Consultancy Project: Greening the UIT

By
Ellen Guimaraes
Fotis Alatas
Nejc Frece
Marten Verdenius

Energy and Material Efficiency

GEO4-2324

Professor: Ernst Worrel
Supervisor: Jesus Rosales

10, April, 2014

Content

Abbreviations **3**

1 Introduction **4**

1.1 Sustainability at the University of Utrecht 4

1.2 Research questions 4

1.3 Methods 5

2 Plastic bag usage **6**

2.1 Environmental and material pressures 6

2.2 Recycling opportunities 7

2.3 Alternatives 7

2.3.1 Jute bags 8

2.3.2 Other options of Re-usable bags 8

2.4 Price of Alternatives 10

2.5 Reusable bags at the UIT 11

3 Paper usage **12**

3.1. The paper problem 12

3.1.1Paper use at the UIT 13

3.1.2 Plan analysis 14

3.1.3 Strengths and weaknesses 17

3.1.4 Paper use at the UIT 17

3.1.5 Plan analysis 18

4 Volunteer Management **20**

4.1 Volunteer Management at events 20

4.1.1 Communication 23

4.1.2 Time Management 25

4.1.3 Human Factor 28

5 Electricity generation at the UIT **29**

5.1 Diesel power generation at the UIT 29

5.2 Recommendations for electricity production at the UIT 30

6 Discussion **31**

7 Conclusion **31**

Bibliography **34**

Appendices **40**

Notes 40

Paper and pulp creation process 40

Extra information on power generation 48

Abbreviations

PE= Polyethylene
UU= University Utrecht
UIT= Utrecht Introduction Time
LCA = Life Cycle Assesment
HDPE = High density polyethylene
UK.EA=British Environmental Agency
PP= Polyproplylene
BATNA = (Best Alternative To Negotiated Agreement)
kWh = Kilo Watt hour
kg= kilograms
g=grams
H2SO3= sulfurous acid
HSO3= bisulfite ion
CL2 = Elemental Chlorine
NCASI =National Council for Air and Stream Improvement
AIChE = American Institute of Chemical Engineers
USDE = US Department of Energy
Btu = British Thermal Unit
ASA = American Sociological Assosiation
CA= Commonwealth of Australia
MISAC = Manufacturing Industry Skills Advisory Council
Wi-Fi = Wireless Network
EU= European Union

1 Introduction

1.1 Sustainability at the University of Utrecht

Sustainability is one of the four strategic pillars of the University of Utrecht, with an explicit focus on knowledge valorization and operations (UU, 2012). The Utrecht Introduction Time (UIT) is an event that takes plays over 4 consequent days and is meant to let new students get acquainted with student life in Utrecht, the University (UU) and the HU University of Applied Science in an entertaining and informative manner (UIT[1], 2014). During this event 3500 new students, assisted by over 650 student co-workers, are introduced to the University. Over the course of the event, large flows of food, electricity (mostly produced using diesel) and waste are used or accumulated. As such, this event offers a great opportunity to put sustainability, as one of the four strategic pillars, in operation.

The organizing committee of the UIT (ICU) has already acknowledged its responsibility for sustainable practices by signing the covenant of Sustainable Events Utrecht. Partners within the covenant share knowledge and experiences with regard to sustainability. The covenant works on a list of sustainable suppliers, and investigates opportunities for joint purchasing and sharing of materials. All partners of the covenant keep record of their efforts using an Environmental Barometer. As a further step towards sustainability the ICU aims to obtain the internationally renowned Green Key certificate (UIT[2], 2014). In order to qualify, a list of numerous requirements has to be fulfilled. One of the key-requirements is a record of costs and amounts of gas, diesel, electricity, water, waste, linen and resource flows, preferably over 3 previous editions of the event. Furthermore this report should contain recommendations to improve the sustainability performance on the topics (among others) waste, energy, diesel and water (KMVK, 2013).

Compiling the data on gas, diesel, electricity and waste flows, and providing recommendations for sustainable performance improvements are thus a key step for the future acquisition of the Green Key certificate. As the ICU has indicated to the authors, no clear record of this data exists to date. Therefore we advise the ICU to keep record of the flows of gas, diesel, electricity and waste during the coming UIT-events. For this consultancy project the focus will be on assessing the current status of environmental impacts caused by the UIT and providing recommendations for improvement, as an important step towards obtaining the Green Key certificate. In accordance with the ICU and the Green Office, special attention will be given to the following subjects: plastic bags, paper and electricity generation.

1.2 Research questions

The UIT provides an ideal opportunity for the UU to present themselves as a leading institute towards sustainability. The ICU recognizes this opportunity, and by striving for the Green Key certificate this commitment can transparently be communicated to the public. The aim of this research will thus be to aid the ICU in reaching their goal of obtaining the Green Key certificate and reducing their environmental impact. More specifically the research aim is defined as: to identify and explore opportunities for the improvement of the sustainability performance of the Utrecht Introduction Time (UIT). The research question accompanying this aim is:
Which major environmental pressures caused by the UIT can be identified and which

opportunities to reduce these pressures exist?

Sub-questions that contribute to the answering of the main research question are:
Which environmental pressures result from the plastic bags used at the UIT and how can these pressures be reduced?

Which environmental pressures result from the paper use at the UIT and how can these pressures be reduced?

How can the environmental pressure caused by electricity generation at the UIT be reduced?

Over the course of this research, answering of the research questions will lead to a better understanding of the environmental pressures caused by the UIT. Furthermore, insight will be provided in the opportunities that exist to reduce these environmental pressures. As such, this research aims to support the ICU in creating a more sustainable UIT, make an important step towards the Green Key certificate and boost the sustainable image of the UU.

1.3 Methods

As stated above, focus points for improving the sustainability performance of the UIT are chosen in accordance with the ICU and the Green Office. These focus points, being plastic bags, paper and electricity generation, are evaluated on their current status with regard to environmental pressures. For each of the focus points, an extensive literature research is conducted compiling current scientific knowledge on the environmental pressures related to the specific industry and currently available alternatives. The literature research is conducted using scientific search engines like google scholar and science direct. Access to restricted articles is provided by the use of the UU UBU link. Information on the actual material and energy flows during the UIT are provided, to the extent of availability, by the ICU. Using this information, the connection between the industries under analysis and the UIT is discussed.

Using the theoretical background provided by the literature research, the current status of environmental pressures resulting from the specific industries related to the UIT is evaluated. Furthermore, alternatives and their environmental pressures are discussed, resulting in a recommendation for sustainability improvement for the UIT.

2 Plastic bag usage

The first issue discussed with the Green Office and the ICU regarding material use during the UIT was the usage of plastic bags. According to the ICU, at the start of the event around 4000 bags containing information about the UIT and some promotional articles are provided to the students and the volunteers. As such, this goodie-bag functions as a sort of 'business card' of the University. Hence the goodie-bag might have an important impact on the perception new students have of the University. However, the 4000 plastic bags needed to be produced for the UIT are assumed to compose a significant part of the material and environmental pressures of the UIT. Furthermore the 'unsustainable' image of plastic bags reflects negatively on the desired image of a sustainable UU. This chapter aims to explore the pressure that plastic bags actually pose on material usage and the environment, and to explore which sustainable alternatives exist. Since the ICU indicated that financial limitations might prevent them from switching to more sustainable alternatives, also financial factors are taken into consideration.

2.1 Environmental and material pressures

Plastic bags and generally bags are one of the most well-known means for carrying products, hence they are widely used (Ayalona et al., 2009). Currently many countries have started to put regulations on the usage of plastic bags, indicating the widespread arguments against them. These regulations generally take the form of putting high taxes on plastic bags to discourage the usage, or simply by banning all domestic sale of plastic bags (Leeuwen and Williams, 2013). Some places in the State of California (e.g. Campbell) belong to that particular category that has banned plastic bags. On top, Campbell has put a fee on the usage of paper bags, trying to force consumers in the new bag "fashion" of reusable bags (Leeuwen, 2014).

One of the major arguments against plastic bags is their fragility, and the general tendency of disposing them after one single usage (Ayalona et al., 2009). After being disposed the plastic bags often end up in landfills, posing an enormous impact on the local environment (Ayalona et al., 2009). In the Netherlands however, domestic waste is generally incinerated in AVI's (Waste Processing Installations in Dutch) (Rijkswaterstaat, 2013). As a result of this incineration, useful heat and electricity are produced (Rijkswaterstaat, 2013). However, these AVI's are still an important source of CO2 and other unfavorable emissions (Voerman, 2012).

On top of the sustainability issues offered by the regular disposal of the plastic bags, plastic bags are often disposed in the urban or natural environment, creating an important source of urban environmental pollution (Ayalona et al., 2009). As a result of its persistent chemical nature, plastic migrates across ecosystems over long periods of time, posing a threat to natural ecosystems. This is exemplified by the enormous accumulation of plastic waste culminating in the Great Pacific Garbage Patch. The share of plastic bags in this 'island' of plastic is considered to be significant (Sharma et al., 2013). Due to fragmentation of the plastic overtime, small (and less small) fragments of plastic cause the pollution of aquatic and terrestrial animals (Altalhi et al., 2013).

2.2 Recycling opportunities

As a reaction to the environmental threats posed by plastic bag disposal, many governments have adopted recycling strategies (Altalhi et al., 2013). Besides reducing the threats to the environment, recycling offers opportunities for economic benefits (Altalhi et al., 2013). In the case of British industry, reuse of plastic bags as a raw material provided a serious opportunity to reduce the costs of import (Douglas and Birch , 1975).

Unfortunately the recycle rates have not proven to reduce the environmental pressure of plastic bags sufficiently. In spite of increased efforts to stimulate recycling, the US Environmental Protection Agency (EPA) only found plastic bag recycling to be at 5.2% by 2005 (Boustead, 2010). Although this percentage was found to be increased to 13% by 2009, it is still considered low (Sharma et al., 2013). On top, effort needed in the recycling process was found to increase due to persistent equipment malfunction, reducing cost-effectiveness (Misseldine, 2010).

Besides general recycling of plastic bags, Sharma et al. (2013) consider the possibility of producing plastic crude oil from High Density Polyethylene (HDPE) bags using pyrolysis. In the research of Sharma et al. (2013) a batch reactor in triplicate was used to thermo-chemically convert HDPE bags to oil from 500g of simple grocery bags*. As a result, Sharma et al. (2013) found that 74% of these simple grocery bags could be converted into plastic crude oil. Although the results look promising, pyrolysis is an energy/emissions consuming process (Sharma et al., 2013) and economic feasibility of implementing pyrolysis as a serious possibility for plastic bag recycling has not been assessed.

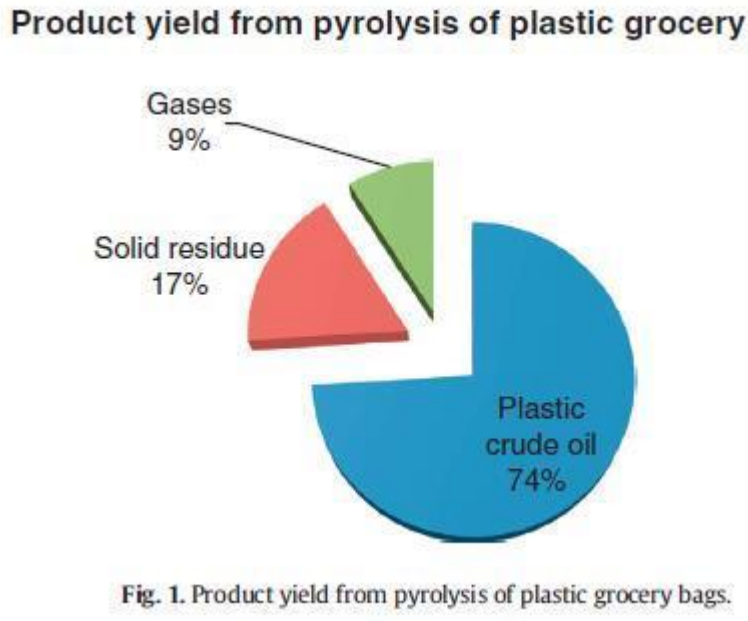


Figure 1 : Product yield from pyrolysis of plastic grocery bags, Source:(Sharma et al., 2013)

2.3 Alternatives

Like stated previously, government policies tend to discourage plastic bag usage, at the same time stimulating reusable bag usage (UK.EA, 2011). Such reusable bags can be made from a

variety of materials (plastic, cloth etc.) and have the capacity of being used many times (100+ of times) and generally present less environmental impact than conventional containers (Misseldine, 2010). Especially non-plastic reusable bags are recommended by LCA's as the most environmentally friendly ones (Misseldine, 2010). Although the production of reusable bags generally requires greater material and energetic input (see figure 2), reuse of such bags ensures a better sustainability performance (Misseldine, 2010). Considering the significantly larger capacity and the expected lifetime of 4 years, a single reusable bag can replace around 600 plastic bags (Lin et al., 2013). On top of the advantages regarding environmental pressures as listed above, non-plastic reusable bags are generally breathable, making the bags more hygienic and suitable for vegetable-storage (Lin et al., 2013).

2.3.1 Jute bags

One of the fabrics currently taking the lead with regard to reusable bag production is jute (Lin et al., 2013). According to FAO (2010), in 2009/10, global production of jute was estimated to be around 2.6 Mtonnes. This is also the fabric considered by the ICU as a potential substitute for the currently used plastic bags. Jute fiber production, represents the second most economically important agricultural production (after cotton) and is a natural composition of lignin, cellulose and hemicellulose (Basua et al., 2008). As a natural product with low processing, jute is renewable and biodegradable and has a low cost availability (Basua et al., 2008). As a result, the waste accumulation problem that exists for plastic bags could be overcome by switching to jute. Over the lifecycle of jute bags, hardly any chemicals or pesticides are used, adding to their sustainable performance (Basua et al., 2008).

2.3.2 Other options of Re-usable bags

The UK Environmental Agency conducted a research on supermarket carrier bags in 2011 (UK.EA., 2011), assessing life cycle impacts of a variety of carrier bags. The research included the following stages: extraction / production of raw materials, packaging, production processes, transport, end-of-life, recycling, reuse and avoided products. As such, the research provides a very comprehensive study of the environmental impacts of carrier bags along the full lifecycle. Since jute bags are not accounted for in the assessment, the study provides great insight in the other options for more sustainable carrier bags.

Figure 2 indicates that generally sustainable alternatives require more electricity for its production (per 1000 bags) compared to the conventional HDPE-bags. Also the Global Warming Potential (GWP), based on lifecycle CO2-eq. emissions, is higher per bag for the alternatives (UK.EA., 2011). As such, these figures seem to suggest that the alternatives are not more sustainable at all. Put differently however, the potential reuse offered by the alternatives does assure that the GWP over the lifecycle of the bags is lowered. Figure 3 shows the necessary reuse to ensure an alternative bag has a lower GWP than a HDPE bag. As the study found that 40.3% of conventional HDPE bags is reused as a bin liner, these figures can be considered most relevant for comparison.

Energy consumption and waste generation for film and cotton bags (per 1000 bags)

Bag type	Electricity	Heat (from natural gas)	Heat (from heavy fuel oil)	Waste
Conventional high-density polyethylene (HDPE) bag	6.151 kWh (22.144 MJ) (0.758 kWh/kg)			418.4 g
High-density polyethylene (HDPE) bag with a prodegradant additive	6.392 kWh (23.011 MJ) (0.773 kWh/kg)			426.1 g
Starch-polyester blend bag	17.24 kWh (62.064 MJ) (1.045 kWh/kg)			94.8 g
Low-density polyethylene (LDPE) bag	32.58 kWh (117.288 MJ) (0.932 kWh/kg)	13.953 kWh (50.23 MJ) (0.399 kWh/kg)		171.2 g*
Non-woven polypropylene (PP) bag			87.75 kWh (315.9 MJ) (0.758 kWh/kg)	5,850 g
Cotton bag	11 kWh (39.6 MJ) (0.06 kWh/kg) *			1,800 g*

Figure 2 : Energy consumption and waste generation for conventional and re-usable bags. Source : UK.EA , 2011

Type of carrier	HDPE bag (No secondary reuse)	HDPE bag (40.3% reused as bin liners)	HDPE bag (100% reused as bin liners)	HDPE bag (Used 3 times)
Paper bag	3	4	7	9
LDPE bag	4	5	9	12
Non-woven PP bag	11	14	26	33
Cotton bag	131	173	327	393

Figure 3: Necessary reuse to ensure a lower GWP compared to HDPE. Source: UK.EA (2011)

On the basis of figure 3, it seems that paper bags are the most environmentally friendly, as they only need 4 reuses before they have a lower GWP than conventional HDPE bags. However, paper bags are less suitable for reuse as they are intolerable to water (UK.EA., 2011). Furthermore many other environmental concerns are associated with paper production, as elaborated on in chapter 2 of this paper.

LDPE and PP bags, as number 2 and 3 on the list of necessary reuses have similar end-of-life impacts as HDPE bags (UK.EA., 2011), potentially adding to the plastic 'islands' in the oceans. As such, these alternatives would not be suitable for the desired sustainable image improvement. The HDPE bag with pro-degradant additive in turn, is found to have a slightly higher GWP over its lifecycle, and end-of-life impacts are not proven to be less than conventional HDPE (UK.EA., 2011). As such, the HDPE bag with pro-degradant additive can

also not be considered a more sustainable alternative.

This leaves the cotton bag as sustainable alternative. Although the cotton bag needs a high amount of reuses, before an actual improvement of GWP is achieved compared to the HDPE bags, the estimated lifetime of 4 years suggests that this amount of reuses could easily be achieved. Furthermore, it should be noted that GWP does not account for the disposal issues (like addition to the plastic islands) caused by conventional HDPE bags. Therefore the comparison between conventional HDPE and cotton bags with regard to sustainability is even more in favour of the cotton bags, as these are biodegradable.

From the life cycle assessment, it can be concluded that 99% of the impacts of cotton bags are accounted for by the production of raw materials. As the cultivation of jute is considered to be less energy intensive, less expensive and less prone to pesticide-use (Basua et al., 2008), jute can be considered to have a lower GWP than cotton. As such, a jute bag would have to be reused less times before an improvement in GWP compared to conventional HDPE-bags would be achieved.

From the above, it can be concluded that reuse is a decisive factor for the lifecycle impact of carrier bags. Indicative of its importance, without reuse conventional HDPE bags have the lowest GWP. Furthermore, it is found that the current level of plastic bag usage and disposal poses serious threats to the natural environment, leading many governments to stimulate reusable bags. In sum, reusable bags are the way forward, and jute bags can be considered the most sustainable type of reusable bag.

2.4 Price of alternatives

As the ICU indicated to have considered switching to jute bags, but to be hesitant due to the expected higher costs, a research on bag prices has been conducted. On the well-known site.alibaba.com a range of prices was found as depicted in the table below.

Type	Price(Euro)/bag	Min.Order
Plastic	0,2-0,7 euro	1000(100/month)
Jute	0,15-0,51 euro	2000
Cotton	0,28-0,65	3000

Figure 4 : Price of different types of bags , Source : alibaba.com

This table suggest that prices of jute bags are not necessarily higher than those of plastic containers with similar durable size.

Even if the price that is considered high the price can change (higher or lower) regarding the merchant and the kind of negotiations every institute will do with him(More, 2013).

For negotiating the price there are steps that must be taken into account(More,2013):
Use of objective criteria
To know the best alternative choice in order to negotiate an agreement (BATNA)

Vendors are not easily persuaded to drop the price , that's why the potential buyer needs to adopt the best available tactic (More, 2013). Usually when there is a potential purchase of a big amount of products (in our case 4000 jute bags , a certain flexibility is being observed because of the high margin profit for the vendor, making them more suitable for negotiations(More, 2013). In order to do this a price target must be selected, how much the ICU wants to pay for each bag and try to find the most suitable vendor for it (More, 2013). Nevertheless , everything is depending on how much the merchant needs in order to feel satisfied about his cash flow and how much money the buyer is willing to give (More, 2013). Last but not least is the ability of the negotiator, because it is also dispended on buyers 's impatience , other options and the risk that he/she is willing to take in a negotiation (Raskovich, 2006). Utrecht University is a well-known institute in Europe and it can attract many stakeholders in order to supply with products it's introduction week , that must be taken into advantage during the brainstorming and present promising ideas for longer term collaboration if the first approach proved fruitful (Roger Fisher and William Ury, 1991)

2.5 Reusable bags at the UIT

Reusable jute bags can be introduced as an alternative to the 4000 plastic bags used at the UIT. However, high investment costs generally provide a hindrance regarding the adoption of sustainability or "green" initiatives (Blok, 2009). Although the ICU expected jute bags to be more expensive, it is found that this does not necessarily have to be the case. Besides, the quality of jute bags is higher and uses are more plentiful. Furthermore, as extensively discussed above, the lifecycle impact of jute bags, assuming they are reused, is much less than the plastic bags. In sum, these arguments should provide a founded backing for the shift to jute bags at the UIT. On top, measures discussed in the chapter (2) below, could provide the financial means needed to fund the adoption of this more sustainable alternative. It should however be stressed, that when implementing the jute bag in favour of the plastic bags, reuse of the bag should be actively stimulated to ensure an actual improvement in sustainable performance.

3 Paper usage

During the UIT, students and volunteers receive a goodie bag containing the event schedule, documents and some commercial material from the event sponsors. In the previous chapter we emphasized the importance of choosing more sustainable containers for the goodie package. Besides the pressure caused by plastic bags, the content of the bags might also have an impact on the environment. Since a large share of the content of the goodie bags consists of paper products, this chapter evaluates the environmental pressures caused by paper usage. Furthermore an alternative for paper, being mobile applications, is suggested and evaluated. For the implementation of such a system, it is fundamental that the volunteers and staff responsible for the event organization are engaged on the idea of a non-paper event. Therefore organizational features of the alternative are also discussed.

3.1. The paper problem

Energy and material consumed during paper and pulp production is usually neglected, mainly because it is such a widely used, everyday item (EPA, 2010). Although paper industry over the last years has shown significant improvements in technology and energy efficiency (EPA, 2010), the paper industry is still considered to present a serious threat to the natural environmental.

Paper production		Paper consumption	
USA	85,495	USA	92,355
Japan	31,828	China	36,277
China	30,900	Japan	31,736
Canada	20,689	Germany	19,112
Germany	18,182	UK	12,684
Finland	13,509	France	11,376
Sweden	10,786	Italy	10,942
France	9,991	Canada	7,476
Korea	9,308	Korea	7,385
Italy	9,000	Spain	6,922

Figure 5: Worlds lead producers and consumers . Values presented are in tonnes. Source : ***Judson***

This is highlighted by the fact that 40% of the 30 million acres of forest destroyed annually, is used in the paper industry (Judson,.). This loss of forest ends up in the paper industry,

Paper industry is a highly energy and material intensive industry (US DE, 2005), using wood as a main input to its production (EPA, 2010). In 2002 US pulp and paper industry consumed over

2200 trillion Btu, amounting to around 14% of fuel consumed by the U.S manufacturing sector (Kramer et al., 2009). At the same time, GHGs are emitted during and after the production-process. The report made by Kramer et al. (2009), sponsored by the U.S. Environmental Protection Agency, used the following steps to set out the environmental impacts caused by paper**.

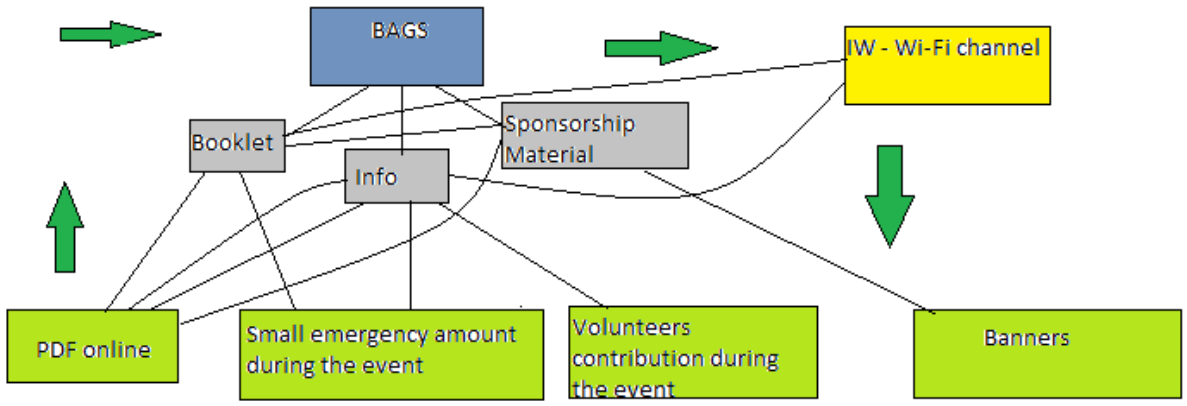
1. Material Consumption
2. Energy Consumption
3. GHG emissions

Paper and pulp industry , processes consume a great amount of energy and materials causing pressure on the environmental capital and produces GHG emissions. In order for the reader to understand these pressures there is a thorough report about the paper and pulp industry processes in the appendix of this report.

3.1.1 Paper use at the UIT

During the UIT, around 4000 goodie bags are handed out containing information about the event. At the UIT of 2013, the booklet existed of 97 pages plus the front and back cover, adding up to a total of approx. 400.000 pages of paper used for the booklet only. However, as extensively discussed above, paper production is associated with large energy and material consumption, posing a large pressure on the global environment. As this paper aims to provide a set of recommendations to improve the sustainability performance of the UIT, paper reduction provides an important opportunity to this aim.

The following pattern comprises the steps to be taken in order to reduce paper use regarding the booklet, sponsorship material and focus on the coordination of the event :



Focus points of the UIT paper reduction pattern:
Following this pattern we intend to :

- Reduce the amount of paper products used during the event
- Electronically provide the desired material weeks before the starting date
- Provide easy access to the information , through a Wi-Fi channel created for the introduction week
- Take advantage of the 500 volunteers

- Create a general more “green” event
- Keep quality of the UIT intact
- Keep the sponsors satisfied

3.1.2 Plan analysis

At first glance the pattern might seem a bold plan, but even if the entire pattern cannot be actually put in action (which the authors believe it can) at once, it can slowly be establish and re-adjusted in the future. The goodie bag consists of an advertisement of the UIT and a memento to the students to remember their experiences at the UIT. Nevertheless, it is the authors believe that a well-planned event that actually focuses more on the activities than the “goodies” that students receive (Oxford, 2008). At the same time , new innovative ideas can create a positive attention , taking into account the beneficial results of innovation in the market (Chemney) and at the same time innovation brings more motivation for adaptation and widespread of new initiatives (Tang , 1998).

An almost 100 pages booklet is given during the introduction that can be avoided by providing it online beforehand like all the available information that the students need to know (Oxford, 2008).

In order to apply this idea in the event , the authors are proposing to take advantage of the smartphones that most of the students have and use every day in order to access their social media or web browsing (Edison and Arbitron,2012). According to *Nielsen (2013)* in Italy and the UK 97% of youngsters at the age of 16+ possess a smartphone. Similar figures are found for other European countries with comparative GDP’s, making it safe to assume that a similar percentage can be found for the Netherlands and the attending students at the UIT.

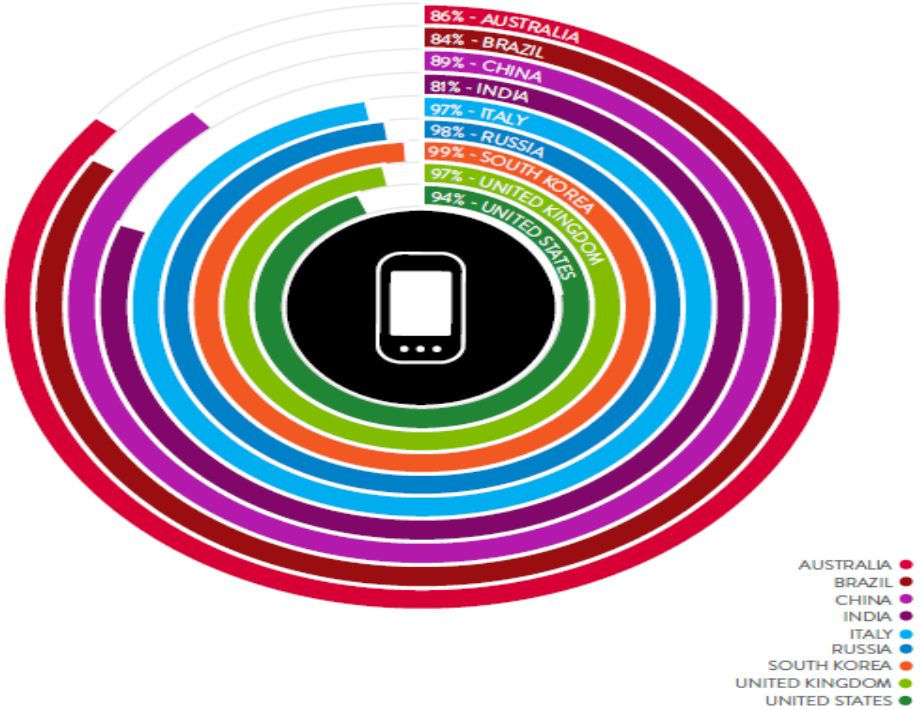


Figure 6 : Percentages of people that uses smartphones on the age of 16+, Source : Nielsen , 2012

In order to assure that information is provided to the students adequately, documents should be put online weeks before the start of the event, as time preparation is crucial to any event (Oxford, 2008). Other crucial points for successful implementation are:

- Downloading the material from the UIT site and uploading into the smartphone beforehand
- Downloading the material from UU's computers during the event
- Using an extra Wi-Fi "branch" created for the UIT in order to downloaded
- Receiving in personal e-mail before hand

All of the ideas have something in common, the condition that the students will have their phones with them every time. That is an uncertainty that the authors realized and according to *Edison and Arbitron, 2012,* the majority of the young people keep their smartphones with them all the time. That argument can be strengthened by the statistics of the social networking which shows that Facebook has 500 million people accessing it via mobile phones (Mills,2012) and that every person check's it's web browser at least three times per day (Nielsen,2012). Moreover, the sales of smartphones have increased to 44% in 2012 amount that seems promising regarding the chance of students to have a smart phone (OPA,2012) and another interesting figure is that three out of 10 smartphones users have also in their possession a tablet (Edison and Arbitron,2012)

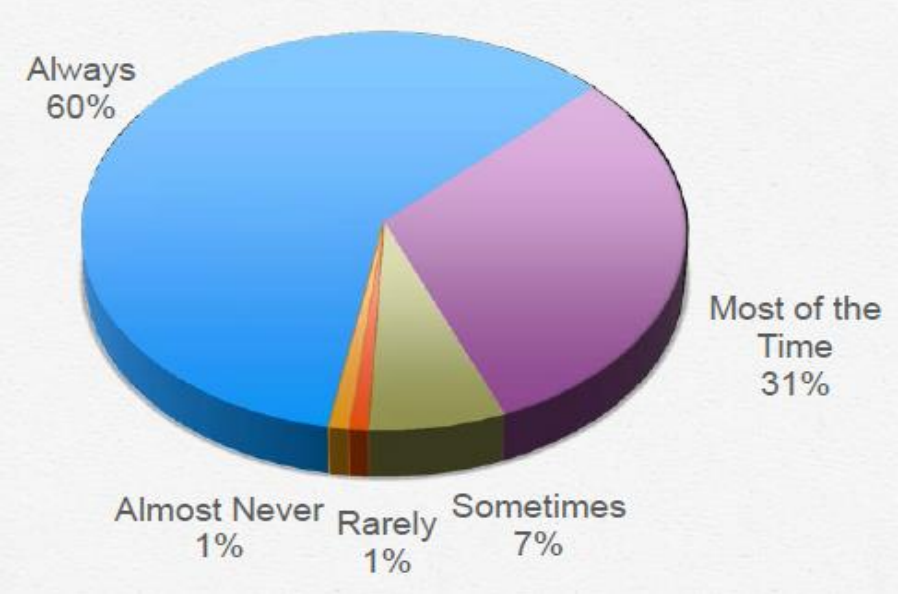


Figure 7 : Percentage of people tha keep their smartphones with them , Source : Edison and Arbitron , 2012

At the same time providing the booklet in electronic form can have other positive effects such as the electronic archive providing a more flexible and user friendly than the paper based one (Wright , 1997). At the same time it has the advantage of accessibility to the public and students can check every time the schedule just with a click on their phone without having to search for paper (Nielsen, 2013).

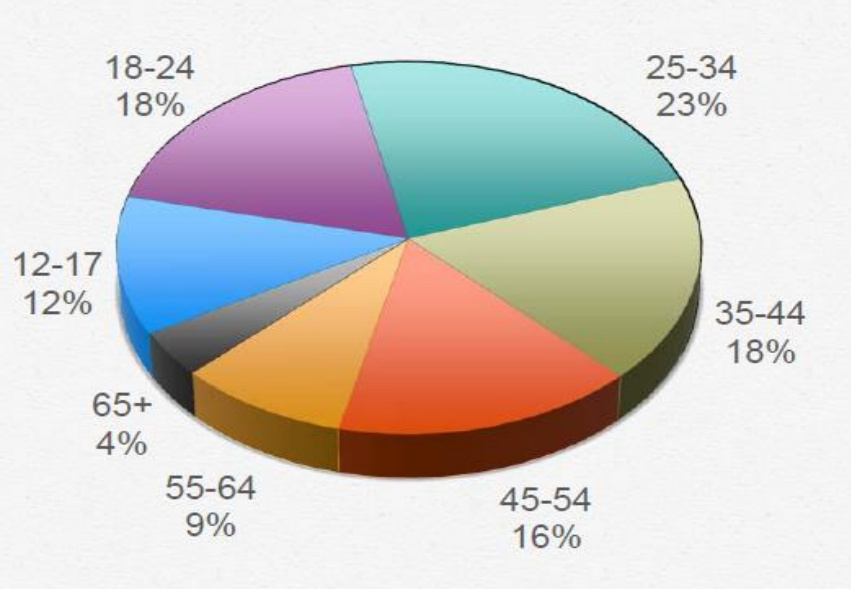


Figure 8 : Age range that posseses a smartphone , Source : Edison and arbitron , 2012

For the last idea the authors were “inspired” by a similar method that is used in Paris Eiffel tower where the available Wi-Fi, gives access to the user only to download the touristic application of Eiffel tower. Similarly taking advantage the Uithof has Wi-Fi access in almost all of its perimeters , the same idea can be applied to UIT where a new “branch” can be added, in order to give access to the desired .pdf files and which is not going to be overflowed with users because of its limited accessibility. Finally, the last thought is the desired documents to arrive at every participant after his/hers electronic application, but that requires a specific amount of time in order to prepare everything weeks (even months) before the main event.

Figure 9 : Current Wi-Fi state in Uithof

3.1.3 Strengths and weaknesses

Strengths of Method

- Minimum use of paper
- Taking advantage of modern trends and technology
- Accessibility everywhere in Uithof
- Easily used by the students since they are used in smartphone attributes

Weaknesses of Methods

- Not all people possess a smartphone
- Sponsorship lack of advertisement
- Needs a serious amount of time to set up

In order to minimize the weaknesses of the proposal, the authors elaborated a solution that involves the activation of volunteers that take also participation in the event.* Even though the majority of the students possess a smartphone, there are students that don't have the luxury or the desire to provide themselves with such a device. In order to overcome this obstacle, the authors came up with the following tips:

- 4000 booklets are given , thinking that 3% of the population don't possess a smartphone by simple math , we can assume that 120 booklets are needed but in order to create a smooth and flexible event propose the printing of 300 booklets of recycle paper that will be given to people that don't possess an electronic device.
- Volunteers can provide with the proper information the participants and encourage them to socialize with other people with whom they can learn and participate together to the various activities.
- Time** is essential in reducing materials because by planning beforehand , the event reduces the possibilities of not including all the parameters of the proposed plan and deal with any obstacles that may come up in the process (Oxford,2008)
- Map online of the activities and the areas that recycle bins will be in order to throw non needed material

(For more information about the volunteer inportance see sector : Volunteer Management**)*
(For mosre information about the importane of time see sector : **Time Management)*

3.1.4 Sponsorship

It does not require explicit economic knowledge in order to understand the importance of sponsorship in organizing an event, that´s why the authors chose to spend a quite amount of research time in order to find if the proposal was realistic and attractive.

Sponsors means advertisement for both the company and the event , economic benefits for both and chances of future business collaboration (Coppetti , 2004). In the recent years it has been observed, companies to spend extravagant amounts of money in marketing reaching the percentage of 40% turnover (Coppetti,2004). With the flourishing of the internet and its use in the everyday life of people, a turn in the web marketing has come into the light (Coppetti, 2004). Companies usually sponsor credible organizations (like UU) and innovative ideas (like the ones

described above) that are consistent and can create an impact (Stevenson, 2012). The attraction of sponsors can be made by the proof of ample perks that the committee organize the event may offer (Stevenson, 2012). As it is known , corporation spend great amounts of money in sponsoring non-profit events , let alone events like UIT that attracts the interest of over 4000 people (Stevenson,2012). According to the guidelines, found in *Stevenson 2012*, sponsorship attraction can be achieved, by taking advantage of the events website (logos, adverts and so forth) strengthening the idea of a more electronically based marketing that was already proposed (see above).

Flyers are not necessarily needed in order to promote, but banners or representatives with stands of the corporation can create a more personal approach to the participants of the event making a more successful and direct advertising and at the same time saving money and material in printing paper (DEFRA, 2007). Even though, if the sponsors insist in flyer distribution, choose recycle paper and with the help of volunteers, (*see Volunteers Management section*) try to inspire the students to throw the waste in the recycle bins placed in the area around the event (DEFRA , 2007).

Furthermore, with the popularity gain of sustainability the recent years, giving green credential and initiatives can attract corporate sponsorship (Stevenson, 2012) and as it is known

UU has a sustainability programme running called “Sustainable Uithof” (this report is part of this). Nevertheless, it must be noted that with the increase in smartphone purchases, the web advertising increased and corporations are seeking new ways of advertising through mobile platforms (Nielsen, 2013). Smartphones users appear to be accustomed with phone advertisements because research results , have indicated that everyday a user is receiving at least one advertisement in his/hers phone, especially in high growth economic countries (like Netherlands) (Nielsen,2013).

Therefore, in order to attract and persuade the sponsor about the change in the format of the event, the committee must create a strong ,simple and inspiring proposal to the sponsors in order to persuade them “investing” in this different way of advertising (Stevenson,2013).

3.1.5 Carton box/Food

Another “perk” of the UIT is the carton boxes that provided to the students containing food. Carton boxes falls to the same category as the sector above (paper), consume a great amount of energy and materials in order to create them (EPA, 2010). Moreover, carton boxes and the food that they contain create waste after the event which can be avoided (or at least reduced to minimum) by organizing and promoting ideas about waste management (UNEP, 2012)*. In order to describe the plan, the decision was taken to focus on the two main characteristics of the situation:

1. Avoid or use more environmental friendly carton boxes
2. Avoid offering food or use food management

Carton box

The initial plan of the authors is the avoidance of using carton boxes in the first place during the event. That can be achieved by taking advantage of all the available time before the planning and the event*. The carton box is used in order to provide the participants with food, but what if the food was given to them without a package?

Food

According to the ICU, the carton boxes contain:

- A sandwich
- Bottle of juice

The proposed idea is to prepare a different type of catering with hand in foods (DEFRA, 2007). Hand in foods require the use of catering service, which with the proper guidelines can use sustainable practices (DEFRA, 2007). Again time and early planning is playing a crucial role regarding the application of this imitative (Oxford, 2008) and the points that the author's focuses are (Defra, 2007):

- Explain the shift towards more sustainable catering to the catering service
- Choose seasonable products
- Offer tap water and not mineral water , if this is not possible choose corn-based bottles that are environmental friendly
- Recycling of materials (Bottles)
- Fresh fruit as desserts
- Participants must sign up beforehand if they prefer having a small snack

There are catering services that have implemented and applied environmental policies in their business (UNEP, 2012). In order to persuade the participants that the variation in the menu happened for sustainability reasons have a products that indicate eco-friendly labelling (UNEP, 2012).

Another approach would be the combination of Sponsorship with catering. There have been events where the sponsor was also the caterer for means of advertising (Stevenson, 2012). Having a large market pool (UU) is beneficial for a catering service so through the sponsorship and advertisement it is possible to balance the payment or reduce the cost of the service (Stevenson, 2012). As it was mentioned above (see Sponsorship) given the time needed and an inspiring and persuasive proposal, any sponsor can be persuaded to participate in such event (with high advertising results).

Last but not least, because the proposal has to do with human beings, we cannot exclude the human factor that is always present in these situations (Shapell and Wiegmann , 2000). Even if the event is perfectly designed and put in action, the results cannot be always optimal because the participants will simply not comply with the guidance (Shapell and Wiegmann , 2000). This fact can be minimized with the proper information beforehand but also the contribution of the volunteers (more will be explained in further sections). Nevertheless, one possible solution is help provided by a new (established in late 2013) student imitative called 100% *Food Use-No Food Is Left Behind* , by students of UU Sustainable Development Master Program and has as its main goal to turn the Uithof campus in a no food wasting place (http://100percentfooduse.orzanna.de/). The creator and coordinator of the initiative student Robert Orzanna , created a non-profit imitative that won the support of the University and the Green Office in order to prevent food going to waste.

Figure 10 : Ecolabeling product

(For more information see : **Time Management)*

4 Volunteer Management

4.1 Volunteer management at events

As it was mentioned above the authors strongly believe that the role of volunteers is crucial regarding the application of the measures described concerning the diminishing of material consumption. Volunteers represent the “image” of the event that they are participating to and regarding their behavior can have a crucial impact regarding the success of the event itself (Stevenson, 2008). While voluntary work is mostly benefiting the event (Giannoulakis et al., 2008) it has beneficial results in themselves as well (Latham, 2003). One of them is the interaction with different personalities, characteristics even nationalities from their own making the more knowledgeable in terms of everyday life (Latham, 2003). Moreover, one important fact that came into light with surveys was that of volunteers trying to improve their job opportunities by acquiring new skills in volunteering (NSGVP, 2000). A great amount of those say that they volunteered for this reason by a percentage of 23% which can also be assumed by findings of peoples who are already employed that they found their job through volunteering (NSGVP, 2000).

According to IECA volunteers have a the advantage of personal contact with the participant of the event making them important “tool” in promoting the eco-friendly ideas the author proposed in this report. Taking advantage of the large number of volunteers (500) a plan of assisting the participants was created that is based on the following points:

- Help in the check in of the participants
- Handle the goodie bags

- Directing the participants regarding the activities if they don't have the program with them
- Informing the participants about the environmental friendly policies the event is applying
- Guiding the participants around the venue in order to show them potential spaces for recycle in order to minimize the waste
- Explain information that participants find difficult to understand
- Help in the catering distribution
- Record data in order to use it on the next event

All this require a considerate amount of time in order to explain the purpose to the volunteers and motivate them, in order to get 100% of their capability (CA, 2008). In other words, volunteer training and supervising is important in order for the volunteers to be able to learn, adopt and understand the proposed guidelines (Stevenson, 2008|). Logically the training becomes from companies or manages that are especially trained for that (Brewis et al., 2010) the authors propose the idea of a Volunteer coordinator(s) that will work together with ICU committee in order to understand the plan and pass it to the volunteers. Together they will define the expectations they have from the volunteers , divide them in groups (each group responsible for different task) and create a specific plan of tasks for the groups that they will be explained by the Coordinator and must be applied by them (IECA). At the same time a database of all volunteers must be created that will have all the contact e-mails in order to distribute to them , their task program and other information that the coordinator wants to share with them (Stevenson ,2008).

The categorization of the groups should not happen randomly because the lack of homogeneity can create lack of coordination and de-motivate them, so a numerous criteria were gathered from Stenenson 2008 and IECA in order to guide the authors of how important a group homogeneity is:

➔ Past experience with events can be an advantage
➔ Leadership is one of the most crucial attributes a volunteer can have but careful not to put more than one person with this attribute because it can create frictions.
➔ Communication skills are the most important one not only among the group but with the participants as well
➔ Ability and willingness to serve the others
➔ Reliability in order to create minimum chances of error

Aside from the elements that a good volunteer must possess, the same must be applied for a good coordinator (Brewis et al, 2010). Managing the volunteers can be really tough assignment that is why most of the companies as it was mentioned refer to paid coordinators (to a percentage of 63%) with the remaining percentage to be un-paid but trustworthy people that can deal with potential problems that may arise (Brewis et al, 2010). Some attributes that a coordinator must have are (Brewis et al, 2010):

➔ Experience with events
➔ Education
➔ Administration
➔ Being a volunteer in the past themselves

The authors proposal is that because of the reason that UIT is an annual event , a space for Volunteer Coordinator must be created by inside the University students, since it possess students with the above attributes plus proper education. Some examples can be students of Bachelor or Master Program in Human Resource Managements, who will get paid (the monetary reward will be decided by the ICU committee) in order to overview the great number of volunteers.

As it was already mentioned, there are 500 volunteers that need to be organized and monitored that is impossible from just one coordinator, but in terms of flexibility and money saving the idea of creating a committee from each group leader that will work directly with the coordinator is proposed.

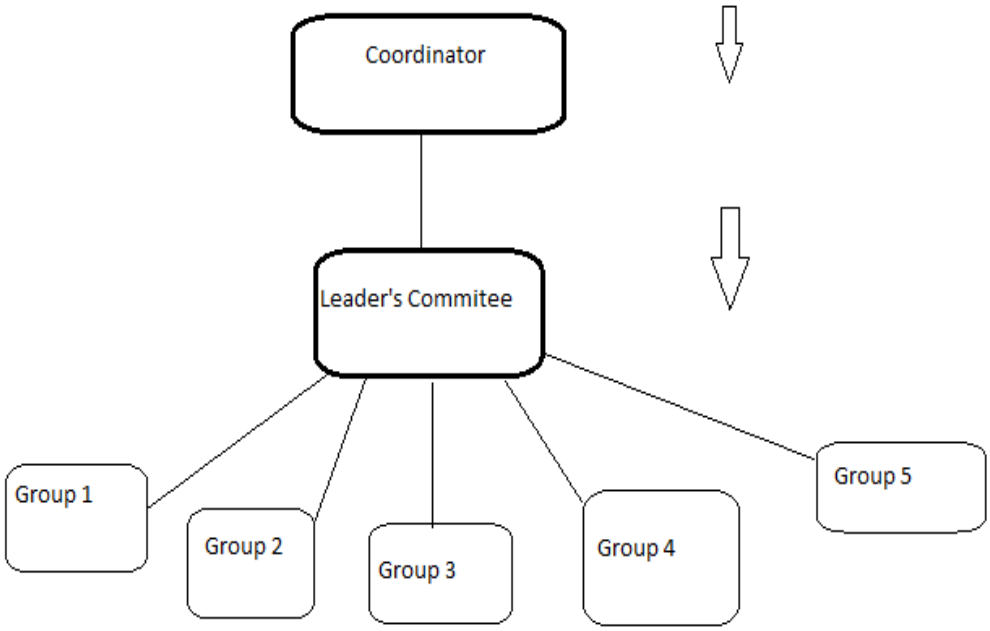


Figure 11 :Proposed leadership pattern

The people who are going to participate in the committees need support and training according to *Stevenson 2008*. The points that need to be addressed in order to help the committee members are:

1. Special training about their responsibilities and their boundaries against the volunteers
2. Realization of the importance of their contribution to the event
3. Behave to them as paid personnel which can increase their level of responsibility
4. Keep communication with them all the time because of lack of experience they may be come against issues they have never encountered before
5. Create an atmosphere of cooperation among them
6. Reward them

Even though different volunteer group would probably have different tasks and responsibilities they should be able to support each other when an emergency occur , so mixing the groups in some tasks together can create cooperation and communication(Stevenson, 2008).

"Volunteers in fact need better management than paid workers in a number of respects, such as recognizing volunteers and ensuring they are happy undertaking the role they are in"
Mrs Grear , CA 2008

During the beginning of this section we numbered the tasks that the volunteers should do but some of them need to be described in more detail in order to achieve a more sustainable event.

4.1.1 Communication

During the paper problem section the proposal was to shift from paper printing information to electronically distribution of the desired documents. This specific idea can cause confusion to people that are not accustomed with such practices (even though the percentage will be low regarding the high percentage of smartphone users).

Communication skills play an important role to every volunteer and it has three different categories of understanding which are (Reis and Geller, 2010):

- What the volunteer says
- What the participant hears
- What the participant interprets

That is the reason why the volunteer must explain as more simple as he/she can using virtual examples (download a document in his/her phone) in order for the student ti understand it better (Reis and Geller , 2010). At the same time socializing in such event is considered the best solution in order to acquire information from fellow participants through activities but also through abetment from the volunteers, can create a network through the participants. For this reason the type of **assertive** communication has choose which has characteristic that matches the needs of such an event. Those are (Reis and Geller, 2010):

- Direct
- Strong with neutral voice
- Influence's people
- Active listener
- Confident
- Depend on body gestures

The type of communication can play a drastic role also to the persuasion of the participant to follow a desired suggestion, in this case to use the recycle bins in order to dispose personal waste (Reis and Geller, 2010).

Waste management task

Waste problem is a crucial task that costs the ICU almost 3000 euro's per event (ICU data) and the methods the authors proposed tend to create an environment with less materials than the previous event so less waste. Nevertheless, even the material flow that is left can create an unpleasant sight and loss of recyclable material. For this reason recycle bins can be put to the various sites of event and the group of volunteers can find through the map (see section Goodie bag) as well as the tour that can be offered around the venue from the volunteers.

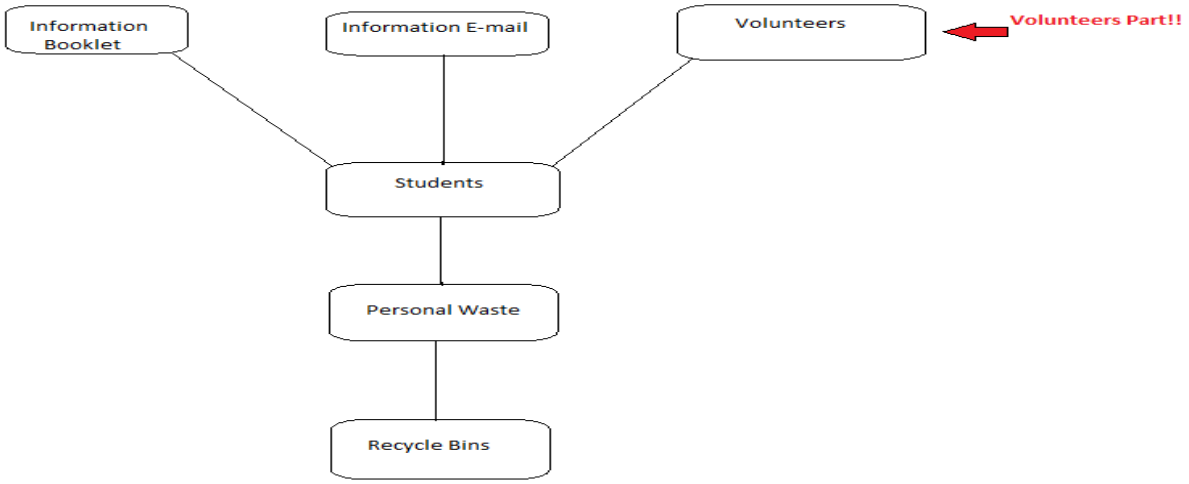


Figure 12 : Volunteer's part in the waste management

Sponsorship

During the sponsorship paragraph above, it was mentioned that volunteers can help in order to decrease the numbers of flyers or non-needed material. Through communication or during the tour can encourage the students to visit the sponsorship kiosks that will exist around the venue. In this it can play an important role the presence of some volunteers outside the kiosks where they can communicate with the students.

Data and material gathering

Data is a crucial part of the event, the presence of data can create a better understanding of the current situation and give foothold for even better policies in the future (ASA, 2003). For example how many of the booklets were actually used in order to account for a larger or smaller number in the future.

The behavior and motivation of volunteers is crucial as it was mentioned above, the coordinator must create a positive atmosphere and use motivation word to them and the information that they receive must be consistent and specific in order to avoid confusion (CA, 2008).

Express the gratitude and the appreciation about their work in the end by sending them a detailed e-mail of how important their work was regarding the smooth organizing of the event and ask for feedback in order to make future events better (Stevenson, 2008). At the same time, inform them beforehand for a party or specific perks that they can have after the event which can inspire them to do even a better job and ask them for feedback in order to improve the event next time in terms of planning, volunteer training and even new ideas (Stevenson, 2008).

Free will

Something that was left for the last part in order to note its importance is the free-will of the volunteers as the word volunteer means that someone is willing to take part in an event (UNV, 1999). Forcing the volunteer to do something that he/she can't is not something that will help the event and the general friendly atmosphere that must be built (UNV, 1999). Even though many people have reasons for volunteering (acquire or honing job skills), the word volunteering is

drawing boundaries by itself meaning that they cannot be forced to do things they don't want (UNV, 1999).

4.1.2 Time Management

Time is an essential tool for planning thoroughly an event, reducing the possibility for mistakes, miscalculations and mistreatment of various aspects of the desired event (Mancini, 2003). What is Time Management?

"Managing time means taking more control over how you spend your time and making sensible decisions about the way you use it."

Bradley , 2007

The various key points of Time Management are (Bradley, 2007):

- More tasks completed in less time
- Time control
- Consuming time in more crucial tasks
- Avoid last minute call's

Many of the proposal's that are listed in the various sectors of the report, describe time as an important factor for their best application. It is logical to understand the meaning of this as sustainability needs time and cannot happened suddenly (De Vries, 2013). By starting the most crucial points that the ICU have to take into account are (Mancini, 2003):

1. Project Management activities
2. Planning
3. The exact series of the activities that will take place
4. Supply
5. Other variations that may affect the UIT event

The first that must be set up is a work plan or better an activity list, where all the work that have to be done in order to complete the project must be written down (Heldman,2002). All the data and plans must be put in that list and spent time in order to elaborate it as good as possible because extra activities or plans that will take place in the last "minute" will cost extra money (Heldman, 2002).

After writing down the activities, the next step is to map them in order to acquire a visual image of the event and all the different variations in it like:

- Combinations of similar activities (Mancini,2002)\
- Dependencies of sponsorship, food, electricity and so forth (Heldman,2002)
- Obstacles (Heldman.2002)

Next step is the creation of a working network (Heldman,2002) and assign different tasks to people that have the knowledge/experience to handle (Zhyzhneuski). Moreover, the help of the technology cannot be overlooked because electronic archives are more efficient regarding time consumption(Mancini,2002) than paper based ones (as it was mentioned on the paper sector) and through electronic calendars can divide the daily tasks and file the reports that the different members will give(Zhyzhneuski).

At the same time except from planning and archiving, monitoring the entire process and it's efficiency concerning time is crucial that why certain time duration for every activity must be decided (PMP, 2002).

The work of manager is difficult because he/she has to oversee all the preparations and decide if they are efficient or not and act accordingly (Bardey, 2007). That's why from the fear of not wasting time many of them find themselves wrapped in the time schedule not being able to bend it towards any change, resulting in an **activity trap** (Bardey, 2007). Traps like these are costing money, time and can be solved through cooperation and change the routine pattern to a more efficient one, if they have too(Bardey,2007).

In order to avoid these traps, in the first place details of every activity must be documented (as it was mentioned above) but be able to shift into a more efficient and flexible model if the conditions demands it (PMP, 2002).Also, a nice pattern of Urgent/Non-urgent activities/tasks is proposed, in order for the committee not to get panicked with non-urgent details (MTD, 2010).

It was decided to leave some important aspects of time management of the event in order to describe their importance in more detail. Those are (MTD, 2010):

1. The budget
2. Supervisor
3. Needed tools
4. Profit (Not always monetary)
5. Volunteer coordinator appointment

<u>The budget</u>

It is understood by reading the report the lack of material usage in order to fulfill the various needs of the event proposing electronic replacements and combining sponsorship with catering. This can have an important decrease in money spent for material and increase investment in improving the quality for activities, which is something preferred from the students than spending money in booklets*.

<u>Supervisor</u>

Above it was described the different angles the planning of an event can have, these must be supervised by the managers (PMP, 2002), that will define the budget, the timeline, will distribute the different tasks (Pardey , 2007) and set up the meeting (MTD, 2010). The spot of a manager is crucial because he/she has more than one task and shoulder the weight of the final outcome of the project (MISAC, 2007). As with the volunteer coordinator the same can be indicated about a good manager have certain attributes (Wagner and Harness, 2006):

- The ability to make decisions under difficult circumstances
- Contribute to the work and not only "order"
- Build up boundaries between the manger and the employer but without affecting the working atmosphere
- They are charismatic
- Have ability of communication
- Influential toward the subordinates

Fair and Impartial

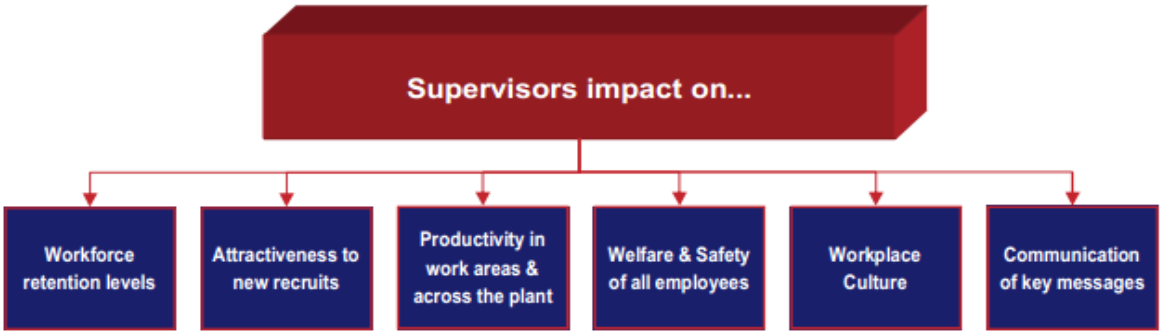


Figure 13 : Aspects of a good manager , Source : MISAC , 2007

From all of the above it is understood that the person that will manage the whole planning of the UIT event plays a key role in the smooth implementation of the new initiatives that were decided.

(More information on : Conducted Survey**)*

Needed Tools

The tools that are needed for planning an event beforehand with great success is adequate data. Through data calculations and number approaches can be made in order to have a clear plan and account for the different uncertainties that may be created. After that limiting the uncertainties is the next task which can happen through research or creative proposal of the members that organize the event (Barrett , 2008).

"Imagination is more important than knowledge."
Albert Einstein, Barrett, 2008

Profit

Profit of the event is something that is not only measured in money. As mentioned in the introduction of this research, the UIT represents the image and advertisement of UU which can lead to more student applications towards university but also attractions of new investors. The implementation of new unprecedented indicatives can create a positive view to the students but also the public view, which can boost the already good image of the university and promote the Sustainable Uithof program. As it was advised time is needed for new "ideas" in order to be applied and organized properly, so through this time managements is proved to be crucial.

Volunteer coordinator

In the previous sector, we addressed the importance of appointing a volunteer coordinator and the main elements that he/she should possess in order to be considered successful. Nevertheless, the appointment of such a key role cannot be a last minute decision it needs time, thorough interviews and time for the final decision.

From all of the above the importance of time management becomes obvious and it is crucial for

a number of initiatives that were proposed like:

1. Information online about the “Green” turn of the Event
2. Available material online
3. Volunteer planning
4. Wi-Fi “branch” creation
5. Sponsorship management
6. Catering
7. Reducing cost through bargaining deals
8. Creation of an e-mail that will be send to every participant after the registration or some days before the event , consisting of all the needed material

4.1.3 Human Factor

During the paper sector the human factor was mentioned regarding the crude numbers that was taken (about smartphone possession) and that can be applied to numerous other cases (Shappell and Wiegmann, 2000). Those are:

- How many will upload the needed material on their phone
- How many will follow the guidelines of the volunteers
- Other errors may occur

According to *Shappel and Wiegmann , 2000* there are three types of error that a person can do :

★ Decision Errors (which are dominant in our case)
★ Lack of skilled errors
★ Perceptual errors

One way to minimize the human factor is the environment that the participants are going to find. As in a working place or education, the shame can be said about entertainment, the environment that the participant meets is a factor that cannot be neglected (Mourlas et al, 2009). The students must not feel obeyed to recycle their personal wasted but ethically obligated. The authors by examining the volunteer training found in Stevenson, 2008, came up with some propositions regarding the **acclimatization** of the students to their obligations through personal interaction with volunteers or by information beforehand:

- Tour by the volunteers in order to have a visual contact of the recycle spots
- Information speech that will make them realize the goal of the university
- Make them feel part of the goal , of a more Sustainable Uithof
- The online documents must contain information about the sustainability “color” the event posses
- Images and mottos are important also because visual messages can be imprinted in the memory better (Victoria, 2012).

The last remark can be also found in the research that was found in the book Introduction to Psychology (Introduction to Psychology) among game users that were asked to play violent and non-violent games to see the impact on their behavior, because the hypothesis was that viewing violence may result to actual violence.

5 Electricity generation at the UIT

At the several UIT event locations, generally large tents are placed to facilitate the activities. The tent and installed equipment need a permanent supply of electricity in order to support the numerous electrical appliances used for the event. According to the ICU, electricity at the event locations is provided mainly by the use of diesel generators. This type of electricity generation takes place locally, and as such is fundamentally different from the centrally generated electricity of the grid. Such decentralized electricity generation however is highly suitable for the mobile and temporary nature of events like the UIT.

In order to make an analysis of the sustainability performance of electricity generation at the UIT, characteristics of diesel power generators and the actual costs and energy consumption at the UIT are described. Further information on power generators in general, and power generation in developing countries is included in the appendix. Finally, a conclusion on electricity generation at the UIT is given, containing suggestions and recommendations for more sustainable generation.

5.1 Diesel power generation at the UIT

Electricity is used during Utrecht University introduction week during 4 days at 5 different locations. That is the main reason why diesel power generator which is portable seems to be a suitable option.
We collected information about the total amount of money paid for electricity during the introduction week. From this we can derive the amount of diesel consumed during the introduction week.
Price paid in total for electricity = 40 030 euros.
Since electricity is produced from diesel generator, we can take into account a price of diesel fuel, which is 1.5 euro per litre in the Netherlands (Petrol prices, 2014).
We can just make a rough estimate of how much diesel had been consumed since we do not have actual data about it.
We take 20 kW generator as an example. 20 kW generator operating at ¾ load will approximately burn 4.9 litre of diesel per hour. You get than 15 kWh of electricity from the 4.9 litre of diesel fuel. Therefore you need 0.33 litre of diesel per kWh of electricity. The initial investments have to be regarded also and they are roughly estimated for a period of 10 years. It adds 5.5 cents per every kWh (Answers, 2014). Operation and maintenance costs also have to be regarded in equation. They are considered to be about 0.18 euros per kWh (Energy Find, 2010).
0.33 litre of diesel costs 0.5 euro. The total price of diesel generated electricity is therefore 0.5 euro plus 0.055 euro plus 0.18 euro and that is 0.735 euro per kWh of produced electricity.
Since total price paid for electricity has been 40 030 euros, we can divide it with 0.735 euro. We get the information that 54 462,6 kWh of electricity had been produced and consumed during the introduction week. The amount of diesel consumed during introduction week is therefore 17 973 litres.

We can now make a comparison table with information on costs and fuel consumption during Utrecht University introduction week:

Price paid for electricity during UIT (in euros)	**40 030**
Amount of electricity produced (in kWh)	**54 462,6**
Amount of diesel consumed (in litres)	**17 973**

5.2 Recommendations for electricity production at the UIT

The main field of interest in how to make electricity production during the UIT more sustainable is not in changing the fuel, since diesel generators are more efficient, require less maintenance and emit less greenhouse gases than other type of fossil fuel generators (Soshinskaya, 2013). As electricity is needed on a temporary and flexible (mobile) basis, connecting to the grid can also not be considered an optional solution. As such, reducing the emissions of diesel fuelled electricity generation is the main target for improving the sustainability performance of the UIT with regard to electricity.

We can look at a research made by B.M. Penetrante from 1997 in which option of removal of NOx from diesel generator exhaust by pulsed electron beams is mentioned. This option has been already used in industry and in power plants. That way exhausts from a diesel generator would contain much less NOx, improving the environmental performance. There are also other options available to reduce NOx in diesel exhausted. One of them is called Exhaust gas recirculation (EGR). During EGR, some of the exhaust gases are re-circulated into the engine and mixed with the air in the combustion chamber. This lowers significantly the adiabatic flame temperature and lifts the heat capacity of the mix allowing for combustion at a much lower temperature and therefore reducing NOx production. There is another method for reducing NOx exhausts during diesel combustion. It is called Selective catalytic reduction (SCR). This method is using a catalyst such as for example anhydrous or aqueous ammonia even or urea in order to transform NOx into diatomic nitrogen and water. This method is widely known to reduce NOx emissions from 75 up to 95% (Recent advances, 2013).

Another innovative option of making electricity production during the UIT more sustainable is to improve the efficiency of the diesel generator. This can be achieved by adapting some technical features of the diesel engine. Combustion chambers in which diesel is being combusted need to have a suitable size in order to achieve maximum combustion rates. Advanced Common-Rail Fuel Injection is also an excellent option. It means that the system of fuel injection into engine is electronically modified. Digital control instead of analogue control of diesel generator during production is also a better option (Recent advances, 2013). Although the research by Penetrante (1997) shows that technical solutions for emission reduction from diesel powered generators exist, most of these technologies have not yet exceeded the pilot phase for actual usage at events. The Dutch companies Bredenoord and Dura Vermeer however, have started large scale implementation of hybrid generators at construction and infrastructure projects (Dura

Vermeer, 2013). Implementation of the ESaver, rented by Dura Vermeer, can reduce fuel use by 40%, significantly reducing associated emissions (Dura Vermeer, 2013). The ESaver technology works by linking the used generator to a set of batteries, allowing the generator to run at the most efficient operational configuration at all times (Dura Vermeer, 2013). As a result of the reduced fuel use, total rental and usage costs can be expected to be reduced by implementing the ESaver. In sum, the ESaver as rented by Dura Vermeer provides an interesting opportunity for the UIT to reduce the environmental pressures caused by diesel powered electricity, at the same time reducing costs.

6 Discussion

Over the course of this research, environmental pressures of material and energy use at the UIT has been evaluated, and suggestions for improvement have been made. Due to a lack of specific information about actual usages at the site and actual production and processing figures of the materials used at the UIT, general literature on environmental pressures of the different industries has been used for the evaluation. As such, the data presented in the cited literature are considered to be valid for paper, plastic or diesel generators in general. Hence the associated pressures are considered to be representative for the environmental pressures caused by the UIT. However, case specific differences might be significant, and actual environmental pressures might differ per diesel generator, paper production facility or plastic bag manufacturer. Estimates of environmental pressures caused by material and energy use at the UIT should thus be seen as rough approximates.

Recommendations made in this research should provide a guideline for steps to be taken in order to reduce the environmental pressures caused by the UIT. As such, these guidelines do not assure the full accomplishment of a fully sustainable event, nor are they inclusive of all steps to be taken for a successful event. Within the limitations of this research, it is sought to provide a grounded foundation on which sustainability improvements can be made.

7 Conclusion

In accordance with the ICU and Green Office, a set of key domains were chosen to assess the sustainability performance of the UIT. These domains are: plastic, paper and electricity. For each of the domains, an analysis of the current state and pressure on the environment was conducted. Plastic was found to be used at the UIT in considerable amounts, in the first place as a container for the goodie bag handed out at the start of the event. The ICU has indicated to have considered shifting to jute bags due to the alleged environmental pressure caused by plastic production and the unsustainable image of plastic bags. The use and production of plastic bags indeed possess a significant threat to the environment. Main attributors to this threat are the use of energy and associated emissions, and end-of-life related pressures. Among this end-of-life pressures are; emissions through incineration, disturbance of the natural environment (especially in the oceans) due to the long breakdown of plastic and pollution of aquatic and terrestrial fauna. In sum, these are the environmental pressures related to plastic usage, to which the UIT contributes by handing out 4000 plastic bags at the start of the event.

For the improvement of the sustainability performance of plastic bags, first opportunities of recycling were assessed. Although such opportunities look promising, they have not been implemented on a large scale yet, and economic feasibility has not been researched. Suggested alternatives for the plastic bag include: HDPE (conventional) with pro-degradant additive, LDPE, PP, cotton and jute bags. Of these alternatives, the jute bag was found to be the most sustainable. Jute bags, like cotton, are biodegradable and do not pose the same end-of-life pressures as the other bags do. As jute production is less energy and pesticide intensive, global warming potential of jute bags is lower than cotton, making jute the fabric of choice for sustainable bags and the recommended opportunity for reducing the environmental pressures caused by plastic usage at the UIT. It should be noted however, that to ensure a lower global warming potential is achieved compared to HDPE bags, reuse of the jute bag is essential and should be actively pursued.

In total around 400.000 pages of paper are provided to the participants at the start of the UIT. However, several environmental pressures are found to be related to paper. The production of paper is highly energy intensive, and requires large quantities of wood and numerous chemical additives. Furthermore greenhouse gasses are emitted over the various stages of the paper production process. In sum, paper production is an environmentally intensive industry. Although efficiency of paper manufacturing has significantly improved and recycling already provides a serious improvement regarding environmental stresses, avoidance of paper use should be preferred regarding environmental impact.

Therefore, this report suggests the implementation of an online information provision system, enabling a large reduction of paper use. Hence, the environmental pressures related to paper usage at the UIT are reduced. The finding that a vast majority of students can be expected to own a smartphone facilitates the possibility of implementing the online provision of information. For the implementation of the system a series of steps and considerations should be taken into account. These steps encompass the setting up of a freely accessible WiFi-zone, meticulous time planning and strict organisation, for which the volunteers carry an important responsibility.

For the effective deployment of the potential offered by the volunteers, adequate supervision and training are needed. Further requirements for successful volunteer management are: selection of homogenous groups, experienced and communicative volunteers, experienced, educated and administrative managers.

To support the numerous activities of the UIT, diesel generators are used to supply the necessary electricity. Although diesel generators are more efficient, require less maintenance and produce less emissions than other fossil fuelled generators, diesel combustion still produces unfavourable emissions. As such, electricity generation at the UIT is currently contributing to climatic change, in turn posing severe pressure on the environment.

Several possibilities to reduce the emissions from diesel powered electricity exist. Most of these technologies however are not yet available for rent in the Netherlands. The ESaver, reducing fuel consumption with 40% is a technology that can be rented in the Netherlands through Dura

Vermeer. As a result of the reduced fuel consumption, associated emissions and environmental pressures are lowered significantly. Furthermore, total rental and usage costs are lower when implementing the ESaver, making this an ideal opportunity for the UIT.

In sum, a variety of environmental pressures are currently related to the UIT, and the materials used during the event. Plastic, paper and diesel powered electricity at the UIT all pose significant pressures, and currently provide a hindrance for the UIT to become a sustainable event. In order to reduce these pressures, several possibilities for improvement have been suggested. As with most transitions, a successful switch to a sustainable event hinges on the dedication and determination of the people involved. The goal of this report is to provide these people with a tool to make this transition possible. We hope we have succeeded.

Bibliography

Altalhi, T., Kumeria, T., Santos, A. , Losic, D. (2013). *Synthesis of well-organised carbon nanotube membranes from non-degradable plastic bags with tuneable molecular transport: Towards nanotechnological recycling.*

A portrait of Today's Smartphone User. (2012). Online Publishers Association.

A road map for Jute. (2006). Amsterdam: International Trade Centre.

Bajpai, P. (2012). *Brief Description of the Pulp and Paper Making Process*. Biotechnology for Pulp and Paper Processing.

Barrett, W. D. (2008). *The Importance of Doing Research*. Journal of Undergraduate Psychological Research, Vol. 3.

Basua, G. , Dea, S. S. , Samanta, A. K. (2008). *Effect of bio-friendly conditioning agents on jute fibre spinning*.

Blok, K. (2009). *Introduction to Energy Analysis*. Amsterdam: Techne Press.

Brewis, G., Hill, M., Stevens, D. (2010). *Valuing Volunteer : Management Skills.*

Chemney, A. (2014). *Integrated Marketing and Integrated innovation for your business*. Ignition. Retrieved March 6, 2014, from: http://www.regeneratepl.co.uk/wp-content/uploads/2011/08/Marketing-Innovation-Slides-Edge-Hill.pdf

Connolly, S. (2013). *Diesel Generators in Developing Countries.* My generator blog. Retrieved March 7, 2014, from: http://blog.mygenerator.com.au/diesel-generators-in-developing-countries/

Coppetti, F. C. (2004). *Building Brands through Event Sponsorship – Providing On-site Ausiences with a Vivd Brand Experience.*

De Vries, B., J., M. (2013). *Sustainability Science*. New York, NY: Cambridge University Press.

Diesel Generation Operation Costs. (2010). Retrieved March 6, 2005, from the: http://www.energyfind.co.za/dieselmnu/opcostmnu/139-diesel-operating-costs

Diesel Generators in Developing Countries. (2013). Retrieved March 17, 2014 from http://www.dieselserviceandsupply.com/Generators_in_Developing_Countries.aspx

Diesel Generators: a reliable and clean source of power. (2014). Retrieved March 16, 2014, from: http://www.dieselforum.org/files/dmfile/DTF_powergen_2013factsheet_FIN1.pdf

Douglas, E. , Birch, P. R. (1975). *Recovery of potentially reusable materials from domestic refuse by physical sorting.* CRC Press.

Dura Vermeer *(2013). Bredenoord en Dura Vermeer zorgen voor grootse inzet hybride aggregaten.* Retrieved April 10, 2014, from: http://infra.duravermeer.nl/mediahoek/artikel/1185/bredenoord-en-dura-vermeer-zorgen-voor-grootse-inzet-hybride-aggregaten

Environmental Footprint Comparison tool : A tool for understanding environmental decisions related to the pulp and paper industry (2013). National Council for Air and Stream Improvement.

Event Planning Guidelines. (2008). Oxford University.

EPA. (2010). *Available and Emerging technologies for reducing Greenhouse Gas Emissions from the Pulp and Paper Manufacturing Industry.* NC: U.S. EPA.

EPA. (2011). *Pulp and Paper Manufacturing Final Rule : Mandatory Reporting of Greenhouse Gases.* NC: U.S. EPA.

European Commision. (2009). *Europeans' attitudes towards the issue of sustainable consumption and production: Analytical report*. Flash Eurobarometer: The Gallup Organisation.

FAO (2010). Jute, Kenaf and Allied Fibers. Food and Agriculture Organisation of the United Nations (FAO), Rome, June 2010. Retrieved March 25, 2014, from: http://www.fao.org/economic/est/publications/jute-hard-fibres-publications/en/

Fisher, R., Ury, W. (1991). *Getting to say Yes : Negotiating Aggrement Without Giving*. Harvard Negotiation Project: 2nd Edition.

Guay, J., *Piggyback or Leapfrog? Cell Phone Towers and Community Power*. Compass. Retrieved March 6, 2014 from http://sierraclub.typepad.com/compass/2011/01/sierra-club-india-environment-post-piggyback-or-leapfrog-cell-phone-towers-and-community-power.html

Giannoulakis C., Wang, C., Gray, D. (2008). *Measuring Volunteer motivation in mega-sporting events.* USA*:* Event Management, Vol. 11.

Heldman, K. (2002). *Creating the Project Plan*. Project Management Professional Study Guide.

Inhabitant.com. (2014). Retrieved March 3, 2014, from: http://www.inhabitant.com

Institute of Leadership & Management (Great Britain) (Ed.). (2007). Achieving Objectives Through Time Management Super Series. Routledge.

Jankunaite, D. (2012). *Pulp and Paper Industry*.

Judson, D.S. (2004). *Paper- The environmental catastrophe*. United Kingdom: University of Brighton.

Kramer, K. J., Masanet, E., Xu, T., & Worrell, E. (2009). *Energy efficiency improvement and cost saving opportunities for the pulp and paper industry*. An ENERGY STAR® guide for energy and plant managers. LBNL-2268E. Lawrence Berkeley National Laboratory.

Latham, M. (2003). *Young Volunteers: The Benefits of Community Service*. University of Nevada-Reno.

Leeuwen, A.,Williams, D. (2013). *Plastic Bag Alternatives Much More Costly to Consumers.*

Leeuwen, A. (2014). *Bag Bans : Trading one Problem for Another.* Fight the plastic bag ban.

Lin, H., G., Yang, X., W., Xiong, J., T., Norkhairunnisa, M. (2013). *Reusable Bag Guidelines*. Workplace Safety and Prevention Services.

Mancini, M., & Mancini, M. (2003). Time management. New York: McGraw-Hill.

Mills, C. (2012). *Social network numbers*.

Misseldine, C. (2010). *Green Cities California , Master Environmental Assesment on Single-Use and Reusable Bags.*

More, J. (2013). *Negotiating the price*. Assesing Vendors.

Mourlas, C., Tsianos, N. , Germanakos, P. (2009). *Cognitive and Emotional Processes in Web-Based Education: Integrating Human Factors and Personalization.* Information Science Reference. New York: Hershey.

Ofira, A., Goldratha, G., R., T., Grossmanc, M. (2009). *Reduction of plastic carrier bag use: An analysis of alternatives in Israel*.

Petrol prices in the Netherlands (2014). Retrieved March 6, 2014 from: http://www.mytravelcost.com/Netherlands/gas-prices/

Pulp and Paper Industry Energy. (2006). Bandwich American Institute of Chemical Engineers.

Raskovich, A. (2006). *Competition or Collusion?Negotiating discount off posted prices*. (2006). International Joural of Industrial Organization.

Recent Advances in Diesel Engines & Diesel Generator Sets. (2013). Retrieved March 7, 2014

from: http://www.dieselserviceandsupply.com/Diesel_Generator_Advancements.aspx

Reis, M., Geller, J. (2010). *A Manager's Guide to Human Behavior*. Fifth Edition.

Rogerson, R., Bellingham, R. (2009). *Changing behaviour and attitudes to sustainability: a Report for the Department of Enterprise, Trade and Investment.*

Sappi (2003). *The Paper Making Process : From wood to coated Paper.*

Sharma, K. B., Moser, R. B., Vermillion, E. K., Doll, M. K. & Rajagopalan, N.(2013). *Production , characterization and fuel properties of alternative diesel fuel from pyrolysis of waste plastic grocery bags.*

Shappell, A. S. , Wiegmann, A. D.(2000). *The Human Factors Analysis and Classification System.*

Sign up. (2013). El Cid. Retrieved March 1, 2014 from: http://www.elcidweek.nl/pages/english/21/24/Inschrijving

Soshinskaya, M.(2013). *Integrating Renewable Energy Resources: A microgrid case study of a Dutch drink water treatment plant (Master's Thesis)*, 2013. Retrieved March, 16, 2014 from http://www.google.si/url?sa=t&rct=j&q=&esrc=s&source=web&cd=2&ved=0CDEQFjAB&url=http%3A%2F%2Fdspace.library.uu.nl%2Fbitstream%2Fhandle%2F1874%2F279521%2FM.Soshinskaya.3777065.Master%2520Thesis%2520Final%2520Draftv2%2C1.pdf%3Fsequence%3D1&ei=sLAYU_LYLMTK4ATprICYCQ&usg=AFQjCNFcRfXoLHzUH10ZhlM7dKkOkt4HuA&bvm=bv.62577051,d.bGE

Statement of the American Sociological Association on : The importance of Collecting Data and Doing Social Scientific Research on Race American Sociological Association. (2003).

Stevenon, S. (2012). *All about Sponsorships*. Stevenson Inc.

Stevenson, S. (2008). *109 Ways to Retain Volunteers and Members*. Stevenson Inc.

Stichting Keurmerk Duurzaamheid (2013), Veiligheid en Kwaliteit (KMVK).

Succesful Time Management. (2010). MTD Training.

Sustainable events guide (2007). DEFRA.

Tang H.K. , (1998). *An integrated model of innovation in organizations , tecnovation*. 297-308.

The mobile consumer: A global snapshot. (2013). Nielsen.

The benefits of Volunteering. (2000). NSGVP.

The History of Paper. (2013). Confederation of paper industries. Retrieved March 6, 2014, from: http://www.paper.org.uk/information/factsheets/history.pdf [1 March 2014]

The Value of Volunteering : A discussion paper on volunteering in the community and welfare sector. (2008). Commonwealth of Australia.

The Smartphone Consumer. (2012). Edison and Arbitron. Retrieved March 7, 2014 from: http://www.edisonresearch.com/home/archives/2012/06/the-smartphone-consumer-2012.php

The Role of volunteers in Not-For-Profit Organizations Volunteering and Social Development. (1999). NY: A Background Paper for Discussion at an Expert Group Meeting New York, INECA.

The pulp and paper industry (2007). Retrieved March, 1, 2014 from http://nzic.org.nz/ChemProcesses/forestry/4C.pdf

Thomsen, S.(1997). *Diesel generator power is a sensible choice*. Backwoods Home Magazine. Retrieved March, 16, 2014 from http://www.backwoodshome.com/articles/thomsen43.html

Types of generators (2013). Retrieved March, 16, 2014 from http://www.steadypower.com/pages.php?pageid=55

UNEP , 2012 , Sustainable Events Guide : Give your large event a small footprint

UNIDO (1993). *Paper and Pulp Industry , Output of a Seminar on Energy Conservation in Paper and Pulp Industry.*

United Kingdom Environmental Agency , 2011 , Life Cycle Assesment of Supermarket Carrier Bags

United Kingdom Environmental Agency (2009). Paper and Pulp (EPR 6.01)

US Department of Energy (2005). *Energy and Environemntal Profile of the U.S. Pulp and Paper Industry*. Retrieved February, 24, 2014 at http://www.energetics.com/resourcecenter/products/studies/Documents/pulppaper_profile.pdf

Utrecht and Utrecht University (2014). Retrieved Februare, 27, 2014 fromUtrecht Univercity website at http://www.tedxutrechtuniversity.com/utrechtandutrechtuniversity.php

Utrecht Introduction Time (UIT), (2014). Utrechtse Introductie Tijd (UIT) stapt in duurzame projectgroep. Retrieved February, 12, 2014 from Utrecht University website at http://www.utrechtseintroductietijd.nl/nieuws/30/2013/05/utrechtse_introductie_tijd_uit_stapt_in_

duurzame_projectgroep%3E

Utrecht University (UU) (2012). *Utrecht University Strategic Plan for 2012-2016, Utrecht University: Curiosity-driven, relevant to society*. Retrieved February, 11, 2014 from Utrecht University website at http://www.uu.nl/university/utrecht/EN/profile/profileandmissionstatement/Documents/SP_EN_def.pdf?refer=/university/utrecht/EN/profileandmissionstatement/Documents/SP_EN_def.pdf

Utrecht Introduction Time (UIT) (2014). International Students. Retrieved February, 11, 2014 from http://www.utrechtseintroductietijd.nl/47/welkom_bij_de_uit_2013/international_students

Victioria Certificate of Education Study Design Acreditation Period (2013-2016). Publish by Victorian Curriculum And Assestment Authority.

Wagner, R., Harter,J.(2006). 12: *The Elements of Gear Managing. Gallup Press*. New Yor, NY.

What makes a good Supervisor? A practical guide for Employers, Supervisors and Team Leaders in the South Australian Manufacturing Industry. (2007). Manufacturing Industry Skills Advisory Council.

Wright T. (1997). *Electronic Records : Maximizing Best Practises*. Information and Privacy Commissioner, Ontario, Canada.

Zhyzhneuski, A.. *Effective Time Management and its importance for construction projects : Time Management techniques and tools.* Retrieved March 10, 2014 from the Academia.edu at https://dit.academia.edu/AnatoliZhyzhneuski.

Appendices

Notes

* The whole pyrolisis procedure can be find in Sharma et al 2013 , it is not completely analyzed here because of flexibility reasons that has to do with the understanding of the reader.

** The process are xplained generally and the most important steps are used i order to make the readed able to understand the intensive industry of paper but not loose focus on the project of sustainable Uithof

***Pulp from the digester has a Kappa number of 20-35 for softwood and 15-20 for hardwood (hardwood contains less lignin and can therefore be cooked to a lower Kappa number)

**** The 3 steps are not going to be discussed for the same reasons as appendix point number three. The authors are referring the readers to EPA, 2010 for more analytical information.
***** The unit used in the study was originally Btu but the authors prefered MJ , so there is a conversion.

Paper and pulp creation process

Material Consumption

Paper is manufactured from cellulose wood fibres and agricultural remnants, furthermore paper can be produced by recycling disposed paper (Bajpai, 2012). Generally wood is the main source for the cellulose fibers. In developing countries however, almost 60% of cellulose fibers that are used for paper making, is compiled from non-wood materials like bamboo or jute (Bajpai, 2012). There is a variety of methods and different scientific applications that are used during the production-process of paper. Among which are; thermomechanical, mechanical, chemical and chemi mechanical methods (Bajpai, 2012). According to EPA (2010), the major steps during the production-process of paper, each having its specific pressures, are:

- Wood-fibre preparation
- Pulping
- Bleaching
- Chemical Recovery
- Pulp Drying/Papermaking

Wood-fibre preparation

At the start of the wood-fibre preparation phase, wood or paper inputs are transported using ships, trucks or trains to a storage area. From this storage area the inputs are transported to the slasher, where the wood or paper inputs are processed to a suitable size and form in order to be used in the pulping process (EPA, 2010). If the inputs are delivered ready-processed, this step is unnecessary and inputs can directly be passed over to pulping. Generally, processed wood is chipped and the logs have their bark removed using a hydraulic or a drum debarker (EPA, 2010). The removed bark is than used as a fuel during the next processes of the paper manufacturing (EPA, 2010).

Wood inputs are preferably provided by conifer trees, as these produce longer fibres. Longer fibres result in a stronger fibrous web, which in turn produces a higher quality of paper (Sappi, 2003).

Pulping

One of the goals of pulping is to remove lignin from the wood in order to be able to extract the pure fibres from the pulp (Sappi , 2003). Lignin refers to a group of dimensional polymers, aromatic acids and hemicelluloses (Bajpai, 2012). This group of chemicals, referred to as lignin, is what provides trees simultaneously with their strength and flexibility. Lignin, among others, is also what provides the wood and pulp with its characteristic brown color. Untreated, this brown pulp can serve as an input to brown paper or cardboard (EPA, 2010).

From the various methods of producing pulp, kraft pulping is the most widespread (mechanical pulping being the second). The word “kraft”, meaning strong, is derived from Swedish, and as such, kraft pulping produces a strong pulp. This type of pulping can be used with all kinds of wood and is highly suitable for chemical recovery (Johnson and Packer).

Despite the advantages of the kraft method, one of the disadvantages of the method is its use of sulphite (EPA , 2010). The kraft pulping process uses an acidic mix of HSO3 and H2SO3 , while during the preparation of cooking phase sulphur gas is send in the water (EPA, 2010) making the resulting pulp inherit all these fetid compounds(Bajpai,2012).

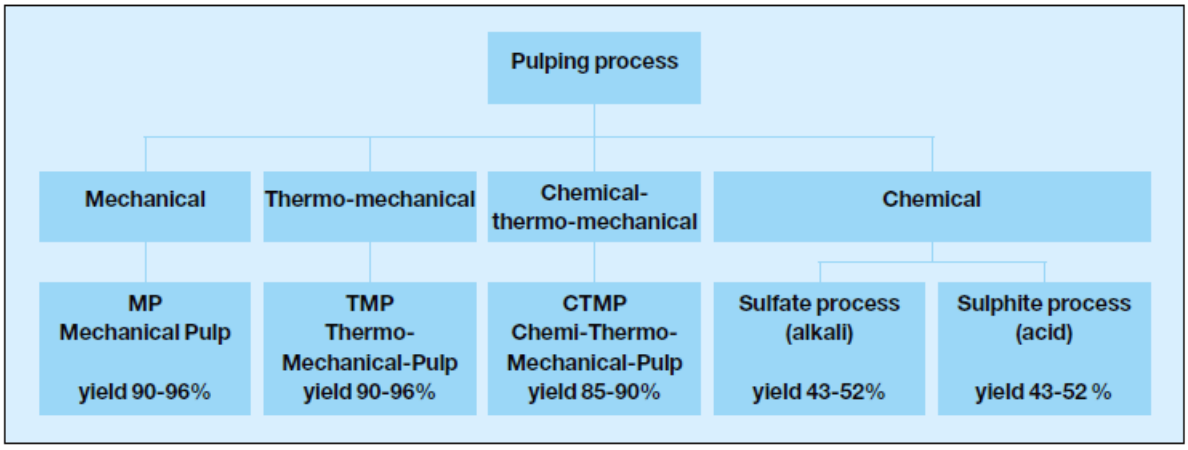


Figure 1: Pulping process. Source: Sappi, 2003

Bleaching

As mentioned before, at the end of the pulping phase the pulp has acquired a brown colour. As such, the pulp needs to be bleached in order for the paper to acquire it’s bright white color (Sappi ,2003). Part of the bleaching process is to remove half of the remaining lignin. For this, a method called oxygen delignification is applied (Johnson and Packer). During the bleaching process a wide range of chemicals is used, commonly consisting of the following (EPA, 2010) :

- Chlorine dioxide
- Oxygen

- Chlorine
- Sodium hypochlorite
- Hydrogen peroxide
- Chlorine dioxide

The bleaching process consists of many chemicals process steps, each step requiring an important amount of water (Sappi,2003). Traditionally, CL2 was used in the bleaching process, posing serious environmental concerns. Among these concerns are the consequential production of chlorinated organic compounds, dioxins , chloroform and furnas (EPA , 2010) and considerable amounts of COD/BOD in the water (UK.EA , 2009). In modern production facilities, generally no *elemental* chlorine is used (Johnson and Packer). These so called elemental chlorine free plants (ECF) often use the more environmentally friendly chlorine dioxide. Bleaching properties of chlorine dioxide are however less, resulting in higher effort needed in order to reach a satisfactory level of white. An even more environmentally friendly type of plant is the total chlorine free plant (TCF). For this type of bleaching process however, even more effort is needed, and generally chemical costs are higher (Johnson and Packer).

In TCF plants however, bleaching fluids are put in the recovery boiler, for steam generation. This steam in turn produces electricity, at the same time resulting in a reduction of discharged pollutants (Bajmai, 2012).

Picture 1 : Left un-bleached pulp - Right : Bleached pulp, Source: Sappi, 2003.

Chemical Recovery

Overtime, pushed by environmental and economic considerations, several ways to recover spend chemicals in the paper production process have been developed (EPA , 2010). For the kraft pulping method, a chemical referred to as “weak black liquor” is recovered and reused in the process (EPA , 2010). The process of chemical recovery involves the combustion of organic compounds, reduction of inorganic compounds and the reconstitution of the liquor (EPA , 2010). According to EPA (2010) the steps for chemical recovery are**** :

1. Black liquor concentration
2. Recovery furnace
3. Causticizing and calcining

Pulp Drying/Papermaking

The final step of the paper creation is the pulp drying and actual paper making. The processes described above were concerned with the bleaching and pulping. After these processes the pulp goes to stock preparation (Bejpai, 2012), in which the pulp passes through a refiner (Sappi, 2003). In the refiner, pulp is cut or fibrillated by rotating and stationary blades (so called rotors and stators). During the refining process, higher density and strength is achieved. Furthermore in the refiner, additives like waxes, clays or talcs are added to the pulp giving the end product desired characteristics regarding e.g. printing effect and brightness (EPA, 2010). The refining process can be divided into the following steps (Bejpai,2012):

- Dispersion
- Beating/Refining
- Metering
- Blending of additives

Depending on the raw material provided, and the quality requirements of the end product, steps can be shortened or even skipped (Bejpai,2012).

Finally, the pulp fibres are diluted and spread out over a meshed surface. Next, water is removed by suction and the resulting fibrous patch is pressed and dried to produce the end product.

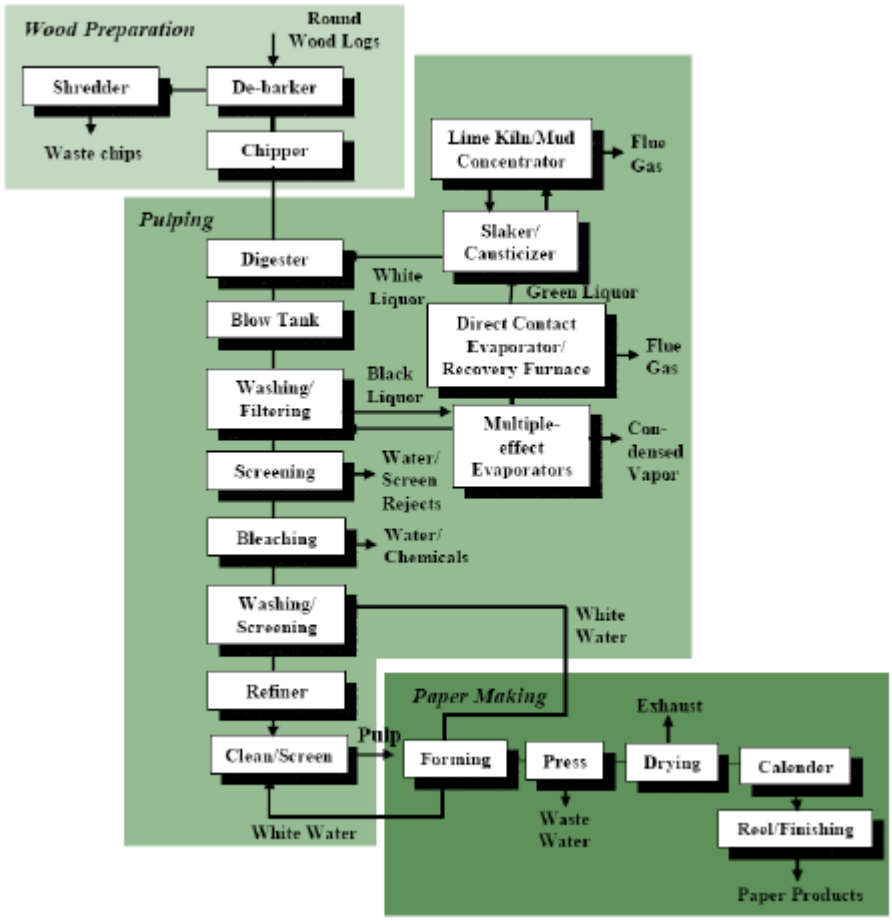
By going through the 5 steps of paper making it can be surely understood that paper and pulp industry requires large amounts of energy and materials like:

- ➔ Wood (or other replacements)
- ➔ Large amounts of water in each phase
- ➔ Electricity (extensively discussed below)
- ➔ Various chemicals (e.g. chlorine dioxide)

Nevertheless, various steps have been taken to increase material and energy efficiency:

- ➔ Water is being re-used in most steps
- ➔ Chemical recovery after the creation of the pulp
- ➔ Use of more environmentally friendly chemicals

➔ Re-using heated steam in order to heat other processes or generate electricity



Picture 2 : Paper making process, Source: EPA, 2010

Energy Consumption

Like in most industrial processes, paper production requires energy for each of the production steps: gathering of raw materials, processing of raw materials, bleaching and refining of the pulp, diluting, pressing and drying of the paper and eventually; distribution of the end product (UNIDO, 1993). Within industry in general, overtime processes have become more technology dependent (shift from manual to automatic technology), complex and more efficient (UNIDO, 1993). In this context, more efficiency refers to (EPA,2010 , UNIDO,1993) :

- ❏ Efficient energy management
- ❏ Efficient material management
- ❏ Reducing losses of materials, chemical and energy through operations
- ❏ Reducing overall environmental impact
- ❏ Improving cost efficiency

As paper and pulp industry is well noted for the production cost (UNIDO, 1993), and is highly energy intensive, the industry is also very sensitive to energy price volatility (Kramer et al., 2009). As a reaction, paper and pulp industries have invested in more energy efficient solutions, which include (Kramer et al., 2009):

1. Technology
2. Energy efficiency improvement through operations.

Plants and equipment, even when serving the same usage stage, show a variety of energy performances (NCASI, 2013). A large reduction of energy consumption at paper mills can be achieved by skipping wood processing steps (NCASI, 2013). Besides reducing operational costs and reducing environmental impacts, energy efficiency improvement may result in economic benefits through increase in production quality and process efficiency (Kramer et al., 2009).

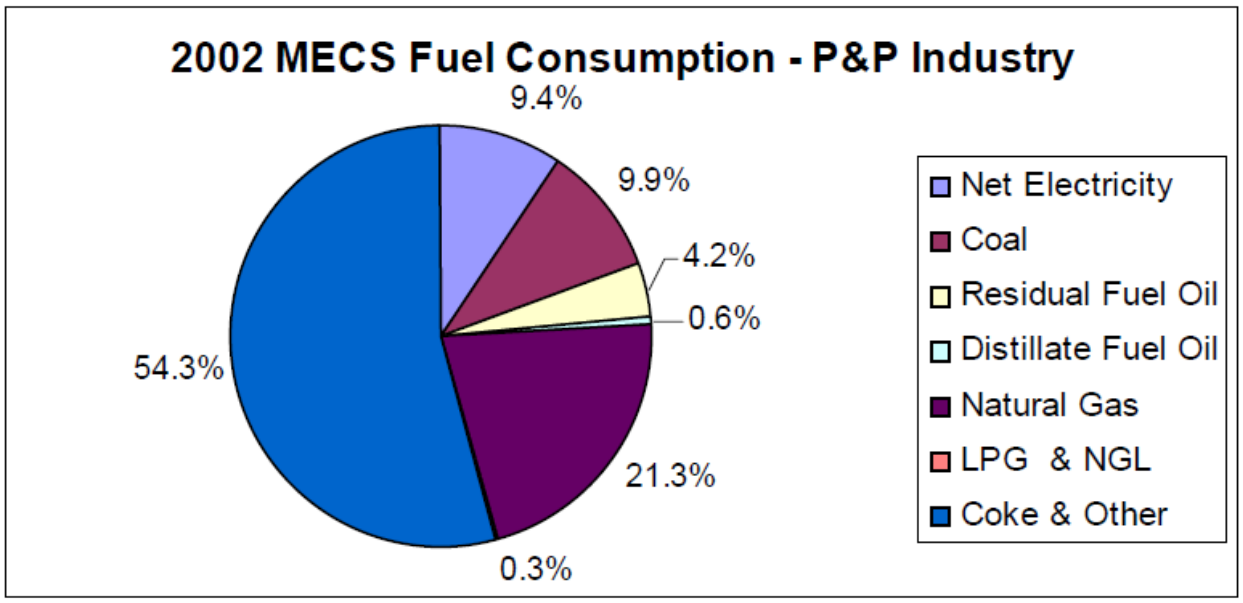


Figure 1: Fuel consumption of Paper and Pulp industry 2002 , Source :AIChE , 2006

Transport phase

In order to understand the energy consumption of the paper production the whole process must be analyzed. One of the first stages in the lifecycle of paper is the transport phase. Wood (among other inputs) needs to be transported from the plantations to the processing plants, as recovered paper needs to be transported to the recycling mills (NCASI, 2013). Even though the energy in the production face is significantly more, the transportation phase cannot be neglected (NCASI, 2013).

Wood/Fiber preparation

As it was mentioned above, energy use in every stage varies among power plants because of different (NCASI, 2013):

A. Equipment efficiency
B. Practices
C. Amount of production

According to the U.S. Department of Energy (2005) ****:

- During the wood preparation debarking has an energy consumption range from 31.7 MJ to 263.8 MJ per ton of pulp.
- Chipping and Conveying has a range of 274.3 MJ to 654.1 MJ per ton of pulp

In the pulping chapter above, it was mentioned that some plants have the ability to skip the chipping process saving a considerable amount of energy of average 464.2 MJ.

Pulping

Pulping is the most complex and time consuming process of the paper manufacturing procedure (Bajpai, 2012). The different processes consume different amounts of energy in all stages again regarding the same parameters (A-C) that were mentioned during the wood preparation stage above.

Analytically (NCASI, 2013) per year pulping consumes:

- Chemical process: 1.37*10^14 MJ
- Semi Chemical process : 1.34*10^10 MJ
- Mechanical : 3.7*10^10 MJ
- Recycled paper process: 4.6*10^10 MJ

Chemical Recovery

According to NCASI , 2013 chemical recovery has a total consumption of 4,5 *10^5 MJ per year.

Bleaching

Another energy and material consuming process is the bleaching, using steam and electricity at an average total energy consumption of 9.1 *10^10 MJ from which :

- Electricity : 1.2 * 10^10 MJ
- Steam : 7,9 * 10^10 MJ

Papermaking

Papermaking has numerous processes that consumes great amounts of electricity, in sum amounting to around 5.85*10^11 MJ per year (NCASI,2013).

GHG emissions

Energy intensive industries, like paper and pulp, generally are considered to produce considerable amounts of GHG emissions (EPA, 2010). According to *EPA (2011)* an industry with 25000 or more metric tonnes of CO2-eq. per year must report its emissions. Pulp and paper industry's emissions predominantly exist of CO2, followed by CH4 and N2O. Emissions are mainly produced by (EPA, 2010)*:

1. Combustion of fuels
2. Chemical reaction of waste water treatment might create CO2,CH4
3. Indirect emissions from outside- energy that is transferred to the mill

*(Anallyticaly the emmisions can be observed on the following board given by *EPA, 2010*).

Emission Source	Million metric tonnes of CO_2e per year[1]	Million short tons of CO_2e per year
Direct Emissions		
Direct emissions associated with fuel combustion (excluding biomass CO_2)	57.7	63.6
Wastewater treatment plant CH_4 releases	0.4	0.4
Forest products industry landfills[2]	2.2	2.4
Use of carbonate make-up chemicals and flue gas desulfurization chemicals	0.39[3]	0.43[3]
Secondary pulp and paper manufacturing operations (i.e., converting primary products into final products)	2.5	2.8
Direct emissions of CO_2 from biomass fuel combustion (biogenic)[4]	*113*	*125*
Process-related CO_2 including CO_2 emitted from lime kilns (biogenic)[4]	*unavailable*[5]	*unavailable*[5]
Indirect Emissions		
Electricity purchases by pulp and paper mills	25.4	28
Electricity purchases by secondary manufacturing operations (i.e., converting primary products into final products)	8.9	9.8
Steam purchases	unavailable[5]	unavailable[5]

Board No 1 Emmisions of paper and pulp industry per year , Source : EPA,2010

Important measures, potentially resulting in significant GHG emission reductions are energy efficiency improvements. As a large share of emissions result from fuel combustion needed to provide energy inputs, energy efficiency improvements have a direct effect on such associated emissions (EPA, 2010, Kramer et al., 2009). Like mentioned above, energy efficiency improvements can have a number of other positive effects; economic benefits, production quality, process efficiency, environmental impact reduction. In sum making energy efficiency policies an important component of a company's overall environmental strategy and a sound business strategy in today's manufacturing environment.

Extra information on power generation

Power generators in general

Depending on their purpose, the following types of power generators can be used (Steadypower.com, 2013):

- **portable RV or recreational generators**:

The innovative technology makes them function quietly. They are mostly used for recreational use and provide the cleanest power for electronics like computers. This type of generators is running on gasoline.

- **portable residential generators**:

This type of generators is mostly used to supply essential equipment in people's homes with electricity when the power-cuts occur (for example refrigerators, freezers, pumps, sump pumps, furnaces, lights, etc.) and sometimes they are also being used around the house (electrical tools, etc.). Most of residential portable generators are running on gasoline, but some exceptions also run on liquid petrol, natural gas or on combination of all three fuels.

- **portable construction & industrial generators:**

These types of generators are being used mostly for industrial applications. We can distinguish between single phase gasoline or diesel models and three phase diesel models. High cycle generators offer 60 Hz power for standard tools and 180Hz power for high-cycle vibrators.

- **mobile towable generators**:

These generators running on diesel are providing bigger amounts of transportable power for many construction and industrial applications. Voltage models that are being switchable are allowing use with several different voltage applications. However, single voltage models are for more defined single voltage applications.

- **standby generators**:

These generators that are stationary are designed especially to supply households with electricity when the power goes out. These generators are often used with an automatic starting and switch systems. Standby generators are also used for agriculture and industrial applications.

- **PTO generators**:

These are mostly used in agriculture.

- **two bearing generators**:

These generators are being supplied with power by a variety of power sources independently running and using a pulley system – often these generators are being used on trucks.

- **vehicle mounted generators**:

These generators are normally part of vehicles and are there for emergency, oil field, spray foam, construction and mining applications.

- **welder generators**:

They are a combination of a generator and welding capabilities all in one unit. They are available as portable gasoline models and as mobile diesel units (Types of generators, 2013).

Diesel power generators

A diesel generator is combining a diesel engine with an electrical generator (or: alternator) in order to produce electricity. Diesel generators are most commonly used in places without

connection to the power grid or as an emergency power supply tool in cases of electricity break-downs.

In order to illustrate costs and efficiency of diesel power generators, a research made by Soshinskaya (2013) is used, in which a 660 kW diesel generator has been taken as an example. This type of diesel generators is widely known as being reliable. Moreover, it can be used at commercial and industrial sites. Their lifetime can be expressed in hours since they are not being used all the time. For this case, we assume that generator has a lifetime of about 15,000 hours and 30% minimum load ratio. Diesel generators are more efficient than the ones that have gasoline as a fuel. They are more efficient in terms of fuel consumption, they need less maintenance and produce fewer emissions than gasoline fueled generators (Soshinskaya, 2013). As such, environmental performance of diesel generators is generally better than gasoline generators. However, diesel generators require higher initial investment costs, which again is compensated over the lifespan of the generator by the use of cheaper fuel (diesel vs gasoline). (Soshinskaya, 2013).
Table below gives us insight into fuel consumption of a diesel generator taken as an example.

kW	**150**	**300**	**450**	**600**
Fuel consumption (l/hr)	**50.0**	**83.3**	**119.2**	**162.0**

Source: Soshinskaya, 2013.

Cost assumptions for diesel generators have also been made in a research introduced. The initial investment for a 600 kW diesel generator is about 65 000 euro using a 1.3 conversion. We also have to regard that at the end of their lifetime, which depends on how often they had been used, the replacement need will occur. Diesel generators are already a sufficiently developed technology and that means prices will not dramatically change over their lifetime. Replacement costs are therefore evaluated to be 90% of the today's investment cost. Table 18 below shows the cost and fuel price predictions which are based on the historical average trend of a 12% increase in diesel fuel prices every two years in the Netherlands from 2004-2012, the price of diesel in 2018 is expected to be 1 777 €/ litre (2% inflation taken into account) (Soshinskaya, 2013).

Category of costs	**Amount of costs (in €)**
Initial investments	0

Replacement	58 500
O & M	8,58/ hours[a]
Diesel price now	1,478/ litre
Diesel price in 2018 (predicted due to inflation)	1,777/ litre

Source: Soshinskaya, 2013.

We can make a comparison between gasoline powered generators and diesel powered generators. Gasoline powered generators have spark plugs which have to be replaced sometimes and also carburetors that demand to be rebuild and serviced from time to time. Diesel powered generators do not have previously mentioned characteristics. Diesel engines consume less than half of fuel needed for the same amount of work than gasoline generators. An average gasoline power generator will normally run for around 1000 hours before needing a replacement or at least a complete service. The average diesel generator will run for about 20 000 hours before being replaced. The fuel itself can also be compared on this place. Gasoline is much more explosive than diesel and that makes diesel a safer option in terms of storage. Emissions that are produced from a diesel engine are proved to be less toxic than ones produced from gasoline. Initial costs for diesel power generators are higher than for gasoline ones. However, after a longer amount of time, calculations tell that diesel is cheaper after the entire life span (Thomsen, 1997).

So, for the conclusion we can assure that diesel powered generators are a more sustainable option than gasoline powered ones. Emissions are not so toxic, costs are lower and consumption of fuel is also lower. After these facts we can recommend diesel as a fuel for generators in order to produce electricity for generators more sustainably. Since a power generator producing electricity for a tent in which most of the activities during introduction week are taking place is running on diesel, this is already a step towards higher sustainability during introduction week.

General characteristics of diesel powered generators:

- **Very quick start-up time**:

In many times 10 seconds or less, other fossil resources need much more – up to 10 minutes

- **Fuel efficiency**:

More energy is released during the combustion of diesel per unit than any other source of commonly used power and that happens due to the chemical structure of diesel itself.

- **Continuous strength**:

Diesel usually provides a very reliable power supply and is capable to handle broader swings in power use.

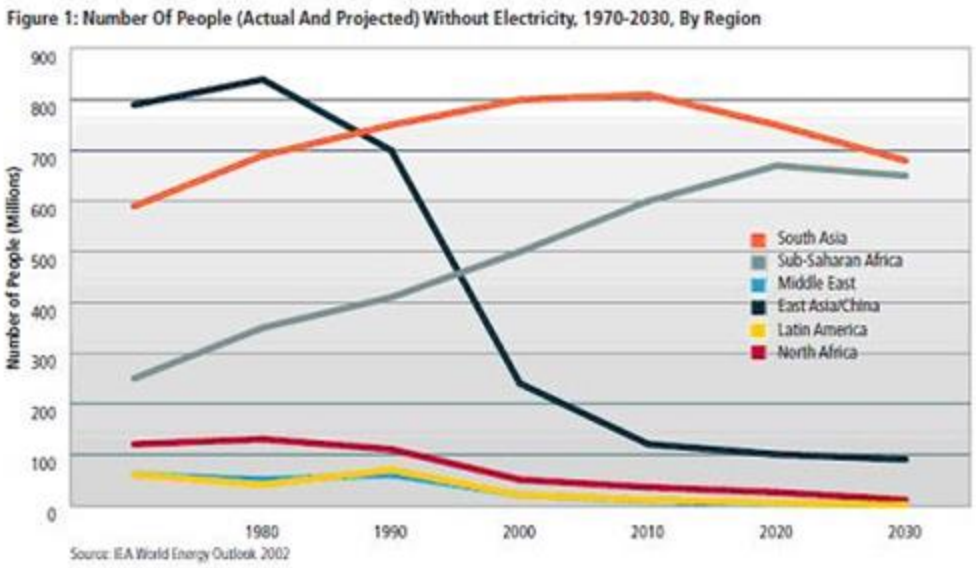
- **Disaster utility**:
  Diesel generators normally have their own reservoir for fresh diesel fuel, which is normally immediately available and can be replenished.
- **Reliability**:
  A diesel generator possesses the ability to generate power very quickly and without interruptions.
- **Portability**:
  Diesel generators are in many cases highly mobile and can be transported to almost every place where electricity is immediately needed.
- **Durability**:
  Diesel generators have a high amount of operational hours. They can function properly up to 20 – 30 000 hours before they are needed to be replaced or serviced (Diesel forum, 2014).

Today's diesel technologies have made combustion of diesel fuel much more sustainable in time. Newest diesel powered generators normally emit 26 times less small parts than those operating 10 years ago. This contributes to improved air quality. Thanks to upper facts, clean diesel power will play a huge role in key sectors of the U.S. economy in years to come (Diesel forum, 2014).

Diesel generators in developing countries

Many areas in developing countries, especially in Africa, have minimally developed grid infrastructure. There are often no sufficient lines to supply consumers with adequate amount of electricity. That happens partly as establishment of wider electricity lines is not economically viable (electricity demand in rural areas of those countries is not high). In those cases, diesel generators are a logical and suitable solution to supply rural areas with electricity. They seem to be very easy to install and they can be either standalone systems or connected to other power production sources as for example wind power plants. In these cases, sufficiently educated staff is needed to maintain the stability of systems. Diesel generators are therefore important and reliable source of electricity in rural areas of developing countries, where electricity is used mostly for irrigation pumping, cottage industries, lighting, rural processing facilities etc. We can mention an example of India, where they use about 4 million small diesel generators in order to run irrigation pumps. Economies in developing world are often growing with a fast rate. This fast growing rate is in many cases connected to development in infrastructure. Diesel generators can in these cases provide round-the-clock power supply also when a grid failures occur (Diesel Generators, 2013).

Figure 1 illustrates very well the number of people without access to electricity by different regions of developing world on a time scale up to 2030. At the moment (2014), the most concerning situation is in South Asia, where still about 800 million people do not have access to electricity. A concerning trend is taking place in Sub-Saharan Africa, where a number of people without electricity is intensively increasing. A positive quote is, however, that by 2030 number of people without access to electricity will have decreased on a global scale.



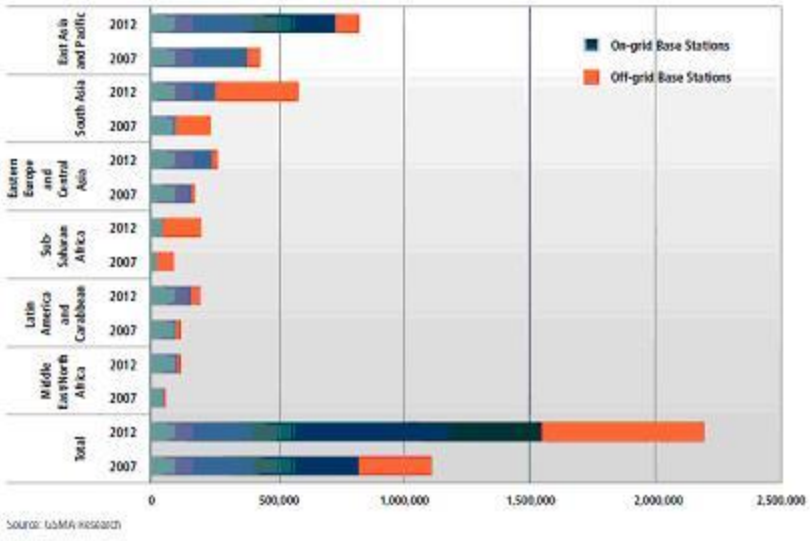
Source: Compass, 2011.

Barge-mounted diesel generators have been used often. Their structure is simple and they are mounted on offshore barges. Single diesel units are available in capacities from 5 MW to 50 MW and they can as well be united together in order to produce more than 100 MW of power. The most important advantage of BMD units is that they are portable (Diesel Generators, 2013).

Electricity demand in developing countries is many times higher than electricity supply. When it happens for example in metropolitan cities of India, power deficits of about 2000 MW occur. Therefore diesel generators can be used as backup power units in commercial and residential buildings (Diesel Generators, 2013).

Figure 4 shows us the actual growth in usage of off-grid base stations (with other words generators) to produce electricity in developed countries worldwide from 2007 to 2012. The most significant increase of generators use can be seen in South Asia, what is consistent with a previously mentioned fact that in South Asia amount of people without access to electricity is highest in the world. A huge increase can be also seen in Sub-Saharan Africa. The lowest increase in use of generators is observed in Middle East and Northern Africa as there national power grids are more widespread and reliable.

Figure 4: Growth in Base Stations in Developing Regions 2007-2012



Source: Compass, 2011.

A major concern in developing countries is a capital cost of power generation. Although diesel generators costs can vary, they are in general a most affordable option compared to other alternatives. Since developing countries often have limited budgets, diesel generators remain a top choice for prime and backup electricity production. Running costs of diesel powered generators involve costs of operation, costs of maintenance and a cost of diesel fuel itself. (Diesel Generators, 2013).

On the picture below we can see a set of diesel power generators producing electricity for rural village in India.

Source: Connolly, 2013.