. • The mature electronic tablets improved efficiency caused a significant decrease in GHG emissions impacts by more than.
Paper disposal	Book is not disposed off	Unknown	Recycled 2.3 times	Made from 50% recycled	• 90% of office paper recycled, 8% landfiled and 2% incinerated	• 80% fibre recovery and 20% incineration of waste paper from books		
Digital disposal	landfilled	Unknown	• Electronic goods were incinerated			• 95% of electronics are recovered for re-use in other products and energy recovery and 5% is sent to landfill.		80% tablet recovered 20% landfilled

APPENDIX B: CALCULATIONS FOR INPUT DATA

Print System

Pulpwood transportation

Distance	108	km
Density	440	$kg.m^{-3}$
Input per m3	47.52	ton.km

Offset Printing

Book size - Printed offset paper	1210	g
No. of books	21	
Input for Printed offset paper	25419.82	g

Paper transportation

Distance	1635	km
Input per tonne	41.56141	ton.km

Retail transportation

Return trip distance	10	km
No. of books	21	
No. of trips assumed	4	
No. of books per trip	5.25	
Input	1.904762	km/book

NB: The remaining process were edited in the SimaPro

Digital System

Use - battery charge calculations

Mode	Energy (kWh)	Days	Time (hrs)	Energy (Wh)
Sleep	0.16	2.25	**47.0**	7.5
Active	3.62	2.25	**7.0**	25.2
Total			**54**	32.8

Source: Apple Air iPad Environmental Report 2013

Allocation of Apple Air iPad energy used for reading

Time for reading (hours)	2.0	SADC, 2000
Active time (hours)	3.10	saleforce.com, 2014
Percentage of active time allocated to reading	**64.52%**	

Apple Air Production

Tablet pc composition	Mass (g)			
Component	Business as usual	Recovered material	Electronic waste	Ipad recovered
Battery	161		161	161
Plastics	22	22		
Circuit Boards	32	32	32	
Glass	61	61		
Aluminium	86	86		
Display	109	109	109	
Corrugated paper	166	66.4	302	166
High-impact polystyrene	66	376.4		66
Other plastics	11			11
Total mass	714	753	604	404
Reading allocation share	64.5%	64.5%	64.5%	64.5%
Mass based on reading allocation	461	486	390	261

Source: Apple Air iPad Environmental Report 2013

Size of ebook

books read over 4 years	21
books read per year	5.25
years	4
Download size (kB/book)	**9184**

Download energy per ebook (Taylor & Koomey, 2008)

Component	kWh/GB	g CO_2 e/GB
User equipment (Modem)	0.22	3.66
User equipment (Router)	0.11	3.66
Access network DSLAM	0.08	3.66
Internet	0.10	14
Data centre	0.40	25
Cables		14
Operational activities	0.01	11
Total	0.92	74.98
Download size (kB/book)	9184.42	
Per book (Wh)	**8.47**	

Formatting energy per ebook

Time used to edit book	50	hrs	Enroth (2009)
Users per book	1000		
Computer for editting	0.05	hrs	

Energy used for reading

Total battery energy (Wh)	32.9	
Times battery is charged per year	162.2	
Times battery is charged over 4 years	648.9	
Allocation	64.5%	
Allocated reading energy (Wh)	13773	
Energy per e-book	656	

Distribution Transport

Europe to China	20500	km	http://www.searates.com/reference/portdistance/
Europe to Africa	12000	km	http://www.searates.com/reference/portdistance/
Total Mileage for ship	32500	km	
Apple Air mass	741	g	
Allocation for reading	64.52%		
Ship transportation	15.537	km.ton	
Truck Distance	569	km	
Truck transportation	0.422	km.ton	

Retail distribution

Petroleum car return trip distance	10	km

Book List and Book Size Calculations

Original Booklist

Course[1,2]	Author[1,2]	Title[1,2]	Edition[1,2]	Publisher[1,2]	Year[1,2]	Pages[3]	Weight (g)[3]	Download Size (kB)[3]
ACC2012W	SAICA	IFRS for SME's		Lexis Nexis	2009	230		6114
ACC3501W	Colin Drury	Management and Cost Accounting	8th Edition	Southern Western Cengage Learning	2011	250		4924
ACC3022H	IRBA	Manual of Information	latest edition	IRBA	2014	270		834
ACC3004H	Roeleveld, Warneke, West	Questions on SA Tax	15th Edition	Juta	2014	464		
ACC3502H	Shawn Kopel	Guide to Business Law	5th Edition	Oxford University Press	Jun-12	544	861	1862
ACC1006F	Kew, J; Watson, A.	Accounting, An Introduction	4th Edition	Oxford	2012	736	1192	17379
ACC2012W	Lubbe, Modack and Watson	Financial Accounting, GAAP Principles	3rd Edition	Oxford University Press	2011	738	1204	5514
ACC4000H	Corriea, C; Flynn, D. et al	Financial Management	7th Edition	Juta	2011	832		
ACC3004H	Phillip Haupt	Notes on South African Income Tax	33rd Edition	Hedron cc	2014	1068	2600	
ACC2022F	Corriea, C; Langefield,-Smith, K; Thorne, H.; & Hilton, RW.	Managment Accounting - Information for Managing and Creating Value	SA Edition	McGraw Hill	2008	1232	2044	
ACC4025H	Puttick and Esch	Principles and Practice of Auditing	9th Edition	Juta	2007	1271	1846	
ACC4025H	Marx, van der Walt, Bourne, Hamel	Dynamic Auditing	Latest Edition	Lexis Nexis	2012/2013		1130	5324
ACC3022H	Jackson & Stent	Auditing Notes for South African Students	latest edition	Lexis Nexis	2013		1910	6138
ACC4023W	IASCF	A Guide through International Financial Reporting Standards	Latest Edition	Lexis Nexis	2013			2060
ACC2023F	Carpenter, Parsons & West	Fundamentals of South African Income Tax	4th Edition	Hedron CC	2014			
ACC3004H	Integritas SAICA	SAICA Legislation Handbook	latest edition	Lexis Nexis	2014			
ACC3009W	SAICA	A Guide through IFRS		Lexis Nexis	Jul-13			
ACC3022H	SAICA	Member's Handbook	Volumes 1-4	SAICA	2013/2014			
ACC3022H	IRBA	IRBA Code of Professional Conduct	latest edition	IRBA	2014			
ACC1012S	Graham, M; Winfield, J.	Understanding Financial Statements	2nd Edition	Cape Business Seminars	2010			
ACC2012W	Prof Daniel Coetsee, Raymond Chamboko, Allan Lamboard, Bruce Macken	Applying IFRS for SME's	1st Edition	W. Consulting	2010			
						694	1598	5572

Sources:

1 -http://www.booklists.uct.ac.za/commerce/recommended/, accessed on 6 July 2014

2 - http://www.booklists.uct.ac.za/commerce/recommended/?sm=f&id=1, accessed on 6 July 2014

3 - http://www.kalahari.com/, accessed on 6 July 2014

Book List and Book Size Calculations

Booklist excluding books with no information

Course[1]	Author[1]	Title[1]	Edition[1]	Publisher[1]	Year[1]	Pages[2]	Weight (g)[2]	Download Size (kB)[2]
ACC2012W	SAICA	IFRS for SME's		Lexis Nexis	2009	230		6114
ACC3501W	Colin Drury	Management and Cost Accounting	8th Edition	Southern Western Cengage Learning	2011	250		4924
ACC3022H	IRBA	Manual of Information	latest edition	IRBA	2014	270		834
ACC3004H	Roeleveld, Warneke, West	Questions on SA Tax	15th Edition	Juta	2014	464		
ACC3502H	Shawn Kopel	Guide to Business Law	5th Edition	Oxford University Press	Jun-12	544	861	1862
ACC1006F	Kew, J; Watson, A.	Accounting, An Introduction	4th Edition	Oxford	2012	736	1192	17379
ACC2012W	Lubbe, Modack and Watson	Financial Accounting, GAAP Principles	3rd Edition	Oxford University Press	2011	738	1204	5514
ACC4000H	Corriea, C; Flynn, D. et al	Financial Management	7th Edition	Juta	2011	832		
ACC3004H	Phillip Haupt	Notes on South African Income Tax	33rd Edition	Hedron cc	2014	1068	2600	
ACC2022F	Corriea, C; Langefield,-Smith, K; Thorne, H.; & Hilton, RW.	Managment Accounting - Information for Managing and Creating Value	SA Edition	McGraw Hill	2008	1232	2044	
ACC4025H	Puttick and Esch	Principles and Practice of Auditing	9th Edition	Juta	2007	1271	1846	
ACC4025H	Marx, van der Walt, Bourne, Hamel	Dynamic Auditing	Latest Edition	Lexis Nexis	2012/2013		1130	5324
ACC3022H	Jackson & Stent	Auditing Notes for South African Students	latest edition	Lexis Nexis	2013		1910	6138
ACC4023W	IASCF	A Guide through International Financial Reporting Standards	Latest Edition	Lexis Nexis	2013			2060
ACC2023F	Carpenter, Parsons & West	Fundamentals of South African Income Tax	4th Edition	Hedron CC	2014			
ACC3004H	Integritas SAICA	SAICA Legislation Handbook	latest edition	Lexis Nexis	2014			
ACC3009W	SAICA	A Guide through IFRS		Lexis Nexis	Jul-13			
ACC3022H	SAICA	Member's Handbook	Volumes 1-4	SAICA	2013/2014			
ACC3022H	IRBA	IRBA Code of Professional Conduct	latest edition	IRBA	2014			
ACC1012S	Graham, M; Winfield, J.	Understanding Financial Statements	2nd Edition	Cape Business Seminars	2010			
ACC2012W	Prof Daniel Coetsee, Raymond Chamboko, Allan Lamboard, Bruce Macken	Applying IFRS for SME's	1st Edition	W. Consulting	2010			

Book and e-book size calculations

Description	Quantity	Unit
Average mass per page	1.74	g
Average kB per page	13.23	kB
Average pages per book	694	g
Average kB per book	**9184**	**kB**
Average mass per book	**1210**	**g**
Weight per book	1210.47	g
Number of books	21	
Total mass of 21 printed books	25420	g
Total mass of 21 printed books	25.42	kg
Total download size of 21 e-books	192873	kB
Total download size of 21 e-books	192.87	MB

APPENDIX C: PRINT SYSTEM SIMAPRO PROCESS EDITS

SimaPro Original Hardwood, CO2-removal and land use {GLO}

SimaPro 8.0.2	process	Date:	2/12/2015	Time:	11:06 PM
Project	Digital vs Print LCA				

Process

Category type	material
Process identifier	EI3ADUNI61667504346
Type	Unit process
Process name	market for hardwood, CO2-removal and land use GLO
Status	
Time period	Unspecified
Geography	Unspecified
Technology	Unspecified
Representativeness	Unspecified
Multiple output allocation	Unspecified
Substitution allocation	Unspecified
Cut off rules	Unspecified
Capital goods	Unspecified
Boundary with nature	Unspecified
Infrastructure	No
Date	10/22/2013
Record	data entry by: [System] support@ecoinvent.org is active author:
Generator	generated by: [System] support@ecoinvent.org
Literature references	Ecoinvent 3 is copyright protected: false
Collection method	
Data treatment	extrapolations: This dataset has been extrapolated from year 2011 to the year of the calculation (2013). The uncertainty has been adjusted accordingly.
Verification	
Comment	Production volume: 2237954066 m3 Technology level: 0 undefined Start date: 2011-01-01 End date: 2013-12-31 Is data valid for entire period: true Macro-economic scenario name: Business-as-Usual Version: 3.0.2.1 Created: 2011-08-02T09:59:51 Last edited: 2011-08-02T09:59:51 Source: 9220eee6-c246-49bb-bb82-2eea0789b642_669701c5-1051-45fb-a302-12bbadb379ed.spold Link: https://ecoquery.ecoinvent.org/Details/UPR/12368619-0A10-4458-AC3D-7908C89FC079/06590A66-662A-4885-8494-AD0CF410F956
Allocation rules	
System description	Ecoinvent v3.01

Products

Hardwood, CO2-removal and land use {GLO}| market for | Alloc Def, U	1	m3	100 Wood	Wood\Extraction\ Market

Avoided products

Resources

Materials/fuels

Hardwood, CO2-removal and land use {Europe without NORDEL (NCPA)}| hardwood forestry, CO2-removal and land use | Alloc Def, U	0.007233982	m3	Undefined	Production Volume Amount: 16189320
Hardwood, CO2-removal and land use {NORDEL}| hardwood forestry, CO2-removal and land use | Alloc Def, U	0.007233982	m3	Undefined	Production Volume Amount: 16189320
Hardwood, CO2-removal and land use {RoW}| hardwood forestry, CO2-removal and land use | Alloc Def, U	0.985532035	m3	Undefined	Production Volume Amount: 2205575426

Electricity/heat
Emissions to air
Emissions to water
Emissions to soil
Final waste flows
Non material emissions
Social issues
Economic issues
Waste to treatment
Input parameters
Calculated parameters

SimaPro Edit Hardwood, CO2-removal and land use {ZA} - No change to loriginal GLO since no South African data

SimaPro 8.0.2	process	Date:	2/12/2015	Time: 11:06 PM
Project	Digital vs Print LCA			

Process

Category type	material
Process identifier	FFLUCT7595335400024
Type	Unit process
Process name	market for hardwood, CO2-removal and land use GLO
Status	
Time period	Unspecified
Geography	Unspecified
Technology	Unspecified
Representativeness	Unspecified
Multiple output allocation	Unspecified
Substitution allocation	Unspecified
Cut off rules	Unspecified
Capital goods	Unspecified
Boundary with nature	Unspecified
Infrastructure	No
Date	10/22/2013
Record	data entry by: [System] support@ecoinvent.org is active author: generated by: [System]
Generator	support@ecoinvent.org
Literature references	Ecoinvent 3
Collection method	is copyright protected: false
Data treatment	extrapolations: This dataset has been extrapolated from year 2011 to the year of the calculation (2013). The uncertainty has been adjusted accordingly.
Verification	
Comment	Production volume: 2237954066 m3 Technology level: 0 undefined Start date: 2011-01-01 End date: 2013-12-31 Is data valid for entire period: true Macro-economic scenario name: Business-as-Usual Version: 3.0.2.1 Created: 2011-08-02T09:59:51 Last edited: 2011-08-02T09:59:51 Source: 9220eee6-c246-49bb-bb82-2eea0789b642_669701c5-1051-45fb-a302-12bbadb379ed.spold Link: https://ecoquery.ecoinvent.org/Details/UPR/12368619-0A10-4458-AC3D-7908C89FC079/06590A66-662A-4885-8494-AD0CF410F956
Allocation rules	
System description	Ecoinvent v3.01

Products

Hardwood, CO2-removal and land use {ZA}| market for | Alloc Def, U	1 m3	not 100 defined		Wood\Extraction\Market

Avoided products

Resources

Materials/fuels

Hardwood, CO2-removal and land use {Europe without NORDEL (NCPA)}| hardwood forestry, CO2-removal and land use | Alloc Def, U	0 m3	Undefined	Production Volume Amount: 16189320
Hardwood, CO2-removal and land use {NORDEL}| hardwood forestry, CO2-removal and land use | Alloc Def, U	0 m3	Undefined	Production Volume Amount: 16189320
Hardwood, CO2-removal and land use {RoW}| hardwood forestry, CO2-removal and land use | Alloc Def, U	1 m3	Undefined	Production Volume Amount: 2205575426

Electricity/heat
Emissions to air
Emissions to water
Emissions to soil
Final waste flows
Non material emissions
Social issues
Economic issues
Waste to treatment
Input parameters
Calculated parameters

SimaPro Original Hardwood {RoW}

SimaPro 8.0.2	process	Date:	2/12/2015	Time:	11:05 PM
Project	Digital vs Print LCA				

Process

Category type	material
Process identifier	EI3ADUNI61667503865
Type	Unit process
Process name	hardwood forestry, for pulp RoW
Status	
Time period	Unspecified
Geography	Unspecified
Technology	Unspecified
Representativeness	Unspecified
Multiple output allocation	Unspecified
Substitution allocation	Unspecified
Cut off rules	Unspecified
Capital goods	Unspecified
Boundary with nature	Unspecified
Infrastructure	No
Date	10/22/2013
Record	data entry by: [System] support@ecoinvent.org is active author: generated by: Roland Hischier roland.hischier@empa.ch Lerchenfeldstrasse 5, 9014 St-Gallen,
Generator	Switzerland
Literature references	Ecoinvent 3 data published in: 2 Data has been published entirely in (refers to field 757) data published by: Life Cycle Inventories of Packaging and Graphical Paper 2007 Separate publication is copyright protected: true
Collection method	sampling procedure: Literature extrapolations: Allocation to roundwood (logs) and industrial wood already made by authors of the finnish LCA database. Allocation factors unknown. This dataset has been copied from an original dataset covering the geography NORDEL. The
Data treatment	uncertainty has been adjusted accordingly.
Verification	
Comment	The volume does not include the bark. CO2 assimilation is based on 49.4% carbon in the wood. Biomass energy equals gross calorific value including bark. [This is a dataset automatically generated based on a dataset transferred from ecoSpold v1 / ecoinvent database version 2. It may not in all aspects fulfill the requirements of the ecoinvent data quality guideline for version 3.] Production volume: 21376659 m3 Included activities end: This module includes material and energy amounts for stand establishment, tending, site development, thinnings and final cutting of scandinavian industrial hardwood (for pulp and paper industry), its transport to the nearest forest road as well as the land and materials use for the forest roads Energy values: Undefined (default) Geography: Typical data for the forest industry in Scandinavia from a finnish LCA database Technology level: 3 Current (default) Technology: Modern average technology used in Scandinavia Start date: 2000-01-01 End date: 2013-12-31 Is data valid for entire period: true Macro-economic scenario name: Business-as-Usual

SimaPro Original Hardwood {RoW}

Version: 3.0.109.1
Created: 2010-07-28T18:35:01
Source: ad8f6c1b-5be1-449a-8e06-d4ec6722dd10_aed42e37-62bc-4f3f-a527-b92f5187c0e8.spold
Link: https://ecoquery.ecoinvent.org/Details/UPR/ECD29B98-4B32-46F8-8689-71644E1D477B/06590A66-662A-4885-8494-AD0CF410F956

Allocation rules
System description: Ecoinvent v3.01

Products

Pulpwood, hardwood, measured as solid wood under bark {RoW}| hardwood forestry, for pulp | Alloc Def, U		1	m3	100	Wood	Wood\Extraction\Transformation	

Avoided products

Resources

Transformation, to traffic area, rail/road embankment	land	0.465	m2		Lognormal	2.3064	(2,4,5,5,1,na), average data from KCL database
Transformation, from forest, extensive	land	0.465	m2		Lognormal	2.3064	(2,4,5,5,1,na), average data from KCL database
Occupation, traffic area, rail/road embankment	land	69.7	m2a		Lognormal	1.8499	(2,4,5,5,1,na), average data from KCL database

Materials/fuels

Power sawing, without catalytic converter {GLO}| market for | Alloc Def, U	0.233	hr	Lognormal	1.5957	(2,4,5,5,1,na), average data from KCL database
Gravel, crushed {GLO}| market for | Alloc Def, U	397	kg	Lognormal	3.3789	(2,5,5,5,1,na), data from European module
Lubricating oil {GLO}| market for | Alloc Def, U	0.09	kg	Lognormal	1.5957	(2,4,5,5,1,na), average data from KCL database
Ammonium sulfate, as N {GLO}| market for | Alloc Def, U	1.46	kg	Lognormal	1.5957	(2,4,5,5,1,na), average data from KCL database
Hardwood, CO2-removal and land use {GLO}| market for | Alloc Def, U	1	m3	Lognormal	1.7013	(2,5,5,5,1,na)

Electricity/heat

Diesel, burned in building machine {GLO}| market for | Alloc Def, U	143	MJ	Lognormal	1.5957	(2,4,5,5,1,na), average data from KCL database

Emissions to air

Emissions to water

Nitrogen	river	0.026	kg		Lognormal	1.8499	(2,4,5,5,1,na), average data from KCL database

Emissions to soil
Final waste flows
Non material emissions
Social issues
Economic issues
Waste to treatment
Input parameters
Calculated parameters

SimaPro Original Hardwood {ZA} - No change to original RoW since no South African data

SimaPro 8.0.2	process	Date:	2/12/2015	Time:	11:05 PM
Project	Digital vs Print LCA				

Process

Category type	material
Process identifier	FFLUCT7595335400026
Type	Unit process
Process name	hardwood forestry RoW
Status	
Time period	Unspecified
Geography	Unspecified
Technology	Unspecified
Representativeness	Unspecified
Multiple output allocation	Unspecified
Substitution allocation	Unspecified
Cut off rules	Unspecified
Capital goods	Unspecified
Boundary with nature	Unspecified
Infrastructure	No
Date	10/22/2013
Record	data entry by: [System] support@ecoinvent.org is active author:
Generator	generated by: Hans-Jörg Althaus empa@ecoinvent.org Überlandstrasse 129, 8600 Dübendorf
Literature references	Ecoinvent 3
	data published in: 2 Data has been published entirely in (refers to field 757)
	data published by: Life Cycle Inventories of Wood as Fuel and Construction Material 2007 Separate publication
	is copyright protected: true
Collection method	sampling procedure: Literature
Data treatment	extrapolations: see Geography and Technology This dataset has been copied from an original dataset covering the geography RER. The uncertainty has been adjusted accordingly.
Verification	
Comment	[This is a dataset automatically generated based on a dataset transferred from ecoSpold v1 / ecoinvent database version 2. It may not in all aspects fulfill the requirements of the ecoinvent data quality guideline for version 3.]

SimaPro Original Hardwood {ZA} - No change to original RoW since no South African data

The volume refers to the wood not including the bark. The multi-output process "hardwood, thinning/final cutting, under bark" delivers the three coproducts "round wood, hardwood, under bark, u=70%, at forest road", "residual wood, hardwood, under bark, u=80%, at forest road" and "industrial wood, hardwood, under bark, u=80%, at forest road".

Production volume: 161418544.058823 m3

Included activities end: Includes motormanual processes for thinning and final cutting as well as transport of the products to the nearest forest road.

Energy values: Undefined (default)

Geography: Data for Germany used for central Europe

Technology level: 3 Current (default)

Technology: Considers only one type of forest interventions (Motormanual processes for "Buche, II. Ertragsklasse, starke Durchforstung")
Start date: 1996-01-01
End date: 2013-12-31

Is data valid for entire period: true

Macro-economic scenario name: Business-as-Usual

Version: 3.0.79.0

Created: 2010-07-28T18:05:38

Last edited: 2012-09-21T16:53:16

Source: 5ee823d4-eeb4-4b9e-b233-846e63a67083_aed42e37-62bc-4f3f-a527-b92f5187c0e8.spold

Link: https://ecoquery.ecoinvent.org/Details/UPR/ECD29B98-4B32-46F8-8689-71644E1D477B/06590A66-662A-4885-8494-AD0CF410F956

Allocation rules
System description Ecoinvent v3.01

Products

Pulpwood, hardwood, measured as solid wood under bark {ZA}| hardwood forestry | Alloc Def, U	1	m3	not 100 defined	Wood\Extraction\Transformation

Avoided products

Resources

SimaPro Original Hardwood {ZA} - No change to original RoW since no South African data

Materials/fuels				
Hardwood forestry operation, except harvesting {GLO}| market for | Alloc Def, U	1.936908608 m3	Lognormal	1.511	(1,3,5,5,1,na) (1,3,2,3,1,1,3)
Power sawing, without catalytic converter {GLO}| market for | Alloc Def, U	0.286662474 hr	Lognormal	2.24	(1,3,5,5,1,na) (1,3,2,3,1,1,5)
Wood fuel, hardwood, wet, measured as solid wood under bark {GLO}| market for | Alloc Def, U	-0.304094651 m3	Undefined		
				Production Volume Amount: 76104238.4901961
Agricultural trailer {GLO}| market for | Alloc Def, U	0.807690889 kg	Lognormal	2.7618	(4,5,5,5,5,na) (4,n.A.,n.A.,n.A.,n.A.,n.A. ,5)
Hardwood, CO2-removal and land use {ZA}| market for | Alloc Def, U	1.936908608 m3	Lognormal	1.5074	(1,2,5,5,1,na) (1,2,2,3,1,1,11)
Electricity/heat				
Diesel, burned in building machine {GLO}| market for | Alloc Def, U	87.93565078 MJ	Lognormal	2.24	(1,3,5,5,1,na) (1,3,2,3,1,1,5)
Emissions to air				
Emissions to water				
Emissions to soil				
Final waste flows				
Non material emissions				
Social issues				
Economic issues				
Waste to treatment				
Input parameters				
Calculated parameters				

Pulpwood transportation {GLO}

SimaPro 8.0.2	process	Date:	2/13/2015	Time:	12:00 AM
Project	Digital vs Print LCA				

Process

Category type	material
Process identifier	EI3ADUNI61667504212
Type	Unit process
Process name	market for pulpwood, hardwood, measured as solid wood under bark GLO
Status	
Time period	Unspecified
Geography	Unspecified
Technology	Unspecified
Representativeness	Unspecified
Multiple output allocation	Unspecified
Substitution allocation	Unspecified
Cut off rules	Unspecified
Capital goods	Unspecified
Boundary with nature	Unspecified
Infrastructure	No
Date	10/22/2013
Record	data entry by: [System] support@ecoinvent.org is active author: generated by: [System]
Generator	support@ecoinvent.org
Literature references	Ecoinvent 3
Collection method	is copyright protected: false
Data treatment	extrapolations: This dataset has been extrapolated from year 2011 to the year of the calculation (2013). The uncertainty has been adjusted accordingly.
Verification	
Comment	Production volume: 224260999.141176 m3 Technology level: 0 undefined Start date: 2011-01-01 End date: 2013-12-31 Is data valid for entire period: true Macro-economic scenario name: Business-as-Usual Version: 3.0.3.0 Created: 2011-08-02T09:59:52 Last edited: 2013-03-12T18:03:39 Source: 99705437-6b8e-4393-8ea2-9f7a6b552aed_aed42e37-62bc-4f3f-a527-b92f5187c0e8.spold Link: https://ecoquery.ecoinvent.org/Details/UPR/74648622-4298-4A32-8798-CD5F6F99286F/06590A66-662A-4885-8494-AD0CF410F956
Allocation rules	
System description	Ecoinvent v3.01

Products

Pulpwood, hardwood, measured as solid wood under bark {GLO}| market for | Alloc Def, U	1	m3	100	Wood	Wood\Extraction\Market

Avoided products

Resources

Materials/fuels

Transport, freight, lorry, unspecified {GLO}| market for | Alloc Def, U	23.622	tkm	Lognormal	2.281	(1,1,4,5,4,na)

Pulpwood transportation {GLO}

				Transport distance based on US BTS Commodity Flow Surveys 1993, 1997, 2002, 2007, US Dep. Of Transportation, Bureau of Transportation Statistics. Of the total road transport, 6% is assumed to be by delivery van for goods with a large share of retail sale, and 3% for goods that are mainly sold via wholesale. This transport distance was reduced by 90% according to expert judgement.
Transport, freight, light commercial vehicle {GLO}| market for | Alloc Def, U	7.254 tkm	Lognormal	2.281	(1,1,4,5,4,na) Transport distance based on US BTS Commodity Flow Surveys 1993, 1997, 2002, 2007, US Dep. Of Transportation, Bureau of Transportation Statistics. Of the total road transport, 6% is assumed to be by delivery van for goods with a large share of retail sale, and 3% for goods that are mainly sold via wholesale.
Transport, freight, sea, transoceanic ship {GLO}| market for | Alloc Def, U	207.792 tkm	Lognormal	2.281	(1,1,4,5,4,na) The total marine transport volume differentiated into major commodity groups based on data from FearnResearch (2001): Fearnley's Annual Review 2000. Oslo: Fearnley/AS, p. 1-78. The category “Other cargo” accounts for 38% of total maritime transport volume and has been distributed on commodity groups based on the proportions of transport by rail and inland waterways. The total marine transport volume differentiated into major commodity groups based on data from FearnResearch (2001): Fearnley's Annual Review 2000. Oslo: Fearnley/AS, p. 1-78. The category “Other cargo” accounts for 38% of total maritime transport volume and has been distributed on commodity groups based on the proportions in the marine import and export of the US in 2001-2010.
Pulpwood, hardwood, measured as solid wood under bark {NORDEL}| hardwood forestry, for pulp | Alloc Def, U	0.041399245 m3	Undefined		Production Volume Amount: 9284236
Pulpwood, hardwood, measured as solid wood under bark {RER}| hardwood forestry | Alloc Def, U	0.143500476 m3	Undefined		Production Volume Amount: 32181560.0823529
Pulpwood, hardwood, measured as solid wood under bark {RoW}| hardwood forestry, for pulp | Alloc Def, U	0.095320448 m3	Undefined		Production Volume Amount: 21376659
Pulpwood, hardwood, measured as solid wood under bark {RoW}| hardwood forestry | Alloc Def, U	0.719779831 m3	Undefined		Production Volume Amount: 161418544.058823
Transport, freight train {Europe without Switzerland}| market for | Alloc Def, U	9.134497754 tkm	Lognormal	2.281	(1,1,4,5,4,na)
Transport, freight train {CN}| market for | Alloc Def, U	30.91383803 tkm	Lognormal	2.281	(1,1,4,5,4,na)
Transport, freight train {CH}| market for | Alloc Def, U	0.182069818 tkm	Lognormal	2.281	(1,1,4,5,4,na)
Transport, freight train {US}| market for | Alloc Def, U	43.42435476 tkm	Lognormal	2.281	(1,1,4,5,4,na)
Transport, freight train {RoW}| market for | Alloc Def, U	56.51123964 tkm	Lognormal	2.281	(1,1,4,5,4,na)

Electricity/heat
Emissions to air
Emissions to water
Emissions to soil
Final waste flows
Non material emissions
Social issues
Economic issues
Waste to treatment
Input parameters
Calculated parameters

Pulpwood transportation {ZA}

SimaPro 8.0.2	process	Date:	2/12/2015	Time:	11:55 PM
Project	Digital vs Print LCA				

Process

Category type	material
Process identifier	FFLUCT7595335400025
Type	Unit process
Process name	market for pulpwood, hardwood, measured as solid wood under bark GLO
Status	
Time period	Unspecified
Geography	Unspecified
Technology	Unspecified
Representativeness	Unspecified
Multiple output allocation	Unspecified
Substitution allocation	Unspecified
Cut off rules	Unspecified
Capital goods	Unspecified
Boundary with nature	Unspecified
Infrastructure	No
Date	10/22/2013
Record	data entry by: [System] support@ecoinvent.org is active author:
Generator	generated by: [System] support@ecoinvent.org
Literature references	Ecoinvent 3
Collection method	is copyright protected: false
Data treatment	extrapolations: This dataset has been extrapolated from year 2011 to the year of the calculation (2013). The uncertainty has been adjusted accordingly.
Verification	
Comment	Production volume: 224260999.141176 m3 Technology level: 0 undefined Start date: 2011-01-01 End date: 2013-12-31 Is data valid for entire period: true Macro-economic scenario name: Business-as-Usual Version: 3.0.3.0 Created: 2011-08-02T09:59:52 Last edited: 2013-03-12T18:03:39 Source: 99705437-6b8e-4393-8ea2-9f7a6b552aed_aed42e37-62bc-4f3f-a527-b92f5187c0e8.spold Link: https://ecoquery.ecoinvent.org/Details/UPR/74648622-4298-4A32-8798-CD5F6F99286F/06590A66-662A-4885-8494-AD0CF410F956
Allocation rules	
System description	Ecoinvent v3.01

Products

Pulpwood, hardwood, measured as solid wood under bark {ZA}| market for | Alloc Def, U	1	m3	not defined	100	Wood\Extraction\Market

Avoided products

Pulpwood transportation {ZA}
Resources

Materials/fuels				
Transport, freight, lorry >32 metric ton, EURO3 {GLO}| market for | Alloc Def, U	47.52 tkm	Lognormal	2.281	(1,1,4,5,4,na) Transport distance based on US BTS Commodity Flow Surveys 1993, 1997, 2002, 2007, US Dep. Of Transportation, Bureau of Transportation Statistics. Of the total road transport, 6% is assumed to be by delivery van for goods with a large share of retail sale, and 3% for goods that are mainly sold via wholesale. This transport distance was reduced by 90% according to expert judgement.
Pulpwood, hardwood, measured as solid wood under bark {NORDEL}| hardwood forestry, for pulp | Alloc Def, U	0 m3	Undefined		Production Volume Amount: 9284236
Pulpwood, hardwood, measured as solid wood under bark {RER}| hardwood forestry | Alloc Def, U	0 m3	Undefined		Production Volume Amount: 32181560.0823529
Pulpwood, hardwood, measured as solid wood under bark {RoW}| hardwood forestry, for pulp | Alloc Def, U	0 m3	Undefined		Production Volume Amount: 21376659
Pulpwood, hardwood, measured as solid wood under bark {ZA}| hardwood forestry | Alloc Def, U	1 m3	Undefined		Production Volume Amount: 161418544.058823
Electricity/heat				
Emissions to air				
Emissions to water				
Emissions to soil				
Final waste flows				
Non material emissions				
Social issues				
Economic issues				
Waste to treatment				
Input parameters				
Calculated parameters				

SimaPro Original Paper Production RoW

SimaPro 8.0.2	process	Date:	2/12/2015	Time:	11:07 PM
Project	Digital vs Print LCA				

Process

Category type	material
Process identifier	EI3ADUNI61667500070
Type	Unit process
Process name	sulfite pulp production, bleached RoW
Status	
Time period	Unspecified
Geography	Unspecified
Technology	Unspecified
Representativeness	Unspecified
Multiple output allocation	Unspecified
Substitution allocation	Unspecified
Cut off rules	Unspecified
Capital goods	Unspecified
Boundary with nature	Unspecified
Infrastructure	No
Date	10/22/2013
Record	data entry by: [System] support@ecoinvent.org is active author: generated by: Roland Hischier roland.hischier@empa.ch Lerchenfeldstrasse 5, 9014 St-Gallen,
Generator	Switzerland
Literature references	Ecoinvent 3
	data published in: 2 Data has been published entirely in (refers to field 757)
	data published by: Life Cycle Inventories of Packaging and Graphical Paper 2007 Separate publication is copyright protected: true
Collection method	
	extrapolations: This dataset has been copied from an original dataset covering the geography RER. The uncertainty
Data treatment	has been adjusted accordingly.
Verification	
	[This is a dataset automatically generated based on a dataset transferred from ecoSpold v1 / ecoinvent database version 2. It may not in all aspects fulfill the requirements of the ecoinvent data quality guideline
Comment	for version 3.]
	Production volume: 1210197000 kg Included activities end: This module includes the production of bleached sulphite pulp - including transports to the pulp mill, wood handling, chemical pulping and bleaching, drying process, energy production on-site, recovery cycles of chemicals and internal waste water treatment. Energy values: Undefined (default) Geography: Data from a small European producer and from the finnish database used as European average data. Technology level: 3 Current (default) Technology: Mix of modern Ca-bisulphite and Mg-sulphite bleaching technology. Start date: 1997-01-01 End date: 2013-12-31 Is data valid for entire period: true Macro-economic scenario name: Business-as-Usual
	Version: 3.0.109.1 Created: 2010-07-28T18:26:09 Source: 05aec00c-fe17-43b4-b182-9815f4d56df8_23ff52d3-06a2-4d3a-8039-cfeb12f7cb9a.spold Link: https://ecoquery.ecoinvent.org/Details/UPR/D66AC690-44D5-45DF-8B05-EABD0CC8A052/06590A66-662A-4885-8494-AD0CF410F956
Allocation rules	
System description	Ecoinvent v3.01

SimaPro Original Paper Production RoW

Products							
Sulfite pulp, bleached {RoW}| production | Alloc Def, U		1	kg	100	Paper	Paper+ Board\Pulp\Transformation	
Avoided products							
Resources							
Water, cooling, unspecified natural origin, RoW	in water	0.017498	m3		Lognormal	1.5861	(2,3,5,5,1,na) , based on filled in questionnaire from 1 site Calculated based on literature (Byers, W., 2003, Industrial Water Management, Fibria, 2010, Sustainability Report_pulp from eucalyptus), (Vionnet, S., Quantis Water Database - Technical Report, 2012). It includes the main processes: wood washing and screening, evaporation, recausticizing, bleach plant chemical preparation and pulp dryer.
Water, unspecified natural origin, RoW	in water	0.07249	m3		Lognormal	1.5957	(3,3,5,5,1,na) , average from finnish DB, SE-EPA and 1 site Calculated based on literature (Byers, W., 2003, Industrial Water Management, Fibria, 2010, Sustainability Report_pulp from eucalyptus), (Vionnet, S., Quantis Water Database - Technical Report, 2012). It includes the main processes: wood washing and screening, evaporation, recausticizing, bleach plant chemical preparation and pulp dryer.
Materials/fuels							
Waste plastic, mixture {GLO}| market for | Alloc Def, U		-0.007559004	kg		Lognormal	1.5154	(2,3,5,5,1,na) , average Swedish data from SE-EPA report Production Volume Amount: 9149089.32
Municipal solid waste {GLO}| market for | Alloc Def, U		-0.003799499	kg		Lognormal	1.5154	(2,3,5,5,1,na) , average Swedish data from SE-EPA report Production Volume Amount: 4598748.6
Oxygen, liquid {GLO}| market for | Alloc Def, U		0.011898432	kg		Lognormal	1.5154	(2,3,5,5,1,na) , average from finnish DB, SE-EPA and 1 site
Scrap steel {GLO}| market for | Alloc Def, U		-0.000839889	kg		Lognormal	1.5154	(2,3,5,5,1,na) , average Swedish data from SE-EPA report Production Volume Amount: 1016565.48
Sodium hydroxide, without water, in 50% solution state {GLO}| market for | Alloc Def, U		0.042394414	kg		Lognormal	1.5154	(2,3,5,5,1,na) , average from finnish DB, SE-EPA and 1 site
Sludge from pulp and paper production {GLO}| market for | Alloc Def, U		-0.01039863	kg		Lognormal	1.5154	(2,3,5,5,1,na) , average Swedish data from SE-EPA report Production Volume Amount: 12586048.8
Magnesium oxide {GLO}| market for | Alloc Def, U		0.006499144	kg		Lognormal	1.5154	(2,3,5,5,1,na) , average from finnish DB, SE-EPA and 1 site
Waste graphical paper {GLO}| market for | Alloc Def, U		-0.002399684	kg		Lognormal	1.5154	(2,3,5,5,1,na) , average Swedish data from SE-EPA report Production Volume Amount: 2904472.8
Diesel {RoW}| market for | Alloc Def, U		0.000239968	kg		Lognormal	1.5154	(2,3,5,5,1,na)

SimaPro Original Paper Production RoW

				, average from finnish DB, SE-EPA and 1 site
Hydrogen peroxide, without water, in 50% solution state {GLO}| market for | Alloc Def, U	0.025696614 kg	Lognormal	1.5154	(2,3,5,5,1,na) , average from finnish DB, SE-EPA and 1 site
Chlorine dioxide {GLO}| market for | Alloc Def, U	0.001599789 kg	Lognormal	1.5154	(2,3,5,5,1,na) , average from finnish DB, SE-EPA and 1 site
Sulfur dioxide, liquid {GLO}| market for | Alloc Def, U	0.026796469 kg	Lognormal	1.5154	(2,3,5,5,1,na) , average from finnish DB, SE-EPA and 1 site
Waste textile, soiled {GLO}| market for | Alloc Def, U	-0.000779897 kg	Lognormal	1.5154	(2,3,5,5,1,na) , average Swedish data from SE-EPA report Production Volume Amount: 943953.66
Sodium chlorate, powder {GLO}| market for | Alloc Def, U	0.000599921 kg	Lognormal	1.5154	(2,3,5,5,1,na) , average from finnish DB, SE-EPA and 1 site
Pulp factory {GLO}| market for | Alloc Def, U	4.99934E-11 p	Lognormal	3.8139	(4,5,5,5,5,na) (4,na,na,na,na,na), assumption
Pulpwood, hardwood, measured as solid wood under bark {GLO}| market for | Alloc Def, U	0.000793895 m3	Lognormal	1.5154	(2,3,5,5,1,na) , average from finnish DB, SE-EPA and 1 site
Lime {GLO}| market for | Alloc Def, U	0.052093136 kg	Lognormal	1.5154	(2,3,5,5,1,na) , average from finnish DB, SE-EPA and 1 site
Wood ash mixture, pure {GLO}| market for | Alloc Def, U	-0.044694111 kg	Lognormal	1.5154	(2,3,5,5,1,na) , average Swedish data from SE-EPA report Production Volume Amount: 54095805.9
Waste wood, untreated {GLO}| market for | Alloc Def, U	-0.000419945 kg	Lognormal	1.5154	(2,3,5,5,1,na) , average Swedish data from SE-EPA report Production Volume Amount: 508282.74
Green liquor dregs {GLO}| market for | Alloc Def, U	-0.003599526 kg	Lognormal	1.5154	(2,3,5,5,1,na) , average Swedish data from SE-EPA report Production Volume Amount: 4356709.2
Sulfuric acid {GLO}| market for | Alloc Def, U	0.000399947 kg	Lognormal	1.5154	(2,3,5,5,1,na) , average from finnish DB, SE-EPA and 1 site
Ash from paper production sludge {GLO}| market for | Alloc Def, U	-0.002939613 kg	Lognormal	1.5154	(2,3,5,5,1,na) , average Swedish data from SE-EPA report Production Volume Amount: 3557979.18
Sulfur {GLO}| market for | Alloc Def, U	0.025596627 kg	Lognormal	1.5154	(2,3,5,5,1,na) , average from finnish DB, SE-EPA and 1 site
Pulpwood, softwood, measured as solid wood under bark {GLO}| market for | Alloc Def, U	0.003439547 m3	Lognormal	1.5154	(2,3,5,5,1,na) , average from finnish DB, SE-EPA and 1 site
Electricity/heat				
Heat, district or industrial, other than natural gas {RoW}| market for | Alloc Def, U	12.49740031 MJ	Lognormal	1.5154	(2,3,5,5,1,na) , average from finnish DB, SE-EPA and 1 site
Electricity, medium voltage {ASCC}| market for | Alloc Def, U	5.9907E-05 kWh	Lognormal	1.5154	(2,3,5,5,1,na)
Electricity, medium voltage {AU}| market for | Alloc Def, U	0.002021171 kWh	Lognormal	1.5154	(2,3,5,5,1,na)
Electricity, medium voltage {BR}| market for | Alloc Def, U	0.003949267 kWh	Lognormal	1.5154	(2,3,5,5,1,na)
Electricity, medium voltage {CA-AB}| market for | Alloc Def, U	0.00028566 kWh	Lognormal	1.5154	(2,3,5,5,1,na)
Electricity, medium voltage {CA-BC}| market for | Alloc Def, U	0.000630983 kWh	Lognormal	1.5154	(2,3,5,5,1,na)

SimaPro Original Paper Production RoW

Electricity, medium voltage {CA-MB}| market for | Alloc Def, U		0.000366115 kWh	Lognormal	1.5154	(2,3,5,5,1,na)
Electricity, medium voltage {CA-NB}| market for | Alloc Def, U		0.000214245 kWh	Lognormal	1.5154	(2,3,5,5,1,na)
Electricity, medium voltage {CA-NF}| market for | Alloc Def, U		0.000430298 kWh	Lognormal	1.5154	(2,3,5,5,1,na)
Electricity, medium voltage {CA-NS}| market for | Alloc Def, U		0.00026306 kWh	Lognormal	1.5154	(2,3,5,5,1,na)
Electricity, medium voltage {CA-NT}| market for | Alloc Def, U		4.03178E-06 kWh	Lognormal	1.5154	(2,3,5,5,1,na)
Electricity, medium voltage {CA-NU}| market for | Alloc Def, U		1.68142E-06 kWh	Lognormal	1.5154	(2,3,5,5,1,na)
Electricity, medium voltage {CA-ON}| market for | Alloc Def, U		0.001581978 kWh	Lognormal	1.5154	(2,3,5,5,1,na)
Electricity, medium voltage {CA-PE}| market for | Alloc Def, U		4.98097E-07 kWh	Lognormal	1.5154	(2,3,5,5,1,na)
Electricity, medium voltage {CA-SK}| market for | Alloc Def, U		0.000108478 kWh	Lognormal	1.5154	(2,3,5,5,1,na)
Electricity, medium voltage {CA-YK}| market for | Alloc Def, U		3.85099E-06 kWh	Lognormal	1.5154	(2,3,5,5,1,na)
Electricity, medium voltage {CL}| market for | Alloc Def, U		0.000495313 kWh	Lognormal	1.5154	(2,3,5,5,1,na)
Electricity, medium voltage {CN}| market for | Alloc Def, U		0.026880783 kWh	Lognormal	1.5154	(2,3,5,5,1,na)
Electricity, medium voltage {FRCC}| market for | Alloc Def, U		0.001835232 kWh	Lognormal	1.5154	(2,3,5,5,1,na)
Electricity, medium voltage {HICC}| market for | Alloc Def, U		9.4913E-05 kWh	Lognormal	1.5154	(2,3,5,5,1,na)
Electricity, medium voltage {ID}| market for | Alloc Def, U		0.0011963 kWh	Lognormal	1.5154	(2,3,5,5,1,na)
Electricity, medium voltage {IN}| market for | Alloc Def, U		0.006401871 kWh	Lognormal	1.5154	(2,3,5,5,1,na)
Electricity, medium voltage {IR}| market for | Alloc Def, U		0.001632962 kWh	Lognormal	1.5154	(2,3,5,5,1,na)
Electricity, medium voltage {JP}| market for | Alloc Def, U		0.008735735 kWh	Lognormal	1.5154	(2,3,5,5,1,na)
Electricity, medium voltage {KR}| market for | Alloc Def, U		0.00363439 kWh	Lognormal	1.5154	(2,3,5,5,1,na)
Electricity, medium voltage {MRO, US only}| market for | Alloc Def, U		0.001963623 kWh	Lognormal	1.5154	(2,3,5,5,1,na)
Electricity, medium voltage {MX}| market for | Alloc Def, U		0.002018423 kWh	Lognormal	1.5154	(2,3,5,5,1,na)
Electricity, medium voltage {MY}| market for | Alloc Def, U		0.000887426 kWh	Lognormal	1.5154	(2,3,5,5,1,na)
Electricity, medium voltage {NPCC, US only}| market for | Alloc Def, U		0.002295665 kWh	Lognormal	1.5154	(2,3,5,5,1,na)
Electricity, medium voltage {PE}| market for | Alloc Def, U		0.000267074 kWh	Lognormal	1.5154	(2,3,5,5,1,na)
Electricity, medium voltage {Quebec}| market for | Alloc Def, U		0.001374061 kWh	Lognormal	1.5154	(2,3,5,5,1,na)
Electricity, medium voltage {RFC}| market for | Alloc Def, U		0.008097726 kWh	Lognormal	1.5154	(2,3,5,5,1,na)
Electricity, medium voltage {RU}| market for | Alloc Def, U		0.007872065 kWh	Lognormal	1.5154	(2,3,5,5,1,na)
Electricity, medium voltage {SA}| market for | Alloc Def, U		0.001661962 kWh	Lognormal	1.5154	(2,3,5,5,1,na)
Electricity, medium voltage {SERC}| market for | Alloc Def, U		0.009462824 kWh	Lognormal	1.5154	(2,3,5,5,1,na)
Electricity, medium voltage {SPP}| market for | Alloc Def, U		0.001833428 kWh	Lognormal	1.5154	(2,3,5,5,1,na)
Electricity, medium voltage {TH}| market for | Alloc Def, U		0.0012206 kWh	Lognormal	1.5154	(2,3,5,5,1,na)
Electricity, medium voltage {TR}| market for | Alloc Def, U		0.001544227 kWh	Lognormal	1.5154	(2,3,5,5,1,na)
Electricity, medium voltage {TRE}| market for | Alloc Def, U		0.003006029 kWh	Lognormal	1.5154	(2,3,5,5,1,na)
Electricity, medium voltage {TW}| market for | Alloc Def, U		0.001903291 kWh	Lognormal	1.5154	(2,3,5,5,1,na)
Electricity, medium voltage {TZ}| market for | Alloc Def, U		3.49301E-05 kWh	Lognormal	1.5154	(2,3,5,5,1,na)
Electricity, medium voltage {WECC, US only}| market for | Alloc Def, U		0.006512065 kWh	Lognormal	1.5154	(2,3,5,5,1,na)
Electricity, medium voltage {ZA}| market for | Alloc Def, U		0.001965847 kWh	Lognormal	1.5154	(2,3,5,5,1,na)
Electricity, medium voltage {RoW}| market for | Alloc Def, U		0.025231566 kWh	Lognormal	1.5154	(2,3,5,5,1,na)
Emissions to air					
Sulfur dioxide	high. pop.	0.00245 kg	Lognormal	1.5154	(2,3,5,5,1,na) , process emission average from finnish DB, SE-EPA and 1 site
Water/m3		0.023593 m3	Lognormal	1.7774	(2,2,5,5,1,na) Calculated value based on literature values and expert opinion. See comments in the parametres' comment field.

SimaPro Original Paper Production RoW

Nitrogen oxides	high. pop.	0.00143 kg	Lognormal	1.8415	(2,3,5,5,1,na) , process emission average from finnish DB, SE-EPA and 1 site
Emissions to water					
Suspended solids, unspecified	river	0.005099 kg	Lognormal	1.8415	(2,3,5,5,1,na) , average from finnish DB, SE-EPA and 1 site
Phosphorus	river	4E-05 kg	Lognormal	1.8415	(2,3,5,5,1,na) , average from finnish DB, SE-EPA and 1 site
DOC, Dissolved Organic Carbon	river	0.019775 kg	Lognormal	1.8415	(2,3,5,5,1,na) Calculated as equal to TOC.
Nitrogen	river	0.00051 kg	Lognormal	1.8415	(2,3,5,5,1,na) , average from finnish DB, SE-EPA and 1 site
COD, Chemical Oxygen Demand	river	0.053393 kg	Lognormal	1.8415	(2,3,5,5,1,na) , average from finnish DB, SE-EPA and 1 site
Sulfate	river	0.023497 kg	Lognormal	1.8415	(2,3,5,5,1,na) , average from finnish DB, SE-EPA and 1 site
Water, RoW		0.066396 m3	Lognormal	1.7774	(2,2,5,5,1,na) Calculated value based on literature values and expert opinion. See comments in the parametres' comment field.
BOD5, Biological Oxygen Demand	river	0.004209 kg	Lognormal	1.8415	(2,3,5,5,1,na) , average from finnish DB, SE-EPA and 1 site
AOX, Adsorbable Organic Halogen as Cl	river	0.0002 kg	Lognormal	1.8415	(2,3,5,5,1,na) , average from finnish DB, SE-EPA and 1 site
TOC, Total Organic Carbon	river	0.019775 kg	Lognormal	1.8415	(2,3,5,5,1,na) Calculated by default as TOC (gC) = COD/2.7 (COD measured in g O2). Should more correctly be calculated from the carbon content of the specified emissions to water.
Emissions to soil					
Final waste flows					
Non material emissions					
Social issues					
Economic issues					
Waste to treatment					
Input parameters					
Calculated parameters					

SimaPro Edit Paper Production ZA

SimaPro 8.0.2	process	Date:	2/12/2015	Time:	11:07 PM
Project	Digital vs Print LCA				

Process

Category type	material
Process identifier	FFLUCT7595335400028
Type	Unit process
Process name	sulfite pulp production, bleached RoW
Status	
Time period	Unspecified
Geography	Unspecified
Technology	Unspecified
Representativeness	Unspecified
Multiple output allocation	Unspecified
Substitution allocation	Unspecified
Cut off rules	Unspecified
Capital goods	Unspecified
Boundary with nature	Unspecified
Infrastructure	No
Date	10/22/2013
Record	data entry by: [System] support@ecoinvent.org is active author:
Generator	generated by: Roland Hischier roland.hischier@empa.ch Lerchenfeldstrasse 5, 9014 St-Gallen, Switzerland
Literature references	Ecoinvent 3 data published in: 2 Data has been published entirely in (refers to field 757) data published by: Life Cycle Inventories of Packaging and Graphical Paper 2007 Separate publication is copyright protected: true
Collection method	
Data treatment	extrapolations: This dataset has been copied from an original dataset covering the geography RER. The uncertainty has been adjusted accordingly.
Verification	
Comment	[This is a dataset automatically generated based on a dataset transferred from ecoSpold v1 / ecoinvent database version 2. It may not in all aspects fulfill the requirements of the ecoinvent data quality guideline for version 3.] Production volume: 1210197000 kg Included activities end: This module includes the production of bleached sulphite pulp - including transports to the pulp mill, wood handling, chemical pulping and bleaching, drying process, energy production on-site, recovery cycles of chemicals and internal waste water treatment. Energy values: Undefined (default) Geography: Data from a small European producer and from the finnish database used as European average data. Technology level: 3 Current (default) Technology: Mix of modern Ca-bisulphite and Mg-sulphite bleaching technology. Start date: 1997-01-01 End date: 2013-12-31 Is data valid for entire period: true Macro-economic scenario name: Business-as-Usual Version: 3.0.109.1 Created: 2010-07-28T18:26:09 Source: 05aec00c-fe17-43b4-b182-9815f4d56df8_23ff52d3-06a2-4d3a-8039-cfeb12f7cb9a.spold Link: https://ecoquery.ecoinvent.org/Details/UPR/D66AC690-44D5-45DF-8B05-EABD0CC8A052/06590A66-662A-4885-8494-AD0CF410F956
Allocation rules	
System description	Ecoinvent v3.01

Products

Sulfite pulp, bleached {ZA}| production | Al	1 kg	100	Paper	Paper+ Board\Pulp\Transformation

Avoided products

SimaPro Edit Paper Production ZA

Resources					
Water, cooling, unspecified natural origin,	0.017498	m3	Lognormal	1.5861	(2,3,5,5,1,na) , based on filled in questionnaire from 1 site
Water, unspecified natural origin, ZA	0.07249	m3	Lognormal	1.5957	Calculated based on literature (Byers, W., 2003, Industrial Water Management, Fibria, 2010, Sustainability Report_pulp from eucalyptus), (Vionnet, S., Quantis Water Database - Technical Report, 2012). It includes the main processes: wood washing and screening, evaporation, recausticizing, bleach plant chemical preparation and pulp dryer. (3,3,5,5,1,na) , average from finnish DB, SE-EPA and 1 site Calculated based on literature (Byers, W., 2003, Industrial Water Management, Fibria, 2010, Sustainability Report_pulp from eucalyptus), (Vionnet, S., Quantis Water Database - Technical Report, 2012). It includes the main processes: wood washing and screening, evaporation, recausticizing, bleach plant chemical preparation and pulp dryer.
Materials/fuels					
Waste plastic, mixture {GLO}| market for |	-0.007559004	kg	Lognormal	1.5154	(2,3,5,5,1,na) , average Swedish data from SE-EPA report
Municipal solid waste {GLO}| market for | A	-0.003799499	kg	Lognormal	1.5154	Production Volume Amount: 9149089.32 (2,3,5,5,1,na) , average Swedish data from SE-EPA report
Oxygen, liquid {GLO}| market for | Alloc De	0.011898432	kg	Lognormal	1.5154	Production Volume Amount: 4598748.6 (2,3,5,5,1,na) , average from finnish DB, SE-EPA and 1 site
Scrap steel {GLO}| market for | Alloc Def, U	-0.000839889	kg	Lognormal	1.5154	(2,3,5,5,1,na) , average Swedish data from SE-EPA report
Sodium hydroxide, without water, in 50% s	0.042394414	kg	Lognormal	1.5154	Production Volume Amount: 1016565.48 (2,3,5,5,1,na) , average from finnish DB, SE-EPA and 1 site
Sludge from pulp and paper production {G	-0.01039863	kg	Lognormal	1.5154	(2,3,5,5,1,na) , average Swedish data from SE-EPA report
Magnesium oxide {GLO}| market for | Alloc	0.006499144	kg	Lognormal	1.5154	Production Volume Amount: 12586048.8 (2,3,5,5,1,na) , average from finnish DB, SE-EPA and 1 site
Waste graphical paper {GLO}| market for |	-0.002399684	kg	Lognormal	1.5154	(2,3,5,5,1,na) , average Swedish data from SE-EPA report
Diesel {RoW}| market for | Alloc Def, U	0.000239968	kg	Lognormal	1.5154	Production Volume Amount: 2904472.8 (2,3,5,5,1,na) , average from finnish DB, SE-EPA and 1 site
Hydrogen peroxide, without water, in 50%	0.025696614	kg	Lognormal	1.5154	(2,3,5,5,1,na) , average from finnish DB, SE-EPA and 1 site
Chlorine dioxide {GLO}| market for | Alloc I	0.001599789	kg	Lognormal	1.5154	(2,3,5,5,1,na) , average from finnish DB, SE-EPA and 1 site
Sulfur dioxide, liquid {GLO}| market for | Al	0.026796469	kg	Lognormal	1.5154	(2,3,5,5,1,na) , average from finnish DB, SE-EPA and 1 site
Waste textile, soiled {GLO}| market for | Al	-0.000779897	kg	Lognormal	1.5154	(2,3,5,5,1,na) , average Swedish data from SE-EPA report
Sodium chlorate, powder {GLO}| market fo	0.000599921	kg	Lognormal	1.5154	Production Volume Amount: 943953.66 (2,3,5,5,1,na) , average from finnish DB, SE-EPA and 1 site
Pulp factory {GLO}| market for | Alloc Def,	4.99934E-11	p	Lognormal	3.8139	(4,5,5,5,5,na) (4,na,na,na,na,na), assumption
Pulpwood, hardwood, measured as solid w	0.000793895	m3	Lognormal	1.5154	(2,3,5,5,1,na) , average from finnish DB, SE-EPA and 1 site
Lime {GLO}| market for | Alloc Def, U	0.052093136	kg	Lognormal	1.5154	(2,3,5,5,1,na) , average from finnish DB, SE-EPA and 1 site
Wood ash mixture, pure {GLO}| market for	-0.044694111	kg	Lognormal	1.5154	(2,3,5,5,1,na) , average Swedish data from SE-EPA report
Waste wood, untreated {GLO}| market for	-0.000419945	kg	Lognormal	1.5154	Production Volume Amount: 54095805.9 (2,3,5,5,1,na) , average Swedish data from SE-EPA report
Green liquor dregs {GLO}| market for | Allo	-0.003599526	kg	Lognormal	1.5154	Production Volume Amount: 508282.74 (2,3,5,5,1,na) , average Swedish data from SE-EPA report
Sulfuric acid {GLO}| market for | Alloc Def,	0.000399947	kg	Lognormal	1.5154	Production Volume Amount: 4356709.2 (2,3,5,5,1,na) , average from finnish DB, SE-EPA and 1 site
Ash from paper production sludge {GLO}|	-0.002939613	kg	Lognormal	1.5154	(2,3,5,5,1,na) , average Swedish data from SE-EPA report
Sulfur {GLO}| market for | Alloc Def, U	0.025596627	kg	Lognormal	1.5154	Production Volume Amount: 3557979.18 (2,3,5,5,1,na) , average from finnish DB, SE-EPA and 1 site
Pulpwood, hardwood, measured as solid w	0.003439547	m3	Lognormal	1.5154	(2,3,5,5,1,na) , average from finnish DB, SE-EPA and 1 site
Electricity/heat					
Heat, district or industrial, other than natura	12.49740031	MJ	Lognormal	1.5154	(2,3,5,5,1,na)

SimaPro Edit Paper Production ZA

						, average from finnish DB, SE-EPA and 1 site
Electricity, medium voltage {ASCC}| marke		0	kWh	Lognormal	1.5154	(2,3,5,5,1,na)
Electricity, medium voltage {AU}| market fo		0	kWh	Lognormal	1.5154	(2,3,5,5,1,na)
Electricity, medium voltage {BR}| market fo		0	kWh	Lognormal	1.5154	(2,3,5,5,1,na)
Electricity, medium voltage {CA-AB}| mark		0	kWh	Lognormal	1.5154	(2,3,5,5,1,na)
Electricity, medium voltage {CA-BC}| mark		0	kWh	Lognormal	1.5154	(2,3,5,5,1,na)
Electricity, medium voltage {CA-MB}| mark		0	kWh	Lognormal	1.5154	(2,3,5,5,1,na)
Electricity, medium voltage {CA-NB}| mark		0	kWh	Lognormal	1.5154	(2,3,5,5,1,na)
Electricity, medium voltage {CA-NF}| mark		0	kWh	Lognormal	1.5154	(2,3,5,5,1,na)
Electricity, medium voltage {CA-NS}| mark		0	kWh	Lognormal	1.5154	(2,3,5,5,1,na)
Electricity, medium voltage {CA-NT}| mark		0	kWh	Lognormal	1.5154	(2,3,5,5,1,na)
Electricity, medium voltage {CA-NU}| mark		0	kWh	Lognormal	1.5154	(2,3,5,5,1,na)
Electricity, medium voltage {CA-ON}| mark		0	kWh	Lognormal	1.5154	(2,3,5,5,1,na)
Electricity, medium voltage {CA-PE}| mark		0	kWh	Lognormal	1.5154	(2,3,5,5,1,na)
Electricity, medium voltage {CA-SK}| mark		0	kWh	Lognormal	1.5154	(2,3,5,5,1,na)
Electricity, medium voltage {CA-YK}| mark		0	kWh	Lognormal	1.5154	(2,3,5,5,1,na)
Electricity, medium voltage {CL}| market fo		0	kWh	Lognormal	1.5154	(2,3,5,5,1,na)
Electricity, medium voltage {CN}| market fo		0	kWh	Lognormal	1.5154	(2,3,5,5,1,na)
Electricity, medium voltage {FRCC}| marke		0	kWh	Lognormal	1.5154	(2,3,5,5,1,na)
Electricity, medium voltage {HICC}| marke		0	kWh	Lognormal	1.5154	(2,3,5,5,1,na)
Electricity, medium voltage {ID}| market fo		0	kWh	Lognormal	1.5154	(2,3,5,5,1,na)
Electricity, medium voltage {IN}| market fo		0	kWh	Lognormal	1.5154	(2,3,5,5,1,na)
Electricity, medium voltage {IR}| market fo		0	kWh	Lognormal	1.5154	(2,3,5,5,1,na)
Electricity, medium voltage {JP}| market fo		0	kWh	Lognormal	1.5154	(2,3,5,5,1,na)
Electricity, medium voltage {KR}| market fo		0	kWh	Lognormal	1.5154	(2,3,5,5,1,na)
Electricity, medium voltage {MRO, US only		0	kWh	Lognormal	1.5154	(2,3,5,5,1,na)
Electricity, medium voltage {MX}| market fo		0	kWh	Lognormal	1.5154	(2,3,5,5,1,na)
Electricity, medium voltage {MY}| market fo		0	kWh	Lognormal	1.5154	(2,3,5,5,1,na)
Electricity, medium voltage {NPCC, US on		0	kWh	Lognormal	1.5154	(2,3,5,5,1,na)
Electricity, medium voltage {PE}| market fo		0	kWh	Lognormal	1.5154	(2,3,5,5,1,na)
Electricity, medium voltage {Quebec}| mar		0	kWh	Lognormal	1.5154	(2,3,5,5,1,na)
Electricity, medium voltage {RFC}| market		0	kWh	Lognormal	1.5154	(2,3,5,5,1,na)
Electricity, medium voltage {RU}| market fo		0	kWh	Lognormal	1.5154	(2,3,5,5,1,na)
Electricity, medium voltage {SA}| market fo		0	kWh	Lognormal	1.5154	(2,3,5,5,1,na)
Electricity, medium voltage {SERC}| marke		0	kWh	Lognormal	1.5154	(2,3,5,5,1,na)
Electricity, medium voltage {SPP}| market		0	kWh	Lognormal	1.5154	(2,3,5,5,1,na)
Electricity, medium voltage {TH}| market fo		0	kWh	Lognormal	1.5154	(2,3,5,5,1,na)
Electricity, medium voltage {TR}| market fo		0	kWh	Lognormal	1.5154	(2,3,5,5,1,na)
Electricity, medium voltage {TRE}| market		0	kWh	Lognormal	1.5154	(2,3,5,5,1,na)
Electricity, medium voltage {TW}| market f		0	kWh	Lognormal	1.5154	(2,3,5,5,1,na)
Electricity, medium voltage {TZ}| market fo		0	kWh	Lognormal	1.5154	(2,3,5,5,1,na)
Electricity, medium voltage {WECC, US or		0	kWh	Lognormal	1.5154	(2,3,5,5,1,na)
Electricity, medium voltage {ZA}| market fo		0.139981556	kWh	Lognormal	1.5154	(2,3,5,5,1,na)
Electricity, medium voltage {RoW}| market		0	kWh	Lognormal	1.5154	(2,3,5,5,1,na)
Emissions to air						
Sulfur dioxide	high. pop.	0.00245	kg	Lognormal	1.5154	(2,3,5,5,1,na) , process emission average from finnish DB, SE-EPA and 1 site
Water/m3		0.023593	m3	Lognormal	1.7774	(2,2,5,5,1,na) Calculated value based on literature values and expert opinion. See comments in the parametres' comment field.
Nitrogen oxides	high. pop.	0.00143	kg	Lognormal	1.8415	(2,3,5,5,1,na) , process emission average from finnish DB, SE-EPA and 1 site
Emissions to water						
Suspended solids, unspecified	river	0.005099	kg	Lognormal	1.8415	(2,3,5,5,1,na) , average from finnish DB, SE-EPA and 1 site
Phosphorus	river	4E-05	kg	Lognormal	1.8415	(2,3,5,5,1,na) , average from finnish DB, SE-EPA and 1 site
DOC, Dissolved Organic Carbon	river	0.019775	kg	Lognormal	1.8415	(2,3,5,5,1,na) Calculated as equal to TOC.
Nitrogen	river	0.00051	kg	Lognormal	1.8415	(2,3,5,5,1,na) , average from finnish DB, SE-EPA and 1 site
COD, Chemical Oxygen Demand	river	0.053393	kg	Lognormal	1.8415	(2,3,5,5,1,na) , average from finnish DB, SE-EPA and 1 site
Sulfate	river	0.023497	kg	Lognormal	1.8415	(2,3,5,5,1,na) , average from finnish DB, SE-EPA and 1 site
Water, RoW		0.066396	m3	Lognormal	1.7774	(2,2,5,5,1,na) Calculated value based on literature values and expert opinion. See comments in the parametres' comment field.
BOD5, Biological Oxygen Demand	river	0.004209	kg	Lognormal	1.8415	(2,3,5,5,1,na) , average from finnish DB, SE-EPA and 1 site
AOX, Adsorbable Organic Halogen as Cl	river	0.0002	kg	Lognormal	1.8415	(2,3,5,5,1,na) , average from finnish DB, SE-EPA and 1 site
TOC, Total Organic Carbon	river	0.019775	kg	Lognormal	1.8415	(2,3,5,5,1,na) Calculated by default as TOC (gC) = COD/2.7 (COD measured in g O2). Should more correctly be calculated from the carbon content of the specified emissions to water.
Emissions to soil						
Final waste flows						
Non material emissions						
Social issues						
Economic issues						

SimaPro Edit Paper Production ZA
Waste to treatment

Input parameters

Calculated parameters

SimaPro Original Paper Production RoW

SimaPro 8.0.2	process	Date:	2/12/2015	Time:	11:09 PM
Project	Digital vs Print LCA				

Process

Category type	material
Process identifier	EI3ADUNI61667503114
Type	Unit process
Process name	paper production, woodfree, coated, at non-integrated mill RoW
Status	
Time period	Unspecified
Geography	Unspecified
Technology	Unspecified
Representativeness	Unspecified
Multiple output allocation	Unspecified
Substitution allocation	Unspecified
Cut off rules	Unspecified
Capital goods	Unspecified
Boundary with nature	Unspecified
Infrastructure	No
Date	10/22/2013
Record	data entry by: [System] support@ecoinvent.org is active author: generated by: Roland Hischier roland.hischier@empa.ch Lerchenfeldstrasse 5, 9014 St-Gallen,
Generator	Switzerland
Literature references	Ecoinvent 3 data published in: 2 Data has been published entirely in (refers to field 757) data published by: Life Cycle Inventories of Packaging and Graphical Paper 2007 Separate publication is copyright protected: true
Collection method	
Data treatment	extrapolations: This dataset has been copied from an original dataset covering the geography RER. The uncertainty has been adjusted accordingly.
Verification	
Comment	[This is a dataset automatically generated based on a dataset transferred from ecoSpold v1 / ecoinvent database version 2. It may not in all aspects fulfill the requirements of the ecoinvent data quality guideline for version 3.] Production volume: 6677485500 kg Included activities end: This module includes the European production of coated woodfree paper in a non-integrated mill - including transports to paper mill, pulp preparation, paper production, energy production on-site and internal waste water treatment. Energy values: Undefined (default) Geography: Data from several European fine paper producers used as European average data. Technology level: 3 Current (default) Technology: Average of present used technology Start date: 2000-01-01 End date: 2013-12-31 Is data valid for entire period: true Macro-economic scenario name: Business-as-Usual Version: 3.0.109.1 Created: 2010-07-28T18:25:53 Source: d3437a17-7d9a-4e4a-9eba-45eacefa7707_931288b5-8b40-4393-8421-f715faf39712.spold Link: https://ecoquery.ecoinvent.org/Details/UPR/6EC2E91F-B8D4-4C6B-8105-07A8649021A2/06590A66-662A-4885-8494-AD0CF410F956
Allocation rules	
System description	Ecoinvent v3.01

SimaPro Original Paper Production RoW

Products							
Paper, woodfree, coated {RoW}| paper production, woodfree, coated, at non-integrated mill | Alloc Def, U		1	kg		100	Paper+ Board\Graphic paper\Transformation	
Avoided products							
Resources							
Water, unspecified natural origin, RoW	in water	0.0084	m3		Lognormal	1.511	(1,3,5,5,1,na) , average from several european fine paper producers
Water, cooling, unspecified natural origin, RoW	in water	0.0124	m3		Lognormal	1.511	(1,3,5,5,1,na) , average from several european fine paper producers
Materials/fuels							
Kaolin {GLO}| market for | Alloc Def, U		0.202345244	kg	Lognormal	1.5212		(1,4,5,5,1,na) , information from one fine paper producer
Ash from paper production sludge {GLO}| market for | Alloc Def, U		-0.001339955	kg	Lognormal	1.511		(1,3,5,5,1,na) , average from several european fine paper producers Production Volume Amount: 8947830.57
Paper mill, non-integrated {GLO}| market for | Alloc Def, U		5.43982E-11	p	Lognormal	3.8139		(4,5,5,5,5,na) (4,na,na,na,na,na), own assumption
Chemical, inorganic {GLO}| market for chemicals, inorganic | Alloc Def, U		0.037198758	kg	Lognormal	1.5212		(1,4,5,5,1,na) , information from one fine paper producer
Optical brighteners, for paper production {GLO}| market for | Alloc Def, U		0.004839838	kg	Lognormal	1.5212		(1,4,5,5,1,na) , information from one fine paper producer
Municipal solid waste {GLO}| market for | Alloc Def, U		-0.001559948	kg	Lognormal	1.511		(1,3,5,5,1,na) , average from several european fine paper producers Production Volume Amount: 10416877.38
Sulfate pulp {GLO}| market for | Alloc Def, U		0.542981872	kg	Lognormal	1.511		(1,3,5,5,1,na) , average from several european fine paper producers
Potato starch {GLO}| market for | Alloc Def, U		0.039698675	kg	Lognormal	1.5212		(1,4,5,5,1,na) , information from one fine paper producer
Alkylketene dimer sizing agent, for paper production {GLO}| market for | Alloc Def, U		0.004339855	kg	Lognormal	1.5212		(1,4,5,5,1,na) , information from one fine paper producer
Lime {GLO}| market for | Alloc Def, U		0.202393243	kg	Lognormal	1.5212		(1,4,5,5,1,na) , information from one fine paper producer
Malusil {GLO}| market for | Alloc Def, U		4.79984E-05	kg	Lognormal	1.5212		(1,4,5,5,1,na)
Sludge from pulp and paper production {GLO}| market for | Alloc Def, U		-0.004729842	kg	Lognormal	1.511		(1,3,5,5,1,na) , average from several european fine paper producers Production Volume Amount: 31584506.415
Chemical, organic {GLO}| market for | Alloc Def, U		0.007419752	kg	Lognormal	1.5212		(1,4,5,5,1,na) , information from one fine paper producer
Hazardous waste, for underground deposit {GLO}| market for | Alloc Def, U		-0.000159995	kg	Lognormal	1.511		(1,3,5,5,1,na) , average from several european fine paper producers Production Volume Amount: 1068397.68

SimaPro Original Paper Production RoW

Electricity/heat				
Heat, district or industrial, natural gas {RoW}| market for heat, district or industrial, natural gas | Alloc Def, U	3.191893434 MJ	Lognormal	1.511	(1,3,5,5,1,na) , average from several european fine paper producers
Heat, district or industrial, other than natural gas {RoW}| market for | Alloc Def, U	0.245091817 MJ	Lognormal	1.511	(1,3,5,5,1,na) , average from several european fine paper producers
Electricity, medium voltage {ASCC}| market for | Alloc Def, U	0.00017563 kWh	Lognormal	1.511	(1,3,5,5,1,na)
Electricity, medium voltage {AU}| market for | Alloc Def, U	0.0059255 kWh	Lognormal	1.511	(1,3,5,5,1,na)
Electricity, medium voltage {BR}| market for | Alloc Def, U	0.011578133 kWh	Lognormal	1.511	(1,3,5,5,1,na)
Electricity, medium voltage {CA-AB}| market for | Alloc Def, U	0.000837474 kWh	Lognormal	1.511	(1,3,5,5,1,na)
Electricity, medium voltage {CA-BC}| market for | Alloc Def, U	0.001849864 kWh	Lognormal	1.511	(1,3,5,5,1,na)
Electricity, medium voltage {CA-MB}| market for | Alloc Def, U	0.001073345 kWh	Lognormal	1.511	(1,3,5,5,1,na)
Electricity, medium voltage {CA-NB}| market for | Alloc Def, U	0.000628106 kWh	Lognormal	1.511	(1,3,5,5,1,na)
Electricity, medium voltage {CA-NF}| market for | Alloc Def, U	0.001261512 kWh	Lognormal	1.511	(1,3,5,5,1,na)
Electricity, medium voltage {CA-NS}| market for | Alloc Def, U	0.000771218 kWh	Lognormal	1.511	(1,3,5,5,1,na)
Electricity, medium voltage {CA-NT}| market for | Alloc Def, U	1.182E-05 kWh	Lognormal	1.511	(1,3,5,5,1,na)
Electricity, medium voltage {CA-NU}| market for | Alloc Def, U	4.92944E-06 kWh	Lognormal	1.511	(1,3,5,5,1,na)
Electricity, medium voltage {CA-ON}| market for | Alloc Def, U	0.004637911 kWh	Lognormal	1.511	(1,3,5,5,1,na)
Electricity, medium voltage {CA-PE}| market for | Alloc Def, U	1.46028E-06 kWh	Lognormal	1.511	(1,3,5,5,1,na)
Electricity, medium voltage {CA-SK}| market for | Alloc Def, U	0.000318028 kWh	Lognormal	1.511	(1,3,5,5,1,na)
Electricity, medium voltage {CA-YK}| market for | Alloc Def, U	1.129E-05 kWh	Lognormal	1.511	(1,3,5,5,1,na)
Electricity, medium voltage {CL}| market for | Alloc Def, U	0.001452117 kWh	Lognormal	1.511	(1,3,5,5,1,na)
Electricity, medium voltage {CN}| market for | Alloc Def, U	0.078806846 kWh	Lognormal	1.511	(1,3,5,5,1,na)
Electricity, medium voltage {FRCC}| market for | Alloc Def, U	0.005380381 kWh	Lognormal	1.511	(1,3,5,5,1,na)
Electricity, medium voltage {HICC}| market for | Alloc Def, U	0.000278258 kWh	Lognormal	1.511	(1,3,5,5,1,na)
Electricity, medium voltage {ID}| market for | Alloc Def, U	0.003507214 kWh	Lognormal	1.511	(1,3,5,5,1,na)
Electricity, medium voltage {IN}| market for | Alloc Def, U	0.018768474 kWh	Lognormal	1.511	(1,3,5,5,1,na)
Electricity, medium voltage {IR}| market for | Alloc Def, U	0.004787384 kWh	Lognormal	1.511	(1,3,5,5,1,na)
Electricity, medium voltage {JP}| market for | Alloc Def, U	0.025610701 kWh	Lognormal	1.511	(1,3,5,5,1,na)
Electricity, medium voltage {KR}| market for | Alloc Def, U	0.010655003 kWh	Lognormal	1.511	(1,3,5,5,1,na)
Electricity, medium voltage {MRO, US only}| market for | Alloc Def, U	0.005756787 kWh	Lognormal	1.511	(1,3,5,5,1,na)
Electricity, medium voltage {MX}| market for | Alloc Def, U	0.005917444 kWh	Lognormal	1.511	(1,3,5,5,1,na)
Electricity, medium voltage {MY}| market for | Alloc Def, U	0.002601682 kWh	Lognormal	1.511	(1,3,5,5,1,na)

SimaPro Original Paper Production RoW

Electricity, medium voltage {NPCC, US only}| market for | Alloc Def, U		0.00673024	kWh	Lognormal	1.511	(1,3,5,5,1,na)
Electricity, medium voltage {PE}| market for | Alloc Def, U		0.000782985	kWh	Lognormal	1.511	(1,3,5,5,1,na)
Electricity, medium voltage {Quebec}| market for | Alloc Def, U		0.004028357	kWh	Lognormal	1.511	(1,3,5,5,1,na)
Electricity, medium voltage {RFC}| market for | Alloc Def, U		0.023740241	kWh	Lognormal	1.511	(1,3,5,5,1,na)
Electricity, medium voltage {RU}| market for | Alloc Def, U		0.023078667	kWh	Lognormal	1.511	(1,3,5,5,1,na)
Electricity, medium voltage {SA}| market for | Alloc Def, U		0.004872403	kWh	Lognormal	1.511	(1,3,5,5,1,na)
Electricity, medium voltage {SERC}| market for | Alloc Def, U		0.027742322	kWh	Lognormal	1.511	(1,3,5,5,1,na)
Electricity, medium voltage {SPP}| market for | Alloc Def, U		0.005375093	kWh	Lognormal	1.511	(1,3,5,5,1,na)
Electricity, medium voltage {TH}| market for | Alloc Def, U		0.003578453	kWh	Lognormal	1.511	(1,3,5,5,1,na)
Electricity, medium voltage {TR}| market for | Alloc Def, U		0.004527237	kWh	Lognormal	1.511	(1,3,5,5,1,na)
Electricity, medium voltage {TRE}| market for | Alloc Def, U		0.008812827	kWh	Lognormal	1.511	(1,3,5,5,1,na)
Electricity, medium voltage {TW}| market for | Alloc Def, U		0.00557991	kWh	Lognormal	1.511	(1,3,5,5,1,na)
Electricity, medium voltage {TZ}| market for | Alloc Def, U		0.000102405	kWh	Lognormal	1.511	(1,3,5,5,1,na)
Electricity, medium voltage {WECC, US only}| market for | Alloc Def, U		0.019091533	kWh	Lognormal	1.511	(1,3,5,5,1,na)
Electricity, medium voltage {ZA}| market for | Alloc Def, U		0.005763306	kWh	Lognormal	1.511	(1,3,5,5,1,na)
Electricity, medium voltage {RoW}| market for | Alloc Def, U		0.073971809	kWh	Lognormal	1.511	(1,3,5,5,1,na)
Emissions to air						
Water/m3		0.006065	m3	Lognormal	1.7774	(2,2,5,5,1,na) Calculated value based on literature values and expert opinion. See comments in the parametres' comment field.
Emissions to water						
Suspended solids, unspecified	river	0.00011	kg	Lognormal	1.7768	(1,3,5,5,1,na) , average from several european fine paper producers
Water, RoW		0.014735	m3	Lognormal	1.7774	(2,2,5,5,1,na) Calculated value based on literature values and expert opinion. See comments in the parametres' comment field.
DOC, Dissolved Organic Carbon	river	0.000637	kg	Lognormal	1.7768	(1,3,5,5,1,na) Calculated as equal to TOC.
TOC, Total Organic Carbon	river	0.000637	kg	Lognormal	1.7768	(1,3,5,5,1,na) Calculated by default as TOC (gC) = COD/2.7 (COD measured in g O2). Should more correctly be calculated from the carbon content of the specified emissions to water.
Phosphorus	river	5.1E-06	kg	Lognormal	1.7768	(1,3,5,5,1,na) , average from several european fine paper producers
Nitrogen	river	4E-05	kg	Lognormal	1.7768	(1,3,5,5,1,na) , average from several european fine paper producers
BOD5, Biological Oxygen Demand	river	0.00047	kg	Lognormal	1.7768	(1,3,5,5,1,na) , average from several european fine paper producers
COD, Chemical Oxygen Demand	river	0.00172	kg	Lognormal	1.7768	(1,3,5,5,1,na)

SimaPro Original Paper Production RoW

, average from several european fine paper producers

Emissions to soil

Final waste flows

Non material emissions

Social issues

Economic issues

Waste to treatment

Input parameters

Calculated parameters

SimaPro Edit Paper Production ZA

SimaPro 8.0.2	process	Date:	2/12/2015	Time:	11:09 PM
Project	Digital vs Print LCA				

Process

Category type	material
Process identifier	FFLUCT7595335400030
Type	Unit process
Process name	paper production, woodfree, coated, at integrated mill RoW
Status	
Time period	Unspecified
Geography	Unspecified
Technology	Unspecified
Representativeness	Unspecified
Multiple output allocation	Unspecified
Substitution allocation	Unspecified
Cut off rules	Unspecified
Capital goods	Unspecified
Boundary with nature	Unspecified
Infrastructure	No
Date	10/22/2013
Record	data entry by: [System] support@ecoinvent.org is active author:
Generator	generated by: Roland Hischier roland.hischier@empa.ch Lerchenfeldstrasse 5, 9014 St-Gallen, Switzerland
Literature references	Ecoinvent 3 data published in: 2 Data has been published entirely in (refers to field 757) data published by: Life Cycle Inventories of Packaging and Graphical Paper 2007 Separate publication is copyright protected: true
Collection method	
Data treatment	extrapolations: This dataset has been copied from an original dataset covering the geography RER. The uncertainty has been adjusted accordingly.
Verification	
Comment	[This is a dataset automatically generated based on a dataset transferred from ecoSpold v1 / ecoinvent database version 2. It may not in all aspects fulfill the requirements of the ecoinvent data quality guideline for version 3.] Production volume: 6077485500 kg Included activities end: This module includes the European production of coated woodfree paper in an integrated paper mill - including transports to paper mill, wood handling, chemical pulping and bleaching, paper production, energy production on-site, recovery cycles of chemicals and internal waste water treatment. Energy values: Undefined (default) Geography: Data from a finnish database and from several European fine paper producers used as European average data. Technology level: 3 Current (default) Technology: Average of present used technology Start date: 2000-01-01 End date: 2013-12-31 Is data valid for entire period: true Macro-economic scenario name: Business-as-Usual Version: 3.0.97.1 Created: 2010-07-28T18:25:52 Source: 6b9918af-725b-4d14-a1c6-743734f42127_931288b5-8b40-4393-8421-f715faf39712.spold Link: https://ecoquery.ecoinvent.org/Details/UPR/6EC2E91F-B8D4-4C6B-8105-07A8649021A2/06590A66-662A-4885-8494-AD0CF410F956
Allocation rules	
System description	Ecoinvent v3.01

SimaPro Edit Paper Production ZA

Products

Paper, woodfree, coated {ZA}| paper production, woodfree, coated, at integrated mill | Alloc Def, U	1 kg		100 Paper	Paper+ Board\Graphic paper\Transformation	
Avoided products					
Resources					
Water, unspecified natural origin, ZA	0.05236593 m3	Lognormal	1.511		(1,3,5,5,1,na) , average from finnish database and several companies
Water, cooling, unspecified natural origin, ZA	0.056263395 m3	Lognormal	1.511		(1,3,5,5,1,na) , average from several european fine paper producers
Materials/fuels					
Carbon dioxide, liquid {GLO}| market for | Alloc Def, U	0.001089291 kg	Lognormal	1.5957		(2,4,5,5,1,na) , average data from finnish database
Municipal solid waste {GLO}| market for | Alloc Def, U	-0.030380234 kg	Lognormal	1.511		(1,3,5,5,1,na) , average from finnish database and several companies Production Volume Amount: 184755559.2
Pulpwood, hardwood, measured as solid wood under bark {ZA}| market for | Alloc Def, U	0.001043321 m3	Lognormal	1.511		(1,3,5,5,1,na) , average from several european fine paper producers
Sulfuric acid {GLO}| market for | Alloc Def, U	0.016489272 kg	Lognormal	1.5957		(2,4,5,5,1,na) , average data from finnish database
Chemical, organic {GLO}| market for | Alloc Def, U	0.00262829 kg	Lognormal	1.5957		(2,4,5,5,1,na) , average data from finnish database
Quicklime, milled, loose {GLO}| market for | Alloc Def, U	0.004716931 kg	Lognormal	1.5957		(2,4,5,5,1,na) , average data from finnish database
Heavy fuel oil {RoW}| market for | Alloc Def, U	0.02788186 kg	Lognormal	1.511		(1,3,5,5,1,na) , average from finnish database and several companies
Kaolin {GLO}| market for | Alloc Def, U	0.171888168 kg	Lognormal	1.511		(1,3,5,5,1,na) , average from several european fine paper producers
Magnesium sulfate {GLO}| market for | Alloc Def, U	0.002338479 kg	Lognormal	1.5957		(2,4,5,5,1,na) , average data from finnish database
Hydrogen peroxide, without water, in 50% solution state {GLO}| market for | Alloc Def, U	0.004007393 kg	Lognormal	1.5957		(2,4,5,5,1,na) , average data from finnish database
Sodium hydroxide, without water, in 50% solution state {GLO}| market for | Alloc Def, U	0.020586606 kg	Lognormal	1.5957		(2,4,5,5,1,na) , average data from finnish database
Alkylketene dimer sizing agent, for paper production {GLO}| market for | Alloc Def, U	0.002128615 kg	Lognormal	1.5957		(2,4,5,5,1,na) , average data from finnish database
Optical brighteners, for paper production {GLO}| market for | Alloc Def, U	0.0019987 kg	Lognormal	1.5957		(2,4,5,5,1,na) , average data from finnish database
Sodium chlorate, powder {GLO}| market for | Alloc Def, U	0.013691092 kg	Lognormal	1.5957		(2,4,5,5,1,na) , average data from finnish database
Wood ash mixture, pure {GLO}| market for | Alloc Def, U	-0.003447757 kg	Lognormal	1.511		(1,3,5,5,1,na) , average from finnish database and several companies Production Volume Amount: 20967324.975
Nitrogen, liquid {GLO}| market for | Alloc Def, U	0.000119922 kg	Lognormal	1.5957		(2,4,5,5,1,na) , average data from finnish database
Sulfite pulp, bleached {ZA}| market for | Alloc Def, U	0.029580754 kg	Lognormal	1.511		(1,3,5,5,1,na) , average from several european fine paper producers
Sodium chloride, powder {GLO}| market for | Alloc Def, U	0.000219857 kg	Lognormal	1.5957		(2,4,5,5,1,na) , average data from finnish database
Lime {GLO}| market for | Alloc Def, U	0.171888168 kg	Lognormal	1.511		(1,3,5,5,1,na) , average from several european fine paper producers
Potato starch {GLO}| market for | Alloc Def, U	0.015190117 kg	Lognormal	1.5957		(2,4,5,5,1,na) , average data from finnish database
Latex {GLO}| market for | Alloc Def, U	0.040973342 kg	Lognormal	1.5957		(2,4,5,5,1,na) , average data from finnish database
Methanol {GLO}| market for | Alloc Def, U	0.001189226 kg	Lognormal	1.5957		(2,4,5,5,1,na) , average data from finnish database
Hazardous waste, for underground deposit {GLO}| market for | Alloc Def, U	-3.9974E-05 kg	Lognormal	1.511		(1,3,5,5,1,na) , average from finnish database and several companies Production Volume Amount: 243099.42

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Oxygen, liquid {GLO}| market for | Alloc Def, U	0.012891613 kg	Lognormal	1.5957	(2,4,5,5,1,na) , average data from finnish database
Paper mill, integrated {GLO}| market for | Alloc Def, U	5.43646E-11 p	Lognormal	3.8139	(4,5,5,5,5,na) (4,na,na,na,na,na), own assumption
Pulpwood, hardwood, measured as solid wood under bark {ZA}| market for | Alloc Def, U	0.001559985 m3	Lognormal	1.511	(1,3,5,5,1,na) , average from several european fine paper producers
Pulpwood, hardwood, measured as solid wood under bark {ZA}| market for | Alloc Def, U	0.000205067 m3	Lognormal	1.511	(1,3,5,5,1,na) , average from several european fine paper producers
Carboxymethyl cellulose, powder {GLO}| market for | Alloc Def, U	0.00219857 kg	Lognormal	1.5957	(2,4,5,5,1,na) , average data from finnish database
Sulfur dioxide, liquid {GLO}| market for | Alloc Def, U	0.001089291 kg	Lognormal	1.5957	(2,4,5,5,1,na) , average data from finnish database
Hard coal {AU}| market for | Alloc Def, U	0 kg	Lognormal	1.511	(1,3,5,5,1,na)
Hard coal {CN}| market for | Alloc Def, U	0 kg	Lognormal	1.511	(1,3,5,5,1,na)
Hard coal {ID}| market for | Alloc Def, U	0 kg	Lognormal	1.511	(1,3,5,5,1,na)
Hard coal {RLA}| market for | Alloc Def, U	0 kg	Lognormal	1.511	(1,3,5,5,1,na)
Hard coal {RNA}| market for | Alloc Def, U	0 kg	Lognormal	1.511	(1,3,5,5,1,na)
Hard coal {RU}| market for | Alloc Def, U	0 kg	Lognormal	1.511	(1,3,5,5,1,na)
Hard coal {ZA}| market for | Alloc Def, U	0.008434512 kg	Lognormal	1.511	(1,3,5,5,1,na)
Hard coal {RoW}| market for | Alloc Def, U	0 kg	Lognormal	1.511	(1,3,5,5,1,na)
Natural gas, high pressure {JP}| market for | Alloc Def, U	0.001244216 m3	Lognormal	1.511	(1,3,5,5,1,na)
Natural gas, high pressure {RNA}| market for | Alloc Def, U	0.009029518 m3	Lognormal	1.511	(1,3,5,5,1,na)
Natural gas, high pressure {RoW}| market for | Alloc Def, U	0.036875078 m3	Lognormal	1.511	(1,3,5,5,1,na)
Electricity/heat				
Lignite briquettes {GLO}| market for | Alloc Def, U	1.628940196 MJ	Lognormal	1.511	(1,3,5,5,1,na) , average from finnish database and several companies
Electricity, medium voltage {ASCC}| market for | Alloc Def, U	0 kWh	Lognormal	1.511	(1,3,5,5,1,na)
Electricity, medium voltage {AU}| market for | Alloc Def, U	0 kWh	Lognormal	1.511	(1,3,5,5,1,na)
Electricity, medium voltage {BR}| market for | Alloc Def, U	0 kWh	Lognormal	1.511	(1,3,5,5,1,na)
Electricity, medium voltage {CA-AB}| market for | Alloc Def, U	0 kWh	Lognormal	1.511	(1,3,5,5,1,na)
Electricity, medium voltage {CA-BC}| market for | Alloc Def, U	0 kWh	Lognormal	1.511	(1,3,5,5,1,na)
Electricity, medium voltage {CA-MB}| market for | Alloc Def, U	0 kWh	Lognormal	1.511	(1,3,5,5,1,na)
Electricity, medium voltage {CA-NB}| market for | Alloc Def, U	0 kWh	Lognormal	1.511	(1,3,5,5,1,na)
Electricity, medium voltage {CA-NF}| market for | Alloc Def, U	0 kWh	Lognormal	1.511	(1,3,5,5,1,na)
Electricity, medium voltage {CA-NS}| market for | Alloc Def, U	0 kWh	Lognormal	1.511	(1,3,5,5,1,na)
Electricity, medium voltage {CA-NT}| market for | Alloc Def, U	0 kWh	Lognormal	1.511	(1,3,5,5,1,na)
Electricity, medium voltage {CA-NU}| market for | Alloc Def, U	0 kWh	Lognormal	1.511	(1,3,5,5,1,na)
Electricity, medium voltage {CA-ON}| market for | Alloc Def, U	0 kWh	Lognormal	1.511	(1,3,5,5,1,na)
Electricity, medium voltage {CA-PE}| market for | Alloc Def, U	0 kWh	Lognormal	1.511	(1,3,5,5,1,na)
Electricity, medium voltage {CA-SK}| market for | Alloc Def, U	0 kWh	Lognormal	1.511	(1,3,5,5,1,na)
Electricity, medium voltage {CA-YK}| market for | Alloc Def, U	0 kWh	Lognormal	1.511	(1,3,5,5,1,na)
Electricity, medium voltage {CL}| market for | Alloc Def, U	0 kWh	Lognormal	1.511	(1,3,5,5,1,na)
Electricity, medium voltage {CN}| market for | Alloc Def, U	0 kWh	Lognormal	1.511	(1,3,5,5,1,na)
Electricity, medium voltage {FRCC}| market for | Alloc Def, U	0 kWh	Lognormal	1.511	(1,3,5,5,1,na)
Electricity, medium voltage {HICC}| market for | Alloc Def, U	0 kWh	Lognormal	1.511	(1,3,5,5,1,na)
Electricity, medium voltage {ID}| market for | Alloc Def, U	0 kWh	Lognormal	1.511	(1,3,5,5,1,na)
Electricity, medium voltage {IN}| market for | Alloc Def, U	0 kWh	Lognormal	1.511	(1,3,5,5,1,na)
Electricity, medium voltage {IR}| market for | Alloc Def, U	0 kWh	Lognormal	1.511	(1,3,5,5,1,na)
Electricity, medium voltage {JP}| market for | Alloc Def, U	0 kWh	Lognormal	1.511	(1,3,5,5,1,na)
Electricity, medium voltage {KR}| market for | Alloc Def, U	0 kWh	Lognormal	1.511	(1,3,5,5,1,na)
Electricity, medium voltage {MRO, US only}| market for | Alloc Def, U	0 kWh	Lognormal	1.511	(1,3,5,5,1,na)
Electricity, medium voltage {MX}| market for | Alloc Def, U	0 kWh	Lognormal	1.511	(1,3,5,5,1,na)
Electricity, medium voltage {MY}| market for | Alloc Def, U	0 kWh	Lognormal	1.511	(1,3,5,5,1,na)
Electricity, medium voltage {NPCC, US only}| market for | Alloc Def, U	0 kWh	Lognormal	1.511	(1,3,5,5,1,na)
Electricity, medium voltage {PE}| market for | Alloc Def, U	0 kWh	Lognormal	1.511	(1,3,5,5,1,na)
Electricity, medium voltage {Quebec}| market for | Alloc Def, U	0 kWh	Lognormal	1.511	(1,3,5,5,1,na)
Electricity, medium voltage {RFC}| market for | Alloc Def, U	0 kWh	Lognormal	1.511	(1,3,5,5,1,na)

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Electricity, medium voltage {RU}| market for | Alloc Def, U		0 kWh	Lognormal	1.511	(1,3,5,5,1,na)
Electricity, medium voltage {SA}| market for | Alloc Def, U		0 kWh	Lognormal	1.511	(1,3,5,5,1,na)
Electricity, medium voltage {SERC}| market for | Alloc Def, U		0 kWh	Lognormal	1.511	(1,3,5,5,1,na)
Electricity, medium voltage {SPP}| market for | Alloc Def, U		0 kWh	Lognormal	1.511	(1,3,5,5,1,na)
Electricity, medium voltage {TH}| market for | Alloc Def, U		0 kWh	Lognormal	1.511	(1,3,5,5,1,na)
Electricity, medium voltage {TR}| market for | Alloc Def, U		0 kWh	Lognormal	1.511	(1,3,5,5,1,na)
Electricity, medium voltage {TRE}| market for | Alloc Def, U		0 kWh	Lognormal	1.511	(1,3,5,5,1,na)
Electricity, medium voltage {TW}| market for | Alloc Def, U		0 kWh	Lognormal	1.511	(1,3,5,5,1,na)
Electricity, medium voltage {TZ}| market for | Alloc Def, U		0 kWh	Lognormal	1.511	(1,3,5,5,1,na)
Electricity, medium voltage {WECC, US only}| market for | Alloc Def, U		0 kWh	Lognormal	1.511	(1,3,5,5,1,na)
Electricity, medium voltage {ZA}| market for | Alloc Def, U		0.35007224 kWh	Lognormal	1.511	(1,3,5,5,1,na)
Electricity, medium voltage {RoW}| market for | Alloc Def, U		0 kWh	Lognormal	1.511	(1,3,5,5,1,na)

Emissions to air

Fluorine	high. pop.	6.5258E-07 kg	Lognormal	2.3395	(2,5,5,5,4,na) , estimation - based on respective heating modules
Hydrocarbons, aliphatic, alkanes, unspecified	high. pop.	2.0786E-05 kg	Lognormal	2.3395	(2,5,5,5,4,na) , estimation - based on respective heating modules
Dinitrogen monoxide	high. pop.	3.5677E-05 kg	Lognormal	2.3395	(2,5,5,5,4,na) , estimation - based on respective heating modules
Thorium-228	high. pop.	1.3391E-05 kBq	Lognormal	3.7718	(2,5,5,5,4,na) , estimation - based on respective heating modules
Potassium-40	high. pop.	3.048E-05 kBq	Lognormal	3.7718	(2,5,5,5,4,na) , estimation - based on respective heating modules
Ethanol	high. pop.	3.4478E-07 kg	Lognormal	2.3395	(2,5,5,5,4,na) , estimation - based on respective heating modules
Methanol	high. pop.	5.8562E-07 kg	Lognormal	2.3395	(2,5,5,5,4,na) , estimation - based on respective heating modules
Thorium	high. pop.	5.3965E-09 kg	Lognormal	5.8535	(2,5,5,5,4,na) , estimation - based on respective heating modules
Methane, fossil	high. pop.	0.00049868 kg	Lognormal	2.3395	(2,5,5,5,4,na) , estimation - based on respective heating modules
Ethene	high. pop.	4.9568E-05 kg	Lognormal	5.8535	(2,5,5,5,4,na) , estimation - based on respective heating modules
Bromine	high. pop.	8.1047E-07 kg	Lognormal	2.3395	(2,5,5,5,4,na) , estimation - based on respective heating modules
Selenium	high. pop.	1.3991E-07 kg	Lognormal	5.8535	(2,5,5,5,4,na) , estimation - based on respective heating modules
Sulfur dioxide	high. pop.	0.00048968 kg	Lognormal	1.511	(1,3,5,5,1,na) , average from finnish database and several companies
Acetaldehyde	high. pop.	9.7037E-07 kg	Lognormal	2.3395	(2,5,5,5,4,na) , estimation - based on respective heating modules
Phenol, pentachloro-	high. pop.	1.0593E-10 kg	Lognormal	2.3395	(2,5,5,5,4,na) , estimation - based on respective heating modules
Hydrogen sulfide	high. pop.	1.6289E-07 kg	Lognormal	2.3395	(2,5,5,5,4,na) , estimation - based on respective heating modules
Scandium	high. pop.	1.3391E-09 kg	Lognormal	5.8535	(2,5,5,5,4,na) , estimation - based on respective heating modules
Carbon dioxide, biogenic	high. pop.	1.43906373 kg	Lognormal	1.511	(1,3,5,5,1,na) , average from finnish database and several companies
Carbon dioxide, fossil	high. pop.	0.37375683 kg	Lognormal	1.511	(1,3,5,5,1,na) , average from finnish database and several companies
Zinc	high. pop.	3.9774E-06 kg	Lognormal	5.8535	(2,5,5,5,4,na)

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					, estimation - based on respective heating modules
Cobalt	high. pop.	9.9935E-08 kg	Lognormal	5.8535	(2,5,5,5,4,na) , estimation - based on respective heating modules
Hydrogen fluoride	high. pop.	6.7456E-07 kg	Lognormal	2.3395	(2,5,5,5,4,na) , estimation - based on respective heating modules
Benzene, ethyl-	high. pop.	3.9175E-07 kg	Lognormal	2.3395	(2,5,5,5,4,na) , estimation - based on respective heating modules
Formaldehyde	high. pop.	2.5783E-06 kg	Lognormal	2.3395	(2,5,5,5,4,na) , estimation - based on respective heating modules
Silicon	high. pop.	0.00020087 kg	Lognormal	5.8535	(2,5,5,5,4,na) , estimation - based on respective heating modules
Lead	high. pop.	4.7169E-07 kg	Lognormal	5.8535	(2,5,5,5,4,na) , estimation - based on respective heating modules
Particulates, > 10 um	high. pop.	0.00024184 kg	Lognormal	2.3395	(2,5,5,5,4,na) , estimation - based on respective heating modules
Chromium VI	high. pop.	2.5383E-09 kg	Lognormal	5.8535	(2,5,5,5,4,na) , estimation - based on respective heating modules
Benzene	high. pop.	2.0886E-05 kg	Lognormal	2.3395	(2,5,5,5,4,na) , estimation - based on respective heating modules
Sodium	high. pop.	2.1686E-05 kg	Lognormal	5.8535	(2,5,5,5,4,na) , estimation - based on respective heating modules
Radium-226	high. pop.	2.8981E-05 kBq	Lognormal	3.7718	(2,5,5,5,4,na) , estimation - based on respective heating modules
Strontium	high. pop.	4.7769E-07 kg	Lognormal	5.8535	(2,5,5,5,4,na) , estimation - based on respective heating modules
Dioxin, 2,3,7,8 Tetrachlorodibenzo-p-	high. pop.	5.6064E-12 kg	Lognormal	2.3395	(2,5,5,5,4,na) , estimation - based on respective heating modules
Methane, biogenic	high. pop.	5.2166E-06 kg	Lognormal	2.3395	(2,5,5,5,4,na) , estimation - based on respective heating modules
Thorium-232	high. pop.	8.3446E-06 kBq	Lognormal	3.7718	(2,5,5,5,4,na) , estimation - based on respective heating modules
Hydrocarbons, aliphatic, unsaturated	high. pop.	4.8768E-05 kg	Lognormal	2.3395	(2,5,5,5,4,na) , estimation - based on respective heating modules
Iodine	high. pop.	7.685E-08 kg	Lognormal	2.3395	(2,5,5,5,4,na) , estimation - based on respective heating modules
Xylene	high. pop.	5.3965E-06 kg	Lognormal	2.3395	(2,5,5,5,4,na) , estimation - based on respective heating modules
Nickel	high. pop.	9.224E-07 kg	Lognormal	5.8535	(2,5,5,5,4,na) , estimation - based on respective heating modules
Phosphorus	high. pop.	4.0973E-06 kg	Lognormal	2.3395	(2,5,5,5,4,na) , estimation - based on respective heating modules
Mercury	high. pop.	2.3385E-08 kg	Lognormal	5.8535	(2,5,5,5,4,na) , estimation - based on respective heating modules
PAH, polycyclic aromatic hydrocarbons	high. pop.	1.6389E-07 kg	Lognormal	2.3395	(2,5,5,5,4,na) , estimation - based on respective heating modules
Uranium	high. pop.	8.8442E-09 kg	Lognormal	5.8535	(2,5,5,5,4,na) , estimation - based on respective heating modules
Phenol	high. pop.	8.1447E-07 kg	Lognormal	2.3395	(2,5,5,5,4,na) , estimation - based on respective heating modules
Particulates, < 2.5 um	high. pop.	0.00067856 kg	Lognormal	3.7718	(2,5,5,5,4,na) , estimation - based on respective heating modules
Nitrogen oxides	high. pop.	0.00167891 kg	Lognormal	1.7768	(1,3,5,5,1,na)

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					, average from finnish database and several companies
Carbon monoxide, fossil	high. pop.	0.00655573 kg	Lognormal	5.8535	(2,5,5,5,4,na) , estimation - based on respective heating modules
Titanium	high. pop.	5.0467E-07 kg	Lognormal	5.8535	(2,5,5,5,4,na) , estimation - based on respective heating modules
Chromium	high. pop.	1.8988E-07 kg	Lognormal	5.8535	(2,5,5,5,4,na) , estimation - based on respective heating modules
Magnesium	high. pop.	1.7988E-05 kg	Lognormal	5.8535	(2,5,5,5,4,na) , estimation - based on respective heating modules
Cadmium	high. pop.	5.9961E-08 kg	Lognormal	5.8535	(2,5,5,5,4,na) , estimation - based on respective heating modules
Boron	high. pop.	1.8688E-05 kg	Lognormal	5.8535	(2,5,5,5,4,na) , estimation - based on respective heating modules
Pentane	high. pop.	2.2086E-06 kg	Lognormal	2.3395	(2,5,5,5,4,na) , estimation - based on respective heating modules
Chlorine	high. pop.	2.3485E-06 kg	Lognormal	3.7718	(2,5,5,5,4,na) , estimation - based on respective heating modules
Ammonia	high. pop.	2.2585E-05 kg	Lognormal	2.3395	(2,5,5,5,4,na) , estimation - based on respective heating modules
Benzene, hexachloro-	high. pop.	9.3939E-14 kg	Lognormal	2.3395	(2,5,5,5,4,na) , estimation - based on respective heating modules
Calcium	high. pop.	0.0001589 kg	Lognormal	3.7718	(2,5,5,5,4,na) , estimation - based on respective heating modules
Particulates, > 2.5 um, and < 10um	high. pop.	7.5751E-05 kg	Lognormal	2.7759	(2,5,5,5,4,na) , estimation - based on respective heating modules
Toluene	high. pop.	5.9761E-06 kg	Lognormal	2.3395	(2,5,5,5,4,na) , estimation - based on respective heating modules
Manganese	high. pop.	2.2685E-06 kg	Lognormal	5.8535	(2,5,5,5,4,na) , estimation - based on respective heating modules
Butane	high. pop.	1.2892E-06 kg	Lognormal	3.7718	(2,5,5,5,4,na) , estimation - based on respective heating modules
Acetone	high. pop.	1.7189E-07 kg	Lognormal	2.3395	(2,5,5,5,4,na) , estimation - based on respective heating modules
Propionic acid	high. pop.	3.6876E-08 kg	Lognormal	2.3395	(2,5,5,5,4,na) , estimation - based on respective heating modules
Propene	high. pop.	8.2646E-06 kg	Lognormal	2.3395	(2,5,5,5,4,na) , estimation - based on respective heating modules
Water/m3		0.02965695 m3	Lognormal	1.7774	(2,2,5,5,1,na) Calculated value based on literature values and expert opinion. See comments in the parametres' comment field.
Barium	high. pop.	4.4271E-07 kg	Lognormal	5.8535	(2,5,5,5,4,na) , estimation - based on respective heating modules
Arsenic	high. pop.	1.1592E-07 kg	Lognormal	2.3395	(2,5,5,5,4,na) , estimation - based on respective heating modules
Potassium	high. pop.	0.0003078 kg	Lognormal	5.8535	(2,5,5,5,4,na) , estimation - based on respective heating modules
NMVOC, non-methane volatile organic compounds, unspecified origin	high. pop.	3.6576E-05 kg	Lognormal	2.3395	(2,5,5,5,4,na) , estimation - based on respective heating modules
Thallium	high. pop.	5.9062E-10 kg	Lognormal	5.8535	(2,5,5,5,4,na) , estimation - based on respective heating modules
Radium-228	high. pop.	2.9881E-05 kBq	Lognormal	3.7718	(2,5,5,5,4,na) , estimation - based on respective heating modules

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Ethyne	high. pop.	8.2646E-06 kg	Lognormal	2.3395	(2,5,5,5,4,na) , estimation - based on respective heating modules
Lead-210	high. pop.	0.00011193 kBq	Lognormal	3.7718	(2,5,5,5,4,na) , estimation - based on respective heating modules
Hydrocarbons, aromatic	high. pop.	1.7189E-07 kg	Lognormal	2.3395	(2,5,5,5,4,na) , estimation - based on respective heating modules
Beryllium	high. pop.	4.4271E-09 kg	Lognormal	5.8535	(2,5,5,5,4,na) , estimation - based on respective heating modules
Polonium-210	high. pop.	0.00020687 kBq	Lognormal	3.7718	(2,5,5,5,4,na) , estimation - based on respective heating modules
Radon-222	high. pop.	6.7556E-06 kBq	Lognormal	3.7718	(2,5,5,5,4,na) , estimation - based on respective heating modules
Ethane	high. pop.	2.4784E-05 kg	Lognormal	2.3395	(2,5,5,5,4,na) , estimation - based on respective heating modules
Aluminium	high. pop.	2.1986E-05 kg	Lognormal	2.3395	(2,5,5,5,4,na) , estimation - based on respective heating modules
Hydrogen chloride	high. pop.	1.6889E-05 kg	Lognormal	2.3395	(2,5,5,5,4,na) , estimation - based on respective heating modules
Tin	high. pop.	3.4478E-09 kg	Lognormal	5.8535	(2,5,5,5,4,na) , estimation - based on respective heating modules
Radon-220	high. pop.	6.7556E-06 kBq	Lognormal	3.7718	(2,5,5,5,4,na) , estimation - based on respective heating modules
Antimony	high. pop.	4.1573E-08 kg	Lognormal	2.3395	(2,5,5,5,4,na) , estimation - based on respective heating modules
Acetic acid	high. pop.	9.6537E-07 kg	Lognormal	2.3395	(2,5,5,5,4,na) , estimation - based on respective heating modules
Molybdenum	high. pop.	9.154E-08 kg	Lognormal	5.8535	(2,5,5,5,4,na) , estimation - based on respective heating modules
Vanadium	high. pop.	3.2079E-06 kg	Lognormal	5.8535	(2,5,5,5,4,na) , estimation - based on respective heating modules
Iron	high. pop.	2.3485E-05 kg	Lognormal	5.8535	(2,5,5,5,4,na) , estimation - based on respective heating modules
m-Xylene	high. pop.	1.569E-06 kg	Lognormal	2.3395	(2,5,5,5,4,na) , estimation - based on respective heating modules
Uranium-238	high. pop.	2.4284E-05 kBq	Lognormal	3.7718	(2,5,5,5,4,na) , estimation - based on respective heating modules
Propane	high. pop.	1.6889E-05 kg	Lognormal	2.3395	(2,5,5,5,4,na) , estimation - based on respective heating modules
Benzo(a)pyrene	high. pop.	3.9175E-08 kg	Lognormal	2.3395	(2,5,5,5,4,na) , estimation - based on respective heating modules
Copper	high. pop.	3.9075E-07 kg	Lognormal	5.8535	(2,5,5,5,4,na) , estimation - based on respective heating modules
Carbon monoxide, biogenic	high. pop.	0.00062659 kg	Lognormal	5.8535	(2,5,5,5,4,na) , estimation - based on respective heating modules
Emissions to water					
COD, Chemical Oxygen Demand	river	0.01329135 kg	Lognormal	1.7768	(1,3,5,5,1,na) , average from finnish database and several companies
Suspended solids, unspecified	river	0.00118923 kg	Lognormal	1.7768	(1,3,5,5,1,na) , average from finnish database and several companies
AOX, Adsorbable Organic Halogen as Cl	river	0.00010993 kg	Lognormal	1.7768	(1,3,5,5,1,na) , average from finnish database and several companies
BOD5, Biological Oxygen Demand	river	0.00120921 kg	Lognormal	1.7768	(1,3,5,5,1,na)

					, average from finnish database and several companies
Phosphorus	river	1.2992E-05 kg	Lognormal	1.7768	(1,3,5,5,1,na) , average from finnish database and several companies
Water, RoW		0.07897237 m3	Lognormal	1.7774	(2,2,5,5,1,na) Calculated value based on literature values and expert opinion. See comments in the parametres' comment field.
TOC, Total Organic Carbon	river	0.00492272 kg	Lognormal	1.7768	(1,3,5,5,1,na) Calculated by default as TOC (gC) = COD/2.7 (COD measured in g O2). Should more correctly be calculated from the carbon content of the specified emissions to water.
Nitrogen	river	0.00012992 kg	Lognormal	1.7768	(1,3,5,5,1,na) , average from finnish database and several companies
DOC, Dissolved Organic Carbon	river	0.00492272 kg	Lognormal	1.7768	(1,3,5,5,1,na) Calculated as equal to TOC.

Emissions to soil

Final waste flows

Non material emissions

Social issues

Economic issues

Waste to treatment

Input parameters

Calculated parameters

SimaPro Original Offset Printing

SimaPro 8.0.2 process Date: 2/12/2015 Time: 11:10 PM
Project Digital vs Print LCA

Process

Category type	material
Process identifier	EBADUNI61667502514
Type	Unit process
Process name	offset printing, per kg printed paper RoW
Status	
Time period	Unspecified
Geography	Unspecified
Technology	Unspecified
Representativeness	Unspecified
Multiple output allocation	Unspecified
Substitution allocation	Unspecified
Cut off rules	Unspecified
Capital goods	Unspecified
Boundary with nature	Unspecified
Infrastructure	No
Date	10/22/2013
Record	data entry by: Cornelia Stettler c.stettler@carbotech.ch Carbotech, Eulerstrasse 68, 4051 Baselis active author:
Generator	generated by: Cornelia Stettler c.stettler@carbotech.ch Carbotech, Eulerstrasse 68, 4051 Basel
Literature references	Ecoinvent 3 data published in: 0 Data as such not published elsewhere (default) is copyright protected: false company: Carbotech AG company code: CARBOTE
Collection method	sampling procedure: Comanpy data of three average companies (few literature values and own assumptions.
Data treatment	
Verification	
Comment	The data set for offset printing is calculated from the annual material and energy consumption of three Swiss companies using modern technologies with low VOC use (solvents and cleaners). The dataset refers to 1 kg of the final product leaving the company and includes all paper loss from the preparation and further processings of print products (about 28% paper loss). A life span of 10 years was assumed for the machinery except for walves. VOC-emissions were calculated from the mass balance input minus recovery of VOC. Production volume: 35919446160 kg Included activities start: The activity starts with the reception of materials for the printing process including paper, colours, machine and auxiliary materials as for example cleaners, printing plates and textiles. Included activities end: The activity offset printing ends with the packaging of final product at plant.The dataset incudes the consumption of paper, printing materials and processing elements, materials of printer systems, the energy comsumption of the offset printing company, the delivery of used materials from supplier, the VOC emissions from the printing process and the amount of waste waste paper, waste packaging board, waste paints and used solvent mixtures from the printing process. The dataset doesn't include the delivery of the final product to the client and its final disposal. Energy values: Undefined (default) Geography: The data is based on information from three average Swiss companies. Technology level: 3 Current (default) Technology: The dataset refers to the present technology for low VOC use in offset print and to the average production of printed products. Data is not valid for special applications as newspapers, packaging and books. Start date: 2007-01-01 End date: 2013-12-31 Is data valid for entire period: true Macro-economic scenario name: Business-as-Usual Version: 3.0.1.0 Created: 2012-01-04T12:01:37 Last edited: 2012-06-05T15:51:39 Source: 5243d456-1273-48b9-8969-9698cc432030_fbc37f1d-6f28-4b37-9d7e-82695f151db3.spold Link: https://ecoquery.ecoinvent.org/Details/UPR/4606A622-7F99-4790-9818-A71472FC78FC/06590A66-662A-4885-8494-AD0CF410F956
Allocation rules	
System description	Ecoinvent v3.01

Products

Printed paper, offset {RoW}| offset printing, per	1 kg		100	Paper	Paper+ Bo technology with low VOC-use

Avoided products

Resources

Materials/fuels

Industrial machine, heavy, unspecified {GLO}| market for | Alloc Def, U	0.000217276	kg	Lognormal	1.503	(5,3,2,3,1,na) Estimate value: Weight of offset printing equipment given by one of the companies indicating main material steal and furhter materials aluminium, rubber and electronics. Assumption comparable equipment weight in other companies and similar production as for industrial machines.
White spirit {GLO}| market for | Alloc Def, U	0.003039875	kg	Lognormal	1.1256	(3,3,2,3,1,na) Calculate value: Average value for different petrol based cleaners of three companies. Only a portion is relied to the use of white spirit itself, the data set ist used also as estimate for the production of other petrol based mixtures. Except for mixtures containing VOCs with high boiling point all VOCs are assumed to be emitted to air. The less volatil content with high boiling VOCs is assumed to be delivered to a professional treatment. Heptan emissions represent emissions from white spirit. Methanol and Propylene oxide emissions represent the Methoxypropanol content and Toluol, Xylene and Ethylbenzol the content of solvent naphtha in furhter used mixtures.
Corrugated board box {GLO}| market for corrugated board box | Alloc Def, U	0.087907206	kg	Lognormal	1.096	(2,3,2,3,1,na) the
Acrylic varnish, without water, in 87.5% solution state {GLO}| market for | Alloc Def, U	0.000389702	kg	Lognormal	1.096	(2,3,2,3,1,na) Calculated value: average consumption of three companies
Printing ink, offset, without solvent, in 47.5% solution state {GLO}| market for | Alloc Def, U	0.009239227	kg	Lognormal	1.096	(2,3,2,3,1,na) Calculated value: average ink consumption of three companies
Paper, woodfree, coated {RoW}| market for | Alloc Def, U	1.385385679	kg	Lognormal	1.096	(2,3,2,3,1,na) Calculated value: Average paper consumption of three companies. Paper, woodfree, coated assumed for printing services.
Spent solvent mixture {GLO}| market for | Alloc Def, U	-0.001495021	kg	Lognormal	1.1256	(3,3,2,3,1,na) Estimate value: recovered solvent given declared only by one of tree companies. Recovery and professional waste treatment of 'non-voc wash' products assumed for the other companies. Production Volume Amount: 53879169.24
Ethylene glycol monoethyl ether {GLO}| market for | Alloc Def, U	0.000522261	kg	Lognormal	1.096	(2,3,2,3,1,na) Calculated value: Average consumption of three companies
Isopropanol {GLO}| market for | Alloc Def, U	0.002172763	kg	Lognormal	1.096	(2,3,2,3,1,na) Calculated value: average Ispopropanol use of three companies (with low VOC consumption)
Sheet rolling, aluminium {GLO}| market for | Alloc Def, U	0.024817341	kg	Lognormal	2.2749	(5,5,2,3,5,na) Estimate value: assumed processing for the production of printing plates
Synthetic rubber {GLO}| market for | Alloc Def, U	0.000178406	kg	Lognormal	1.5176	(3,3,2,3,4,na) Calculated value: average consumption of rubber blankets of three companies. Assumptions on the portion of rubber and textile content derived from product declarations
Maize starch {GLO}| market for | Alloc Def, U	0.000171429	kg	Lognormal	1.5562	(5,5,2,3,1,na) Calculated value: average use of developer used of three offset printing companies. Starch main component of developer.
Textile, woven cotton {GLO}| market for | Alloc Def, U	0.000281064	kg	Lognormal	1.5604	(4,3,2,3,4,na) Calculated value: average consumption of textiles in printing process of three companies (including the portion of textile within rubber blankets)
Aluminium, wrought alloy {GLO}| market for | Alloc Def, U	0.024817341	kg	Lognormal	2.9987	(2,3,2,3,1,na) Calculated value: average consumption of printing plates of three companies. Product information indicating wrought alloy as material quality
Thermoforming, with calendering {GLO}| market for | Alloc Def, U	0.000396679	kg	Lognormal	1.8154	(5,5,2,3,4,na) Estimate value: Assumed processing for rubber blankets.
Waste paperboard {GLO}| market for | Alloc Def, U	-0.087907206	kg	Undefined		Production Volume Amount: 3168095151.312
Waste emulsion paint {GLO}| market for | Alloc Def, U	-0.000281064	kg	Lognormal	1.096	(2,3,2,3,1,na) Calculated value: average value for disposal of paints of three companies Production Volume Amount: 10129283.81712
Acrylic dispersion, without water, in 65% solution state {GLO}| market for | Alloc Def, U	0.00118605	kg	Lognormal	1.096	(2,3,2,3,1,na) Calculated value: average consumption of three companies
Waste paper, unsorted {Europe without Switzerland}| market for | Alloc Def, U	-9.78318E-12	kg	Lognormal	1.1256	(3,3,2,3,1,na)
Waste paper, unsorted {RoW}| market for | Alloc Def, U	-0.388705334	kg	Lognormal	1.1256	Production Volume Amount: 14008584002.4 (3,3,2,3,1,na)

SimaPro Original Offset Printing

Production Volume Amount: 14008584002.4

Electricity/heat				
Electricity, low voltage {ASCC}| market for | Alloc Def, U	0.000252909 kWh	Lognormal	1.096	(2,3,2,3,1,na)
Electricity, low voltage {AT}| market for | Alloc Def, U	0.002312353 kWh	Lognormal	1.096	(2,3,2,3,1,na)
Electricity, low voltage {AU}| market for | Alloc Def, U	0.008520832 kWh	Lognormal	1.096	(2,3,2,3,1,na)
Electricity, low voltage {BA}| market for | Alloc Def, U	0.000321436 kWh	Lognormal	1.096	(2,3,2,3,1,na)
Electricity, low voltage {BE}| market for | Alloc Def, U	0.003249602 kWh	Lognormal	1.096	(2,3,2,3,1,na)
Electricity, low voltage {BG}| market for | Alloc Def, U	0.001174887 kWh	Lognormal	1.096	(2,3,2,3,1,na)
Electricity, low voltage {BR}| market for | Alloc Def, U	0.01629025 kWh	Lognormal	1.096	(2,3,2,3,1,na)
Electricity, low voltage {CA-AB}| market for | Alloc Def, U	0.001200172 kWh	Lognormal	1.096	(2,3,2,3,1,na)
Electricity, low voltage {CA-BC}| market for | Alloc Def, U	0.002649646 kWh	Lognormal	1.096	(2,3,2,3,1,na)
Electricity, low voltage {CA-MB}| market for | Alloc Def, U	0.001536446 kWh	Lognormal	1.096	(2,3,2,3,1,na)
Electricity, low voltage {CA-NB}| market for | Alloc Def, U	0.000898675 kWh	Lognormal	1.096	(2,3,2,3,1,na)
Electricity, low voltage {CA-NF}| market for | Alloc Def, U	0.001808945 kWh	Lognormal	1.096	(2,3,2,3,1,na)
Electricity, low voltage {CA-NS}| market for | Alloc Def, U	0.00110160 2 kWh	Lognormal	1.096	(2,3,2,3,1,na)
Electricity, low voltage {CA-NT}| market for | Alloc Def, U	1.69303E-05 kWh	Lognormal	1.096	(2,3,2,3,1,na)
Electricity, low voltage {CA-NU}| market for | Alloc Def, U	7.07356E-06 kWh	Lognormal	1.096	(2,3,2,3,1,na)
Electricity, low voltage {CA-ON}| market for | Alloc Def, U	0.006669384 kWh	Lognormal	1.096	(2,3,2,3,1,na)
Electricity, low voltage {CA-PE}| market for | Alloc Def, U	2.09453E-06 kWh	Lognormal	1.096	(2,3,2,3,1,na)
Electricity, low voltage {CA-SK}| market for | Alloc Def, U	0.000456878 kWh	Lognormal	1.096	(2,3,2,3,1,na)
Electricity, low voltage {CA-YK}| market for | Alloc Def, U	1.61765E-05 kWh	Lognormal	1.096	(2,3,2,3,1,na)
Electricity, low voltage {CL}| market for | Alloc Def, U	0.002078432 kWh	Lognormal	1.096	(2,3,2,3,1,na)
Electricity, low voltage {CN}| market for | Alloc Def, U	0.113463981 kWh	Lognormal	1.096	(2,3,2,3,1,na)
Electricity, low voltage {CZ}| market for | Alloc Def, U	0.002307353 kWh	Lognormal	1.096	(2,3,2,3,1,na)
Electricity, low voltage {DE}| market for | Alloc Def, U	0.020488626 kWh	Lognormal	1.096	(2,3,2,3,1,na)
Electricity, low voltage {DK}| market for | Alloc Def, U	0.001306317 kWh	Lognormal	1.096	(2,3,2,3,1,na)
Electricity, low voltage {ES}| market for | Alloc Def, U	0.010299505 kWh	Lognormal	1.096	(2,3,2,3,1,na)
Electricity, low voltage {FI}| market for | Alloc Def, U	0.003155671 kWh	Lognormal	1.096	(2,3,2,3,1,na)
Electricity, low voltage {FR}| market for | Alloc Def, U	0.017610719 kWh	Lognormal	1.096	(2,3,2,3,1,na)
Electricity, low voltage {FRCC}| market for | Alloc Def, U	0.007748335 kWh	Lognormal	1.096	(2,3,2,3,1,na)
Electricity, low voltage {GB}| market for | Alloc Def, U	0.013399192 kWh	Lognormal	1.096	(2,3,2,3,1,na)
Electricity, low voltage {GR}| market for | Alloc Def, U	0.002249398 kWh	Lognormal	1.096	(2,3,2,3,1,na)
Electricity, low voltage {HICC}| market for | Alloc Def, U	0.000400774 kWh	Lognormal	1.096	(2,3,2,3,1,na)
Electricity, low voltage {HR}| market for | Alloc Def, U	0.000635914 kWh	Lognormal	1.096	(2,3,2,3,1,na)
Electricity, low voltage {HU}| market for | Alloc Def, U	0.001442109 kWh	Lognormal	1.096	(2,3,2,3,1,na)
Electricity, low voltage {ID}| market for | Alloc Def, U	0.004999183 kWh	Lognormal	1.096	(2,3,2,3,1,na)
Electricity, low voltage {IE}| market for | Alloc Def, U	0.000999094 kWh	Lognormal	1.096	(2,3,2,3,1,na)
Electricity, low voltage {IN}| market for | Alloc Def, U	0.026505748 kWh	Lognormal	1.096	(2,3,2,3,1,na)
Electricity, low voltage {IR}| market for | Alloc Def, U	0.00668846 kWh	Lognormal	1.096	(2,3,2,3,1,na)
Electricity, low voltage {IT}| market for | Alloc Def, U	0.012135203 kWh	Lognormal	1.096	(2,3,2,3,1,na)
Electricity, low voltage {JP}| market for | Alloc Def, U	0.037038717 kWh	Lognormal	1.096	(2,3,2,3,1,na)
Electricity, low voltage {KR}| market for | Alloc Def, U	0.015431166 kWh	Lognormal	1.096	(2,3,2,3,1,na)
Electricity, low voltage {LU}| market for | Alloc Def, U	0.000247396 kWh	Lognormal	1.096	(2,3,2,3,1,na)
Electricity, low voltage {MK}| market for | Alloc Def, U	0.000282938 kWh	Lognormal	1.096	(2,3,2,3,1,na)
Electricity, low voltage {MRO, US only}| market for | Alloc Def, U	0.008289813 kWh	Lognormal	1.096	(2,3,2,3,1,na)
Electricity, low voltage {MX}| market for | Alloc Def, U	0.008298454 kWh	Lognormal	1.096	(2,3,2,3,1,na)
Electricity, low voltage {MY}| market for | Alloc Def, U	0.003775185 kWh	Lognormal	1.096	(2,3,2,3,1,na)
Electricity, low voltage {NL}| market for | Alloc Def, U	0.004316195 kWh	Lognormal	1.096	(2,3,2,3,1,na)
Electricity, low voltage {NO}| market for | Alloc Def, U	0.004424031 kWh	Lognormal	1.096	(2,3,2,3,1,na)
Electricity, low voltage {NPCC, US only}| market for | Alloc Def, U	0.009691594 kWh	Lognormal	1.096	(2,3,2,3,1,na)
Electricity, low voltage {PE}| market for | Alloc Def, U	0.00112108 2 kWh	Lognormal	1.096	(2,3,2,3,1,na)
Electricity, low voltage {PL}| market for | Alloc Def, U	0.004915229 kWh	Lognormal	1.096	(2,3,2,3,1,na)
Electricity, low voltage {PT}| market for | Alloc Def, U	0.001886179 kWh	Lognormal	1.096	(2,3,2,3,1,na)
Electricity, low voltage {Quebec}| market for | Alloc Def, U	0.005763115 kWh	Lognormal	1.096	(2,3,2,3,1,na)
Electricity, low voltage {RFC}| market for | Alloc Def, U	0.034188938 kWh	Lognormal	1.096	(2,3,2,3,1,na)
Electricity, low voltage {RO}| market for | Alloc Def, U	0.001907278 kWh	Lognormal	1.096	(2,3,2,3,1,na)
Electricity, low voltage {RS}| market for | Alloc Def, U	0.00112108 2 kWh	Lognormal	1.096	(2,3,2,3,1,na)
Electricity, low voltage {RU}| market for | Alloc Def, U	0.032815198 kWh	Lognormal	1.096	(2,3,2,3,1,na)
Electricity, low voltage {SA}| market for | Alloc Def, U	0.006970934 kWh	Lognormal	1.096	(2,3,2,3,1,na)
Electricity, low voltage {SE}| market for | Alloc Def, U	0.005032714 kWh	Lognormal	1.096	(2,3,2,3,1,na)
Electricity, low voltage {SERC}| market for | Alloc Def, U	0.039949398 kWh	Lognormal	1.096	(2,3,2,3,1,na)
Electricity, low voltage {SI}| market for | Alloc Def, U	0.000493573 kWh	Lognormal	1.096	(2,3,2,3,1,na)
Electricity, low voltage {SK}| market for | Alloc Def, U	0.000974975 kWh	Lognormal	1.096	(2,3,2,3,1,na)
Electricity, low voltage {SPP}| market for | Alloc Def, U	0.00774017 kWh	Lognormal	1.096	(2,3,2,3,1,na)
Electricity, low voltage {TH}| market for | Alloc Def, U	0.00514963 kWh	Lognormal	1.096	(2,3,2,3,1,na)
Electricity, low voltage {TR}| market for | Alloc Def, U	0.006390216 kWh	Lognormal	1.096	(2,3,2,3,1,na)
Electricity, low voltage {TRE}| market for | Alloc Def, U	0.012690531 kWh	Lognormal	1.096	(2,3,2,3,1,na)
Electricity, low voltage {TW}| market for | Alloc Def, U	0.008071828 kWh	Lognormal	1.096	(2,3,2,3,1,na)
Electricity, low voltage {TZ}| market for | Alloc Def, U	0.000142396 kWh	Lognormal	1.096	(2,3,2,3,1,na)
Electricity, low voltage {UA}| market for | Alloc Def, U	0.005807179 kWh	Lognormal	1.096	(2,3,2,3,1,na)
Electricity, low voltage {WECC, US only}| market for | Alloc Def, U	0.02754142 kWh	Lognormal	1.096	(2,3,2,3,1,na)
Electricity, low voltage {ZA}| market for | Alloc Def, U	0.008232842 kWh	Lognormal	1.096	(2,3,2,3,1,na)
Electricity, low voltage {RoW}| market for | Alloc Def, U	0.109513467 kWh	Lognormal	1.096	(2,3,2,3,1,na)
Heat, district or industrial, natural gas {Europe without Switzerland}| market for heat, district or industrial, natural gas | Alloc Def, U	0.058341544 MJ	Lognormal	1.096	(2,3,2,3,1,na)
Heat, district or industrial, natural gas {RoW}| market for heat, district or industrial, natural gas | Alloc Def, U	1.516413401 MJ	Lognormal	1.096	(2,3,2,3,1,na)

SimaPro Original Offset Printing

Emissions to air					
Xylene	high. pop.	8.53E-05 kg	Lognormal	1.1503	(3,4,2,3,1,na) Calculated value: Emissions from the use of solvent Naphtha, white spirit and other petrol based derivates. Average of three companies calculated from the mass balance of product use and recovery for recycling/disposal. Toluene and Xylene assumed main components of cyclic hydrocarbons, related content of cylcic hydrocarbons from product specifications expressed by 50% Xylene and 50% Toluene.
Propylene oxide	high. pop.	0.000181 kg	Lognormal	1.2152	(4,3,2,3,1,na) Calculated, stochiometric value: Emissions from the use of ink solvent. Average of three companies calculated from the mass balance of product use and recovery for recycling/disposal. Portion of Methoxypropanol derived from product specifications and related emissions expressed by the portion of methanol and propylene oxide used for the production of Methoxypropanol.
Toluene	high. pop.	8.53E-05 kg	Lognormal	1.2152	(4,3,2,3,1,na) Calculated value: Emissions from the use of solvent Naphtha, white spirit and other petrol based derivates. Average of three companies calculated from the mass balance of product use and recovery for recycling. Toluene and Xylene assumed for the portion of cyclic hydrocarbons, related portion derived from product specifications and expressed by 50% Xylene and 50% Toluene.
Benzene, ethyl-	high. pop.	9.66E-05 kg	Lognormal	1.1256	(3,3,2,3,1,na) Calculated value: Emissions from the use of solvent Naphtha, white spirit and other petrol based derivates (i.e. ink solvent). Average of three companies calculated from the mass balance of product use and its recovery for recycling. Benzene, ethyl- content of products derived from product specifications.
2-Propanol	high. pop.	0.002173 kg	Lognormal	1.1256	(3,3,2,3,1,na) Calculated value: average from three companies calculated from the mass balance of solvent consumption and solvent recovery for recycling.
Heptane	high. pop.	0.000945 kg	Lognormal	1.1256	(3,3,2,3,1,na) Calculated value: Emissions from the use of solvent Naphtha, white spirit and other petrol based derivates. Average of three companies calculated from the mass balance of product use and recovery for recycling. Heptane used for the portion of aliphatic hydrocarbons C7-C12 given in product specifications.
Methanol	high. pop.	9.97E-05 kg	Lognormal	1.2152	(4,3,2,3,1,na) Calculated, stochiometric value: Emissions from the use of ink solvent. Average of three companies calculated from the mass balance of product use and recovery for recycling/disposal. Portion of Methoxypropanol in ink solvent derived from product specifications and related emissions expressed by the portion of methanol and propylene oxide used for the production of Methoxypropanol.
Emissions to water					
Emissions to soil					
Final waste flows					
Non material emissions					
Social issues					
Economic issues					
Waste to treatment					
Input parameters					
Calculated parameters					

Paper Distribution Transportation

SimaPro 8.0.2			process	Date:	2/2/2015	Time: 1:46 PM
Project			Digital vs Print LCA			

Process

Category type	transport
Process identifier	FFLUCT7595335400022
Type	
Process name	
Status	
Time period	Unspecified
Geography	Unspecified
Technology	Unspecified
Representativeness	Unspecified
Multiple output allocation	Unspecified
Substitution allocation	Unspecified
Cut off rules	Unspecified
Capital goods	Unspecified
Boundary with nature	Unspecified
Infrastructure	No
Date	12/19/2014
Record	
Generator	
Literature references	
Collection method	
Data treatment	
Verification	
Comment	
Allocation rules	
System description	

Products

Paper Distribution Transportation	1	p	100 not defined	Road

Avoided products

Resources

Materials/fuels

Transport, freight, lorry 16-32 metric ton, EURO3 {GLO}| market for | Alloc Def, U	41.5614	tkm	Undefined

Electricity/heat

Emissions to air

Emissions to water

Emissions to soil

Final waste flows

Non material emissions

Social issues

Economic issues

Waste to treatment

Input parameters

Calculated parameters

SimaPro Edited Offset Printing ZA

SimaPro 8.0.2 process Date: 2/12/2015 Time: 11:10 PM
Project Digital vs Print LCA

Process

Category type	material
Process identifier	FFLUCT7595335400040
Type	Unit process
Process name	offset printing, per kg printed paper RoW
Status	
Time period	Unspecified
Geography	Unspecified
Technology	Unspecified
Representativeness	Unspecified
Multiple output allocation	Unspecified
Substitution allocation	Unspecified
Cut off rules	Unspecified
Capital goods	Unspecified
Boundary with nature	Unspecified
Infrastructure	No
Date	10/22/2013
Record	data entry by: Cornelia Stettler c.stettler@carbotech.ch Carbotech, Eulerstrasse 68, 4051 Baselis active author:
Generator	generated by: Cornelia Stettler c.stettler@carbotech.ch Carbotech, Eulerstrasse 68, 4051 Basel
Literature references	Ecoinvent 3 data published in: 0 Data as such not published elsewhere (default) is copyright protected: false company: Carbotech AG company code: CARBOTE
Collection method	sampling procedure: Comanpy data of three average companies (few literature values and own assumptions.
Data treatment	
Verification	
Comment	

The data set for offset printing is calculated from the annual material and energy consumption of three Swiss companies using modern technologies with low VOC use (solvents and cleaners). The dataset refers to 1 kg of the final product leaving the company and includes all paper loss from the preparation and further processings of print products (about 28% paper loss). A life span of 10 years was assumed for the machinery except for walves. VOC-emissions were calculated from the mass balance input minus recovery of VOC.

Production volume: 35919446160 kg

Included activities start: The activity starts with the reception of materials for the printing process including paper, colours, machine and auxiliary materials as for example cleaners, printing plates and textiles.
Included activities end: The activity offset printing ends with the packaging of final product at plant.The dataset incudes the consumption of paper, printing materials and processing elements, materials of printer systems, the energy comsumption of the offset printing company, the delivery of used materials from supplier, the VOC emissions from the printing process and the amount of waste waste paper, waste packaging board, waste paints and used solvent mixtures from the printing process. The dataset doesn't include the delivery of the final product to the client and its final disposal.
Energy values: Undefined (default)
Geography: The data is based on information from three average Swiss companies.
Technology level: 3 Current (default)

Technology: The dataset refers to the present technology for low VOC use in offset print and to the average production of printed products. Data is not valid for special applications as newspapers, packaging and books.
Start date: 2007-01-01
End date: 2013-12-31
Is data valid for entire period: true
Macro-economic scenario name: Business-as-Usual

Version: 3.0.1.0
Created: 2012-01-04T12:01:37
Last edited: 2012-06-05T15:51:39
Source: 5243d456-1273-48b9-8969-9698cc432030_fbc37f1d-6f28-4b37-9d7e-82695f151db3.spold

Link: https://ecoquery.ecoinvent.org/Details/UPR/4606A622-7F99-4790-9818-A71472FC78FC/06590A66-662A-4885-8494-AD0CF410F956

Allocation rules	
System description	Ecoinvent v3.01

SimaPro Edited Offset Printing ZA
Products

Printed paper, offset {ZA}| offset printing, per kg printed paper | Alloc Def, U	1	kg	100	Paper	Paper+ Bo technology with low VOC-use

Avoided products

Resources

Materials/fuels

Industrial machine, heavy, unspecified {GLO}| market for | Alloc Def, U	0.000217276 kg	Lognormal	1.503	(5,3,2,3,1,na) Estimate value: Weight of offset printing equipment given by one of the companies indicating main material steal and furhter materials aluminium, rubber and electronics. Assumption comparable equipment weight in other companies and similar production as for industrial machines.
White spirit {GLO}| market for | Alloc Def, U	0.003039875 kg	Lognormal	1.1256	(3,3,2,3,1,na) Calculate value: Average value for different petrol based cleaners of three companies. Only a portion is relied to the use of white spirit itself, the data set ist used also as estimate for the production of other petrol based mixtures. Except for mixtures containing VOCs with high boiling point all VOCs are assumed to be emitted to air. The less volatil content with high boiling VOCs is assumed to be delivered to a professional treatment. Heptan emissions represent emissions from white spirit. Methanol and Propylene oxide emissions represent the Methoxypropanol content and Toluol, Xylene and Ethylbenzol the content of solvent naphtha in furhter used mixtures.
Corrugated board box {GLO}| market for corrugated board box | Alloc Def, U	0.087907206 kg	Lognormal	1.096	(2,3,2,3,1,na) the
Acrylic varnish, without water, in 87.5% solution state {GLO}| market for | Alloc Def, U	0.000389702 kg	Lognormal	1.096	(2,3,2,3,1,na) Calculated value: average consumption of three companies
Printing ink, offset, without solvent, in 47.5% solution state {GLO}| market for | Alloc Def, U	0.009239227 kg	Lognormal	1.096	(2,3,2,3,1,na) Calculated value: average ink consumption of three companies
Paper, woodfree, coated {ZA}| market for | Alloc Def, U	1.385385679 kg	Lognormal	1.096	(2,3,2,3,1,na) Calculated value: Average paper consumption of three companies. Paper, woodfree, coated assumed for printing services.
Spent solvent mixture {GLO}| market for | Alloc Def, U	-0.001495021 kg	Lognormal	1.1256	(3,3,2,3,1,na) Estimate value: recovered solvent given declared only by one of tree companies. Recovery and professional waste treatment of 'non-voc wash' products assumed for the other companies. Production Volume Amount: 5387169.24
Ethylene glycol monoethyl ether {GLO}| market for | Alloc Def, U	0.000522261 kg	Lognormal	1.096	(2,3,2,3,1,na) Calculated value: Average consumption of three companies
Isopropanol {GLO}| market for | Alloc Def, U	0.002172763 kg	Lognormal	1.096	(2,3,2,3,1,na) Calculated value: average Ispopropanol use of three companies (with low VOC consumption)
Sheet rolling, aluminium {GLO}| market for | Alloc Def, U	0.024817341 kg	Lognormal	2.2749	(5,5,2,3,5,na) Estimate value: assumed processing for the production of printing plates
Synthetic rubber {GLO}| market for | Alloc Def, U	0.000178406 kg	Lognormal	1.5176	(3,3,2,3,4,na) Calculated value: average consumption of rubber blankets of three companies. Assumptions on the portion of rubber and textile content derived from product declarations
Maize starch {GLO}| market for | Alloc Def, U	0.000171429 kg	Lognormal	1.5562	(5,5,2,3,1,na) Calculated value: average use of developer used of three offset printing companies. Starch main component of developer.
Textile, woven cotton {GLO}| market for | Alloc Def, U	0.000281064 kg	Lognormal	1.5604	(4,3,2,3,4,na) Calculated value: average consumption of textiles in printing process of three companies (including the portion of textile within rubber blankets)
Aluminium, wrought alloy {GLO}| market for | Alloc Def, U	0.024817341 kg	Lognormal	2.9987	(2,3,2,3,1,na) Calculated value: average consumption of printing plates of three companies. Product information indicating wrought alloy as material quality
Thermoforming, with calendering {GLO}| market for | Alloc Def, U	0.000396679 kg	Lognormal	1.8154	(5,5,2,3,4,na) Estimate value: Assumed processing for rubber blankets.
Waste paperboard {GLO}| market for | Alloc Def, U	-0.087907206 kg	Undefined		 Production Volume Amount: 3168095151.312
Waste emulsion paint {GLO}| market for | Alloc Def, U	-0.000281064 kg	Lognormal	1.096	(2,3,2,3,1,na) Calculated value: average value for disposal of paints of three companies Production Volume Amount: 10129283.81712
Acrylic dispersion, without water, in 65% solution state {GLO}| market for | Alloc Def, U	0.00118605 kg	Lognormal	1.096	(2,3,2,3,1,na) Calculated value: average consumption of three companies
Waste paper, unsorted {Europe without Switzerland}| market for | Alloc Def, U	-9.78318E-12 kg	Lognormal	1.1256	(3,3,2,3,1,na) Production Volume Amount: 14008584002.4
Waste paper, unsorted {RoW}| market for | Alloc Def, U	-0.388705334 kg	Lognormal	1.1256	(3,3,2,3,1,na) Production Volume Amount: 14008584002.4

SimaPro Edited Offset Printing ZA

Electricity/heat						
Electricity, low voltage {ASCC}| market for | Alloc Def, U		0	kWh	Lognormal	1.096	(2,3,2,3,1,na)
Electricity, low voltage {AT}| market for | Alloc Def, U		0	kWh	Lognormal	1.096	(2,3,2,3,1,na)
Electricity, low voltage {AU}| market for | Alloc Def, U		0	kWh	Lognormal	1.096	(2,3,2,3,1,na)
Electricity, low voltage {BA}| market for | Alloc Def, U		0	kWh	Lognormal	1.096	(2,3,2,3,1,na)
Electricity, low voltage {BE}| market for | Alloc Def, U		0	kWh	Lognormal	1.096	(2,3,2,3,1,na)
Electricity, low voltage {BG}| market for | Alloc Def, U		0	kWh	Lognormal	1.096	(2,3,2,3,1,na)
Electricity, low voltage {BR}| market for | Alloc Def, U		0	kWh	Lognormal	1.096	(2,3,2,3,1,na)
Electricity, low voltage {CA-AB}| market for | Alloc Def, U		0	kWh	Lognormal	1.096	(2,3,2,3,1,na)
Electricity, low voltage {CA-BC}| market for | Alloc Def, U		0	kWh	Lognormal	1.096	(2,3,2,3,1,na)
Electricity, low voltage {CA-MB}| market for | Alloc Def, U		0	kWh	Lognormal	1.096	(2,3,2,3,1,na)
Electricity, low voltage {CA-NB}| market for | Alloc Def, U		0	kWh	Lognormal	1.096	(2,3,2,3,1,na)
Electricity, low voltage {CA-NF}| market for | Alloc Def, U		0	kWh	Lognormal	1.096	(2,3,2,3,1,na)
Electricity, low voltage {CA-NS}| market for | Alloc Def, U		0	kWh	Lognormal	1.096	(2,3,2,3,1,na)
Electricity, low voltage {CA-NT}| market for | Alloc Def, U		0	kWh	Lognormal	1.096	(2,3,2,3,1,na)
Electricity, low voltage {CA-NU}| market for | Alloc Def, U		0	kWh	Lognormal	1.096	(2,3,2,3,1,na)
Electricity, low voltage {CA-ON}| market for | Alloc Def, U		0	kWh	Lognormal	1.096	(2,3,2,3,1,na)
Electricity, low voltage {CA-PE}| market for | Alloc Def, U		0	kWh	Lognormal	1.096	(2,3,2,3,1,na)
Electricity, low voltage {CA-SK}| market for | Alloc Def, U		0	kWh	Lognormal	1.096	(2,3,2,3,1,na)
Electricity, low voltage {CA-YK}| market for | Alloc Def, U		0	kWh	Lognormal	1.096	(2,3,2,3,1,na)
Electricity, low voltage {CL}| market for | Alloc Def, U		0	kWh	Lognormal	1.096	(2,3,2,3,1,na)
Electricity, low voltage {CN}| market for | Alloc Def, U		0	kWh	Lognormal	1.096	(2,3,2,3,1,na)
Electricity, low voltage {CZ}| market for | Alloc Def, U		0	kWh	Lognormal	1.096	(2,3,2,3,1,na)
Electricity, low voltage {DE}| market for | Alloc Def, U		0	kWh	Lognormal	1.096	(2,3,2,3,1,na)
Electricity, low voltage {DK}| market for | Alloc Def, U		0	kWh	Lognormal	1.096	(2,3,2,3,1,na)
Electricity, low voltage {ES}| market for | Alloc Def, U		0	kWh	Lognormal	1.096	(2,3,2,3,1,na)
Electricity, low voltage {FI}| market for | Alloc Def, U		0	kWh	Lognormal	1.096	(2,3,2,3,1,na)
Electricity, low voltage {FR}| market for | Alloc Def, U		0	kWh	Lognormal	1.096	(2,3,2,3,1,na)
Electricity, low voltage {FRCC}| market for | Alloc Def, U		0	kWh	Lognormal	1.096	(2,3,2,3,1,na)
Electricity, low voltage {GB}| market for | Alloc Def, U		0	kWh	Lognormal	1.096	(2,3,2,3,1,na)
Electricity, low voltage {GR}| market for | Alloc Def, U		0	kWh	Lognormal	1.096	(2,3,2,3,1,na)
Electricity, low voltage {HICC}| market for | Alloc Def, U		0	kWh	Lognormal	1.096	(2,3,2,3,1,na)
Electricity, low voltage {HR}| market for | Alloc Def, U		0	kWh	Lognormal	1.096	(2,3,2,3,1,na)
Electricity, low voltage {HU}| market for | Alloc Def, U		0	kWh	Lognormal	1.096	(2,3,2,3,1,na)
Electricity, low voltage {ID}| market for | Alloc Def, U		0	kWh	Lognormal	1.096	(2,3,2,3,1,na)
Electricity, low voltage {IE}| market for | Alloc Def, U		0	kWh	Lognormal	1.096	(2,3,2,3,1,na)
Electricity, low voltage {IN}| market for | Alloc Def, U		0	kWh	Lognormal	1.096	(2,3,2,3,1,na)
Electricity, low voltage {IR}| market for | Alloc Def, U		0	kWh	Lognormal	1.096	(2,3,2,3,1,na)
Electricity, low voltage {IT}| market for | Alloc Def, U		0	kWh	Lognormal	1.096	(2,3,2,3,1,na)
Electricity, low voltage {JP}| market for | Alloc Def, U		0	kWh	Lognormal	1.096	(2,3,2,3,1,na)
Electricity, low voltage {KR}| market for | Alloc Def, U		0	kWh	Lognormal	1.096	(2,3,2,3,1,na)
Electricity, low voltage {LU}| market for | Alloc Def, U		0	kWh	Lognormal	1.096	(2,3,2,3,1,na)
Electricity, low voltage {MK}| market for | Alloc Def, U		0	kWh	Lognormal	1.096	(2,3,2,3,1,na)
Electricity, low voltage {MRO, US only}| market for | Alloc Def, U		0	kWh	Lognormal	1.096	(2,3,2,3,1,na)
Electricity, low voltage {MX}| market for | Alloc Def, U		0	kWh	Lognormal	1.096	(2,3,2,3,1,na)
Electricity, low voltage {MY}| market for | Alloc Def, U		0	kWh	Lognormal	1.096	(2,3,2,3,1,na)
Electricity, low voltage {NL}| market for | Alloc Def, U		0	kWh	Lognormal	1.096	(2,3,2,3,1,na)
Electricity, low voltage {NO}| market for | Alloc Def, U		0	kWh	Lognormal	1.096	(2,3,2,3,1,na)
Electricity, low voltage {NPCC, US only}| market for | Alloc Def, U		0	kWh	Lognormal	1.096	(2,3,2,3,1,na)
Electricity, low voltage {PE}| market for | Alloc Def, U		0	kWh	Lognormal	1.096	(2,3,2,3,1,na)
Electricity, low voltage {PL}| market for | Alloc Def, U		0	kWh	Lognormal	1.096	(2,3,2,3,1,na)
Electricity, low voltage {PT}| market for | Alloc Def, U		0	kWh	Lognormal	1.096	(2,3,2,3,1,na)
Electricity, low voltage {Quebec}| market for | Alloc Def, U		0	kWh	Lognormal	1.096	(2,3,2,3,1,na)
Electricity, low voltage {RFC}| market for | Alloc Def, U		0	kWh	Lognormal	1.096	(2,3,2,3,1,na)
Electricity, low voltage {RO}| market for | Alloc Def, U		0	kWh	Lognormal	1.096	(2,3,2,3,1,na)
Electricity, low voltage {RS}| market for | Alloc Def, U		0	kWh	Lognormal	1.096	(2,3,2,3,1,na)
Electricity, low voltage {RU}| market for | Alloc Def, U		0	kWh	Lognormal	1.096	(2,3,2,3,1,na)
Electricity, low voltage {SA}| market for | Alloc Def, U		0	kWh	Lognormal	1.096	(2,3,2,3,1,na)
Electricity, low voltage {SE}| market for | Alloc Def, U		0	kWh	Lognormal	1.096	(2,3,2,3,1,na)
Electricity, low voltage {SERC}| market for | Alloc Def, U		0	kWh	Lognormal	1.096	(2,3,2,3,1,na)
Electricity, low voltage {SI}| market for | Alloc Def, U		0	kWh	Lognormal	1.096	(2,3,2,3,1,na)
Electricity, low voltage {SK}| market for | Alloc Def, U		0	kWh	Lognormal	1.096	(2,3,2,3,1,na)
Electricity, low voltage {SPP}| market for | Alloc Def, U		0	kWh	Lognormal	1.096	(2,3,2,3,1,na)
Electricity, low voltage {TH}| market for | Alloc Def, U		0	kWh	Lognormal	1.096	(2,3,2,3,1,na)
Electricity, low voltage {TR}| market for | Alloc Def, U		0	kWh	Lognormal	1.096	(2,3,2,3,1,na)
Electricity, low voltage {TRE}| market for | Alloc Def, U		0	kWh	Lognormal	1.096	(2,3,2,3,1,na)
Electricity, low voltage {TW}| market for | Alloc Def, U		0	kWh	Lognormal	1.096	(2,3,2,3,1,na)
Electricity, low voltage {TZ}| market for | Alloc Def, U		0	kWh	Lognormal	1.096	(2,3,2,3,1,na)
Electricity, low voltage {UA}| market for | Alloc Def, U		0	kWh	Lognormal	1.096	(2,3,2,3,1,na)
Electricity, low voltage {WECC, US only}| market for | Alloc Def, U		0	kWh	Lognormal	1.096	(2,3,2,3,1,na)
Electricity, low voltage {ZA}| market for | Alloc Def, U		0.716613168	kWh	Lognormal	1.096	(2,3,2,3,1,na)
Electricity, low voltage {RoW}| market for | Alloc Def, U		0	kWh	Lognormal	1.096	(2,3,2,3,1,na)
Heat, district or industrial, natural gas {Europe without Switzerland}| market for heat, district or industrial, natural gas | Alloc Def, U		0.058341544	MJ	Lognormal	1.096	(2,3,2,3,1,na)
Heat, district or industrial, natural gas {RoW}| market for heat, district or industrial, natural gas | Alloc Def, U		1.516413401	MJ	Lognormal	1.096	(2,3,2,3,1,na)
Emissions to air						
Xylene	high. pop.	8.53E-05	kg	Lognormal	1.1503	(3,4,2,3,1,na)

SimaPro Edited Offset Printing ZA

					Calculated value: Emissions from the use of solvent Naphtha, white spirit and other petrol based derivates. Average of three companies calculated from the mass balance of product use and recovery for recycling/disposal. Toluene and Xylene assumed main components of cyclic hydrocarbons, related content of cylcic hydrocarbons from product specifications expressed by 50% Xylene and 50% Toluene.
Propylene oxide	high. pop.	0.000181 kg	Lognormal	1.2152	(4,3,2,3,1,na)
					Calculated, stochiometric value: Emissions from the use of ink solvent. Average of three companies calculated from the mass balance of product use and recovery for recycling/disposal. Portion of Methoxypropanol derived from product specifications and related emissions expressed by the portion of methanol and propylene oxide used for the production of Methoxypropanol.
Toluene	high. pop.	8.53E-05 kg	Lognormal	1.2152	(4,3,2,3,1,na)
					Calculated value: Emissions from the use of solvent Naphtha, white spirit and other petrol based derivates. Average of three companies calculated from the mass balance of product use and recovery for recycling. Toluene and Xylene assumed for the portion of cyclic hydrocarbons, related portion derived from product specifications and expressed by 50% Xylene and 50% Toluene.
Benzene, ethyl-	high. pop.	9.66E-05 kg	Lognormal	1.1256	(3,3,2,3,1,na)
					Calculated value: Emissions from the use of solvent Naphtha, white spirit and other petrol based derivates (i.e. ink solvent). Average of three companies calculated from the mass balance of product use and its recovery for recycling. Benzene, ethyl- content of products derived from product specifications.
2-Propanol	high. pop.	0.002173 kg	Lognormal	1.1256	(3,3,2,3,1,na)
					Calculated value: average from three companies calculated from the mass balance of solvent consumption and solvent recovery for recycling.
Heptane	high. pop.	0.000945 kg	Lognormal	1.1256	(3,3,2,3,1,na)
					Calculated value: Emissions from the use of solvent Naphtha, white spirit and other petrol based derivates. Average of three companies calculated from the mass balance of product use and recovery for recycling. Heptane used for the portion of aliphatic hydrocarbons C7-C12 given in product specifications.
Methanol	high. pop.	9.97E-05 kg	Lognormal	1.2152	(4,3,2,3,1,na)
					Calculated, stochiometric value: Emissions from the use of ink solvent. Average of three companies calculated from the mass balance of product use and recovery for recycling/disposal. Portion of Methoxypropanol in ink solvent derived from product specifications and related emissions expressed by the portion of methanol and propylene oxide used for the production of Methoxypropanol.
Emissions to water					
Emissions to soil					
Final waste flows					
Non material emissions					
Social issues					
Economic issues					
Waste to treatment					
Input parameters					
Calculated parameters					

Electricity, high voltage {ZA IRP}

SimaPro 8.0.2 process Date: 2/2/2015 Time: 10:58 AM
Project Digital vs Print LCA

Process

Category type	energy
Process identifier	FFLUCT7595335400013
Type	Unit process
Process name	market for electricity, high voltage ZA
Status	
Time period	Unspecified
Geography	Unspecified
Technology	Unspecified
Representativeness	Unspecified
Multiple output allocation	Unspecified
Substitution allocation	Unspecified
Cut off rules	Unspecified
Capital goods	Unspecified
Boundary with nature	Unspecified
Infrastructure	No
Date	10/22/2013
Record	data entry by: Karin Treyer karin.treyer@psi.ch ,, . ., Switzerlandis active author:
Generator	generated by: Karin Treyer karin.treyer@psi.ch ,, . ., Switzerland
Literature references	Ecoinvent 3 data published in: 2 Data has been published entirely in (refers to field 757) data published by: Life Cycle Inventory of Electricity Mixes and Grid 2012 Separate publication page numbers: chapter 4 is copyright protected: true
Collection method	sampling procedure: Literature, statistics
Data treatment	extrapolations: This dataset has been extrapolated from year 2008 to the year of the calculation (2013). The uncertainty has been adjusted accordingly.
Verification	
Comment	This dataset describes the electricity available on the high voltage level in this country. This is done by showing the transmission of 1kWh electricity at high voltage. Production volume: 239082798613.511 kWh Included activities start: This activity starts from 1kWh of electricity fed into the high voltage transmission network. Included activities end: This activity ends with the transport of 1 kWh of high voltage electricity in the transmission network over aerial lines and cables. This dataset includes: - electricity inputs produced in this country and from imports - the transmission network - direct emissions to air (ozone and N2O). - electricity losses during transmission This dataset doesn't include - electricity losses during transformation, as these are included in the dataset for transformation - Zinc emissions from steel masts. Steel masts used for aerial lines are coated in order to prevent corrosion. The commonly used process is hot-dip galvanising using zinc as anticorrosive. In general a duplex process is used applying a zinc and paint coating to further improve the corrosion protection. In addition, the selection of the colour can improve the embedding into the landscape <van Oeteren 1988>. With this additional protection the zinc emissions into soil can be neglected <van Oeteren 1988>. - leakage of insulation oil from cables and electro technical equipment (transformers, switchgear, circuit breakers) because this only happens in case of accidental release - data for electromagnetic fields - SF6 emissions during the transmission, as these are allocated to the market dataset for medium voltage. - SF6 emissions during production and deconstruction of the switchgear, as these are accounted for in the transmission network dataset. K.-A. van Oeteren, "Feuerverzinkung", expert-Verlag, Ehningen 1988 Energy values: Undefined (default) Technology level: 0 undefined Technology: Average technology used to transmit and distribute electricity. Includes underground and overhead lines. Electricity production according to related technology datasets. Definition of the voltage levels: - High voltage level above 24 kV (large scale industry) - Medium voltage level between 1 kV and 24 kV (medium to small scale industry, service sector and public buildings) - Low voltage level below 1 kV (Households) Start date: 2008-01-01 End date: 2013-12-31 Is data valid for entire period: true Time period: The annual production volumes of all electricity production datasets in ecoinvent version 3.0 are taken from IEA/OECD statistics and are valid for 2008. Macro-economic scenario name: Business-as-Usual Version: 3.0.1.0 Created: 2012-06-20T07:32:31 Last edited: 2012-07-04T18:29:49 Source: a8606fb9-7bf5-42c0-bceb-2510b9271e5d_66c93e71-f32b-4591-901c-5539Sdb5c132.spold Link: https://ecoquery.ecoinvent.org/Details/UPR/E528B231-8BCE-4A9F-95A9-013A8FFD30F7/06590A66-662A-4885-8494-AD0CF410F956

Electricity, high voltage {ZA IRP}
Allocation rules
System description Ecoinvent v3.01

Products

Electricity, high voltage {ZA IRP}| market for | Alloc Def,		1	kWh	100	not define	Electricity country mix\High Voltage\Market

Avoided products

Resources

Materials/fuels

Transmission network, electricity, high voltage {GLO}| m	6.5821E-09	km	Lognormal	1.9918	(3,2,4,4,3,na) Estimation. Data overtaken from Switzerland. Swiss data are calculated values based on the electricity transported in this voltage level (60129 GWh) and the total medium voltage power line length in Switzerland (cables and aerial lines - 15831 km). Lifetime is assumed to be 40 years. See Itten&Frischknecht 2012, Tab. 4.1 and Tab. 4.3.
Transmission network, long-distance {GLO}| market for |	3.17E-10	km	Lognormal	1.9918	(3,2,4,4,3,na) Estimation. Data overtaken from Switzerland. Swiss data are calculated values based on the capacity of the power lines (1GWh), the load (60%) and the lifetime (30a) (see Frischknecht et al. 2007)

Electricity/heat

Electricity, high voltage {ZA IRP}| market for | Alloc Def, U	0.03432	kWh	Lognormal	1.0936	(1,1,3,1,1,na) Estimation. Compensation for the losses during transmission.
Electricity, high voltage {ZA IRP}| electricity production, hard coal | Alloc Def, U	0.628432207	kWh	Undefined		Production Volume Amount: 211903120000
Electricity, high voltage {ZA IRP}| electricity production, hydro, reservoir, non-alpine region | Alloc Def, U	0.048340939	kWh	Undefined		Production Volume Amount: 1277000000
Electricity, high voltage {ZA IRP}| electricity production, nuclear, pressure water reactor | Alloc Def, U	0.193363756	kWh	Undefined		Production Volume Amount: 12224003561.0279
Electricity, high voltage {ZA IRP}| electricity production, oil | Alloc Def, U	0.009668188	kWh	Undefined		Production Volume Amount: 132992220.264932
Electricity, high voltage {ZA}| electricity production, wind, 1-3MW turbine, onshore | Alloc Def, U	0.038672751	kWh	Undefined		Production Volume Amount: 30983040
Electricity, low voltage {RoW IRP}| electricity production, photovoltaic, 570kWp open ground installation, multi-Si | Alloc Def, U	0.048340939	kWh	Undefined		

Emissions to air

Dinitrogen monoxide	0.00005	kg	Lognormal	4.4554	(5,5,5,3,5,na) Literatur value/estimation. The electro-magnetic field near high voltage aerial lines can lead to the ionisation of air molecules and to the formation of nitrous oxide and ozone. This reaction happens in a boundary layer called corona. The formation of pollutants depends on the weather and the surface of the conductor. Therefore, only a few general assumptions can be made. Hill et al. 1984 report a nitrous oxide formation rate between 0.01 and 0.21 g per kWh of electricity transmitted, valid for North American conditions. The geometric mean of 0.05 g/kWh. This emission rate is overtaken for this country.
Ozone	4.15773E-06	kg	Lognormal	5.3937	(5,5,5,5,5,na) Literatur value/estimation. The electro-magnetic field near high voltage aerial lines can lead to the ionisation of air molecules and to the formation of nitrous oxide and ozone. This reaction happens in a boundary layer called corona. The formation of pollutants depends on the weather and the surface of the conductor. Therefore, only a few general assumptions can be made. Bohlin et al. 1991 and Böhringer et al. 1988 report very low ozone concentrations near the corona, which hardly can be measured. The value here is estimated from Swiss data: - annual ozone emissions: 50-1250 tons (Knoepfel 1995, p. 99). The geometric mean of 250 t/year is used for calculations. - annual amount of electricity transported in Switzerland: 60129 GWh. S. Bohlin, K. Eriksson, G. Flisberg, ""Electrical transmission"", World Clean Energy Conf., Geneva, Nov. 1991 A. Böhringer et al., ""Ozonbildung an Hochspannungsfreileitungen"", Elektrizitätswirtschaft 87(1988) Nr. 21, S. 1017-1022

Emissions to water

Emissions to soil

Final waste flows

Non material emissions

Social issues

Economic issues

Waste to treatment

Input parameters

Calculated parameters

APPENDIX D: DIGITAL SYSTEM SIMAPRO PROCESS EDITS

Apple Air iPad Production

SimaPro 8.0.2	process	Date:	2/2/2015	Time:	10:49 AM
Project	Digital vs Print LCA				
Process					
Category type	material				
Process identifier	FFLUCT7595335400004				
Type	Unit process				
Process name	Apple Air iPad				
Status					
Time period	Unspecified				
Geography	Unspecified				
Technology	Unspecified				
Representativeness	Unspecified				
Multiple output allocation	Unspecified				
Substitution allocation	Unspecified				
Cut off rules	Unspecified				
Capital goods	Unspecified				
Boundary with nature	Unspecified				
Infrastructure	No				
Date	10/20/2014				
Record					
Generator					
Literature references					
Collection method					
Data treatment					
Verification					
Comment					
Allocation rules					
System description					

Products			
Apple Air iPad	741 g	100 Others	Electronics
Avoided products			
Resources			
Materials/fuels			
Flat glass, coated {RER}| production | Alloc Def, U	61 g	Undefined	
Liquid crystal display, unmounted {GLO}| production | Alloc Def, U	109 g	Undefined	
Aluminium, wrought alloy {RoW}| aluminium production, primary | Alloc Def, U	86 g	Undefined	
Battery cell, Li-ion {CN}| production | Alloc Def, U	161 g	Undefined	
Acrylonitrile-butadiene-styrene copolymer {RoW}| production | Alloc Def, U	33 g	Undefined	
Polystyrene, general purpose {RoW}| production | Alloc Def, U	66 g	Undefined	
Corrugated board box {RoW}| corrugated board box production | Alloc Def, U	166 g	Undefined	
Integrated circuit, logic type {GLO}| production | Alloc Def, U	24 g	Undefined	
Integrated circuit, memory type {GLO}| production | Alloc Def, U	8 g	Undefined	
Electricity/heat			
Emissions to air			
Emissions to water			
Emissions to soil			
Final waste flows			
Non material emissions			
Social issues			
Economic issues			
Waste to treatment			
Input parameters			
Calculated parameters			

Apple Air iPad Distribution

SimaPro 8.0.2	process	Date:	2/2/2015	Time:	10:55 AM
Project	Digital vs Print LCA				

Process

Category type	transport
Process identifier	FFLUCT7595335400012
Type	
Process name	
Status	
Time period	Unspecified
Geography	Unspecified
Technology	Unspecified
Representativeness	Unspecified
Multiple output allocation	Unspecified
Substitution allocation	Unspecified
Cut off rules	Unspecified
Capital goods	Unspecified
Boundary with nature	Unspecified
Infrastructure	No
Date	12/19/2014
Record	
Generator	
Literature references	
Collection method	
Data treatment	
Verification	
Comment	
Allocation rules	
System description	

Products

Apple Air iPad Distribution Transportation	1	p	100	not definec Road

Avoided products

Resources

Materials/fuels

Transport, freight, sea, transoceanic ship {GLO}| market for | Alloc Def, U	5.734718	tkm	Undefined
Transport, freight, lorry 16-32 metric ton, EURO4 {GLO}| market for | Alloc Def, S	0.240858	tkm	Undefined

Electricity/heat

Emissions to air

Emissions to water

Emissions to soil

Final waste flows

Non material emissions

Social issues

Economic issues

Waste to treatment

Input parameters

Calculated parameters

Retail transportation

SimaPro 8.0.2			process	Date: 2014/10/08	Time: 11:22 PM
Project			Electronic tablet pc vs printed paper books		

Process

Category type	Retail transportation
Process identifier	FFLUCT0795365300022
Type	
Process name	
Status	
Time period	Unspecified
Geography	Unspecified
Technology	Unspecified
Representativeness	Unspecified
Multiple output allocation	Unspecified
Substitution allocation	Unspecified
Cut off rules	Unspecified
Capital goods	Unspecified
Boundary with nature	Unspecified
Infrastructure	No
Date	6/20/2014
Record	
Generator	
Literature references	
Collection method	
Data treatment	
Verification	
Comment	
Allocation rules	
System description	

Products

Retail transportation	1	p	100 not definec	Road\Market

Avoided products

Resources

Materials/fuels

Transport, passenger car, medium size, petrol, EURO 3 {GLO}| market for | Alloc Def, U	10	km	Undefined

Electricity/heat

Emissions to air

Emissions to water

Emissions to soil

Final waste flows

Non material emissions

Social issues

Economic issues

Waste to treatment

Input parameters

e-book formatting

SimaPro 8.0.2	process	Date:	2/2/2015	Time:	10:53 AM
Project	Digital vs Print LCA				

Process

Category type	processing
Process identifier	FFLUCT7595335400009
Type	
Process name	
Status	
Time period	Unspecified
Geography	Unspecified
Technology	Unspecified
Representativeness	Unspecified
Multiple output allocation	Unspecified
Substitution allocation	Unspecified
Cut off rules	Unspecified
Capital goods	Unspecified
Boundary with nature	Unspecified
Infrastructure	No
Date	12/19/2014
Record	
Generator	
Literature references	
Collection method	
Data treatment	
Verification	
Comment	
Allocation rules	
System description	

Products

e-book formatting	1	p	100	not definec Electronics

Avoided products

Resources

Materials/fuels

Operation, computer, desktop, office use {GLO}| market for | Alloc Def, U	0.05	hr	Undefined

Electricity/heat

Emissions to air

Emissions to water

Emissions to soil

Final waste flows

Non material emissions

Social issues

Economic issues

Waste to treatment

Input parameters

Calculated parameters

e-book download

SimaPro 8.0.2			process	Date:	2/2/2015 Time: 10:57 AM
Project			Digital vs Print LCA		

Process

Category type	processing
Process identifier	FFLUCT7595335400007
Type	
Process name	
Status	
Time period	Unspecified
Geography	Unspecified
Technology	Unspecified
Representativeness	Unspecified
Multiple output allocation	Unspecified
Substitution allocation	Unspecified
Cut off rules	Unspecified
Capital goods	Unspecified
Boundary with nature	Unspecified
Infrastructure	No
Date	12/19/2014
Record	
Generator	
Literature references	
Collection method	
Data treatment	
Verification	
Comment	
Allocation rules	
System description	

Products

e-book download	1	p	100	not definec Electronics

Avoided products

Resources

Materials/fuels

Electricity, low voltage {ZA}| electricity voltage transformation from medium to low voltage | Alloc Def, U	8.46803	Wh	Undefined

Electricity/heat

Emissions to air

Emissions to water

Emissions to soil

Final waste flows

Non material emissions

Social issues

Economic issues

Waste to treatment

Input parameters

Calculated parameters

E-book Reading

SimaPro 8.0.2	process	Date:	2/2/2015	Time:	10:51 AM
Project	Digital vs Print LCA				

Process

Category type	processing
Process identifier	FFLUCT7595335400010
Type	
Process name	
Status	
Time period	Unspecified
Geography	Unspecified
Technology	Unspecified
Representativeness	Unspecified
Multiple output allocation	Unspecified
Substitution allocation	Unspecified
Cut off rules	Unspecified
Capital goods	Unspecified
Boundary with nature	Unspecified
Infrastructure	No
Date	12/19/2014
Record	
Generator	
Literature references	
Collection method	
Data treatment	
Verification	
Comment	
Allocation rules	
System description	

Products

e-book reading	1 p	100	not defined	Electronics

Avoided products

Resources

Materials/fuels

Electricity, low voltage {ZA}| market for | Alloc Def, U	654.71	Wh	Undefined

Electricity/heat

Emissions to air

Emissions to water

Emissions to soil

Final waste flows

Non material emissions

Social issues

Economic issues

Waste to treatment

Input parameters

Calculated parameters

Waste scenario

SimaPro 8.0.2	process	Date:	2/2/2015	Time:	2:55 F
Project	Digital vs Print LCA				

Process

Category type	waste scenario
Process identifier	FFLUCT7595335400057
Type	
Process name	
Status	
Time period	Unspecified
Geography	Unspecified
Technology	Unspecified
Representativeness	Unspecified
Cut off rules	Unspecified
Capital goods	Unspecified
Boundary with nature	Unspecified
Infrastructure	No
Date	6/17/2013
Record	
Generator	
Literature references	
Collection method	
Data treatment	
Verification	
Comment	
Allocation rules	
System description	

Waste scenario

Municipal solid waste (waste scenario) {ZA iPad Base}| Treatment of municipal solid waste, landfill | Alloc Def, U	1 kg	All waste t	Landfill	Note th

Materials/fuels

Electricity/heat

Separated waste

Scrap steel (waste treatment) {CH}| treatment of scrap steel, inert material landfill | Alloc Def, U	Steel	0
Waste glass (waste treatment) {CH}| treatment of waste glass, inert material landfill | Alloc Def, U	Glass	0
Scrap tin sheet (waste treatment) {CH}| treatment of scrap tin sheet, sanitary landfill | Alloc Def, U	Tin Sheet	100
Waste aluminium (waste treatment) {RoW}| treatment of waste aluminium, sanitary landfill | Alloc Def, U	Aluminium	0
Waste graphical paper (waste treatment) {RoW}| treatment of waste graphical paper, sanitary landfill | Alloc Def, U	Paper	0
Waste graphical paper (waste treatment) {RoW}| treatment of waste graphical paper, sanitary landfill | Alloc Def, U	Packaging paper	0
Waste graphical paper (waste treatment) {RoW}| treatment of waste graphical paper, sanitary landfill | Alloc Def, U	Newspaper	100
Waste paint (waste treatment) {RoW}| treatment of waste paint, sanitary landfill | Alloc Def, U	Paint	100
Waste paperboard (waste treatment) {RoW}| treatment of waste paperboard, sanitary landfill | Alloc Def, U	Cardboard	0
Waste plastic, mixture (waste treatment) {CH}| treatment of waste plastic, mixture, sanitary landfill | Alloc Def, U	Plastics	0
Waste polyethylene (waste treatment) {CH}| treatment of waste polyethylene, sanitary landfill | Alloc Def, U	PE	0
Waste polyethylene terephtalate (waste treatment) {CH}| treatment of waste polyethylene terephtalate, sanitary landfill | Alloc Def, U	PET	0
Waste polypropylene (waste treatment) {CH}| treatment of waste polypropylene, sanitary landfill | Alloc Def, U	PP	0
Waste polystyrene (waste treatment) {CH}| treatment of waste polystyrene, sanitary landfill | Alloc Def, U	PS	0
Waste polyurethane (waste treatment) {RoW}| treatment of waste polyurethane, sanitary landfill | Alloc Def, U	PUR	0
Waste polyvinylchloride (waste treatment) {CH}| treatment of waste polyvinylchloride, sanitary landfill | Alloc Def, U	PVC	0
Waste wood, untreated (waste treatment) {CH}| treatment of waste wood, untreated, sanitary landfill | Alloc Def, U	Wood	100

Remaining waste

Municipal solid waste (waste treatment) {RoW}| treatment of municipal solid waste, sanitary landfill | Alloc Def, U	100

Input parameters

Calculated parameters

Electricity, high voltage {ZA IRP}

SimaPro 8.0.2 process Date: 2/2/2015 Time: 10:58 AM
Project Digital vs Print LCA

Process

Category type	energy
Process identifier	FFLUCT7595335400013
Type	Unit process
Process name	market for electricity, high voltage ZA
Status	
Time period	Unspecified
Geography	Unspecified
Technology	Unspecified
Representativeness	Unspecified
Multiple output allocation	Unspecified
Substitution allocation	Unspecified
Cut off rules	Unspecified
Capital goods	Unspecified
Boundary with nature	Unspecified
Infrastructure	No
Date	10/22/2013
Record	data entry by: Karin Treyer karin.treyer@psi.ch ,, . ., Switzerlandis active author:
Generator	generated by: Karin Treyer karin.treyer@psi.ch ,, . ., Switzerland
Literature references	Ecoinvent 3 data published in: 2 Data has been published entirely in (refers to field 757) data published by: Life Cycle Inventory of Electricity Mixes and Grid 2012 Separate publication page numbers: chapter 4 is copyright protected: true
Collection method	sampling procedure: Literature, statistics
Data treatment	extrapolations: This dataset has been extrapolated from year 2008 to the year of the calculation (2013). The uncertainty has been adjusted accordingly.
Verification	
Comment	This dataset describes the electricity available on the high voltage level in this country. This is done by showing the transmission of 1kWh electricity at high voltage. Production volume: 239082798613.511 kWh Included activities start: This activity starts from 1kWh of electricity fed into the high voltage transmission network. Included activities end: This activity ends with the transport of 1 kWh of high voltage electricity in the transmission network over aerial lines and cables. This dataset includes: - electricity inputs produced in this country and from imports - the transmission network - direct emissions to air (ozone and N2O). - electricity losses during transmission This dataset doesn't include - electricity losses during transformation, as these are included in the dataset for transformation - Zinc emissions from steel masts. Steel masts used for aerial lines are coated in order to prevent corrosion. The commonly used process is hot-dip galvanising using zinc as anticorrosive. In general a duplex process is used applying a zinc and paint coating to further improve the corrosion protection. In addition, the selection of the colour can improve the embedding into the landscape <van Oeteren 1988>. With this additional protection the zinc emissions into soil can be neglected <van Oeteren 1988>. - leakage of insulation oil from cables and electro technical equipment (transformers, switchgear, circuit breakers) because this only happens in case of accidental release - data for electromagnetic fields - SF6 emissions during the transmission, as these are allocated to the market dataset for medium voltage. - SF6 emissions during production and deconstruction of the switchgear, as these are accounted for in the transmission network dataset. K.-A. van Oeteren, "Feuerverzinkung", expert-Verlag, Ehningen 1988 Energy values: Undefined (default) Technology level: 0 undefined Technology: Average technology used to transmit and distribute electricity. Includes underground and overhead lines. Electricity production according to related technology datasets. Definition of the voltage levels: - High voltage level above 24 kV (large scale industry) - Medium voltage level between 1 kV and 24 kV (medium to small scale industry, service sector and public buildings) - Low voltage level below 1 kV (Households) Start date: 2008-01-01 End date: 2013-12-31 Is data valid for entire period: true Time period: The annual production volumes of all electricity production datasets in ecoinvent version 3.0 are taken from IEA/OECD statistics and are valid for 2008. Macro-economic scenario name: Business-as-Usual Version: 3.0.1.0 Created: 2012-06-20T07:32:31 Last edited: 2012-07-04T18:29:49 Source: a8606fb9-7bf5-42c0-bceb-2510b9271e5d_66c93e71-f32b-4591-901c-5539Sdb5c132.spold Link: https://ecoquery.ecoinvent.org/Details/UPR/E528B231-8BCE-4A9F-95A9-013A8FFD30F7/06590A66-662A-4885-8494-AD0CF410F956

Electricity, high voltage {ZA IRP}
Allocation rules
System description Ecoinvent v3.01

Products

Electricity, high voltage {ZA IRP}| market for | Alloc Def,		1	kWh	100	not define	Electricity country mix\High Voltage\Market

Avoided products

Resources

Materials/fuels

Transmission network, electricity, high voltage {GLO}| m	6.5821E-09	km	Lognormal	1.9918	(3,2,4,4,3,na) Estimation. Data overtaken from Switzerland. Swiss data are calculated values based on the electricity transported in this voltage level (60129 GWh) and the total medium voltage power line length in Switzerland (cables and aerial lines - 15831 km). Lifetime is assumed to be 40 years. See Itten&Frischknecht 2012, Tab. 4.1 and Tab. 4.3.
Transmission network, long-distance {GLO}| market for |	3.17E-10	km	Lognormal	1.9918	(3,2,4,4,3,na) Estimation. Data overtaken from Switzerland. Swiss data are calculated values based on the capacity of the power lines (1GWh), the load (60%) and the lifetime (30a) (see Frischknecht et al. 2007)

Electricity/heat

Electricity, high voltage {ZA IRP}| market for | Alloc Def, U	0.03432	kWh	Lognormal	1.0936	(1,1,3,1,1,na) Estimation. Compensation for the losses during transmission.
Electricity, high voltage {ZA IRP}| electricity production, hard coal | Alloc Def, U	0.628432207	kWh	Undefined		Production Volume Amount: 211903120000
Electricity, high voltage {ZA IRP}| electricity production, hydro, reservoir, non-alpine region | Alloc Def, U	0.048340939	kWh	Undefined		Production Volume Amount: 1277000000
Electricity, high voltage {ZA IRP}| electricity production, nuclear, pressure water reactor | Alloc Def, U	0.193363756	kWh	Undefined		Production Volume Amount: 12224003561.0279
Electricity, high voltage {ZA IRP}| electricity production, oil | Alloc Def, U	0.009668188	kWh	Undefined		Production Volume Amount: 132992220.264932
Electricity, high voltage {ZA}| electricity production, wind, 1-3MW turbine, onshore | Alloc Def, U	0.038672751	kWh	Undefined		Production Volume Amount: 30983040
Electricity, low voltage {RoW IRP}| electricity production, photovoltaic, 570kWp open ground installation, multi-Si | Alloc Def, U	0.048340939	kWh	Undefined		

Emissions to air

Dinitrogen monoxide	0.00005	kg	Lognormal	4.4554	(5,5,5,3,5,na) Literatur value/estimation. The electro-magnetic field near high voltage aerial lines can lead to the ionisation of air molecules and to the formation of nitrous oxide and ozone. This reaction happens in a boundary layer called corona. The formation of pollutants depends on the weather and the surface of the conductor. Therefore, only a few general assumptions can be made. Hill et al. 1984 report a nitrous oxide formation rate between 0.01 and 0.21 g per kWh of electricity transmitted, valid for North American conditions. The geometric mean of 0.05 g/kWh. This emission rate is overtaken for this country.
Ozone	4.15773E-06	kg	Lognormal	5.3937	(5,5,5,5,5,na) Literatur value/estimation. The electro-magnetic field near high voltage aerial lines can lead to the ionisation of air molecules and to the formation of nitrous oxide and ozone. This reaction happens in a boundary layer called corona. The formation of pollutants depends on the weather and the surface of the conductor. Therefore, only a few general assumptions can be made. Bohlin et al. 1991 and Böhringer et al. 1988 report very low ozone concentrations near the corona, which hardly can be measured. The value here is estimated from Swiss data: - annual ozone emissions: 50-1250 tons (Knoepfel 1995, p. 99). The geometric mean of 250 t/year is used for calculations. - annual amount of electricity transported in Switzerland: 60129 GWh. S. Bohlin, K. Eriksson, G. Flisberg, ""Electrical transmission"", World Clean Energy Conf., Geneva, Nov. 1991 A. Böhringer et al., ""Ozonbildung an Hochspannungsfreileitungen"", Elektrizitätswirtschaft 87(1988) Nr. 21, S. 1017-1022

Emissions to water

Emissions to soil

Final waste flows

Non material emissions

Social issues

Economic issues

Waste to treatment

Input parameters

Calculated parameters

APPENDIX E: SIMAPRO LCA OUTPUT RESULTS

Print System Base Case SimaPro LCA Results

Calculation: Analyze
Results: Impact assessment
1 p Printed Book System Base Case (of project Digital vs
Product: Print LCA)
Method: ReCiPe Midpoint (H) V1.09 / Europe Recipe H
Indicator: Characterization
Skip categories: Never
Mode: Group
Exclude infrastructure processes: Yes
Exclude long-term emissions: Yes
Sorted on item: Impact category
Sort order: Ascending

Impact category	Unit	Total	Top	Pulpwood	Pulp	Paper	Waste Management	Printing	Distribution transportation	Retail Transportation
Climate change	kg CO2 eq	1.32E+02	0.00E+00	2.50E+00	1.90E+00	4.21E+01	1.95E+01	4.82E+01	6.42E+00	1.13E+01
Ozone depletion	kg CFC-11 eq	5.12E-06	0.00E+00	1.29E-07	6.07E-08	1.59E-06	1.02E-08	2.21E-06	4.18E-07	7.02E-07
Terrestrial acidification	kg SO2 eq	7.24E-01	0.00E+00	3.58E-02	1.68E-02	2.78E-01	2.99E-03	3.44E-01	3.16E-02	1.56E-02
Freshwater eutrophication	kg P eq	9.35E-03	0.00E+00	8.38E-04	3.46E-04	4.26E-03	7.07E-05	3.81E-03	6.84E-06	1.55E-05
Marine eutrophication	kg N eq	9.51E-02	0.00E+00	2.67E-03	1.03E-03	1.79E-02	4.38E-02	2.72E-02	1.96E-03	4.18E-04
Human toxicity	kg 1,4-DB eq	8.38E+00	0.00E+00	7.59E-01	1.70E-01	3.54E+00	1.57E-01	3.21E+00	6.78E-02	4.81E-01
Photochemical oxidant formation	kg NMVOC	6.29E-01	0.00E+00	9.70E-02	7.38E-03	2.07E-01	1.00E-02	2.29E-01	5.45E-02	2.40E-02
Particulate matter formation	kg PM10 eq	2.76E-01	0.00E+00	3.26E-02	4.83E-03	1.09E-01	1.02E-03	1.10E-01	1.31E-02	5.62E-03
Terrestrial ecotoxicity	kg 1,4-DB eq	1.99E-02	0.00E+00	1.12E-03	1.86E-04	1.01E-02	2.96E-05	6.65E-03	6.05E-04	1.21E-03
Freshwater ecotoxicity	kg 1,4-DB eq	6.29E-02	0.00E+00	1.03E-03	5.66E-04	2.94E-02	2.40E-03	2.62E-02	1.26E-03	2.08E-03
Marine ecotoxicity	kg 1,4-DB eq	8.29E-02	0.00E+00	5.49E-03	9.63E-04	3.66E-02	1.73E-03	2.28E-02	5.27E-03	9.97E-03
Ionising radiation	kBq U235 eq	3.27E+00	0.00E+00	1.20E-01	2.82E-02	8.96E-01	1.72E-02	1.34E+00	3.27E-01	5.48E-01
Agricultural land occupation	m2a	4.62E+02	0.00E+00	4.50E+02	1.65E-01	1.58E+00	3.35E-03	1.03E+01	3.51E-03	1.06E-02
Urban land occupation	m2a	4.50E+00	0.00E+00	4.14E+00	1.00E-02	8.10E-02	1.33E-03	2.59E-01	5.11E-04	2.28E-03
Natural land transformation	m2	3.47E-02	0.00E+00	2.78E-02	4.27E-05	4.54E-03	8.13E-06	2.26E-03	3.25E-06	1.23E-05
Water depletion	m3	1.93E+02	0.00E+00	2.28E+00	9.34E-01	4.17E+01	1.20E+00	1.45E+02	5.29E-01	1.25E+00
Metal depletion	kg Fe eq	4.65E-01	0.00E+00	4.44E-03	4.08E-03	1.05E-01	1.29E-03	3.41E-01	1.55E-03	7.46E-03
Fossil depletion	kg oil eq	3.22E+01	0.00E+00	6.71E-01	4.06E-01	1.30E+01	6.44E-02	1.22E+01	2.12E+00	3.68E+00

Print System Base Case SimaPro LCA Results

Calculation: Analyze
Results: Process contribution
1 p Printed Book System Base Case (of project Digital vs
Product: Print LCA)
Method: ReCiPe Midpoint (H) V1.09 / Europe Recipe H
Indicator: Characterization
Category: Climate change
Cut-off: 1%
Mode: Group
Exclude infrastructure processes: Yes
Exclude long-term emissions: Yes
Sorted on item: Total
Sort order: Descending

`	Process	Project	Unit	Total	Top	Pulpwood	Pulp	Paper	Waste Management	Printing	Distribution transportation	Retail Transportation
	Total of all processes		kg CO2 eq	1.32E+02	0.00E+00	2.50E+00	1.90E+00	4.21E+01	1.95E+01	4.82E+01	6.42E+00	1.13E+01
	Remaining processes		kg CO2 eq	4.01E+01	0.00E+00	2.34E+00	6.49E-01	1.11E+01	1.90E-01	2.18E+01	1.80E+00	2.12E+00
1	Electricity, high voltage {ZA}| electricity production, hard coal | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg CO2 eq	3.16E+01	0.00E+00	7.83E-03	1.48E-01	1.23E+01	3.75E-03	1.91E+01	5.37E-03	1.02E-02
2	Waste graphical paper {RoW}| treatment of, sanitary landfill | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg CO2 eq	1.43E+01	0.00E+00	2.22E-06	1.17E-03	1.04E-04	1.43E+01	1.33E-04	2.53E-06	4.36E-06
3	Paper, woodfree, coated {ZA}| paper production, woodfree, coated, at integrated mill | Alloc Def, U	Digital vs Print LCA	kg CO2 eq	1.40E+01	0.00E+00	0.00E+00	0.00E+00	1.40E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
4	Transport, passenger car, medium size, petrol, EURO 3 {RoW}| transport, passenger car, medium size, petrol, EURO 3 | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg CO2 eq	7.41E+00	0.00E+00	2.55E-08	3.23E-08	3.86E-07	1.20E-08	8.40E-07	1.51E-08	7.41E+00
5	Electricity, high voltage {RoW}| electricity production, hard coal | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg CO2 eq	5.47E+00	0.00E+00	3.46E-02	1.46E-02	6.60E-01	2.15E-02	4.72E+00	3.00E-03	8.53E-03
6	Municipal solid waste {RoW}| treatment of, sanitary landfill | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg CO2 eq	5.46E+00	0.00E+00	4.09E-05	2.30E-03	3.92E-01	4.99E+00	7.80E-02	9.31E-05	1.76E-04
7	Transport, freight, lorry 16-32 metric ton, EURO3 {RER}| transport, freight, lorry 16-32 metric ton, EURO3 | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg CO2 eq	5.04E+00	0.00E+00	4.20E-02	2.46E-03	1.42E-01	1.66E-04	2.55E-01	4.59E+00	1.46E-02
8	Electricity, high voltage {CN}| electricity production, hard coal | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg CO2 eq	2.63E+00	0.00E+00	7.78E-02	2.86E-02	7.56E-01	3.92E-02	1.59E+00	1.22E-02	1.31E-01
9	Latex {RoW}| production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg CO2 eq	2.61E+00	0.00E+00	4.75E-07	1.19E-06	2.54E+00	1.92E-07	7.20E-02	4.55E-07	4.42E-07
10	Heat, district or industrial, other than natural gas {RoW}| heat production, at hard coal industrial furnace 1-10MW | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg CO2 eq	1.86E+00	0.00E+00	3.11E-03	1.05E+00	2.21E-01	5.70E-03	5.25E-01	5.99E-03	4.72E-02
11	Transport, passenger car, medium size, petrol, EURO 3 {RER}| transport, passenger car, medium size, petrol, EURO 3 | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg CO2 eq	1.58E+00	0.00E+00	5.42E-09	6.86E-09	8.21E-08	2.55E-09	1.79E-07	3.20E-09	1.58E+00

Print System Base Case SimaPro LCA Results

Calculation: Analyze
Results: Process contribution
1 p Printed Book System Base Case (of project Digital vs
Product: Print LCA)
Method: ReCiPe Midpoint (H) V1.09 / Europe Recipe H
Indicator: Characterization
Category: Ozone depletion
Cut-off: 1%
Mode: Group
Exclude infrastructure processes: Yes
Exclude long-term emissions: Yes
Sorted on item: Total
Sort order: Descending

No	Process	Project	Unit	Total	Top	Pulpwood	Pulp	Paper	Waste Management	Printing	Distribution transportation	Retail Transportation
	Total of all processes		kg CFC-11 eq	5.12E-06	0.00E+00	1.29E-07	6.07E-08	1.59E-06	1.02E-08	2.21E-06	4.18E-07	7.02E-07
	Remaining processes		kg CFC-11 eq	5.95E-07	0.00E+00	7.29E-09	6.11E-09	2.37E-07	2.31E-09	3.03E-07	1.46E-08	2.44E-08
1	Petroleum {RoW}| and gas production, on-shore | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg CFC-11 eq	1.10E-06	0.00E+00	6.37E-08	1.14E-08	2.12E-07	6.73E-10	1.79E-07	2.37E-07	3.98E-07
2	Uranium, enriched 4.2%, per separative work unit {US}| uranium production, diffusion, enriched 4.2% | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg CFC-11 eq	3.90E-07	0.00E+00	5.55E-09	2.62E-09	1.34E-07	2.87E-09	2.41E-07	1.38E-09	1.98E-09
3	Transport, pipeline, long distance, natural gas {RU}| processing | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg CFC-11 eq	3.07E-07	0.00E+00	2.18E-09	1.12E-09	5.54E-08	1.16E-09	2.45E-07	7.98E-10	1.57E-09
4	Sodium hydroxide, without water, in 50% solution state {RoW}| chlor-alkali electrolysis, diaphragm cell | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg CFC-11 eq	2.82E-07	0.00E+00	3.05E-11	1.20E-08	2.21E-07	1.13E-11	4.88E-08	3.01E-11	2.33E-10
5	Tetrafluoroethylene {RoW}| production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg CFC-11 eq	2.70E-07	0.00E+00	6.20E-13	1.23E-12	9.77E-12	2.41E-13	2.70E-07	6.87E-13	6.39E-13
6	Sodium hydroxide, without water, in 50% solution state {RoW}| chlor-alkali electrolysis, membrane cell | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg CFC-11 eq	2.28E-07	0.00E+00	2.47E-11	9.74E-09	1.79E-07	9.14E-12	3.95E-08	2.43E-11	1.88E-10
7	Petroleum {NG}| and gas production, on-shore | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg CFC-11 eq	2.26E-07	0.00E+00	1.31E-08	2.33E-09	4.36E-08	1.38E-10	3.68E-08	4.86E-08	8.17E-08
8	Petroleum {RAF}| production, onshore | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg CFC-11 eq	2.07E-07	0.00E+00	1.20E-08	2.14E-09	4.00E-08	1.27E-10	3.37E-08	4.46E-08	7.48E-08
9	Petroleum {RME}| production, onshore | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg CFC-11 eq	1.99E-07	0.00E+00	1.15E-08	2.05E-09	3.83E-08	1.21E-10	3.23E-08	4.27E-08	7.17E-08
10	Uranium, enriched 3.8%, per separative work unit {US}| uranium production, diffusion, enriched 3.8% | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg CFC-11 eq	1.86E-07	0.00E+00	5.01E-09	1.38E-09	5.81E-08	2.08E-09	1.15E-07	1.92E-09	2.62E-09
11	Transport, pipeline, long distance, natural gas {RoW}| processing | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg CFC-11 eq	1.28E-07	0.00E+00	9.08E-10	4.38E-10	2.16E-08	4.99E-10	1.03E-07	3.14E-10	5.75E-10
12	Tetrafluoroethylene {RER}| production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg CFC-11 eq	1.25E-07	0.00E+00	2.86E-13	5.67E-13	4.51E-12	1.11E-13	1.25E-07	3.17E-13	2.95E-13
13	Chlorodifluoromethane {RoW}| production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg CFC-11 eq	1.25E-07	0.00E+00	1.60E-10	3.17E-10	2.48E-09	6.04E-11	1.21E-07	1.78E-10	1.59E-10
14	Petroleum {RU}| production, onshore | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg CFC-11 eq	1.22E-07	0.00E+00	7.07E-09	1.26E-09	2.36E-08	7.47E-11	1.99E-08	2.63E-08	4.41E-08
15	Trichloromethane {RER}| production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg CFC-11 eq	1.10E-07	0.00E+00	3.11E-10	2.73E-10	4.12E-09	5.52E-11	1.05E-07	1.55E-10	1.39E-10
16	Fluorescent whitening agent, distyrylbiphenyl type {RoW}| production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg CFC-11 eq	1.04E-07	0.00E+00	2.24E-14	4.41E-14	8.38E-08	8.47E-15	2.03E-08	2.46E-14	2.21E-14
17	Fluorescent whitening agent, DAS1, triazinylaminostilben type {RoW}| production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg CFC-11 eq	7.37E-08	0.00E+00	1.59E-14	3.12E-14	5.93E-08	6.00E-15	1.44E-08	1.74E-14	1.56E-14
18	Sodium hydroxide, without water, in 50% solution state {RoW}| chlor-alkali electrolysis, mercury cell | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg CFC-11 eq	6.05E-08	0.00E+00	6.55E-12	2.58E-09	4.73E-08	2.42E-12	1.05E-08	6.45E-12	4.99E-11
19	Sodium hydroxide, without water, in 50% solution state {RER}| chlor-alkali electrolysis, mercury cell | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg CFC-11 eq	6.05E-08	0.00E+00	6.55E-12	2.58E-09	4.73E-08	2.42E-12	1.05E-08	6.45E-12	4.99E-11
20	Trichloromethane {RoW}| production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg CFC-11 eq	6.02E-08	0.00E+00	1.70E-10	1.49E-10	2.25E-09	3.01E-11	5.74E-08	8.43E-11	7.58E-11
21	Refrigerant R134a {RoW}| production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg CFC-11 eq	5.44E-08	0.00E+00	7.35E-12	8.07E-12	1.66E-10	4.11E-12	5.42E-08	1.94E-12	1.61E-11
22	Sodium hydroxide, without water, in 50% solution state {RER}| chlor-alkali electrolysis, membrane cell | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg CFC-11 eq	5.26E-08	0.00E+00	5.69E-12	2.24E-09	4.12E-08	2.11E-12	9.11E-09	5.61E-12	4.34E-11
23	Fluorescent whitening agent, distyrylbiphenyl type {RER}| production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg CFC-11 eq	5.14E-08	0.00E+00	1.11E-14	2.18E-14	4.14E-08	4.18E-15	1.00E-08	1.21E-14	1.09E-14

Print System Base Case SimaPro LCA Results

Calculation: Analyze
Results: Process contribution
1 p Printed Book System Base Case (of project Digital vs
Product: Print LCA)
Method: ReCiPe Midpoint (H) V1.09 / Europe Recipe H
Indicator: Characterization
Category: Terrestrial acidification
Cut-off: 1%
Mode: Group
Exclude infrastructure processes: Yes
Exclude long-term emissions: Yes
Sorted on item: Total
Sort order: Descending

No	Process	Project	Unit	Total	Top	Pulpwood	Pulp	Paper	Waste Management	Printing	Distribution transportation	Retail Transportation
	Total of all processes		kg SO2 eq	7.24E-01	0.00E+00	3.58E-02	1.68E-02	2.78E-01	2.99E-03	3.44E-01	3.16E-02	1.56E-02
	Remaining processes		kg SO2 eq	1.96E-01	0.00E+00	1.81E-02	7.75E-03	6.29E-02	2.23E-03	8.21E-02	9.28E-03	1.35E-02
1	Electricity, high voltage {ZA}| electricity production, hard coal | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg SO2 eq	3.02E-01	0.00E+00	7.48E-05	1.41E-03	1.18E-01	3.58E-05	1.82E-01	5.13E-05	9.71E-05
2	Paper, woodfree, coated {ZA}| paper production, woodfree, coated, at integrated mill | Alloc Def, U	Digital vs Print LCA	kg SO2 eq	5.23E-02	0.00E+00	0.00E+00	0.00E+00	5.23E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
3	Electricity, high voltage {RoW}| electricity production, hard coal | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg SO2 eq	3.96E-02	0.00E+00	2.51E-04	1.06E-04	4.78E-03	1.56E-04	3.42E-02	2.17E-05	6.18E-05
4	Electricity, high voltage {CN}| electricity production, hard coal | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg SO2 eq	2.77E-02	0.00E+00	8.18E-04	3.01E-04	7.96E-03	4.13E-04	1.67E-02	1.29E-04	1.38E-03
5	Transport, freight, lorry 16-32 metric ton, EURO3 {RER}| transport, freight, lorry 16-32 metric ton, EURO3 | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg SO2 eq	2.42E-02	0.00E+00	2.02E-04	1.18E-05	6.82E-04	7.96E-07	1.23E-03	2.20E-02	7.02E-05
6	Natural gas, high pressure {RNA}| natural gas production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg SO2 eq	1.74E-02	0.00E+00	1.88E-04	7.46E-05	9.50E-03	1.06E-04	7.41E-03	1.66E-05	1.14E-04
7	Transport, freight, sea, transoceanic ship {GLO}| processing | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg SO2 eq	1.48E-02	0.00E+00	4.10E-04	9.74E-05	6.66E-03	8.31E-06	7.57E-03	4.13E-06	2.41E-05
8	Latex {RoW}| production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg SO2 eq	1.37E-02	0.00E+00	2.50E-09	6.27E-09	1.34E-02	1.01E-09	3.79E-04	2.39E-09	2.32E-09
9	Heat, district or industrial, other than natural gas {RoW}| heat production, at hard coal industrial furnace 1-10MW | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg SO2 eq	1.24E-02	0.00E+00	2.07E-05	6.99E-03	1.47E-03	3.79E-05	3.49E-03	3.98E-05	3.14E-04
10	Diesel, burned in building machine {GLO}| processing | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg SO2 eq	8.49E-03	0.00E+00	7.43E-03	1.60E-05	3.46E-04	1.57E-06	6.91E-04	7.96E-07	2.76E-06
11	Log, energy wood, split, measured as solid wood under bark {RoW}| heat production, mixed logs, at wood heater 6kW | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg SO2 eq	8.43E-03	0.00E+00	8.29E-03	2.54E-06	1.59E-06	4.76E-08	1.42E-04	4.69E-08	1.56E-07
12	Aluminium, primary, liquid {GLO}| aluminium production, primary, liquid, prebake | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg SO2 eq	7.71E-03	0.00E+00	7.10E-08	3.37E-07	9.73E-06	3.77E-08	7.70E-03	2.16E-08	5.02E-08

Print System Base Case SimaPro LCA Results

Calculation: Analyze
Results: Process contribution
1 p Printed Book System Base Case (of project Digital vs
Product: Print LCA)
Method: ReCiPe Midpoint (H) V1.09 / Europe Recipe H
Indicator: Characterization
Category: Freshwater eutrophication
Cut-off: 1%
Mode: Group
Exclude infrastructure processes: Yes
Exclude long-term emissions: Yes
Sorted on item: Total
Sort order: Descending

No	Process	Project	Unit	Total	Top	Pulpwood	Pulp	Paper	Waste Management	Printing	Distribution transportation	Retail Transportation
	Total of all processes		kg P eq	9.35E-03	0.00E+00	8.38E-04	3.46E-04	4.26E-03	7.07E-05	3.81E-03	6.84E-06	1.55E-05
	Remaining processes		kg P eq	4.79E-04	0.00E+00	1.69E-05	4.41E-05	1.42E-04	5.83E-05	2.17E-04	3.58E-07	8.62E-07
1	Spoil from hard coal mining {GLO}| treatment of, in surface landfill | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg P eq	3.80E-03	0.00E+00	1.40E-05	6.70E-05	1.37E-03	8.08E-06	2.33E-03	2.92E-06	9.50E-06
2	Wood ash mixture, pure {CH}| treatment of, landfarming | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg P eq	2.18E-03	0.00E+00	7.99E-04	2.31E-04	6.01E-04	1.49E-07	5.47E-04	9.43E-08	2.36E-07
3	Spoil from lignite mining {GLO}| treatment of, in surface landfill | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg P eq	2.17E-03	0.00E+00	7.60E-06	2.67E-06	1.66E-03	4.14E-06	4.92E-04	3.24E-06	3.42E-06
4	Paper, woodfree, coated {ZA}| paper production, woodfree, coated, at integrated mill | Alloc Def, U	Digital vs Print LCA	kg P eq	4.58E-04	0.00E+00	0.00E+00	0.00E+00	4.58E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00
5	Waste paper, unsorted {RoW}| graphic paper production, 100% recycled | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg P eq	1.58E-04	0.00E+00	3.50E-13	8.19E-13	6.06E-12	1.27E-13	1.58E-04	3.28E-13	3.08E-13
6	Sulfidic tailing, off-site {GLO}| treatment of | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg P eq	1.08E-04	0.00E+00	2.47E-07	4.61E-07	3.70E-05	6.72E-08	6.87E-05	2.28E-07	1.46E-06

Print System Base Case SimaPro LCA Results

Calculation: Analyze
Results: Process contribution
1 p Printed Book System Base Case (of project Digital vs
Product: Print LCA)
Method: ReCiPe Midpoint (H) V1.09 / Europe Recipe H
Indicator: Characterization
Category: Marine eutrophication
Cut-off: 1%
Mode: Group
Exclude infrastructure processes: Yes
Exclude long-term emissions: Yes
Sorted on item: Total
Sort order: Descending

No	Process	Project	Unit	Total	Top	Pulpwood	Pulp	Paper	Waste Management	Printing	Distribution transportation	Retail Transportation
	Total of all processes		kg N eq	9.51E-02	0.00E+00	2.67E-03	1.03E-03	1.79E-02	4.38E-02	2.72E-02	1.96E-03	4.18E-04
	Remaining processes		kg N eq	1.40E-02	0.00E+00	2.27E-03	7.66E-04	4.32E-03	2.57E-05	5.81E-03	4.32E-04	4.12E-04
1	Waste graphical paper {RoW}| treatment of, sanitary landfill | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg N eq	3.10E-02	0.00E+00	4.81E-09	2.54E-06	2.25E-07	3.10E-02	2.88E-07	5.49E-09	9.44E-09
2	Municipal solid waste {RoW}| treatment of, sanitary landfill | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg N eq	1.40E-02	0.00E+00	1.05E-07	5.91E-06	1.01E-03	1.28E-02	2.00E-04	2.39E-07	4.52E-07
3	Waste paper, unsorted {RoW}| graphic paper production, 100% recycled | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg N eq	8.70E-03	0.00E+00	1.93E-11	4.51E-11	3.33E-10	7.01E-12	8.70E-03	1.81E-11	1.70E-11
4	Paper, woodfree, coated {ZA}| paper production, woodfree, coated, at integrated mill | Alloc Def, U	Digital vs Print LCA	kg N eq	6.95E-03	0.00E+00	0.00E+00	0.00E+00	6.95E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00
5	Electricity, high voltage {ZA}| electricity production, hard coal | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg N eq	4.88E-03	0.00E+00	1.21E-06	2.28E-05	1.90E-03	5.79E-07	2.95E-03	8.30E-07	1.57E-06
6	Potato, Swiss integrated production {CH}| potato production, Swiss integrated production, intensive | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg N eq	3.97E-03	0.00E+00	4.34E-09	1.64E-08	2.07E-03	2.08E-09	1.90E-03	2.33E-09	3.17E-09
7	Waste paper, unsorted {RER}| graphic paper production, 100% recycled | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg N eq	3.23E-03	0.00E+00	7.15E-12	1.67E-11	1.24E-10	2.60E-12	3.23E-03	6.70E-12	6.29E-12
8	Green manure, Swiss integrated production, until March {RoW}| production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg N eq	2.56E-03	0.00E+00	2.24E-05	2.17E-08	1.30E-03	1.59E-09	1.24E-03	4.17E-09	6.70E-09
9	Soybean {RoW}| production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg N eq	1.83E-03	0.00E+00	3.63E-04	1.88E-07	3.40E-04	5.01E-09	1.13E-03	4.42E-08	7.68E-08
10	Transport, freight, lorry 16-32 metric ton, EURO3 {RER}| transport, freight, lorry 16-32 metric ton, EURO3 | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg N eq	1.67E-03	0.00E+00	1.40E-05	8.17E-07	4.71E-05	5.50E-08	8.48E-05	1.52E-03	4.85E-06
11	Sludge from pulp and paper production {RoW}| treatment of, sanitary landfill | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg N eq	1.15E-03	0.00E+00	2.19E-08	2.29E-04	3.87E-07	1.20E-08	9.18E-04	1.08E-08	1.73E-08
12	Waste paperboard {RoW}| treatment of, sanitary landfill | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg N eq	1.07E-03	0.00E+00	1.02E-10	4.89E-10	8.59E-09	5.17E-11	1.07E-03	5.41E-11	8.79E-11

Print System Base Case SimaPro LCA Results

Calculation: Analyze
Results: Process contribution
1 p Printed Book System Base Case (of project Digital vs
Product: Print LCA)
Method: ReCiPe Midpoint (H) V1.09 / Europe Recipe H
Indicator: Characterization
Category: Human toxicity
Cut-off: 1%
Mode: Group
Exclude infrastructure processes: Yes
Exclude long-term emissions: Yes
Sorted on item: Total
Sort order: Descending

No	Process	Project	Unit	Total	Top	Pulpwood	Pulp	Paper	Waste Management	Printing	Distribution transportation	Retail Transportation
	Total of all processes		kg 1,4-DB eq	8.38E+00	0.00E+00	7.59E-01	1.70E-01	3.54E+00	1.57E-01	3.21E+00	6.78E-02	4.81E-01
	Remaining processes		kg 1,4-DB eq	1.45E+00	0.00E+00	1.39E-01	3.42E-02	3.82E-01	3.62E-02	6.76E-01	6.60E-02	1.17E-01
1	Paper, woodfree, coated {ZA}| paper production, woodfree, coated, at integrated mill | Alloc Def, U	Digital vs Print LCA	kg 1,4-DB eq	1.91E+00	0.00E+00	0.00E+00	0.00E+00	1.91E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2	Aluminium, primary, liquid {GLO}| aluminium production, primary, liquid, prebake | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	6.85E-01	0.00E+00	6.31E-06	3.00E-05	8.64E-04	3.35E-06	6.84E-01	1.92E-06	4.46E-06
3	Electricity, high voltage {ZA}| electricity production, hard coal | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	5.98E-01	0.00E+00	1.48E-04	2.79E-03	2.33E-01	7.10E-05	3.61E-01	1.02E-04	1.92E-04
4	Natural gas, unprocessed, at extraction {RNA}| production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	5.43E-01	0.00E+00	5.09E-03	2.07E-03	3.10E-01	2.87E-03	2.18E-01	5.10E-04	3.63E-03
5	Wood ash mixture, pure {CH}| treatment of, landfarming | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	5.39E-01	0.00E+00	1.98E-01	5.72E-02	1.49E-01	3.68E-05	1.35E-01	2.33E-05	5.83E-05
6	Redmud from bauxite digestion {RoW}| treatment of, residual material landfill | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	4.88E-01	0.00E+00	5.29E-06	1.37E-04	1.26E-03	1.82E-05	4.87E-01	2.50E-06	7.97E-06
7	Latex {RoW}| production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	2.97E-01	0.00E+00	5.40E-08	1.36E-07	2.89E-01	2.19E-08	8.19E-03	5.18E-08	5.03E-08
8	Brake wear emissions, passenger car {RoW}| treatment of | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	2.57E-01	0.00E+00	9.56E-09	1.21E-08	1.76E-07	4.51E-09	3.25E-07	5.66E-09	2.57E-01
9	Printed paper, offset {ZA}| offset printing, per kg printed paper | Alloc Def, U	Digital vs Print LCA	kg 1,4-DB eq	2.00E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.00E-01	0.00E+00	0.00E+00
10	Latex {RER}| production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	1.47E-01	0.00E+00	2.67E-08	6.70E-08	1.43E-01	1.08E-08	4.05E-03	2.56E-08	2.48E-08
11	Aluminium hydroxide {GLO}| aluminium hydroxide production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	1.38E-01	0.00E+00	1.49E-06	3.85E-05	3.54E-04	5.13E-06	1.37E-01	7.05E-07	2.24E-06
12	Log, energy wood, split, measured as solid wood under bark {RoW}| heat production, mixed logs, at furnace 30kW | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	1.34E-01	0.00E+00	1.32E-01	4.03E-05	2.53E-05	7.57E-07	2.26E-03	7.46E-07	2.48E-06
13	Log, energy wood, split, measured as solid wood under bark {RoW}| heat production, mixed logs, at furnace 100kW | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	1.31E-01	0.00E+00	1.28E-01	3.92E-05	2.47E-05	7.37E-07	2.20E-03	7.26E-07	2.41E-06
14	Electricity, high voltage {CN}| electricity production, hard coal | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	1.27E-01	0.00E+00	3.76E-03	1.38E-03	3.66E-02	1.90E-03	7.67E-02	5.92E-04	6.34E-03
15	Log, energy wood, split, measured as solid wood under bark {RoW}| heat production, mixed logs, at wood heater 6kW | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	1.21E-01	0.00E+00	1.19E-01	3.65E-05	2.29E-05	6.85E-07	2.05E-03	6.75E-07	2.24E-06
16	Spoil from hard coal mining {GLO}| treatment of, in surface landfill | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	1.16E-01	0.00E+00	4.25E-04	2.04E-03	4.17E-02	2.46E-04	7.09E-02	8.90E-05	2.89E-04
17	Waste graphical paper {RoW}| treatment of, sanitary landfill | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	1.15E-01	0.00E+00	1.79E-08	9.42E-06	8.35E-07	1.15E-01	1.07E-06	2.03E-08	3.50E-08
18	Heat, district or industrial, other than natural gas {RoW}| heat production, at hard coal industrial furnace 1-10MW | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	1.06E-01	0.00E+00	1.77E-04	5.99E-02	1.26E-02	3.24E-04	2.99E-02	3.41E-04	2.69E-03
19	Electricity, high voltage {RoW}| electricity production, hard coal | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	1.04E-01	0.00E+00	6.56E-04	2.77E-04	1.25E-02	4.08E-04	8.95E-02	5.69E-05	1.62E-04
20	Brake wear emissions, passenger car {RER}| treatment of | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	9.41E-02	0.00E+00	3.50E-09	4.44E-09	6.45E-08	1.65E-09	1.19E-07	2.08E-09	9.41E-02
21	Wood ash mixture, pure {CH}| treatment of, sanitary landfill | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	9.06E-02	0.00E+00	3.32E-02	9.61E-03	2.50E-02	6.20E-06	2.27E-02	3.96E-06	9.83E-06

Print System Base Case SimaPro LCA Results

Calculation: Analyze
Results: Process contribution
1 p Printed Book System Base Case (of project Digital vs
Product: Print LCA)
Method: ReCiPe Midpoint (H) V1.09 / Europe Recipe H
Indicator: Characterization
Category: Photochemical oxidant formation
Cut-off: 1%
Mode: Group
Exclude infrastructure processes: Yes
Exclude long-term emissions: Yes
Sorted on item: Total
Sort order: Descending

No	Process	Project	Unit	Total	Top	Pulpwood	Pulp	Paper	Waste Management	Printing	Distribution transportation	Retail Transportation
	Total of all processes		kg NMVOC	6.29E-01	0.00E+00	9.70E-02	7.38E-03	2.07E-01	1.00E-02	2.29E-01	5.45E-02	2.40E-02
	Remaining processes		kg NMVOC	1.13E-01	0.00E+00	6.04E-03	5.99E-03	2.98E-02	2.80E-03	5.40E-02	4.17E-03	1.04E-02
1	Electricity, high voltage {ZA}| electricity production, hard coal | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg NMVOC	1.44E-01	0.00E+00	3.58E-05	6.75E-04	5.63E-02	1.71E-05	8.72E-02	2.46E-05	4.65E-05
2	Paper, woodfree, coated {ZA}| paper production, woodfree, coated, at integrated mill | Alloc Def, U	Digital vs Print LCA	kg NMVOC	7.83E-02	0.00E+00	0.00E+00	0.00E+00	7.83E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
3	Transport, freight, lorry 16-32 metric ton, EURO3 {RER}| transport, freight, lorry 16-32 metric ton, EURO3 | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg NMVOC	4.38E-02	0.00E+00	3.65E-04	2.14E-05	1.23E-03	1.44E-06	2.22E-03	3.99E-02	1.27E-04
4	Printed paper, offset {ZA}| offset printing, per kg printed paper | Alloc Def, U	Digital vs Print LCA	kg NMVOC	4.36E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.36E-02	0.00E+00	0.00E+00
5	Log, energy wood, split, measured as solid wood under bark {RoW}| heat production, mixed logs, at wood heater 6kW | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg NMVOC	2.42E-02	0.00E+00	2.38E-02	7.27E-06	4.56E-06	1.36E-07	4.07E-04	1.34E-07	4.47E-07
6	Electricity, high voltage {RoW}| electricity production, hard coal | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg NMVOC	1.81E-02	0.00E+00	1.15E-04	4.84E-05	2.18E-03	7.13E-05	1.56E-02	9.94E-06	2.82E-05
7	Power sawing, without catalytic converter {RoW}| processing | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg NMVOC	1.70E-02	0.00E+00	1.65E-02	8.17E-06	1.08E-05	1.35E-07	4.36E-04	1.44E-07	4.90E-07
8	Diesel, burned in building machine {GLO}| processing | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg NMVOC	1.64E-02	0.00E+00	1.44E-02	3.10E-05	6.70E-04	3.04E-06	1.34E-03	1.54E-06	5.35E-06
9	Log, energy wood, split, measured as solid wood under bark {RoW}| heat production, mixed logs, at furnace 30kW | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg NMVOC	1.39E-02	0.00E+00	1.37E-02	4.19E-06	2.63E-06	7.86E-08	2.35E-04	7.74E-08	2.58E-07
10	Latex {RoW}| production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg NMVOC	1.38E-02	0.00E+00	2.51E-09	6.31E-09	1.34E-02	1.02E-09	3.81E-04	2.41E-09	2.34E-09
11	Electricity, high voltage {CN}| electricity production, hard coal | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg NMVOC	1.30E-02	0.00E+00	3.85E-04	1.42E-04	3.75E-03	1.94E-04	7.85E-03	6.06E-05	6.49E-04
12	Natural gas, vented {GLO}| natural gas venting from petroleum/natural gas production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg NMVOC	1.26E-02	0.00E+00	7.09E-04	1.27E-04	2.59E-03	8.67E-06	2.11E-03	2.63E-03	4.42E-03
13	Log, energy wood, split, measured as solid wood under bark {RoW}| heat production, mixed logs, at furnace 100kW | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg NMVOC	1.23E-02	0.00E+00	1.21E-02	3.70E-06	2.32E-06	6.94E-08	2.07E-04	6.84E-08	2.27E-07
14	Transport, freight, sea, transoceanic ship {GLO}| processing | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg NMVOC	1.14E-02	0.00E+00	3.16E-04	7.50E-05	5.14E-03	6.41E-06	5.83E-03	3.18E-06	1.86E-05
15	Transport, freight, lorry 16-32 metric ton, EURO3 {RoW}| transport, freight, lorry 16-32 metric ton, EURO3 | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg NMVOC	8.45E-03	0.00E+00	7.04E-05	4.12E-06	2.38E-04	2.77E-07	4.28E-04	7.68E-03	2.45E-05
16	Power sawing, without catalytic converter {RER}| processing | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg NMVOC	8.38E-03	0.00E+00	8.15E-03	4.03E-06	5.35E-06	6.67E-08	2.16E-04	7.13E-08	2.42E-07
17	Transport, passenger car, medium size, petrol, EURO 3 {RoW}| transport, passenger car, medium size, petrol, EURO 3 | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg NMVOC	8.15E-03	0.00E+00	2.80E-11	3.55E-11	4.25E-10	1.32E-11	9.24E-10	1.66E-11	8.15E-03
18	Transport, freight, lorry >32 metric ton, EURO3 {RER}| transport, freight, lorry >32 metric ton, EURO3 | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg NMVOC	7.48E-03	0.00E+00	4.05E-04	1.52E-04	4.25E-03	1.60E-06	2.46E-03	7.53E-05	1.41E-04
19	Blasting {RoW}| processing | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg NMVOC	7.00E-03	0.00E+00	1.62E-05	8.98E-05	2.67E-03	9.26E-06	4.19E-03	3.46E-06	1.00E-05
20	Waste graphical paper {RoW}| treatment of, sanitary landfill | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg NMVOC	6.89E-03	0.00E+00	1.07E-09	5.65E-07	5.01E-08	6.89E-03	6.41E-08	1.22E-09	2.10E-09
21	Latex {RER}| production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg NMVOC	6.83E-03	0.00E+00	1.24E-09	3.11E-09	6.64E-03	5.03E-10	1.88E-04	1.19E-09	1.15E-09

Print System Base Case SimaPro LCA Results

Calculation: Analyze
Results: Process contribution
1 p Printed Book System Base Case (of project Digital vs
Product: Print LCA)
Method: ReCiPe Midpoint (H) V1.09 / Europe Recipe H
Indicator: Characterization
Category: Particulate matter formation
Cut-off: 1%
Mode: Group
Exclude infrastructure processes: Yes
Exclude long-term emissions: Yes
Sorted on item: Total
Sort order: Descending

No	Process	Project	Unit	Total	Top	Pulpwood	Pulp	Paper	Waste Management	Printing	Distribution transportation	Retail Transportation
	Total of all processes		kg PM10 eq	2.76E-01	0.00E+00	3.26E-02	4.83E-03	1.09E-01	1.02E-03	1.10E-01	1.31E-02	5.62E-03
	Remaining processes		kg PM10 eq	6.39E-02	0.00E+00	2.95E-03	2.13E-03	2.09E-02	7.32E-04	2.89E-02	3.32E-03	4.99E-03
1	Electricity, high voltage {ZA}| electricity production, hard coal | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg PM10 eq	7.65E-02	0.00E+00	1.90E-05	3.58E-04	2.99E-02	9.09E-06	4.62E-02	1.30E-05	2.46E-05
2	Paper, woodfree, coated {ZA}| paper production, woodfree, coated, at integrated mill | Alloc Def, U	Digital vs Print LCA	kg PM10 eq	4.33E-02	0.00E+00	0.00E+00	0.00E+00	4.33E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
3	Log, energy wood, split, measured as solid wood under bark {RoW}| heat production, mixed logs, at wood heater 6kW | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg PM10 eq	1.34E-02	0.00E+00	1.32E-02	4.03E-06	2.53E-06	7.57E-08	2.26E-04	7.46E-08	2.48E-07
4	Electricity, high voltage {RoW}| electricity production, lignite | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg PM10 eq	1.17E-02	0.00E+00	4.23E-05	1.80E-05	8.11E-04	2.63E-05	1.08E-02	3.68E-06	1.04E-05
5	Electricity, high voltage {RoW}| electricity production, hard coal | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg PM10 eq	1.15E-02	0.00E+00	7.28E-05	3.07E-05	1.39E-03	4.53E-05	9.93E-03	6.32E-06	1.79E-05
6	Transport, freight, lorry 16-32 metric ton, EURO3 {RER}| transport, freight, lorry 16-32 metric ton, EURO3 | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg PM10 eq	1.06E-02	0.00E+00	8.85E-05	5.19E-06	2.99E-04	3.49E-07	5.38E-04	9.66E-03	3.08E-05
7	Electricity, high voltage {CN}| electricity production, hard coal | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg PM10 eq	8.06E-03	0.00E+00	2.38E-04	8.76E-05	2.32E-03	1.20E-04	4.86E-03	3.75E-05	4.02E-04
8	Log, energy wood, split, measured as solid wood under bark {RoW}| heat production, mixed logs, at furnace 30kW | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg PM10 eq	6.46E-03	0.00E+00	6.35E-03	1.94E-06	1.22E-06	3.65E-08	1.09E-04	3.59E-08	1.19E-07
9	Log, energy wood, split, measured as solid wood under bark {RoW}| heat production, mixed logs, at furnace 100kW | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg PM10 eq	5.44E-03	0.00E+00	5.35E-03	1.64E-06	1.03E-06	3.07E-08	9.17E-05	3.02E-08	1.01E-07
10	Latex {RoW}| production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg PM10 eq	5.11E-03	0.00E+00	9.29E-10	2.33E-09	4.97E-03	3.76E-10	1.41E-04	8.90E-10	8.65E-10
11	Diesel, burned in building machine {GLO}| processing | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg PM10 eq	4.65E-03	0.00E+00	4.07E-03	8.77E-06	1.90E-04	8.60E-07	3.79E-04	4.37E-07	1.51E-06
12	Transport, freight, sea, transoceanic ship {GLO}| processing | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg PM10 eq	4.59E-03	0.00E+00	1.28E-04	3.03E-05	2.07E-03	2.58E-06	2.35E-03	1.28E-06	7.50E-06
13	Electricity, high voltage {ID}| electricity production, lignite | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg PM10 eq	3.87E-03	0.00E+00	8.56E-05	3.78E-05	9.94E-04	4.94E-05	2.67E-03	7.03E-06	2.03E-05
14	Heat, district or industrial, other than natural gas {RoW}| heat production, at hard coal industrial furnace 1-10MW | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg PM10 eq	3.72E-03	0.00E+00	6.22E-06	2.10E-03	4.41E-04	1.14E-05	1.05E-03	1.20E-05	9.44E-05
15	Natural gas, high pressure {RNA}| natural gas production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg PM10 eq	3.48E-03	0.00E+00	3.76E-05	1.49E-05	1.90E-03	2.13E-05	1.48E-03	3.33E-06	2.27E-05

Print System Base Case SimaPro LCA Results

Calculation: Analyze
Results: Process contribution
1 p Printed Book System Base Case (of project Digital vs
Product: Print LCA)
Method: ReCiPe Midpoint (H) V1.09 / Europe Recipe H
Indicator: Characterization
Category: Terrestrial ecotoxicity
Cut-off: 1%
Mode: Group
Exclude infrastructure processes: Yes
Exclude long-term emissions: Yes
Sorted on item: Total
Sort order: Descending

No	Process	Project	Unit	Total	Top	Pulpwood	Pulp	Paper	Waste Management	Printing	Distribution transportation	Retail Transportation
	Total of all processes		kg 1,4-DB eq	1.99E-02	0.00E+00	1.12E-03	1.86E-04	1.01E-02	2.96E-05	6.65E-03	6.05E-04	1.21E-03
	Remaining processes		kg 1,4-DB eq	3.71E-03	0.00E+00	7.02E-04	9.15E-05	8.42E-04	2.43E-05	1.57E-03	1.34E-04	3.53E-04
1	Palm fruit bunch {RoW}| production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	2.81E-03	0.00E+00	3.55E-07	4.59E-07	2.16E-03	8.54E-08	6.45E-04	5.23E-07	6.84E-07
2	Palm fruit bunch {MY}| production, on land recently transformed | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	2.81E-03	0.00E+00	3.55E-07	4.59E-07	2.16E-03	8.54E-08	6.45E-04	5.23E-07	6.84E-07
3	Paper, woodfree, coated {ZA}| paper production, woodfree, coated, at integrated mill | Alloc Def, U	Digital vs Print LCA	kg 1,4-DB eq	2.19E-03	0.00E+00	0.00E+00	0.00E+00	2.19E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00
4	Palm fruit bunch {MY}| production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	1.48E-03	0.00E+00	1.88E-07	2.43E-07	1.14E-03	4.52E-08	3.41E-04	2.77E-07	3.62E-07
5	Potato, Swiss integrated production {CH}| potato production, Swiss integrated production, intensive | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	1.36E-03	0.00E+00	1.49E-09	5.63E-09	7.12E-04	7.14E-10	6.52E-04	8.00E-10	1.09E-09
6	Cotton fibre {RoW}| cotton production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	8.57E-04	0.00E+00	5.27E-12	9.75E-12	8.17E-11	1.49E-12	8.57E-04	8.20E-12	1.17E-11
7	Wood ash mixture, pure {CH}| treatment of, landfarming | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	8.30E-04	0.00E+00	3.05E-04	8.81E-05	2.29E-04	5.67E-08	2.09E-04	3.59E-08	8.98E-08
8	Brake wear emissions, passenger car {RoW}| treatment of | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	6.17E-04	0.00E+00	2.30E-11	2.91E-11	4.22E-10	1.08E-11	7.80E-10	1.36E-11	6.17E-04
9	Natural gas, unprocessed, at extraction {RNA}| production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	5.58E-04	0.00E+00	5.24E-06	2.13E-06	3.19E-04	2.95E-06	2.25E-04	5.25E-07	3.73E-06
10	Transport, freight, lorry 16-32 metric ton, EURO3 {RER}| transport, freight, lorry 16-32 metric ton, EURO3 | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	5.12E-04	0.00E+00	4.27E-06	2.50E-07	1.44E-05	1.68E-08	2.59E-05	4.66E-04	1.48E-06
11	Maize grain, Swiss integrated production {CH}| production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	4.16E-04	0.00E+00	8.04E-09	1.64E-08	1.22E-07	4.31E-09	4.15E-04	1.01E-08	1.10E-08
12	Electricity, high voltage {ZA}| electricity production, hard coal | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	3.51E-04	0.00E+00	8.71E-08	1.64E-06	1.37E-04	4.17E-08	2.12E-04	5.98E-08	1.13E-07
13	Soybean {RoW}| production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	2.55E-04	0.00E+00	5.04E-05	2.61E-08	4.71E-05	6.95E-10	1.57E-04	6.13E-09	1.07E-08
14	Soybean, Swiss integrated production {RoW}| soybean production, Swiss integrated production, intensive | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	2.34E-04	0.00E+00	4.63E-05	2.40E-08	4.33E-05	6.40E-10	1.44E-04	5.64E-09	9.80E-09
15	Electricity, high voltage {DE}| heat and power co-generation, biogas, gas engine | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	2.28E-04	0.00E+00	4.38E-06	1.17E-06	8.08E-05	1.96E-06	1.34E-04	3.32E-06	2.84E-06
16	Brake wear emissions, passenger car {RER}| treatment of | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	2.26E-04	0.00E+00	8.42E-12	1.07E-11	1.55E-10	3.97E-12	2.86E-10	4.99E-12	2.26E-04
17	Cotton fibre {CN}| cotton production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	2.20E-04	0.00E+00	1.35E-12	2.50E-12	2.10E-11	3.84E-13	2.20E-04	2.10E-12	3.00E-12
18	Cotton fibre {US}| cotton production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	2.00E-04	0.00E+00	1.23E-12	2.28E-12	1.91E-11	3.49E-13	2.00E-04	1.91E-12	2.73E-12

Print System Base Case SimaPro LCA Results

Calculation: Analyze
Results: Process contribution
1 p Printed Book System Base Case (of project Digital vs
Product: Print LCA)
Method: ReCiPe Midpoint (H) V1.09 / Europe Recipe H
Indicator: Characterization
Category: Freshwater ecotoxicity
Cut-off: 1%
Mode: Group
Exclude infrastructure processes: Yes
Exclude long-term emissions: Yes
Sorted on item: Total
Sort order: Descending

No	Process	Project	Unit	Total	Top	Pulpwood	Pulp	Paper	Waste Management	Printing	Distribution transportation	Retail Transportation
	Total of all processes		kg 1,4-DB eq	6.29E-02	0.00E+00	1.03E-03	5.66E-04	2.94E-02	2.40E-03	2.62E-02	1.26E-03	2.08E-03
	Remaining processes		kg 1,4-DB eq	1.01E-02	0.00E+00	4.59E-04	3.52E-04	3.48E-03	1.23E-05	4.69E-03	5.00E-04	5.96E-04
1	Natural gas, unprocessed, at extraction {RNA}| production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	3.93E-02	0.00E+00	3.69E-04	1.50E-04	2.25E-02	2.08E-04	1.58E-02	3.69E-05	2.63E-04
2	Water discharge from petroleum/natural gas extraction, onshore {GLO}| treatment of | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	3.44E-03	0.00E+00	1.95E-04	3.50E-05	6.91E-04	2.28E-06	5.71E-04	7.25E-04	1.22E-03
3	Spent solvent mixture {RoW}| treatment of, hazardous waste incineration | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	3.20E-03	0.00E+00	1.48E-08	1.20E-08	1.42E-07	1.98E-09	3.20E-03	1.17E-08	2.08E-08
4	Spoil from hard coal mining {GLO}| treatment of, in surface landfill | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	1.49E-03	0.00E+00	5.48E-06	2.63E-05	5.37E-04	3.17E-06	9.14E-04	1.15E-06	3.73E-06
5	Municipal solid waste {RoW}| treatment of, sanitary landfill | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	1.37E-03	0.00E+00	1.02E-08	5.76E-07	9.82E-05	1.25E-03	1.96E-05	2.33E-08	4.40E-08
6	Waste graphical paper {RoW}| treatment of, sanitary landfill | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	9.20E-04	0.00E+00	1.43E-10	7.55E-08	6.69E-09	9.19E-04	8.56E-09	1.63E-10	2.80E-10
7	Spoil from lignite mining {GLO}| treatment of, in surface landfill | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	8.53E-04	0.00E+00	2.99E-06	1.05E-06	6.51E-04	1.63E-06	1.94E-04	1.27E-06	1.34E-06
8	Redmud from bauxite digestion {RoW}| treatment of, residual material landfill | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	7.91E-04	0.00E+00	8.56E-09	2.22E-07	2.03E-06	2.95E-08	7.89E-04	4.06E-09	1.29E-08
9	Paper, woodfree, coated {ZA}| paper production, woodfree, coated, at integrated mill | Alloc Def, U	Digital vs Print LCA	kg 1,4-DB eq	7.61E-04	0.00E+00	0.00E+00	0.00E+00	7.61E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00
10	Latex {RoW}| production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	7.00E-04	0.00E+00	1.27E-10	3.19E-10	6.81E-04	5.15E-11	1.93E-05	1.22E-10	1.18E-10

Print System Base Case SimaPro LCA Results

Calculation: Analyze
Results: Process contribution
1 p Printed Book System Base Case (of project Digital vs
Product: Print LCA)
Method: ReCiPe Midpoint (H) V1.09 / Europe Recipe H
Indicator: Characterization
Category: Marine ecotoxicity
Cut-off: 1%
Mode: Group
Exclude infrastructure processes: Yes
Exclude long-term emissions: Yes
Sorted on item: Total
Sort order: Descending

No	Process	Project	Unit	Total	Top	Pulpwood	Pulp	Paper	Waste Management	Printing	Distribution transportation	Retail Transportation
	Total of all processes		kg 1,4-DB eq	8.29E-02	0.00E+00	5.49E-03	9.63E-04	3.66E-02	1.73E-03	2.28E-02	5.27E-03	9.97E-03
	Remaining processes		kg 1,4-DB eq	2.16E-02	0.00E+00	9.81E-04	5.21E-04	5.91E-03	7.74E-04	1.08E-02	1.16E-03	1.50E-03
1	Paper, woodfree, coated {ZA}| paper production, woodfree, coated, at integrated mill | Alloc Def, U	Digital vs Print LCA	kg 1,4-DB eq	1.98E-02	0.00E+00	0.00E+00	0.00E+00	1.98E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2	Natural gas, unprocessed, at extraction {RNA}| production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	1.11E-02	0.00E+00	1.04E-04	4.24E-05	6.34E-03	5.87E-05	4.47E-03	1.04E-05	7.42E-05
3	Brake wear emissions, passenger car {RoW}| treatment of | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	4.68E-03	0.00E+00	1.74E-10	2.21E-10	3.20E-09	8.21E-11	5.91E-09	1.03E-10	4.68E-03
4	Electricity, high voltage {ZA}| electricity production, hard coal | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	4.64E-03	0.00E+00	1.15E-06	2.17E-05	1.81E-03	5.51E-07	2.80E-03	7.90E-07	1.49E-06
5	Transport, freight, lorry 16-32 metric ton, EURO3 {RER}| transport, freight, lorry 16-32 metric ton, EURO3 | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	4.12E-03	0.00E+00	3.43E-05	2.01E-06	1.16E-04	1.35E-07	2.08E-04	3.74E-03	1.19E-05
6	Transport, freight, sea, transoceanic ship {GLO}| processing | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	2.08E-03	0.00E+00	5.77E-05	1.37E-05	9.38E-04	1.17E-06	1.06E-03	5.81E-07	3.40E-06
7	Brake wear emissions, passenger car {RER}| treatment of | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	1.71E-03	0.00E+00	6.39E-11	8.10E-11	1.17E-09	3.01E-11	2.17E-09	3.78E-11	1.71E-03
8	Potato, Swiss integrated production {CH}| potato production, Swiss integrated production, intensive | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	1.58E-03	0.00E+00	1.72E-09	6.51E-09	8.24E-04	8.26E-10	7.55E-04	9.26E-10	1.26E-09
9	Log, energy wood, split, measured as solid wood under bark {RoW}| heat production, mixed logs, at furnace 30kW | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	1.49E-03	0.00E+00	1.46E-03	4.47E-07	2.81E-07	8.38E-09	2.50E-05	8.26E-09	2.75E-08
10	Log, energy wood, split, measured as solid wood under bark {RoW}| heat production, mixed logs, at furnace 100kW | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	1.45E-03	0.00E+00	1.42E-03	4.34E-07	2.73E-07	8.15E-09	2.44E-05	8.03E-09	2.67E-08
11	Spoil from hard coal mining {GLO}| treatment of, in surface landfill | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	1.41E-03	0.00E+00	5.20E-06	2.50E-05	5.10E-04	3.01E-06	8.67E-04	1.09E-06	3.54E-06
12	Log, energy wood, split, measured as solid wood under bark {RoW}| heat production, mixed logs, at wood heater 6kW | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	1.34E-03	0.00E+00	1.32E-03	4.04E-07	2.54E-07	7.58E-09	2.27E-05	7.47E-09	2.48E-08
13	Transport, passenger car, medium size, petrol, EURO 3 {RoW}| transport, passenger car, medium size, petrol, EURO 3 | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	1.13E-03	0.00E+00	3.87E-12	4.90E-12	5.86E-11	1.82E-12	1.28E-10	2.29E-12	1.13E-03
14	Heat, district or industrial, other than natural gas {RoW}| heat production, heavy fuel oil, at industrial furnace 1MW | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	1.07E-03	0.00E+00	9.34E-07	3.15E-04	6.72E-05	1.72E-06	6.73E-04	1.79E-06	1.41E-05
15	Transport, freight, sea, transoceanic tanker {GLO}| processing | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	1.01E-03	0.00E+00	5.51E-05	1.05E-05	2.31E-04	5.87E-07	1.54E-04	1.86E-04	3.72E-04
16	Heat, district or industrial, other than natural gas {RoW}| heat and power co-generation, wood chips, 6400kW thermal, with extensive emission control | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	9.02E-04	0.00E+00	1.70E-08	5.75E-06	1.20E-06	3.11E-08	8.94E-04	3.28E-08	2.58E-07
17	Waste graphical paper {RoW}| treatment of, sanitary landfill | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	8.93E-04	0.00E+00	1.39E-10	7.33E-08	6.49E-09	8.93E-04	8.31E-09	1.58E-10	2.72E-10
18	Heavy fuel oil, burned in refinery furnace {RoW}| processing | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	8.91E-04	0.00E+00	4.74E-05	5.72E-06	1.09E-04	3.10E-07	9.41E-05	1.62E-04	4.73E-04

Print System Base Case SimaPro LCA Results

Calculation: Analyze
Results: Process contribution
1 p Printed Book System Base Case (of project Digital vs
Product: Print LCA)
Method: ReCiPe Midpoint (H) V1.09 / Europe Recipe H
Indicator: Characterization
Category: Ionising radiation
Cut-off: 1%
Mode: Group
Exclude infrastructure processes: Yes
Exclude long-term emissions: Yes
Sorted on item: Total
Sort order: Descending

No	Process	Project	Unit	Total	Top	Pulpwood	Pulp	Paper	Waste Management	Printing	Distribution transportation	Retail Transportation
	Total of all processes		kBq U235 eq	3.27E+00	0.00E+00	1.20E-01	2.82E-02	8.96E-01	1.72E-02	1.34E+00	3.27E-01	5.48E-01
	Remaining processes		kBq U235 eq	3.32E-01	0.00E+00	8.90E-03	2.73E-03	1.17E-01	3.41E-03	1.94E-01	2.61E-03	3.90E-03
1	Low level radioactive waste {CH}| treatment of, plasma torch incineration | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kBq U235 eq	1.81E+00	0.00E+00	9.09E-02	1.74E-02	4.05E-01	3.48E-03	4.41E-01	3.20E-01	5.36E-01
2	Spent nuclear fuel {RoW}| treatment of, reprocessing | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kBq U235 eq	4.99E-01	0.00E+00	9.30E-03	3.42E-03	1.67E-01	4.32E-03	3.08E-01	3.18E-03	4.20E-03
3	Electricity, high voltage {ZA}| electricity production, nuclear, pressure water reactor | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kBq U235 eq	1.28E-01	0.00E+00	3.17E-05	5.97E-04	4.98E-02	1.52E-05	7.71E-02	2.17E-05	4.11E-05
4	Electricity, high voltage {RoW}| electricity production, nuclear, boiling water reactor | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kBq U235 eq	8.55E-02	0.00E+00	1.46E-03	6.11E-04	2.77E-02	9.09E-04	5.44E-02	1.27E-04	3.59E-04
5	Electricity, high voltage {JP}| electricity production, nuclear, boiling water reactor | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kBq U235 eq	7.03E-02	0.00E+00	1.90E-03	6.94E-04	2.14E-02	1.09E-03	4.46E-02	1.57E-04	4.49E-04
6	Uranium ore, as U {RNA}| uranium mine operation, underground | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kBq U235 eq	5.99E-02	0.00E+00	1.11E-03	4.20E-04	2.00E-02	5.17E-04	3.69E-02	3.72E-04	4.96E-04
7	Uranium ore, as U {RoW}| uranium mine operation, underground | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kBq U235 eq	5.65E-02	0.00E+00	1.04E-03	3.97E-04	1.89E-02	4.88E-04	3.49E-02	3.51E-04	4.69E-04
8	Electricity, high voltage {SERC}| electricity production, nuclear, boiling water reactor | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kBq U235 eq	5.12E-02	0.00E+00	1.39E-03	5.10E-04	1.57E-02	7.96E-04	3.24E-02	1.16E-04	3.29E-04
9	Electricity, high voltage {RU}| electricity production, nuclear, boiling water reactor | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kBq U235 eq	4.67E-02	0.00E+00	1.09E-03	4.50E-04	1.31E-02	6.24E-04	3.10E-02	1.19E-04	3.02E-04
10	Electricity, high voltage {RFC}| electricity production, nuclear, boiling water reactor | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kBq U235 eq	4.67E-02	0.00E+00	1.27E-03	4.65E-04	1.43E-02	7.26E-04	2.95E-02	1.05E-04	3.00E-04
11	Electricity, high voltage {RoW}| electricity production, nuclear, pressure water reactor | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kBq U235 eq	4.40E-02	0.00E+00	7.51E-04	3.14E-04	1.42E-02	4.67E-04	2.80E-02	6.50E-05	1.85E-04
12	Electricity, high voltage {SE}| electricity production, nuclear, boiling water reactor | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kBq U235 eq	3.86E-02	0.00E+00	6.88E-04	2.12E-04	1.23E-02	3.69E-04	2.40E-02	5.38E-04	4.47E-04

Print System Base Case SimaPro LCA Results

Calculation: Analyze
Results: Process contribution
1 p Printed Book System Base Case (of project Digital vs
Product: Print LCA)
Method: ReCiPe Midpoint (H) V1.09 / Europe Recipe H
Indicator: Characterization
Category: Agricultural land occupation
Cut-off: 1%
Mode: Group
Exclude infrastructure processes: Yes
Exclude long-term emissions: Yes
Sorted on item: Total
Sort order: Descending

No	Process	Project	Unit	Total	Top	Pulpwood	Pulp	Paper	Waste Management	Printing	Distribution transportation	Retail Transportation
	Total of all processes		m2a	4.62E+02	0.00E+00	4.50E+02	1.65E-01	1.58E+00	3.35E-03	1.03E+01	3.51E-03	1.06E-02
	Remaining processes		m2a	8.41E+00	0.00E+00	1.60E-01	1.28E-01	1.54E+00	2.06E-03	6.56E+00	2.53E-03	7.80E-03
1	Hardwood, CO2-removal and land use {RoW}| hardwood forestry, CO2-removal and land use | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	m2a	4.53E+02	0.00E+00	4.49E+02	3.73E-02	4.18E-02	1.30E-03	3.75E+00	9.82E-04	2.76E-03

Calculation: Analyze
Results: Process contribution
1 p Printed Book System Base Case (of project Digital vs
Product: Print LCA)
Method: ReCiPe Midpoint (H) V1.09 / Europe Recipe H
Indicator: Characterization
Category: Urban land occupation
Cut-off: 1%
Mode: Group
Exclude infrastructure processes: Yes
Exclude long-term emissions: Yes
Sorted on item: Total
Sort order: Descending

No	Process	Project	Unit	Total	Top	Pulpwood	Pulp	Paper	Waste Management	Printing	Distribution transportation	Retail Transportation
	Total of all processes		m2a	4.50E+00	0.00E+00	4.14E+00	1.00E-02	8.10E-02	1.33E-03	2.59E-01	5.11E-04	2.28E-03
	Remaining processes		m2a	2.01E-01	0.00E+00	2.16E-03	8.77E-03	4.53E-02	1.10E-03	1.41E-01	4.57E-04	2.12E-03
1	Hardwood forestry operation, except harvesting {RoW}| hardwood forestry, operation, except harvesting | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	m2a	3.64E+00	0.00E+00	3.61E+00	2.87E-04	3.27E-04	1.02E-05	2.88E-02	7.63E-06	2.14E-05
2	Hardwood forestry operation, except harvesting {RER}| hardwood forestry, operation, except harvesting | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	m2a	5.37E-01	0.00E+00	5.33E-01	4.24E-05	4.83E-05	1.51E-06	4.25E-03	1.13E-06	3.16E-06
3	Hard coal {ZA}| mine operation | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	m2a	7.24E-02	0.00E+00	1.85E-05	4.17E-04	2.91E-02	9.34E-06	4.28E-02	1.29E-05	2.76E-05
4	Hard coal {ID}| mine operation | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	m2a	5.00E-02	0.00E+00	3.33E-04	5.13E-04	6.21E-03	2.08E-04	4.26E-02	3.22E-05	1.02E-04

Print System Base Case SimaPro LCA Results

Calculation: Analyze
Results: Process contribution
1 p Printed Book System Base Case (of project Digital vs
Product: Print LCA)
Method: ReCiPe Midpoint (H) V1.09 / Europe Recipe H
Indicator: Characterization
Category: Natural land transformation
Cut-off: 1%
Mode: Group
Exclude infrastructure processes: Yes
Exclude long-term emissions: Yes
Sorted on item: Total
Sort order: Descending

No	Process	Project	Unit	Total	Top	Pulpwood	Pulp	Paper	Waste Management	Printing	Distribution transportation	Retail Transportation
	Total of all processes		m2	3.47E-02	0.00E+00	2.78E-02	4.27E-05	4.54E-03	8.13E-06	2.26E-03	3.25E-06	1.23E-05
	Remaining processes		m2	1.65E-03	0.00E+00	1.44E-05	4.00E-05	5.03E-04	7.99E-06	1.07E-03	2.80E-06	1.16E-05
1	Hardwood forestry operation, except harvesting {RoW}| hardwood forestry, operation, except harvesting | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	m2	2.43E-02	0.00E+00	2.41E-02	1.91E-06	2.18E-06	6.82E-08	1.92E-04	5.09E-08	1.43E-07
2	Hardwood forestry operation, except harvesting {RER}| hardwood forestry, operation, except harvesting | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	m2	3.58E-03	0.00E+00	3.55E-03	2.83E-07	3.22E-07	1.01E-08	2.83E-05	7.51E-09	2.11E-08
3	Coconut, husked {RoW}| production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	m2	2.39E-03	0.00E+00	8.27E-08	1.37E-07	2.29E-03	2.54E-08	1.05E-04	1.33E-07	1.66E-07
4	Land tenure, arable land, measured as carbon net primary productivity {MY}| clear-cutting, primary forest to arable land | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	m2	1.01E-03	0.00E+00	1.28E-07	1.65E-07	7.76E-04	3.07E-08	2.32E-04	1.88E-07	2.46E-07
5	Land tenure, arable land, measured as carbon net primary productivity {BR}| clear-cutting, primary forest to arable land | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	m2	9.66E-04	0.00E+00	1.91E-04	9.92E-08	1.79E-04	2.64E-09	5.96E-04	2.33E-08	4.05E-08
6	Coconut, husked {PH}| production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	m2	8.33E-04	0.00E+00	2.88E-08	4.79E-08	7.96E-04	8.85E-09	3.64E-05	4.63E-08	5.77E-08

Calculation: Analyze
Results: Process contribution
1 p Printed Book System Base Case (of project Digital vs
Product: Print LCA)
Method: ReCiPe Midpoint (H) V1.09 / Europe Recipe H
Indicator: Characterization
Category: Water depletion
Cut-off: 1%
Mode: Group
Exclude infrastructure processes: Yes
Exclude long-term emissions: Yes
Sorted on item: Total
Sort order: Descending

No	Process	Project	Unit	Total	Top	Pulpwood	Pulp	Paper	Waste Management	Printing	Distribution transportation	Retail Transportation
	Total of all processes		m3	1.93E+02	0.00E+00	2.28E+00	9.34E-01	4.17E+01	1.20E+00	1.45E+02	5.29E-01	1.25E+00
	Remaining processes		m3	3.22E+01	0.00E+00	6.23E-01	2.55E-01	1.15E+01	3.40E-01	1.91E+01	1.96E-01	2.46E-01
1	Electricity, high voltage {RoW}| electricity production, hydro, run-of-river | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	m3	9.67E+01	0.00E+00	2.52E-01	1.48E-01	9.64E+00	1.48E-01	8.65E+01	2.21E-02	6.15E-02
2	Electricity, high voltage {RoW}| electricity production, hydro, reservoir, non-alpine region | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	m3	1.39E+01	0.00E+00	4.09E-02	7.22E-02	5.41E+00	2.41E-02	8.30E+00	5.68E-03	1.33E-02
3	Electricity, high voltage {RU}| electricity production, hydro, run-of-river | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	m3	7.59E+00	0.00E+00	1.78E-01	7.31E-02	2.13E+00	1.01E-01	5.04E+00	1.93E-02	4.91E-02
4	Electricity, high voltage {CN}| electricity production, hydro, run-of-river | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	m3	7.46E+00	0.00E+00	2.21E-01	8.11E-02	2.15E+00	1.11E-01	4.50E+00	3.47E-02	3.72E-01
5	Electricity, high voltage {WECC, US only}| electricity production, hydro, run-of-river | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	m3	6.42E+00	0.00E+00	1.75E-01	6.40E-02	1.97E+00	9.98E-02	4.06E+00	1.45E-02	4.13E-02
6	Electricity, high voltage {FR}| electricity production, hydro, run-of-river | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	m3	4.81E+00	0.00E+00	1.76E-01	2.68E-02	1.51E+00	3.80E-02	2.86E+00	9.08E-02	1.03E-01
7	Electricity, high voltage {SE}| electricity production, hydro, run-of-river | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	m3	4.31E+00	0.00E+00	7.68E-02	2.36E-02	1.38E+00	4.12E-02	2.68E+00	6.00E-02	4.99E-02
8	Electricity, high voltage {CN}| electricity production, hydro, reservoir, non-alpine region | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	m3	4.03E+00	0.00E+00	1.19E-01	4.38E-02	1.16E+00	6.01E-02	2.43E+00	1.87E-02	2.01E-01
9	Electricity, high voltage {BR}| electricity production, hydro, reservoir, tropical region | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	m3	3.06E+00	0.00E+00	8.94E-02	2.94E-02	9.35E-01	4.86E-02	1.93E+00	6.79E-03	1.95E-02
10	Electricity, high voltage {JP}| electricity production, hydro, run-of-river | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	m3	2.96E+00	0.00E+00	8.00E-02	2.92E-02	9.02E-01	4.58E-02	1.87E+00	6.60E-03	1.89E-02
11	Electricity, high voltage {Quebec}| electricity production, hydro, run-of-river | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	m3	2.79E+00	0.00E+00	7.54E-02	2.78E-02	8.74E-01	4.34E-02	1.75E+00	6.16E-03	1.78E-02
12	Electricity, high voltage {CA-BC}| electricity production, hydro, run-of-river | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	m3	2.67E+00	0.00E+00	7.26E-02	2.67E-02	8.33E-01	4.17E-02	1.68E+00	5.92E-03	1.71E-02
13	Electricity, high voltage {AT}| electricity production, hydro, run-of-river | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	m3	2.26E+00	0.00E+00	4.64E-02	1.22E-02	7.39E-01	2.08E-02	1.38E+00	3.68E-02	3.06E-02
14	Electricity, high voltage {CA-MB}| electricity production, hydro, run-of-river | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	m3	2.08E+00	0.00E+00	5.68E-02	2.08E-02	6.41E-01	3.26E-02	1.31E+00	4.64E-03	1.34E-02

Print System Base Case SimaPro LCA Results

Calculation: Analyze
Results: Process contribution
1 p Printed Book System Base Case (of project Digital vs
Product: Print LCA)
Method: ReCiPe Midpoint (H) V1.09 / Europe Recipe H
Indicator: Characterization
Category: Metal depletion
Cut-off: 1%
Mode: Group
Exclude infrastructure processes: Yes
Exclude long-term emissions: Yes
Sorted on item: Total
Sort order: Descending

No	Process	Project	Unit	Total	Top	Pulpwood	Pulp	Paper	Waste Management	Printing	Distribution transportation	Retail Transportation
	Total of all processes		kg Fe eq	4.65E-01	0.00E+00	4.44E-03	4.08E-03	1.05E-01	1.29E-03	3.41E-01	1.55E-03	7.46E-03
	Remaining processes		kg Fe eq	5.70E-02	0.00E+00	3.13E-04	7.01E-04	1.98E-02	5.98E-05	3.13E-02	2.30E-04	4.63E-03
1	Iron ore, crude ore, 46% Fe {GLO}| iron mine operation, crude ore, 46% Fe | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg Fe eq	8.56E-02	0.00E+00	1.65E-03	1.91E-03	2.29E-02	8.72E-04	5.66E-02	6.06E-04	1.09E-03
2	Bauxite, without water {GLO}| bauxite mine operation | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg Fe eq	6.73E-02	0.00E+00	9.38E-07	1.90E-05	1.74E-04	2.54E-06	6.71E-02	3.97E-07	1.15E-06
3	Copper concentrate {RoW}| copper mine operation | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg Fe eq	3.43E-02	0.00E+00	1.06E-04	1.97E-04	1.67E-03	3.83E-05	3.21E-02	1.11E-04	1.52E-04
4	Manganese concentrate {GLO}| production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg Fe eq	3.33E-02	0.00E+00	4.18E-05	1.02E-04	5.21E-03	1.42E-05	2.79E-02	9.70E-06	4.09E-05
5	Tin {RoW}| production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg Fe eq	2.87E-02	0.00E+00	2.24E-04	4.42E-04	3.48E-03	8.45E-05	2.40E-02	2.48E-04	2.24E-04
6	Sulfuric acid {GLO}| copper production, solvent-extraction electro-winning | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg Fe eq	1.89E-02	0.00E+00	1.99E-05	7.98E-05	1.70E-02	4.33E-06	1.85E-03	5.76E-06	8.99E-06
7	Waste paperboard, sorted {RoW}| treatment of waste paperboard, sorting plant | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg Fe eq	1.74E-02	0.00E+00	1.01E-07	1.24E-07	1.35E-06	5.20E-08	1.74E-02	4.93E-08	6.18E-08
8	Chromite ore concentrate {GLO}| production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg Fe eq	1.69E-02	0.00E+00	7.71E-04	1.05E-04	3.82E-03	1.93E-05	1.21E-02	2.60E-05	4.13E-05
9	Ferronickel, 25% Ni {GLO}| production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg Fe eq	1.64E-02	0.00E+00	8.73E-04	9.47E-05	5.69E-04	1.66E-05	1.48E-02	1.59E-05	4.32E-05
10	Tin {RER}| production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg Fe eq	1.42E-02	0.00E+00	1.10E-04	2.18E-04	1.72E-03	4.17E-05	1.18E-02	1.23E-04	1.11E-04
11	Carboxymethyl cellulose, powder {RoW}| production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg Fe eq	1.04E-02	0.00E+00	1.90E-09	5.40E-09	1.04E-02	8.07E-10	9.45E-07	1.68E-09	1.71E-09
12	Platinum {ZA}| group metal mine operation, ore with high rhodium content | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg Fe eq	9.86E-03	0.00E+00	3.39E-05	1.51E-06	2.69E-05	3.50E-07	8.85E-03	2.48E-05	9.19E-04
13	Copper concentrate {RAS}| copper mine operation | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg Fe eq	9.04E-03	0.00E+00	2.79E-05	5.18E-05	4.39E-04	1.01E-05	8.44E-03	2.91E-05	4.01E-05
14	Fluorescent whitening agent, DAS1, triazinylaminostilben type {RoW}| production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg Fe eq	8.64E-03	0.00E+00	1.86E-09	3.66E-09	6.95E-03	7.03E-10	1.69E-03	2.04E-09	1.83E-09
15	Copper concentrate {RLA}| copper mine operation | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg Fe eq	6.83E-03	0.00E+00	2.11E-05	3.92E-05	3.32E-04	7.62E-06	6.38E-03	2.20E-05	3.03E-05
16	Gold {RoW}| -silver mine operation with refinery | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg Fe eq	6.67E-03	0.00E+00	5.26E-07	9.30E-07	1.13E-05	8.05E-07	6.65E-03	3.76E-07	3.84E-06
17	Uranium ore, as U {RNA}| uranium mine operation, underground | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg Fe eq	6.49E-03	0.00E+00	1.20E-04	4.55E-05	2.17E-03	5.59E-05	4.00E-03	4.03E-05	5.38E-05
18	Uranium ore, as U {RoW}| uranium mine operation, underground | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg Fe eq	6.12E-03	0.00E+00	1.13E-04	4.30E-05	2.05E-03	5.28E-05	3.78E-03	3.81E-05	5.08E-05
19	Carboxymethyl cellulose, powder {RER}| production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg Fe eq	5.89E-03	0.00E+00	1.07E-09	3.05E-09	5.89E-03	4.55E-10	5.32E-07	9.44E-10	9.64E-10
20	Copper concentrate {RNA}| copper mine operation | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg Fe eq	4.94E-03	0.00E+00	1.52E-05	2.83E-05	2.40E-04	5.51E-06	4.61E-03	1.59E-05	2.19E-05

Print System Base Case SimaPro LCA Results

Calculation: Analyze
Results: Process contribution
1 p Printed Book System Base Case (of project Digital vs
Product: Print LCA)
Method: ReCiPe Midpoint (H) V1.09 / Europe Recipe H
Indicator: Characterization
Category: Fossil depletion
Cut-off: 1%
Mode: Group
Exclude infrastructure processes: Yes
Exclude long-term emissions: Yes
Sorted on item: Total
Sort order: Descending

No	Process	Project	Unit	Total	Top	Pulpwood	Pulp	Paper	Waste Management	Printing	Distribution transportation	Retail Transportation
	Total of all processes		kg oil eq	3.22E+01	0.00E+00	6.71E-01	4.06E-01	1.30E+01	6.44E-02	1.22E+01	2.12E+00	3.68E+00
	Remaining processes		kg oil eq	4.47E+00	0.00E+00	1.08E-01	5.54E-02	1.64E+00	1.09E-02	1.70E+00	3.34E-01	6.25E-01
1	Hard coal {ZA}| mine operation | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg oil eq	8.41E+00	0.00E+00	2.15E-03	4.84E-02	3.38E+00	1.08E-03	4.97E+00	1.50E-03	3.21E-03
2	Petroleum {RoW}| and gas production, off-shore | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg oil eq	4.85E+00	0.00E+00	2.80E-01	5.01E-02	9.36E-01	2.96E-03	7.88E-01	1.04E+00	1.75E+00
3	Latex {RoW}| production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg oil eq	1.89E+00	0.00E+00	3.43E-07	8.61E-07	1.84E+00	1.39E-07	5.20E-02	3.29E-07	3.19E-07
4	Lignite {RoW}| mine operation | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg oil eq	1.75E+00	0.00E+00	3.64E-03	1.50E-03	1.40E+00	2.14E-03	3.46E-01	3.45E-04	9.37E-04
5	Petroleum {RoW}| and gas production, on-shore | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg oil eq	1.63E+00	0.00E+00	9.44E-02	1.69E-02	3.15E-01	9.97E-04	2.65E-01	3.51E-01	5.89E-01
6	Hard coal {ID}| mine operation | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg oil eq	1.28E+00	0.00E+00	8.51E-03	1.31E-02	1.59E-01	5.30E-03	1.09E+00	8.21E-04	2.61E-03
7	Natural gas, unprocessed, at extraction {RNA}| production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg oil eq	1.15E+00	0.00E+00	1.08E-02	4.39E-03	6.57E-01	6.08E-03	4.63E-01	1.08E-03	7.68E-03
8	Petroleum {RoW}| gas and petroleum production, off-shore | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg oil eq	1.09E+00	0.00E+00	6.29E-02	1.12E-02	2.10E-01	6.64E-04	1.77E-01	2.34E-01	3.93E-01
9	Latex {RER}| production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg oil eq	9.32E-01	0.00E+00	1.69E-07	4.25E-07	9.07E-01	6.86E-08	2.57E-02	1.62E-07	1.58E-07
10	Hard coal {CN}| mine operation | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg oil eq	8.76E-01	0.00E+00	2.09E-02	9.50E-02	2.23E-01	1.10E-02	4.84E-01	4.01E-03	3.86E-02
11	Natural gas, high pressure {RU}| natural gas production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg oil eq	7.91E-01	0.00E+00	5.12E-03	2.47E-03	3.31E-01	2.76E-03	4.43E-01	1.35E-03	4.86E-03
12	Hard coal {RNA}| mine operation | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg oil eq	6.86E-01	0.00E+00	1.66E-02	4.63E-02	1.95E-01	9.66E-03	4.11E-01	1.74E-03	6.10E-03
13	Hard coal {RoW}| mine operation | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg oil eq	5.43E-01	0.00E+00	1.11E-02	5.15E-02	1.51E-01	6.48E-03	3.14E-01	3.14E-03	6.27E-03
14	Natural gas, high pressure {RoW}| gas and petroleum production, off-shore | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg oil eq	4.40E-01	0.00E+00	2.60E-03	1.17E-03	2.79E-01	1.43E-03	1.52E-01	3.94E-04	3.11E-03
15	Natural gas, high pressure {RoW}| natural gas production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg oil eq	3.76E-01	0.00E+00	2.22E-03	9.96E-04	2.39E-01	1.22E-03	1.30E-01	3.36E-04	2.66E-03
16	Petroleum {GB}| and gas production, off-shore | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg oil eq	3.54E-01	0.00E+00	2.05E-02	3.65E-03	6.83E-02	2.16E-04	5.75E-02	7.61E-02	1.28E-01
17	Natural gas, high pressure {DE}| natural gas production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg oil eq	3.51E-01	0.00E+00	2.10E-03	9.57E-04	4.41E-02	1.23E-03	3.02E-01	2.68E-04	8.16E-04

Print System Base Case SimaPro LCA Results

Calculation: Analyze
Results: Impact assessment
1 p Printed Book System Base Case (of project Digital vs
Product: Print LCA)
Cumulative Energy Demand V1.08 / Cumulative energy
Method: demand
Indicator: Characterization
Skip categories: Never
Mode: Group
Exclude infrastructure processes: Yes
Exclude long-term emissions: Yes
Sorted on item: Total
Sort order: Descending

Impact category	Unit	Total	Top	Pulpwood	Pulp	Paper	Waste Management	Printing	Distribution transportation	Retail Transportation
Non renewable, fossil	MJ	1.44E+03	0.00E+00	3.00E+01	1.80E+01	5.84E+02	2.88E+00	5.46E+02	9.51E+01	1.65E+02
Non-renewable, nuclear	MJ	8.52E+01	0.00E+00	1.41E+00	5.39E-01	3.31E+01	6.57E-01	4.83E+01	4.75E-01	6.90E-01
Renewable, water	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Renewable, wind, solar, geothe	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Renewable, biomass	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Non-renewable, biomass	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
		94%								

Calculation: Analyze
Results: Process contribution
1 p Printed Book System Base Case (of project Digital vs
Product: Print LCA)
Cumulative Energy Demand V1.08 / Cumulative energy
Method: demand
Indicator: Characterization
Category: Non renewable, fossil
Cut-off: 1%
Mode: Group
Exclude infrastructure processes: Yes
Exclude long-term emissions: Yes
Sorted on item: Total
Sort order: Descending

No	Process	Project	Unit	Total	Top	Pulpwood	Pulp	Paper	Waste Management	Printing	Distribution transportation	Retail Transportation
	Total of all processes		MJ	1.44E+03	0.00E+00	3.00E+01	1.80E+01	5.84E+02	2.88E+00	5.46E+02	9.51E+01	1.65E+02
	Remaining processes		MJ	2.02E+02	0.00E+00	4.84E+00	2.47E+00	7.41E+01	4.94E-01	7.73E+01	1.50E+01	2.80E+01
1	Hard coal {ZA}| mine operation | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	MJ	3.70E+02	0.00E+00	9.46E-02	2.13E+00	1.49E+02	4.77E-02	2.19E+02	6.59E-02	1.41E-01
2	Petroleum {RoW}| and gas production, off-shore | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	MJ	2.16E+02	0.00E+00	1.25E+01	2.23E+00	4.17E+01	1.32E-01	3.51E+01	4.65E+01	7.80E+01
3	Latex {RoW}| production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	MJ	8.55E+01	0.00E+00	1.55E-05	3.90E-05	8.31E+01	6.29E-06	2.36E+00	1.49E-05	1.45E-05
4	Lignite {RoW}| mine operation | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	MJ	7.70E+01	0.00E+00	1.60E-01	6.60E-02	6.14E+01	9.43E-02	1.52E+01	1.52E-02	4.12E-02
5	Petroleum {RoW}| and gas production, on-shore | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	MJ	7.23E+01	0.00E+00	4.18E+00	7.46E-01	1.39E+01	4.41E-02	1.17E+01	1.55E+01	2.61E+01
6	Hard coal {ID}| mine operation | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	MJ	5.62E+01	0.00E+00	3.75E-01	5.77E-01	6.99E+00	2.33E-01	4.79E+01	3.62E-02	1.15E-01
7	Natural gas, unprocessed, at extraction {RNA}| production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	MJ	5.35E+01	0.00E+00	5.02E-01	2.04E-01	3.06E+01	2.83E-01	2.15E+01	5.02E-02	3.58E-01
8	Petroleum {RoW}| gas and petroleum production, off-shore | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	MJ	5.05E+01	0.00E+00	2.92E+00	5.21E-01	9.75E+00	3.09E-02	8.21E+00	1.09E+01	1.82E+01
9	Latex {RER}| production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	MJ	4.22E+01	0.00E+00	7.67E-06	1.93E-05	4.11E+01	3.11E-06	1.16E+00	7.35E-06	7.14E-06
10	Hard coal {CN}| mine operation | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	MJ	3.86E+01	0.00E+00	9.21E-01	4.19E+00	9.81E+00	4.84E-01	2.13E+01	1.77E-01	1.70E+00
11	Natural gas, high pressure {RU}| natural gas production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	MJ	3.68E+01	0.00E+00	2.38E-01	1.15E-01	1.54E+01	1.29E-01	2.06E+01	6.27E-02	2.26E-01
12	Hard coal {RNA}| mine operation | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	MJ	3.02E+01	0.00E+00	7.31E-01	2.04E+00	8.58E+00	4.25E-01	1.81E+01	7.65E-02	2.69E-01
13	Hard coal {RoW}| mine operation | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	MJ	2.39E+01	0.00E+00	4.91E-01	2.27E+00	6.63E+00	2.85E-01	1.38E+01	1.38E-01	2.76E-01
14	Natural gas, high pressure {RoW}| gas and petroleum production, off-shore | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	MJ	2.05E+01	0.00E+00	1.21E-01	5.42E-02	1.30E+01	6.65E-02	7.08E+00	1.83E-02	1.45E-01
15	Natural gas, high pressure {RoW}| natural gas production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	MJ	1.75E+01	0.00E+00	1.03E-01	4.64E-02	1.11E+01	5.68E-02	6.06E+00	1.57E-02	1.24E-01
16	Natural gas, high pressure {DE}| natural gas production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	MJ	1.63E+01	0.00E+00	9.78E-02	4.45E-02	2.05E+00	5.73E-02	1.40E+01	1.25E-02	3.80E-02
17	Petroleum {GB}| and gas production, off-shore | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	MJ	1.59E+01	0.00E+00	9.20E-01	1.64E-01	3.07E+00	9.72E-03	2.59E+00	3.42E+00	5.74E+00
18	Petroleum {NG}| and gas production, on-shore | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	MJ	1.48E+01	0.00E+00	8.58E-01	1.53E-01	2.86E+00	9.07E-03	2.41E+00	3.19E+00	5.36E+00

Calculation: Analyze
Results: Process contribution
1 p Printed Book System Base Case (of project Digital vs
Product: Print LCA)
Cumulative Energy Demand V1.08 / Cumulative energy
Method: demand
Indicator: Characterization
Category: Non-renewable, nuclear
Cut-off: 1%
Mode: Group
Exclude infrastructure processes: Yes
Exclude long-term emissions: Yes
Sorted on item: Total
Sort order: Descending

No	Process	Project	Unit	Total	Top	Pulpwood	Pulp	Paper	Waste Management	Printing	Distribution transportation	Retail Transportation
	Total of all processes		MJ	8.52E+01	0.00E+00	1.41E+00	5.39E-01	3.31E+01	6.57E-01	4.83E+01	4.75E-01	6.90E-01
	Remaining processes		MJ	1.80E+00	0.00E+00	2.87E-03	4.38E-03	1.22E+00	1.98E-04	5.06E-01	1.87E-03	5.88E-02
1	Uranium ore, as U {RNA}| uranium mine operation, underground | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	MJ	2.95E+01	0.00E+00	5.46E-01	2.07E-01	9.88E+00	2.55E-01	1.82E+01	1.84E-01	2.45E-01
2	Uranium ore, as U {RoW}| uranium mine operation, underground | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	MJ	2.79E+01	0.00E+00	5.15E-01	1.96E-01	9.33E+00	2.40E-01	1.72E+01	1.73E-01	2.31E-01
3	Uranium ore, as U {RoW}| uranium mine operation, open cast | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	MJ	1.10E+01	0.00E+00	2.03E-01	7.73E-02	3.68E+00	9.50E-02	6.79E+00	6.84E-02	9.13E-02
4	Uranium ore, as U {RNA}| uranium mine operation, open cast | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	MJ	7.68E+00	0.00E+00	1.42E-01	5.39E-02	2.57E+00	6.62E-02	4.74E+00	4.77E-02	6.37E-02
5	Latex {RoW}| production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	MJ	2.16E+00	0.00E+00	3.92E-07	9.85E-07	2.10E+00	1.59E-07	5.95E-02	3.76E-07	3.65E-07
6	Fluorescent whitening agent, distyrylbiphenyl type {RoW}| production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	MJ	1.88E+00	0.00E+00	4.04E-07	7.94E-07	1.51E+00	1.53E-07	3.66E-01	4.43E-07	3.97E-07
7	Fluorescent whitening agent, DAS1, triazinylaminostilben type {RoW}| production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	MJ	1.23E+00	0.00E+00	2.66E-07	5.22E-07	9.93E-01	1.00E-07	2.41E-01	2.91E-07	2.61E-07
8	Latex {RER}| production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	MJ	1.07E+00	0.00E+00	1.94E-07	4.86E-07	1.04E+00	7.85E-08	2.94E-02	1.86E-07	1.80E-07
9	Fluorescent whitening agent, distyrylbiphenyl type {RER}| production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	MJ	9.26E-01	0.00E+00	2.00E-07	3.92E-07	7.45E-01	7.53E-08	1.81E-01	2.19E-07	1.96E-07

Digital System Base Case SimaPro LCA Results

Calculation: Analyze
Results: Impact assessment
1 p Apple Air iPad Base Case (of project
Product: Digital vs Print LCA)
ReCiPe Midpoint (H) V1.09 / Europe Recipe
Method: H
Indicator: Characterization
Skip categories: Never
Mode: Group
Exclude infrastructure processes: Yes
Exclude long-term emissions: Yes
Sorted on item: Impact category
Sort order: Ascending

Impact category	Unit	Total	Top	Production	Apple Air iPad distribution transportation	Retail transportation	e-book formatting	e-book downloading	e-book reading	Waste Management
Climate change	kg CO2 eq	3.75E+01	0.00E+00	1.88E+01	9.34E-02	2.83E+00	3.56E-02	1.95E-01	1.54E+01	2.29E-01
Ozone depletion	kg CFC-11 eq	1.18E-06	0.00E+00	8.87E-07	6.34E-09	1.75E-07	1.81E-09	1.35E-09	1.07E-07	1.47E-10
Terrestrial acidification	kg SO2 eq	2.89E-01	0.00E+00	1.40E-01	1.35E-03	3.89E-03	2.30E-04	1.79E-03	1.41E-01	3.86E-05
Freshwater eutrophication	kg P eq	2.10E-02	0.00E+00	1.97E-02	7.63E-07	3.87E-06	9.31E-06	1.67E-05	1.32E-03	2.38E-06
Marine eutrophication	kg N eq	2.44E-02	0.00E+00	2.11E-02	4.04E-05	1.05E-04	2.09E-05	3.17E-05	2.51E-03	5.81E-04
Human toxicity	kg 1,4-DB eq	5.21E+00	0.00E+00	4.74E+00	2.45E-03	1.20E-01	5.67E-03	4.23E-03	3.35E-01	1.61E-03
Photochemical oxidant formation	kg NMVOC	1.66E-01	0.00E+00	8.70E-02	1.20E-03	6.01E-03	1.21E-04	8.96E-04	7.08E-02	1.18E-04
Particulate matter formation	kg PM10 eq	8.92E-02	0.00E+00	5.05E-02	4.45E-04	1.41E-03	8.52E-05	4.58E-04	3.62E-02	1.31E-05
Terrestrial ecotoxicity	kg 1,4-DB eq	2.46E-03	0.00E+00	1.96E-03	5.43E-06	3.01E-04	4.28E-06	2.30E-06	1.82E-04	7.38E-07
Freshwater ecotoxicity	kg 1,4-DB eq	2.06E-01	0.00E+00	2.04E-01	1.99E-05	5.20E-04	1.11E-04	1.19E-05	9.40E-04	5.97E-05
Marine ecotoxicity	kg 1,4-DB eq	2.72E-01	0.00E+00	2.66E-01	2.27E-04	2.49E-03	1.38E-04	3.75E-05	2.96E-03	3.43E-05
Ionising radiation	kBq U235 eq	1.36E+00	0.00E+00	1.03E+00	5.05E-03	1.37E-01	2.35E-03	2.38E-03	1.88E-01	2.29E-04
Agricultural land occupation	m2a	5.57E-01	0.00E+00	5.37E-01	7.22E-04	2.64E-03	6.37E-04	2.00E-04	1.58E-02	4.56E-05
Urban land occupation	m2a	2.49E-01	0.00E+00	2.05E-01	2.63E-03	5.69E-04	2.43E-04	5.00E-04	3.96E-02	1.76E-05
Natural land transformation	m2	1.17E-03	0.00E+00	9.40E-04	1.25E-05	3.07E-06	1.42E-06	2.67E-06	2.11E-04	1.08E-07
Water depletion	m3	8.62E+01	0.00E+00	7.85E+01	2.74E-02	3.13E-01	1.67E-01	8.98E-02	7.11E+00	1.59E-02
Metal depletion	kg Fe eq	1.52E+01	0.00E+00	1.52E+01	2.23E-03	1.87E-03	9.77E-03	3.89E-05	3.07E-03	1.75E-05
Fossil depletion	kg oil eq	9.58E+00	0.00E+00	4.78E+00	3.21E-02	9.21E-01	9.01E-03	4.79E-02	3.79E+00	8.57E-04

Digital System Base Case SimaPro LCA Results

Calculation: Analyze
Results: Process contribution
1 p Apple Air iPad Base Case (of project
Product: Digital vs Print LCA)
ReCiPe Midpoint (H) V1.09 / Europe Recipe
Method: H
Indicator: Characterization
Category: Climate change
Cut-off: 1%
Mode: Group
Exclude infrastructure processes: Yes
Exclude long-term emissions: Yes
Sorted on item: Total
Sort order: Descending

No	Process	Project	Unit	Total	Top	Production	Apple Air iPad distribution transportation	Retail transportation	e-book formatting	e-book downloading	e-book reading	Waste Management
	Total of all processes		kg CO2 eq	3.75E+01	0.00E+00	1.88E+01	9.34E-02	2.83E+00	3.56E-02	1.95E-01	1.54E+01	2.29E-01
	Remaining processes		kg CO2 eq	1.07E+01	0.00E+00	9.01E+00	9.29E-02	5.12E-01	1.88E-02	1.28E-02	1.01E+00	1.67E-03
6	Electricity, high voltage {ZA}| electricity production, hard coal | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg CO2 eq	1.47E+01	0.00E+00	2.07E-01	4.99E-05	2.54E-03	4.55E-04	1.81E-01	1.43E+01	4.97E-05
1	Electricity, high voltage {CN}| electricity production, hard coal | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg CO2 eq	2.20E+00	0.00E+00	2.15E+00	1.29E-04	3.28E-02	4.74E-03	7.45E-05	5.89E-03	5.20E-04
2	Transport, passenger car, medium size, petrol, EURO 3 {RoW}| transport, passenger car, medium size, petrol, EURO 3 | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg CO2 eq	1.85E+00	0.00E+00	2.61E-06	4.61E-11	1.85E+00	3.64E-09	4.32E-10	3.42E-08	1.61E-10
3	Electricity, high voltage {RoW}| electricity production, hard coal | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg CO2 eq	1.62E+00	0.00E+00	1.60E+00	5.17E-05	2.13E-03	2.65E-03	2.95E-04	2.34E-02	2.86E-04
4	Heat, district or industrial, other than natural gas {RoW}| heat production, at hard coal industrial furnace 1-10MW | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg CO2 eq	1.10E+00	0.00E+00	1.06E+00	2.73E-05	1.18E-02	5.38E-04	3.86E-04	3.05E-02	7.82E-05
5	Hard coal {CN}| mine operation | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg CO2 eq	9.60E-01	0.00E+00	9.38E-01	6.71E-05	1.36E-02	1.86E-03	7.49E-05	5.93E-03	2.05E-04
7	Electricity, high voltage {IN}| electricity production, hard coal | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg CO2 eq	7.02E-01	0.00E+00	6.93E-01	3.27E-05	1.30E-03	1.55E-03	6.94E-05	5.49E-03	1.71E-04
8	Diesel, burned in building machine {GLO}| processing | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg CO2 eq	6.97E-01	0.00E+00	6.72E-01	8.59E-07	8.48E-05	2.95E-04	2.98E-04	2.36E-02	2.65E-06
9	Electricity, high voltage {RFC}| electricity production, hard coal | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg CO2 eq	5.71E-01	0.00E+00	5.64E-01	2.65E-05	1.06E-03	1.24E-03	6.22E-05	4.92E-03	1.36E-04
10	Electricity, high voltage {SERC}| electricity production, hard coal | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg CO2 eq	5.63E-01	0.00E+00	5.56E-01	2.62E-05	1.05E-03	1.22E-03	6.13E-05	4.85E-03	1.34E-04
11	Transport, passenger car, medium size, petrol, EURO 3 {RER}| transport, passenger car, medium size, petrol, EURO 3 | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg CO2 eq	3.94E-01	0.00E+00	5.56E-07	9.82E-12	3.94E-01	7.74E-10	9.20E-11	7.28E-09	3.42E-11
12	Electricity, high voltage {RoW}| electricity production, lignite | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg CO2 eq	2.90E-01	0.00E+00	2.85E-01	6.92E-06	2.86E-04	3.90E-04	4.78E-05	3.78E-03	3.82E-05
13	Electricity, high voltage {RU}| heat and power co-generation, natural gas, conventional power plant, 100MW electrical | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg CO2 eq	2.80E-01	0.00E+00	2.76E-01	1.30E-05	6.05E-04	6.15E-04	2.89E-05	2.28E-03	6.63E-05
15	Heat, district or industrial, other than natural gas {RoW}| heat production, heavy fuel oil, at industrial furnace 1MW | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg CO2 eq	2.57E-01	0.00E+00	2.49E-01	5.31E-06	2.29E-03	1.25E-04	7.91E-05	6.26E-03	1.54E-05
14	Electricity, high voltage {RoW}| electricity production, natural gas, at conventional power plant | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg CO2 eq	2.57E-01	0.00E+00	2.52E-01	1.10E-05	4.54E-04	5.24E-04	5.27E-05	4.17E-03	6.10E-05
16	Electricity, high voltage {WECC, US only}| electricity production, hard coal | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg CO2 eq	2.41E-01	0.00E+00	2.38E-01	1.12E-05	4.49E-04	5.25E-04	2.63E-05	2.08E-03	5.75E-05
17	Municipal solid waste {RoW}| treatment of, sanitary landfill | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg CO2 eq	2.30E-01	0.00E+00	3.16E-03	6.68E-07	4.39E-05	4.15E-06	4.28E-06	3.38E-04	2.26E-01

Digital System Base Case SimaPro LCA Results

Calculation: Analyze
Results: Process contribution
1 p Apple Air iPad Base Case (of project
Product: Digital vs Print LCA)
ReCiPe Midpoint (H) V1.09 / Europe Recipe
Method: H
Indicator: Characterization
Category: Ozone depletion
Cut-off: 1%
Mode: Group
Exclude infrastructure processes: Yes
Exclude long-term emissions: Yes
Sorted on item: Total
Sort order: Descending

`	Process	Project	Unit	Total	Top	Production	Apple Air iPad distribution transportation	Retail transportation	e-book formatting	e-book downloading	e-book reading	Waste Management
	Total of all processes		kg CFC-11 eq	1.18E-06	0.00E+00	8.87E-07	6.34E-09	1.75E-07	1.81E-09	1.35E-09	1.07E-07	1.47E-10
	Remaining processes		kg CFC-11 eq	2.16E-07	0.00E+00	1.84E-07	2.99E-09	6.13E-09	4.39E-10	2.78E-10	2.20E-08	3.85E-11
2	Uranium, enriched 4.2%, per separative work unit {US}| uranium production, diffusion, enriched 4.2% | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg CFC-11 eq	2.34E-07	0.00E+00	1.58E-07	9.30E-12	4.96E-10	3.77E-10	9.38E-10	7.42E-08	3.81E-11
1	Petroleum {RoW}| and gas production, on-shore | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg CFC-11 eq	1.92E-07	0.00E+00	8.62E-08	1.97E-09	9.94E-08	1.19E-10	5.59E-11	4.42E-09	9.14E-12
3	Uranium, enriched 3.8%, per separative work unit {US}| uranium production, diffusion, enriched 3.8% | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg CFC-11 eq	1.19E-07	0.00E+00	1.17E-07	9.38E-12	6.54E-10	3.04E-10	1.95E-11	1.55E-09	2.76E-11
4	Transport, pipeline, long distance, natural gas {RU}| processing | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg CFC-11 eq	8.62E-08	0.00E+00	8.48E-08	3.48E-12	3.92E-10	1.76E-10	1.03E-11	8.13E-10	1.54E-11
5	Copper {GLO}| treatment of used cable | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg CFC-11 eq	7.59E-08	0.00E+00	7.58E-08	2.06E-14	3.81E-12	8.90E-11	4.94E-14	3.91E-12	5.28E-14
6	Petroleum {NG}| and gas production, on-shore | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg CFC-11 eq	3.95E-08	0.00E+00	1.77E-08	4.05E-10	2.04E-08	2.43E-11	1.15E-11	9.08E-10	1.88E-12
7	Petroleum {RAF}| production, onshore | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg CFC-11 eq	3.62E-08	0.00E+00	1.62E-08	3.71E-10	1.87E-08	2.23E-11	1.05E-11	8.32E-10	1.72E-12
8	Transport, pipeline, long distance, natural gas {RoW}| processing | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg CFC-11 eq	3.51E-08	0.00E+00	3.45E-08	1.42E-12	1.44E-10	7.36E-11	4.45E-12	3.52E-10	6.66E-12
9	Petroleum {RME}| production, onshore | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg CFC-11 eq	3.46E-08	0.00E+00	1.55E-08	3.55E-10	1.79E-08	2.14E-11	1.01E-11	7.97E-10	1.65E-12
10	Polarizer, liquid crystals and colour filters, for liquid crystal display {GLO}| production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg CFC-11 eq	3.32E-08	0.00E+00	3.32E-08	3.93E-19	3.32E-17	2.42E-11	3.35E-18	2.65E-16	7.87E-19
11	Petroleum {RU}| production, onshore | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg CFC-11 eq	2.13E-08	0.00E+00	9.57E-09	2.19E-10	1.10E-08	1.32E-11	6.20E-12	4.91E-10	1.01E-12
12	Polycarbonate {RoW}| production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg CFC-11 eq	1.82E-08	0.00E+00	1.81E-08	6.74E-18	3.41E-15	3.78E-11	2.86E-16	2.27E-14	1.20E-17
13	Transport, pipeline, onshore, long distance, natural gas {DZ}| processing | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg CFC-11 eq	1.28E-08	0.00E+00	1.26E-08	6.02E-13	6.91E-11	3.10E-11	1.19E-12	9.40E-11	2.41E-12
14	Uranium, enriched 4.0%, per separative work unit {US}| uranium production, diffusion, enriched 4.0% | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg CFC-11 eq	1.22E-08	0.00E+00	1.20E-08	9.13E-13	7.69E-11	3.80E-11	1.01E-12	7.96E-11	2.82E-12
15	Sodium hydroxide, without water, in 50% solution state {RoW}| chlor-alkali electrolysis, diaphragm cell | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg CFC-11 eq	1.19E-08	0.00E+00	1.17E-08	4.15E-13	5.82E-11	2.00E-11	1.50E-12	1.18E-10	2.27E-13

Digital System Base Case SimaPro LCA Results

Calculation: Analyze
Results: Process contribution
1 p Apple Air iPad Base Case (of project
Product: Digital vs Print LCA)
ReCiPe Midpoint (H) V1.09 / Europe Recipe
Method: H
Indicator: Characterization
Category: Terrestrial acidification
Cut-off: 1%
Mode: Group
Exclude infrastructure processes: Yes
Exclude long-term emissions: Yes
Sorted on item: Total
Sort order: Descending

No	Process	Project	Unit	Total	Top	Production	Apple Air iPad distribution transportation	Retail transportation	e-book formatting	e-book downloading	e-book reading	Waste Management
	Total of all processes		kg SO2 eq	2.89E-01	0.00E+00	1.40E-01	1.35E-03	3.89E-03	2.30E-04	1.79E-03	1.41E-01	3.86E-05
	Remaining processes		kg SO2 eq	4.63E-02	0.00E+00	4.18E-02	2.04E-04	3.31E-03	8.45E-05	1.02E-05	8.04E-04	2.44E-05
4	Electricity, high voltage {ZA}| electricity production, hard coal | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg SO2 eq	1.40E-01	0.00E+00	1.98E-03	4.76E-07	2.43E-05	4.34E-06	1.72E-03	1.36E-01	4.74E-07
1	Electricity, high voltage {CN}| electricity production, hard coal | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg SO2 eq	2.31E-02	0.00E+00	2.27E-02	1.35E-06	3.45E-04	4.98E-05	7.84E-07	6.20E-05	5.47E-06
2	Blasting {RoW}| processing | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg SO2 eq	1.41E-02	0.00E+00	1.19E-02	3.32E-08	2.10E-06	5.60E-06	2.71E-05	2.14E-03	1.03E-07
3	Electricity, high voltage {RoW}| electricity production, hard coal | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg SO2 eq	1.18E-02	0.00E+00	1.15E-02	3.75E-07	1.54E-05	1.92E-05	2.14E-06	1.69E-04	2.07E-06
5	Heat, district or industrial, other than natural gas {RoW}| heat production, at hard coal industrial furnace 1-10MW | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg SO2 eq	7.33E-03	0.00E+00	7.04E-03	1.82E-07	7.85E-05	3.58E-06	2.57E-06	2.03E-04	5.20E-07
7	Blasting {RER}| processing | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg SO2 eq	6.96E-03	0.00E+00	5.88E-03	1.64E-08	1.04E-06	2.77E-06	1.34E-05	1.06E-03	5.10E-08
6	Natural gas, high pressure {RNA}| natural gas production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg SO2 eq	6.22E-03	0.00E+00	6.12E-03	2.76E-07	2.84E-05	1.31E-05	7.32E-07	5.79E-05	1.41E-06
8	Diesel, burned in building machine {GLO}| processing | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg SO2 eq	5.67E-03	0.00E+00	5.47E-03	6.99E-09	6.90E-07	2.40E-06	2.42E-06	1.92E-04	2.16E-08
9	Electricity, high voltage {IN}| electricity production, hard coal | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg SO2 eq	4.62E-03	0.00E+00	4.56E-03	2.15E-07	8.55E-06	1.02E-05	4.56E-07	3.61E-05	1.12E-06
10	Electricity, high voltage {RFC}| electricity production, hard coal | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg SO2 eq	4.24E-03	0.00E+00	4.19E-03	1.97E-07	7.90E-06	9.22E-06	4.62E-07	3.65E-05	1.01E-06
11	Hard coal {CN}| mine operation | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg SO2 eq	3.83E-03	0.00E+00	3.74E-03	2.67E-07	5.40E-05	7.42E-06	2.99E-07	2.36E-05	8.17E-07
12	Electricity, high voltage {SERC}| electricity production, hard coal | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg SO2 eq	3.36E-03	0.00E+00	3.31E-03	1.56E-07	6.24E-06	7.29E-06	3.65E-07	2.89E-05	7.99E-07
13	Liquid crystal display, minor components, auxilliaries and assembly effort {GLO}| production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg SO2 eq	2.80E-03	0.00E+00	2.80E-03	3.31E-14	2.80E-12	2.04E-06	2.82E-13	2.23E-11	6.63E-14
14	Transport, freight, sea, transoceanic ship {GLO}| processing | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg SO2 eq	2.61E-03	0.00E+00	1.43E-03	1.14E-03	6.03E-06	2.12E-06	4.23E-07	3.35E-05	1.25E-07
15	Copper {RAS}| production, primary | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg SO2 eq	2.21E-03	0.00E+00	2.20E-03	6.00E-10	1.11E-07	2.59E-06	1.44E-09	1.14E-07	1.53E-09
16	Copper {RoW}| production, primary | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg SO2 eq	1.80E-03	0.00E+00	1.79E-03	4.88E-10	9.01E-08	2.11E-06	1.17E-09	9.25E-08	1.25E-09
17	Electricity, high voltage {RoW}| electricity production, lignite | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg SO2 eq	1.58E-03	0.00E+00	1.56E-03	3.77E-08	1.56E-06	2.12E-06	2.60E-07	2.06E-05	2.08E-07

Digital System Base Case SimaPro LCA Results

Calculation: Analyze
Results: Process contribution
1 p Apple Air iPad Base Case (of project
Product: Digital vs Print LCA)
ReCiPe Midpoint (H) V1.09 / Europe Recipe
Method: H
Indicator: Characterization
Category: Freshwater eutrophication
Cut-off: 1%
Mode: Group
Exclude infrastructure processes: Yes
Exclude long-term emissions: Yes
Sorted on item: Total
Sort order: Descending

No	Process	Project	Unit	Total	Top	Production	Apple Air iPad distribution transportation	Retail transportation	e-book formatting	e-book downloading	e-book reading	Waste Management
	Total of all processes		kg P eq	2.10E-02	0.00E+00	1.97E-02	7.63E-07	3.87E-06	9.31E-06	1.67E-05	1.32E-03	2.38E-06
	Remaining processes		kg P eq	1.30E-04	0.00E+00	1.26E-04	7.17E-07	2.74E-07	2.65E-07	1.39E-08	1.10E-06	2.22E-06
1	Sulfidic tailing, off-site {GLO}| treatment of | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg P eq	1.88E-02	0.00E+00	1.88E-02	6.17E-10	3.66E-07	7.43E-06	2.18E-09	1.72E-07	1.09E-09
2	Spoil from hard coal mining {GLO}| treatment of, in surface landfill | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg P eq	1.84E-03	0.00E+00	5.05E-04	3.22E-08	2.37E-06	1.00E-06	1.66E-05	1.31E-03	1.07E-07
3	Spoil from lignite mining {GLO}| treatment of, in surface landfill | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg P eq	2.63E-04	0.00E+00	2.59E-04	1.39E-08	8.54E-07	6.15E-07	2.87E-08	2.27E-06	5.50E-08

Digital System Base Case SimaPro LCA Results

Calculation: Analyze
Results: Process contribution
1 p Apple Air iPad Base Case (of project
Product: Digital vs Print LCA)
ReCiPe Midpoint (H) V1.09 / Europe Recipe
Method: H
Indicator: Characterization
Category: Marine eutrophication
Cut-off: 1%
Mode: Group
Exclude infrastructure processes: Yes
Exclude long-term emissions: Yes
Sorted on item: Total
Sort order: Descending

No	Process	Project	Unit	Total	Top	Production	Apple Air iPad distribution transportation	Retail transportation	e-book formatting	e-book downloading	e-book reading	Waste Management
	Total of all processes		kg N eq	2.44E-02	0.00E+00	2.11E-02	4.04E-05	1.05E-04	2.09E-05	3.17E-05	2.51E-03	5.81E-04
	Remaining processes		kg N eq	4.50E-03	0.00E+00	2.01E-03	4.04E-05	9.88E-05	3.80E-06	2.93E-05	2.32E-03	2.74E-07
1	Wastewater from liquid crystal display production {RoW}| treatment of, capacity 1.1E10l/year | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg N eq	1.47E-02	0.00E+00	1.47E-02	1.48E-12	1.44E-09	1.41E-05	1.55E-12	1.23E-10	3.67E-13
2	Liquid crystal display, minor components, auxilliaries and assembly effort {GLO}| production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg N eq	1.56E-03	0.00E+00	1.56E-03	1.84E-14	1.56E-12	1.13E-06	1.57E-13	1.24E-11	3.69E-14
3	Gold {RoW}| -silver mine operation with refinery | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg N eq	8.75E-04	0.00E+00	8.75E-04	1.27E-13	7.96E-11	2.99E-07	6.36E-12	5.03E-10	2.27E-12
4	Blasting {RoW}| processing | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg N eq	7.83E-04	0.00E+00	6.62E-04	1.84E-09	1.17E-07	3.11E-07	1.51E-06	1.19E-04	5.74E-09
5	Municipal solid waste {RoW}| treatment of, sanitary landfill | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg N eq	5.90E-04	0.00E+00	8.12E-06	1.72E-09	1.13E-07	1.07E-08	1.10E-08	8.69E-07	5.81E-04
8	Blasting {RER}| processing | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg N eq	3.87E-04	0.00E+00	3.27E-04	9.11E-10	5.76E-08	1.54E-07	7.43E-07	5.88E-05	2.83E-09
7	Diesel, burned in building machine {GLO}| processing | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg N eq	3.79E-04	0.00E+00	3.66E-04	4.67E-10	4.62E-08	1.61E-07	1.62E-07	1.28E-05	1.44E-09
6	Electricity, high voltage {CN}| electricity production, hard coal | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg N eq	3.68E-04	0.00E+00	3.60E-04	2.15E-08	5.48E-06	7.92E-07	1.25E-08	9.85E-07	8.69E-08
9	Sulfidic tailing, off-site {GLO}| treatment of | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg N eq	2.87E-04	0.00E+00	2.87E-04	9.42E-12	5.59E-09	1.13E-07	3.33E-11	2.63E-09	1.66E-11

Digital System Base Case SimaPro LCA Results

Calculation: Analyze
Results: Process contribution
Product: 1 p Apple Air iPad Base Case (of project Digital vs Print LCA)
Method: ReCiPe Midpoint (H) V1.09 / Europe Recipe H
Indicator: Characterization
Category: Human toxicity
Cut-off: 1%
Mode: Group
Exclude infrastructure processes: Yes
Exclude long-term emissions: Yes
Sorted on item: Total
Sort order: Descending

No	Process	Project	Unit	Total	Top	Production	Apple Air iPad distribution transportation	Retail transportation	e-book formatting	e-book downloading	e-book reading	Waste Management
	Total of all processes		kg 1,4-DB eq	5.21E+00	0.00E+00	4.74E+00	2.45E-03	1.20E-01	5.67E-03	4.23E-03	3.35E-01	1.61E-03
	Remaining processes		kg 1,4-DB eq	8.89E-01	0.00E+00	4.97E-01	2.44E-03	5.27E-02	1.54E-03	4.17E-03	3.30E-01	1.54E-03
1	Liquid crystal display, minor components, auxilliaries and assembly effort {GLO}| production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	1.34E+00	0.00E+00	1.34E+00	1.58E-11	1.34E-09	9.75E-04	1.35E-10	1.07E-08	3.17E-11
2	Copper {RoW}| production, primary | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	9.66E-01	0.00E+00	9.64E-01	2.62E-07	4.85E-05	1.13E-03	6.29E-07	4.97E-05	6.71E-07
3	Copper {RAS}| production, primary | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	5.00E-01	0.00E+00	4.99E-01	1.36E-07	2.51E-05	5.86E-04	3.25E-07	2.57E-05	3.47E-07
4	Copper {RLA}| production, primary | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	4.19E-01	0.00E+00	4.18E-01	1.14E-07	2.10E-05	4.91E-04	2.73E-07	2.16E-05	2.91E-07
5	Gold {RoW}| -silver mine operation with refinery | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	3.02E-01	0.00E+00	3.02E-01	4.38E-11	2.75E-08	1.03E-04	2.20E-09	1.74E-07	7.83E-10
6	Natural gas, unprocessed, at extraction {RNA}| production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	1.71E-01	0.00E+00	1.68E-01	7.50E-06	9.07E-04	3.59E-04	1.99E-05	1.58E-03	3.81E-05
7	Sulfidic tailing, off-site {GLO}| treatment of | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	1.62E-01	0.00E+00	1.61E-01	5.30E-09	3.15E-06	6.39E-05	1.87E-08	1.48E-06	9.36E-09
8	Electricity, high voltage {CN}| electricity production, hard coal | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	1.06E-01	0.00E+00	1.04E-01	6.22E-06	1.58E-03	2.29E-04	3.60E-06	2.85E-04	2.51E-05
9	Aluminium, primary, liquid {GLO}| aluminium production, primary, liquid, prebake | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	9.03E-02	0.00E+00	8.95E-02	1.47E-08	1.11E-06	4.14E-05	1.03E-05	8.15E-04	4.58E-08
10	Copper {AU}| production, primary | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	7.19E-02	0.00E+00	7.19E-02	1.96E-08	3.61E-06	8.44E-05	4.68E-08	3.70E-06	5.00E-08
12	Redmud from bauxite digestion {RoW}| treatment of, residual material landfill | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	6.45E-02	0.00E+00	6.39E-02	1.95E-08	1.99E-06	3.01E-05	7.34E-06	5.80E-04	6.34E-07
11	Brake wear emissions, passenger car {RoW}| treatment of | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	6.42E-02	0.00E+00	9.80E-07	1.74E-11	6.42E-02	1.37E-09	1.62E-10	1.28E-08	6.03E-11
13	Heat, district or industrial, other than natural gas {RoW}| heat production, at hard coal industrial furnace 1-10MW | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	6.28E-02	0.00E+00	6.03E-02	1.56E-06	6.72E-04	3.06E-05	2.20E-05	1.74E-03	4.45E-06

Digital System Base Case SimaPro LCA Results

Calculation: Analyze
Results: Process contribution
1 p Apple Air iPad Base Case (of project
Product: Digital vs Print LCA)
ReCiPe Midpoint (H) V1.09 / Europe Recipe
Method: H
Indicator: Characterization
Category: Photochemical oxidant formation
Cut-off: 1%
Mode: Group
Exclude infrastructure processes: Yes
Exclude long-term emissions: Yes
Sorted on item: Total
Sort order: Descending

No	Process	Project	Unit	Total	Top	Production	Apple Air iPad distribution transportation	Retail transportation	e-book formatting	e-book downloading	e-book reading	Waste Management
	Total of all processes		kg NMVOC	1.66E-01	0.00E+00	8.70E-02	1.20E-03	6.01E-03	1.21E-04	8.96E-04	7.08E-02	1.18E-04
	Remaining processes		kg NMVOC	3.07E-02	0.00E+00	2.65E-02	2.95E-04	2.63E-03	5.53E-05	1.32E-05	1.04E-03	1.12E-04
6	Electricity, high voltage {ZA}| electricity production, hard coal | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg NMVOC	6.71E-02	0.00E+00	9.46E-04	2.28E-07	1.16E-05	2.08E-06	8.25E-04	6.53E-02	2.27E-07
1	Blasting {RoW}| processing | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg NMVOC	1.69E-02	0.00E+00	1.42E-02	3.97E-08	2.51E-06	6.70E-06	3.24E-05	2.56E-03	1.23E-07
3	Diesel, burned in building machine {GLO}| processing | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg NMVOC	1.10E-02	0.00E+00	1.06E-02	1.35E-08	1.34E-06	4.65E-06	4.69E-06	3.71E-04	4.18E-08
2	Electricity, high voltage {CN}| electricity production, hard coal | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg NMVOC	1.09E-02	0.00E+00	1.07E-02	6.37E-07	1.62E-04	2.35E-05	3.69E-07	2.92E-05	2.57E-06
4	Blasting {RER}| processing | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg NMVOC	8.32E-03	0.00E+00	7.04E-03	1.96E-08	1.24E-06	3.31E-06	1.60E-05	1.27E-03	6.10E-08
5	Electricity, high voltage {RoW}| electricity production, hard coal | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg NMVOC	5.38E-03	0.00E+00	5.28E-03	1.71E-07	7.06E-06	8.77E-06	9.78E-07	7.74E-05	9.47E-07
7	Heat, district or industrial, other than natural gas {RoW}| heat production, at hard coal industrial furnace 1-10MW | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg NMVOC	3.04E-03	0.00E+00	2.92E-03	7.55E-08	3.26E-05	1.48E-06	1.06E-06	8.42E-05	2.16E-07
8	Electricity, high voltage {IN}| electricity production, hard coal | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg NMVOC	2.30E-03	0.00E+00	2.27E-03	1.07E-07	4.26E-06	5.07E-06	2.27E-07	1.80E-05	5.60E-07
9	Natural gas, vented {GLO}| natural gas venting from petroleum/natural gas production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg NMVOC	2.21E-03	0.00E+00	1.03E-03	2.19E-05	1.10E-03	1.48E-06	6.30E-07	4.98E-05	1.17E-07
10	Transport, passenger car, medium size, petrol, EURO 3 {RoW}| transport, passenger car, medium size, petrol, EURO 3 | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg NMVOC	2.04E-03	0.00E+00	2.87E-09	5.08E-14	2.04E-03	4.01E-12	4.76E-13	3.76E-11	1.77E-13
11	Transport, freight, sea, transoceanic ship {GLO}| processing | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg NMVOC	2.01E-03	0.00E+00	1.10E-03	8.78E-04	4.65E-06	1.64E-06	3.26E-07	2.58E-05	9.63E-08
12	Liquid crystal display, minor components, auxilliaries and assembly effort {GLO}| production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg NMVOC	1.97E-03	0.00E+00	1.97E-03	2.33E-14	1.96E-12	1.43E-06	1.98E-13	1.57E-11	4.66E-14
13	Electricity, high voltage {RFC}| electricity production, hard coal | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg NMVOC	1.31E-03	0.00E+00	1.29E-03	6.09E-08	2.44E-06	2.85E-06	1.43E-07	1.13E-05	3.12E-07
14	Electricity, high voltage {SERC}| electricity production, hard coal | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg NMVOC	1.11E-03	0.00E+00	1.10E-03	5.16E-08	2.07E-06	2.41E-06	1.21E-07	9.56E-06	2.65E-07

Digital System Base Case SimaPro LCA Results

Calculation: Analyze
Results: Process contribution
1 p Apple Air iPad Base Case (of project
Product: Digital vs Print LCA)
ReCiPe Midpoint (H) V1.09 / Europe Recipe
Method: H
Indicator: Characterization
Category: Particulate matter formation
Cut-off: 1%
Mode: Group
Exclude infrastructure processes: Yes
Exclude long-term emissions: Yes
Sorted on item: Total
Sort order: Descending

No	Process	Project	Unit	Total	Top	Production	Apple Air iPad distribution transportation	Retail transportation	e-book formatting	e-book downloading	e-book reading	Waste Management
	Total of all processes		kg PM10 eq	8.92E-02	0.00E+00	5.05E-02	4.45E-04	1.41E-03	8.52E-05	4.58E-04	3.62E-02	1.31E-05
	Remaining processes		kg PM10 eq	1.58E-02	0.00E+00	1.41E-02	8.97E-05	1.21E-03	2.79E-05	3.71E-06	2.94E-04	7.27E-06
8	Electricity, high voltage {ZA}| electricity production, hard coal | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg PM10 eq	3.56E-02	0.00E+00	5.01E-04	1.21E-07	6.16E-06	1.10E-06	4.38E-04	3.46E-02	1.20E-07
1	Electricity, high voltage {CN}| electricity production, hard coal | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg PM10 eq	6.74E-03	0.00E+00	6.60E-03	3.94E-07	1.00E-04	1.45E-05	2.28E-07	1.81E-05	1.59E-06
2	Blasting {RoW}| processing | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg PM10 eq	4.16E-03	0.00E+00	3.52E-03	9.80E-09	6.20E-07	1.65E-06	7.99E-06	6.32E-04	3.05E-08
3	Electricity, high voltage {RoW}| electricity production, hard coal | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg PM10 eq	3.41E-03	0.00E+00	3.35E-03	1.09E-07	4.48E-06	5.57E-06	6.21E-07	4.91E-05	6.02E-07
4	Diesel, burned in building machine {GLO}| processing | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg PM10 eq	3.11E-03	0.00E+00	3.00E-03	3.83E-09	3.79E-07	1.32E-06	1.33E-06	1.05E-04	1.18E-08
5	Electricity, high voltage {ID}| electricity production, lignite | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg PM10 eq	2.79E-03	0.00E+00	2.76E-03	1.26E-07	5.08E-06	5.95E-06	3.00E-07	2.38E-05	6.54E-07
6	Electricity, high voltage {RoW}| electricity production, lignite | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg PM10 eq	2.65E-03	0.00E+00	2.61E-03	6.33E-08	2.61E-06	3.56E-06	4.37E-07	3.46E-05	3.50E-07
7	Heat, district or industrial, other than natural gas {RoW}| heat production, at hard coal industrial furnace 1-10MW | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg PM10 eq	2.20E-03	0.00E+00	2.12E-03	5.47E-08	2.36E-05	1.07E-06	7.71E-07	6.10E-05	1.56E-07
9	Blasting {RER}| processing | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg PM10 eq	2.05E-03	0.00E+00	1.74E-03	4.84E-09	3.06E-07	8.17E-07	3.95E-06	3.12E-04	1.51E-08
10	Electricity, high voltage {IN}| electricity production, hard coal | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg PM10 eq	1.37E-03	0.00E+00	1.35E-03	6.38E-08	2.54E-06	3.03E-06	1.35E-07	1.07E-05	3.34E-07
11	Natural gas, high pressure {RNA}| natural gas production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg PM10 eq	1.24E-03	0.00E+00	1.22E-03	5.53E-08	5.68E-06	2.63E-06	1.46E-07	1.16E-05	2.82E-07
12	Electricity, high voltage {RU}| electricity production, lignite | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg PM10 eq	1.24E-03	0.00E+00	1.22E-03	5.73E-08	2.67E-06	2.72E-06	1.27E-07	1.01E-05	2.93E-07
13	Electricity, high voltage {IN}| electricity production, lignite | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg PM10 eq	1.16E-03	0.00E+00	1.14E-03	5.38E-08	2.14E-06	2.56E-06	1.14E-07	9.04E-06	2.82E-07
14	Electricity, high voltage {TR}| electricity production, lignite | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg PM10 eq	1.03E-03	0.00E+00	1.02E-03	4.80E-08	1.91E-06	2.28E-06	1.02E-07	8.04E-06	2.51E-07
15	Electricity, high voltage {RFC}| electricity production, hard coal | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg PM10 eq	9.78E-04	0.00E+00	9.66E-04	4.55E-08	1.82E-06	2.13E-06	1.06E-07	8.42E-06	2.33E-07
16	Transport, freight, sea, transoceanic ship {GLO}| processing | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg PM10 eq	8.12E-04	0.00E+00	4.45E-04	3.54E-04	1.88E-06	6.60E-07	1.31E-07	1.04E-05	3.88E-08
17	Electricity, high voltage {SERC}| electricity production, hard coal | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg PM10 eq	7.86E-04	0.00E+00	7.76E-04	3.65E-08	1.46E-06	1.71E-06	8.56E-08	6.77E-06	1.87E-07
18	Hard coal {CN}| mine operation | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg PM10 eq	7.65E-04	0.00E+00	7.48E-04	5.35E-08	1.08E-05	1.48E-06	5.97E-08	4.73E-06	1.63E-07
19	Electricity, high voltage, for internal use in coal mining {RoW}| electricity production, hard coal, at coal mine power plant | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg PM10 eq	7.24E-04	0.00E+00	7.08E-04	5.06E-08	1.02E-05	1.40E-06	5.65E-08	4.47E-06	1.55E-07
20	Electricity, high voltage, for internal use in coal mining {CN}| electricity production, hard coal, at coal mine power plant | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg PM10 eq	5.95E-04	0.00E+00	5.82E-04	4.16E-08	8.41E-06	1.15E-06	4.65E-08	3.68E-06	1.27E-07

Digital System Base Case SimaPro LCA Results

Calculation: Analyze
Results: Process contribution
1 p Apple Air iPad Base Case (of project
Product: Digital vs Print LCA)
ReCiPe Midpoint (H) V1.09 / Europe Recipe
Method: H
Indicator: Characterization
Category: Terrestrial ecotoxicity
Cut-off: 1%
Mode: Group
Exclude infrastructure processes: Yes
Exclude long-term emissions: Yes
Sorted on item: Total
Sort order: Descending

No	Process	Project	Unit	Total	Top	Production	Apple Air iPad distribution transportation	Retail transportation	e-book formatting	e-book downloading	e-book reading	Waste Management
	Total of all processes		kg 1,4-DB eq	2.46E-03	0.00E+00	1.96E-03	5.43E-06	3.01E-04	4.28E-06	2.30E-06	1.82E-04	7.38E-07
	Remaining processes		kg 1,4-DB eq	8.34E-04	0.00E+00	6.00E-04	5.40E-06	5.20E-05	1.82E-06	2.17E-06	1.72E-04	6.01E-07
1	Copper {RoW}| production, primary | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	1.78E-04	0.00E+00	1.77E-04	4.83E-11	8.92E-09	2.08E-07	1.16E-10	9.15E-09	1.23E-10
2	Natural gas, unprocessed, at extraction {RNA}| production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	1.76E-04	0.00E+00	1.73E-04	7.72E-09	9.33E-07	3.69E-07	2.05E-08	1.62E-06	3.92E-08
3	Gold {RoW}| -silver mine operation with refinery | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	1.74E-04	0.00E+00	1.74E-04	2.52E-14	1.58E-11	5.93E-08	1.26E-12	1.00E-10	4.50E-13
4	Brake wear emissions, passenger car {RoW}| treatment of | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	1.54E-04	0.00E+00	2.35E-09	4.17E-14	1.54E-04	3.28E-12	3.90E-13	3.08E-11	1.45E-13
5	Electricity, high voltage {DE}| heat and power co-generation, biogas, gas engine | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	1.13E-04	0.00E+00	1.11E-04	8.45E-09	7.11E-07	3.52E-07	9.30E-09	7.36E-07	2.61E-08
6	Copper {RAS}| production, primary | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	9.36E-05	0.00E+00	9.35E-05	2.54E-11	4.70E-09	1.10E-07	6.09E-11	4.82E-09	6.51E-11
7	Spent solvent mixture {RoW}| treatment of, hazardous waste incineration | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	9.32E-05	0.00E+00	9.31E-05	1.29E-12	9.05E-11	1.01E-07	2.74E-12	2.16E-10	5.11E-13
8	Copper {RLA}| production, primary | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	7.86E-05	0.00E+00	7.85E-05	2.14E-11	3.94E-09	9.21E-08	5.11E-11	4.05E-09	5.46E-11
9	Sugarcane {BR}| production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	7.70E-05	0.00E+00	7.60E-05	3.57E-09	1.75E-07	1.67E-07	8.35E-09	6.61E-07	1.83E-08
10	Brake wear emissions, passenger car {RER}| treatment of | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	5.65E-05	0.00E+00	8.63E-10	1.53E-14	5.65E-05	1.20E-12	1.43E-13	1.13E-11	5.31E-14
11	Electricity, high voltage {GB}| heat and power co-generation, biogas, gas engine | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	5.57E-05	0.00E+00	5.48E-05	3.23E-09	2.99E-07	1.76E-07	4.27E-09	3.38E-07	1.31E-08
12	Sugarcane {BR}| production, on land recently transformed | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	5.57E-05	0.00E+00	5.49E-05	2.58E-09	1.26E-07	1.20E-07	6.04E-09	4.78E-07	1.33E-08
13	Electricity, high voltage {CN}| electricity production, hard coal | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	5.30E-05	0.00E+00	5.20E-05	3.10E-09	7.90E-07	1.14E-07	1.80E-09	1.42E-07	1.25E-08
14	Waste plastic, consumer electronics {RoW}| treatment of, municipal incineration | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	4.86E-05	0.00E+00	4.85E-05	2.67E-13	6.40E-11	4.30E-08	9.10E-12	7.20E-10	8.57E-13
15	Electricity, high voltage {RoW}| heat and power co-generation, biogas, gas engine | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	4.42E-05	0.00E+00	4.33E-05	2.06E-09	8.49E-08	9.53E-08	9.45E-09	7.48E-07	1.14E-08
16	Printed wiring board, for surface mounting, Pb free surface {GLO}| production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	4.13E-05	0.00E+00	4.08E-05	1.52E-13	9.68E-11	4.25E-07	1.22E-11	9.62E-10	4.37E-12
17	Transport, passenger car, medium size, petrol, EURO 3 {RoW}| transport, passenger car, medium size, petrol, EURO 3 | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	3.52E-05	0.00E+00	4.97E-11	8.78E-16	3.52E-05	6.92E-14	8.22E-15	6.50E-13	3.05E-15
18	Phosphorus pentachloride {RoW}| production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	3.47E-05	0.00E+00	3.47E-05	1.04E-13	1.32E-11	2.92E-11	6.90E-13	5.46E-11	2.63E-13
19	Heat, district or industrial, other than natural gas {RoW}| heat production, heavy fuel oil, at industrial furnace 1MW | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	3.32E-05	0.00E+00	3.21E-05	6.85E-10	2.95E-07	1.61E-08	1.02E-08	8.07E-07	1.99E-09
20	Nitrogen fertiliser, as N {GLO}| field application of compost | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	2.95E-05	0.00E+00	2.50E-05	8.58E-11	5.92E-09	1.47E-08	5.58E-08	4.41E-06	2.70E-10

Digital System Base Case SimaPro LCA Results

Calculation: Analyze
Results: Process contribution
1 p Apple Air iPad Base Case (of project
Product: Digital vs Print LCA)
ReCiPe Midpoint (H) V1.09 / Europe Recipe
Method: H
Indicator: Characterization
Category: Freshwater ecotoxicity
Cut-off: 1%
Mode: Group
Exclude infrastructure processes: Yes
Exclude long-term emissions: Yes
Sorted on item: Total
Sort order: Descending

No	Process	Project	Unit	Total	Top	Production	Apple Air iPad distribution transportation	Retail transportation	e-book formatting	e-book downloading	e-book reading	Waste Management
	Total of all processes		kg 1,4-DB eq	2.06E-01	0.00E+00	2.04E-01	1.99E-05	5.20E-04	1.11E-04	1.19E-05	9.40E-04	5.97E-05
	Remaining processes		kg 1,4-DB eq	4.94E-03	0.00E+00	3.56E-03	1.93E-05	4.54E-04	1.53E-05	1.04E-05	8.26E-04	5.69E-05
1	Gold {RoW}| -silver mine operation with refinery | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	1.77E-01	0.00E+00	1.77E-01	2.57E-11	1.61E-08	6.05E-05	1.29E-09	1.02E-07	4.59E-10
2	Natural gas, unprocessed, at extraction {RNA}| production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	1.24E-02	0.00E+00	1.22E-02	5.44E-07	6.57E-05	2.60E-05	1.45E-06	1.14E-04	2.76E-06
3	Spent solvent mixture {RoW}| treatment of, hazardous waste incineration | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	5.35E-03	0.00E+00	5.34E-03	7.40E-11	5.19E-09	5.80E-06	1.57E-10	1.24E-08	2.93E-11
4	Waste plastic, consumer electronics {RoW}| treatment of, municipal incineration | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	3.15E-03	0.00E+00	3.14E-03	1.73E-11	4.14E-09	2.79E-06	5.89E-10	4.66E-08	5.55E-11
5	Sulfidic tailing, off-site {GLO}| treatment of | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	2.81E-03	0.00E+00	2.81E-03	9.24E-11	5.48E-08	1.11E-06	3.27E-10	2.58E-08	1.63E-10

Calculation: Analyze
Results: Process contribution
1 p Apple Air iPad Base Case (of project
Product: Digital vs Print LCA)
ReCiPe Midpoint (H) V1.09 / Europe Recipe
Method: H
Indicator: Characterization
Category: Marine ecotoxicity
Cut-off: 1%
Mode: Group
Exclude infrastructure processes: Yes
Exclude long-term emissions: Yes
Sorted on item: Total
Sort order: Descending

No	Process	Project	Unit	Total	Top	Production	Apple Air iPad distribution transportation	Retail transportation	e-book formatting	e-book downloading	e-book reading	Waste Management
	Total of all processes		kg 1,4-DB eq	2.72E-01	0.00E+00	2.66E-01	2.27E-04	2.49E-03	1.38E-04	3.75E-05	2.96E-03	3.43E-05
	Remaining processes		kg 1,4-DB eq	1.87E-02	0.00E+00	1.30E-02	2.27E-04	2.47E-03	2.86E-05	3.70E-05	2.93E-03	3.35E-05
1	Gold {RoW}| -silver mine operation with refinery | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	2.30E-01	0.00E+00	2.30E-01	3.33E-11	2.09E-08	7.84E-05	1.67E-09	1.32E-07	5.95E-10
2	Copper {RoW}| production, primary | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	1.01E-02	0.00E+00	1.00E-02	2.73E-09	5.05E-07	1.18E-05	6.54E-09	5.18E-07	6.99E-09
3	Copper {RAS}| production, primary | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	5.32E-03	0.00E+00	5.31E-03	1.44E-09	2.67E-07	6.23E-06	3.46E-09	2.74E-07	3.69E-09
4	Copper {RLA}| production, primary | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	4.46E-03	0.00E+00	4.46E-03	1.21E-09	2.24E-07	5.23E-06	2.91E-09	2.30E-07	3.10E-09
5	Natural gas, unprocessed, at extraction {RNA}| production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	3.51E-03	0.00E+00	3.45E-03	1.54E-07	1.86E-05	7.34E-06	4.08E-07	3.23E-05	7.79E-07

Digital System Base Case SimaPro LCA Results

Calculation: Analyze
Results: Process contribution
1 p Apple Air iPad Base Case (of project
Product: Digital vs Print LCA)
ReCiPe Midpoint (H) V1.09 / Europe Recipe
Method: H
Indicator: Characterization
Category: Ionising radiation
Cut-off: 1%
Mode: Group
Exclude infrastructure processes: Yes
Exclude long-term emissions: Yes
Sorted on item: Total
Sort order: Descending

No	Process	Project	Unit	Total	Top	Production	Apple Air iPad distribution transportation	Retail transportation	e-book formatting	e-book downloading	e-book reading	Waste Management
	Total of all processes		kBq U235 eq	1.36E+00	0.00E+00	1.03E+00	5.05E-03	1.37E-01	2.35E-03	2.38E-03	1.88E-01	2.29E-04
	Remaining processes		kBq U235 eq	2.46E-01	0.00E+00	1.67E-01	2.36E-03	9.34E-04	4.13E-04	9.43E-04	7.46E-02	3.89E-05
1	Low level radioactive waste {CH}| treatment of, plasma torch incineration | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kBq U235 eq	4.37E-01	0.00E+00	2.64E-01	2.65E-03	1.34E-01	5.21E-04	4.44E-04	3.51E-02	4.65E-05
2	Spent nuclear fuel {RoW}| treatment of, reprocessing | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kBq U235 eq	3.03E-01	0.00E+00	2.40E-01	1.66E-05	1.05E-03	6.06E-04	7.67E-04	6.07E-02	5.73E-05
3	Electricity, high voltage {JP}| electricity production, nuclear, boiling water reactor | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kBq U235 eq	6.08E-02	0.00E+00	6.00E-02	2.82E-06	1.12E-04	1.32E-04	5.94E-06	4.70E-04	1.44E-05
4	Electricity, high voltage {RoW}| electricity production, nuclear, boiling water reactor | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kBq U235 eq	4.94E-02	0.00E+00	4.84E-02	2.18E-06	8.98E-05	1.02E-04	1.03E-05	8.15E-04	1.21E-05
5	Electricity, high voltage {SERC}| electricity production, nuclear, boiling water reactor | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kBq U235 eq	4.42E-02	0.00E+00	4.37E-02	2.06E-06	8.23E-05	9.61E-05	4.81E-06	3.81E-04	1.05E-05
6	Electricity, high voltage {RFC}| electricity production, nuclear, boiling water reactor | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kBq U235 eq	4.04E-02	0.00E+00	3.98E-02	1.87E-06	7.51E-05	8.77E-05	4.39E-06	3.47E-04	9.61E-06
8	Uranium ore, as U {RNA}| uranium mine operation, underground | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kBq U235 eq	3.64E-02	0.00E+00	2.87E-02	1.97E-06	1.24E-04	7.21E-05	9.41E-05	7.44E-03	6.85E-06
7	Electricity, high voltage {RU}| electricity production, nuclear, boiling water reactor | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kBq U235 eq	3.49E-02	0.00E+00	3.44E-02	1.62E-06	7.55E-05	7.67E-05	3.76E-06	2.97E-04	8.26E-06
9	Uranium ore, as U {RoW}| uranium mine operation, underground | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kBq U235 eq	3.44E-02	0.00E+00	2.71E-02	1.86E-06	1.17E-04	6.80E-05	8.88E-05	7.03E-03	6.47E-06
10	Electricity, high voltage {RoW}| electricity production, nuclear, pressure water reactor | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kBq U235 eq	2.54E-02	0.00E+00	2.48E-02	1.12E-06	4.62E-05	5.25E-05	5.29E-06	4.18E-04	6.21E-06
11	Electricity, high voltage {SE}| electricity production, nuclear, boiling water reactor | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kBq U235 eq	2.09E-02	0.00E+00	2.06E-02	1.21E-06	1.12E-04	6.65E-05	1.58E-06	1.25E-04	4.91E-06
12	Electricity, high voltage {SERC}| electricity production, nuclear, pressure water reactor | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kBq U235 eq	1.44E-02	0.00E+00	1.42E-02	6.71E-07	2.69E-05	3.14E-05	1.57E-06	1.24E-04	3.44E-06
13	Electricity, high voltage {RFC}| electricity production, nuclear, pressure water reactor | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kBq U235 eq	1.32E-02	0.00E+00	1.30E-02	6.12E-07	2.45E-05	2.86E-05	1.43E-06	1.13E-04	3.14E-06

Digital System Base Case SimaPro LCA Results

Calculation: Analyze
Results: Process contribution
1 p Apple Air iPad Base Case (of project
Product: Digital vs Print LCA)
ReCiPe Midpoint (H) V1.09 / Europe Recipe
Method: H
Indicator: Characterization
Category: Agricultural land occupation
Cut-off: 1%
Mode: Group
Exclude infrastructure processes: Yes
Exclude long-term emissions: Yes
Sorted on item: Total
Sort order: Descending

No	Process	Project	Unit	Total	Top	Production	Apple Air iPad distribution transportation	Retail transportation	e-book formatting	e-book downloading	e-book reading	Waste Management
	Total of all processes		m2a	5.57E-01	0.00E+00	5.37E-01	7.22E-04	2.64E-03	6.37E-04	2.00E-04	1.58E-02	4.56E-05
	Remaining processes		m2a	3.96E-02	0.00E+00	3.79E-02	6.85E-04	1.41E-04	6.84E-05	1.00E-05	7.92E-04	5.08E-06
1	Softwood, CO2-removal and land use {RoW}| softwood forestry, CO2-removal and land use | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	m2a	1.81E-01	0.00E+00	1.75E-01	1.48E-05	9.42E-04	1.80E-04	5.48E-05	4.34E-03	1.15E-05
2	Hardwood, CO2-removal and land use {RoW}| hardwood forestry, CO2-removal and land use | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	m2a	1.72E-01	0.00E+00	1.64E-01	8.86E-06	6.89E-04	2.11E-04	8.65E-05	6.84E-03	1.74E-05
3	Softwood, CO2-removal and land use {NORDEL}| softwood forestry, CO2-removal and land use | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	m2a	7.96E-02	0.00E+00	7.71E-02	6.49E-06	4.14E-04	7.92E-05	2.41E-05	1.91E-03	5.07E-06
4	Softwood, CO2-removal and land use {Europe without NORDEL (NCPA)}| softwood forestry, CO2-removal and land use | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	m2a	7.96E-02	0.00E+00	7.71E-02	6.49E-06	4.14E-04	7.92E-05	2.41E-05	1.91E-03	5.07E-06
5	Electricity, high voltage {DE}| heat and power co-generation, biogas, gas engine | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	m2a	6.12E-03	0.00E+00	6.02E-03	4.58E-07	3.85E-05	1.91E-05	5.05E-07	3.99E-05	1.41E-06

Calculation: Analyze
Results: Process contribution
1 p Apple Air iPad Base Case (of project
Product: Digital vs Print LCA)
ReCiPe Midpoint (H) V1.09 / Europe Recipe
Method: H
Indicator: Characterization
Category: Urban land occupation
Cut-off: 1%
Mode: Group
Exclude infrastructure processes: Yes
Exclude long-term emissions: Yes
Sorted on item: Total
Sort order: Descending

No	Process	Project	Unit	Total	Top	Production	Apple Air iPad distribution transportation	Retail transportation	e-book formatting	e-book downloading	e-book reading	Waste Management
	Total of all processes		m2a	2.49E-01	0.00E+00	2.05E-01	2.63E-03	5.69E-04	2.43E-04	5.00E-04	3.96E-02	1.76E-05
	Remaining processes		m2a	6.10E-02	0.00E+00	2.15E-02	1.16E-06	9.13E-05	5.75E-05	4.91E-04	3.89E-02	2.47E-06
1	Sulfidic tailing, off-site {GLO}| treatment of | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	m2a	1.13E-01	0.00E+00	1.13E-01	3.71E-09	2.20E-06	4.47E-05	1.31E-08	1.04E-06	6.55E-09
2	Hard coal {CN}| mine operation | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	m2a	2.46E-02	0.00E+00	2.41E-02	1.72E-06	3.48E-04	4.77E-05	1.92E-06	1.52E-04	5.26E-06
3	Hard coal {RNA}| mine operation | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	m2a	1.91E-02	0.00E+00	1.88E-02	1.03E-06	5.12E-05	3.92E-05	2.40E-06	1.90E-04	4.31E-06
4	Hard coal {ID}| mine operation | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	m2a	1.56E-02	0.00E+00	1.53E-02	5.55E-07	2.55E-05	2.55E-05	2.83E-06	2.24E-04	2.76E-06
5	Hard coal {RoW}| mine operation | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	m2a	1.29E-02	0.00E+00	1.27E-02	7.98E-07	5.13E-05	2.81E-05	1.61E-06	1.28E-04	2.82E-06
6	Transport, freight, lorry 16-32 metric ton, EURO4 {GLO}| market for | Alloc Def, S	Ecoinvent 3 - allocation, default - system	m2a	2.63E-03	0.00E+00	0.00E+00	2.63E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Digital System Base Case SimaPro LCA Results

Calculation: Analyze
Results: Process contribution
1 p Apple Air iPad Base Case (of project
Product: Digital vs Print LCA)
ReCiPe Midpoint (H) V1.09 / Europe Recipe
Method: H
Indicator: Characterization
Category: Natural land transformation
Cut-off: 1%
Mode: Group
Exclude infrastructure processes: Yes
Exclude long-term emissions: Yes
Sorted on item: Total
Sort order: Descending

No	Process	Project	Unit	Total	Top	Production	Apple Air iPad distribution transportation	Retail transportation	e-book formatting	e-book downloading	e-book reading	Waste Management
	Total of all processes		m2	1.17E-03	0.00E+00	9.40E-04	1.25E-05	3.07E-06	1.42E-06	2.67E-06	2.11E-04	1.08E-07
	Remaining processes		m2	3.00E-04	0.00E+00	1.52E-04	1.04E-08	7.15E-07	3.54E-07	1.83E-06	1.45E-04	2.34E-08
1	Sulfidic tailing, off-site {GLO}| treatment of | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	m2	3.48E-04	0.00E+00	3.48E-04	1.14E-11	6.78E-09	1.38E-07	4.04E-11	3.19E-09	2.02E-11
2	Hard coal {CN}| mine operation | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	m2	8.21E-05	0.00E+00	8.03E-05	5.74E-09	1.16E-06	1.59E-07	6.41E-09	5.07E-07	1.75E-08
10	Electricity, high voltage {RoW}| electricity production, hydro, reservoir, non-alpine region | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	m2	7.83E-05	0.00E+00	1.41E-05	8.53E-10	3.76E-08	3.14E-08	7.99E-07	6.32E-05	3.64E-09
3	Electricity, high voltage {BR}| electricity production, hydro, reservoir, tropical region | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	m2	7.50E-05	0.00E+00	7.40E-05	3.48E-09	1.38E-07	1.66E-07	7.46E-09	5.90E-07	1.83E-08
4	Hard coal {RNA}| mine operation | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	m2	6.15E-05	0.00E+00	6.06E-05	3.32E-09	1.65E-07	1.26E-07	7.73E-09	6.12E-07	1.39E-08
5	Hard coal {ID}| mine operation | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	m2	5.21E-05	0.00E+00	5.11E-05	1.85E-09	8.52E-08	8.51E-08	9.44E-09	7.47E-07	9.21E-09
6	Tin {RoW}| production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	m2	4.83E-05	0.00E+00	4.82E-05	2.55E-11	3.12E-09	1.08E-07	5.28E-11	4.17E-09	6.31E-11
7	Hard coal {RoW}| mine operation | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	m2	4.28E-05	0.00E+00	4.21E-05	2.65E-09	1.70E-07	9.31E-08	5.36E-09	4.24E-07	9.35E-09
8	Electricity, high voltage {CN}| electricity production, hydro, reservoir, non-alpine region | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	m2	3.83E-05	0.00E+00	3.75E-05	2.24E-09	5.70E-07	8.24E-08	1.30E-09	1.03E-07	9.04E-09
9	Tin {RER}| production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	m2	2.39E-05	0.00E+00	2.38E-05	1.26E-11	1.54E-09	5.32E-08	2.61E-11	2.06E-09	3.12E-11
11	Electricity, high voltage {RoW}| electricity production, hydro, reservoir, tropical region | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	m2	1.46E-05	0.00E+00	1.43E-05	6.80E-10	2.80E-08	3.14E-08	3.12E-09	2.46E-07	3.76E-09
12	Bauxite, without water {GLO}| bauxite mine operation | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	m2	1.37E-05	0.00E+00	1.35E-05	4.29E-12	4.41E-10	6.43E-09	1.55E-09	1.23E-07	1.35E-10
13	Transport, freight, lorry 16-32 metric ton, EURO4 {GLO}| market for | Alloc Def, S	Ecoinvent 3 - allocation, default - system	m2	1.24E-05	0.00E+00	0.00E+00	1.24E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
14	Recultivation, bauxite mine {GLO}| processing | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	m2	-1.97E-05	0.00E+00	-1.95E-05	-1.13E-10	-6.51E-09	-1.09E-08	-2.16E-09	-1.71E-07	-2.75E-10

Digital System Base Case SimaPro LCA Results

Calculation: Analyze
Results: Process contribution
1 p Apple Air iPad Base Case (of project
Product: Digital vs Print LCA)
ReCiPe Midpoint (H) V1.09 / Europe Recipe
Method: H
Indicator: Characterization
Category: Water depletion
Cut-off: 1%
Mode: Group
Exclude infrastructure processes: Yes
Exclude long-term emissions: Yes
Sorted on item: Total
Sort order: Descending

No	Process	Project	Unit	Total	Top	Production	Apple Air iPad distribution transportation	Retail transportation	e-book formatting	e-book downloading	e-book reading	Waste Management
	Total of all processes		m3	8.62E+01	0.00E+00	7.85E+01	2.74E-02	3.13E-01	1.67E-01	8.98E-02	7.11E+00	1.59E-02
	Remaining processes		m3	1.35E+01	0.00E+00	1.24E+01	2.44E-02	4.94E-02	3.24E-02	1.20E-02	9.49E-01	2.93E-03
1	Electricity, high voltage {RoW}| electricity production, hydro, run-of-river | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	m3	2.08E+01	0.00E+00	2.05E+01	3.60E-04	1.54E-02	2.79E-02	3.10E-03	2.46E-01	1.98E-03
14	Electricity, high voltage {RoW}| electricity production, hydro, reservoir, non-alpine region | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	m3	6.89E+00	0.00E+00	1.24E+00	7.51E-05	3.31E-03	2.77E-03	7.04E-02	5.57E+00	3.20E-04
2	Electricity, high voltage {CN}| electricity production, hydro, run-of-river | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	m3	6.24E+00	0.00E+00	6.11E+00	3.65E-04	9.29E-02	1.34E-02	2.11E-04	1.67E-02	1.47E-03
3	Electricity, high voltage {RU}| electricity production, hydro, run-of-river | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	m3	5.67E+00	0.00E+00	5.60E+00	2.63E-04	1.23E-02	1.25E-02	5.85E-04	4.63E-02	1.34E-03
4	Electricity, high voltage {WECC, US only}| electricity production, hydro, run-of-river | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	m3	5.54E+00	0.00E+00	5.47E+00	2.58E-04	1.03E-02	1.20E-02	6.05E-04	4.79E-02	1.32E-03
5	Electricity, high voltage {CN}| electricity production, hydro, reservoir, non-alpine region | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	m3	3.37E+00	0.00E+00	3.30E+00	1.97E-04	5.02E-02	7.26E-03	1.14E-04	9.03E-03	7.96E-04
6	Electricity, high voltage {BR}| electricity production, hydro, reservoir, tropical region | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	m3	2.64E+00	0.00E+00	2.61E+00	1.22E-04	4.87E-03	5.83E-03	2.63E-04	2.08E-02	6.43E-04
7	Electricity, high voltage {JP}| electricity production, hydro, run-of-river | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	m3	2.56E+00	0.00E+00	2.52E+00	1.18E-04	4.72E-03	5.54E-03	2.50E-04	1.98E-02	6.07E-04
8	Electricity, high voltage {Quebec}| electricity production, hydro, run-of-river | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	m3	2.39E+00	0.00E+00	2.36E+00	1.11E-04	4.44E-03	5.21E-03	2.49E-04	1.97E-02	5.74E-04
10	Electricity, high voltage {FR}| electricity production, hydro, run-of-river | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	m3	2.37E+00	0.00E+00	2.28E+00	4.00E-04	2.58E-02	7.20E-03	7.02E-04	5.55E-02	5.06E-04
9	Electricity, high voltage {SE}| electricity production, hydro, run-of-river | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	m3	2.34E+00	0.00E+00	2.30E+00	1.35E-04	1.25E-02	7.42E-03	1.76E-04	1.39E-02	5.47E-04
11	Electricity, high voltage {CA-BC}| electricity production, hydro, run-of-river | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	m3	2.30E+00	0.00E+00	2.27E+00	1.07E-04	4.27E-03	5.01E-03	2.36E-04	1.87E-02	5.52E-04
12	Electricity, high voltage {CA-MB}| electricity production, hydro, run-of-river | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	m3	1.80E+00	0.00E+00	1.78E+00	8.35E-05	3.34E-03	3.92E-03	1.81E-04	1.44E-02	4.31E-04
13	Electricity, high voltage {MX}| electricity production, hydro, run-of-river | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	m3	1.68E+00	0.00E+00	1.66E+00	7.79E-05	3.10E-03	3.72E-03	1.65E-04	1.30E-02	4.11E-04
15	Electricity, high voltage {CA-ON}| electricity production, hydro, run-of-river | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	m3	1.49E+00	0.00E+00	1.47E+00	6.92E-05	2.77E-03	3.26E-03	1.51E-04	1.20E-02	3.59E-04
16	Electricity, high voltage {SERC}| electricity production, hydro, run-of-river | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	m3	1.31E+00	0.00E+00	1.29E+00	6.09E-05	2.44E-03	2.85E-03	1.43E-04	1.13E-02	3.12E-04
17	Electricity, high voltage {AT}| electricity production, hydro, run-of-river | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	m3	1.19E+00	0.00E+00	1.17E+00	9.00E-05	7.64E-03	3.72E-03	9.77E-05	7.73E-03	2.77E-04
18	Electricity, high voltage {NPCC, US only}| electricity production, hydro, run-of-river | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	m3	1.07E+00	0.00E+00	1.05E+00	4.95E-05	1.99E-03	2.32E-03	1.21E-04	9.55E-03	2.55E-04
19	Electricity, high voltage {CL}| electricity production, hydro, run-of-river | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	m3	1.04E+00	0.00E+00	1.03E+00	4.78E-05	1.89E-03	2.27E-03	1.00E-04	7.92E-03	2.47E-04

Digital System Base Case SimaPro LCA Results

Calculation: Analyze
Results: Process contribution
1 p Apple Air iPad Base Case (of project
Product: Digital vs Print LCA)
ReCiPe Midpoint (H) V1.09 / Europe Recipe
Method: H
Indicator: Characterization
Category: Metal depletion
Cut-off: 1%
Mode: Group
Exclude infrastructure processes: Yes
Exclude long-term emissions: Yes
Sorted on item: Total
Sort order: Descending

No	Process	Project	Unit	Total	Top	Production	Apple Air iPad distribution transportation	Retail transportation	e-book formatting	e-book downloading	e-book reading	Waste Management
	Total of all processes		kg Fe eq	1.52E+01	0.00E+00	1.52E+01	2.23E-03	1.87E-03	9.77E-03	3.89E-05	3.07E-03	1.75E-05
	Remaining processes		kg Fe eq	8.78E-01	0.00E+00	8.69E-01	2.23E-03	1.72E-03	1.69E-03	3.65E-05	2.89E-03	1.49E-05
1	Gold {RoW}| -silver mine operation with refinery | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg Fe eq	1.06E+01	0.00E+00	1.05E+01	1.53E-09	9.60E-07	3.60E-03	7.67E-08	6.07E-06	2.73E-08
2	Manganese concentrate {GLO}| production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg Fe eq	1.49E+00	0.00E+00	1.49E+00	5.77E-08	1.02E-05	4.62E-04	2.23E-07	1.76E-05	2.23E-07
3	Tin {RoW}| production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg Fe eq	8.66E-01	0.00E+00	8.64E-01	4.56E-07	5.60E-05	1.93E-03	9.46E-07	7.48E-05	1.13E-06
4	Copper concentrate {RoW}| copper mine operation | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg Fe eq	7.58E-01	0.00E+00	7.58E-01	2.06E-07	3.81E-05	8.89E-04	4.95E-07	3.91E-05	5.31E-07
5	Tin {RER}| production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg Fe eq	4.28E-01	0.00E+00	4.27E-01	2.25E-07	2.76E-05	9.54E-04	4.67E-07	3.70E-05	5.59E-07
6	Copper concentrate {RAS}| copper mine operation | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg Fe eq	2.00E-01	0.00E+00	1.99E-01	5.43E-08	1.00E-05	2.34E-04	1.30E-07	1.03E-05	1.40E-07

Digital System Base Case SimaPro LCA Results

Calculation: Analyze
Results: Process contribution
1 p Apple Air iPad Base Case (of project
Product: Digital vs Print LCA)
ReCiPe Midpoint (H) V1.09 / Europe Recipe
Method: H
Indicator: Characterization
Category: Fossil depletion
Cut-off: 1%
Mode: Group
Exclude infrastructure processes: Yes
Exclude long-term emissions: Yes
Sorted on item: Total
Sort order: Descending

No	Process	Project	Unit	Total	Top	Production	Apple Air iPad distribution transportation	Retail transportation	e-book formatting	e-book downloading	e-book reading	Waste Management
	Total of all processes		kg oil eq	9.58E+00	0.00E+00	4.78E+00	3.21E-02	9.21E-01	9.01E-03	4.79E-02	3.79E+00	8.57E-04
	Remaining processes		kg oil eq	1.03E+00	0.00E+00	8.18E-01	1.78E-02	1.85E-01	1.50E-03	1.44E-04	1.14E-02	9.81E-05
8	Hard coal {ZA}| mine operation | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg oil eq	3.83E+00	0.00E+00	6.71E-02	1.47E-05	8.02E-04	1.31E-04	4.70E-02	3.72E+00	1.44E-05
1	Petroleum {RoW}| and gas production, off-shore | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg oil eq	8.46E-01	0.00E+00	3.80E-01	8.68E-03	4.38E-01	5.22E-04	2.46E-04	1.95E-02	4.03E-05
2	Hard coal {CN}| mine operation | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg oil eq	6.83E-01	0.00E+00	6.68E-01	4.78E-05	9.65E-03	1.33E-03	5.34E-05	4.22E-03	1.46E-04
3	Hard coal {RNA}| mine operation | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg oil eq	5.68E-01	0.00E+00	5.60E-01	3.06E-05	1.52E-03	1.17E-03	7.14E-05	5.65E-03	1.28E-04
4	Hard coal {ID}| mine operation | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg oil eq	3.98E-01	0.00E+00	3.91E-01	1.42E-05	6.51E-04	6.51E-04	7.22E-05	5.71E-03	7.05E-05
5	Hard coal {RoW}| mine operation | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg oil eq	3.95E-01	0.00E+00	3.88E-01	2.44E-05	1.57E-03	8.58E-04	4.94E-05	3.90E-03	8.62E-05
6	Natural gas, unprocessed, at extraction {RNA}| production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg oil eq	3.63E-01	0.00E+00	3.57E-01	1.59E-05	1.92E-03	7.60E-04	4.22E-05	3.34E-03	8.07E-05
7	Petroleum {RoW}| and gas production, on-shore | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg oil eq	2.85E-01	0.00E+00	1.28E-01	2.92E-03	1.47E-01	1.76E-04	8.28E-05	6.55E-03	1.36E-05
9	Natural gas, high pressure {RU}| natural gas production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg oil eq	1.94E-01	0.00E+00	1.91E-01	7.91E-06	1.21E-03	3.94E-04	2.24E-05	1.77E-03	3.68E-05
10	Petroleum {RoW}| gas and petroleum production, off-shore | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg oil eq	1.90E-01	0.00E+00	8.51E-02	1.94E-03	9.81E-02	1.17E-04	5.52E-05	4.36E-03	9.03E-06
11	Lignite {RoW}| mine operation | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg oil eq	1.48E-01	0.00E+00	1.46E-01	6.61E-06	2.34E-04	2.68E-04	1.92E-05	1.52E-03	2.85E-05
12	Lignite {RER}| mine operation | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg oil eq	9.70E-02	0.00E+00	9.55E-02	6.40E-06	5.62E-04	3.05E-04	7.63E-06	6.04E-04	2.28E-05
13	Natural gas, high pressure {RoW}| gas and petroleum production, off-shore | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg oil eq	9.39E-02	0.00E+00	9.21E-02	3.87E-06	7.78E-04	1.90E-04	1.04E-05	8.26E-04	1.90E-05
16	Hard coal {AU}| mine operation | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg oil eq	8.02E-02	0.00E+00	7.88E-02	5.12E-06	3.02E-04	1.52E-04	1.12E-05	8.87E-04	1.67E-05
15	Natural gas, high pressure {RoW}| natural gas production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg oil eq	8.02E-02	0.00E+00	7.86E-02	3.31E-06	6.64E-04	1.62E-04	8.92E-06	7.05E-04	1.62E-05
17	Natural gas, high pressure {DE}| natural gas production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg oil eq	7.99E-02	0.00E+00	7.85E-02	2.99E-06	2.04E-04	1.55E-04	1.29E-05	1.02E-03	1.64E-05
14	Polystyrene, general purpose {RoW}| production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg oil eq	7.95E-02	0.00E+00	7.95E-02	2.39E-10	2.59E-08	1.01E-08	1.00E-09	7.91E-08	6.43E-10
18	Natural gas, high pressure {GB}| petroleum and gas production, off-shore | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg oil eq	6.68E-02	0.00E+00	6.58E-02	2.51E-06	3.63E-04	1.45E-04	5.98E-06	4.73E-04	1.13E-05
19	Petroleum {GB}| and gas production, off-shore | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg oil eq	6.17E-02	0.00E+00	2.77E-02	6.33E-04	3.19E-02	3.81E-05	1.80E-05	1.42E-03	2.94E-06

Digital System Base Case SimaPro LCA Results

Calculation:	Analyze
Results:	Impact assessment
	1 p Apple Air iPad Base Case (of project
Product:	Digital vs Print LCA)
	Cumulative Energy Demand V1.08 /
Method:	Cumulative energy demand
Indicator:	Characterization
Skip categories:	Never
Mode:	Group
Exclude infrastructure processes:	Yes
Exclude long-term emissions:	Yes
Sorted on item:	Total
Sort order:	Descending

Impact category	Unit	Total	Top	Production	Apple Air iPad distribution transportation	Retail transportation	e-book formatting	e-book downloading	e-book reading	Waste Management		
Non renewable, fossil	MJ	4.26E+02	0.00E+00	2.14E+02	1.44E+00	4.12E+01	4.04E-01	2.11E+00	1.67E+02	3.84E-02		
Non-renewable, nuclear	MJ	4.73E+01	0.00E+00	3.74E+01	1.88E-02	1.72E-01	9.27E-02	1.20E-01	9.46E+00	8.71E-03		
Renewable, water	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00		
Renewable, wind, solar, geothe	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00		
Renewable, biomass	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00		
Non-renewable, biomass	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00		

Digital System Base Case SimaPro LCA Results

Calculation: Analyze
Results: Process contribution
1 p Apple Air iPad Base Case (of project
Product: Digital vs Print LCA)
Cumulative Energy Demand V1.08 /
Method: Cumulative energy demand
Indicator: Characterization
Category: Non renewable, fossil
Cut-off: 1%
Mode: Group
Exclude infrastructure processes: Yes
Exclude long-term emissions: Yes
Sorted on item: Total
Sort order: Descending

No	Process	Project	Unit	Total	Top	Production	Apple Air iPad distribution transportation	Retail transportation	e-book formatting	e-book downloading	e-book reading	Waste Management
	Total of all processes		MJ	4.26E+02	0.00E+00	2.14E+02	1.44E+00	4.12E+01	4.04E-01	2.11E+00	1.67E+02	3.84E-02
	Remaining processes		MJ	4.68E+01	0.00E+00	3.71E+01	7.95E-01	8.29E+00	6.80E-02	6.50E-03	5.14E-01	4.47E-03
8	Hard coal {ZA}| mine operation | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	MJ	1.69E+02	0.00E+00	2.95E+00	6.46E-04	3.53E-02	5.78E-03	2.07E+00	1.64E+02	6.35E-04
1	Petroleum {RoW}| and gas production, off-shore | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	MJ	3.77E+01	0.00E+00	1.69E+01	3.86E-01	1.95E+01	2.32E-02	1.10E-02	8.67E-01	1.79E-03
2	Hard coal {CN}| mine operation | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	MJ	3.01E+01	0.00E+00	2.94E+01	2.11E-03	4.25E-01	5.84E-02	2.35E-03	1.86E-01	6.43E-03
3	Hard coal {RNA}| mine operation | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	MJ	2.50E+01	0.00E+00	2.47E+01	1.35E-03	6.71E-02	5.14E-02	3.15E-03	2.49E-01	5.64E-03
4	Hard coal {ID}| mine operation | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	MJ	1.76E+01	0.00E+00	1.72E+01	6.24E-04	2.87E-02	2.87E-02	3.18E-03	2.52E-01	3.10E-03
5	Hard coal {RoW}| mine operation | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	MJ	1.74E+01	0.00E+00	1.71E+01	1.07E-03	6.91E-02	3.78E-02	2.17E-03	1.72E-01	3.80E-03
6	Natural gas, unprocessed, at extraction {RNA}| production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	MJ	1.69E+01	0.00E+00	1.66E+01	7.40E-04	8.94E-02	3.54E-02	1.97E-03	1.56E-01	3.75E-03
7	Petroleum {RoW}| and gas production, on-shore | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	MJ	1.26E+01	0.00E+00	5.66E+00	1.29E-01	6.52E+00	7.78E-03	3.67E-03	2.90E-01	6.00E-04
9	Natural gas, high pressure {RU}| natural gas production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	MJ	9.03E+00	0.00E+00	8.87E+00	3.68E-04	5.65E-02	1.84E-02	1.04E-03	8.25E-02	1.71E-03
10	Petroleum {RoW}| gas and petroleum production, off-shore | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	MJ	8.82E+00	0.00E+00	3.96E+00	9.04E-02	4.56E+00	5.44E-03	2.56E-03	2.03E-01	4.19E-04
11	Lignite {RoW}| mine operation | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	MJ	6.53E+00	0.00E+00	6.44E+00	2.91E-04	1.03E-02	1.18E-02	8.44E-04	6.67E-02	1.25E-03
12	Natural gas, high pressure {RoW}| gas and petroleum production, off-shore | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	MJ	4.36E+00	0.00E+00	4.28E+00	1.80E-04	3.61E-02	8.83E-03	4.85E-04	3.84E-02	8.84E-04
13	Lignite {RER}| mine operation | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	MJ	4.27E+00	0.00E+00	4.20E+00	2.82E-04	2.47E-02	1.34E-02	3.36E-04	2.66E-02	1.00E-03
14	Natural gas, high pressure {RoW}| natural gas production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	MJ	3.73E+00	0.00E+00	3.66E+00	1.54E-04	3.09E-02	7.55E-03	4.15E-04	3.28E-02	7.56E-04
15	Natural gas, high pressure {DE}| natural gas production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	MJ	3.72E+00	0.00E+00	3.65E+00	1.39E-04	9.49E-03	7.21E-03	6.02E-04	4.76E-02	7.63E-04
16	Polystyrene, general purpose {RoW}| production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	MJ	3.58E+00	0.00E+00	3.58E+00	1.08E-08	1.17E-06	4.54E-07	4.50E-08	3.56E-06	2.90E-08
17	Hard coal {AU}| mine operation | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	MJ	3.53E+00	0.00E+00	3.47E+00	2.25E-04	1.33E-02	6.67E-03	4.94E-04	3.91E-02	7.36E-04
18	Natural gas, high pressure {GB}| petroleum and gas production, off-shore | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	MJ	3.00E+00	0.00E+00	2.96E+00	1.13E-04	1.63E-02	6.53E-03	2.69E-04	2.13E-02	5.07E-04
19	Petroleum {GB}| and gas production, off-shore | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	MJ	2.78E+00	0.00E+00	1.25E+00	2.85E-02	1.44E+00	1.71E-03	8.07E-04	6.39E-02	1.32E-04

Calculation: Analyze
Results: Process contribution
1 p Apple Air iPad Base Case (of project
Product: Digital vs Print LCA)
Cumulative Energy Demand V1.08 /
Method: Cumulative energy demand
Indicator: Characterization
Category: Non-renewable, nuclear
Cut-off: 1%
Mode: Group
Exclude infrastructure processes: Yes
Exclude long-term emissions: Yes
Sorted on item: Total
Sort order: Descending

No	Process	Project	Unit	Total	Top	Production	Apple Air iPad distribution transportation	Retail transportation	e-book formatting	e-book downloading	e-book reading	Waste Management
	Total of all processes		MJ	4.73E+01	0.00E+00	3.74E+01	1.88E-02	1.72E-01	9.27E-02	1.20E-01	9.46E+00	8.71E-03
	Remaining processes		MJ	9.54E-01	0.00E+00	9.21E-01	1.63E-02	1.47E-02	1.08E-03	3.05E-06	2.41E-04	2.84E-06
1	Uranium ore, as U {RNA}| uranium mine operation, underground | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	MJ	1.80E+01	0.00E+00	1.41E+01	9.70E-04	6.12E-02	3.55E-02	4.64E-02	3.67E+00	3.38E-03
2	Uranium ore, as U {RoW}| uranium mine operation, underground | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	MJ	1.70E+01	0.00E+00	1.34E+01	9.16E-04	5.78E-02	3.35E-02	4.38E-02	3.47E+00	3.19E-03
3	Uranium ore, as U {RoW}| uranium mine operation, open cast | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	MJ	6.70E+00	0.00E+00	5.27E+00	3.62E-04	2.28E-02	1.33E-02	1.73E-02	1.37E+00	1.26E-03
4	Uranium ore, as U {RNA}| uranium mine operation, open cast | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	MJ	4.67E+00	0.00E+00	3.68E+00	2.52E-04	1.59E-02	9.24E-03	1.21E-02	9.55E-01	8.79E-04

Print System IRP SimaPro LCA Results

Calculation:	Analyze
Results:	Impact assessment
Product:	1 p Printed Book System IRP (of project Digital vs Print LCA)
Method:	ReCiPe Midpoint (H) V1.09 / Europe
Indicator:	Recipe H
Skip categories:	Characterization
Mode:	Never
Exclude infrastructure processes:	Group
Exclude long-term emissions:	Yes
Sorted on item:	Yes
Sort order:	Impact category
	Ascending

Impact category	Unit	Total	Top	Pulp wood	Pulp	Paper	Printing	Distribution Transportation	Retail Transportation	Waste Management
Climate change	kg CO2 eq	1.22E+02	0.00E+00	2.50E+00	1.85E+00	3.84E+01	4.23E+01	6.42E+00	1.13E+01	1.95E+01
Ozone depletion	kg CFC-11 eq	5.57E-06	0.00E+00	1.29E-07	6.28E-08	1.77E-06	2.48E-06	4.18E-07	7.02E-07	1.02E-08
Terrestrial acidification	kg SO2 eq	6.33E-01	0.00E+00	3.58E-02	1.63E-02	2.42E-01	2.89E-01	3.16E-02	1.56E-02	2.99E-03
Freshwater eutrophication	kg P eq	8.47E-03	0.00E+00	8.38E-04	3.41E-04	3.92E-03	3.28E-03	6.84E-06	1.55E-05	7.07E-05
Marine eutrophication	kg N eq	9.35E-02	0.00E+00	2.67E-03	1.02E-03	1.73E-02	2.63E-02	1.96E-03	4.18E-04	4.38E-02
Human toxicity	kg 1,4-DB eq	8.19E+00	0.00E+00	7.59E-01	1.69E-01	3.47E+00	3.09E+00	6.78E-02	4.81E-01	1.57E-01
Photochemical oxidant formation	kg NMVOC	5.84E-01	0.00E+00	9.70E-02	7.17E-03	1.90E-01	2.01E-01	5.45E-02	2.40E-02	1.00E-02
Particulate matter formation	kg PM10 eq	2.53E-01	0.00E+00	3.26E-02	4.72E-03	1.00E-01	9.57E-02	1.31E-02	5.62E-03	1.02E-03
Terrestrial ecotoxicity	kg 1,4-DB eq	1.98E-02	0.00E+00	1.12E-03	1.86E-04	1.00E-02	6.60E-03	6.05E-04	1.21E-03	2.96E-05
Freshwater ecotoxicity	kg 1,4-DB eq	6.26E-02	0.00E+00	1.03E-03	5.64E-04	2.92E-02	2.60E-02	1.26E-03	2.08E-03	2.40E-03
Marine ecotoxicity	kg 1,4-DB eq	8.16E-02	0.00E+00	5.49E-03	9.57E-04	3.61E-02	2.20E-02	5.27E-03	9.97E-03	1.73E-03
Ionising radiation	kBq U235 eq	4.23E+00	0.00E+00	1.20E-01	3.26E-02	1.27E+00	1.92E+00	3.27E-01	5.48E-01	1.72E-02
Agricultural land occupation	m2a	4.62E+02	0.00E+00	4.50E+02	1.65E-01	1.58E+00	1.03E+01	3.51E-03	1.06E-02	3.35E-03
Urban land occupation	m2a	4.47E+00	0.00E+00	4.14E+00	9.92E-03	7.09E-02	2.44E-01	5.11E-04	2.28E-03	1.33E-03
Natural land transformation	m2	3.46E-02	0.00E+00	2.78E-02	4.22E-05	4.51E-03	2.20E-03	3.25E-06	1.23E-05	8.13E-06
Water depletion	m3	1.92E+02	0.00E+00	2.28E+00	9.29E-01	4.14E+01	1.45E+02	5.29E-01	1.25E+00	1.20E+00
Metal depletion	kg Fe eq	4.77E-01	0.00E+00	4.44E-03	4.14E-03	1.10E-01	3.49E-01	1.55E-03	7.46E-03	1.29E-03
Fossil depletion	kg oil eq	2.98E+01	0.00E+00	6.71E-01	3.95E-01	1.21E+01	1.08E+01	2.12E+00	3.68E+00	6.44E-02

Print System IRP SimaPro LCA Results

Calculation:	Analyze
Results:	Process contribution
Product:	1 p Printed Book System IRP (of project Digital vs Print LCA)
Method:	ReCiPe Midpoint (H) V1.09 / Europe
Indicator:	Recipe H
Category:	Characterization
Cut-off:	Climate change
Mode:	1%
Exclude infrastructure processes:	Group
Exclude long-term emissions:	Yes
Sorted on item:	Yes
Sort order:	Total
	Descending

No	Process	Project	Unit	Total	Top	Pulp wood	Pulp	Paper	Printing	Distribution Transportation	Retail Transportation	Waste Management
	Total of all processes		kg CO2 eq	1.22E+02	0.00E+00	2.50E+00	1.85E+00	3.84E+01	4.23E+01	6.42E+00	1.13E+01	1.95E+01
	Remaining processes		kg CO2 eq	3.66E+01	0.00E+00	2.31E+00	5.17E-01	9.60E+00	2.01E+01	1.80E+00	2.07E+00	1.75E-01
1	Electricity, high voltage {ZA IRP}| electricity production, hard coal | Alloc Def, U	Digital vs Print LCA	kg CO2 eq	2.16E+01	0.00E+00	0.00E+00	9.99E-02	8.45E+00	1.31E+01	0.00E+00	0.00E+00	0.00E+00
2	Waste graphical paper {RoW}| treatment of, sanitary landfill | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg CO2 eq	1.43E+01	0.00E+00	2.22E-06	1.17E-03	1.04E-04	1.33E-04	2.53E-06	4.36E-06	1.43E+01
3	Paper, woodfree, coated {ZA IRP}| paper production, woodfree, coated, at integrated mill | Alloc Def, U	Digital vs Print LCA	kg CO2 eq	1.40E+01	0.00E+00	0.00E+00	0.00E+00	1.40E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
4	Transport, passenger car, medium size, petrol, EURO 3 {RoW}| transport, passenger car, medium size, petrol, EURO 3 | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg CO2 eq	7.41E+00	0.00E+00	2.55E-08	3.30E-08	4.49E-07	9.37E-07	1.51E-08	7.41E+00	1.20E-08
5	Municipal solid waste {RoW}| treatment of, sanitary landfill | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg CO2 eq	5.46E+00	0.00E+00	4.09E-05	2.30E-03	3.92E-01	7.79E-02	9.31E-05	1.76E-04	4.99E+00
6	Electricity, high voltage {RoW}| electricity production, hard coal | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg CO2 eq	5.45E+00	0.00E+00	3.46E-02	1.46E-02	6.55E-01	4.72E+00	3.00E-03	8.53E-03	2.15E-02
7	Transport, freight, lorry 16-32 metric ton, EURO3 {RER}| transport, freight, lorry 16-32 metric ton, EURO3 | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg CO2 eq	5.04E+00	0.00E+00	4.20E-02	2.44E-03	1.40E-01	2.52E-01	4.59E+00	1.46E-02	1.66E-04
8	Electricity, high voltage {CN}| electricity production, hard coal | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg CO2 eq	2.63E+00	0.00E+00	7.78E-02	2.86E-02	7.56E-01	1.58E+00	1.22E-02	1.31E-01	3.92E-02
9	Latex {RoW}| production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg CO2 eq	2.61E+00	0.00E+00	4.75E-07	1.16E-06	2.54E+00	7.20E-02	4.55E-07	4.42E-07	1.92E-07
10	Heat, district or industrial, other than natural gas {RoW}| heat production, at hard coal industrial furnace 1-10MW | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg CO2 eq	1.84E+00	0.00E+00	3.11E-03	1.05E+00	2.13E-01	5.13E-01	5.99E-03	4.72E-02	5.70E-03
11	Transport, passenger car, medium size, petrol, EURO 3 {RER}| transport, passenger car, medium size, petrol, EURO 3 | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg CO2 eq	1.58E+00	0.00E+00	5.42E-09	7.02E-09	9.55E-08	1.99E-07	3.20E-09	1.58E+00	2.55E-09
12	Latex {RER}| production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg CO2 eq	1.29E+00	0.00E+00	2.34E-07	5.72E-07	1.25E+00	3.55E-02	2.25E-07	2.18E-07	9.49E-08
13	Electricity, high voltage {RoW}| electricity production, lignite | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg CO2 eq	1.28E+00	0.00E+00	4.63E-03	1.96E-03	8.79E-02	1.18E+00	4.02E-04	1.14E-03	2.88E-03
14	Hard coal {CN}| mine operation | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg CO2 eq	1.23E+00	0.00E+00	2.93E-02	1.33E-01	3.12E-01	6.78E-01	5.62E-03	5.42E-02	1.54E-02

Print System IRP SimaPro LCA Results

Calculation:	Analyze
Results:	Process contribution
Product:	1 p Printed Book System IRP (of project Digital vs Print LCA)
Method:	ReCiPe Midpoint (H) V1.09 / Europe
Indicator:	Recipe H
Category:	Characterization
Cut-off:	Ozone depletion
Mode:	1%
Exclude infrastructure processes:	Group
Exclude long-term emissions:	Yes
Sorted on item:	Yes
Sort order:	Total
	Descending

No	Process	Project	Unit	Total	Top	Pulp wood	Pulp	Paper	Printing	Distribution Transportation	Retail Transportation	Waste Management
	Total of all processes		kg CFC-11 eq	5.57E-06	0.00E+00	1.29E-07	6.28E-08	1.77E-06	2.48E-06	4.18E-07	7.02E-07	1.02E-08
	Remaining processes		kg CFC-11 eq	7.60E-07	0.00E+00	7.30E-09	8.39E-09	3.23E-07	3.80E-07	1.46E-08	2.44E-08	2.32E-09
1	Petroleum {RoW}| and gas production, on-shore | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg CFC-11 eq	1.11E-06	0.00E+00	6.37E-08	1.14E-08	2.17E-07	1.85E-07	2.37E-07	3.98E-07	6.73E-10
2	Uranium, enriched 4.2%, per separative work unit {US}| uranium production, diffusion, enriched 4.2% | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg CFC-11 eq	8.18E-07	0.00E+00	5.55E-09	4.60E-09	3.02E-07	5.00E-07	1.38E-09	1.98E-09	2.87E-09
3	Transport, pipeline, long distance, natural gas {RU}| processing | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg CFC-11 eq	3.07E-07	0.00E+00	2.18E-09	1.11E-09	5.54E-08	2.45E-07	7.98E-10	1.57E-09	1.16E-09
4	Sodium hydroxide, without water, in 50% solution state {RoW}| chlor-alkali electrolysis, diaphragm cell | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg CFC-11 eq	2.82E-07	0.00E+00	3.05E-11	1.20E-08	2.21E-07	4.88E-08	3.01E-11	2.33E-10	1.13E-11
5	Tetrafluoroethylene {RoW}| production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg CFC-11 eq	2.70E-07	0.00E+00	6.20E-13	1.23E-12	9.74E-12	2.70E-07	6.87E-13	6.39E-13	2.41E-13
6	Petroleum {NG}| and gas production, on-shore | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg CFC-11 eq	2.28E-07	0.00E+00	1.31E-08	2.34E-09	4.45E-08	3.81E-08	4.86E-08	8.17E-08	1.38E-10
7	Sodium hydroxide, without water, in 50% solution state {RoW}| chlor-alkali electrolysis, membrane cell | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg CFC-11 eq	2.28E-07	0.00E+00	2.47E-11	9.74E-09	1.79E-07	3.95E-08	2.43E-11	1.88E-10	9.14E-12
8	Petroleum {RAF}| production, onshore | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg CFC-11 eq	2.09E-07	0.00E+00	1.20E-08	2.15E-09	4.07E-08	3.49E-08	4.46E-08	7.48E-08	1.27E-10
9	Petroleum {RME}| production, onshore | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg CFC-11 eq	2.00E-07	0.00E+00	1.15E-08	2.06E-09	3.90E-08	3.34E-08	4.27E-08	7.17E-08	1.21E-10
10	Uranium, enriched 3.8%, per separative work unit {US}| uranium production, diffusion, enriched 3.8% | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg CFC-11 eq	1.89E-07	0.00E+00	5.01E-09	1.39E-09	5.90E-08	1.17E-07	1.92E-09	2.62E-09	2.08E-09
11	Transport, pipeline, long distance, natural gas {RoW}| processing | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg CFC-11 eq	1.28E-07	0.00E+00	9.08E-10	4.38E-10	2.16E-08	1.03E-07	3.14E-10	5.75E-10	4.99E-10
12	Tetrafluoroethylene {RER}| production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg CFC-11 eq	1.25E-07	0.00E+00	2.86E-13	5.66E-13	4.50E-12	1.25E-07	3.17E-13	2.95E-13	1.11E-13
13	Chlorodifluoromethane {RoW}| production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg CFC-11 eq	1.25E-07	0.00E+00	1.60E-10	3.17E-10	2.49E-09	1.21E-07	1.78E-10	1.59E-10	6.04E-11
14	Petroleum {RU}| production, onshore | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg CFC-11 eq	1.23E-07	0.00E+00	7.07E-09	1.27E-09	2.40E-08	2.06E-08	2.63E-08	4.41E-08	7.47E-11
15	Trichloromethane {RER}| production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg CFC-11 eq	1.10E-07	0.00E+00	3.11E-10	2.73E-10	4.14E-09	1.05E-07	1.55E-10	1.39E-10	5.52E-11
16	Fluorescent whitening agent, distyrylbiphenyl type {RoW}| production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg CFC-11 eq	1.04E-07	0.00E+00	2.24E-14	4.42E-14	8.38E-08	2.03E-08	2.46E-14	2.21E-14	8.47E-15
17	Fluorescent whitening agent, DAS1, triazinylaminostilben type {RoW}| production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg CFC-11 eq	7.37E-08	0.00E+00	1.59E-14	3.13E-14	5.93E-08	1.44E-08	1.74E-14	1.56E-14	6.00E-15
18	Sodium hydroxide, without water, in 50% solution state {RoW}| chlor-alkali electrolysis, mercury cell | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg CFC-11 eq	6.04E-08	0.00E+00	6.55E-12	2.58E-09	4.73E-08	1.05E-08	6.45E-12	4.99E-11	2.42E-12
19	Sodium hydroxide, without water, in 50% solution state {RER}| chlor-alkali electrolysis, mercury cell | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg CFC-11 eq	6.04E-08	0.00E+00	6.55E-12	2.58E-09	4.73E-08	1.05E-08	6.45E-12	4.99E-11	2.42E-12
20	Trichloromethane {RoW}| production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg CFC-11 eq	6.02E-08	0.00E+00	1.70E-10	1.49E-10	2.26E-09	5.74E-08	8.43E-11	7.58E-11	3.01E-11

Print System IRP SimaPro LCA Results

Calculation:	Analyze
Results:	Process contribution
Product:	1 p Printed Book System IRP (of project Digital vs Print LCA)
Method:	ReCiPe Midpoint (H) V1.09 / Europe Recipe H
Indicator:	Characterization
Category:	Terrestrial acidification
Cut-off:	1%
Mode:	Group
Exclude infrastructure processes:	Yes
Exclude long-term emissions:	Yes
Sorted on item:	Total
Sort order:	Descending

No	Process	Project	Unit	Total	Top	Pulp wood	Pulp	Paper	Printing	Distribution Transportation	Retail Transportation	Waste Management
	Total of all processes		kg SO2 eq	6.33E-01	0.00E+00	3.58E-02	1.63E-02	2.42E-01	2.89E-01	3.16E-02	1.56E-02	2.99E-03
	Remaining processes		kg SO2 eq	1.72E-01	0.00E+00	1.12E-02	7.76E-03	5.29E-02	7.55E-02	9.32E-03	1.36E-02	2.22E-03
1	Electricity, high voltage {ZA IRP}| electricity production, hard coal | Alloc Def, U	Digital vs Print LCA	kg SO2 eq	2.06E-01	0.00E+00	0.00E+00	9.55E-04	8.07E-02	1.25E-01	0.00E+00	0.00E+00	0.00E+00
2	Paper, woodfree, coated {ZA IRP}| paper production, woodfree, coated, at integrated mill | Alloc Def, U	Digital vs Print LCA	kg SO2 eq	5.23E-02	0.00E+00	0.00E+00	0.00E+00	5.23E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
3	Electricity, high voltage {RoW}| electricity production, hard coal | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg SO2 eq	3.95E-02	0.00E+00	2.51E-04	1.05E-04	4.74E-03	3.41E-02	2.17E-05	6.18E-05	1.56E-04
4	Electricity, high voltage {CN}| electricity production, hard coal | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg SO2 eq	2.77E-02	0.00E+00	8.18E-04	3.01E-04	7.95E-03	1.67E-02	1.29E-04	1.38E-03	4.13E-04
5	Transport, freight, lorry 16-32 metric ton, EURO3 {RER}| transport, freight, lorry 16-32 metric ton, EURO3 | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg SO2 eq	2.42E-02	0.00E+00	2.02E-04	1.17E-05	6.72E-04	1.21E-03	2.20E-02	7.02E-05	7.96E-07
6	Natural gas, high pressure {RNA}| natural gas production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg SO2 eq	1.74E-02	0.00E+00	1.88E-04	7.46E-05	9.50E-03	7.41E-03	1.66E-05	1.14E-04	1.06E-04
7	Transport, freight, sea, transoceanic ship {GLO}| processing | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg SO2 eq	1.48E-02	0.00E+00	4.10E-04	9.73E-05	6.66E-03	7.55E-03	4.13E-06	2.41E-05	8.31E-06
8	Latex {RoW}| production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg SO2 eq	1.37E-02	0.00E+00	2.50E-09	6.09E-09	1.34E-02	3.79E-04	2.39E-09	2.32E-09	1.01E-09
9	Heat, district or industrial, other than natural gas {RoW}| heat production, at hard coal industrial furnace 1-10MW | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg SO2 eq	1.22E-02	0.00E+00	2.07E-05	6.99E-03	1.42E-03	3.41E-03	3.98E-05	3.14E-04	3.79E-05
10	Log, energy wood, split, measured as solid wood under bark {RoW}| heat production, mixed logs, at wood heater 6kW | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg SO2 eq	8.43E-03	0.00E+00	8.29E-03	2.53E-06	1.46E-06	1.42E-04	4.69E-08	1.56E-07	4.76E-08
11	Diesel, burned in building machine {GLO}| processing | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg SO2 eq	8.36E-03	0.00E+00	7.43E-03	1.54E-05	2.96E-04	6.15E-04	7.96E-07	2.76E-06	1.57E-06
12	Aluminium, primary, liquid {GLO}| aluminium production, primary, liquid, prebake | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg SO2 eq	7.71E-03	0.00E+00	7.10E-08	3.10E-07	7.39E-06	7.70E-03	2.16E-08	5.02E-08	3.77E-08
13	Natural gas, high pressure {RoW}| natural gas production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg SO2 eq	7.06E-03	0.00E+00	4.17E-05	1.87E-05	4.48E-03	2.44E-03	6.32E-06	4.99E-05	2.30E-05
14	Log, energy wood, split, measured as solid wood under bark {RoW}| heat production, mixed logs, at furnace 30kW | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg SO2 eq	6.99E-03	0.00E+00	6.87E-03	2.10E-06	1.21E-06	1.18E-04	3.89E-08	1.29E-07	3.95E-08
15	Electricity, high voltage {RoW}| electricity production, lignite | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg SO2 eq	6.99E-03	0.00E+00	2.52E-05	1.07E-05	4.79E-04	6.45E-03	2.19E-06	6.23E-06	1.57E-05
16	Latex {RER}| production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg SO2 eq	6.79E-03	0.00E+00	1.23E-09	3.01E-09	6.60E-03	1.87E-04	1.18E-09	1.15E-09	5.00E-10

Print System IRP SimaPro LCA Results

Calculation:	Analyze
Results:	Process contribution
Product:	1 p Printed Book System IRP (of project Digital vs Print LCA)
Method:	ReCiPe Midpoint (H) V1.09 / Europe
Indicator:	Recipe H
Category:	Characterization
Cut-off:	Freshwater eutrophication
Mode:	1%
Exclude infrastructure processes:	Group
Exclude long-term emissions:	Yes
Sorted on item:	Yes
Sort order:	Total
	Descending

No	Process	Project	Unit	Total	Top	Pulp wood	Pulp	Paper	Printing	Distribution Transportation	Retail Transportation	Waste Management
	Total of all processes		kg P eq	8.47E-03	0.00E+00	8.38E-04	3.41E-04	3.92E-03	3.28E-03	6.84E-06	1.55E-05	7.07E-05
	Remaining processes		kg P eq	4.79E-04	0.00E+00	1.69E-05	4.41E-05	1.42E-04	2.17E-04	3.58E-07	8.62E-07	5.83E-05
1	Spoil from hard coal mining {GLO}| treatment of, in surface landfill | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg P eq	2.92E-03	0.00E+00	1.40E-05	6.30E-05	1.03E-03	1.80E-03	2.92E-06	9.50E-06	8.08E-06
2	Wood ash mixture, pure {CH}| treatment of, landfarming | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg P eq	2.18E-03	0.00E+00	7.99E-04	2.31E-04	6.00E-04	5.46E-04	9.43E-08	2.36E-07	1.49E-07
3	Spoil from lignite mining {GLO}| treatment of, in surface landfill | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg P eq	2.17E-03	0.00E+00	7.60E-06	2.67E-06	1.66E-03	4.92E-04	3.24E-06	3.42E-06	4.14E-06
4	Paper, woodfree, coated {ZA IRP}| paper production, woodfree, coated, at integrated mill | Alloc Def, U	Digital vs Print LCA	kg P eq	4.58E-04	0.00E+00	0.00E+00	0.00E+00	4.58E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00
5	Waste paper, unsorted {RoW}| graphic paper production, 100% recycled | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg P eq	1.58E-04	0.00E+00	3.50E-13	8.18E-13	5.99E-12	1.58E-04	3.28E-13	3.08E-13	1.27E-13
6	Sulfidic tailing, off-site {GLO}| treatment of | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg P eq	1.08E-04	0.00E+00	2.47E-07	4.61E-07	3.71E-05	6.88E-05	2.28E-07	1.46E-06	6.72E-08

Print System IRP SimaPro LCA Results

Calculation:	Analyze
Results:	Process contribution
Product:	1 p Printed Book System IRP (of project Digital vs Print LCA)
Method:	ReCiPe Midpoint (H) V1.09 / Europe
Indicator:	Recipe H
Category:	Characterization
Cut-off:	Marine eutrophication
Mode:	1%
Exclude infrastructure processes:	Group
Exclude long-term emissions:	Yes
Sorted on item:	Yes
Sort order:	Total
	Descending

No	Process	Project	Unit	Total	Top	Pulp wood	Pulp	Paper	Printing	Distribution Transportation	Retail Transportation	Waste Management
	Total of all processes		kg N eq	9.35E-02	0.00E+00	2.67E-03	1.02E-03	1.73E-02	2.63E-02	1.96E-03	4.18E-04	4.38E-02
	Remaining processes		kg N eq	1.40E-02	0.00E+00	2.27E-03	7.66E-04	4.31E-03	5.80E-03	4.33E-04	4.13E-04	2.63E-05
1	Waste graphical paper {RoW}| treatment of, sanitary landfill | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg N eq	3.10E-02	0.00E+00	4.81E-09	2.54E-06	2.25E-07	2.88E-07	5.49E-09	9.44E-09	3.10E-02
2	Municipal solid waste {RoW}| treatment of, sanitary landfill | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg N eq	1.40E-02	0.00E+00	1.05E-07	5.91E-06	1.01E-03	2.00E-04	2.39E-07	4.52E-07	1.28E-02
3	Waste paper, unsorted {RoW}| graphic paper production, 100% recycled | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg N eq	8.70E-03	0.00E+00	1.93E-11	4.50E-11	3.30E-10	8.70E-03	1.81E-11	1.70E-11	7.01E-12
4	Paper, woodfree, coated {ZA IRP}| paper production, woodfree, coated, at integrated mill | Alloc Def, U	Digital vs Print LCA	kg N eq	6.95E-03	0.00E+00	0.00E+00	0.00E+00	6.95E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00
5	Potato, Swiss integrated production {CH}| potato production, Swiss integrated production, intensive | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg N eq	3.97E-03	0.00E+00	4.34E-09	1.53E-08	2.07E-03	1.90E-03	2.33E-09	3.17E-09	2.08E-09
6	Electricity, high voltage {ZA IRP}| electricity production, hard coal | Alloc Def, U	Digital vs Print LCA	kg N eq	3.34E-03	0.00E+00	0.00E+00	1.54E-05	1.31E-03	2.02E-03	0.00E+00	0.00E+00	0.00E+00
7	Waste paper, unsorted {RER}| graphic paper production, 100% recycled | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg N eq	3.23E-03	0.00E+00	7.15E-12	1.67E-11	1.22E-10	3.23E-03	6.70E-12	6.29E-12	2.60E-12
8	Green manure, Swiss integrated production, until March {RoW}| production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg N eq	2.56E-03	0.00E+00	2.24E-05	2.11E-08	1.30E-03	1.24E-03	4.17E-09	6.70E-09	1.59E-09
9	Soybean {RoW}| production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg N eq	1.83E-03	0.00E+00	3.63E-04	1.88E-07	3.40E-04	1.13E-03	4.42E-08	7.68E-08	5.01E-09
10	Transport, freight, lorry 16-32 metric ton, EURO3 {RER}| transport, freight, lorry 16-32 metric ton, EURO3 | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg N eq	1.67E-03	0.00E+00	1.40E-05	8.09E-07	4.64E-05	8.37E-05	1.52E-03	4.85E-06	5.50E-08
11	Sludge from pulp and paper production {RoW}| treatment of, sanitary landfill | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg N eq	1.15E-03	0.00E+00	2.19E-08	2.29E-04	3.48E-07	9.18E-04	1.08E-08	1.73E-08	1.20E-08
12	Waste paperboard {RoW}| treatment of, sanitary landfill | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg N eq	1.07E-03	0.00E+00	1.02E-10	4.66E-10	6.64E-09	1.07E-03	5.41E-11	8.79E-11	5.17E-11

Print System IRP SimaPro LCA Results

Calculation:	Analyze
Results:	Process contribution
Product:	1 p Printed Book System IRP (of project Digital vs Print LCA)
	ReCiPe Midpoint (H) V1.09 / Europe
Method:	Recipe H
Indicator:	Characterization
Category:	Human toxicity
Cut-off:	1%
Mode:	Group
Exclude infrastructure processes:	Yes
Exclude long-term emissions:	Yes
Sorted on item:	Total
Sort order:	Descending

No	Process	Project	Unit	Total	Top	Pulp wood	Pulp	Paper	Printing	Distribution Transportation	Retail Transportation	Waste Management
	Total of all processes		kg 1,4-DB eq	8.19E+00	0.00E+00	7.59E-01	1.69E-01	3.47E+00	3.09E+00	6.78E-02	4.81E-01	1.57E-01
	Remaining processes		kg 1,4-DB eq	1.48E+00	0.00E+00	1.39E-01	3.43E-02	3.92E-01	6.92E-01	6.61E-02	1.17E-01	3.63E-02
1	Paper, woodfree, coated {ZA IRP}| paper production, woodfree, coated, at integrated mill | Alloc Def, U	Digital vs Print LCA	kg 1,4-DB eq	1.91E+00	0.00E+00	0.00E+00	0.00E+00	1.91E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2	Aluminium, primary, liquid {GLO}| aluminium production, primary, liquid, prebake | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	6.84E-01	0.00E+00	6.31E-06	2.75E-05	6.56E-04	6.84E-01	1.92E-06	4.46E-06	3.35E-06
3	Natural gas, unprocessed, at extraction {RNA}| production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	5.43E-01	0.00E+00	5.09E-03	2.07E-03	3.10E-01	2.18E-01	5.10E-04	3.63E-03	2.87E-03
4	Wood ash mixture, pure {CH}| treatment of, landfarming | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	5.38E-01	0.00E+00	1.98E-01	5.72E-02	1.48E-01	1.35E-01	2.33E-05	5.83E-05	3.68E-05
5	Redmud from bauxite digestion {RoW}| treatment of, residual material landfill | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	4.88E-01	0.00E+00	5.29E-06	1.35E-04	1.11E-03	4.87E-01	2.50E-06	7.97E-06	1.82E-05
6	Electricity, high voltage {ZA IRP}| electricity production, hard coal | Alloc Def, U	Digital vs Print LCA	kg 1,4-DB eq	4.09E-01	0.00E+00	0.00E+00	1.89E-03	1.60E-01	2.47E-01	0.00E+00	0.00E+00	0.00E+00
7	Latex {RoW}| production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	2.97E-01	0.00E+00	5.40E-08	1.32E-07	2.89E-01	8.19E-03	5.18E-08	5.03E-08	2.19E-08
8	Brake wear emissions, passenger car {RoW}| treatment of | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	2.57E-01	0.00E+00	9.56E-09	1.24E-08	2.00E-07	3.61E-07	5.66E-09	2.57E-01	4.51E-09
9	Printed paper, offset {ZA IRP}| offset printing, per kg printed paper | Alloc Def, U	Digital vs Print LCA	kg 1,4-DB eq	2.00E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.00E-01	0.00E+00	0.00E+00	0.00E+00
10	Latex {RER}| production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	1.47E-01	0.00E+00	2.67E-08	6.51E-08	1.43E-01	4.05E-03	2.56E-08	2.48E-08	1.08E-08
11	Aluminium hydroxide {GLO}| aluminium hydroxide production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	1.37E-01	0.00E+00	1.49E-06	3.80E-05	3.12E-04	1.37E-01	7.05E-07	2.24E-06	5.13E-06
12	Log, energy wood, split, measured as solid wood under bark {RoW}| heat production, mixed logs, at furnace 30kW | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	1.34E-01	0.00E+00	1.32E-01	4.03E-05	2.32E-05	2.26E-03	7.46E-07	2.48E-06	7.57E-07
13	Log, energy wood, split, measured as solid wood under bark {RoW}| heat production, mixed logs, at furnace 100kW | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	1.31E-01	0.00E+00	1.28E-01	3.92E-05	2.25E-05	2.20E-03	7.26E-07	2.41E-06	7.37E-07
14	Electricity, high voltage {CN}| electricity production, hard coal | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	1.27E-01	0.00E+00	3.76E-03	1.38E-03	3.66E-02	7.66E-02	5.92E-04	6.34E-03	1.90E-03
15	Log, energy wood, split, measured as solid wood under bark {RoW}| heat production, mixed logs, at wood heater 6kW | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	1.21E-01	0.00E+00	1.19E-01	3.65E-05	2.09E-05	2.04E-03	6.75E-07	2.24E-06	6.85E-07
16	Waste graphical paper {RoW}| treatment of, sanitary landfill | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	1.15E-01	0.00E+00	1.79E-08	9.42E-06	8.36E-07	1.07E-06	2.03E-08	3.50E-08	1.15E-01
17	Heat, district or industrial, other than natural gas {RoW}| heat production, at hard coal industrial furnace 1-10MW | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	1.05E-01	0.00E+00	1.77E-04	5.99E-02	1.21E-02	2.92E-02	3.41E-04	2.69E-03	3.24E-04
18	Electricity, high voltage {RoW}| electricity production, hard coal | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	1.03E-01	0.00E+00	6.56E-04	2.76E-04	1.24E-02	8.93E-02	5.69E-05	1.62E-04	4.08E-04
19	Brake wear emissions, passenger car {RER}| treatment of | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	9.41E-02	0.00E+00	3.50E-09	4.55E-09	7.31E-08	1.32E-07	2.08E-09	9.41E-02	1.65E-09
20	Wood ash mixture, pure {CH}| treatment of, sanitary landfill | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	9.05E-02	0.00E+00	3.32E-02	9.61E-03	2.50E-02	2.27E-02	3.96E-06	9.83E-06	6.20E-06
21	Spoil from hard coal mining {GLO}| treatment of, in surface landfill | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	8.91E-02	0.00E+00	4.25E-04	1.92E-03	3.13E-02	5.48E-02	8.90E-05	2.89E-04	2.46E-04

Print System IRP SimaPro LCA Results

Calculation: Analyze
Results: Process contribution
Product: 1 p Printed Book System IRP (of project Digital vs Print LCA)
ReCiPe Midpoint (H) V1.09 / Europe
Method: Recipe H
Indicator: Characterization
Category: Photochemical oxidant formation
Cut-off: 1%
Mode: Group
Exclude infrastructure processes: Yes
Exclude long-term emissions: Yes
Sorted on item: Total
Sort order: Descending

No	Process	Project	Unit	Total	Top	Pulp wood	Pulp	Paper	Printing	Distribution Transportation	Retail Transportation	Waste Management
	Total of all processes		kg NMVOC	5.84E-01	0.00E+00	9.70E-02	7.17E-03	1.90E-01	2.01E-01	5.45E-02	2.40E-02	1.00E-02
	Remaining processes		kg NMVOC	1.21E-01	0.00E+00	6.09E-03	6.09E-03	3.26E-02	5.84E-02	4.20E-03	1.05E-02	2.83E-03
1	Electricity, high voltage {ZA IRP}| electricity production, hard coal | Alloc Def, U	Digital vs Print LCA	kg NMVOC	9.88E-02	0.00E+00	0.00E+00	4.57E-04	3.86E-02	5.97E-02	0.00E+00	0.00E+00	0.00E+00
2	Paper, woodfree, coated {ZA IRP}| paper production, woodfree, coated, at integrated mill | Alloc Def, U	Digital vs Print LCA	kg NMVOC	7.83E-02	0.00E+00	0.00E+00	0.00E+00	7.83E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
3	Transport, freight, lorry 16-32 metric ton, EURO3 {RER}| transport, freight, lorry 16-32 metric ton, EURO3 | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg NMVOC	4.38E-02	0.00E+00	3.65E-04	2.12E-05	1.21E-03	2.19E-03	3.99E-02	1.27E-04	1.44E-06
4	Printed paper, offset {ZA IRP}| offset printing, per kg printed paper | Alloc Def, U	Digital vs Print LCA	kg NMVOC	4.36E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.36E-02	0.00E+00	0.00E+00	0.00E+00
5	Log, energy wood, split, measured as solid wood under bark {RoW}| heat production, mixed logs, at wood heater 6kW | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg NMVOC	2.42E-02	0.00E+00	2.38E-02	7.26E-06	4.17E-06	4.07E-04	1.34E-07	4.47E-07	1.36E-07
6	Electricity, high voltage {RoW}| electricity production, hard coal | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg NMVOC	1.81E-02	0.00E+00	1.15E-04	4.82E-05	2.17E-03	1.56E-02	9.94E-06	2.82E-05	7.13E-05
7	Power sawing, without catalytic converter {RoW}| processing | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg NMVOC	1.70E-02	0.00E+00	1.65E-02	8.16E-06	1.05E-05	4.36E-04	1.44E-07	4.90E-07	1.35E-07
8	Diesel, burned in building machine {GLO}| processing | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg NMVOC	1.62E-02	0.00E+00	1.44E-02	2.98E-05	5.74E-04	1.19E-03	1.54E-06	5.35E-06	3.04E-06
9	Log, energy wood, split, measured as solid wood under bark {RoW}| heat production, mixed logs, at furnace 30kW | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg NMVOC	1.39E-02	0.00E+00	1.37E-02	4.19E-06	2.40E-06	2.35E-04	7.74E-08	2.58E-07	7.86E-08
10	Latex {RoW}| production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg NMVOC	1.38E-02	0.00E+00	2.51E-09	6.13E-09	1.34E-02	3.81E-04	2.41E-09	2.34E-09	1.02E-09
11	Electricity, high voltage {CN}| electricity production, hard coal | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg NMVOC	1.30E-02	0.00E+00	3.85E-04	1.42E-04	3.74E-03	7.85E-03	6.06E-05	6.49E-04	1.94E-04
12	Natural gas, vented {GLO}| natural gas venting from petroleum/natural gas production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg NMVOC	1.27E-02	0.00E+00	7.09E-04	1.28E-04	2.64E-03	2.18E-03	2.63E-03	4.42E-03	8.67E-06
13	Log, energy wood, split, measured as solid wood under bark {RoW}| heat production, mixed logs, at furnace 100kW | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg NMVOC	1.23E-02	0.00E+00	1.21E-02	3.70E-06	2.12E-06	2.07E-04	6.84E-08	2.27E-07	6.94E-08
14	Transport, freight, sea, transoceanic ship {GLO}| processing | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg NMVOC	1.14E-02	0.00E+00	3.16E-04	7.50E-05	5.13E-03	5.82E-03	3.18E-06	1.86E-05	6.41E-06
15	Transport, freight, lorry 16-32 metric ton, EURO3 {RoW}| transport, freight, lorry 16-32 metric ton, EURO3 | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg NMVOC	8.44E-03	0.00E+00	7.04E-05	4.08E-06	2.34E-04	4.22E-04	7.68E-03	2.45E-05	2.77E-07
16	Power sawing, without catalytic converter {RER}| processing | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg NMVOC	8.38E-03	0.00E+00	8.15E-03	4.03E-06	5.17E-06	2.15E-04	7.13E-08	2.42E-07	6.67E-08
17	Transport, passenger car, medium size, petrol, EURO 3 {RoW}| transport, passenger car, medium size, petrol, EURO 3 | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg NMVOC	8.15E-03	0.00E+00	2.80E-11	3.63E-11	4.94E-10	1.03E-09	1.66E-11	8.15E-03	1.32E-11
18	Transport, freight, lorry >32 metric ton, EURO3 {RER}| transport, freight, lorry >32 metric ton, EURO3 | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg NMVOC	7.43E-03	0.00E+00	4.05E-04	1.52E-04	4.23E-03	2.43E-03	7.53E-05	1.41E-04	1.60E-06
19	Waste graphical paper {RoW}| treatment of, sanitary landfill | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg NMVOC	6.89E-03	0.00E+00	1.07E-09	5.65E-07	5.01E-08	6.42E-08	1.22E-09	2.10E-09	6.89E-03
20	Latex {RER}| production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg NMVOC	6.83E-03	0.00E+00	1.24E-09	3.03E-09	6.64E-03	1.88E-04	1.19E-09	1.15E-09	5.03E-10

Print System IRP SimaPro LCA Results

Calculation:	Analyze
Results:	Process contribution
Product:	1 p Printed Book System IRP (of project Digital vs Print LCA)
Method:	ReCiPe Midpoint (H) V1.09 / Europe
Indicator:	Recipe H
Category:	Characterization
Cut-off:	Particulate matter formation
Mode:	1%
Exclude infrastructure processes:	Group
Exclude long-term emissions:	Yes
Sorted on item:	Yes
Sort order:	Total
	Descending

No	Process	Project	Unit	Total	Top	Pulp wood	Pulp	Paper	Printing	Distribution Transportation	Retail Transportation	Waste Management
	Total of all processes		kg PM10 eq	2.53E-01	0.00E+00	3.26E-02	4.72E-03	1.00E-01	9.57E-02	1.31E-02	5.62E-03	1.02E-03
	Remaining processes		kg PM10 eq	6.49E-02	0.00E+00	2.97E-03	2.14E-03	2.12E-02	2.95E-02	3.33E-03	5.02E-03	7.41E-04
1	Electricity, high voltage {ZA IRP}| electricity production, hard coal | Alloc Def, U	Digital vs Print LCA	kg PM10 eq	5.24E-02	0.00E+00	0.00E+00	2.42E-04	2.05E-02	3.17E-02	0.00E+00	0.00E+00	0.00E+00
2	Paper, woodfree, coated {ZA IRP}| paper production, woodfree, coated, at integrated mill | Alloc Def, U	Digital vs Print LCA	kg PM10 eq	4.33E-02	0.00E+00	0.00E+00	0.00E+00	4.33E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
3	Log, energy wood, split, measured as solid wood under bark {RoW}| heat production, mixed logs, at wood heater 6kW | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg PM10 eq	1.34E-02	0.00E+00	1.32E-02	4.03E-06	2.31E-06	2.26E-04	7.46E-08	2.48E-07	7.57E-08
4	Electricity, high voltage {RoW}| electricity production, lignite | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg PM10 eq	1.17E-02	0.00E+00	4.23E-05	1.80E-05	8.04E-04	1.08E-02	3.68E-06	1.04E-05	2.63E-05
5	Electricity, high voltage {RoW}| electricity production, hard coal | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg PM10 eq	1.15E-02	0.00E+00	7.28E-05	3.06E-05	1.38E-03	9.91E-03	6.32E-06	1.79E-05	4.53E-05
6	Transport, freight, lorry 16-32 metric ton, EURO3 {RER}| transport, freight, lorry 16-32 metric ton, EURO3 | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg PM10 eq	1.06E-02	0.00E+00	8.85E-05	5.13E-06	2.94E-04	5.31E-04	9.66E-03	3.08E-05	3.49E-07
7	Electricity, high voltage {CN}| electricity production, hard coal | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg PM10 eq	8.06E-03	0.00E+00	2.38E-04	8.76E-05	2.32E-03	4.85E-03	3.75E-05	4.02E-04	1.20E-04
8	Log, energy wood, split, measured as solid wood under bark {RoW}| heat production, mixed logs, at furnace 30kW | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg PM10 eq	6.46E-03	0.00E+00	6.35E-03	1.94E-06	1.12E-06	1.09E-04	3.59E-08	1.19E-07	3.65E-08
9	Log, energy wood, split, measured as solid wood under bark {RoW}| heat production, mixed logs, at furnace 100kW | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg PM10 eq	5.44E-03	0.00E+00	5.35E-03	1.63E-06	9.39E-07	9.16E-05	3.02E-08	1.01E-07	3.07E-08
10	Latex {RoW}| production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg PM10 eq	5.11E-03	0.00E+00	9.29E-10	2.27E-09	4.97E-03	1.41E-04	8.90E-10	8.65E-10	3.76E-10
11	Transport, freight, sea, transoceanic ship {GLO}| processing | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg PM10 eq	4.59E-03	0.00E+00	1.28E-04	3.02E-05	2.07E-03	2.35E-03	1.28E-06	7.50E-06	2.58E-06
12	Diesel, burned in building machine {GLO}| processing | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg PM10 eq	4.58E-03	0.00E+00	4.07E-03	8.45E-06	1.63E-04	3.37E-04	4.37E-07	1.51E-06	8.60E-07
13	Electricity, high voltage {ID}| electricity production, lignite | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg PM10 eq	3.85E-03	0.00E+00	8.56E-05	3.77E-05	9.89E-04	2.66E-03	7.03E-06	2.03E-05	4.94E-05
14	Heat, district or industrial, other than natural gas {RoW}| heat production, at hard coal industrial furnace 1-10MW | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg PM10 eq	3.68E-03	0.00E+00	6.22E-06	2.10E-03	4.27E-04	1.03E-03	1.20E-05	9.44E-05	1.14E-05
15	Natural gas, high pressure {RNA}| natural gas production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg PM10 eq	3.48E-03	0.00E+00	3.76E-05	1.49E-05	1.90E-03	1.48E-03	3.33E-06	2.27E-05	2.13E-05

Print System IRP SimaPro LCA Results

Calculation:	Analyze
Results:	Process contribution
Product:	1 p Printed Book System IRP (of project Digital vs Print LCA)
Method:	ReCiPe Midpoint (H) V1.09 / Europe
Indicator:	Recipe H
Category:	Characterization
Cut-off:	Terrestrial ecotoxicity
Mode:	1%
Exclude infrastructure processes:	Group
Exclude long-term emissions:	Yes
Sorted on item:	Yes
Sort order:	Total
	Descending

No	Process	Project	Unit	Total	Top	Pulp wood	Pulp	Paper	Printing	Distribution Transportation	Retail Transportation	Waste Management
	Total of all processes		kg 1,4-DB eq	1.98E-02	0.00E+00	1.12E-03	1.86E-04	1.00E-02	6.60E-03	6.05E-04	1.21E-03	2.96E-05
	Remaining processes		kg 1,4-DB eq	3.75E-03	0.00E+00	7.02E-04	9.17E-05	8.56E-04	1.59E-03	1.34E-04	3.53E-04	2.44E-05
1	Palm fruit bunch {RoW}| production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	2.81E-03	0.00E+00	3.55E-07	4.59E-07	2.16E-03	6.45E-04	5.23E-07	6.84E-07	8.54E-08
2	Palm fruit bunch {MY}| production, on land recently transformed | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	2.81E-03	0.00E+00	3.55E-07	4.59E-07	2.16E-03	6.45E-04	5.23E-07	6.84E-07	8.54E-08
3	Paper, woodfree, coated {ZA IRP}| paper production, woodfree, coated, at integrated mill | Alloc Def, U	Digital vs Print LCA	kg 1,4-DB eq	2.19E-03	0.00E+00	0.00E+00	0.00E+00	2.19E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00
4	Palm fruit bunch {MY}| production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	1.48E-03	0.00E+00	1.88E-07	2.43E-07	1.14E-03	3.41E-04	2.77E-07	3.62E-07	4.52E-08
5	Potato, Swiss integrated production {CH}| potato production, Swiss integrated production, intensive | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	1.36E-03	0.00E+00	1.49E-09	5.26E-09	7.12E-04	6.52E-04	8.00E-10	1.09E-09	7.14E-10
6	Cotton fibre {RoW}| cotton production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	8.57E-04	0.00E+00	5.27E-12	9.75E-12	8.14E-11	8.57E-04	8.20E-12	1.17E-11	1.49E-12
7	Wood ash mixture, pure {CH}| treatment of, landfarming | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	8.30E-04	0.00E+00	3.05E-04	8.81E-05	2.29E-04	2.08E-04	3.59E-08	8.98E-08	5.67E-08
8	Brake wear emissions, passenger car {RoW}| treatment of | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	6.17E-04	0.00E+00	2.30E-11	2.98E-11	4.79E-10	8.67E-10	1.36E-11	6.17E-04	1.08E-11
9	Natural gas, unprocessed, at extraction {RNA}| production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	5.58E-04	0.00E+00	5.24E-06	2.13E-06	3.19E-04	2.25E-04	5.25E-07	3.73E-06	2.95E-06
10	Transport, freight, lorry 16-32 metric ton, EURO3 {RER}| transport, freight, lorry 16-32 metric ton, EURO3 | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	5.12E-04	0.00E+00	4.27E-06	2.48E-07	1.42E-05	2.56E-05	4.66E-04	1.48E-06	1.68E-08
11	Maize grain, Swiss integrated production {CH}| production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	4.16E-04	0.00E+00	8.04E-09	1.64E-08	1.21E-07	4.15E-04	1.01E-08	1.10E-08	4.31E-09
12	Soybean {RoW}| production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	2.55E-04	0.00E+00	5.04E-05	2.61E-08	4.71E-05	1.57E-04	6.13E-09	1.07E-08	6.95E-10
13	Electricity, high voltage {ZA IRP}| electricity production, hard coal | Alloc Def, U	Digital vs Print LCA	kg 1,4-DB eq	2.41E-04	0.00E+00	0.00E+00	1.11E-06	9.40E-05	1.45E-04	0.00E+00	0.00E+00	0.00E+00
14	Soybean, Swiss integrated production {RoW}| soybean production, Swiss integrated production, intensive | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	2.34E-04	0.00E+00	4.63E-05	2.40E-08	4.33E-05	1.44E-04	5.64E-09	9.80E-09	6.40E-10
15	Electricity, high voltage {DE}| heat and power co-generation, biogas, gas engine | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	2.28E-04	0.00E+00	4.38E-06	1.17E-06	8.07E-05	1.34E-04	3.32E-06	2.84E-06	1.96E-06
16	Brake wear emissions, passenger car {RER}| treatment of | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	2.26E-04	0.00E+00	8.42E-12	1.09E-11	1.76E-10	3.18E-10	4.99E-12	2.26E-04	3.97E-12
17	Cotton fibre {CN}| cotton production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	2.20E-04	0.00E+00	1.35E-12	2.50E-12	2.09E-11	2.20E-04	2.10E-12	3.00E-12	3.84E-13
18	Cotton fibre {US}| cotton production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	2.00E-04	0.00E+00	1.23E-12	2.28E-12	1.90E-11	2.00E-04	1.91E-12	2.73E-12	3.49E-13

Print System IRP SimaPro LCA Results

Calculation:	Analyze
Results:	Process contribution
Product:	1 p Printed Book System IRP (of project Digital vs Print LCA)
Method:	ReCiPe Midpoint (H) V1.09 / Europe
Indicator:	Recipe H
Category:	Characterization
Cut-off:	Freshwater ecotoxicity
Mode:	1%
Exclude infrastructure processes:	Group
Exclude long-term emissions:	Yes
Sorted on item:	Yes
Sort order:	Total
	Descending

No	Process	Project	Unit	Total	Top	Pulp wood	Pulp	Paper	Printing	Distribution Transportation	Retail Transportation	Waste Management
	Total of all processes		kg 1,4-DB eq	6.26E-02	0.00E+00	1.03E-03	5.64E-04	2.92E-02	2.60E-02	1.26E-03	2.08E-03	2.40E-03
	Remaining processes		kg 1,4-DB eq	1.00E-02	0.00E+00	4.59E-04	3.52E-04	3.46E-03	4.66E-03	5.00E-04	5.96E-04	1.23E-05
1	Natural gas, unprocessed, at extraction {RNA}| production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	3.93E-02	0.00E+00	3.69E-04	1.50E-04	2.25E-02	1.58E-02	3.69E-05	2.63E-04	2.08E-04
2	Water discharge from petroleum/natural gas extraction, onshore {GLO}| treatment of | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	3.47E-03	0.00E+00	1.95E-04	3.52E-05	7.04E-04	5.91E-04	7.25E-04	1.22E-03	2.28E-06
3	Spent solvent mixture {RoW}| treatment of, hazardous waste incineration | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	3.20E-03	0.00E+00	1.48E-08	1.20E-08	1.44E-07	3.20E-03	1.17E-08	2.08E-08	1.98E-09
4	Municipal solid waste {RoW}| treatment of, sanitary landfill | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	1.37E-03	0.00E+00	1.02E-08	5.76E-07	9.82E-05	1.95E-05	2.33E-08	4.40E-08	1.25E-03
5	Spoil from hard coal mining {GLO}| treatment of, in surface landfill | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	1.15E-03	0.00E+00	5.48E-06	2.47E-05	4.03E-04	7.07E-04	1.15E-06	3.73E-06	3.17E-06
6	Waste graphical paper {RoW}| treatment of, sanitary landfill | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	9.20E-04	0.00E+00	1.43E-10	7.55E-08	6.69E-09	8.57E-09	1.63E-10	2.80E-10	9.19E-04
7	Spoil from lignite mining {GLO}| treatment of, in surface landfill | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	8.52E-04	0.00E+00	2.99E-06	1.05E-06	6.51E-04	1.93E-04	1.27E-06	1.34E-06	1.63E-06
8	Redmud from bauxite digestion {RoW}| treatment of, residual material landfill | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	7.91E-04	0.00E+00	8.56E-09	2.19E-07	1.80E-06	7.89E-04	4.06E-09	1.29E-08	2.95E-08
9	Paper, woodfree, coated {ZA IRP}| paper production, woodfree, coated, at integrated mill | Alloc Def, U	Digital vs Print LCA	kg 1,4-DB eq	7.61E-04	0.00E+00	0.00E+00	0.00E+00	7.61E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00
10	Latex {RoW}| production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	7.00E-04	0.00E+00	1.27E-10	3.10E-10	6.81E-04	1.93E-05	1.22E-10	1.18E-10	5.15E-11

Print System IRP SimaPro LCA Results

Calculation:	Analyze
Results:	Process contribution
Product:	1 p Printed Book System IRP (of project Digital vs Print LCA)
	ReCiPe Midpoint (H) V1.09 / Europe
Method:	Recipe H
Indicator:	Characterization
Category:	Marine ecotoxicity
Cut-off:	1%
Mode:	Group
Exclude infrastructure processes:	Yes
Exclude long-term emissions:	Yes
Sorted on item:	Total
Sort order:	Descending

No	Process	Project	Unit	Total	Top	Pulp wood	Pulp	Paper	Printing	Distribution Transportation	Retail Transportation	Waste Management
	Total of all processes		kg 1,4-DB eq	8.16E-02	0.00E+00	5.49E-03	9.57E-04	3.61E-02	2.20E-02	5.27E-03	9.97E-03	1.73E-03
	Remaining processes		kg 1,4-DB eq	2.13E-02	0.00E+00	9.35E-04	5.15E-04	5.92E-03	1.09E-02	9.92E-04	1.21E-03	7.74E-04
1	Paper, woodfree, coated {ZA IRP}| paper production, woodfree, coated, at integrated mill | Alloc Def, U	Digital vs Print LCA	kg 1,4-DB eq	1.98E-02	0.00E+00	0.00E+00	0.00E+00	1.98E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2	Natural gas, unprocessed, at extraction {RNA}| production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	1.11E-02	0.00E+00	1.04E-04	4.24E-05	6.34E-03	4.47E-03	1.04E-05	7.42E-05	5.87E-05
3	Brake wear emissions, passenger car {RoW}| treatment of | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	4.68E-03	0.00E+00	1.74E-10	2.26E-10	3.64E-09	6.58E-09	1.03E-10	4.68E-03	8.21E-11
4	Transport, freight, lorry 16-32 metric ton, EURO3 {RER}| transport, freight, lorry 16-32 metric ton, EURO3 | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	4.11E-03	0.00E+00	3.43E-05	1.99E-06	1.14E-04	2.06E-04	3.74E-03	1.19E-05	1.35E-07
5	Electricity, high voltage {ZA IRP}| electricity production, hard coal | Alloc Def, U	Digital vs Print LCA	kg 1,4-DB eq	3.18E-03	0.00E+00	0.00E+00	1.47E-05	1.24E-03	1.92E-03	0.00E+00	0.00E+00	0.00E+00
6	Transport, freight, sea, transoceanic ship {GLO}| processing | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	2.08E-03	0.00E+00	5.77E-05	1.37E-05	9.37E-04	1.06E-03	5.81E-07	3.40E-06	1.17E-06
7	Brake wear emissions, passenger car {RER}| treatment of | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	1.71E-03	0.00E+00	6.39E-11	8.28E-11	1.33E-09	2.41E-09	3.78E-11	1.71E-03	3.01E-11
8	Potato, Swiss integrated production {CH}| potato production, Swiss integrated production, intensive | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	1.58E-03	0.00E+00	1.72E-09	6.09E-09	8.24E-04	7.55E-04	9.26E-10	1.26E-09	8.26E-10
9	Log, energy wood, split, measured as solid wood under bark {RoW}| heat production, mixed logs, at furnace 30kW | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	1.49E-03	0.00E+00	1.46E-03	4.46E-07	2.56E-07	2.50E-05	8.26E-09	2.75E-08	8.38E-09
10	Log, energy wood, split, measured as solid wood under bark {RoW}| heat production, mixed logs, at furnace 100kW | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	1.45E-03	0.00E+00	1.42E-03	4.34E-07	2.49E-07	2.43E-05	8.03E-09	2.67E-08	8.15E-09
11	Log, energy wood, split, measured as solid wood under bark {RoW}| heat production, mixed logs, at wood heater 6kW | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	1.34E-03	0.00E+00	1.32E-03	4.04E-07	2.32E-07	2.26E-05	7.47E-09	2.48E-08	7.58E-09
12	Transport, passenger car, medium size, petrol, EURO 3 {RoW}| transport, passenger car, medium size, petrol, EURO 3 | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	1.13E-03	0.00E+00	3.87E-12	5.02E-12	6.82E-11	1.42E-10	2.29E-12	1.13E-03	1.82E-12
13	Spoil from hard coal mining {GLO}| treatment of, in surface landfill | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	1.09E-03	0.00E+00	5.20E-06	2.35E-05	3.83E-04	6.71E-04	1.09E-06	3.54E-06	3.01E-06
14	Heat, district or industrial, other than natural gas {RoW}| heat production, heavy fuel oil, at industrial furnace 1MW | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	1.07E-03	0.00E+00	9.34E-07	3.15E-04	6.48E-05	6.70E-04	1.79E-06	1.41E-05	1.72E-06
15	Transport, freight, sea, transoceanic tanker {GLO}| processing | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	1.02E-03	0.00E+00	5.51E-05	1.05E-05	2.35E-04	1.60E-04	1.86E-04	3.72E-04	5.87E-07
16	Heat, district or industrial, other than natural gas {RoW}| heat and power co-generation, wood chips, 6400kW thermal, with extensive emission control | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	9.02E-04	0.00E+00	1.70E-08	5.75E-06	1.16E-06	8.94E-04	3.28E-08	2.58E-07	3.11E-08
17	Heavy fuel oil, burned in refinery furnace {RoW}| processing | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	8.96E-04	0.00E+00	4.74E-05	5.74E-06	1.11E-04	9.68E-05	1.62E-04	4.73E-04	3.10E-07
18	Waste graphical paper {RoW}| treatment of, sanitary landfill | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	8.93E-04	0.00E+00	1.39E-10	7.33E-08	6.50E-09	8.32E-09	1.58E-10	2.72E-10	8.93E-04
19	Water discharge from petroleum/natural gas extraction, onshore {GLO}| treatment of | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	8.26E-04	0.00E+00	4.65E-05	8.37E-06	1.68E-04	1.41E-04	1.72E-04	2.90E-04	5.44E-07

Print System IRP SimaPro LCA Results

Calculation: Analyze
Results: Process contribution
Product: 1 p Printed Book System IRP (of project Digital vs Print LCA)
ReCiPe Midpoint (H) V1.09 / Europe
Method: Recipe H
Indicator: Characterization
Category: Ionising radiation
Cut-off: 1%
Mode: Group
Exclude infrastructure processes: Yes
Exclude long-term emissions: Yes
Sorted on item: Total
Sort order: Descending

No	Process	Project	Unit	Total	Top	Pulp wood	Pulp	Paper	Printing	Distribution Transportation	Retail Transportation	Waste Management
	Total of all processes		kBq U235 eq	4.23E+00	0.00E+00	1.20E-01	3.26E-02	1.27E+00	1.92E+00	3.27E-01	5.48E-01	1.72E-02
	Remaining processes		kBq U235 eq	3.89E-01	0.00E+00	9.62E-03	3.03E-03	1.36E-01	2.29E-01	3.17E-03	4.39E-03	3.80E-03
1	Low level radioactive waste {CH}| treatment of, plasma torch incineration | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kBq U235 eq	1.99E+00	0.00E+00	9.09E-02	1.82E-02	4.74E-01	5.49E-01	3.20E-01	5.36E-01	3.48E-03
2	Spent nuclear fuel {RoW}| treatment of, reprocessing | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kBq U235 eq	8.43E-01	0.00E+00	9.30E-03	5.01E-03	3.01E-01	5.16E-01	3.18E-03	4.20E-03	4.32E-03
3	Electricity, high voltage {ZA IRP}| electricity production, nuclear, pressure water reactor | Alloc Def, U	Digital vs Print LCA	kBq U235 eq	4.66E-01	0.00E+00	0.00E+00	2.16E-03	1.82E-01	2.82E-01	0.00E+00	0.00E+00	0.00E+00
4	Uranium ore, as U {RNA}| uranium mine operation, underground | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kBq U235 eq	1.02E-01	0.00E+00	1.11E-03	6.16E-04	3.65E-02	6.25E-02	3.72E-04	4.96E-04	5.17E-04
5	Uranium ore, as U {RoW}| uranium mine operation, underground | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kBq U235 eq	9.64E-02	0.00E+00	1.04E-03	5.81E-04	3.45E-02	5.90E-02	3.51E-04	4.69E-04	4.88E-04
6	Electricity, high voltage {RoW}| electricity production, nuclear, boiling water reactor | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kBq U235 eq	8.52E-02	0.00E+00	1.46E-03	6.09E-04	2.75E-02	5.42E-02	1.27E-04	3.59E-04	9.09E-04
7	Electricity, high voltage {JP}| electricity production, nuclear, boiling water reactor | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kBq U235 eq	7.01E-02	0.00E+00	1.90E-03	6.93E-04	2.14E-02	4.44E-02	1.57E-04	4.49E-04	1.09E-03
8	Electricity, high voltage {SERC}| electricity production, nuclear, boiling water reactor | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kBq U235 eq	5.12E-02	0.00E+00	1.39E-03	5.11E-04	1.57E-02	3.24E-02	1.16E-04	3.29E-04	7.96E-04
9	Electricity, high voltage {RFC}| electricity production, nuclear, boiling water reactor | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kBq U235 eq	4.67E-02	0.00E+00	1.27E-03	4.66E-04	1.43E-02	2.96E-02	1.05E-04	3.00E-04	7.26E-04
10	Electricity, high voltage {RU}| electricity production, nuclear, boiling water reactor | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kBq U235 eq	4.67E-02	0.00E+00	1.09E-03	4.50E-04	1.31E-02	3.10E-02	1.19E-04	3.02E-04	6.24E-04
11	Electricity, high voltage {RoW}| electricity production, nuclear, pressure water reactor | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kBq U235 eq	4.38E-02	0.00E+00	7.51E-04	3.13E-04	1.41E-02	2.78E-02	6.50E-05	1.85E-04	4.67E-04

Calculation: Analyze
Results: Process contribution
Product: 1 p Printed Book System IRP (of project Digital vs Print LCA)
ReCiPe Midpoint (H) V1.09 / Europe
Method: Recipe H
Indicator: Characterization
Category: Agricultural land occupation
Cut-off: 1%
Mode: Group
Exclude infrastructure processes: Yes
Exclude long-term emissions: Yes
Sorted on item: Total
Sort order: Descending

No	Process	Project	Unit	Total	Top	Pulp wood	Pulp	Paper	Printing	Distribution Transportation	Retail Transportation	Waste Management
	Total of all processes		m2a	4.62E+02	0.00E+00	4.50E+02	1.65E-01	1.58E+00	1.03E+01	3.51E-03	1.06E-02	3.35E-03
	Remaining processes		m2a	8.40E+00	0.00E+00	1.60E-01	1.28E-01	1.54E+00	6.56E+00	2.53E-03	7.80E-03	2.06E-03
1	Hardwood, CO2-removal and land use {RoW}| hardwood forestry, CO2-removal and land use | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	m2a	4.53E+02	0.00E+00	4.49E+02	3.72E-02	3.72E-02	3.74E+00	9.82E-04	2.76E-03	1.30E-03

Print System IRP SimaPro LCA Results

Calculation: Analyze
Results: Process contribution
Product: 1 p Printed Book System IRP (of project Digital vs Print LCA)
Method: ReCiPe Midpoint (H) V1.09 / Europe
Indicator: Recipe H
Category: Characterization
Cut-off: Urban land occupation
Mode: 1%
Exclude infrastructure processes: Group
Exclude long-term emissions: Yes
Sorted on item: Yes
Sort order: Total
Descending

No	Process	Project	Unit	Total	Top	Pulp wood	Pulp	Paper	Printing	Distribution Transportation	Retail Transportation	Waste Management
	Total of all processes		m2a	4.47E+00	0.00E+00	4.14E+00	9.92E-03	7.09E-02	2.44E-01	5.11E-04	2.28E-03	1.33E-03
	Remaining processes		m2a	1.97E-01	0.00E+00	2.16E-03	8.76E-03	4.36E-02	1.38E-01	4.57E-04	2.12E-03	1.10E-03
1	Hardwood forestry operation, except harvesting {RoW}| hardwood forestry, operation, except harvesting | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	m2a	3.64E+00	0.00E+00	3.61E+00	2.87E-04	2.91E-04	2.87E-02	7.63E-06	2.14E-05	1.02E-05
2	Hardwood forestry operation, except harvesting {RER}| hardwood forestry, operation, except harvesting | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	m2a	5.37E-01	0.00E+00	5.33E-01	4.23E-05	4.30E-05	4.24E-03	1.13E-06	3.16E-06	1.51E-06
3	Hard coal {ZA}| mine operation | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	m2a	5.12E-02	0.00E+00	1.85E-05	3.19E-04	2.08E-02	3.00E-02	1.29E-05	2.76E-05	9.34E-06
4	Hard coal {ID}| mine operation | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	m2a	4.99E-02	0.00E+00	3.33E-04	5.13E-04	6.17E-03	4.25E-02	3.22E-05	1.02E-04	2.08E-04

Calculation: Analyze
Results: Process contribution
Product: 1 p Printed Book System IRP (of project Digital vs Print LCA)
Method: ReCiPe Midpoint (H) V1.09 / Europe
Indicator: Recipe H
Category: Characterization
Cut-off: Natural land transformation
Mode: 1%
Exclude infrastructure processes: Group
Exclude long-term emissions: Yes
Sorted on item: Yes
Sort order: Total
Descending

No	Process	Project	Unit	Total	Top	Pulp wood	Pulp	Paper	Printing	Distribution Transportation	Retail Transportation	Waste Management
	Total of all processes		m2	3.46E-02	0.00E+00	2.78E-02	4.22E-05	4.51E-03	2.20E-03	3.25E-06	1.23E-05	8.13E-06
	Remaining processes		m2	1.55E-03	0.00E+00	1.44E-05	3.96E-05	4.65E-04	1.01E-03	2.80E-06	1.16E-05	7.99E-06
1	Hardwood forestry operation, except harvesting {RoW}| hardwood forestry, operation, except harvesting | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	m2	2.43E-02	0.00E+00	2.41E-02	1.91E-06	1.94E-06	1.92E-04	5.09E-08	1.43E-07	6.82E-08
2	Hardwood forestry operation, except harvesting {RER}| hardwood forestry, operation, except harvesting | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	m2	3.58E-03	0.00E+00	3.55E-03	2.82E-07	2.87E-07	2.83E-05	7.51E-09	2.11E-08	1.01E-08
3	Coconut, husked {RoW}| production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	m2	2.39E-03	0.00E+00	8.27E-08	1.37E-07	2.29E-03	1.05E-04	1.33E-07	1.66E-07	2.54E-08
4	Land tenure, arable land, measured as carbon net primary productivity {MY}| clear-cutting, primary forest to arable land | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	m2	1.01E-03	0.00E+00	1.28E-07	1.65E-07	7.76E-04	2.32E-04	1.88E-07	2.46E-07	3.07E-08
5	Land tenure, arable land, measured as carbon net primary productivity {BR}| clear-cutting, primary forest to arable land | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	m2	9.66E-04	0.00E+00	1.91E-04	9.91E-08	1.79E-04	5.96E-04	2.33E-08	4.05E-08	2.64E-09
6	Coconut, husked {PH}| production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	m2	8.33E-04	0.00E+00	2.88E-08	4.79E-08	7.96E-04	3.64E-05	4.63E-08	5.77E-08	8.85E-09

Print System IRP SimaPro LCA Results

Calculation:	Analyze
Results:	Process contribution
Product:	1 p Printed Book System IRP (of project Digital vs Print LCA)
Method:	ReCiPe Midpoint (H) V1.09 / Europe
Indicator:	Recipe H
Category:	Characterization
Cut-off:	Water depletion
Mode:	1%
Exclude infrastructure processes:	Group
Exclude long-term emissions:	Yes
Sorted on item:	Yes
Sort order:	Total
	Descending

No	Process	Project	Unit	Total	Top	Pulp wood	Pulp	Paper	Printing	Distribution Transportation	Retail Transportation	Waste Management
	Total of all processes		m3	1.92E+02	0.00E+00	2.28E+00	9.29E-01	4.14E+01	1.45E+02	5.29E-01	1.25E+00	1.20E+00
	Remaining processes		m3	3.22E+01	0.00E+00	6.64E-01	2.63E-01	1.15E+01	1.90E+01	2.02E-01	2.59E-01	3.64E-01
1	Electricity, high voltage {RoW}| electricity production, hydro, run-of-river | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	m3	9.66E+01	0.00E+00	2.52E-01	1.47E-01	9.59E+00	8.64E+01	2.21E-02	6.15E-02	1.48E-01
2	Electricity, high voltage {ZA IRP}| electricity production, hydro, reservoir, non-alpine region | Alloc Def, U	Digital vs Print LCA	m3	1.29E+01	0.00E+00	0.00E+00	5.99E-02	5.06E+00	7.83E+00	0.00E+00	0.00E+00	0.00E+00
3	Electricity, high voltage {RU}| electricity production, hydro, run-of-river | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	m3	7.57E+00	0.00E+00	1.78E-01	7.31E-02	2.12E+00	5.03E+00	1.93E-02	4.91E-02	1.01E-01
4	Electricity, high voltage {CN}| electricity production, hydro, run-of-river | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	m3	7.46E+00	0.00E+00	2.21E-01	8.11E-02	2.14E+00	4.50E+00	3.47E-02	3.72E-01	1.11E-01
5	Electricity, high voltage {WECC, US only}| electricity production, hydro, run-of-river | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	m3	6.43E+00	0.00E+00	1.75E-01	6.40E-02	1.97E+00	4.06E+00	1.45E-02	4.13E-02	9.98E-02
6	Electricity, high voltage {FR}| electricity production, hydro, run-of-river | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	m3	4.92E+00	0.00E+00	1.76E-01	2.74E-02	1.55E+00	2.93E+00	9.08E-02	1.03E-01	3.80E-02
7	Electricity, high voltage {SE}| electricity production, hydro, run-of-river | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	m3	4.31E+00	0.00E+00	7.68E-02	2.36E-02	1.38E+00	2.68E+00	6.00E-02	4.99E-02	4.12E-02
8	Electricity, high voltage {CN}| electricity production, hydro, reservoir, non-alpine region | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	m3	4.03E+00	0.00E+00	1.19E-01	4.38E-02	1.16E+00	2.43E+00	1.87E-02	2.01E-01	6.01E-02
9	Electricity, high voltage {BR}| electricity production, hydro, reservoir, tropical region | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	m3	3.05E+00	0.00E+00	8.94E-02	2.94E-02	9.31E-01	1.93E+00	6.79E-03	1.95E-02	4.86E-02
10	Electricity, high voltage {JP}| electricity production, hydro, run-of-river | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	m3	2.94E+00	0.00E+00	8.00E-02	2.91E-02	8.98E-01	1.87E+00	6.60E-03	1.89E-02	4.58E-02
11	Electricity, high voltage {Quebec}| electricity production, hydro, run-of-river | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	m3	2.78E+00	0.00E+00	7.54E-02	2.78E-02	8.71E-01	1.74E+00	6.16E-03	1.78E-02	4.34E-02
12	Electricity, high voltage {CA-BC}| electricity production, hydro, run-of-river | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	m3	2.67E+00	0.00E+00	7.26E-02	2.66E-02	8.29E-01	1.67E+00	5.92E-03	1.71E-02	4.17E-02
13	Electricity, high voltage {AT}| electricity production, hydro, run-of-river | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	m3	2.26E+00	0.00E+00	4.64E-02	1.22E-02	7.38E-01	1.37E+00	3.68E-02	3.06E-02	2.08E-02
14	Electricity, high voltage {CA-MB}| electricity production, hydro, run-of-river | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	m3	2.08E+00	0.00E+00	5.68E-02	2.08E-02	6.39E-01	1.31E+00	4.64E-03	1.34E-02	3.26E-02

Print System IRP SimaPro LCA Results

Calculation:	Analyze
Results:	Process contribution
Product:	1 p Printed Book System IRP (of project Digital vs Print LCA)
Method:	ReCiPe Midpoint (H) V1.09 / Europe
Indicator:	Recipe H
Category:	Characterization
Cut-off:	Metal depletion
Mode:	1%
Exclude infrastructure processes:	Group
Exclude long-term emissions:	Yes
Sorted on item:	Yes
Sort order:	Total
	Descending

No	Process	Project	Unit	Total	Top	Pulp wood	Pulp	Paper	Printing	Distribution Transportation	Retail Transportation	Waste Management
	Total of all processes		kg Fe eq	4.77E-01	0.00E+00	4.44E-03	4.14E-03	1.10E-01	3.49E-01	1.55E-03	7.46E-03	1.29E-03
	Remaining processes		kg Fe eq	5.99E-02	0.00E+00	3.13E-04	7.15E-04	2.09E-02	3.30E-02	2.30E-04	4.63E-03	5.98E-05
1	Iron ore, crude ore, 46% Fe {GLO}| iron mine operation, crude ore, 46% Fe | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg Fe eq	8.56E-02	0.00E+00	1.65E-03	1.91E-03	2.28E-02	5.66E-02	6.06E-04	1.09E-03	8.72E-04
2	Bauxite, without water {GLO}| bauxite mine operation | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg Fe eq	6.72E-02	0.00E+00	9.38E-07	1.87E-05	1.53E-04	6.71E-02	3.97E-07	1.15E-06	2.54E-06
3	Copper concentrate {RoW}| copper mine operation | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg Fe eq	3.43E-02	0.00E+00	1.06E-04	1.97E-04	1.67E-03	3.21E-02	1.11E-04	1.52E-04	3.83E-05
4	Manganese concentrate {GLO}| production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg Fe eq	3.34E-02	0.00E+00	4.18E-05	1.02E-04	5.21E-03	2.79E-02	9.70E-06	4.09E-05	1.42E-05
5	Tin {RoW}| production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg Fe eq	2.87E-02	0.00E+00	2.24E-04	4.42E-04	3.48E-03	2.40E-02	2.48E-04	2.24E-04	8.45E-05
6	Sulfuric acid {GLO}| copper production, solvent-extraction electro-winning | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg Fe eq	1.90E-02	0.00E+00	1.99E-05	8.00E-05	1.70E-02	1.89E-03	5.76E-06	8.99E-06	4.33E-06
7	Waste paperboard, sorted {RoW}| treatment of waste paperboard, sorting plant | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg Fe eq	1.74E-02	0.00E+00	1.01E-07	1.24E-07	1.30E-06	1.74E-02	4.93E-08	6.18E-08	5.20E-08
8	Chromite ore concentrate {GLO}| production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg Fe eq	1.73E-02	0.00E+00	7.71E-04	1.07E-04	4.00E-03	1.24E-02	2.60E-05	4.13E-05	1.93E-05
9	Ferronickel, 25% Ni {GLO}| production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg Fe eq	1.66E-02	0.00E+00	8.73E-04	9.59E-05	6.72E-04	1.49E-02	1.59E-05	4.32E-05	1.66E-05
10	Tin {RER}| production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg Fe eq	1.42E-02	0.00E+00	1.10E-04	2.18E-04	1.72E-03	1.18E-02	1.23E-04	1.11E-04	4.17E-05
11	Uranium ore, as U {RNA}| uranium mine operation, underground | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg Fe eq	1.11E-02	0.00E+00	1.20E-04	6.67E-05	3.96E-03	6.77E-03	4.03E-05	5.38E-05	5.59E-05
12	Carboxymethyl cellulose, powder {RoW}| production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg Fe eq	1.04E-02	0.00E+00	1.90E-09	5.18E-09	1.04E-02	9.16E-07	1.68E-09	1.71E-09	8.07E-10
13	Uranium ore, as U {RoW}| uranium mine operation, underground | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg Fe eq	1.04E-02	0.00E+00	1.13E-04	6.29E-05	3.74E-03	6.39E-03	3.81E-05	5.08E-05	5.28E-05
14	Platinum {ZA}| group metal mine operation, ore with high rhodium content | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg Fe eq	9.86E-03	0.00E+00	3.39E-05	1.51E-06	2.72E-05	8.85E-03	2.48E-05	9.19E-04	3.50E-07
15	Copper concentrate {RAS}| copper mine operation | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg Fe eq	9.04E-03	0.00E+00	2.79E-05	5.18E-05	4.39E-04	8.44E-03	2.91E-05	4.01E-05	1.01E-05
16	Fluorescent whitening agent, DAS1, triazinylaminostilben type {RoW}| production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg Fe eq	8.64E-03	0.00E+00	1.86E-09	3.66E-09	6.95E-03	1.69E-03	2.04E-09	1.83E-09	7.03E-10
17	Copper concentrate {RLA}| copper mine operation | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg Fe eq	6.83E-03	0.00E+00	2.11E-05	3.92E-05	3.32E-04	6.38E-03	2.20E-05	3.03E-05	7.62E-06
18	Gold {RoW}| -silver mine operation with refinery | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg Fe eq	6.67E-03	0.00E+00	5.26E-07	9.12E-07	9.79E-06	6.65E-03	3.76E-07	3.84E-06	8.05E-07
19	Carboxymethyl cellulose, powder {RER}| production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg Fe eq	5.89E-03	0.00E+00	1.07E-09	2.92E-09	5.89E-03	5.16E-07	9.44E-10	9.64E-10	4.55E-10
20	Copper concentrate {RNA}| copper mine operation | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg Fe eq	4.94E-03	0.00E+00	1.52E-05	2.83E-05	2.40E-04	4.61E-03	1.59E-05	2.19E-05	5.51E-06

Print System IRP SimaPro LCA Results

Calculation: Analyze
Results: Process contribution
Product: 1 p Printed Book System IRP (of project Digital vs Print LCA)
Method: ReCiPe Midpoint (H) V1.09 / Europe
Indicator: Recipe H
Category: Characterization
Cut-off: Fossil depletion
Mode: 1%
Exclude infrastructure processes: Group
Exclude long-term emissions: Yes
Sorted on item: Yes
Sort order: Total
Descending

No	Process	Project	Unit	Total	Top	Pulp wood	Pulp	Paper	Printing	Distribution Transportation	Retail Transportation	Waste Management
	Total of all processes		kg oil eq	2.98E+01	0.00E+00	6.71E-01	3.95E-01	1.21E+01	1.08E+01	2.12E+00	3.68E+00	6.44E-02
	Remaining processes		kg oil eq	3.87E+00	0.00E+00	7.27E-02	4.92E-02	1.53E+00	1.60E+00	2.04E-01	4.07E-01	1.06E-02
1	Hard coal {ZA}| mine operation | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg oil eq	5.94E+00	0.00E+00	2.15E-03	3.70E-02	2.41E+00	3.48E+00	1.50E-03	3.21E-03	1.08E-03
2	Petroleum {RoW}| and gas production, off-shore | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg oil eq	4.90E+00	0.00E+00	2.80E-01	5.03E-02	9.54E-01	8.16E-01	1.04E+00	1.75E+00	2.96E-03
3	Latex {RoW}| production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg oil eq	1.89E+00	0.00E+00	3.43E-07	8.37E-07	1.84E+00	5.20E-02	3.29E-07	3.19E-07	1.39E-07
4	Lignite {RoW}| mine operation | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg oil eq	1.75E+00	0.00E+00	3.64E-03	1.50E-03	1.40E+00	3.46E-01	3.45E-04	9.37E-04	2.14E-03
5	Petroleum {RoW}| and gas production, on-shore | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg oil eq	1.65E+00	0.00E+00	9.44E-02	1.69E-02	3.21E-01	2.75E-01	3.51E-01	5.89E-01	9.97E-04
6	Hard coal {ID}| mine operation | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg oil eq	1.27E+00	0.00E+00	8.51E-03	1.31E-02	1.57E-01	1.09E+00	8.21E-04	2.61E-03	5.30E-03
7	Natural gas, unprocessed, at extraction {RNA}| production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg oil eq	1.15E+00	0.00E+00	1.08E-02	4.39E-03	6.57E-01	4.63E-01	1.08E-03	7.68E-03	6.08E-03
8	Petroleum {RoW}| gas and petroleum production, off-shore | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg oil eq	1.10E+00	0.00E+00	6.29E-02	1.13E-02	2.14E-01	1.83E-01	2.34E-01	3.93E-01	6.64E-04
9	Latex {RER}| production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg oil eq	9.32E-01	0.00E+00	1.69E-07	4.13E-07	9.06E-01	2.57E-02	1.62E-07	1.58E-07	6.86E-08
10	Hard coal {CN}| mine operation | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg oil eq	8.74E-01	0.00E+00	2.09E-02	9.50E-02	2.22E-01	4.83E-01	4.01E-03	3.86E-02	1.10E-02
11	Natural gas, high pressure {RU}| natural gas production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg oil eq	7.91E-01	0.00E+00	5.12E-03	2.46E-03	3.31E-01	4.43E-01	1.35E-03	4.86E-03	2.76E-03
12	Hard coal {RNA}| mine operation | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg oil eq	6.86E-01	0.00E+00	1.66E-02	4.63E-02	1.95E-01	4.11E-01	1.74E-03	6.10E-03	9.66E-03
13	Hard coal {RoW}| mine operation | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg oil eq	5.41E-01	0.00E+00	1.11E-02	5.14E-02	1.50E-01	3.13E-01	3.14E-03	6.27E-03	6.48E-03
14	Natural gas, high pressure {RoW}| gas and petroleum production, off-shore | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg oil eq	4.40E-01	0.00E+00	2.60E-03	1.17E-03	2.79E-01	1.52E-01	3.94E-04	3.11E-03	1.43E-03
15	Natural gas, high pressure {RoW}| natural gas production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg oil eq	3.76E-01	0.00E+00	2.22E-03	9.95E-04	2.38E-01	1.30E-01	3.36E-04	2.66E-03	1.22E-03
16	Petroleum {GB}| and gas production, off-shore | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg oil eq	3.57E-01	0.00E+00	2.05E-02	3.67E-03	6.96E-02	5.95E-02	7.61E-02	1.28E-01	2.16E-04
17	Natural gas, high pressure {DE}| natural gas production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg oil eq	3.51E-01	0.00E+00	2.10E-03	9.55E-04	4.39E-02	3.01E-01	2.68E-04	8.16E-04	1.23E-03
18	Petroleum {NG}| and gas production, on-shore | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg oil eq	3.39E-01	0.00E+00	1.94E-02	3.48E-03	6.60E-02	5.64E-02	7.21E-02	1.21E-01	2.05E-04
19	Petroleum {RAF}| production, onshore | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg oil eq	3.12E-01	0.00E+00	1.78E-02	3.20E-03	6.07E-02	5.19E-02	6.63E-02	1.11E-01	1.88E-04
20	Petroleum {RME}| production, onshore | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg oil eq	2.99E-01	0.00E+00	1.71E-02	3.06E-03	5.81E-02	4.97E-02	6.36E-02	1.07E-01	1.81E-04

Calculation: Analyze
Results: Impact assessment
Product: 1 p Printed Book System IRP (of project Digital vs Print LCA)
Method: Cumulative Energy Demand V1.08 / Cumulative energy demand
Indicator: Characterization
Skip categories: Never
Mode: Group
Exclude infrastructure processes: Yes
Exclude long-term emissions: Yes
Sorted on item: Total
Sort order: Descending

Impact category	Unit	Total	Top	Pulp wood	Pulp	Paper	Printing	Distribution Transportation	Retail Transportation	Waste Management
Non renewable, fossil	MJ	1.34E+03	0.00E+00	3.00E+01	1.75E+01	5.43E+02	4.82E+02	9.51E+01	1.65E+02	2.88E+00
Non-renewable, nuclear	MJ	1.39E+02	0.00E+00	1.41E+00	7.87E-01	5.40E+01	8.08E+01	4.75E-01	6.90E-01	6.57E-01
Renewable, water	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Renewable, wind, solar, geothe	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Renewable, biomass	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Non-renewable, biomass	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Print System IRP SimaPro LCA Results

Calculation:	Analyze
Results:	Process contribution
Product:	1 p Printed Book System IRP (of project Digital vs Print LCA)
Method:	Cumulative Energy Demand V1.08 / Cumulative energy demand
Indicator:	Characterization
Category:	Non renewable, fossil
Cut-off:	1%
Mode:	Group
Exclude infrastructure processes:	Yes
Exclude long-term emissions:	Yes
Sorted on item:	Total
Sort order:	Descending

No	Process	Project	Unit	Total	Top	Pulp wood	Pulp	Paper	Printing	Distribution Transportation	Retail Transportation	Waste Management
	Total of all processes		MJ	1.34E+03	0.00E+00	3.00E+01	1.75E+01	5.43E+02	4.82E+02	9.51E+01	1.65E+02	2.88E+00
	Remaining processes		MJ	1.89E+02	0.00E+00	4.05E+00	2.33E+00	7.16E+01	7.54E+01	1.21E+01	2.31E+01	4.85E-01
1	Hard coal {ZA}| mine operation | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	MJ	2.61E+02	0.00E+00	9.46E-02	1.63E+00	1.06E+02	1.53E+02	6.59E-02	1.41E-01	4.77E-02
2	Petroleum {RoW}| and gas production, off-shore | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	MJ	2.18E+02	0.00E+00	1.25E+01	2.24E+00	4.25E+01	3.63E+01	4.65E+01	7.80E+01	1.32E-01
3	Latex {RoW}| production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	MJ	8.55E+01	0.00E+00	1.55E-05	3.79E-05	8.31E+01	2.36E+00	1.49E-05	1.45E-05	6.29E-06
4	Lignite {RoW}| mine operation | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	MJ	7.70E+01	0.00E+00	1.60E-01	6.58E-02	6.14E+01	1.52E+01	1.52E-02	4.12E-02	9.43E-02
5	Petroleum {RoW}| and gas production, on-shore | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	MJ	7.30E+01	0.00E+00	4.18E+00	7.49E-01	1.42E+01	1.22E+01	1.55E+01	2.61E+01	4.41E-02
6	Hard coal {ID}| mine operation | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	MJ	5.61E+01	0.00E+00	3.75E-01	5.77E-01	6.94E+00	4.78E+01	3.62E-02	1.15E-01	2.33E-01
7	Natural gas, unprocessed, at extraction {RNA}| production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	MJ	5.35E+01	0.00E+00	5.02E-01	2.04E-01	3.06E+01	2.15E+01	5.02E-02	3.58E-01	2.83E-01
8	Petroleum {RoW}| gas and petroleum production, off-shore | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	MJ	5.10E+01	0.00E+00	2.92E+00	5.24E-01	9.94E+00	8.50E+00	1.09E+01	1.82E+01	3.09E-02
9	Latex {RER}| production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	MJ	4.22E+01	0.00E+00	7.67E-06	1.87E-05	4.11E+01	1.16E+00	7.35E-06	7.14E-06	3.11E-06
10	Hard coal {CN}| mine operation | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	MJ	3.85E+01	0.00E+00	9.21E-01	4.18E+00	9.78E+00	2.13E+01	1.77E-01	1.70E+00	4.84E-01
11	Natural gas, high pressure {RU}| natural gas production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	MJ	3.68E+01	0.00E+00	2.38E-01	1.15E-01	1.54E+01	2.06E+01	6.27E-02	2.26E-01	1.29E-01
12	Hard coal {RNA}| mine operation | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	MJ	3.02E+01	0.00E+00	7.31E-01	2.04E+00	8.58E+00	1.81E+01	7.65E-02	2.69E-01	4.25E-01
13	Hard coal {RoW}| mine operation | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	MJ	2.38E+01	0.00E+00	4.91E-01	2.27E+00	6.59E+00	1.38E+01	1.38E-01	2.76E-01	2.85E-01
14	Natural gas, high pressure {RoW}| gas and petroleum production, off-shore | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	MJ	2.05E+01	0.00E+00	1.21E-01	5.42E-02	1.30E+01	7.07E+00	1.83E-02	1.45E-01	6.65E-02
15	Natural gas, high pressure {RoW}| natural gas production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	MJ	1.75E+01	0.00E+00	1.03E-01	4.63E-02	1.11E+01	6.05E+00	1.57E-02	1.24E-01	5.68E-02
16	Natural gas, high pressure {DE}| natural gas production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	MJ	1.63E+01	0.00E+00	9.78E-02	4.44E-02	2.04E+00	1.40E+01	1.25E-02	3.80E-02	5.73E-02
17	Petroleum {GB}| and gas production, off-shore | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	MJ	1.61E+01	0.00E+00	9.20E-01	1.65E-01	3.13E+00	2.68E+00	3.42E+00	5.74E+00	9.72E-03
18	Petroleum {NG}| and gas production, on-shore | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	MJ	1.50E+01	0.00E+00	8.58E-01	1.54E-01	2.92E+00	2.50E+00	3.19E+00	5.36E+00	9.07E-03
19	Petroleum {RAF}| production, onshore | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	MJ	1.37E+01	0.00E+00	7.86E-01	1.41E-01	2.67E+00	2.29E+00	2.92E+00	4.91E+00	8.30E-03

Print System IRP SimaPro LCA Results

Calculation:	Analyze
Results:	Process contribution
Product:	1 p Printed Book System IRP (of project Digital vs Print LCA)
Method:	Cumulative Energy Demand V1.08 / Cumulative energy demand
Indicator:	Characterization
Category:	Non-renewable, nuclear
Cut-off:	1%
Mode:	Group
Exclude infrastructure processes:	Yes
Exclude long-term emissions:	Yes
Sorted on item:	Total
Sort order:	Descending

No	Process	Project	Unit	Total	Top	Pulp wood	Pulp	Paper	Printing	Distribution Transportation	Retail Transportation	Waste Management
	Total of all processes		MJ	1.39E+02	0.00E+00	1.41E+00	7.87E-01	5.40E+01	8.08E+01	4.75E-01	6.90E-01	6.57E-01
	Remaining processes		MJ	5.03E+00	0.00E+00	2.87E-03	4.38E-03	4.00E+00	9.57E-01	1.87E-03	5.88E-02	1.98E-04
1	Uranium ore, as U {RNA}| uranium mine operation, underground | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	MJ	5.04E+01	0.00E+00	5.46E-01	3.04E-01	1.80E+01	3.08E+01	1.84E-01	2.45E-01	2.55E-01
2	Uranium ore, as U {RoW}| uranium mine operation, underground | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	MJ	4.75E+01	0.00E+00	5.15E-01	2.87E-01	1.70E+01	2.91E+01	1.73E-01	2.31E-01	2.40E-01
3	Uranium ore, as U {RoW}| uranium mine operation, open cast | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	MJ	1.88E+01	0.00E+00	2.03E-01	1.13E-01	6.72E+00	1.15E+01	6.84E-02	9.13E-02	9.50E-02
4	Uranium ore, as U {RNA}| uranium mine operation, open cast | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	MJ	1.31E+01	0.00E+00	1.42E-01	7.90E-02	4.69E+00	8.01E+00	4.77E-02	6.37E-02	6.62E-02
5	Latex {RoW}| production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	MJ	2.16E+00	0.00E+00	3.92E-07	9.57E-07	2.10E+00	5.95E-02	3.76E-07	3.65E-07	1.59E-07
6	Fluorescent whitening agent, distyrylbiphenyl type {RoW}| production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	MJ	1.88E+00	0.00E+00	4.04E-07	7.95E-07	1.51E+00	3.66E-01	4.43E-07	3.97E-07	1.53E-07

Digital System IRP SimaPro LCA Results

Calculation: Analyze
Results: Impact assessment
1 p Apple Air iPad IRP (of project Digital vs Print LCA)
Product:
Method: ReCiPe Midpoint (H) V1.09 / Europe Recipe H
Indicator: Characterization
Skip categories: Never
Mode: Group
Exclude infrastructure processes: Yes
Exclude long-term emissions: Yes
Sorted on item: Total
Sort order: Descending

Impact category	Unit	Total	Top	Production	Apple Air iPad distribution transportation	Retail transportation	e-book formatting	e-book downloading	e-book reading	Waste Management
Water depletion	m3	8.57E+01	0.00E+00	7.85E+01	2.74E-02	3.13E-01	1.67E-01	8.43E-02	6.67E+00	1.59E-02
Climate change	kg CO2 eq	3.31E+01	0.00E+00	1.88E+01	9.34E-02	2.83E+00	3.56E-02	1.39E-01	1.10E+01	2.29E-01
Metal depletion	kg Fe eq	1.52E+01	0.00E+00	1.52E+01	2.23E-03	1.87E-03	9.77E-03	1.11E-04	8.77E-03	1.75E-05
Fossil depletion	kg oil eq	8.47E+00	0.00E+00	4.78E+00	3.21E-02	9.21E-01	9.01E-03	3.42E-02	2.70E+00	8.57E-04
Human toxicity	kg 1,4-DB eq	5.12E+00	0.00E+00	4.74E+00	2.45E-03	1.20E-01	5.67E-03	3.13E-03	2.48E-01	1.61E-03
Ionising radiation	kBq U235 eq	1.80E+00	0.00E+00	1.03E+00	5.05E-03	1.37E-01	2.35E-03	7.91E-03	6.25E-01	2.29E-04
Agricultural land occupation	m2a	5.47E-01	0.00E+00	5.37E-01	7.22E-04	2.64E-03	6.37E-04	7.78E-05	6.15E-03	4.56E-05
Marine ecotoxicity	kg 1,4-DB eq	2.71E-01	0.00E+00	2.66E-01	2.27E-04	2.49E-03	1.38E-04	2.98E-05	2.36E-03	3.43E-05
Urban land occupation	m2a	2.37E-01	0.00E+00	2.05E-01	2.63E-03	5.69E-04	2.43E-04	3.52E-04	2.79E-02	1.76E-05
Freshwater ecotoxicity	kg 1,4-DB eq	2.06E-01	0.00E+00	2.04E-01	1.99E-05	5.20E-04	1.11E-04	9.75E-06	7.72E-04	5.97E-05
Terrestrial acidification	kg SO2 eq	2.47E-01	0.00E+00	1.40E-01	1.35E-03	3.89E-03	2.30E-04	1.26E-03	9.98E-02	3.86E-05
Photochemical oxidant formation	kg NMVOC	1.45E-01	0.00E+00	8.70E-02	1.20E-03	6.01E-03	1.21E-04	6.34E-04	5.02E-02	1.18E-04
Particulate matter formation	kg PM10 eq	7.84E-02	0.00E+00	5.05E-02	4.45E-04	1.41E-03	8.52E-05	3.24E-04	2.56E-02	1.31E-05
Marine eutrophication	kg N eq	2.37E-02	0.00E+00	2.11E-02	4.04E-05	1.05E-04	2.09E-05	2.27E-05	1.79E-03	5.81E-04
Freshwater eutrophication	kg P eq	2.06E-02	0.00E+00	1.97E-02	7.63E-07	3.87E-06	9.31E-06	1.16E-05	9.20E-04	2.38E-06
Terrestrial ecotoxicity	kg 1,4-DB eq	2.42E-03	0.00E+00	1.96E-03	5.43E-06	3.01E-04	4.28E-06	1.86E-06	1.47E-04	7.38E-07
Natural land transformation	m2	1.13E-03	0.00E+00	9.40E-04	1.25E-05	3.07E-06	1.42E-06	2.10E-06	1.66E-04	1.08E-07
Ozone depletion	kg CFC-11 eq	1.39E-06	0.00E+00	8.87E-07	6.34E-09	1.75E-07	1.81E-09	3.97E-09	3.14E-07	1.47E-10

Digital System IRP SimaPro LCA Results

Calculation: Analyze
Results: Process contribution
1 p Apple Air iPad IRP (of project Digital vs Print
Product: LCA)
Method: ReCiPe Midpoint (H) V1.09 / Europe Recipe H
Indicator: Characterization
Category: Climate change
Cut-off: 1%
Mode: Group
Exclude infrastructure processes: Yes
Exclude long-term emissions: Yes
Sorted on item: Total
Sort order: Descending

No	Process	Project	Unit	Total	Top	Production	Apple Air iPad distribution transportation	Retail transportation	e-book formatting	e-book downloading	e-book reading	Waste Management
	Total of all processes		kg CO2 eq	2.24E+01	0.00E+00	1.88E+01	9.34E-02	2.83E+00	3.56E-02	1.39E-01	1.10E+01	2.29E-01
	Remaining processes		kg CO2 eq	9.89E+00	0.00E+00	9.22E+00	9.30E-02	5.15E-01	1.93E-02	1.33E-02	1.06E+00	1.72E-03
1	Electricity, high voltage {CN}| electricity production, hard coal | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg CO2 eq	2.19E+00	0.00E+00	2.15E+00	1.29E-04	3.28E-02	4.74E-03	6.53E-05	5.17E-03	5.20E-04
2	Transport, passenger car, medium size, petrol, EURO 3 {RoW}| transport, passenger car, medium size, petrol, EURO 3 | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg CO2 eq	1.85E+00	0.00E+00	2.61E-06	4.61E-11	1.85E+00	3.64E-09	1.36E-09	1.08E-07	1.61E-10
3	Electricity, high voltage {RoW}| electricity production, hard coal | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg CO2 eq	1.60E+00	0.00E+00	1.60E+00	5.17E-05	2.13E-03	2.65E-03	2.28E-04	1.80E-02	2.86E-04
4	Heat, district or industrial, other than natural gas {RoW}| heat production, at hard coal industrial furnace 1-10MW | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg CO2 eq	1.07E+00	0.00E+00	1.06E+00	2.73E-05	1.18E-02	5.38E-04	2.78E-04	2.20E-02	7.82E-05
5	Hard coal {CN}| mine operation | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg CO2 eq	9.54E-01	0.00E+00	9.38E-01	6.71E-05	1.36E-02	1.86E-03	5.81E-05	4.60E-03	2.05E-04
6	Electricity, high voltage {IN}| electricity production, hard coal | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg CO2 eq	6.97E-01	0.00E+00	6.93E-01	3.27E-05	1.30E-03	1.55E-03	5.26E-05	4.16E-03	1.71E-04
7	Diesel, burned in building machine {GLO}| processing | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg CO2 eq	6.73E-01	0.00E+00	6.72E-01	8.59E-07	8.48E-05	2.95E-04	2.08E-04	1.64E-02	2.65E-06
8	Electricity, high voltage {RFC}| electricity production, hard coal | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg CO2 eq	5.67E-01	0.00E+00	5.64E-01	2.65E-05	1.06E-03	1.24E-03	6.71E-05	5.31E-03	1.36E-04
9	Electricity, high voltage {SERC}| electricity production, hard coal | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg CO2 eq	5.58E-01	0.00E+00	5.56E-01	2.62E-05	1.05E-03	1.22E-03	6.62E-05	5.23E-03	1.34E-04
10	Electricity, high voltage {ZA IRP}| electricity production, hard coal | Alloc Def, U	Digital vs Print LCA	kg CO2 eq	4.24E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.25E-01	9.86E+00	0.00E+00
11	Transport, passenger car, medium size, petrol, EURO 3 {RER}| transport, passenger car, medium size, petrol, EURO 3 | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg CO2 eq	3.94E-01	0.00E+00	5.56E-07	9.82E-12	3.94E-01	7.74E-10	2.90E-10	2.29E-08	3.42E-11
12	Electricity, high voltage {RoW}| electricity production, lignite | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg CO2 eq	2.86E-01	0.00E+00	2.85E-01	6.92E-06	2.86E-04	3.90E-04	3.63E-05	2.87E-03	3.82E-05
13	Electricity, high voltage {RU}| heat and power co-generation, natural gas, conventional power plant, 100MW electrical | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg CO2 eq	2.77E-01	0.00E+00	2.76E-01	1.30E-05	6.05E-04	6.15E-04	2.48E-05	1.96E-03	6.63E-05
14	Electricity, high voltage {RoW}| electricity production, natural gas, at conventional power plant | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg CO2 eq	2.53E-01	0.00E+00	2.52E-01	1.10E-05	4.54E-04	5.24E-04	4.14E-05	3.27E-03	6.10E-05
15	Heat, district or industrial, other than natural gas {RoW}| heat production, heavy fuel oil, at industrial furnace 1MW | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg CO2 eq	2.51E-01	0.00E+00	2.49E-01	5.31E-06	2.29E-03	1.25E-04	5.68E-05	4.50E-03	1.54E-05
16	Electricity, high voltage {WECC, US only}| electricity production, hard coal | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg CO2 eq	2.39E-01	0.00E+00	2.38E-01	1.12E-05	4.49E-04	5.25E-04	2.84E-05	2.25E-03	5.75E-05
17	Municipal solid waste {RoW}| treatment of, sanitary landfill | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg CO2 eq	2.29E-01	0.00E+00	3.16E-03	6.68E-07	4.39E-05	4.15E-06	3.27E-06	2.58E-04	2.26E-01

Digital System IRP SimaPro LCA Results

Calculation: Analyze
Results: Process contribution
1 p Apple Air iPad IRP (of project Digital vs Print
Product: LCA)
Method: ReCiPe Midpoint (H) V1.09 / Europe Recipe H
Indicator: Characterization
Category: Ozone depletion
Cut-off: 1%
Mode: Group
Exclude infrastructure processes: Yes
Exclude long-term emissions: Yes
Sorted on item: Total
Sort order: Descending

No	Process	Project	Unit	Total	Top	Production	Apple Air iPad distribution transportation	Retail transportation	e-book formatting	e-book downloading	e-book reading	Waste Management
	Total of all processes		kg CFC-11 eq	1.08E-06	0.00E+00	8.87E-07	6.34E-09	1.75E-07	1.81E-09	3.97E-09	3.14E-07	1.47E-10
	Remaining processes		kg CFC-11 eq	1.95E-07	0.00E+00	1.84E-07	2.99E-09	6.13E-09	4.39E-10	3.15E-10	2.49E-08	3.85E-11
1	Petroleum {RoW}| and gas production, on-shore | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg CFC-11 eq	1.88E-07	0.00E+00	8.62E-08	1.97E-09	9.94E-08	1.19E-10	1.16E-10	9.19E-09	9.14E-12
2	Uranium, enriched 4.2%, per separative work unit {US}| uranium production, diffusion, enriched 4.2% | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg CFC-11 eq	1.70E-07	0.00E+00	1.58E-07	9.30E-12	4.96E-10	3.77E-10	3.41E-09	2.69E-07	3.81E-11
3	Uranium, enriched 3.8%, per separative work unit {US}| uranium production, diffusion, enriched 3.8% | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg CFC-11 eq	1.18E-07	0.00E+00	1.17E-07	9.38E-12	6.54E-10	3.04E-10	3.35E-11	2.65E-09	2.76E-11
4	Transport, pipeline, long distance, natural gas {RU}| processing | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg CFC-11 eq	8.54E-08	0.00E+00	8.48E-08	3.48E-12	3.92E-10	1.76E-10	9.14E-12	7.23E-10	1.54E-11
5	Copper {GLO}| treatment of used cable | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg CFC-11 eq	7.59E-08	0.00E+00	7.58E-08	2.06E-14	3.81E-12	8.90E-11	5.14E-14	4.06E-12	5.28E-14
6	Petroleum {NG}| and gas production, on-shore | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg CFC-11 eq	3.86E-08	0.00E+00	1.77E-08	4.05E-10	2.04E-08	2.43E-11	2.39E-11	1.89E-09	1.88E-12
7	Petroleum {RAF}| production, onshore | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg CFC-11 eq	3.54E-08	0.00E+00	1.62E-08	3.71E-10	1.87E-08	2.23E-11	2.19E-11	1.73E-09	1.72E-12
8	Transport, pipeline, long distance, natural gas {RoW}| processing | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg CFC-11 eq	3.48E-08	0.00E+00	3.45E-08	1.42E-12	1.44E-10	7.36E-11	3.86E-12	3.05E-10	6.66E-12
9	Petroleum {RME}| production, onshore | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg CFC-11 eq	3.39E-08	0.00E+00	1.55E-08	3.55E-10	1.79E-08	2.14E-11	2.09E-11	1.66E-09	1.65E-12
10	Polarizer, liquid crystals and colour filters, for liquid crystal display {GLO}| production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg CFC-11 eq	3.32E-08	0.00E+00	3.32E-08	3.93E-19	3.32E-17	2.42E-11	2.51E-18	1.98E-16	7.87E-19
11	Petroleum {RU}| production, onshore | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg CFC-11 eq	2.09E-08	0.00E+00	9.57E-09	2.19E-10	1.10E-08	1.32E-11	1.29E-11	1.02E-09	1.01E-12
12	Polycarbonate {RoW}| production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg CFC-11 eq	1.82E-08	0.00E+00	1.81E-08	6.74E-18	3.41E-15	3.78E-11	2.02E-16	1.60E-14	1.20E-17
13	Transport, pipeline, onshore, long distance, natural gas {DZ}| processing | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg CFC-11 eq	1.27E-08	0.00E+00	1.26E-08	6.02E-13	6.91E-11	3.10E-11	1.10E-12	8.68E-11	2.41E-12
14	Uranium, enriched 4.0%, per separative work unit {US}| uranium production, diffusion, enriched 4.0% | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg CFC-11 eq	1.21E-08	0.00E+00	1.20E-08	9.13E-13	7.69E-11	3.80E-11	8.91E-13	7.05E-11	2.82E-12
15	Sodium hydroxide, without water, in 50% solution state {RoW}| chlor-alkali electrolysis, diaphragm cell | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg CFC-11 eq	1.18E-08	0.00E+00	1.17E-08	4.15E-13	5.82E-11	2.00E-11	1.17E-12	9.26E-11	2.27E-13

Digital System IRP SimaPro LCA Results

Calculation: Analyze
Results: Process contribution
1 p Apple Air iPad IRP (of project Digital vs Print
Product: LCA)
Method: ReCiPe Midpoint (H) V1.09 / Europe Recipe H
Indicator: Characterization
Category: Terrestrial acidification
Cut-off: 1%
Mode: Group
Exclude infrastructure processes: Yes
Exclude long-term emissions: Yes
Sorted on item: Total
Sort order: Descending

No	Process	Project	Unit	Total	Top	Production	Apple Air iPad distribution transportation	Retail transportation	e-book formatting	e-book downloading	e-book reading	Waste Management
	Total of all processes		kg SO2 eq	1.50E-01	0.00E+00	1.40E-01	1.35E-03	3.89E-03	2.30E-04	1.26E-03	9.98E-02	3.86E-05
	Remaining processes		kg SO2 eq	4.55E-02	0.00E+00	4.18E-02	2.04E-04	3.31E-03	8.45E-05	2.22E-05	1.76E-03	2.44E-05
1	Electricity, high voltage {CN}| electricity production, hard coal | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg SO2 eq	2.31E-02	0.00E+00	2.27E-02	1.35E-06	3.45E-04	4.98E-05	6.87E-07	5.44E-05	5.47E-06
2	Blasting {RoW}| processing | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg SO2 eq	1.20E-02	0.00E+00	1.19E-02	3.32E-08	2.10E-06	5.60E-06	1.89E-05	1.50E-03	1.03E-07
3	Electricity, high voltage {RoW}| electricity production, hard coal | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg SO2 eq	1.16E-02	0.00E+00	1.15E-02	3.75E-07	1.54E-05	1.92E-05	1.65E-06	1.31E-04	2.07E-06
4	Heat, district or industrial, other than natural gas {RoW}| heat production, at hard coal industrial furnace 1-10MW | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg SO2 eq	7.13E-03	0.00E+00	7.04E-03	1.82E-07	7.85E-05	3.58E-06	1.85E-06	1.46E-04	5.20E-07
5	Natural gas, high pressure {RNA}| natural gas production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg SO2 eq	6.16E-03	0.00E+00	6.12E-03	2.76E-07	2.84E-05	1.31E-05	7.29E-07	5.77E-05	1.41E-06
6	Blasting {RER}| processing | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg SO2 eq	5.92E-03	0.00E+00	5.88E-03	1.64E-08	1.04E-06	2.77E-06	9.35E-06	7.39E-04	5.10E-08
7	Diesel, burned in building machine {GLO}| processing | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg SO2 eq	5.48E-03	0.00E+00	5.47E-03	6.99E-09	6.90E-07	2.40E-06	1.69E-06	1.34E-04	2.16E-08
8	Electricity, high voltage {IN}| electricity production, hard coal | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg SO2 eq	4.58E-03	0.00E+00	4.56E-03	2.15E-07	8.55E-06	1.02E-05	3.46E-07	2.74E-05	1.12E-06
9	Electricity, high voltage {RFC}| electricity production, hard coal | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg SO2 eq	4.21E-03	0.00E+00	4.19E-03	1.97E-07	7.90E-06	9.22E-06	4.98E-07	3.94E-05	1.01E-06
10	Electricity, high voltage {ZA IRP}| electricity production, hard coal | Alloc Def, U	Digital vs Print LCA	kg SO2 eq	4.05E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.19E-03	9.42E-02	0.00E+00
11	Hard coal {CN}| mine operation | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg SO2 eq	3.80E-03	0.00E+00	3.74E-03	2.67E-07	5.40E-05	7.42E-06	2.32E-07	1.83E-05	8.17E-07
12	Electricity, high voltage {SERC}| electricity production, hard coal | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg SO2 eq	3.33E-03	0.00E+00	3.31E-03	1.56E-07	6.24E-06	7.29E-06	3.94E-07	3.12E-05	7.99E-07
13	Liquid crystal display, minor components, auxilliaries and assembly effort {GLO}| production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg SO2 eq	2.80E-03	0.00E+00	2.80E-03	3.31E-14	2.80E-12	2.04E-06	2.11E-13	1.67E-11	6.63E-14
14	Transport, freight, sea, transoceanic ship {GLO}| processing | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg SO2 eq	2.58E-03	0.00E+00	1.43E-03	1.14E-03	6.03E-06	2.12E-06	3.07E-07	2.43E-05	1.25E-07
15	Copper {RAS}| production, primary | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg SO2 eq	2.21E-03	0.00E+00	2.20E-03	6.00E-10	1.11E-07	2.59E-06	1.49E-09	1.18E-07	1.53E-09
16	Electricity, high voltage {ZA}| electricity production, hard coal | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg SO2 eq	2.04E-03	0.00E+00	1.98E-03	4.76E-07	2.43E-05	4.34E-06	1.15E-05	9.09E-04	4.74E-07
17	Copper {RoW}| production, primary | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg SO2 eq	1.80E-03	0.00E+00	1.79E-03	4.88E-10	9.01E-08	2.11E-06	1.22E-09	9.61E-08	1.25E-09
18	Electricity, high voltage {RoW}| electricity production, lignite | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg SO2 eq	1.56E-03	0.00E+00	1.56E-03	3.77E-08	1.56E-06	2.12E-06	1.98E-07	1.57E-05	2.08E-07

Digital System IRP SimaPro LCA Results

Calculation: Analyze
Results: Process contribution
1 p Apple Air iPad IRP (of project Digital vs Print
Product: LCA)
Method: ReCiPe Midpoint (H) V1.09 / Europe Recipe H
Indicator: Characterization
Category: Freshwater eutrophication
Cut-off: 1%
Mode: Group
Exclude infrastructure processes: Yes
Exclude long-term emissions: Yes
Sorted on item: Total
Sort order: Descending

No	Process	Project	Unit	Total	Top	Production	Apple Air iPad distribution transportation	Retail transportation	e-book formatting	e-book downloading	e-book reading	Waste Management
	Total of all processes		kg P eq	1.97E-02	0.00E+00	1.97E-02	7.63E-07	3.87E-06	9.31E-06	1.16E-05	9.20E-04	2.38E-06
	Remaining processes		kg P eq	1.29E-04	0.00E+00	1.26E-04	7.17E-07	2.74E-07	2.65E-07	5.48E-09	4.33E-07	2.22E-06
1	Sulfidic tailing, off-site {GLO}| treatment of | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg P eq	1.88E-02	0.00E+00	1.88E-02	6.17E-10	3.66E-07	7.43E-06	2.87E-09	2.27E-07	1.09E-09
2	Spoil from hard coal mining {GLO}| treatment of, in surface landfill | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg P eq	5.48E-04	0.00E+00	5.05E-04	3.22E-08	2.37E-06	1.00E-06	1.16E-05	9.17E-04	1.07E-07
3	Spoil from lignite mining {GLO}| treatment of, in surface landfill | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg P eq	2.61E-04	0.00E+00	2.59E-04	1.39E-08	8.54E-07	6.15E-07	2.26E-08	1.78E-06	5.50E-08

Calculation: Analyze
Results: Process contribution
1 p Apple Air iPad IRP (of project Digital vs Print
Product: LCA)
Method: ReCiPe Midpoint (H) V1.09 / Europe Recipe H
Indicator: Characterization
Category: Marine eutrophication
Cut-off: 1%
Mode: Group
Exclude infrastructure processes: Yes
Exclude long-term emissions: Yes
Sorted on item: Total
Sort order: Descending

No	Process	Project	Unit	Total	Top	Production	Apple Air iPad distribution transportation	Retail transportation	e-book formatting	e-book downloading	e-book reading	Waste Management
	Total of all processes		kg N eq	2.20E-02	0.00E+00	2.11E-02	4.04E-05	1.05E-04	2.09E-05	2.27E-05	1.79E-03	5.81E-04
	Remaining processes		kg N eq	2.22E-03	0.00E+00	2.01E-03	4.04E-05	9.88E-05	3.80E-06	2.10E-05	1.66E-03	2.74E-07
1	Wastewater from liquid crystal display production {RoW}| treatment of, capacity 1.1E10l/year | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg N eq	1.47E-02	0.00E+00	1.47E-02	1.48E-12	1.44E-09	1.41E-05	1.21E-12	9.57E-11	3.67E-13
2	Liquid crystal display, minor components, auxilliaries and assembly effort {GLO}| production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg N eq	1.56E-03	0.00E+00	1.56E-03	1.84E-14	1.56E-12	1.13E-06	1.18E-13	9.30E-12	3.69E-14
3	Gold {RoW}| -silver mine operation with refinery | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg N eq	8.75E-04	0.00E+00	8.75E-04	1.27E-13	7.96E-11	2.99E-07	4.52E-12	3.58E-10	2.27E-12
4	Blasting {RoW}| processing | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg N eq	6.66E-04	0.00E+00	6.62E-04	1.84E-09	1.17E-07	3.11E-07	1.05E-06	8.32E-05	5.74E-09
5	Municipal solid waste {RoW}| treatment of, sanitary landfill | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg N eq	5.89E-04	0.00E+00	8.12E-06	1.72E-09	1.13E-07	1.07E-08	8.39E-09	6.64E-07	5.81E-04
6	Electricity, high voltage {CN}| electricity production, hard coal | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg N eq	3.67E-04	0.00E+00	3.60E-04	2.15E-08	5.48E-06	7.92E-07	1.09E-08	8.64E-07	8.69E-08
7	Diesel, burned in building machine {GLO}| processing | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg N eq	3.66E-04	0.00E+00	3.66E-04	4.67E-10	4.62E-08	1.61E-07	1.13E-07	8.94E-06	1.44E-09
8	Blasting {RER}| processing | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg N eq	3.29E-04	0.00E+00	3.27E-04	9.11E-10	5.76E-08	1.54E-07	5.19E-07	4.11E-05	2.83E-09
9	Sulfidic tailing, off-site {GLO}| treatment of | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg N eq	2.87E-04	0.00E+00	2.87E-04	9.42E-12	5.59E-09	1.13E-07	4.38E-11	3.46E-09	1.66E-11

Digital System IRP SimaPro LCA Results

Calculation: Analyze
Results: Process contribution
1 p Apple Air iPad IRP (of project Digital vs Print LCA)
Product:
Method: ReCiPe Midpoint (H) V1.09 / Europe Recipe H
Indicator: Characterization
Category: Human toxicity
Cut-off: 1%
Mode: Group
Exclude infrastructure processes: Yes
Exclude long-term emissions: Yes
Sorted on item: Total
Sort order: Descending

No	Process	Project	Unit	Total	Top	Production	Apple Air iPad distribution transportation	Retail transportation	e-book formatting	e-book downloading	e-book reading	Waste Management
	Total of all processes		kg 1,4-DB eq	4.88E+00	0.00E+00	4.74E+00	2.45E-03	1.20E-01	5.67E-03	3.13E-03	2.48E-01	1.61E-03
	Remaining processes		kg 1,4-DB eq	5.65E-01	0.00E+00	4.97E-01	2.44E-03	5.27E-02	1.54E-03	3.08E-03	2.43E-01	1.54E-03
1	Liquid crystal display, minor components, auxilliaries and assembly effort {GLO}| production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	1.34E+00	0.00E+00	1.34E+00	1.58E-11	1.34E-09	9.75E-04	1.01E-10	7.99E-09	3.17E-11
2	Copper {RoW}| production, primary | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	9.66E-01	0.00E+00	9.64E-01	2.62E-07	4.85E-05	1.13E-03	6.53E-07	5.17E-05	6.71E-07
3	Copper {RAS}| production, primary | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	5.00E-01	0.00E+00	4.99E-01	1.36E-07	2.51E-05	5.86E-04	3.38E-07	2.68E-05	3.47E-07
4	Copper {RLA}| production, primary | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	4.19E-01	0.00E+00	4.18E-01	1.14E-07	2.10E-05	4.91E-04	2.83E-07	2.24E-05	2.91E-07
5	Gold {RoW}| -silver mine operation with refinery | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	3.02E-01	0.00E+00	3.02E-01	4.38E-11	2.75E-08	1.03E-04	1.56E-09	1.24E-07	7.83E-10
6	Natural gas, unprocessed, at extraction {RNA}| production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	1.70E-01	0.00E+00	1.68E-01	7.50E-06	9.07E-04	3.59E-04	1.92E-05	1.52E-03	3.81E-05
7	Sulfidic tailing, off-site {GLO}| treatment of | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	1.62E-01	0.00E+00	1.61E-01	5.30E-09	3.15E-06	6.39E-05	2.47E-08	1.95E-06	9.36E-09
8	Electricity, high voltage {CN}| electricity production, hard coal | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	1.06E-01	0.00E+00	1.04E-01	6.22E-06	1.58E-03	2.29E-04	3.16E-06	2.50E-04	2.51E-05
9	Aluminium, primary, liquid {GLO}| aluminium production, primary, liquid, prebake | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	8.95E-02	0.00E+00	8.95E-02	1.47E-08	1.11E-06	4.14E-05	7.24E-06	5.73E-04	4.58E-08
10	Copper {AU}| production, primary | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	7.19E-02	0.00E+00	7.19E-02	1.96E-08	3.61E-06	8.44E-05	4.87E-08	3.85E-06	5.00E-08
11	Brake wear emissions, passenger car {RoW}| treatment of | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	6.42E-02	0.00E+00	9.80E-07	1.74E-11	6.42E-02	1.37E-09	5.11E-10	4.04E-08	6.03E-11
12	Redmud from bauxite digestion {RoW}| treatment of, residual material landfill | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	6.39E-02	0.00E+00	6.39E-02	1.95E-08	1.99E-06	3.01E-05	5.16E-06	4.08E-04	6.34E-07
13	Heat, district or industrial, other than natural gas {RoW}| heat production, at hard coal industrial furnace 1-10MW | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	6.11E-02	0.00E+00	6.03E-02	1.56E-06	6.72E-04	3.06E-05	1.58E-05	1.25E-03	4.45E-06

Digital System IRP SimaPro LCA Results

Calculation: Analyze
Results: Process contribution
1 p Apple Air iPad IRP (of project Digital vs Print
Product: LCA)
Method: ReCiPe Midpoint (H) V1.09 / Europe Recipe H
Indicator: Characterization
Category: Photochemical oxidant formation
Cut-off: 1%
Mode: Group
Exclude infrastructure processes: Yes
Exclude long-term emissions: Yes
Sorted on item: Total
Sort order: Descending

No	Process	Project	Unit	Total	Top	Production	Apple Air iPad distribution transportation	Retail transportation	e-book formatting	e-book downloading	e-book reading	Waste Management
	Total of all processes		kg NMVOC	9.66E-02	0.00E+00	8.70E-02	1.20E-03	6.01E-03	1.21E-04	6.34E-04	5.02E-02	1.18E-04
	Remaining processes		kg NMVOC	2.97E-02	0.00E+00	2.65E-02	2.95E-04	2.63E-03	5.53E-05	1.78E-05	1.41E-03	1.12E-04
1	Blasting {RoW}| processing | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg NMVOC	1.43E-02	0.00E+00	1.42E-02	3.97E-08	2.51E-06	6.70E-06	2.26E-05	1.79E-03	1.23E-07
2	Electricity, high voltage {CN}| electricity production, hard coal | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg NMVOC	1.09E-02	0.00E+00	1.07E-02	6.37E-07	1.62E-04	2.35E-05	3.24E-07	2.56E-05	2.57E-06
3	Diesel, burned in building machine {GLO}| processing | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg NMVOC	1.06E-02	0.00E+00	1.06E-02	1.35E-08	1.34E-06	4.65E-06	3.28E-06	2.59E-04	4.18E-08
4	Blasting {RER}| processing | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg NMVOC	7.08E-03	0.00E+00	7.04E-03	1.96E-08	1.24E-06	3.31E-06	1.12E-05	8.84E-04	6.10E-08
5	Electricity, high voltage {RoW}| electricity production, hard coal | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg NMVOC	5.30E-03	0.00E+00	5.28E-03	1.71E-07	7.06E-06	8.77E-06	7.55E-07	5.97E-05	9.47E-07
6	Heat, district or industrial, other than natural gas {RoW}| heat production, at hard coal industrial furnace 1-10MW | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg NMVOC	2.96E-03	0.00E+00	2.92E-03	7.55E-08	3.26E-05	1.48E-06	7.66E-07	6.06E-05	2.16E-07
7	Electricity, high voltage {IN}| electricity production, hard coal | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg NMVOC	2.28E-03	0.00E+00	2.27E-03	1.07E-07	4.26E-06	5.07E-06	1.72E-07	1.36E-05	5.60E-07
8	Natural gas, vented {GLO}| natural gas venting from petroleum/natural gas production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg NMVOC	2.17E-03	0.00E+00	1.03E-03	2.19E-05	1.10E-03	1.48E-06	1.30E-06	1.03E-04	1.17E-07
9	Transport, passenger car, medium size, petrol, EURO 3 {RoW}| transport, passenger car, medium size, petrol, EURO 3 | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg NMVOC	2.04E-03	0.00E+00	2.87E-09	5.08E-14	2.04E-03	4.01E-12	1.50E-12	1.19E-10	1.77E-13
10	Transport, freight, sea, transoceanic ship {GLO}| processing | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg NMVOC	1.99E-03	0.00E+00	1.10E-03	8.78E-04	4.65E-06	1.64E-06	2.36E-07	1.87E-05	9.63E-08
11	Liquid crystal display, minor components, auxilliaries and assembly effort {GLO}| production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg NMVOC	1.97E-03	0.00E+00	1.97E-03	2.33E-14	1.96E-12	1.43E-06	1.48E-13	1.17E-11	4.66E-14
12	Electricity, high voltage {ZA IRP}| electricity production, hard coal | Alloc Def, U	Digital vs Print LCA	kg NMVOC	1.94E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.70E-04	4.51E-02	0.00E+00
13	Electricity, high voltage {RFC}| electricity production, hard coal | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg NMVOC	1.30E-03	0.00E+00	1.29E-03	6.09E-08	2.44E-06	2.85E-06	1.54E-07	1.22E-05	3.12E-07
14	Electricity, high voltage {SERC}| electricity production, hard coal | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg NMVOC	1.10E-03	0.00E+00	1.10E-03	5.16E-08	2.07E-06	2.41E-06	1.30E-07	1.03E-05	2.65E-07
15	Electricity, high voltage {ZA}| electricity production, hard coal | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg NMVOC	9.78E-04	0.00E+00	9.46E-04	2.28E-07	1.16E-05	2.08E-06	5.50E-06	4.35E-04	2.27E-07

Digital System IRP SimaPro LCA Results

Calculation: Analyze
Results: Process contribution
1 p Apple Air iPad IRP (of project Digital vs Print
Product: LCA)
Method: ReCiPe Midpoint (H) V1.09 / Europe Recipe H
Indicator: Characterization
Category: Particulate matter formation
Cut-off: 1%
Mode: Group
Exclude infrastructure processes: Yes
Exclude long-term emissions: Yes
Sorted on item: Total
Sort order: Descending

No	Process	Project	Unit	Total	Top	Production	Apple Air iPad distribution transportation	Retail transportation	e-book formatting	e-book downloading	e-book reading	Waste Management
	Total of all processes		kg PM10 eq	5.36E-02	0.00E+00	5.05E-02	4.45E-04	1.41E-03	8.52E-05	3.24E-04	2.56E-02	1.31E-05
	Remaining processes		kg PM10 eq	1.60E-02	0.00E+00	1.46E-02	8.99E-05	1.22E-03	2.90E-05	9.64E-06	7.63E-04	7.39E-06
1	Electricity, high voltage {CN}| electricity production, hard coal | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg PM10 eq	6.72E-03	0.00E+00	6.60E-03	3.94E-07	1.00E-04	1.45E-05	2.00E-07	1.58E-05	1.59E-06
2	Blasting {RoW}| processing | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg PM10 eq	3.54E-03	0.00E+00	3.52E-03	9.80E-09	6.20E-07	1.65E-06	5.59E-06	4.42E-04	3.05E-08
3	Electricity, high voltage {RoW}| electricity production, hard coal | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg PM10 eq	3.37E-03	0.00E+00	3.35E-03	1.09E-07	4.48E-06	5.57E-06	4.79E-07	3.79E-05	6.02E-07
4	Diesel, burned in building machine {GLO}| processing | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg PM10 eq	3.01E-03	0.00E+00	3.00E-03	3.83E-09	3.79E-07	1.32E-06	9.28E-07	7.34E-05	1.18E-08
5	Electricity, high voltage {ID}| electricity production, lignite | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg PM10 eq	2.77E-03	0.00E+00	2.76E-03	1.26E-07	5.08E-06	5.95E-06	2.28E-07	1.80E-05	6.54E-07
6	Electricity, high voltage {RoW}| electricity production, lignite | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg PM10 eq	2.62E-03	0.00E+00	2.61E-03	6.33E-08	2.61E-06	3.56E-06	3.32E-07	2.63E-05	3.50E-07
7	Heat, district or industrial, other than natural gas {RoW}| heat production, at hard coal industrial furnace 1-10MW | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg PM10 eq	2.14E-03	0.00E+00	2.12E-03	5.47E-08	2.36E-05	1.07E-06	5.55E-07	4.39E-05	1.56E-07
8	Blasting {RER}| processing | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg PM10 eq	1.75E-03	0.00E+00	1.74E-03	4.84E-09	3.06E-07	8.17E-07	2.76E-06	2.18E-04	1.51E-08
9	Electricity, high voltage {IN}| electricity production, hard coal | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg PM10 eq	1.36E-03	0.00E+00	1.35E-03	6.38E-08	2.54E-06	3.03E-06	1.03E-07	8.13E-06	3.34E-07
10	Natural gas, high pressure {RNA}| natural gas production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg PM10 eq	1.23E-03	0.00E+00	1.22E-03	5.53E-08	5.68E-06	2.63E-06	1.46E-07	1.15E-05	2.82E-07
11	Electricity, high voltage {RU}| electricity production, lignite | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg PM10 eq	1.23E-03	0.00E+00	1.22E-03	5.73E-08	2.67E-06	2.72E-06	1.09E-07	8.66E-06	2.93E-07
12	Electricity, high voltage {IN}| electricity production, lignite | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg PM10 eq	1.15E-03	0.00E+00	1.14E-03	5.38E-08	2.14E-06	2.56E-06	8.67E-08	6.86E-06	2.82E-07
13	Electricity, high voltage {ZA IRP}| electricity production, hard coal | Alloc Def, U	Digital vs Print LCA	kg PM10 eq	1.03E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.02E-04	2.39E-02	0.00E+00
14	Electricity, high voltage {TR}| electricity production, lignite | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg PM10 eq	1.02E-03	0.00E+00	1.02E-03	4.80E-08	1.91E-06	2.28E-06	7.70E-08	6.09E-06	2.51E-07
15	Electricity, high voltage {RFC}| electricity production, hard coal | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg PM10 eq	9.70E-04	0.00E+00	9.66E-04	4.55E-08	1.82E-06	2.13E-06	1.15E-07	9.09E-06	2.33E-07
16	Transport, freight, sea, transoceanic ship {GLO}| processing | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg PM10 eq	8.02E-04	0.00E+00	4.45E-04	3.54E-04	1.88E-06	6.60E-07	9.53E-08	7.54E-06	3.88E-08
17	Electricity, high voltage {SERC}| electricity production, hard coal | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg PM10 eq	7.80E-04	0.00E+00	7.76E-04	3.65E-08	1.46E-06	1.71E-06	9.24E-08	7.31E-06	1.87E-07
18	Hard coal {CN}| mine operation | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg PM10 eq	7.60E-04	0.00E+00	7.48E-04	5.35E-08	1.08E-05	1.48E-06	4.64E-08	3.67E-06	1.63E-07
19	Electricity, high voltage, for internal use in coal mining {RoW}| electricity production, hard coal, at coal mine power plant | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg PM10 eq	7.20E-04	0.00E+00	7.08E-04	5.06E-08	1.02E-05	1.40E-06	4.39E-08	3.47E-06	1.55E-07
20	Electricity, high voltage, for internal use in coal mining {CN}| electricity production, hard coal, at coal mine power plant | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg PM10 eq	5.92E-04	0.00E+00	5.82E-04	4.16E-08	8.41E-06	1.15E-06	3.61E-08	2.85E-06	1.27E-07

Digital System IRP SimaPro LCA Results

Calculation: Analyze
Results: Process contribution
1 p Apple Air iPad IRP (of project Digital vs Print
Product: LCA)
Method: ReCiPe Midpoint (H) V1.09 / Europe Recipe H
Indicator: Characterization
Category: Terrestrial ecotoxicity
Cut-off: 1%
Mode: Group
Exclude infrastructure processes: Yes
Exclude long-term emissions: Yes
Sorted on item: Total
Sort order: Descending

No	Process	Project	Unit	Total	Top	Production	Apple Air iPad distribution transportation	Retail transportation	e-book formatting	e-book downloading	e-book reading	Waste Management
	Total of all processes		kg 1,4-DB eq	2.28E-03	0.00E+00	1.96E-03	5.43E-06	3.01E-04	4.28E-06	1.86E-06	1.47E-04	7.38E-07
	Remaining processes		kg 1,4-DB eq	6.66E-04	0.00E+00	6.00E-04	5.40E-06	5.20E-05	1.82E-06	1.76E-06	1.39E-04	6.01E-07
1	Copper {RoW}| production, primary | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	1.78E-04	0.00E+00	1.77E-04	4.83E-11	8.92E-09	2.08E-07	1.20E-10	9.51E-09	1.23E-10
2	Natural gas, unprocessed, at extraction {RNA}| production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	1.75E-04	0.00E+00	1.73E-04	7.72E-09	9.33E-07	3.69E-07	1.98E-08	1.57E-06	3.92E-08
3	Gold {RoW}| -silver mine operation with refinery | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	1.74E-04	0.00E+00	1.74E-04	2.52E-14	1.58E-11	5.93E-08	8.98E-13	7.11E-11	4.50E-13
4	Brake wear emissions, passenger car {RoW}| treatment of | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	1.54E-04	0.00E+00	2.35E-09	4.17E-14	1.54E-04	3.28E-12	1.23E-12	9.71E-11	1.45E-13
5	Electricity, high voltage {DE}| heat and power co-generation, biogas, gas engine | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	1.12E-04	0.00E+00	1.11E-04	8.45E-09	7.11E-07	3.52E-07	8.23E-09	6.51E-07	2.61E-08
6	Copper {RAS}| production, primary | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	9.36E-05	0.00E+00	9.35E-05	2.54E-11	4.70E-09	1.10E-07	6.33E-11	5.01E-09	6.51E-11
7	Spent solvent mixture {RoW}| treatment of, hazardous waste incineration | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	9.32E-05	0.00E+00	9.31E-05	1.29E-12	9.05E-11	1.01E-07	3.26E-12	2.58E-10	5.11E-13
8	Copper {RLA}| production, primary | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	7.86E-05	0.00E+00	7.85E-05	2.14E-11	3.94E-09	9.21E-08	5.32E-11	4.21E-09	5.46E-11
9	Sugarcane {BR}| production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	7.63E-05	0.00E+00	7.60E-05	3.57E-09	1.75E-07	1.67E-07	6.42E-09	5.08E-07	1.83E-08
10	Brake wear emissions, passenger car {RER}| treatment of | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	5.65E-05	0.00E+00	8.63E-10	1.53E-14	5.65E-05	1.20E-12	4.50E-13	3.56E-11	5.31E-14
11	Electricity, high voltage {GB}| heat and power co-generation, biogas, gas engine | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	5.53E-05	0.00E+00	5.48E-05	3.23E-09	2.99E-07	1.76E-07	3.42E-09	2.71E-07	1.31E-08
12	Sugarcane {BR}| production, on land recently transformed | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	5.52E-05	0.00E+00	5.49E-05	2.58E-09	1.26E-07	1.20E-07	4.64E-09	3.67E-07	1.33E-08
13	Electricity, high voltage {CN}| electricity production, hard coal | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	5.29E-05	0.00E+00	5.20E-05	3.10E-09	7.90E-07	1.14E-07	1.58E-09	1.25E-07	1.25E-08
14	Waste plastic, consumer electronics {RoW}| treatment of, municipal incineration | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	4.86E-05	0.00E+00	4.85E-05	2.67E-13	6.40E-11	4.30E-08	6.55E-12	5.19E-10	8.57E-13
15	Electricity, high voltage {RoW}| heat and power co-generation, biogas, gas engine | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	4.35E-05	0.00E+00	4.33E-05	2.06E-09	8.49E-08	9.53E-08	7.45E-09	5.90E-07	1.14E-08
16	Printed wiring board, for surface mounting, Pb free surface {GLO}| production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	4.13E-05	0.00E+00	4.08E-05	1.52E-13	9.68E-11	4.25E-07	8.62E-12	6.82E-10	4.37E-12
17	Transport, passenger car, medium size, petrol, EURO 3 {RoW}| transport, passenger car, medium size, petrol, EURO 3 | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	3.52E-05	0.00E+00	4.97E-11	8.78E-16	3.52E-05	6.92E-14	2.59E-14	2.05E-12	3.05E-15
18	Phosphorus pentachloride {RoW}| production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	3.47E-05	0.00E+00	3.47E-05	1.04E-13	1.32E-11	2.92E-11	5.59E-13	4.42E-11	2.63E-13
19	Heat, district or industrial, other than natural gas {RoW}| heat production, heavy fuel oil, at industrial furnace 1MW | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	3.24E-05	0.00E+00	3.21E-05	6.85E-10	2.95E-07	1.61E-08	7.33E-09	5.80E-07	1.99E-09
20	Nitrogen fertiliser, as N {GLO}| field application of compost | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	2.51E-05	0.00E+00	2.50E-05	8.58E-11	5.92E-09	1.47E-08	3.90E-08	3.08E-06	2.70E-10

Digital System IRP SimaPro LCA Results

Calculation: Analyze
Results: Process contribution
1 p Apple Air iPad IRP (of project Digital vs Print
Product: LCA)
Method: ReCiPe Midpoint (H) V1.09 / Europe Recipe H
Indicator: Characterization
Category: Freshwater ecotoxicity
Cut-off: 1%
Mode: Group
Exclude infrastructure processes: Yes
Exclude long-term emissions: Yes
Sorted on item: Total
Sort order: Descending

No	Process	Project	Unit	Total	Top	Production	Apple Air iPad distribution transportation	Retail transportation	e-book formatting	e-book downloading	e-book reading	Waste Management
	Total of all processes		kg 1,4-DB eq	2.05E-01	0.00E+00	2.04E-01	1.99E-05	5.20E-04	1.11E-04	9.75E-06	7.72E-04	5.97E-05
	Remaining processes		kg 1,4-DB eq	4.14E-03	0.00E+00	3.56E-03	1.93E-05	4.54E-04	1.53E-05	8.36E-06	6.61E-04	5.69E-05
1	Gold {RoW}| -silver mine operation with refinery | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	1.77E-01	0.00E+00	1.77E-01	2.57E-11	1.61E-08	6.05E-05	9.16E-10	7.25E-08	4.59E-10
2	Natural gas, unprocessed, at extraction {RNA}| production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	1.23E-02	0.00E+00	1.22E-02	5.44E-07	6.57E-05	2.60E-05	1.39E-06	1.10E-04	2.76E-06
3	Spent solvent mixture {RoW}| treatment of, hazardous waste incineration | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	5.35E-03	0.00E+00	5.34E-03	7.40E-11	5.19E-09	5.80E-06	1.87E-10	1.48E-08	2.93E-11
4	Waste plastic, consumer electronics {RoW}| treatment of, municipal incineration | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	3.15E-03	0.00E+00	3.14E-03	1.73E-11	4.14E-09	2.79E-06	4.25E-10	3.36E-08	5.55E-11
5	Sulfidic tailing, off-site {GLO}| treatment of | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	2.81E-03	0.00E+00	2.81E-03	9.24E-11	5.48E-08	1.11E-06	4.30E-10	3.40E-08	1.63E-10

Calculation: Analyze
Results: Process contribution
1 p Apple Air iPad IRP (of project Digital vs Print
Product: LCA)
Method: ReCiPe Midpoint (H) V1.09 / Europe Recipe H
Indicator: Characterization
Category: Marine ecotoxicity
Cut-off: 1%
Mode: Group
Exclude infrastructure processes: Yes
Exclude long-term emissions: Yes
Sorted on item: Total
Sort order: Descending

No	Process	Project	Unit	Total	Top	Production	Apple Air iPad distribution transportation	Retail transportation	e-book formatting	e-book downloading	e-book reading	Waste Management
	Total of all processes		kg 1,4-DB eq	2.69E-01	0.00E+00	2.66E-01	2.27E-04	2.49E-03	1.38E-04	2.98E-05	2.36E-03	3.43E-05
	Remaining processes		kg 1,4-DB eq	1.58E-02	0.00E+00	1.30E-02	2.27E-04	2.47E-03	2.86E-05	2.94E-05	2.32E-03	3.35E-05
1	Gold {RoW}| -silver mine operation with refinery | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	2.30E-01	0.00E+00	2.30E-01	3.33E-11	2.09E-08	7.84E-05	1.19E-09	9.40E-08	5.95E-10
2	Copper {RoW}| production, primary | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	1.01E-02	0.00E+00	1.00E-02	2.73E-09	5.05E-07	1.18E-05	6.80E-09	5.38E-07	6.99E-09
3	Copper {RAS}| production, primary | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	5.32E-03	0.00E+00	5.31E-03	1.44E-09	2.67E-07	6.23E-06	3.60E-09	2.85E-07	3.69E-09
4	Copper {RLA}| production, primary | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	4.46E-03	0.00E+00	4.46E-03	1.21E-09	2.24E-07	5.23E-06	3.02E-09	2.39E-07	3.10E-09
5	Natural gas, unprocessed, at extraction {RNA}| production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg 1,4-DB eq	3.48E-03	0.00E+00	3.45E-03	1.54E-07	1.86E-05	7.34E-06	3.94E-07	3.11E-05	7.79E-07

Digital System IRP SimaPro LCA Results

Calculation: Analyze
Results: Process contribution
1 p Apple Air iPad IRP (of project Digital vs Print
Product: LCA)
Method: ReCiPe Midpoint (H) V1.09 / Europe Recipe H
Indicator: Characterization
Category: Ionising radiation
Cut-off: 1%
Mode: Group
Exclude infrastructure processes: Yes
Exclude long-term emissions: Yes
Sorted on item: Total
Sort order: Descending

No	Process	Project	Unit	Total	Top	Production	Apple Air iPad distribution transportation	Retail transportation	e-book formatting	e-book downloading	e-book reading	Waste Management
	Total of all processes		kBq U235 eq	1.20E+00	0.00E+00	1.03E+00	5.05E-03	1.37E-01	2.35E-03	7.91E-03	6.25E-01	2.29E-04
	Remaining processes		kBq U235 eq	1.81E-01	0.00E+00	1.67E-01	2.36E-03	9.34E-04	4.13E-04	3.00E-03	2.37E-01	3.89E-05
1	Low level radioactive waste {CH}| treatment of, plasma torch incineration | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kBq U235 eq	4.06E-01	0.00E+00	2.64E-01	2.65E-03	1.34E-01	5.21E-04	1.47E-03	1.16E-01	4.65E-05
2	Spent nuclear fuel {RoW}| treatment of, reprocessing | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kBq U235 eq	2.51E-01	0.00E+00	2.40E-01	1.66E-05	1.05E-03	6.06E-04	2.75E-03	2.18E-01	5.73E-05
3	Electricity, high voltage {JP}| electricity production, nuclear, boiling water reactor | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kBq U235 eq	6.03E-02	0.00E+00	6.00E-02	2.82E-06	1.12E-04	1.32E-04	4.50E-06	3.56E-04	1.44E-05
4	Electricity, high voltage {RoW}| electricity production, nuclear, boiling water reactor | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kBq U235 eq	4.86E-02	0.00E+00	4.84E-02	2.18E-06	8.98E-05	1.02E-04	8.10E-06	6.41E-04	1.21E-05
5	Electricity, high voltage {SERC}| electricity production, nuclear, boiling water reactor | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kBq U235 eq	4.39E-02	0.00E+00	4.37E-02	2.06E-06	8.23E-05	9.61E-05	5.20E-06	4.11E-04	1.05E-05
6	Electricity, high voltage {RFC}| electricity production, nuclear, boiling water reactor | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kBq U235 eq	4.00E-02	0.00E+00	3.98E-02	1.87E-06	7.51E-05	8.77E-05	4.74E-06	3.75E-04	9.61E-06
7	Electricity, high voltage {RU}| electricity production, nuclear, boiling water reactor | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kBq U235 eq	3.46E-02	0.00E+00	3.44E-02	1.62E-06	7.55E-05	7.67E-05	3.67E-06	2.90E-04	8.26E-06
8	Uranium ore, as U {RNA}| uranium mine operation, underground | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kBq U235 eq	3.00E-02	0.00E+00	2.87E-02	1.97E-06	1.24E-04	7.21E-05	3.38E-04	2.67E-02	6.85E-06
9	Uranium ore, as U {RoW}| uranium mine operation, underground | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kBq U235 eq	2.84E-02	0.00E+00	2.71E-02	1.86E-06	1.17E-04	6.80E-05	3.19E-04	2.52E-02	6.47E-06
10	Electricity, high voltage {RoW}| electricity production, nuclear, pressure water reactor | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kBq U235 eq	2.50E-02	0.00E+00	2.48E-02	1.12E-06	4.62E-05	5.25E-05	4.16E-06	3.29E-04	6.21E-06
11	Electricity, high voltage {SE}| electricity production, nuclear, boiling water reactor | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kBq U235 eq	2.08E-02	0.00E+00	2.06E-02	1.21E-06	1.12E-04	6.65E-05	1.22E-06	9.61E-05	4.91E-06
12	Electricity, high voltage {SERC}| electricity production, nuclear, pressure water reactor | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kBq U235 eq	1.43E-02	0.00E+00	1.42E-02	6.71E-07	2.69E-05	3.14E-05	1.70E-06	1.34E-04	3.44E-06
13	Electricity, high voltage {RFC}| electricity production, nuclear, pressure water reactor | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kBq U235 eq	1.31E-02	0.00E+00	1.30E-02	6.12E-07	2.45E-05	2.86E-05	1.55E-06	1.22E-04	3.14E-06

Digital System IRP SimaPro LCA Results

Calculation: Analyze
Results: Process contribution
1 p Apple Air iPad IRP (of project Digital vs Print
Product: LCA)
Method: ReCiPe Midpoint (H) V1.09 / Europe Recipe H
Indicator: Characterization
Category: Agricultural land occupation
Cut-off: 1%
Mode: Group
Exclude infrastructure processes: Yes
Exclude long-term emissions: Yes
Sorted on item: Total
Sort order: Descending

No	Process	Project	Unit	Total	Top	Production	Apple Air iPad distribution transportation	Retail transportation	e-book formatting	e-book downloading	e-book reading	Waste Management
	Total of all processes		m2a	5.42E-01	0.00E+00	5.37E-01	7.22E-04	2.64E-03	6.37E-04	7.78E-05	6.15E-03	4.56E-05
	Remaining processes		m2a	3.88E-02	0.00E+00	3.79E-02	6.85E-04	1.41E-04	6.84E-05	6.34E-06	5.02E-04	5.08E-06
1	Softwood, CO2-removal and land use {RoW}| softwood forestry, CO2-removal and land use | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	m2a	1.77E-01	0.00E+00	1.75E-01	1.48E-05	9.42E-04	1.80E-04	2.75E-05	2.18E-03	1.15E-05
2	Hardwood, CO2-removal and land use {RoW}| hardwood forestry, CO2-removal and land use | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	m2a	1.65E-01	0.00E+00	1.64E-01	8.86E-06	6.89E-04	2.11E-04	1.92E-05	1.52E-03	1.74E-05
3	Softwood, CO2-removal and land use {NORDEL}| softwood forestry, CO2-removal and land use | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	m2a	7.77E-02	0.00E+00	7.71E-02	6.49E-06	4.14E-04	7.92E-05	1.21E-05	9.58E-04	5.07E-06
4	Softwood, CO2-removal and land use {Europe without NORDEL (NCPA)}| softwood forestry, CO2-removal and land use | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	m2a	7.77E-02	0.00E+00	7.71E-02	6.49E-06	4.14E-04	7.92E-05	1.21E-05	9.58E-04	5.07E-06
5	Electricity, high voltage {DE}| heat and power co-generation, biogas, gas engine | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	m2a	6.09E-03	0.00E+00	6.02E-03	4.58E-07	3.85E-05	1.91E-05	4.46E-07	3.53E-05	1.41E-06

Calculation: Analyze
Results: Process contribution
1 p Apple Air iPad IRP (of project Digital vs Print
Product: LCA)
Method: ReCiPe Midpoint (H) V1.09 / Europe Recipe H
Indicator: Characterization
Category: Urban land occupation
Cut-off: 1%
Mode: Group
Exclude infrastructure processes: Yes
Exclude long-term emissions: Yes
Sorted on item: Total
Sort order: Descending

No	Process	Project	Unit	Total	Top	Production	Apple Air iPad distribution transportation	Retail transportation	e-book formatting	e-book downloading	e-book reading	Waste Management
	Total of all processes		m2a	2.10E-01	0.00E+00	2.05E-01	2.63E-03	5.69E-04	2.43E-04	3.52E-04	2.79E-02	1.76E-05
	Remaining processes		m2a	2.28E-02	0.00E+00	2.15E-02	1.16E-06	9.13E-05	5.75E-05	3.45E-04	2.73E-02	2.47E-06
1	Sulfidic tailing, off-site {GLO}| treatment of | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	m2a	1.13E-01	0.00E+00	1.13E-01	3.71E-09	2.20E-06	4.47E-05	1.73E-08	1.37E-06	6.55E-09
2	Hard coal {CN}| mine operation | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	m2a	2.45E-02	0.00E+00	2.41E-02	1.72E-06	3.48E-04	4.77E-05	1.49E-06	1.18E-04	5.26E-06
3	Hard coal {RNA}| mine operation | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	m2a	1.89E-02	0.00E+00	1.88E-02	1.03E-06	5.12E-05	3.92E-05	2.38E-06	1.88E-04	4.31E-06
4	Hard coal {ID}| mine operation | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	m2a	1.54E-02	0.00E+00	1.53E-02	5.55E-07	2.55E-05	2.55E-05	2.17E-06	1.72E-04	2.76E-06
5	Hard coal {RoW}| mine operation | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	m2a	1.28E-02	0.00E+00	1.27E-02	7.98E-07	5.13E-05	2.81E-05	1.21E-06	9.55E-05	2.82E-06
6	Transport, freight, lorry 16-32 metric ton, EURO4 {GLO}| market for | Alloc Def, S	Ecoinvent 3 - allocation, default - system	m2a	2.63E-03	0.00E+00	0.00E+00	2.63E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Digital System IRP SimaPro LCA Results

Calculation: Analyze
Results: Process contribution
1 p Apple Air iPad IRP (of project Digital vs Print
Product: LCA)
Method: ReCiPe Midpoint (H) V1.09 / Europe Recipe H
Indicator: Characterization
Category: Natural land transformation
Cut-off: 1%
Mode: Group
Exclude infrastructure processes: Yes
Exclude long-term emissions: Yes
Sorted on item: Total
Sort order: Descending

No	Process	Project	Unit	Total	Top	Production	Apple Air iPad distribution transportation	Retail transportation	e-book formatting	e-book downloading	e-book reading	Waste Management
	Total of all processes		m2	9.64E-04	0.00E+00	9.40E-04	1.25E-05	3.07E-06	1.42E-06	2.10E-06	1.66E-04	1.08E-07
	Remaining processes		m2	1.51E-04	0.00E+00	1.43E-04	9.92E-09	7.00E-07	3.37E-07	2.05E-06	1.62E-04	2.15E-08
1	Sulfidic tailing, off-site {GLO}| treatment of | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	m2	3.48E-04	0.00E+00	3.48E-04	1.14E-11	6.78E-09	1.38E-07	5.31E-11	4.20E-09	2.02E-11
2	Hard coal {CN}| mine operation | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	m2	8.16E-05	0.00E+00	8.03E-05	5.74E-09	1.16E-06	1.59E-07	4.98E-09	3.94E-07	1.75E-08
3	Electricity, high voltage {BR}| electricity production, hydro, reservoir, tropical region | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	m2	7.44E-05	0.00E+00	7.40E-05	3.48E-09	1.38E-07	1.66E-07	5.66E-09	4.48E-07	1.83E-08
4	Hard coal {RNA}| mine operation | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	m2	6.09E-05	0.00E+00	6.06E-05	3.32E-09	1.65E-07	1.26E-07	7.65E-09	6.05E-07	1.39E-08
5	Hard coal {ID}| mine operation | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	m2	5.13E-05	0.00E+00	5.11E-05	1.85E-09	8.52E-08	8.51E-08	7.26E-09	5.74E-07	9.21E-09
6	Tin {RoW}| production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	m2	4.83E-05	0.00E+00	4.82E-05	2.55E-11	3.12E-09	1.08E-07	5.53E-11	4.38E-09	6.31E-11
7	Hard coal {RoW}| mine operation | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	m2	4.24E-05	0.00E+00	4.21E-05	2.65E-09	1.70E-07	9.31E-08	4.01E-09	3.17E-07	9.35E-09
8	Electricity, high voltage {CN}| electricity production, hydro, reservoir, non-alpine region | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	m2	3.82E-05	0.00E+00	3.75E-05	2.24E-09	5.70E-07	8.24E-08	1.14E-09	8.99E-08	9.04E-09
9	Tin {RER}| production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	m2	2.39E-05	0.00E+00	2.38E-05	1.26E-11	1.54E-09	5.32E-08	2.73E-11	2.16E-09	3.12E-11
10	Electricity, high voltage {RoW}| electricity production, hydro, reservoir, tropical region | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	m2	1.43E-05	0.00E+00	1.43E-05	6.80E-10	2.80E-08	3.14E-08	2.46E-09	1.94E-07	3.76E-09
11	Electricity, high voltage {RoW}| electricity production, hydro, reservoir, non-alpine region | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	m2	1.42E-05	0.00E+00	1.41E-05	8.53E-10	3.76E-08	3.14E-08	8.87E-09	7.02E-07	3.64E-09
12	Bauxite, without water {GLO}| bauxite mine operation | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	m2	1.35E-05	0.00E+00	1.35E-05	4.29E-12	4.41E-10	6.43E-09	1.09E-09	8.63E-08	1.35E-10
13	Transport, freight, lorry 16-32 metric ton, EURO4 {GLO}| market for | Alloc Def, S	Ecoinvent 3 - allocation, default - system	m2	1.24E-05	0.00E+00	0.00E+00	1.24E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
14	Lignite {RoW}| mine operation | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	m2	9.66E-06	0.00E+00	9.62E-06	4.35E-10	1.54E-08	1.76E-08	9.72E-10	7.69E-08	1.87E-09
15	Recultivation, bauxite mine {GLO}| processing | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	m2	-1.95E-05	0.00E+00	-1.95E-05	-1.13E-10	-6.51E-09	-1.09E-08	-1.55E-09	-1.22E-07	-2.75E-10

Digital System IRP SimaPro LCA Results

Calculation: Analyze
Results: Process contribution
1 p Apple Air iPad IRP (of project Digital vs Print
Product: LCA)
Method: ReCiPe Midpoint (H) V1.09 / Europe Recipe H
Indicator: Characterization
Category: Water depletion
Cut-off: 1%
Mode: Group
Exclude infrastructure processes: Yes
Exclude long-term emissions: Yes
Sorted on item: Total
Sort order: Descending

No	Process	Project	Unit	Total	Top	Production	Apple Air iPad distribution transportation	Retail transportation	e-book formatting	e-book downloading	e-book reading	Waste Management
	Total of all processes		m3	7.93E+01	0.00E+00	7.85E+01	2.74E-02	3.13E-01	1.67E-01	8.43E-02	6.67E+00	1.59E-02
	Remaining processes		m3	1.28E+01	0.00E+00	1.24E+01	2.44E-02	4.94E-02	3.24E-02	7.66E-02	6.06E+00	2.93E-03
1	Electricity, high voltage {RoW}| electricity production, hydro, run-of-river | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	m3	2.05E+01	0.00E+00	2.05E+01	3.60E-04	1.54E-02	2.79E-02	2.40E-03	1.90E-01	1.98E-03
2	Electricity, high voltage {CN}| electricity production, hydro, run-of-river | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	m3	6.22E+00	0.00E+00	6.11E+00	3.65E-04	9.29E-02	1.34E-02	1.85E-04	1.47E-02	1.47E-03
3	Electricity, high voltage {RU}| electricity production, hydro, run-of-river | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	m3	5.63E+00	0.00E+00	5.60E+00	2.63E-04	1.23E-02	1.25E-02	5.03E-04	3.98E-02	1.34E-03
4	Electricity, high voltage {WECC, US only}| electricity production, hydro, run-of-river | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	m3	5.50E+00	0.00E+00	5.47E+00	2.58E-04	1.03E-02	1.20E-02	6.53E-04	5.16E-02	1.32E-03
5	Electricity, high voltage {CN}| electricity production, hydro, reservoir, non-alpine region | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	m3	3.36E+00	0.00E+00	3.30E+00	1.97E-04	5.02E-02	7.26E-03	1.00E-04	7.92E-03	7.96E-04
6	Electricity, high voltage {BR}| electricity production, hydro, reservoir, tropical region | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	m3	2.62E+00	0.00E+00	2.61E+00	1.22E-04	4.87E-03	5.83E-03	1.99E-04	1.58E-02	6.43E-04
7	Electricity, high voltage {JP}| electricity production, hydro, run-of-river | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	m3	2.54E+00	0.00E+00	2.52E+00	1.18E-04	4.72E-03	5.54E-03	1.89E-04	1.50E-02	6.07E-04
8	Electricity, high voltage {Quebec}| electricity production, hydro, run-of-river | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	m3	2.37E+00	0.00E+00	2.36E+00	1.11E-04	4.44E-03	5.21E-03	1.99E-04	1.58E-02	5.74E-04
9	Electricity, high voltage {FR}| electricity production, hydro, run-of-river | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	m3	2.32E+00	0.00E+00	2.28E+00	4.00E-04	2.58E-02	7.20E-03	1.35E-03	1.07E-01	5.06E-04
10	Electricity, high voltage {SE}| electricity production, hydro, run-of-river | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	m3	2.32E+00	0.00E+00	2.30E+00	1.35E-04	1.25E-02	7.42E-03	1.36E-04	1.07E-02	5.47E-04
11	Electricity, high voltage {CA-BC}| electricity production, hydro, run-of-river | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	m3	2.28E+00	0.00E+00	2.27E+00	1.07E-04	4.27E-03	5.01E-03	1.89E-04	1.49E-02	5.52E-04
12	Electricity, high voltage {CA-MB}| electricity production, hydro, run-of-river | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	m3	1.79E+00	0.00E+00	1.78E+00	8.35E-05	3.34E-03	3.92E-03	1.50E-04	1.19E-02	4.31E-04
13	Electricity, high voltage {MX}| electricity production, hydro, run-of-river | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	m3	1.67E+00	0.00E+00	1.66E+00	7.79E-05	3.10E-03	3.72E-03	1.25E-04	9.89E-03	4.11E-04
14	Electricity, high voltage {CA-ON}| electricity production, hydro, run-of-river | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	m3	1.48E+00	0.00E+00	1.47E+00	6.92E-05	2.77E-03	3.26E-03	1.20E-04	9.52E-03	3.59E-04
15	Electricity, high voltage {SERC}| electricity production, hydro, run-of-river | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	m3	1.30E+00	0.00E+00	1.29E+00	6.09E-05	2.44E-03	2.85E-03	1.54E-04	1.22E-02	3.12E-04
16	Electricity, high voltage {RoW}| electricity production, hydro, reservoir, non-alpine region | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	m3	1.25E+00	0.00E+00	1.24E+00	7.51E-05	3.31E-03	2.77E-03	7.81E-04	6.18E-02	3.20E-04
17	Electricity, high voltage {AT}| electricity production, hydro, run-of-river | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	m3	1.18E+00	0.00E+00	1.17E+00	9.00E-05	7.64E-03	3.72E-03	8.36E-05	6.62E-03	2.77E-04
18	Electricity, high voltage {NPCC, US only}| electricity production, hydro, run-of-river | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	m3	1.06E+00	0.00E+00	1.05E+00	4.95E-05	1.99E-03	2.32E-03	1.33E-04	1.05E-02	2.55E-04
19	Electricity, high voltage {CL}| electricity production, hydro, run-of-river | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	m3	1.03E+00	0.00E+00	1.03E+00	4.78E-05	1.89E-03	2.27E-03	7.59E-05	6.00E-03	2.47E-04

Digital System IRP SimaPro LCA Results

Calculation: Analyze
Results: Process contribution
1 p Apple Air iPad IRP (of project Digital vs Print
Product: LCA)
Method: ReCiPe Midpoint (H) V1.09 / Europe Recipe H
Indicator: Characterization
Category: Metal depletion
Cut-off: 1%
Mode: Group
Exclude infrastructure processes: Yes
Exclude long-term emissions: Yes
Sorted on item: Total
Sort order: Descending

No	Process	Project	Unit	Total	Top	Production	Apple Air iPad distribution transportation	Retail transportation	e-book formatting	e-book downloading	e-book reading	Waste Management
	Total of all processes		kg Fe eq	1.52E+01	0.00E+00	1.52E+01	2.23E-03	1.87E-03	9.77E-03	1.11E-04	8.77E-03	1.75E-05
	Remaining processes		kg Fe eq	8.75E-01	0.00E+00	8.69E-01	2.23E-03	1.72E-03	1.69E-03	1.08E-04	8.58E-03	1.49E-05
1	Gold {RoW}| -silver mine operation with refinery | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg Fe eq	1.06E+01	0.00E+00	1.05E+01	1.53E-09	9.60E-07	3.60E-03	5.45E-08	4.32E-06	2.73E-08
2	Manganese concentrate {GLO}| production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg Fe eq	1.49E+00	0.00E+00	1.49E+00	5.77E-08	1.02E-05	4.62E-04	3.00E-07	2.37E-05	2.23E-07
3	Tin {RoW}| production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg Fe eq	8.66E-01	0.00E+00	8.64E-01	4.56E-07	5.60E-05	1.93E-03	9.92E-07	7.85E-05	1.13E-06
4	Copper concentrate {RoW}| copper mine operation | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg Fe eq	7.58E-01	0.00E+00	7.58E-01	2.06E-07	3.81E-05	8.89E-04	5.14E-07	4.07E-05	5.31E-07
5	Tin {RER}| production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg Fe eq	4.28E-01	0.00E+00	4.27E-01	2.25E-07	2.76E-05	9.54E-04	4.90E-07	3.88E-05	5.59E-07
6	Copper concentrate {RAS}| copper mine operation | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg Fe eq	2.00E-01	0.00E+00	1.99E-01	5.43E-08	1.00E-05	2.34E-04	1.35E-07	1.07E-05	1.40E-07

Calculation: Analyze
Results: Process contribution
1 p Apple Air iPad IRP (of project Digital vs Print
Product: LCA)
Method: ReCiPe Midpoint (H) V1.09 / Europe Recipe H
Indicator: Characterization
Category: Fossil depletion
Cut-off: 1%
Mode: Group
Exclude infrastructure processes: Yes
Exclude long-term emissions: Yes
Sorted on item: Total
Sort order: Descending

No	Process	Project	Unit	Total	Top	Production	Apple Air iPad distribution transportation	Retail transportation	e-book formatting	e-book downloading	e-book reading	Waste Management
	Total of all processes		kg oil eq	5.85E+00	0.00E+00	4.78E+00	3.21E-02	9.21E-01	9.01E-03	3.42E-02	2.70E+00	8.57E-04
	Remaining processes		kg oil eq	1.02E+00	0.00E+00	8.18E-01	1.78E-02	1.85E-01	1.50E-03	2.41E-04	1.91E-02	9.81E-05
1	Petroleum {RoW}| and gas production, off-shore | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg oil eq	8.29E-01	0.00E+00	3.80E-01	8.68E-03	4.38E-01	5.22E-04	5.12E-04	4.05E-02	4.03E-05
2	Hard coal {CN}| mine operation | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg oil eq	6.79E-01	0.00E+00	6.68E-01	4.78E-05	9.65E-03	1.33E-03	4.14E-05	3.28E-03	1.46E-04
3	Hard coal {RNA}| mine operation | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg oil eq	5.63E-01	0.00E+00	5.60E-01	3.06E-05	1.52E-03	1.17E-03	7.07E-05	5.59E-03	1.28E-04
4	Hard coal {ID}| mine operation | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg oil eq	3.93E-01	0.00E+00	3.91E-01	1.42E-05	6.51E-04	6.51E-04	5.55E-05	4.39E-03	7.05E-05
5	Hard coal {RoW}| mine operation | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg oil eq	3.91E-01	0.00E+00	3.88E-01	2.44E-05	1.57E-03	8.58E-04	3.69E-05	2.92E-03	8.62E-05
6	Natural gas, unprocessed, at extraction {RNA}| production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg oil eq	3.60E-01	0.00E+00	3.57E-01	1.59E-05	1.92E-03	7.60E-04	4.08E-05	3.22E-03	8.07E-05
7	Petroleum {RoW}| and gas production, on-shore | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg oil eq	2.79E-01	0.00E+00	1.28E-01	2.92E-03	1.47E-01	1.76E-04	1.72E-04	1.36E-02	1.36E-05
8	Natural gas, high pressure {RU}| natural gas production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg oil eq	1.92E-01	0.00E+00	1.91E-01	7.91E-06	1.21E-03	3.94E-04	1.93E-05	1.53E-03	3.68E-05
9	Petroleum {RoW}| gas and petroleum production, off-shore | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg oil eq	1.86E-01	0.00E+00	8.51E-02	1.94E-03	9.81E-02	1.17E-04	1.15E-04	9.08E-03	9.03E-06
10	Hard coal {ZA}| mine operation | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg oil eq	1.80E-01	0.00E+00	6.71E-02	1.47E-05	8.02E-04	1.31E-04	3.27E-02	2.59E+00	1.44E-05
11	Lignite {RoW}| mine operation | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg oil eq	1.47E-01	0.00E+00	1.46E-01	6.61E-06	2.34E-04	2.68E-04	1.48E-05	1.17E-03	2.85E-05
12	Lignite {RER}| mine operation | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg oil eq	9.64E-02	0.00E+00	9.55E-02	6.40E-06	5.62E-04	3.05E-04	6.26E-06	4.95E-04	2.28E-05
13	Natural gas, high pressure {RoW}| gas and petroleum production, off-shore | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg oil eq	9.31E-02	0.00E+00	9.21E-02	3.87E-06	7.78E-04	1.90E-04	8.65E-06	6.84E-04	1.90E-05
14	Polystyrene, general purpose {RoW}| production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg oil eq	7.95E-02	0.00E+00	7.95E-02	2.39E-10	2.59E-08	1.01E-08	2.40E-09	1.90E-07	6.43E-10
15	Natural gas, high pressure {RoW}| natural gas production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg oil eq	7.95E-02	0.00E+00	7.86E-02	3.31E-06	6.64E-04	1.62E-04	7.39E-06	5.84E-04	1.62E-05
16	Hard coal {AU}| mine operation | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg oil eq	7.93E-02	0.00E+00	7.88E-02	5.12E-06	3.02E-04	1.52E-04	8.30E-06	6.57E-04	1.67E-05
17	Natural gas, high pressure {DE}| natural gas production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg oil eq	7.89E-02	0.00E+00	7.85E-02	2.99E-06	2.04E-04	1.55E-04	1.04E-05	8.22E-04	1.64E-05
18	Natural gas, high pressure {GB}| petroleum and gas production, off-shore | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg oil eq	6.63E-02	0.00E+00	6.58E-02	2.51E-06	3.63E-04	1.45E-04	5.39E-06	4.26E-04	1.13E-05
19	Petroleum {GB}| and gas production, off-shore | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	kg oil eq	6.04E-02	0.00E+00	2.77E-02	6.33E-04	3.19E-02	3.81E-05	3.73E-05	2.95E-03	2.94E-06

Digital System IRP SimaPro LCA Results

Calculation: Analyze
Results: Impact assessment
Product: 1 p Apple Air iPad IRP (of project Digital vs Print LCA)
Method: Cumulative Energy Demand V1.08 / Cumulative energy demand
Indicator: Characterization
Skip categories: Never
Mode: Group
Exclude infrastructure processes: Yes
Exclude long-term emissions: Yes
Sorted on item: Total
Sort order: Descending

Impact category	Unit	Total	Top	Production	Apple Air iPad distribution transportation	Retail transportation	e-book formatting	e-book downloading	e-book reading	Waste Management
Non renewable, fossil	MJ	2.62E+02	0.00E+00	2.14E+02	1.44E+00	4.12E+01	4.04E-01	1.50E+00	1.19E+02	3.84E-02
Non-renewable, nuclear	MJ	3.91E+01	0.00E+00	3.74E+01	1.88E-02	1.72E-01	9.27E-02	4.29E-01	3.39E+01	8.71E-03
Renewable, water	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Renewable, wind, solar, geothe	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Renewable, biomass	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Non-renewable, biomass	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Digital System IRP SimaPro LCA Results

Calculation: Analyze
Results: Process contribution
Product: 1 p Apple Air iPad IRP (of project Digital vs Print LCA)
Method: Cumulative Energy Demand V1.08 / Cumulative energy demand
Indicator: Characterization
Category: Non renewable, fossil
Cut-off: 1%
Mode: Group
Exclude infrastructure processes: Yes
Exclude long-term emissions: Yes
Sorted on item: Total
Sort order: Descending

No	Process	Project	Unit	Total	Top	Production	Apple Air iPad distribution transportation	Retail transportation	e-book formatting	e-book downloading	e-book reading	Waste Management
	Total of all processes		MJ	2.62E+02	0.00E+00	2.14E+02	1.44E+00	4.12E+01	4.04E-01	1.50E+00	1.19E+02	3.84E-02
	Remaining processes		MJ	4.63E+01	0.00E+00	3.71E+01	7.95E-01	8.29E+00	6.80E-02	1.08E-02	8.57E-01	4.47E-03
1	Petroleum {RoW}| and gas production, off-shore | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	MJ	3.69E+01	0.00E+00	1.69E+01	3.86E-01	1.95E+01	2.32E-02	2.28E-02	1.80E+00	1.79E-03
2	Hard coal {CN}| mine operation | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	MJ	2.99E+01	0.00E+00	2.94E+01	2.11E-03	4.25E-01	5.84E-02	1.82E-03	1.44E-01	6.43E-03
3	Hard coal {RNA}| mine operation | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	MJ	2.48E+01	0.00E+00	2.47E+01	1.35E-03	6.71E-02	5.14E-02	3.11E-03	2.46E-01	5.64E-03
4	Hard coal {ID}| mine operation | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	MJ	1.73E+01	0.00E+00	1.72E+01	6.24E-04	2.87E-02	2.87E-02	2.45E-03	1.93E-01	3.10E-03
5	Hard coal {RoW}| mine operation | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	MJ	1.72E+01	0.00E+00	1.71E+01	1.07E-03	6.91E-02	3.78E-02	1.63E-03	1.29E-01	3.80E-03
6	Natural gas, unprocessed, at extraction {RNA}| production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	MJ	1.67E+01	0.00E+00	1.66E+01	7.40E-04	8.94E-02	3.54E-02	1.90E-03	1.50E-01	3.75E-03
7	Petroleum {RoW}| and gas production, on-shore | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	MJ	1.23E+01	0.00E+00	5.66E+00	1.29E-01	6.52E+00	7.78E-03	7.62E-03	6.03E-01	6.00E-04
8	Natural gas, high pressure {RU}| natural gas production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	MJ	8.95E+00	0.00E+00	8.87E+00	3.68E-04	5.65E-02	1.84E-02	9.00E-04	7.12E-02	1.71E-03
9	Petroleum {RoW}| gas and petroleum production, off-shore | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	MJ	8.63E+00	0.00E+00	3.96E+00	9.04E-02	4.56E+00	5.44E-03	5.33E-03	4.22E-01	4.19E-04
10	Hard coal {ZA}| mine operation | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	MJ	7.91E+00	0.00E+00	2.95E+00	6.46E-04	3.53E-02	5.78E-03	1.44E+00	1.14E+02	6.35E-04
11	Lignite {RoW}| mine operation | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	MJ	6.46E+00	0.00E+00	6.44E+00	2.91E-04	1.03E-02	1.18E-02	6.50E-04	5.14E-02	1.25E-03
12	Natural gas, high pressure {RoW}| gas and petroleum production, off-shore | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	MJ	4.33E+00	0.00E+00	4.28E+00	1.80E-04	3.61E-02	8.83E-03	4.02E-04	3.18E-02	8.84E-04
13	Lignite {RER}| mine operation | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	MJ	4.24E+00	0.00E+00	4.20E+00	2.82E-04	2.47E-02	1.34E-02	2.75E-04	2.18E-02	1.00E-03
14	Natural gas, high pressure {RoW}| natural gas production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	MJ	3.70E+00	0.00E+00	3.66E+00	1.54E-04	3.09E-02	7.55E-03	3.44E-04	2.72E-02	7.56E-04
15	Natural gas, high pressure {DE}| natural gas production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	MJ	3.67E+00	0.00E+00	3.65E+00	1.39E-04	9.49E-03	7.21E-03	4.84E-04	3.83E-02	7.63E-04
16	Polystyrene, general purpose {RoW}| production | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	MJ	3.58E+00	0.00E+00	3.58E+00	1.08E-08	1.17E-06	4.54E-07	1.08E-07	8.53E-06	2.90E-08
17	Hard coal {AU}| mine operation | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	MJ	3.49E+00	0.00E+00	3.47E+00	2.25E-04	1.33E-02	6.67E-03	3.65E-04	2.89E-02	7.36E-04
18	Natural gas, high pressure {GB}| petroleum and gas production, off-shore | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	MJ	2.98E+00	0.00E+00	2.96E+00	1.13E-04	1.63E-02	6.53E-03	2.42E-04	1.92E-02	5.07E-04
19	Petroleum {GB}| and gas production, off-shore | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	MJ	2.72E+00	0.00E+00	1.25E+00	2.85E-02	1.44E+00	1.71E-03	1.68E-03	1.33E-01	1.32E-04

Calculation: Analyze
Results: Process contribution
Product: 1 p Apple Air iPad IRP (of project Digital vs Print LCA)
Method: Cumulative Energy Demand V1.08 / Cumulative energy demand
Indicator: Characterization
Category: Non-renewable, nuclear
Cut-off: 1%
Mode: Group
Exclude infrastructure processes: Yes
Exclude long-term emissions: Yes
Sorted on item: Total
Sort order: Descending

No	Process	Project	Unit	Total	Top	Production	Apple Air iPad distribution transportation	Retail transportation	e-book formatting	e-book downloading	e-book reading	Waste Management
	Total of all processes		MJ	3.91E+01	0.00E+00	3.74E+01	1.88E-02	1.72E-01	9.27E-02	4.29E-01	3.39E+01	8.71E-03
	Remaining processes		MJ	9.54E-01	0.00E+00	9.21E-01	1.63E-02	1.47E-02	1.08E-03	4.28E-06	3.39E-04	2.84E-06
1	Uranium ore, as U {RNA}| uranium mine operation, underground | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	MJ	1.48E+01	0.00E+00	1.41E+01	9.70E-04	6.12E-02	3.55E-02	1.66E-01	1.32E+01	3.38E-03
2	Uranium ore, as U {RoW}| uranium mine operation, underground | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	MJ	1.40E+01	0.00E+00	1.34E+01	9.16E-04	5.78E-02	3.35E-02	1.57E-01	1.24E+01	3.19E-03
3	Uranium ore, as U {RoW}| uranium mine operation, open cast | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	MJ	5.52E+00	0.00E+00	5.27E+00	3.62E-04	2.28E-02	1.33E-02	6.21E-02	4.91E+00	1.26E-03
4	Uranium ore, as U {RNA}| uranium mine operation, open cast | Alloc Def, U	Ecoinvent 3 - allocation, default - unit	MJ	3.85E+00	0.00E+00	3.68E+00	2.52E-04	1.59E-02	9.24E-03	4.33E-02	3.43E+00	8.79E-04