Sustainability to Implement

A Research about Sustainable, Beneficial and Reasonable Facilities for Zoos and Aquariums

Justine de Herder & Christin Streiter

World Association of Zoos and Aquariums
WAZA | United for Conservation®

University of Applied Sciences
VAN HALL LARENSTEIN
PART OF WAGENINGEN UR

Sustainability to Implement

A Research about Sustainable, Beneficial and Reasonable Facilities for Zoos And Aquariums

---

Bachelor Final Thesis Animal Management

Name: Justine de Herder 870210001
Christin Streiter 870222002

Date: November 2010

On behalf of: World Association of Zoos and Aquariums (WAZA)

Supervisor WAZA: Gerald Dick (Executive Director)

Supervisors Van Hall Larenstein: Maaike Miedema-Coenen
Vincent Pompe

Project number: 59 43 43

Keywords: Zoo, sustainability components, benefit, large-, small-scale projects, ranking, implementation

Source Photo: http://sustainabilityninja.com/wp-content/uploads/2008/11/feature- images/government-industry-sustainability.jpg

Preface

We would like to thank everyone involved in this research. A special thanks to Gerald Dick (Executive Director at WAZA) for giving us the opportunity to conduct and present this research for WAZA and its members. Other thanks to Jo Gipps (Bristol Zoo & WAZA Sustainability committee) for making our presentation in Cologne possible. Furthermore, we are very thankful for the people of the zoos who took the time to fill in the Multi-Criteria Analyses and/or gave us the chance to interview them such as Jens Ove-Heckel (Zoo Landau in der Pfalz, Germany), Dirk Heese and Martina Raffel (Allwetterzoo Münster, Germany), Sue Dow and Katie Clark (Bristol Zoo, U.K.), Joanne Lalumière (Granby Zoo, Canada), Diederik Visscher (Zoo Emmen, The Netherlands) and Alex van Hooff (Burgers' Zoo Arnhem, The Netherlands).
For their support and advice during the many meetings, we also want to thank our teachers and coaches at Van Hall Larenstein (The Netherland) Maaike Miedema-Coenen and Vincent Pompe. Finally, we could not have conducted this research with out the support of our friends and family.

Justine de Herder & Christin Streiter
November, 2010

Final Product

Popular Science Article
‘Sustainability to Implement‘

Sustainability to Implement

Facing the threat of climate change and biodiversity loss, sustainability has become an essential public issue. Not only individual households, but also companies contribute to the fight against climate change and global warming by implementing sustainable applications and operations. Particularly zoos, committed to environmental conservation, can and should adhere to sustainable responsibility and moreover act as educating and encouraging institutions toward their visitors.

Climate Change and Sustainability

The main initiator of climate change and global warming is the rising world population which increases the pressure on the Earth's resources and the environment by a rising demand for energy, transportation and food. Climate change is seen as the most significant environmental problem the world has ever faced. It describes the change in warming and cooling conditions including temperature, rainfall and wind pattern. Comparatively, global warming describes the warming of the Earth's surface and the lower atmosphere which is caused by a rising greenhouse gas concentration in the atmosphere. Both processes have an impact on species extinction and partially entail the loss of biodiversity. But there are solutions to these problems. One solution is to mitigate and reduce greenhouse gas emissions. Furthermore, integrating and incorporating sustainability in strategies, policies and philosophies is essential to stem both climate change and global warming. Sustainability or sustainable development describes the process of balancing environmental efficiency, social responsibility and economic viability.

Zoos as Green Institutions

Zoos as conservation institutions should react to the omnipresent reduction of biodiversity, and secure populations and ecosystems in the long term by being leaders of environmental sustainability. By reaching millions of people zoos have the ability to communicate to and educate a large number of people, inspiring and encouraging their visitors to integrate sustainability into their lifestyles. Zoos can make a serious contribution to a sustainable future by implementing sustainability in their policies, strategies and management and acting as an example.

In 2009, research showed that the majority of British zoos have already integrated sustainability as an inherent part of their policies, and are aiming to reinforce sustainability actions and activities in the future. However, there are still zoos which do not have an understanding of the issues, or do not contribute to sustainability. But what deters them from integrating sustainability, and why are motivated zoos not implementing sustainable elements to a greater extent? One explanation is the lack of financial and human resources which is particularly familiar for non-profit zoos with lower visitation figures. This is also presumed to be the main barrier to zoos investing to a greater extent in sustainable devices. Furthermore, a lack of information could present a further deterring factor for zoos in terms of not integrating sustainable elements.

Guidelines for Zoos

Further research has been conducted to provide guidelines for zoos in terms of sustainable, beneficial, and feasible facilities and operations. Therefore different criteria have been considered to eventually investigate reasonable options for zoos in terms of sustainable development.

- Expenses/costs
- Environmental impact
- Profitability
- Complexity/ Technical realization
- Subsidy / Sponsoring

With the help of a literature review, interviews and Multi Criteria Analyses which were filled in by five WAZA member zoos, it was possible to obtain data which allowed the establishment of sustainable and beneficial devices and operations in terms of small- and large-scale projects.

Surveyed WAZA member zoos:
- Allwetterzoo Münster
- Bristol Zoo Gardens
- Burgers Zoo Arnhem
- Dierenpark Emmen
- Zoo Granby
- Zoo Landau

Beneficial Small-Scale Projects

The following sustainable facilities and operations (brownish squares) are segmented into five sections and are all characterized by:

- Low cost/expenses
- Less complexity to install/ implement
- Positive environmental impact /saving potential
- Profitability to a certain level
- Possible sponsoring/subsidy (depending on country and region)

These characteristics make the following sustainable components perfect for zoos which are aiming to reduce their ecological footprint but are limited by a low or medium budget which does not allow the implementation of large facilities such as wind turbines or biogas facilities.

Figure 1: Selection of high and low ranked sustainability components by five surveyed zoos in 2010

Those who intend to integrate reasonable sustainability elements but want to be sure about a relatively low investment with a high environmental impact should focus on solar energy, time control switches, a green energy supplier, insulated water pipes, waterless urinals, local products, a rainwater harvesting system, repairing leakages or yielding manure.
Despite a low ranking Fairtrade, FSC and MSC products should also be implemented due to their high social responsibility.Zoos with higher budgets should invest in greater facilities such as wind turbines, small scale hydropower systems or geothermal heat pumps.

Overview of Beneficial Small-Scale Projects

Energy & Building
Solar Panels
Time Control Switches
Green Energy Supplier
Occupancy Sensor
Insulation of Buildings

Water
Insulating water pipes
Waterless Urinals
Rainwater harvesting system
Repairing leakages

Waste
Yielding manure to local farmers
Recycling materials

Transport
Bicyle stands/parking area for bikes

Procurement
Local products

Beneficial Large-Scale Projects

So, why are features such as geothermal heat pumps, wind turbines or wave power systems not highly ranked or implemented by many zoos, even though they are supposed to be the most efficient regarding environmental sustainability? This can be explained by the high initial costs, and regarding wind or wave power the effort of implementation, which outweigh the high environmental impact for the five surveyed zoos which on average are medium sized and have a medium visitation figure. For these zoos these installations are considered too expensive. As a consequence these low-ranked facilities present sustainable and beneficial options in terms of large-scale projects which are highly recommendable for zoos with higher budgets. Wind turbines, for instance, require high up-front costs and high operational expenses which most medium sized zoos cannot always afford. But zoos having the financial opportunity could consider investing in this facility due to its enormous energy efficiency and maybe even use the implementation as a publicity event. The same applies for wave power systems which are very expensive and complex to install. This system is known as the most efficient usage of renewable energy resources currently available. So, if a zoo has the financial opportunity to invest, and access to a river or sea, it is highly recommendable to invest in a small scale wave power system due to its high energy efficiency and high environmental impact. Moreover, installing a biogas plant could be the perfect facility for a zoo which produces tonnes of dung each year. These can supply parts of the zoo with energy. This is also possible with a biomass system, which is more focused on combustion and eventually is less expensive in the long run. Additionally, a geothermal heat pump is a very energy efficient facility with a relatively short payback period and a long life expectancy. Also, a water filtration system could be a good investment. It can lead to an enormous reduction in potable water consumption by reuse and recycling. All of these facilities are characterized by high energy efficiency, lower costs as well as a high awareness factor and symbolic characteristic. What is the reason for the low ranking of sustainable certified products such as Fairtrade, FSC or MSC, and why are they not yet procured by some zoos? Certainly, these certified products are not very profitable and cost more than non-certified products. Nevertheless, Fairtrade products score highly on social responsibility as well as environmental sustainability, due to their warrant of sustainable cultivation management and fair conditions for farmers. The same applies for MSC and FSC certified products, while MSC fish is also appropriate and available for feeding animals, which is not known by some zoos. There are already zoos such as the Edinburgh Zoo which have changed the diet of some fish-eating species, from whiting to a new eco-friendly diet of MSC certified hake.

It is particularly important for zoos, which are centres of attraction for millions of people each year, to set an example by implementing symbols for contribution to sustainability. Thus for zoos with higher budgets it is recommended to invest in these applications. It is worthwhile both in terms of high environmental impact and long-term profitability. At the same time, there are numerous zoos all over the world which have already implemented wind- or wave-power system, as well as geothermal and biogas systems.

Examples

The following zoos have already implemented sustainable facilities in terms of small- and large-scale

Photovoltaic System in Adelaide Zoo, Australia

The Adelaide Zoo installed a photovoltaic system with a 10.2 kW output. Thirty four photvoltaic panels are installed on the roof of the panda exhibition. The generated energy supplies the switchboard and contributes to the electrical consumption for the panda environmental management system. Within a 25 year life span the offset of carbon dioxide is about 3.385 kg.

Solar Photovoltaic system

Biogas plant in Toronto Zoo, Canada

Discharge for biogas plant

The Toronto Zoo in Canada installed a 3 to 5 megawatt biogas plant. The implementation cost was about 13 million dollars, but in turn it reduces the gas bill by 1.3 million dollar each year. The zoo produces 1000 tonnes of dung each year, and the generated energy is enough to power 5000 homes.

Wind turbine in Cincinnati Zoo, USA


Wind turbine

The Cincinnati Zoo and Botanical Garden, USA, presents the new Windspire® wind turbine which is 30 feet tall and generates the energy to power the ticketing and membership building. Combined with solar panels, the wind turbine will meet a quarter of all of the power demands for the building. According to the Cincinnati Zoo, installing a wind turbine is a low-cost, safe and energy-efficient method to generate approximately 2000 kilowatt hours per year of energy in average wind speed of 12 miles per hour. This represents one-third to one-fifth of the energy usage of an average U.S. Home, or the operation of a dishwasher and a refrigerator for an entire year (Zoos newest digest, 2010).

Water Filtration System in Melbourne Zoo, Australia

The Melbourne Zoo in Australia which installed a water filtration system which uses rainwater and effluent from the animal enclosures carried in two holding tanks of 895kl. Within 10 months the plant produces about 28,000 kl of recycled water, which is used for exhibit cleaning, pool filling, lawn, ponds, and landscape irrigation.


Water recycling plant building

Light Facilities

CHARACTERISTIC	INCANDESCENT	CFL	LED
1. Life (hour)	750	7500	60,000
2. Number of bulbs	80	8	1
3. Cost of bulbs	\$20.00	\$24.00	\$80.00
4. Watts consumed	100	20	9
5. Electrical operating cost	\$800.00	\$120.00	\$54.00
6. Total cost	\$820.00	\$144.00	\$134.00

Operational Life Cost Comparison

In this table you can see a direct comparison between incandescent bulbs (traditional bulbs), compact fluorescent lamps (energy-saving lamps) and LED bulbs. It is demonstrated the LED lightening is the most efficient type of lighting. The initial costs are four times higher, but the costs are eventually balanced out due to their long life of about seven years, reduction in energy consumption, and low operation costs. A large number of zoos already use compact fluorescent or LED lights, which contribute to lower their energy consumption.

Cooperation

To realize the implementation of sustainable facilities which mostly require high investments, it is essential and crucial to cooperate and collaborate with other institutions. Therefore, it is important to be informed about opportunities for subsidies, which are grants given by the government to promote, for instance, sustainable provisions. There is also the possibility of receiving support by sponsorship, in which an organisation offers goods or money for projects that a zoo intends to realize, and in return the zoo leverages its reputation and media attention to generate publicity for the mutual project. Synergy is another method of cooperation, as it is a mutual promotion of two organisations. Thus for example, a farmer and the municipal utility are investing in a biogas plant where the zoo is the main supplier of dung. In return the zoo receives a part of the produced energy without making large investments.

Conclusion

In order to be more sustainable, it is essential to reduce the ecological footprint of a zoo by implementing and integrating sustainable facilities and operations. This could be achieved with small-scale projects, for instance, solar panels or low light bulbs, or with large-scale projects like the installation of wind turbines or biogas plants. However, this depends on the budget and the opportunities that a zoo has. Particularly for large-scale projects, it is necessary and sometimes crucial for zoos to cooperate or collaborate with other institutions in terms of synergy or sponsorship. Overall, there are many possibilities for every type and size of zoo to implement sustainability on a small- and large-scale, and to lower the environmental impact by balancing environmental efficiency, social responsibility and economic viability.

Article written by Justine de Herder and Christin Streiter, Students of Van Hall Larenstein
October, 2010.

In Association with:

World Association of Zoos and Aquariums (WAZA)

World Association of Zoos and Aquariums
WAZA | United for Conservation®

Van Hall Larenstein-University of Applied Science

Training & Consultancy
VAN HALL LARENSTEIN
PART OF WAGENINGEN UR

Background

Research on Sustainable Facilities in Terms of Small- and Large-Scale Projects

Abstract

Facing the threat of climate change and loss of biodiversity, sustainability has become an essential public issue. Zoos as environmental organisations and leaders in conservation have a sustainable responsibility and could contribute to stem climate change and the exploitation of resources by reducing their environmental impact. With the help of the WAZA Conservation and Sustainability Strategy the WAZA sought to stimulate member zoos to work to¬wards sustainability by reducing their environmental footprint or demonstrating methods for visitors to adopt sustainable lifestyles. The presumed barriers for zoos to integrate sustainability to a greater extent are the lack of financial and human resources as well as the lack of information. Therefore, this research was conducted to gain insight into the status quo of integrated sustainability components in five WAZA member zoos and to reveal reasonable and beneficial sustainability technologies and management implementations in terms of small- and large-scale projects considering financial and operational expenses, profitability as well as environmental impact. This aim was realised by receiving information from interviews, a literature study and Multi Criteria Analyses which was filled in by five WAZA member zoos. The collected data revealed small-scale facilities such as solar systems, rainwater harvesting systems, or recycling materials which cost less, are profitable and have a positive environmental impact. Comparatively, representatives of large-scale projects are wind turbines, biogas plants, or water filtration systems which require higher initial costs, but eventually show higher energy efficiency, and a higher long-term profit. To implement these facilities effectively, particularly large-scale applications, it is essential for zoos to cooperate with other institutions in terms of subsidy, sponsoring, and synergy. Consequently, implementing sustainable applications and operations could reduce the Zoo's ecological footprint and contribute to a sustainable development.

Table of Contents

1. Introduction

The rapid growth of the world population (seven billion inhabitants in 2011) (Population Reference Bureau, 2010) increases the levels of consumption and the demand for energy, transportation and food (National Research Council, 2009, p.1), putting pressure on resources (UNEP, 2009) and the environment (The World Bank, 2002 p.28). This in turn causes environmental degradation linked to poverty (Bruntland, 1987) and global environmental problems such as climate change(Wollard, n.d. p.1). Climate change is seen "as the most significant environmental problem the world has ever faced'' (Grover, 2004 p.3). Furthermore,it reinforces the effects of environmental and socioeconomic changes and problems worldwide (National Research Council, 2009, p.1), such as changes in average climatic warming and cooling conditions (Grover, 2004, p.6) like temperature, wind, rainfall etc (Dawson and Spannagle, 2009, p.190). Most of the world species are adapted to very specific climatic conditions and a temperature rise of 2° C increases the rate of extinction for many habitats and species up to 30 percent which results in a loss of biodiversity (UNFCCC, 2007) and with already a huge amount of endangered species and habitats, a solution by an urgent responsive action is required (Wollard, n.d. p.1).

According to the Carbon trust (2009) every organization should incorporate climate change in their core strategy and policies including investment decisions to move towards a low carbon economy and more sustainable development in order to make a distinctive progress to a more sustainable future (Defra, 2009). The most cited definition of sustainable development is 'development that meets the needs of the present without compromising the ability of future generations to meet their own needs (Bruntland, 1987).

According to the World Association of Zoos and Aquariums(WAZA) (WAZA, 2005. p. 9) zoos as conservation institutions should react to omnipresent destruction of habitat and the reduction of biodiversity of flora and fauna by securing the populations and ecosystems at long term perspective and hence be leaders of environmental sustainability (BIAZA hand¬book, 2008, p.4).

Zoos are predestined to communicate to a large number of people because of its egalitarian appeal and by edu¬cating the visitors, zoos are able to inspire as well as encourage them to take action and to integrate sustainability into their lifestyles, making a serious contribution to a sustainable future (Wollard, n.d.) and to act exemplarily by integrating sustainability into their policies, strategies and management. In 2005 the WAZA published the World Zoo and Aquarium Conservation Strategy (WZACS) which comprises defined standards and policies to achieve the conservation goals, including a chapter on sustainability which seeks to stimulate member zoos and aquariums worldwide to work towards sustainability, for instance, by reduc¬ing their environmental footprint, using green practices or demonstrating methods for visitors to adopt sustainable lifestyles (BIAZA Handbook, 2008. p 2).

This research is commissioned by the WAZA in order for the organization to be able to provide more information to its members about different aspects and recommendations of integrating sustainability effectively in WAZA member zoos and to confirm that several methods of implementing sustainability work efficiently in the practice. Research by Streiter (2010) showed that the vast majority of BIAZA (association of WAZA) member zoos have already partially integrated sustainability into their organization and management whereas a small number of zoos did not yet integrated sustainability at all. WAZA as umbrella organization of these zoos aims to ensure that the potential of zoos and aquariums worldwide is realized in order to contribute to species and habitatsconservation as well asto sustainability in 2020(WAZA flyer, n.d.).

The research discusses factors such as energy and resource management, procurement management as well as waste management which are important determinants to manage future emission levels (Dawson and Spannagle, 2009, p.181). These and more factors which should be considered in the process of sustainable development have been split up by WAZA into Energy management & Building design, Waste reduction management, Water saving management, Transport and Procurement. These are key environmental issues for zoos to consider according to the Department for Environment, Food and rural Affairs in the UK (Defra, 2004). Aspects that have been researched in terms of sustainability and the factors are expenses, environmental impact, profit, effort to install and possibilities for sponsoring or subsidies. With supporting literature and a research among WAZA member zoos, conclusions are drawn about different sustainable facilities, technologies and utilities.

One of the aims of this research is to gain insight into the status quo of sustainability in WAZA member zoos. This aim is followed by the aim to provide information about what sustainable facilities, technologies and utilities are beneficial for zoos in terms of expenses, environmental impact, profit, as well as the effort of implementation and the probability of receiving subsidies and sponsoring, to implement into their management and/or use to become sustainable.

Main research question:

What can WAZA member zoos do to implement/integrate sustainability effectively?

This answer to this question will be supported with the answers to the following sub questions:

Primary research question:

What is the status quo of implemented sustainability components in WAZA member zoos?

Secondary research question:

a) Which sustainable energy and building systems, equipments are yet installed in WAZA member zoos?

b) Which sustainable waste, water, procurement and transport management is conduct ed in WAZA member zoos?

2. To what extent can sustainable facilities, technologies and utilities be reasonable and beneficial for WAZA member zoos?

a) Which sustainable energy and building systems, transport management and equip ments are reasonable as well as beneficial for zoos in terms of expenses, environmen tal impact, profit and effort of implementation?

b) Which sustainable waste and procurement management systems are reasonable as well as beneficial for zoos in terms of expenses, environmental impact, profit and ef fort of implementation?

c) Which sustainable water management systems and methods are reasonable as well as beneficial for zoos in terms of expenses, environmental impact, profit and effort of implementation?

2. Method

2.1.Design of the Study

In order to answer the research questions within this descriptive study amixed methodapproach was conducted combining qualitativeand quantitative data collection techniques. In doing so, semi-structured interviews and a secondary literature study allowed to obtain qualitative data. Moreover, Multi Criteria analyses were conducted to gain quantitative information about the implementation and evaluation of feasible and beneficial sustainability components.

2.2.Study population

To establish a relationship between the obtained literature results and the practical experience in zoos, five different zoos located in different countries were surveyed with the help of the Multi Criteria Analysis.
These WAZA member zoos were selected in association with the executive director of the WAZA, Gerald Dick.Two WAZA member zoos were selected for initial semi-structured interviews whose results combined with secondary literature data defined the elements of the Multi Criteria Analysis which was in turn conducted with the five zoos. Below the particular zoos are listed (for details about the zoo profiles see Appendix II).

Population for Interview:

Allwetter Zoo Münster, Germany (Dirk Heese, technical manager)
Burgers Zoo Arnhem, the Netherlands (Alex van Hoof, Director)

Population for Multi Criteria Analyses:

Allwetter Zoo Münster, Germany
Bristol Zoological Gardens, UK
Emmen Zoo, the Netherlands
Zoo de Granby, Canada
Zoo Landau in der Pfalz, Germany

2.3.Data collection

The data collection was based on the results of the two interviews as well as a separate literature research which resulted in criteria used for the quantitative Multi criteria analyses which were in turn filled in by the five surveyed WAZA member zoos.In order to reach highest possible validity proving that the measurements are stable and consistent when replicating the research, the Multi Criteria Analysis was not influenced or manipulated by the researcher.

Interviews

The first basic elementof the quantitative data collection consists of the two initialsemi-structured interviews, which added up to helpful suggestions for the criteria eventually used in the Multi Criteria Analysis. These open and focused oralinterviews were guided by the usage of a topic list which included subjects like sustainability and conservation, environmental performance and organisation. The interviewees were representatives/key informants of the respective zoos.

Literature /Documents

The second basicelement of the quantitative data collection was asecondary literature research which providedadditional criteria for the Multi Criteria Analysis (MCA). In addition, the criteria which resulted from the initial interviews andthe literature researchare thoroughly described by the literature findings in terms of operation, cost effectiveness and environmental impact. Furthermore,the secondary literature provides demonstrative examples of zoos which have already integrated these criteria. Hence, the direct comparison between literature and MCA entails agreement or disagreement which eventually allows recommendation.
The reliability of the secondary literature data was established by certain attributes. Thus, the relevant documents were required not to beolder than 15 years, to have an objective background, to originate from reliable sources (University data base etc.) and to be written by authorized experts. The collection of documents was completed when adequate data answering which installations and facilities are beneficial for zoos in terms of sustainability and profit was gathered.

Multi Criteria Analysis

To compare the results of the literature research with the practical experience of zoos a Multi Criteria analysis (MCA)was conducted withthe five aforementioned zoos. The vertical row of the MCA was divided into five main parts includingthe sustainability components (criteria) of Energy and building (17 criteria), Waste (6 criteria), Water (9 criteria), Procurement (3 criteria) and Transport (5 criteria) whereas basic information such as organization profile and visitor figures were required in the beginning of the MCA. The horizontal row includessix factors such as Expenses, Environmental Impact, Short- and Long-term Profit, Effort of Implementation and Subsidies. Additionally, the implementation and recommendation of the respective sustainability component (e.g. solar panels) was asked as well. The five zoos had the opportunity to rank the different criteria by a maximum of three plus signs and three minus signs. Hence, a maximum of 54 or a minimum of -54could emerge which was dependent on the weight factor (1-3)every respondent could choose in order to determine a factor's subjective importance. To get a better understanding of the procedure an instruction was added in the appendix.

2.4. Data analysis

Literature/ Document analysis

After fulfilling the reliability attributes the proper literature got selected/fragmentedby labelling or coding to eventually extract the essence of the literature material in terms of the sustainability components. After this procedure all relevant labels were assembled to a coherent textincluding operation, benefits, limitations as well as cost-effectiveness of the respective sustainability component. In addition, relevant examples of zoos that have implemented respective sustainability components were identified.

Multi Criteria Analysis

Every of the five respondent zoos gave a subjective opinion about the different sustainability components (criteria). By choosing the weight factor for every factor the zoos could define their priorities.
Regarding the ranking applicationevery filled MCA was translated from signs (+/-) into numbersimplicatingthe weight factor whereas the factors 'expenses' and 'effort of implementation' where calculated contrarily due to their converted (negative) meaning. Hence, the maximum number a sustainability component or criteria (e.g. solar panels) could reach was 54 pointsor a minimum of -54 points.
Afterwards, for every single criterion, such as 'Solar panels', the average of all numbers was taken from all five participating zoos. Consequently, positive or negative numbers resulted which were put into an Excel stock to eventually make diagrams in form of a ranking. To combine/compress the five diagrams, one bar chart was made including a selection of the best and worst ranked sustainability criteria.
Regarding the implementation and recommendation section the answers filled with 'Yes' were counted and so a proportion/percentage resulted which gave information about the status quo ofintegrated sustainability components and recommendation of these.

3. Results

With the results from the interviews, the literature study and the Multi Criteria Analyses, it was intended to reveal beneficial and efficient sustainability components in terms of environmental as well as financial performance.

3.1. Results from the Interview and Literature study

With the help of the interview and the literature study the following criteria were establishedand eventually put in the Multi Criteria Analysis.

Energy & Building: Solar panel, Geothermal pump, Wind power, Wave power, Biomass, Biogas system, Biofuel, Green Energy Supplier, Low light bulbs, Time control switches, Occupancy sensors, Additional windows, Isolating buildings, Natural Ventilation system, Energy efficient electronics, Green roofs

Waste: Recycling materials, Recycling electronics, Reusing material, Reusing manure, Composting system, Yielding manure

Water: Rainwater harvesting system, Water filtration system, Automatic sensor taps, Low water cisterns, Waterless urinals, repairing lacks, Insulated water pipes, Granulate

Transport: Travel combination tickets, providing eco-friendly cars, providing bicycle stands and sufficient amount of parking areas for bikes

Procurement: Local products, biodegradable cleaning products, Fairtrade products, FSC and MSC products

Within the results from the literature study it is demonstrated that all criteria suggested are already implemented by a number of zoos. Moreover, sustainableequipment, such as wind turbines,wave power systems, or biogas systemswhich require higher initial cost and larger effortbut provide very high energy efficiency are successful integrated in zoos all over the world. For example the Cincinnati Zoo, USA, implemented numerous sustainable equipment such as a wind turbine, solar panel, a rainwater harvesting system as well as a system which converts all animal wastes into biofuel and much more (Building my green life, 2010). The implementation of the appropriate devices depends on the respective opportunities and priorities a zoo has. According to the requirements of a zoo it is possible to implementlow investment equipment which even so has saving potential. Furthermore, zoos can install sustainable facilities which require a high investment and proportionally show higher saving potentials. According to the literature results there are opportunities to receive loans, partial remission of debts etc promoted by governments by investing in regenerative power production such as biogas systems (Deublein and Steinhauser, 2008, p.195).

For more detailed information about the results from the literature study see appendix.

3.2. Results from the Multi Criteria Analyses

The following figure presents an overview of high and low ranked sustainability components which were established by the five respondent zoos in 2010. These criteria are ranked by considering financial and operational expenses as well as the environmental impact.

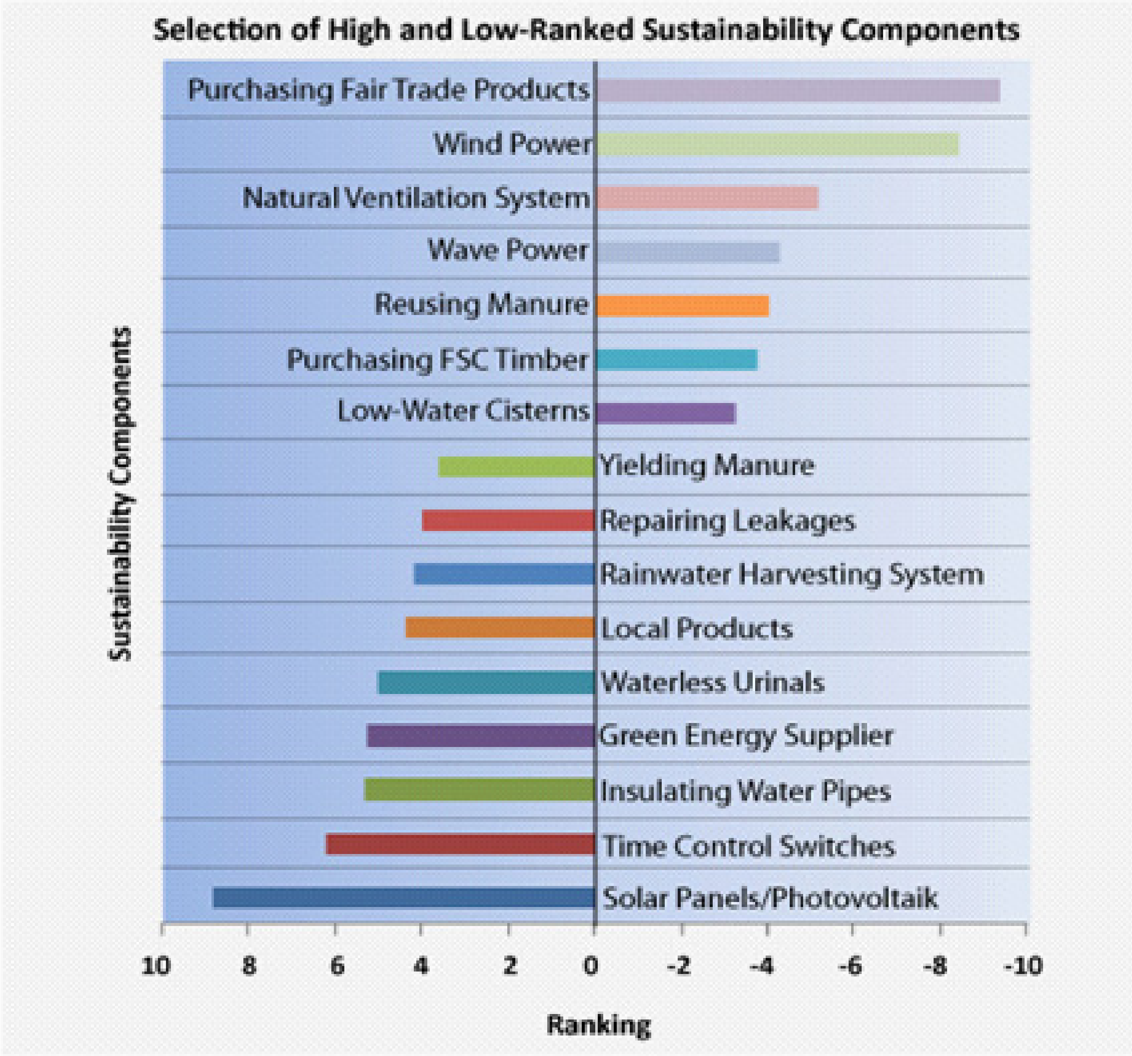


Figure 1: Selection of high and low ranked sustainability components by five surveyed zoos in 2010

The above figure shows that 'Solar panels' as well as 'Time control switches' are averagely the highest ranked sustainability components among the five surveyed zoos. In contrast, 'Wind power systems' and 'Fair Trade products' are the lowest ranked criteria.

Implementation

It emerges that all five surveyed zoos have implemented time control switches, occupancy sensors as well as rainwater harvesting systems, and bicycle stands/parking areas. Furthermore, all respondent zoos insulate an amount of buildings, insulate water pipes, and purchase local products as well as biodegradable cleaning products. Solar panels are installed by all zoos except forthe Bristol Zoo Gardens.
The Allwetterzoo Münster is the only zoo in this study that already reuses manure while the Bristol Zoo Gardens is the only representative of using bio fuel and a biomass system. The Zoo Emmen is the only respondents using granulate for irrigation purposes. The Münster Zoo and the Zoo de Granby have already installed a geothermal heat pump.
However, the five zoos implemented neither a wind Power system, nor a wave power system, much less a biogas system or a woodchip heater.
Moreover, it is obvious that a water filtration system is not implemented by the Allwetterzoo Münster (high visitation figure of nearly one million) and the Bristol Zoo Gardens (medium vis. Figure of 600.000). Within this research the Bristol Zoo Gardens implemented the most of the criteria suggested, apart from the devices which require higher financial and operational expenses such as solar panels, geothermal pump, biogas system etc.
Generally, it is remarkable that the respondent zoos have rarely implemented expensive and complex sustainable components.

Recommendation

Apparently, all of the five surveyed zoos recommended the usage of solar panels, geothermal systems, green energy suppliers as well as low light bulbs, time control switches, insulation of buildings, and energy efficient electronics. Furthermore, all five zoos advised the implementation of rainwater harvesting system, automatic sensor taps, as well as low water cisterns, but also suggested to repair leakages in water conduit and to insulate water pipes. The same applies to the installation of bicycle racks/parking areas, travel combination tickets as well as to all procurement components including local-, biodegradable cleaning-, Fairtrade -as well as FSC- and MSC products which are highly recommended by all five zoos. The less recommended sustainability criteria wind power and reusing manurewhich are both only recommended by the Bristol Zoo and the Münster Zoo. The sustainable criterion granulate is not recommended by any of the surveyed zoos.
The Landau zoo is the only representative, having the lowest visitation figure of 160.000 annually, whichdid not recommend wind power, wave power, natural ventilation system, water filtration system, and providing eco-friendly cars.
Furthermore, it is obvious that reusing manure is only recommended by the Bristol Zoo and the Münster Zoo.
The Allwetterzoo Münster is the only of the participating zoos, which recommended all sustainability criteria. According to this zoo every mentioned sustainability component is useful and beneficial whereas it depends on the opportunity a zoo has.

Generally, it is obvious that the affinity for recommendation exceeds the implementation tendency.

Linkage to Zoo Profiles

It emerges that both zoos with a high visitation figure of about a million per year (Allwetterzoo Münster, Zoo Emmen) ranked solar panels and time control switches, geothermal systems as well as rainwater harvesting systems and yielding manure highly. On the contrary, the insulation of buildings, energy efficient electronics, water filtration systems as well as automatic sensor taps and purchasing Fairtrade products were ranked very low.
Regarding implementation pattern of these zoos it is obvious that both zoos implemented less complex devices such as solar panels, low light bulbs, time control switches etc. while the Münster Zoo already implemented a geothermal heat pump. Both zoos did not integrate a wind turbine, a wave power system or a biogas system, eco-friendly carswhile wind-, wave power and eco-friendly carsgot recommended.

Zoos with a medium visitation figure of 600.000 (represented by Bristol Zoo and Zoo de Granby) rated the green energy supplier and repairing leaks in water pipes as high, while the energy efficient electronics, the natural ventilation system and purchasing Fairtrade products came off badly. Obviously, both zoos implemented and recommended the green energy supplier and a natural ventilation system, rainwater harvesting system, low water cisterns and waterless urinals besides less complex installations. The Zoo de Granby also implemented a geothermal heat pump and solar panels.
The zoo with a low visitation figure of about 160.000 visitors ranked solar panels, time control switches, occupancy sensors and the insulation of buildings as well as reusing manure, insulating water pipes and bicycle stands highly while the natural ventilation systems, additional windows and a composting system, granulate, but also recycling electronics and eco-friendly cars were ranked low. Beside less complex and less expansive sustainable devices such as low light bulbsthe Landau Zoo as a representative of small zoos installed solar panels and insulated their buildings.

Due to the low amount of respondents the linkage of integrated sustainability components to visitation figures might be coincidentally and therewith not significant.
Due to the literature results, the results of the interviews, and the Multi Criteria Analyses, sustainable installations and operations are summarized to present beneficial small- and large-scale projects.

Beneficial Small-Scale Projects

The highest ranked components from the Multi Criteria Analyses were summarized and segmented into the five sections. Hence, beneficial sustainable facilities and operations in terms of small-scale projects were investigated which are all characterized by:

- Low cost/expenses
- Less complexity to install/implement
- Positive environmental impact /saving potential
- Profitability to a certain level
- Possible sponsoring/subsidy (depending on country and region)

Energy & Building
Solar Panels
Time control switches
Green Energy Supplier
Occupancy Sensors
Building insulation

Water
Insulating water pipes
Waterless urinals
Rainwater harvesting system
Repairing leakages

Waste
Yielding manure
Recycling materials

Transport
Bicycle stands/parking area for bikes

Procurement
Local products

Large-Scale Projects

Furthermore, following large-scale projects were investigated by this research which show high energy efficiency, saving potential and have a high awareness factor and a symbolic character but require higher costs.

- Wind turbine
- Wave-power system
- Biogas system
- Biomass system
- Geothermal heat pump
- Water filtration system

4. Discussion

The aim to gain insight into the current status quo of sustainability components in WAZA member zoos and to investigate integration tendencies as well as reasonable and beneficial sustainability technologies and management for WAZA member zoosis achieved by this research.
Inthis research five different statements by five different zoos were analysed. The implementation of different sustainable equipment and operations depends on diverse criteria such as the size of the zoo, its visitation figure, the organization profile, the location as well as the capital of the zoos. Moreover, the five zoos internalized different priorities as well as principles which make it difficult in this research to unify their preferences.
Overall, this study investigated that zoos prefer sustainable equipmentand operations which combine reduction components as well as low operation expenses. That in turn may arise from a lack of resources, which particularly form a barrier for zoos with lower budgets. Hence, according to the surveyed zoos solar systems followed by time control switches are the most reasonable and beneficial facilities due to comparatively low expenses and a high environmental impact. To be more specific, solar panels or photovoltaic systems produce nearly no greenhouse gases and cause no pollution or depletion of non renewable resources and additionally provideprofit by a short payback period of 1 to 4 years (US Department of Energy, n.d.).Another popular instrument is the Green Energy Supplier which, despite its little higher cost, is highly ranked as well as recommended by all surveyed zoos and implemented by two medium and one bigger zoo. This fact supports the assumption that zoos are willing to make a contribution to sustainability but in a way they invest more in sustainable devices which do not take to high operational and financial expenses due to an optional lack of resources, lack of information or insufficient convictions towards sustainability. Coherently with this assumption is that wind power systems are the second lowest ranked component due to very high initial cost and a high implementation effort which is not favoured by the most zoos. Furthermore, the aesthetic problem and the sound production of the wind turbines are disruptive factors (Chiras, 2010, p.8-9) which might abet the low ranking additionally. In actual fact, particularly zoos as conservation institutions could use wind turbines as a symbol of acting sustainably to either inspire their audience. Affirming this issue, literature results showed that there are zoos which already installed wind turbines and describe it as a low-cost and high energy efficient method (Zoos newest digest, 2010). The same applies to the wave power which is ranked low and not implemented by any of the surveyed zoos due to high initial cost, a low environmental impact and a high effort of implementation presumed, however, it is recommended by two big and a medium sized zoo. This in turn shows that an amount of zoos is conscious about its effectiveness but is not able to implement this instrument due to missing funds or access to a flow of water. The British Hydropower Association (2004) affirms that the small-scale hydropower system is one of the most cost-effective, energy efficient and long lasting energy technology systems.
Also the biogas system is low ranked and not yet implemented by one of the surveyed zoos. Probably, this installation is a disincentive to many zoos due to its high up-front cost and high operational expenses. Nevertheless, literature results verify the electrical efficiency and CO2 neutrality of a biogas plant (Hussain et al, n.d., p.3; Deublein and Steinhauser, 2008, p.84). Even transport and disposal costs can be saved by burning bio waste and animal corpses (Hus-

sain et al, n.d., p.3). These assertions and the fact that every day high amounts of animal waste are produced in a zoo (Leech, 2009) lead to the assumption that zoos are predestined to use biogas plants for energy generation purposes.
The geothermal system is already implemented by two respondent zoos with higher visitation figures (600.000; 1 m) and recommended by all zoos which demonstrates that they are convinced by its effectiveness and efficiency and the high environmental impact, however, the main disadvantage, the high installing costs (varying from $5000 to $ 20.000) of this system is either the barrier which detain zoos to not invest (US Department of Energy, n.d.). Exactly the same applies for the natural ventilation system.
Regarding the waste management, all zoos, excepting the Bristol Zoo, yield their manureprobably to local farmers for fertilization purposes or other instances using biogas plants due to saving disposal and transport costs (NTIS, 2003). The Bristol Zoo with his surface of five hectares does not host large species like elephants and due to cost-effectiveness ratio it appears that there is no relevance to yield the dung. Considering the remaining waste management operations such as recycling and reusing as well as composting it is obvious that all participating zoos, exceptfor the Emmen Zoo, reuse materials which is beyond the usual recycling projects. Primarily, this shows a saving perception but either a symbolic value to visitors if the reused material is returned in furniture or facilities.
Regarding the water management insulating water pipes, waterless urinals, rainwater harvesting systems and repairing leakages were ranked very positively and recommended by the surveyed zoos which is explainable by considering the high environmental impact ensured by enormous water and energy saving potential which automatically results in reduction of costs. A comparatively higher investment is required by installing a rainwater harvesting system whereas it depends on the quality and the purpose. The Cincinnati Zoo, for instance, saved up to one million gallons of water by using this system (Cincinnati Zoo, 2009) which shows that zoos accept higher investments due to high long term profit as well as high environmental impact. The component waterless urinals show a high environmental impact and a high long- term profit due to reducing water usage significantly and require a low implementation effort in terms of maintenance (Seneviratne, 2007, p.247). Comparatively, low water cisterns are lower ranked due to being more expensive and saving less and having an insufficient flush power(Seneviratne, 2007, p.242-243). A further high ranked operation is repairing leakages in the water systemwhich does not require high cost but high operational expenses due to detecting the leaks. Implementing this operation can reduce 20-30% of the potable water usage (Seniviratne, 2007, p.59). Contrarily, the water filtration systemwas ranked negatively, but is implemented by three zoos (small, medium, large) and is not recommended explicitly by the smallest zoo (Landau Zoo). This could denote that the Water filtration equipment does not balance the costs and the benefits whereas it depends on the quality and the extent of the filter system. Particularly zoos using millions of liter of water a year for aquaria, or swimming pools are predestined to benefit from a high quality water filtration system.
Considering the ranking of the procurement components it is obvious that local products are high ranked whereas Fairtrade-products are the lowest ranked components. This arises from the assumption that local products are less expensive and have a higher environmental impact due to reducing transportation and therewith carbon dioxide emission (Sustainable connection, n.d.). Although Fairtrade products are more expensive and provide no profit at all, the five surveyed zoos implemented as well as recommended Fairtrade products. This is explainable by the high social responsibility, which is ensured by sustainable trade and cultivation processes. A similar case is represented by FSC-certified products which is implemented and

recommended by four of five zoos but also low ranked due to higher cost and bringing no profit. This certification ensures a sustainable forest management which let the consumer participate to sustainability without much effort.
Due to the results of the study which demonstrate that surveyed zoos mostly prefer sustainable components with high saving potential combined with low effort it infers that zoos are sustainable to a certain level but do not exceed it by implementing more efficient sustainable devices which might result from lacks of financial resources, lacks of information, or missing conviction towards sustainability.
Reaching a huge amount of visitors each year and focusing on wildlife preservation particularly zoos could consider treating sustainability as an essential issue which should be realized by reducing overall consumption and emissions. Furthermore, zoos are exemplarities to their stakeholders and should engage them to contribute to sustainability by integrating it into their life style. Hence, it is crucial to visualize the usage of renewable resources such as solar systems or geothermal systems etc and to promote sustainable management.

5. Conclusion

5.1. Status Quo of Implementation

All of the five surveyed zoos have already implemented sustainability components such as solar panels, time control switches, occupancy sensors and building insulation to reduce the energy consumption to eventually lower the electricity costs. Furthermore, rainwater harvesting systems have been installed by all five zoos to reduce drink water usage. Additionally, all zoos have insulated their water pipes which lead to a higher water efficiency due to less heat loss in the process of warming water. Bicycle stands/ parking areas have also been arranged in all of the surveyed zoos. Moreover, each of the five participating zoos purchases local products and biodegradable cleaning products.
Only one out of the five zoos reuses manure, while another one uses bio fuel and installed a biomass system. Another surveyed zoo is using granulate for irrigation purposes.
Within this research none of the zoos has implemented a woodchip heater, wind power, wave power or a biogas system, though wind power and reusing manure is recommended by two zoos.
The already implemented components are recommended by all five zoos while geothermal systems, green energy suppliers, low light bulbs, energy efficient electronics, automatic sensor taps, low water cisterns, repairing leaks, travel combination tickets and Fairtrade- as well as FSC- and MSC-certified products are highly recommended.

5.2. Sustainable and Beneficial Devices

Regarding the Energy & Building components solar panels, time control switches, green energy supplier as well as occupancy sensors and building insulation are highly ranked by the five surveyed zoos. Furthermore, yielding manure to local farmers, for instance, as a waste management component, is also highly scored by the five zoos. The water management components such as insulating water pipes, waterless urinals, rainwater harvesting systems and repairing leakages are facilities and operations which are ranked well. The procurement component purchasing local products is also scored well. That means that these facilities and operations require low costs, have a positive environmental impact, saving potential, make profit to a certain level and can get sponsored (depending on country and region). Therefore, these sustainable devices are perfect for zoos with lower or medium budgets which aim to contribute to stem climate change and global warming by lower their ecological footprint.

6. Recommendation

Besides focusing on the prudent use of natural resources and the effective protection of the environment it is also essential considering the social progress (Defra, 2004) as well as the profitability and the operation expenses of a sustainable device.
Regarding to different requirements such as organisation profiles, visitor figures, budgets as well as priorities or principles it is not possible to recommend sustainable facilities or components which provide ideal qualities/properties for all zoos.
As conservation organizations and educating instances zoos have the responsibility to demonstrate sustainability by using resources like energy and water more efficiently (Defra, n.d.). To improve human health conditions, reducing the impact on the environment and providing cost savings, it is advisable to use renewable resources such as solar, geothermic, biogas etc. Due to the fact that the most zoos aim to implement sustainability to a greater extent but cannot do large investments it is recommended to install facilities and operations which require relatively low costs, have a positive environmental impact and saving potential, are less complex to install and make profit to a certain level.
Therefore, it is advisable to install solar panels or photovoltaic systems combining these mentioned factors (U.S. Department of Energy b, n.d.). On this account it is reasonable for zoos to implement a green energy supplier, as well as low light bulbs, time control switches and occupancy sensors which are relatively low in cost and allow the reduction of energy consumption by low effort of installation. Beside the already implemented 'convenient facilities' it is advisable, particularly for zoos with higher capital, to focus on larger sustainability equipments such as geothermal pumps, wind power or biogas systems which entail a yet higher sustainability extent.
Water saving devices with lower operation expenses, water saving potential and lower charges such as rainwater harvesting systems, insulation of water pipes as well as repairing leaks are advisable for zoos with lower as well as higher budgets whereas it depends on the quality. Water filtration systems also vary in quality and size, therefore simple systems are characterized to be lower cost (Water Conservation, reuse and recycle, p.59-60) and therefore either applicable for zoos with higher and lower capital. Further devices such as waterless urinals entail the reduction of water consumption whereas the operation expenses are medium rated which make this facility a recommendable installation for lower as well as higher budgets.
Due to producing a high amount of waste each day, zoos should manage their waste sustainably by recycling, composting or reusing materials (Defra, n.d.). Sustainable waste management is not profitably but has a relative high impact on environment. Recycling materials as well as electronics is recommended due to this low impact and its low cost. Contrarily, reusing materials requires higher operation expenses which is not preferred by zoos. However, it is a symbol which demonstrates sustainable exposure to visitors. The same applies for reusing manure which is inevitably linked to the usage of a biogas facility having an enormous energy saving potential and which is in long term less cost intensive than district heating(Hussain et al, n.d., p.3). This installation requires more investment but in fact it is recommendable for zoos with higher budgets. This system is already applied in an amount of zoos all over the world (see literature results in appendix).
For zoos as environmental and conservation organizations it is essential to use their purchas-

ing power prudently by procuring environmentally-preferable (FSC, MSC products) and social responsible goods and services (Fairtrade products) to eventually ensure the contribution to sustainable management, as well as social progress. Although these certified products are more expensive and provide no profit at all, it is advisable to implement them into the procurement strategy regarding their high sustainable and ethical value (BIAZA handbook, 2008, p.21). Furthermore, it is advisable to put local consumption first to reduce the environmental impact by avoiding long distance transports and supporting the local economy (Sustainable Connection, n.d.).

There are a lot of possibilities for zoos to integrate sustainability into their transport policy. The largest impact on the environment regarding to the transport and travel is the target group visitors. Numerous zoos already associate with bus groups to ensure a more sustainable transportation for their visitors. To eventually encourage the visitors to take the bus or the bike some of the zoos offercombined bus and admission tickets or provide lower admission fees by production of a valid train ticket (Paignton Zoo, NQA, 2009). It is also recommendable to provide a sufficient amount of bike parking as well as changing facilities for people visiting the zoo by bike (Bristol Zoo, n.d.).

Furthermore, the transportation of the staff in and between the working areas could be managed more sustainably by purchasing eco-friendly vehicles like electric, hydrogen or hybrid cars which requires higher cost. Therefore, this variant is more appropriate for zoos with a higher budget. Additionally, advertisement promoting the zoo and the sustainable car technology could be positioned on the car and attend potential visitors and communicate sustainable integration to the wider community.

To realize the implementation of sustainable facilities which mostly require high investments, it is essential and crucial to cooperate and collaborate with other institutions. Therefore, it is important to be informed about opportunities for subsidies, which are grants given by the government to promote, for instance, sustainable provisions. There is also the possibility of receiving support by sponsorship, in which an organisation offers goods or money for projects that a zoo intends to realize, and in return the zoo leverages its reputation and media attention to generate publicity for the mutual project. Synergy is another method of cooperation, as it is a mutual promotion of two organisations. Thus, for example a farmer and the municipal utility are investing in a biogas plant where the zoo is the main supplier of dung. In return the zoo receives a part of the produced energy without making large investments.

References

BIAZA handbook, 2008.*How to become a more sustainable zoo.* [online] Available at: http://www.biaza.org.uk/resources/library/images/SustChapterBIAZAHandbook_jan%2008.pdf > [Accessed 22 September 2010].

Bristol Zoo Gardens , n.d. *Environmental sustainability.* [online] Available at: http://www.bristolzoo.org.uk/environmental-sustainability > [Accessed on 19 September 2010].
British Hydro Association, 2004. *Mini Hydro: a step by step guide.* [online] http://www.british-hydro.org/mini-hydro/index.html > [Accessed on 3 October 2010].

Bruntland, G., 1987.*Our common future: The World Commission on Environment and Development.* Oxford: Oxford University Press.

Carbon Trust, 2009. *Climate change: a trillion dollar wake up call.* [online] Available at: http://www.carbontrust.com/EN/trillion.aspx> [Accessed 28 April 2010].

Cincinnati Zoo, 2009. *The greenest Zoo in America*. [online] Available at: http://www.cincinnatizoo.org/documents/LEEDPlatinumAnnouncement09.pdf > [Accessed on 12 September 2010].

Chiras, D., 2010. *Wind Power Basics*. New Society Publishers: Gabriola Island, Canada.

Climapoor,n.d. [online] Available at: http://www.saarpor.de/pdf_Dokumente/produktseiten/climapor_d/rohrisolierung_gb.pdf > [Accessed on 5 September 2010].

Defra - Department for Environment, Food and rural Affairs, 2004. *Sustainability initiatives in UK zoos.* [online] Available at: http://www.defra.gov.uk/wildlife-pets/zoos/documents/zoo-handbook/3.pdf > [Accessed 4 January 2010].

Defra, 2009. [online] Available at: http://www.defra.gov.uk/sustainable/government/what/index.htm > [Accessed on 25 September 2010]

Defra, n.d. [online] Available at: http://www.defra.gov.uk/wildlife-pets/zoos/documents/zoo-handbook/3.pdf, page 2 > [Accessed on 17 September 2010].

Dawson, B. and Spannagle, M. 2009, *The complete Guide to Climate Change*. USA, New York: Routledge.

Deublein, D., Steinhauser, A., 2008.*Biogas from Waste and Renewable Resources An Introduction.*Wiley-VCH: Weinheim

Grover, V.I., 2004. **Climate change: five years after Kyoto**. ISBN 1-57808-326-5. USA, Enfield: Science Publishers, Inc.
Hussain, A., Nielsen, L. L., Hansen, O. A., Canpolat, M., n.d. *Biogas.The Best Solution.A pro-*

posal for alternative thinking and participating in limiting the use of fossil fuels for heating. [online] Available at: http://www.ngceurope.com/combatclimatechange/pdf/UK_Matthe_usgades%20Skole.pdf > [Accessed on 3 September 2010].

Leech,Eric, 2009. More Power to Poop in Colorado's Zoos. [online] Available at: http://www.treehugger.com/files/2009/03/more-power-topoop-in-colorados-zoos.php > [Accessed on 13 September 2010].

MNRE- Ministry of Natural Resources and Environment, 2010.
PRESS RELEASE RAIN HARVESTING SYSTEM (RWH) LAUNCH AT THE NATIONAL ZOO 26JUNE 2010. Malaysia.

National Research Council of the National Academies, 2009. R*estructuring federal climate research to meet the challenges of Climate Change*. USA, Washington: National Academies Press.

NQA , 2009. *Edinburgh Zoo's path to environmental excellence.* [online] Available at: http://www.nqa.com/en/nqanews/article.asp?SECTION=45&ARTICLE=58 > [Accessed 3 November 2009].

Paignton Zoo, 2006. [online] Available at: http://www.paigntonzoo.org.uk/visiting/getting-to-the-zoo.php > [Accessed on 19 September 2010].

Pembina Institute Canada 2, n.d. [online] Available at: http://re.pembina.org/sources/wave, > [Accessed on 17 September 2010].

Population Reference Bureau, 2010. [online] Available at: http://www.prb.org/Publications/Datasheets/2010/2010wpds.aspx > [Accessed on 26 September 2010].

Sustainability Victoria , n.d. *Resource smart Business.* [online] Available at: http://www.resourcesmart.vic.gov.au/documents/Natural_Ventilation_Systems.pdfoo > [Accessed on 21 September 2010].

Seneviratne, M., 2007. *A Practical Approach to Water Conservation for Commercial and Industrial Facilities***.** GB, Oxfort: Elsevier.

Streiter, C., 2010. *Status quo of integrated sustainability components in BIAZA member zoos*.

Sustainable Connection, n.d. T*hink Local First. Top Ten reasons to Think Local - Buy Local - Be Local.* [online] Available at: http://sustainableconnections.org/thinklocal/why > [Accessed on 12 September 2010].

The World Bank, 2002. *World Bank Working Paper; Linking Poverty, Reduction and Environmental Management: Policy Challenges and Opportunities.* USA, Washington. [online] Available at:http://wwwwds.worldbank.org/external/default/WDSContentServer/WDSP/IB/2002/09/27/000094946_02091704130739/Rendered/PDF/multi0page.pdf > [Accessed25 September 2010].

Toronto Zoo, n.d. [online] Available at: http://www.torontozoo.com/conservation/macaques.asp > [Accessed on 13 September 2010].

Toronto Zoo, 2010. *Toronto Zoo issues Request for Proposals (RFP) May 3, 2010 for the construction of a Biogas Facility.* [online] Available at: http://www.torontozoo.com/pdfs/Toronto%20Zoo%20Biogas%20q%20and%20a%20-%202010-05-03.pdf > [Accessed on 13 September 2010].

UNEP- United Environmental Programme, 2009. *Climate change and biodiversity: background.* [online] Available at: http://www.unep-wcmc.org/climate/background.aspx > [Accessed 25 September 2009].

UNFCCC, 2007. *Climate Change: Impacts, Vulnerabilities and Adaptation in developing Countries.* [online] Available at: http://unfccc.int/files/essential_background/background_publications_htmlpdf/application/txt/pub_07_impacts.pdf > [Accessed 27 March 2010].

U.S. Department of Energy, 2009. [online] Available at: http://www.energysavers.gov/your_home/space_heating_cooling/index.cfm/mytopic=12490 > [Accessed on 12 September 2010].

U.S. Department of Energy, 2008. *Benefits of Geothermal Heat PumpSystems.* [online] Available at:http://www.energysavers.gov/your_home/space_heating_cooling/index.cfm/mytopic=12660 > [Accessed on 13 September 2010].

Water Conservation, Reuse, and Recycling, n.d. Washington, D.C.: THE NATIONAL ACADEMIES PRESS.

WAZA, n.d. *Corporate strategy flyer*. [online] Available at: http://www.waza.org/files/webcontent/documents/WAZA_Strategy_Flyer_EN.pdf > [Accessed on 26 September 2010].

WAZA, 2005. *Building a future forwildlife- The World Zoo and Aquarium Conservation Strategy.* ISBN 3-033-00427X. [online] Available at: http://www.waza.org/files/webcontent/documents/cug/docs/WAZA%20CS.pdf > [Accessed on 25 September 2010].

Wollard, S., n.d. *Zoo Education for A Sustainable Future.* [online] Available at: http://www.izea.net/education/Journal%202001%20-%20Zoo%20Education%20for%20a%20Sustainable%20Future.pdf > [Accessed on 25 September 2010].

Zoo News Digest, 2010. Cincinnati Zoo Using Wind Power to Go Green.[online] Available at: http://zoonewsdigest.blogspot.com/2010/06/cincinnati-zoo-using-wind-power-to-go.htm> [Accessed on 23 September 2010].

Appendices

Appendix I: Literature Results

Energy

Vision/ messages:

For a sustainable energy use and building design it is necessary to:

- Reduce the amount of energy that is used (Defra, n.d.)
- Use energy more efficiently by purchasing energy efficient products and fitting energy saving devises (Defra, n.d.)
- Maximize the use of renewable resources (WZACS 2005, page 56)

The energy that is used in the world exists in many different forms, for instance heat, light, motion, electrical, chemical, nuclear and gravitational energy. The sources where this energy comes from can be divided into two categories such as non renewable and renewable energy sources (Energy Information Administration, 2010).
Non renewable energy or fossil energy comes from a finite resource that can not immediately (within human time scale) be recreated and will be used up in the future (Energy Information Administration, 2010). Coal, natural gas, oil and radioactive elements are considered to be non renewable (Re-Energy, n.d.). Fossil energy is seen as a major factor attributing to global warming (European Commission, 2010) and is still being used widely, accounting for 87.3 % in 2007 of all energy used worldwide (Energy Information Administration, 2009).
Contrarily, renewable energy is all energy that is extracted from a natural, repetitive and persistent flow of energy which cannot be depleted and that occurs in the immediate environment (Twidell et al., 2006 sited in Uneca).
According to the Pembina Institute, sustainable energy sources must be save for now and the future, have minimal or no negative environmental or social impacts and have little or no net carbon or other greenhouse gas emissions. Air, land and water must be protected and needs of today and future generations have to be met by energy sources in an accessible, equitable and efficient manner (Pembina Institute Canada 1, n.d). Wind, solar, geothermal energy or biomass are examples of renewable energy sources (Energy Information Administration, 2010).
For any country, business or institute like a zoo it is beneficial to use energy efficiently due to reduced energy cost which eventually releases money for other initiatives and which in turn contributes to economic growth (Uneca, n.d., p.26)
For any country, business or institute like a zoo, efficient supply and use of energy reduces payments on energy when capital costs are alleviated, which frees money for other initiatives and contributes to economic growth and reduces poverty (Uneca, n.d. page 26).
For zoos the energy topic is one of the key environmental issues to consider when integrating sustainability (Defra, n.d. page 2).

Besides choosing for a sustainable and renewable energy resource, there are many ways to reduce energy usage and increase energy efficiency, like insulating buildings while in an uninsulated home a third of the heat is lost through the walls and 26% is lost through the roof (Energy Saving Trust, 2010). Additionally, sustainable design, using durable and long-lasting materials, can increase durability, lower the costs of facility maintenance and decrease the amount of repairs and repair costs (Eere Energy, n.d.). Even many zoos, as institutions with amounts of visitors, employees, volunteers and animals have already implemented sustainable technologies and use renewable resources. In the United Kingdom, for instance, some zoos have already achieved substantial sustainability initiatives (Defra, n.d. page 2). The adoption of sustainable practices will help meet the obligations of zoos as well as stand as a model for sustainable practices and encouraging others (WZACS, 2005, page 57).

Solar Energy /Photovoltaic

Due to the fact that sunlight is the most efficient renewable energy resource solar energy is anticipated to be the foundation of a sustainable energy economy (Zen, 2008, p.239).
There are two different systems to make use of solar power. On one side there are solar thermal principles which are applied to produce hot fluids or air whereas liquid based systems heat water or an anti-freezing solution in a 'hydronic' collector while the air-based system heat the air in an 'air collector'(US department of Energy, 2009). Contrarily, photovoltaic principles are used to produce electricity (Intelligent Energy Europe project, n.d.).
Solar thermal system/ heating system
The basic principle which is common to all solar thermal system includes collecting the solar radiation whereby the heat is absorbed by the heat transfer medium, which is usually a fluid. The heated medium can be used directly by heating swimming pools, for instance, or indirectly by using a heat exchanger transferring the heat to its final usage for example for space heating or hot water. Contrarily, the Photovoltaic system is made of the natural element silicon which becomes directly charged electrically when it is subjected to sun light (Intelligent Energy Europe project, n.d.).
Both of these solar heating systems transfer the solar heat directly to the interior space or to the storage system distributing the heat, by collecting and absorbing solar radiation. Furthermore, a supplementary or back-up system provides the additional heat. Liquid systems are appropriate for radiant heating systems, boilers with hot water radiators as well as absorption heat pumps. Additionally, also coolers are more frequently used when storage is integrated (US Department of Energy, n.d.).
According to the US Department of Energy (n.d.) active solar heating systems are most cost-effective when they are used most of the year. If these systems replace more expensive heating fuels such as electricity, propane and oil heat, they present the most economical performance (NREL, n.d.)

The costs of a commercial active solar heating systems range from $30 to 80$ per square foot of collector area, installed but generally the costs vary by size or purpose (US Department of Energy, n.d.).
Generally considered, the costs of a solar heating system depend on the extent of the installed collectors because the larger the solar heating system, the less it costs per unit of collector area.
If the solar heating system heats domestic water the profitability increases due to heating water in the summer with an idle collector (US Department of Energy, n.d.).

To capture the sunlight there are different types of solar radiation collectors regarding different purposes (Zen, 2008, p.245). There are collectors which are not covered by glass affording for example heating swimming pools during the summer. These collectors are easily to be placed on the roof. Furthermore, the type of Flat plate collectors covered by glass care the main stay of domestic solar water heating (Zen, 2008, p.246) and provide a good price-performance ratio as well as a broad range of mounting possibilities (Intelligent Energy Europe Project, n.d.) whereas the track to the sun is not possible (Zen, 2008, p.248). The sunbeam warms up the black metal plate which in turn warms the water In contrast (Zen, 2008, p.246). In contrast, the Vacuum Absorber Tubes are collectors where the absorber strip is positioned in an evacuated and pressure proof glass tube (Intelligent Energy Europe Project, n.d.).
One example of zoos which implemented Solar thermal systems to heat water is the Seattle Aquarium which stated that solar water heating is a long-term investment that will increase in value as energy costs rise as well as the fact the federal and state tax incentives can significantly improve the economic return (Seattle Aquarium, n.d.). Also the Cincinnati Zoo uses a solar water heating system which meets all of the hot water needs for the restrooms (Cincinnati Zoo, 2009).

Solar Energy for Producing Electricity

The environmental performance of producing electricity with Photovoltaic cells is enormous regarding to the fact that this system emits no pollution and no greenhouse gases as well as uses no finite fossil fuel resources (National Renewable Energy Laboratory, 2004). Photovoltaic solar cells are semiconductor diodes which are designed to capture sunlight and directly converting it into electricity (Zen, 2008, p.257). Energy from Photovoltaic cells ranges from microwatts to megawatts (Zen, 2008, p.258) and allows users to generate their own electricity (Solar Power Inc, 2010).With current technology 10m2 of PV panels are required to generate 1kW of electricity in bright sunlight (Zen, 2008, p. 256). These long lasting types of cells are advantageously noiseless and robust (Zen, 2008, p.258).
During recent decades the cost of Photovoltaic devices has fallen drastically and still is four to six times more expensive of power generation from fossil fuels (Zen, 2008, p.258).
PV's are not practical for large-scale power generation due to their high cost. The energy payback which is estimated for rooftop PV systems are 1 to 4 years whereas it depends on the module material. With this energy payback of 1 to 4 years and a presumed life expectancy of 30 years 87% to 97% of the PV generated energy is free of greenhouse gases and causes no pollution as well as depletion of non renewable resources (US Department of Energy b, n.d.).
In a growing number of regions for example across the USA net-metering allows business and homeowners to sell excess electricity back to utility companies where the produced credits go on the electric bill and is in place (Solar Power Inc, 2010). Furthermore, many countries around the world offer tax incentives, which stimulate the demand for solar PV systems, but also solar rebates, which offers payment depending on the size of the PV system. Additionally, there are regional tariffs for generators of PV solar electricity.
Installing a Photovoltaic solar electric system can increase property values (Solar Power Inc, 2010)

Also flat plate air collectors can be connected with photovoltaic panels to produce heat and electricity (Zen, 2008, p.247).

A number of Australian zoos and animal sanctuaries already demonstrate their commitment to a sustainable infrastructure and investment by utilising renewable energy to power their sites (Eco Generation, 2010).
Also the Adelaide Zoo demonstrates their sustainable commitment by using a 10.2 kW high output and efficiency Photovoltaic system (Monocrystalline type)of 34 panels which is mounted on the roof of the panda exhibit. This PV is sized on 62.4 square meters and is connected to a local electrical switchboard and contributes to the electrical consumption for the specialised panda environmental management system. During the 25 year lifespan the solar PV system predict to offset 3.385 kg CO2 annually. Furthermore, there is a LCD information screen located in the public area which displays the direct and long –term performance of the solar PV system (Eco generation, 2010).
Another example of a zoo installed a solar PV system is the Perth Zoo will install a 90.6kW grid connected solar system to five separate rooftops of various animal shelters to offset the consumption on site (Eco Generation, 2010).

Geothermal Systems

A Geothermal heat pump employs the constant temperature level of the earth) to heat as well as cool and supply the building with hot water if the proper equipment is installed (US Department of Energy III, 2008). A Geothermal heat pump is operating by transforming thermal energy at a low temperature level into thermal energy at a higher temperature which is appropriate for heating purposes. This in turn takes place in a closed-cycle process where the working fluid is constantly enduring a change of state from evaporation, compression, condensation and expansion. By drawing stored solar energy from its surrounding area such as ground the geothermal heat pump transfers this energy and the operation energy (grid) into a heating or water heating circulation loop in form of heat (Ochsner, 2007, p.11).
Generally a Geothermal Heat Pump is three up to six times more efficient by employing 25%-50 % less electricity than conventional heating or cooling systems. In the heating mode three quarter of the costs of electrical heating can be saved whereas the savings in the cooling mode can be up to one quarter to a half of the costs of traditional air conditioner. Geothermal systems can be much more expensive compared to conventional systems however the payback season can be within 2-10 year whereas it depends on varying installation costs, energy costs (Green Energy Efficient Homes, 2010).
One further advantage of Geothermal heating systems is that they last far longer than most heating systems and require a minimal maintenance. Additionally by implementing this system the risk of fires is also much lower than with gas furnace/water heater (Green Energy Efficient Homes, 2010).
Geothermal heat pumps are durable and highly reliable due to their construction which has few moving parts (US Department of Energy, 2009). The underground piping of this system often carries warranties of 25-50 years whereas heat pumps often last 20 years or more (US Department of Energy, 2009). Furthermore, this system is flexible due to the hardware which requires less space than a conventional furnace or air conditioner (Green Energy Efficient Homes, 2010) and can be installed in new and retrofit situations which make this system more flexible (US Department, 2009).
Using Geothermal heating and cooling systems make no contribution to global warming

and does not cause any adverse effects on flora or fauna. In combination with green energy which is provided by a green energy supplier, it is possible to heat and cool buildings without creating any greenhouse gas emissions (Green Energy Efficient Homes, 2010).

The main disadvantage of this system is either the reason of not investing in a geothermal heat system. The high installing and up-front which costs varies from $5.000 to $20.000 discourage people to make the investment (US). Furthermore, disturbances to the land during installation as well as environmental risks, legal conformance risk and maintenance issues relating to open loop systems can occur and form further disadvantages (Green Energy Efficient Homes, 2010).

In 2008 the Toronto Zoo Canada constructed its first geothermal exhibit for the lion-tailed macaques which employs the earth's energy to heat as well as cool itself during the whole year. According to the Toronto Zoo Geothermal systems have the least environmental impacts compared to any other modern space heating technology (Toronto Zoo, n.d.)
The Geothermal system is also implemented in the Protivin Crocodile Zoo Czech Republic. This zoo has three geothermal heat pumps which generate a total heat output of nearly 100kW. From eight 120m deep wells drilled in the Zoo ground area the installed geothermal heat pumps draw heat to sufficiently supply the terrariums and building floor. Therefore, almost 2000 m2 of the floor area is covered for the crocodile sanctuary (Protivin Crocodile Zoo, n.d.).

Biomass

Using biomass resources is potentially the world largest and most sustainable energy source (Rosillo-Calle et al, 2007, p.4).
Biomass is rich in carbon but is not yet recognized as a fossil material. All plants and animals in the ecological system belong to biomass (Deublein, Steinhauser, 2008, p.9)whereas it is divided into woody and non-woody components (Non-woody biomass consists of agricultural residues, animal waste and herbaceous crops (Rosillo-Calle et al, 2007, p.34) but also desinfied biomass such as briquettes, pellets, wood chips as well as secondary (biodiesel, biogas, hydrogen etc) and tertiary fuels (Rosillo-Calle et al, 2007, p.110). In comparison woody biomass includes trees and woody plants as well as other woody parts such as limbs, tops, and needles, leaves which are grown in a forest, woodland or rangeland environment (US Forest Service, n.d.).

There are several processes to transform biomass into solid, liquid or gaseous secondary energy carriers including combustion, thermo-chemical transformation liquefaction or gasification (Deublein and Steinhauser, 2008, p.9). The combustion and the gasification system are the most common systems whereas the combustion system converts biomass fuels into several forms of useful energy such as hot air, hot water, steam and electricity. There are several processes to transform biomass into solid, liquid or gaseous secondary energy carriers including combustion, thermo-chemical transformation liquefaction or gasification (Deublein and Steinhauser, 2008, p.9). The combustion and the gasification system are the most common systems whereas the combustion system converts biomass fuels into several forms of useful energy such as hot air, hot water, steam and electricity (Rosillo-Calle et al, 2007, p.17)by using the principle of chemical reactions whereby carbon and/or hydrogen are oxidized (Maker, 2004, p.28). Biomass heating plants include large-volume fuel storage capability and are usually larger than conventional boiler rooms. From the storage the fuel comes into the burner

and boiler burning the fuel and extracts the usable heat from combustion. The combustion gases are dispersed by a chimney which is usually taller than that of oil or gas system (Maker, 2004, p.12).
Combustion technologies produce about 90 per cent of the energy regarding to biomass (Rosillo-Calle et al, 2007, p.17). Conspicuously the ash-free energy value of animal dung is higher than that of wood (Rosillo-Calle et al, 2007, p.54). On the other hand there is the gasification as main alternative to direct combustion (Rosillo-Calle et al, 2007, p.19) which will be subsequently explained in detail.
Using biomasses for generating energy uses biomasses that are not needed and which are often left to natural deterioration (Deublein and Steinhauser, 2008, p. 83)

Wood Chip Heater

Common examples for combusting biomass are the wood chip or wood pellet system. Wood chips have been burned to make heat for decades. Due to the fact that wood chips are a renewable, locally produced energy source being the least expensive combustion fuel available the installation of wood chip heater plants increased during the last 20 years (Maker, 2004, p.6).

Solid-fuel systems converting energy by burning chunky fuels like wood chips can either burn any other fuel (Maker, 2004, p.8). According to Maker (2004, p.13) wood pellets are comparatively easier to store and handle and are less expensive to install than wood chips. Compared to conventional fuel systems, however, the capital cost of wood-chip systems is considerably higher although the fuel cost of wood-chips is low (Maker, 2004, p.9). The most wood chips come from remaining slabs and edges which cannot be made into marketable lumber. Increasing the health and vitality of forests diseased and deformed trees can be processed into wood chips (Maker, 2004, p.36). Therefore, producing wood chips does not create a demand for harvesting additional trees (Maker, 2004, p.36).
In Bristol Zoo Gardens England biomass boilers running on wood pellets are implemented (Bristol Zoo, n.d.).
Replacing an oil-fired heating plant the Alpine Zoo, Austria, installed a wood chip fired heating system (120kW) which saves about 21.000 litres of fuel oil annually. Over the life span of the biomass heating system 1.140 tonnes of CO2 will be saved (Climate Austria, n.d.).

Biogas System

Biogas is a natural gas (Deublein, Streinhauser, 2008, p.83) and is a form of renewable energy because biomass is a sustainable fuel (Toronto Zoo, 2010). The gasification system which acts as an endothermal technology converts solid fuel into a combustible gas whereas the technology can take advantage of advanced turbine designs as well as heat-recovery steam generators to achieve high energy efficiency (Rosillo-Calle et al, 2007, p.19). A biogas system includes bacteria which are place in an anaerobic environment mixed with fuel. The bacteria consume the bio waste and metabolize methane (Toronto Zoo, n.d.), which can be burned in a gas-fired furnace or it can be transformed to electricity in a motor-driven generator (Hussain et al n.d.,p.3). Methane can also be cleaned and sent directly into natural gas pipelines where the system generates thermal energy (Toronto Zoo, 2010). Biogas consists of 50-70% of methane, 25-50% of carbon dioxide, 0-1% hydrogen sulfite and an insignificant part of hydrogen (Hussain

et al, n.d., p.3). A combination of heat and power plant provides the best energy generation whereas the energy conversion is approximately 60% which is distributed in 25% electricity and 35% exploited heat. The biogas is burned in a gas motor which runs a generator whereas the heat is extracted from the motor's cooling water and exhaust (Hussain et al, n.d.,p.3).
According to the Copenhagen Zoo biogas system has several advantages such as heating many places at the zoo that need tropical heat. Furthermore, bio waste as well as animal corpses which are removed by get burned in the biogas plant saves transport costs. In long term dimension biogas is less cost intensive than district heating (Hussain et al, n.d., p.3).
Compared to the combustion system the gasification shows a higher electrical efficiency whereas the costs can be similar (Rosillo-Calle et al, 2007, p.!!!). One advantage of the biogas system is that it produces electrical power and heat by displaying CO2 neutrality (Deublein and Steinhauser, 2008, p.84) if the necessary electricity which turn biomass into a syngas must come from a renewable energy source (Ebert, 2008, p.1)

Although the costs of gasification and combustion systems are similar the biogas system shows a higher electrical efficiency (Rosillo-Calle et al, 2007, p.???).
Biogas plants are considered not to be economical if the power output is less than 75kW. Presupposing a good harvest larger biogas plants afford an income of up to 3000 $ per hectare (Deublein and Steinhauser, 2008, p.195).
The governments of the European Union for instance as well as power supply companies promote regenerative power production which are displayed by loans, partial remission of debts, garuanteed prices for biogas (Deublein and Steinhauser, 2008, p.195).
Particularly zoos which keep lots of species which produce a high amount of dung each day (Leech, 2009) are predestined to use biomass systems to generating heat or energy (source!!!).
There are lots of other examples of zoos which installed biogas systems to produce heat, water or electricity. So the Dallas Zoo stated that the dung of their two elephants weigh up to 300 pounds a day which will be used to create heating, water and electric power at the zoo through a new biogas facility (Global Energy Network Institute, 2010).
The Denver Zoo, USA, either stated to plan the implementation of a biomass gasification system, which can turn human trash and animal waste into energy to power Asian Tropics. More than 90 per cent of the zoo's waste will be converted into usable energy. According to the zoo biogas presents a clean, environmentally-friendly technology which has put the zoo on the edge of green technology which eventually could change the way businesses worldwide handle their waste. Estimations of the Denver Zoo displayed that there is a potential energy saving of $150.000 a year (Denver Zoo, 2010).

The Copenhagen Zoo, Denmark, plans to install a large biogas plant where all animal dung will be put into the plant. According to the Copenhagen zoo the biogas plant will produce lots of methane gas which gets burned and used for heating the tropical greenhouse at the zoo. The system is supposed to save a lot of money and the remaining can either be sold by using it as a fertilizer or pellets (Hussain et al, n.d., p.3).
The Toronto Zoo, Canada, replaces coal fired energy plants by biogas facility and produces organic waste which includes animal waste and bedding as well as food services and horticulture (Toronto Zoo, n.d.).
Bio Fuels
Bio fuels are fuels like ethanol and biodiesel, used for transportation and are derived from

biomass materials. Ethanol is made from the sugars in grains as corn, sorghum and barley, but also potato skins, rice, sugar cane, sugar beets, yard clippings, bark and switch grass. However, most ethanol comes from corn and it is an alcohol fuel (Energy Information Administration, 2010).

Other promising bio fuels are methanol and hydrogen (IPCC, 1996, p. 22). Conversion of biomass into methanol can be done in many ways, though most likely gasification is used to vaporize biomass at a high temperature after which impurities are removed and the hot gas is passing through a catalyst converting it into methanol (North Carolina Zoo, 2009).

Bio fuels are more expensive, although they make a vehicle performs as well as petroleum products and in mass production manufacturing cost do not need to be higher (IPCC, 1996, p. 22)

Research is being conducted on using all parts of plants instead of only the grain, in order to make it cheaper and more abundant (Energy Information Administration, 2010).

Biodiesel is made from vegetable oils, fats or greases from for instance restaurants. In the United States it is currently the fastest growing alternative fuel, while it is safe, less pollutant and biodegradable (Energy Information Administration, 2010).

Usually these bio fuels tend to be blended with petroleum fuel, like gasoline and diesel. For ethanol in the United States of America the mixture is usually 10 % ethanol and 90 % gasoline, but for specially made vehicles this can be 85% ethanol and 15 % gasoline. However, this mixing is not a necessary process(Energy Information Administration, 2010).

Biodiesel can also be used in diesel engines without blending other fuels in it (B100), though it is often blended with petroleum diesel for 2% (B2), 5% (b5) or 20% (B20), which has excellent lubricating properties beneficial for engine performance. However, biodiesel is sensitive to cold weather and loosens and dissolves sediments in storage tanks, acting like a detergent additive. Pure biodiesel may even cause failure in rubber and other components in older vehicles (Energy Information Administration, 2010).

By using bio fuels, less non renewable fuels have to be used. Bio fuels are often more expensive than fossil fuels, but they are less pollutant because the burn cleaner (Energy Information Administration, 2010), for instance biodiesel has a minimal impact on human and environmental health and provide 93 % more usable energy than fossil energy and corn grain ethanol though it provides smaller energy benefits (25%) it has a greater impact on the environment and human health due to increased release of air pollutants, nitrate, nitrite and pesticides (Hill et al., 2006, p 11208).

Greenhouse gas emissions from the operation of vehicles can be reduced by eighty percent or even more using bio fuels (IPCC, 1996, p. 22). Thereby, lower environmental impacts and lower cost can be reached by advanced bio fuels from woody feedstock's which have a higher energy yield as well (IPCC, 1996, p. 41).

According to the research conducted by Hill et al. (2006), in 2005 the net production cost of ethanol was $0.46 per energy equivalent liter (EEL) of gasoline, whereas the average wholesale price of gasoline was $0.44 per liter. For instance, for soybean biodiesel the estimated production cost was $0.55 per EEL of diesel and diesel had an average wholesale price of $0.46/liter. The cost competitiveness for bio fuels improves with an increase in petroleum prices above the average prices in 2005 (Hill et al. 2006).

For the future, the prices are expected to reduce due to large-scale processing plants though prices for feedstock could rise with the increasing need of feeding a growing world population,

a rising demand for biomass for fuels and global climate change causing uncertain changes in yields (Steenblik, 2007, p 49).
However, especially food-based bio fuels are dependent on varying prizes for feedstock and are competing with food for priority (Steenblik, 2007, p. 39,40) which could lead to higher prices for food or forest products, while land used for bio fuels cannot be used for other purposes and ecosystems could be compromised, deforestation could increase, as well as fertilizer and pesticide intensive agriculture and greenhouse gas emissions (Pembina Bio-energy, n.d.).

Large subsidies may make bio fuel production profitable, even when it is not cost competitive to petroleum or diesel. The federal government of the U.S.A for instance, provides subsidies for both ethanol and biodiesel. Thereby, the government also subsidizes corn and soybean prices which benefits ethanol and biodiesel producers as well. Over the long term non food-based bio fuels produced with a low agricultural input (i.e. fertilizer, pesticides and energy) are seen as most likely to be of greater importance to meet the transportation energy needs, though food- based bio fuels can meet a small portion. (Hill et al. 2006)
In 2007 the European Commission has endorsed a target of increasing the level of bio fuels in transport fuel to 10 % by 2020. This clearly shows the importance of clean fuels for Europe as the use of renewable energy sources is a key element in energy policies in order to reduce dependence on fuel from non member countries, reducing emissions and lower energy costs by promoting energy efficiency (Eurostat, 2009).

There are plenty of examples of zoos using bio fuels for instance, the North Carolina Zoo in the United States of America (2009) uses vegetable fry oil collected by zoo restaurants as biodiesel for trams, buses, trucks, tractors and equipment as a part of their Environmental Management System in order to reduce consumption of natural resources. The restaurants annually provide 7.500 gallons of B20 blend, which is 20 % biodiesel added to 80 % petroleum and meets 40 % of the zoos fuel demand. In the future the zoo hopes to move towards using 100% biodiesel to phase out petroleum diesel fuel and therefore will need to collect waste oil from local restaurants.

Wind Energy

Wind energy as an abundant and renewable resource never runs out compared to fossils like oil or natural gas (Chiras, 2010, p.12).

The most wind turbines are horizontal axis units where three blades are attached to a central hub which forms the rotor. Thereby the blades capture the wind's kinetic energy and convert into mechanical energy whereas the generator converts it into alternating electrical energy (Chiras, 2010, p.33). The generators of wind turbines are often protected by a durable shelter (aluminium, fibreglass), however, the generators of small wind turbines are exposed to the elements.
To ensure reaching the maximum production of energy most wind turbines have a tail that keeps them positioned into the direction of the wind (Chiras, 2010, p.34) whereas some turbines are designed to orient themselves to the wind without using any tails (Chiras, 2010, p.35).
To use this renewable energy efficiently different types of wind turbines are developed.
On one hand there are wind turbines that are directly connected to the electrical grid system

(Chiras, 2010, p.37) whereas others are connected to a grid system but also have a battery back-up system to ensure a continuous supply of electricity, even when the electrical supply wipes out (Chiras, 2010, p.47). Furthermore, there are systems which are not connected to the electricity grid but ensure the production of alternate energy through a battery charging wind turbine (Chiras, 2010, p.51-52).

The cheapest and easiest variant of a wind energy system is the battery less-grid-connected system compared to the off-grid systems (Chiras, 2010, p.57-58). In contrast grid-connected systems with battery banks are more expensive but more suitable for those who want to stay connected to the grid but want to be protected against irregular blackouts or brownouts (Chiras, 2010, p. 58).

Another vital component of the wind turbine is the tower. There are three types of towers which are a vital component of a wind system such as freestanding towers, which is the most expensive one consisting of high-strength hollow tubular steel like that used for streetlight poles (Chiras, 2010, p.35) whereas the fixed guyed tower is supported by high-strength cables which provide stability and avoid a fall over and therefore needs less steel. The third variation of tower is the tilt-up-tower consists of high-strength steel pipe or a lattice structure whereas both are supported by guy cables and is able to get raised and lowered which afford inspection, maintenance and reparation on the ground (Chiras, 2010, p.36).

Due to misguided frugality many wind turbines are installed on towers which are too short. Comparatively, towers which are properly sized (80-120ft)(Chiras, 2010, p.10) position wind turbines in the path of more powerful winds (Chiras, 2010, p.37).

Particularly in rural areas where good wind resources are present all or part of the energy needs can be covered at rates that are often competitive with conventional sources (Chiras, 2010, p.13).

The irregularity of the wind forms a disadvantage which can be solved by installing batteries which store super plus electricity to provide power either when the winds fail to blow (Chiras, 2010, p.7). The super plus energy can be stored in off-grid system as well as in-grid system whereas the excess of energy can be fed onto the grid (Chiras, 2010, p.7). Furthermore there is the opportunity to coupling small wind systems with other renewable energy sources such as solar systems which is called a hybrid system (Chiras, 2010, p.7). The hybrid system is more effective than the single wind power system due to provide a steady year-round supply of electricity (Chiras, 2010, p. 8).

Further disadvantages of the wind turbine system are aesthetic problems, sound production as well as the occurring death of birds which is more applicable for large commercial-scale wind turbines (Chiras, 2010, p.8-9). Additionally, the occurrence of ice is obstructive due to the reduced speed of the turbines (Chiras, 2010, p.11).

The Cincinnati Zoo and Botanical Garden, USA, presents the new Windspire®wind turbine which is 30 feet tall and generates energy to power the ticketing and membership building. Combined with solar panels the wind turbine will meet one-fourth of all of the power demands for the building. According to the Cincinnati Zoo installing a wind turbine is a low-cost, safe and energy efficient method to convert energy of approximately 2000 kilowatt hours per year in 12 miles per hour average winds. This represents one-third to one-fifth of the energy usage of an average U.S. Home, or the operation of a dishwasher and a refrigerator which regarding an entire year (Zoos newest digest, 2010).

A further exemplarity of using wind energy is the Toledo Zoo , Spain, which installed a wind turbine at the main parking lot entrance to generate power for the parking lot booth (Toledo Zoo, n.d.).

Hydro Power/Pilot Wave Power

Since thousands of years the movement of water is used for performances and processes. Nowadays, 20 % of the world electricity is supplied by hydroelectric power whereas for instance Norway produces all of its energy from hydroelectricity. Iceland and Austria produce over 70% of their electricity requirements from hydro plants (The Renewable Energy Centre, n.d.).
Requiring a flow of water and a head of water to give the latent power hydroelectric systems are site specific (The Renewable Energy Centre, n.d.).
The capturing of waves can be conducted in many ways. To generate electricity there are three hydroelectric schemes such as 'impoundment' which is characterized by a dam built across a river impounding a head of water behind it in a reservoir. Eventually the water can be released through a turbine to produce electricity. Another form of hydropower system is the 'diversion' which channels a portion of a river through a canal. Thereby waves were piped into a channel where they force air back and forth over a bi-directional turbine to produce electricity by compressing air in a chamber (Faber et al, 2000. p. 32). This air pressure is used to drive a turbine and a generator (Pembina Institute Canada 2, n.d.). A further hydroelectric scheme is the 'pumped storage' which is appropriate for a low energy demand and describes a pumped storage facility which stores energy by pumping water from a lower reservoir to an upper reservoir. The water is released through a turbine to a lower reservoir when the electrical demand is higher (The Renewable Energy Centre,n.d.). Furthermore, there is a storage system involving a dam or a run-of-the-river system were the force of the river current delivers the needed pressure to make the water flow through a pipe, named a penstock, making the blades in a turbine rotate to accelerate a generator (Energy Information Administration, 2010). However, a dam can form a significant barrier to migrating fish such as the salmon of the Pacific Northwest (Ecology Global Network, 2010) and have other direct and indirect environmental impacts, as well as social consequences.
Another form of energy stored in water is tidal energy. With high tide water is captured and stored behind a barrage and released at low tide, however tidal energy can also be harnessed using under water turbines that also extract energy from other marine currents. In the EU (European Union) there are several countries encouraging their development by having small support programmes (Faber et al, 2000. p. 32).
Once a wave system has been installed, maintenance should not be expensive and the location is unobtrusive when placed offshore. Thereby, the environmental and social impact is supposed to be positive. The downside of wave power is that it needs an appropriate side with a consistent strong wave action to be a reliable energy source, the materials used must withstand rough conditions and salt water and the systems could alter flow patterns of sediment on the ocean floor (Pembina Institute Canada 2, n.d.).
There are small scale hydro and large scale hydro systems whereas the small scale system shows by far the highest energy efficiency (70-90%) and a high capacity factor. Furthermore, this system is characterized by a long life expectancy of about 50 years and low maintenance costs (BHA, 2005, p.2). Large-scale systems such as wave plants installed offshore, at the shore or near the shore provide intermittent power, particularly when the winds are strong. Beside their high energy efficiency this system is supposed to harm endangered species and their habitats (Novinson, 2010).

The Submarium The Deep, UK, implemented several large energy projects including a pilot wave power system which is still in the early stages of development (Streiter, 2010).

Green Energy Supplier

Renewable energy resources are the third largest contributor to global electricity production while about 12.7% of the total primary energy supply came from renewable energy resources (exclusive nuclear energy)(Energy Information Administration, 2009). Almost 90% of the energy produced from renewable resources comes from hydropower plants while about 6% comes from combustible renewable resources and waste. Geothermal power, solar power and wave power accounts for 45% of the renewable resources used for producing electricity (International Energy Agency, 2007, p.5).
There are two opportunities to receive to use renewable energy. One way is to install facilities producing energy from renewable energy such as solar-, wind- or wave power or biogas systems. The other way is to use green energy via the local energy supplier (Australian Bureau of Statistics, 2009). A green energy supplier provides energy from such renewable resources such as mini hydro, wind power or biomass and is nowadays available at most electricity suppliers as well as green tariffs (Defra, n.d. p.2). Furthermore, it has to meet high environmental standards and produces no net greenhouse gas emissions (Green Power, n.d.). Therefore, purchasing green energy from renewable resources reduces the carbon footprint as well as the electricity bill (Green Power, n.d.). Purchasing green energy reduces greenhouse gas emissions and help to compete with polluting coal and gas based generation. Furthermore, it helps to reduce the water consumption because renewable energy generators use less water compared to coal and gas stations (Green Power, n.d.). A disadvantage of purchasing green energy is that additional charge is required by the green energy suppliers which according to' Green Power ' (n.d.)is reinvested in the renewable energy sector.
Also the Paradise Wildlife Park, UK, being at the leading edge of environmental management has changed its electrical supply and is now purchasing electricity from sustainable sources by signing up to a green energy supplier which forms a very important factor to them (Green Energy UK, 2010).

Occupancy and other Sensors

Occupancy sensors (indoor) or motion sensors (outdoor) are devises that detect occupants or occupant activity in a defined area and which can be installed to turn lights and other equipment on or off automatically (U.S. Dep. of Energy, 2010a; U.S. Dep. of Interior, n.d.).
By turning lights on automatically and off soon after the last occupant has left the room not only energy reductions are achieved, the occupancy sensor also provides convenience (U.S. Dep. of Energy, 2010a).
To be able to detect the presence or absence of occupants, the sensor must be placed in a location where it can detect activity in all parts of the room (U.S. Dep. of Energy, 2010a).
Activity can be sensed with an ultrasonic occupancy sensor which detects sound (U.S. Dep. Of Energy, 2010a) and is useful for office areas (medium sensitivity) (SEAV, 2006) or an infrared sensor detecting heat and motion (U.S. Dep. of Energy, 2010a), used for security in small areas with infrequent occupancy (low sensitivity) (SEAV, 2006).

Other sensors, like photosensors sensing ambient light conditions (the amount of daylight available) prevent light from operating during daylight hours. These are mainly used for out-

side lighting while lights inside a building do not need to vary with ambient lighting levels, but rather with the occupant activity (U.S. Dep. of Energy, 2010a).
Besides infrared and ultrasonic sensors there are other types of sensor technologies such as audio sensors and microwave sensors (U.S. Dep. of Interior, n.d.) which are used in large areas with infrequent occupancy (high sensitivity) (SEAV, 2006).
The even more sophisticated sensors units combine different technologies to minimize false detection and can be integrated into the automation and control systems of a building (U.S. Dep. of Interior, n.d.).
Such an occupancy sensor consists of a motion sensor, an electronic control unit and a controllable switch or relay. Usually a complete unit also has a timer to signal the electronic control unit when there has been inactivity after a set period. These units can also be combined with a photo sensor sensing the amount of (day) light (U.S. Dep. of Interior, n.d.). The sensor can be easily installed on the wall of an office or small area as a switch configuration, as well as be mounted on the ceiling or the walls of larger, open areas. For bathrooms, stairwells and hallways there are specifically designed sensors (U.S. Dep. of Interior, n.d.).
Occupancy sensor is inexpensive and effective products and payback time is usually two to three years. However, locally there may be utility rebates available, which might bring the payback time down to less than one year (U.S. Dep. of Interior, n.d.).
Energy savings can be as much as 45 % (Green CA, 2007), though some manufacturers claim savings up to 75% (U.S. Dep. of Interior, n.d.). Area size, type of lighting and the occupancy patterns influence the amount of savings that can be reached (U.S. Dep. of Interior, n.d.). The costs can range from 50 to 100 U.S. Dollars per sensor depending on wattage, size of the area that has to be sensed. The costs of sensors varies with the type that is used, for instance photo sensors are very inexpensive with an average cost of 10 to 50 U.S. Dollars (Green CA, 2007)

Time Switches

To achieve savings, sensors are not always necessary. (U.S. Dep. of Interior, n.d.).
One technology to control energy usage is a key lock switch, which is a switch that requires a key. This could replace the standard switch in areas that rarely need lighting and can only be used by authorized staff (SEAV, 2006).
Another choice could be a timer system to turn outdoor and indoor lights and other equipment on and off at specific predetermined times. This is an effective facility when the occupancy pattern in a certain area is regular and predictable and no extensive rewiring is required (U.S. Dep. of Interior, n.d.). Timers are often used in combination with other controls like photo sensors, whereas the photo sensor turns on a light in the evening and the light is turned off by a timer at a certain hour (U.S. Dep. of Energy, 2010b). Costs depend on the timer used, whereas the most simple ones cost less than 20 U.S. Dollar and more expensive ones range between $20 and $30. They have a saving potential of more than 50% of controlled lighting. Installation usually takes only minutes when replacing an existing light switch and the payback period is less than one year or longer when rewiring is needed (Energy Books, 1999, p. 1111-1112).
A time switch could even be used for an instant water boiler to turn it off overnight. A saving over 52 kg of CO2 a week could be achieved (Macquarie University, 2008).
More sophisticated types of time switches can provide centralized, remote and local control and have the possibility to programme seven days, time- of- day and holiday scheduling as well as manual override, into the system. The approximate costs for this kind of system could be up to 3000 Australian Dollars (SEAV, 2006).

The push button or time delay is another type of time switch. After switching on, light is provided for a pre-set time period ranging from 10 seconds to 30 hours. The costs for this technology range from 20 to 80 Australian Dollars (SEAV, 2006).

As is showed in Figure 1, the saving potential in offices is high for both occupancy sensors and time scheduling (time switch). In a large office time switches can save up to 35 U.S. Dollars a year, while occupancy sensors save 40 U.S. Dollars annually. When a time switch is combined with a daylight dimming might even lead to savings up to 120 U.S. Dollars a year, see figure 2. In less frequently occupied areas savings will be higher as lights can be turned off for a longer period, therefore using less energy.

Typical Lighting Control Applications			
Type of Control	Private Office	Open Office - Daylit	Open Office - Interior
Occupancy Sensors	++	++	++
Time Scheduling	+	++	++
Daylight Dimming	++	++	0
Bi-Level Switching	++	+	+
Demand Lighting	+	++	++

++ = good savings potential
+ = some savings potential
0 = not applicable

Figure 1: Savings potential lighting controls Figure 2. (U.S. Department of Energy, 2010c)

Operating Cost Comparison Private Office, 128 sq. ft.				
Performance	Base Case	Occupancy Sensors	Daylighting	Occupancy Sensor + Daylighting
Annual Energy Use[a]	450 kWh	340 kWh	330 kWh	250 kWh
Annual Energy Cost	$33	$24	$24	$18
Annual Energy Cost Savings	—	**$9**	**$9**	**$15**

[a] Average daily "on" hours for wall switch is 14.7. Average daily occupied hours for the office is 12.9.

Operating Cost Comparison Open Office Area, 1000 sq. ft.					
Performance	Base Case	Time Scheduling	Occupancy Sensors	Daylighting	Time Scheduling + Daylighting
Annual Energy Use[a]	5700 kWh	5100 kWh	5000 kWh	4200 kWh	3700 kWh
Annual Energy Cost	$340	$305	$300	$250	$220
Annual Energy Cost Savings	—	**$35**	**$40**	**$90**	**$120**

[a] Average daily "on" hours for wall switch is 9.1. Average daily occupied hours for the office is 6.8.

Cost-Effectiveness Assumptions: Each of the two operating cost comparisons assumes that the workspace has approximately 1.5 watts per square foot of ceiling lighting, with parabolic troffer luminaires containing T-8 lamps and electronic ballasts. Daylighting examples assume a design light level of 55 footcandles at work surfaces. Assumed electricity price: $0.06/kWh, the Federal average electricity price (including demand charges) in the U.S.

Figure 2: Costs and Savings Lighting Controls (U.S. Department of Energy, 2010c)

Many zoos already have lighting controls, such as the classrooms in The Zoological Society's new school at the Milwaukee County Zoo. These classrooms have an occupancy sensor turning off the lights and the "auto off" switch, which controls light fixtures that are close to windows, when there is no occupancy in the room. The lights at the windows must be turned on manually, when the room is occupied, to ensure the lighting is only used when necessary.
The Lincoln Park Zoo in Chicago U.S.A. even stated the instalment of occupancy sensors in their sustainability improvement plan (Lincoln Park Zoo, 2008).
Time switches and occupancy sensors are perfect technologies for zoos where some areas are offices and others are public or even educational. These rooms have a fluctuating occupancy

and are empty at times. To decrease the dependency on people time switches and sensors could be installed.

Energy Saving Light Facilities

Lighting has an extensive impact on the energy consumption in industrial buildings. Major energy savings between 30 and 50 percent may be achieved by installing the appropriate lightening technology such as energy efficient lamps for instance. Finding an optimal combination of different types of lamps including their supporting hardware and the manner the lighting system is applied in everyday use entails energy saving (Green building II, n.d.).
Fluorescent bulbs/ Energy saving bulbs
Comparatively to usual incandescent lamps fluorescent lamps use 75% less energy (Energy for you,n,d,)and lasting about 10 times longer more precisely 7.000-24.000 hours (US Department of Energy I,2009).
In general, fluorescent light is caused by electricity which is conducted through mercury and inert gases. By operating at a very high frequency and a high start-up voltage fluorescent lamps include electronic ballasts which eliminate flicker and noises and additionally are more energy efficient. There are also special ballasts which are required to allow dimming of the electricity saving lamps
Fluorescent lamps are divided into two general types such as compact fluorescent lamps (CFLs) and Fluorescent tube and circling lamps (US Department of Energy I, 2009).
A further advantage of fluorescent light bulbs is that they produce less heat and therewith reduce the fire risk (Energy for you, n.d.). However, compared to conventional incandescent lamps fluorescent bulbs are more cost- intensive (Energy for you, n.d.) which in turn is balanced by the high energy efficiency and long lasting (Held, 2009, p.90). Due to the induction time fluorescent lamps do not instantly produce light (US Department of Energy I, 2009; Energy for you, n.d.). Furthermore, this type of lightening is partially non-flexible due to a requiring medium temperature and dry locations. It is not usable with light dimmers and may not fit into some light fixtures (Energy for you, n.d.).

Compact fluorescent lamps

Combining the advantages of the energy efficiency of fluorescent lighting and the convenience and popularity of incandescent fixtures the compact fluorescent lamp is an efficient saving component by saving up to 75% of the initial lighting energy (US Department of Energy, 2009). Replacing incandescent lamps by compact fluorescent lamps will keep a half-ton of carbon dioxide out of atmosphere during the whole period of usage (Smithsonian National Zoological Park, n.d.).

When electricity is conducted through the electronic or magnetic ballast to the tube, ultraviolet light glows which in turn excite a white phosphor coating on the inside of the tube. This entails emitting, visible light all through the surface of the tube (US Department of Energy II, 2009). When light is needed for long time periods this type of fluorescent lightening is most cost effective and efficient compared to short time periods, for example in store rooms, where the payback is expect to be slower (US Department of Energy II, 2009). Due to their long lasting characteristics the compact fluorescent lamps are appropriate to install in areas which are hardly to reach (US Department of Energy, 2009). The CFLs can be purchased in different sizes, styles and shapes, varying in amount of tubes whereas some models look similar to conventional incandescent (US Department of Energy II, 2009).

Tube and circling lamps

The tube and circling lamps forming the second type of fluorescent lamps are either more energy efficient compared to standard incandescent lamps.
The tubular fluorescent lamps are more appropriate for ambient lighting in large indoor areas where they creates less direct glare compared to usual incandescent bulbs.
The circling fluorescent lamp which represents another form of the tube type is commonly used for portable task lighting (US Department of Energy III, 2009).

According to the Smithsonian Natural Zoological Park the switch from incandescent lamps to compact fluorescent light bulbs is a step towards environmental sustainability due to its energy saving and long lasting characteristics. They assumed that the energy savings by fluorescent bulbs used by the whole American population could be compared to the energy production of a nuclear power plant which runs throughout the whole year (Smithsonian National Zoological Park, n.,d.).
The commitment to conservation and the sustainable approach of the Cincinnati Zoo is demonstrated by for instance the substitute of 100% of their conventional incandescent lamps into energy saving fluorescent bulbs which use 85% less energy (Zoo and Aquarium Visitor, 2009).
Also the Toledo Zoo, Spain, has replaced many of their old conventional bulbs into compact fluorescent lamps using less energy.

Light emitting Diode (LED)

Due to the low power consumption and their enormous long life of about 60.000 to 100.000 hours, or more than 7 years of continuous operation, the LED bulbs are highly recommended(Held, 2009, p.87-88). A 150-LED bulb consumes 15 W of electricity which means that LEDs uses 80% less energy compared to conventional incandescent . Therefore, the use of LED light bulbs considerably reduces energy cost as well as save the cost of the numerous replacement bulbs (Held, 2009, p.88).
LEDs are so called semiconductors which emit light when a small electric current is conducted in the forward direction. The LED includes a chip which is basically made of a semiconductor material which is doped with impurity construction. Furthermore, LEDs feature a polarity whereas the Anode is the positive, longer lead and the Cathode the negative, shorter lead assumed that the electric current is applied forward (LEDs International, n.d.). When the negative electrical charges and the positive electrical ones are attracted to the junction zone recombination starts, energy is released in form of photons (LEDs International, n.d.).
Compared to conventional light sources LEDs are very flexible lightening elements due to their wide range of wavelengths from Infrared to Ultraviolet and colors available in combination of red, orange, yellow, green and blue (LEDs International, n.d.). High brightness LEDs are either applicable for general-purpose illumination inside as well as outside the home or office (Held, 2009, p.90).

Table 4.3 Operational Life Cost Comparison

CHARACTERISTIC	INCANDESCENT	CFL	LED
1. Life (hour)	750	7500	60,000
2. Number of bulbs	80	8	1
3. Cost of bulbs	$20.00	$24.00	$80.00
4. Watts consumed	100	20	9
5. Electrical operating cost	$800.00	$120.00	$54.00
6. Total cost	$820.00	$144.00	$134.00

Figure B: Operational Life Cost Comparison (Held, 2009, p.90)

According to the figure B the LED lightening is the most cost efficient lighting type compared to incandescent bulbs and Compact Fluorescent lights. The initial costs are about 4 times higher but eventually the costs are balanced due to the longest life the less consumed energy as well as the lowest operation costs (Held, 2009, p.90).

Since the year 2000 the Oregon Zoo has been used LEDs used for its Zoo light display and still continues replacing conventional incandescent bulbs by LEDs. According to the zoo LEDs use only about 1 percent of the power which conventional holiday lights uses and about 10 percent of the power in mini-lights. In 2009 more than 100.000 LEDs have been installed for the year's festival. Compared to the conventional C9 lights using 18.000 watts of energy the new C9 LEDs only need 144 watts which is an enormous energy reduction (Oregon Zoo, 2009).
Within the Festival of Lights the Cincinnati Zoo replaced 2.5 million lights by LEDs effectively (How, 2010).

Energy Efficient Electronics

In the United States, more than the half of the electricity comes from coal burning power plants. Annually, a coal burning power plant emits about 6 million tons of carbon dioxide, 1,200 tons of sulphur oxide and 1,600 tons of nitrogen oxide annually. These chemicals deplete the ozone layer and can entail acid rain and respiratory illness of humans (Roos, n.d.).
Especially home heating and cooling systems use about 45 % of the consumed energy. In the USA, an average household spends $1,400 annually on energy bills. Particularly devices which consume a lot of energy increase the expenses on electricity each month. Switching to energy efficient electronics could be corrective by consuming less energy which save money and have less impact on the environment. Currently, there are many equipment, appliances and gadgets that are energy efficient (Roos, n.d.).
Particularly businesses which have many employees should consider that computers, for instance, use a lot of energy which account for up to 70% of a company's energy bill. Furthermore, computers creating heat which eventually force the air conditioning to keep the temperature favoured (Roos, n.d.). To lower the energy costs and reducing the emission of additional greenhouse gases, new models of energy efficient computers are launched. One Example is the Earth Pc and Earth Server by Tech Networks of Boston which come with a

patent power management system. These computers have an 80 Plus-certified power supplies which means that the power supply uses at least 80% less energy. This system keeps the computers cool and eventually lower air conditioning bills by 33 % (Roos, n.d.). Additionally, reducing energy consumption and improving energy efficiency by electronics and appliances it is recommended to replace incandescent lamps with compact fluorescent lamps or better LED lamps. Furthermore, avoiding unnecessary standby power and reducing electrically powered air-conditioning by installing shaded and passively ventilated buildings are options which contribute to the reduction of the energy consumption (UNECA, n.d., p.34).
In the United States, there are federal energy efficiency standards which have to be fulfilled by appliance manufacturers. The Federal Trade Commission has established the Appliance Labelling Rule which requires manufacturers to attach labels that provide an estimate of the product's energy consumption or energy efficiency (US Department of Energy, 2010). The Energy Guide labels, such as Energy Star, demonstrate the highest and lowest energy consumption or efficiency of the respective products (US Department of Energy, 2010).
The European Union also developed an energy label which informs the consumer about the energy consumption and efficiency as well as water consumption or sound intensity which depends on the respective product. This label is divided into seven energy efficiency classes from A to G. The class A demonstrates that the devices have low energy consumption while G shows high energy consumption (Deutsche Energie Agentur, n.d.).
The Cincinnati Zoo, USA, also replaced energy-intensive office equipment, refrigerators and freezers, as well as washers, dryers and dishwashers which are qualitfied by U.S.E.P.A. Energy Star (Lincoln Park Zoo, 2008).

Natural Ventilation System

Fresh air in buildings is necessary to provide oxygen, alleviate odours and to maintain a healthy, comfortable and productive indoor climate (Walker, 2010). There are several ways to provide fresh air in a building, for example, mechanical ventilation (Heating, ventilation and air- conditioning system (HVAC)), natural ventilation or a combination called mixed mode/hybrid ventilation (Sustainability Victoria, n.d.). Natural ventilation can be as simple as opening a window to benefit from breezes, or be part of a more elaborate approach for cooling or heating buildings, involving building design, landscape, placement and size of openings. It is an attractive alternative to air-conditioning plants to reduce energy use and costs (Walker, 2010).
A natural ventilation system depends on natural driving forces such as pressure differences caused by varying wind, humidity and temperature levels between the building and the outdoor environment (Sustainability Victoria, n.d.;Walker, 2010).
With natural ventilation the amount of ventilation depends on the size and placements of the openings to force the flow of fresh air through a building (Walker, 2010) as air moves from a high pressure to a low pressure zone (Sustainability Victoria, n.d.).
The natural ventilation system can be seen as a circuit where openings between rooms such as windows, louvers, grills or open plans facilitate the fresh airflow circuit through a building (Walker, 2010).
There are two forms of natural ventilation, cross ventilation and induced (stack) ventilation.
Cross ventilation means ventilation through windows on opposite sides of the building or other types of openings, using differences in air pressure caused by the wind (Sustainability Victoria, n.d.;Walker, 2010; House Energy, n.d.).
Wind blows air through openings in the wall on the windward side and suck air out on the

leeward side and the roof (Walker, 2010). Windows that serve as an inlet for air, need to face prevailing winds (FEMP, 2001, p.20) where the pressure is highest (Sustainability Victoria, n.d.) and the area of the opening needs to be equal to or 25 % smaller than the area of exhaust opening (Sustainability Victoria, n.d.).
The flow path of the air will take the line of least resistance and can be restricted by furnishing and distance between openings (Sustainability Victoria, n.d.).
Cross ventilation depends on the availability and direction of the wind and it will work best in narrow buildings with open plans and single loaded corridors (rooms on one side of a corridor) (Sustainability Victoria, n.d.).
When a manual strategy is chosen, training and information should be provided and openings should be accessible and fully operable by occupants (Sustainability Victoria, n.d.).
Constructing a new building, the desire to use cross ventilation will influence the aesthetics and site planning of the building (Sustainability Victoria, n.d.).

In spaces with high ceilings, as well as an open office space planning and where cross ventilation is not effective, induced (stack) ventilation is a feasible option (FEMP, 2001, p. 16) as it uses increased buoyancy (Sustainability Victoria, n.d.). Differences in air density depend on temperature and humidity and eventually cause buoyancy, while cooler air and dry air are heavier than warm air and humid air (Walker, 2010).
Therefore, warm air within a high building rises to the top and is exhausted through openings in the roof, creating ventilation of the adjoining spaces below (FEMP, 2001, p. 16). The incoming air (through operable windows) ((FEMP, 2001, p. 16).) that replaces the warmer air, must be cooler than the air inside the building (Sustainability Victoria, n.d.).
This can be achieved by drawing the air either from shaded or landscaped spaces or another source of cooling, for instance a thermally massive labyrinth, a body of water or a fountain (Sustainability Victoria, n.d.) which is also called humidity induced ventilation, using a cool tower to deliver evaporative cooled air (Walker, 2010). At nighttime this process could be reversed to cool the building venting room air (Walker, 2010).A cool tower can also be combined with temperature induced (stack ventilation) (Walker, 2010).
An atrium with a glazed roof is usually a ideal room for the use of stack ventilation serving as a chimney to exhaust hot air (FEMP, 2001, p. 16) with the sun warming the top layers of air creating more suction at the bottom (Walker, 2010). The inside temperature therefore needs to be warmer than the outside temperature (Walker, 2010).
Induced (stack) ventilation can be best applied in low humidity climates (FEMP, 2001, p. 16) and in the winter when there is a maximum difference between indoor and outdoor temperatures (Walker, 2010) to remove heat, reduce mechanical cooling and the use of a fan, therefore reducing energy use (FEMP, 2001, p. 16).

In most existing buildings a natural ventilation system is applied where some mechanical support is already integrated which is called mixed mode or hybrid ventilation (Sustainability Victoria, n.d.).
However, it is necessary to prevent air conditioning (HVAC) in a room with open windows, otherwise energy use could increase (FEMP, 2001, p. 20). Therefore, a control strategy is necessary, taking advantage of the desire of occupants for environmental control without interfering with the HVAC system (FEMP, 2001, p. 20).
The benefits of this approach are less unpredictability in indoor conditions and occupants have more influence on the indoor climate as well as using less energy than with air-conditioning,

though it results in a higher energy use than with natural ventilation alone (Sustainability Victoria, n.d.).
There are two options for mixed mode or hybrid ventilation (Sustainability Victoria, n.d.). First of all, it is necessary to divide the building in a zone for natural ventilation and a zone for mechanical ventilation. The second option is to use natural ventilation when the weather conditions are favorable, turning of the HVAC system automatically when the windows are opened and switching to HVAC when external conditions are no longer comfortable and close the windows (Sustainability Victoria, n.d.).

Natural ventilation is particularly useful for buildings and locations that have no security concerns and/or do not need strict air quality levels (FEMP, 2001, p.20). The downsides of natural ventilation could be more exterior noise, increased horizontal air motion (FEMP, 2001, p. 20), potential exposure to external pollutants (NatVent, n.d.) and greater fluctuations in indoor thermal conditions in terms of temperature and humidity (Sustainability Victoria, n.d.) as natural ventilation does not reduce humidity of incoming air (Walker, 2010). This makes natural ventilation not very suitable for humid climates (Walker, 2010).
The performance of natural ventilation can be influenced by mechanical devises using room air for combustion, leaky duct systems and other external influences significantly (Walker, 2010).
While designing a natural ventilation system, codes requirements regarding smoke and fire transfer need to be taken into account (Walker, 2010).
When integrating natural ventilation into a building design, the site- specific and seasonal natures of the winds need to be taken into account (FEMP, 2001, p 8). It is essential for the system to be able to work on still days and regardless of the wind direction (Sustainability Victoria, n.d.). Therefore modeling and sometimes the use of mechanical techniques such as fans are needed (Sustainability Victoria, n.d.). A fan could lower the temperature up to 9 degrees Fahrenheit using just one tenth of the electrical energy consumption of a air-conditioning system (Walker, 2010).
Cross ventilation cost are low to moderate, though the initial costs of building may be higher, while operable windows are usually 5 to 10% more expensive than fixed glazing (Sustainability Victoria, n.d.). When choosing a hybrid system the costs rise even more due to the interlocking controls for and the varying costs of installing the HVAC system (Sustainability Victoria, n.d.).
Also, the complexity of the system and whether or not it is manually or automatically controlled determine the costs.
Occupants usually consider buildings with well-designed natural ventilation systems as a very comfortable and pleasant environment (Sustainability Victoria, n.d.).
A natural ventilation system can reduce the perceived interior temperature by 5 degrees Fahrenheit and save 10 to 30% of the total energy consumption of a building in favourable climates and building types by decreasing the need for mechanical cooling (Walker, 2010) (Sustainability Victoria, n.d.), without compromising comfort and functionally when a careful design process is followed (FEMP, 2001, p 8).

Natural ventilation can also be integrated in the building design in zoos. The Adelaide Zoo in South Australia has recently (February 2010) opened a new Entrance Precinct, which houses a range of administrative and public functions. The design of the Entrance Precinct building is a special eco environment design underpinning conservation, education, research and environment (Paul, 2010).

The concrete structure of the entrance building provides a high thermal mass to reduce heat gain in summer and captures, stores and returns heat in winter. Evaporative air-conditioning is used in the café and the shop, while in enclosed spaces the zoo uses a mixed mode ventilation system. During normal use these spaces are naturally ventilated and on days of extreme heat or usage sensors control the windows and the air-conditioning systems to keep internal comfort. Nighttime natural ventilation is used to exhaust the daytime heat, regulated by a central computer (Paul, 2010).

The Tiergarten Schönbrunn in Austria also uses mixed mode ventilation in the Rainforest House. The airconditioning is automatically controlled and the windows in the glass roof providing natural ventilation are supervised by staff (Zoolex 2009). The zoo saves electricity, because of the north exposition of the building and by using natural ventilation for cooling through mechanical windows (Zoolex 2009).

Green Roofs

Green roofs describe an innovative yet established approach to urban design using living materials to make the urban environment more liveable, efficient and sustainable. Other terms describing this system are eco roofs, vegetated roofs or living roofs. The Green Roof Technology (GTR) is the system which is used to implement green roofs on a building (Ryerson University, 2005, p.34). According to the Toronto Zoo green roofs describe a roof construction with one or more extra membranes, including a waterproof and root-proof section which in turn is covered by various types of vegetation (National Geographic, 2009.). There is an intensive and an extensive approach to built green roofs (Ryerson University, 2005, p.34). Intensive green roofs such as lawn, bushes, or trees (Ryerson University, 2005, p.42) require more effort as well as initial and maintenance costs compared to extensive roofs and conventional roofs (Ryerson University, 2005, p.29). Comparatively, the term extensive roofs describe a more passive approach (Ryerson University, 2005, p.34) and include vegetation forms such as moss or grass herbaceous plants (Ryerson University, 2005, p.42).
So compared to a conventional roof system green roofs provide many advantages (National Geographics, n.d.). They improve the air quality through the mitigation of gases (Ryerson University, 2005, p.32) by converting carbon dioxide into oxygen and filtering particles from the air (National Geographic). Furthermore, green roofs act as insulation (Ryerson University, 2005, p.10) and therewith entail a natural cooling effect (Ryerson University, 2005, p.10). Additionally, they provide insulation against sound which can inure to the benefit of animals and visitors in the zoo (National Geographic,). Particularly in cities the implementation of green roofs could reduce the energy consumption by at least 5% up to 15% (National Geographic, 2009) and therewith reduce energy costs. By implementing green roofs the annual energy savings could reach from $2.500 to $12.500 (Ryerson University, 2005, p.32). Another benefit of eco-roofs is that rain-or storm water which falls on a green roof is absorbed by its plants and soil which entails that water vapor is released back into the air by evaporation and transpiration whereas rainwater falling on usual roofs quickly flows off the roof into a storm sewer (National Geographic,). Depending on the quality of the green roof the cost of implementation range from $12 to $24 per square feet compared to a conventional roof which cost about $9 per square feet (Ryerson University, 2005, p.29).Compared to standard roofs which last about 20 years green roofs have a service life of 40 years (Ryerson University, 2005, p.28). A further

benefit of implementing green roofs is that they contribute toward biodiversity by providing habitat for a variety of plant, bird and insect species. Another important factor regarding zoos is that these constructions provide educational opportunities and beautiful visual scenery. Depending on the country and region monetary rewards through for instance tax credits, loans and grants could be realized by implementing green roofs (Toronto Zoo,n.d.).
The Toronto Zoo built a green roof system of about 1200square foot on the top of the Australasia Pavilion and 5000 square feet on the Tundra exhibit which cools and cleans the atmosphere, providing habitat for birds and insects and retains storm water as well as helps to stem climate change. Due to its function as natural insulator the energy consumption is reduced (Toronto Zoo, n.d.).
Also the Zoological Society London constructed a green roof on a surface of 300 square metres as part of their sustainable policy (Living Roofs, n.d.).
Insulation
Buildings are the largest investment which humans conduct during their life. Creating buildings sustainably can lower the environmental impact significantly. Worldwide, buildings consume 25% of virgin wood, entailing 40% of energy use and 16% of water used annually Therefore, it is essential to plan, design and construct buildings sustainably and more efficiently (Auckland Zoo, 2010).
It is a natural occurrence that heat flows from a warmer to a cooler space due to convection, conduction, and radiation (Department of Energy, 2008). Wherever there is a difference in temperature heat moves from heated spaces to the outdoors and to adjacent unheated spaces (Department of Energy, 2008). Furthermore, it is investigated that 25 % of a property's heat is lost through the roof (Knaufinsulation, 2010.). During the summer, heat moves from outdoors to the house interior. To maintain favourite temperature, heating systems in winter and cooling systems in summer have to be installed. Hence, insulating ceilings, walls, and floors provide an effective resistance to the flow of heat (Department of Energy, 2008). Therefore, the thermal insulation of walls and roofs is a commonly used product (National Park Service, n.d., p.1) to control heat transmittance efficiently to eventually reduce energy consumption (Building, n.d.). Providing sufficient insulation and thermal mass within a building is a key element to devise an economical as well as low energy design solution (Building, n.d.).
Insulation of buildings is supposed to be the most cost effective and financially attractive way of all energy efficiency, and renewable energy features to reduce energy consumption and greenhouse gas emissions. Hence, well insulated buildings can contribute to stem climate change and global warming (Ceilite, 2007). Insulating walls and roofs cost about $1800 per house (Healthy Housing, 2010) and reduce the average home heating and cooling costs by about 30% which entails a payback season of around 3-5 years. Once installed, the insulation lasts 50 to 70 years and requires no further maintenance. Furthermore, well insulated buildings reduce the need for additional power generation which saves energy costs and reduces the greenhouse gas emissions (Ceilite, 2007). Overall, the cost-benefit ratio is on the benefit side (Healthy Housing, 2010).
All insulation materials decrease pollutant and greenhouse gas emissions by reducing heating and air conditioning which mostly outweighs environmental problems associated with certain materials. Additionally, all insulation materials boost the local and regional economies by saving energy consumption which reduces the expenditures on fossil fuels generally imported (National Park Service, n.d.). Regarding material choice expanded polystyrene (EPS) presents an efficient and effective component to thermal insulation (Ceilite, 2007). Due to minimal aesthetic requirements insulation material can be a good use for waste and recycling material.

Regarding manufacturing fibre insulation materials such as cellulose, fibreglass, mineral wool, or cotton have lower environmental impacts than foam plastic insulation materials. When insulation thickness is not restricted it is recommended to use fibre insulation materials (National Park Service, n.d.).

The Cincinnati Zoo, USA, is an example zoo which insulates part of their buildings with an innovative spray foam insulation to reduce heating and cooling demands (Zoo and Aquarium Visitor, 2009).
The Newquay Zoo, UK also uses sustainable Rockwool insulation in their enclosures and exhibits of species to ensure that these are living in an appropriate temperature. Furthermore, the new insulation which is completely recyclable and reusable, will assist to limit the zoo's carbon footprint and lower ist energy bills (AzO Network, 2010).

Windows

Windows as building component have long been used for daylighting and ventilation. Furthermore, it is proved that well ventilated indoor environments and access to natural light improves health, comfort and productivity (Gregg and Ander, 2010). Averagely, about 30% of the heat or air-conditioning energy may be lost through the windows (Fisette, 2010).
The United States spend about $20 billion to offset unwanted heat loss and gains through ,for example, energy-efficient glazing windows in residential and commercial buildings in 1990.
Window systems are comprised of glass panes, structural frames, spacers and sealant. The variety of glass types, coatings, and frames has increased enormous within the recent years (Gregg and Ander, 2010).High performance, energy-efficient window and glazing systems are now available that can reduce energy consumption and pollution dramatically by lower heat loss, less air leakages, and warmer window surfaces minimizing condensation. Furthermore, double or triple glazing, specialized transparent coatings, insulating gas sandwiched between panes and improved frames are included in these high-performance windows (Gregg and Ander, 2010).
Through these innovative energy-efficient systems windows save money because they reduce the energy consumption significantly (Fisette, n.d.). In residential optimum window design is able to reduce energy consumption from 10% to 50% while in commercial, industrial, and institutional buildings the saving potential is about 10% to 40% received by reduce lighting and HVAC costs (Gregg and Ander, 2010). The higher initial costs required for new windows can be offset due to consuming less energy (Fisette, n.d).The payback season of energy-efficient windows ranges from two to ten years (Fisette, n.d.).

Using natural light in daily life minimizes energy consumption which eventually lowers the impact on the environment and reduces expenditures on electricity. Windows with high visible transmittance admit natural daylight which can reduces the use of artificial light sources (Fisette, n.d.). Furthermore, installing windows or skylights can benefit mental and physical health. It has been proven that sunlight is even better for human psyches and the physiological situation compared to incandescent or fluorescent lightening (Natural Light, 2010). Additionally, natural sunlight helps the body to emit vitamins A and D which are responsible to build up bones and muscles (Deoquino, 2009). Natural light is also seen as an important component of the internal environment of a building (Building, n.d.). There are tubular skylights which harness the natural light of the sun and reflect it into the room and fill it with pure sunlight (Natu-

ral Light, 2010).Depending on the model, tubular skylights are able to illuminate an equivalent of up to 300-1.450 watts of incandescent lighting (Natural Light, 2010).
Low energy windows contribute to make a building very effective at maintaining its indoor temperature. Installing windows and sky lights being tall and carefully positioned related to the movement of the sun it allows maximal utilisation of natural light (Sustainable Cities, n.d.). Additionally, mobile screens outside will open and close the windows when the sun moves around the facade. Regarding natural ventilation there are motor-controlled windows which open and close automatically to draw fresh air in from optimal locations (Sustainable Cities, n.d.).

A electromagnetic form of energy exchange between the sun and the earth is sunlight which is composed of a range of electromagnetic wavelengths, categorized as ultraviolet (UV), visible, and infrared (IR) which forms the solar spectrum (Gregg and Ander, 2010).
Through conduction, convection, radiation and air leakages, windows lose and gain heat which is expressed with U-values or factors which are the mathematical inverse of R-values. The lower the U-values the higher is the insulative value of the window (Fisette, n.d.). Therefore, the thermal transmittance of glass plays an important role by installing the right windows. Using low-e coatings or inert gases such as argon or krypton within the glazing cavity can reduce mid-pane U-values for triple-glazed units and minimize the thermal transmittance (Building, n.d.) without affecting the shade coefficient (SH) or visible transmittance (Gregg and Ander, 2010).
To select specific wavelengths of energy, glass coatings are formulated which blocks long-wave heat energy, for instance. Therefore, a low solar-heat-gain-coefficient (SHGC) can reduce air-conditioning bills more than increased insulative value of the window with an additional pane of glass (Fisette, n.d.). Furthermore, there are retrofit films or switchable optics available for windows.
Multiple window panes of glass separated by low-conductance gas fillings and warm edge spacers, combined with thermally resistant frames entail the raise of inboard glass temperatures, slow convection and improve comfort (Fisette, n.d.).
The Woodland Park Zoo established natural daylighting package including windows, skylights in office area and daylight sensor and other components. Therefore, a large-scale physical model of the building design including photographs of the existing trees was established. Thereby the amount of solar shading was determined (Woodland Park Zoo, 2010).

Waste

The current problems with solid waste are not only the increased quantities and greater urban concentrations of the generated waste, but also in the variety of waste that has to be managed and the transnational potential of contamination, according to Elizabeth Thomas-Hope (1998).
Currently, there is a substantial proportion of waste being disposed of that is synthetic, metallic, toxic or radioactive, which is virtually indestructible and contaminates the environment. These types of waste greatly increase the potential threat to human health, water resources and the ecology of many habitats and therefore animal health. The implications for environmental management are enormous.
For instance, the Eastern and Western Pacific Garbage Patches in the ocean together called the Great Pacific Garbage Patch found by Charles Moore in 1997. Not only litter items and other marine debris, like fishing nets can be found in these areas, but also small bits of floatable plastic debris. In Hawaii, for instance, marine debris is a hazard to marine habitat, safe navigation and wildlife, including the endangered Hawaiian monk seal (Monachus schauinslandi) and various species of sea turtles, seabirds, and whales (Marine Debris, n.d.).
The complexity of the waste issues is gigantic and therefore it is necessary to tackle it with a wide approach. It must incorporate a proactive dimension, for instance refusing materials, but also the minds and behavior of the population must be redirected towards a level of positive participation in maintaining the environment (Thomas-Hope, 1998).

For zoos waste management is a very important sustainability issue. While zoos also produce a lot of waste, from day to day operations and the waste animal husbandry and visitors produce (Auckland Zoo, 2010).
Particularly zoos could set examples of accomplishing a careful sustainable management of the environment, which should include recycling, reducing and re-using. Overall, waste production should be steadily reduced where possible, especially in packaging. Re-using unavoidable waste, for example paper and cardboard boxes, recycling and composting measures should then be taken to decrease the amount of waste further (Defra, n.d.). Most waste can either be re-used, recycled or composted, like paper, plastics, metal, and glass, cardboard and organic waste.
It is useful to implement the waste reduction process in the environmental policy and introduce it into an action plan in which all the aimed reduction plans are defined in a percentage per year. Keeping a record and administration will also help to lower the amount of waste (Defra, n.d.)

The Seattle Aquarium manage to reduce their waste by recycling over 20 tons of re-usable waste, for instance paper, cardboard, glass, metal, batteries, packaging materials and so called techno-trash. This is the equivalent of 185 trees and 76.000 gallons of water saved (Seattle Aquarium, 2007)

Composting system

Organic matters which are rapidly decomposable can be reduced through heat generation from large volumes to small volumes of slowly decomposing material. This process is called composting (Raabe, n.d.). The heat needed to create compost is generated through the activity of aerobic microorganism such as bacteria, fungi and actinomycetes, which require oxygen, moister and food to grow and multiply, as they convert organic materials into a soil conditioner by changing the chemistry and excreting plant nutrients (USCC, 2008, p.1) (University of Illinois extension, n.d. (b)).

In the later stages of composting with lower temperatures, large decomposers or macro organisms, like the mites, centipedes, millipedes, sow bugs, springtails snails, slugs, spiders, beetles, ants, flies and worms, break the organic material down into smaller peaces for the microorganisms (University of Illinois extension, n.d. (b)).

The carbon and nitrogen in organic material forms food for organisms (University of Illinois extension, n.d. (b)). Wet materials and materials of animal origin tend to contain high levels of nitrogen and decomposes quicker, whereas dried, older and woodier tissues are higher in carbon and take longer to decompose (University of Illinois extension, n.d. (a+b)). A balanced ratio between oxygen, water, carbon and nitrogen and therefore a variety of materials is the key to a good composting process (University of Illinois extension, n.d. (a+b)).

Compost can be produced of many different organic resources such as leaves, manure or food scraps (uncooked) (USCC, 2008, p.1). Table 1 shows what other materials can be used for composting and whether they contain high carbon or nitrogen levels. When it comes to manure, only manure from herbivorous animals like rabbits, goats, cattle, horses, elephants or fowl should be used in a composting pile (Raabe, n.d.). The carbon/ nitrogen ratio should be around 30/ 1 for the rapid and effective composting process, which means equal volumes of naturally dry (dead) plant materials as well as green plant materials should be used (Raabe, n.d.).

TABLE 1. Partial Listing of Compostable Materials (University of Illinois extension n.d. (a))

MATERIAL	C/N	MATERIAL	C/N
	C & N	Hair	N
Blood meal	N	Hay	C
Bone meal	N	Lake weeds	N
Coffee grounds	N	Leaves	C
Crushed egg shells	O,alkalizer	Lint	N
Feathers	N	Manure	N
Fruit	N	Paper(non-recyclable)	C
Fruit peels and rinds	N	Peanut shells	C

Garden debris, dried	C	Straw	C
Garden debris, fresh	C & N	Pumpkins	N
Grass clippings, dried	C	Vegetable scraps	N
Grass clippings, fresh	N	Tea grounds and leaves	N

Often there are regulations or even restrictions on the use of food scraps or lake weeds by a country, state or municipality to ensure that only save and environmentally beneficial composts are marketed (USCC, 2008, p.1) (University of Illinois extension n.d. (a)).
There are also some materials that require some more work before they can be added to the composting process. Either these materials decompose slowly, can only be used in small quantities or the material should be layered. Otherwise these materials might cause a negative effect in the process or in the final product (University of Illinois extension n.d. (a)). Examples of these materials are non-recyclable cardboard, diseased plants or plants/ grass treated with chemicals, hedge trimmings, lime, nut shells (walnut/pecan), peat moss, pine cones and needles, rhubarb/walnut leaves, sawdust, sod, weeds, wood ashes and chips (University of Illinois extension n.d. (a)).
Some materials should not be added at all, for instance bones, cat litter, charcoal, briquettes, cooked food, dairy products, dishwater, fatty oily and greasy foods, fish scraps, meat, glossy coloured paper, human excrements, sludge or manure from carnivorous animals, for instance dogs, cats, lions and tigers etc. (University of Illinois extension n.d. (a)) (Raabe, n.d.). Many of these materials decompose slowly, can attract pests, may contain harmful pathogens, chemicals or toxins and might smell very bad during decomposing (University of Illinois extension n.d. (a)) (Raabe, n.d.).

There are many systems and methods (small and large) that can be used for making compost. Existing systems are Turned windrows, Static windrows (or aerated static piles which can be positively or negatively aerated), Extended pile, In-vessel systems, Animal mortality composting (ore passive piles) and other system components or hybrid systems that combine several systems and methods (Washington State University, 2000) (Brown, Cotton, Messner, Berry & Norem, 2009, p. 4-5).These are mostly large systems producing tonnes of compost annually (IREF, 2008)
There are also some other methods of composting for different amount of compost which are for instance holding units such as bins, turning units, heaps, sheet composting, pit trenching, leaving grass clippings on the lawn, mulching and vermicomposting (using worms) (University of Illinois extension n.d. (d)).

Costs are depending on the size of the area needed for composting, as well as the necessary equipment and type of system that is chosen. The initial costs for instance for a windrow range between less than $20.000 to more than 1 million dollars. The life expectancy of well maintained machinery and pads ranges between 10 to 20 years (IREF, 2008). Hence, small scale

composting systems and methods cost far less.
The length of the composting process varies with the circumstances. In municipal compost facilities using a windrow system turning the rows mechanically, it could take up to 10 to 12 months (University of Illinois extension n.d. (c)). Though, newer technologies could decrease the length of the composting process to between two and three weeks, but it does require more effort (Raabe, R.D. (n.d.).
Temperature is a very significant factor for the length of the process and is related to air and moisture levels. Rapid decomposition takes place at temperatures between 90 and 140 degrees Fahrenheit. With a lower temperature the process slows down and higher temperatures reduce the activity of most organisms (University of Illinois extension n.d. (b)). Above 160 degrees Fahrenheit microorganisms will be killed (Raabe, R.D. (n.d.).
The temperature of compost can be increased by adding nitrogen rich materials and turning the pile (University of Illinois extension n.d. (b)) and heat is better retained in bins than in an open pile (Raabe, R.D. (n.d.). The compost should be turned to prevent the temperature rising to high and to aerate the pile (Raabe, R.D. (n.d.).
Also the particle size of added material should be around 1/2 to1-1/2 inches and a pile should not be to small. It is not recommended to add materials to the pile once it has been started, while decomposition takes a certain length of time and has to start over when materials are added (Raabe, R.D. (n.d.).
Compost is ready for use when the volume has been reduced, no heat is produced anymore and the color of the materials has changed to dark brown (Raabe, R.D. (n.d.).

Compost contains plant nutrients for healthy plant growth (University of Illinois extension n.d. (e)), though is usually not characterized as a fertilizer, but more as a soil conditioner (USCC, 2008, p.1) Soil produces plants with less pest problems. It improves the quality and structure of especially sandy and heavy clay soils in order to better retain nutrients, moister and air (University of Illinois extension n.d. (e)).
Rapid composting kills all plant disease producing organisms as well as most weeds and weed seeds and insects do not survive (Raabe, R.D. (n.d.).
Using compost instead of store bought fertilizers could increase savings and benefit the environment (U.S. EPA, 2008). Heavy metals and other contaminants can be bonded to compost and therefore leachability and absorption is reduced. Compost can help to restore wetlands and has been used to control erosion when mixed with water and then sprayed onto slopes (USCC, 2008, p. 2)

Zoos produce a lot of waste on a daily basis, including some waste most composting centres do not accept, for example high amounts of bamboo and bedding materials from primates or flax from the gardens (Auckland Zoo New Zealand, 2010 (a)). Therefore, zoos need to find other ways to loose their waste. There are already many zoos composting their organic wastes. An AZA survey (2001) showed that 40 % percent of their members is already composting (Grist, 2003). Most zoos recognize waste management as a highly important sustainability issue and reducing and reusing waste are the key factors (Auckland Zoo New Zealand, 2010 (a)). The Auckland Zoo in New Zealand (2010 (b)) uses a industrial worm farm to process the scraps from the staff kitchens and the restaurants in the zoo are also participating by delivering hundreds of kilos of food and paper waste every week. The zoo is sending al other organic waste as well as animal browse to a 90 hectare site to compost and conducts an audit every year which showed that the zoo has sent less waste to a landfill even though the zoo has grown enormously compared to 1992 (Auckland Zoo New Zealand, 2010 (b)).

Recycling and Reusing Materials

Next to composting there are more ways to reduce waste by recycling and reusing materials.
Especially when goods are made of materials that consume a large amount of energy at the manufacturing stage, then recycling and reusing them can save energy and reduce the amount of greenhouse gasses that is released to the atmosphere (IPCC, 1996, p 32).
For instance, the primary materials in steel, copper, glass and paper production release four times the amount of carbon dioxide of recycle materials. For aluminium this is even higher (IPCC, 1996, p 32).
Recycling can be restoring the material for its original use or downgrading it to use it in applications that require lower quality materials (IPCC, 1996, p 32).
Recycling of woody materials for instance, slows down deforestation and assists regeneration and conservation of biomass, which is likely to have a high carbon density and will maintain or improve current biodiversity, soil and watershed benefits. The capital cost of recycling depends on the product which is being recycled (IPCC, 1996, p 56-57).
Multiple options can be combined, such as recycling of some solid waste, composting other waste and place the remainder in a landfill. For solid wastes the cost for recycling are probably low, though the feasibility of specific applications depends on local circumstances in a region or country. The waste stream is nowadays seen as a resource of materials for the production of recycled products, compost or for recovering energy, which is creating jobs, contributes to economic production and also provides health and air pollution benefits, thereby reducing the consumption of primary raw materials (IPCC, 1996, p 66-67).
There are many materials that can be recycled or reused. Cardboard and paper, for instance, can be recycled, which saves lot of water and energy, while reducing the need for fibre trees at the same time. Thereby up to 90% fewer chemicals or other by-products are needed. Recycle one kilogram of cardboard or paper saves up to one kilogram of greenhouse gases (Recycle at work, n.d., p. 2). Aluminium cans require quite some energy and resources in the manufacturing process, therefore they are valuable. One recycled item can saves enough energy to run a television for three hours and one kg of recycled cans prevents the production of 20 kg of greenhouse gases (Recycle at work, n.d., p. 3).
As plastics are made from fossil fuels, they form a major contribution to global warming. By recycling plastic it is possible to save 70% of the energy. Plastics are recycled into many things such as, detergent bottles, carpet fibres, compost bins, rubbish bins, plumbing fittings, packaging, plant pots, video and CD cases and plaster (Recycle at work, n.d., p. 5).
Waste from electronic equipment or E-waste, is a growing form of waste as humans are using more electronics. If these electronic devices such as computers, mobile phones, etc., are brought to a landfill, there is a possibility of poisonous chemicals like lead and cadmium leaking into the environment, building up in living organisms as they do not break down easily, while computer monitors alone already contain more than one kilogram of lead. The equipment can be reused by repairing or rebuilding it or otherwise it is possible to separate the components, like copper, steel, gold, other metals and plastics and recycle them (Recycle at work, n.d., p. 7).
Recycling cell phones also reduces mining for coltan in locations such as gorilla habitats, for instance, which threats wild gorillas (Cincinnati Zoo, 2010 (a)).

Glass, metals and steel are maybe the easiest items to recycle as they are 100% recyclable and can go through that process many times. Also, recycling glass cost 74% less energy than manufacturing it from the raw materials and one kilogram of recycled steel cans saves about two kilogram of greenhouse gases from entering the atmosphere (Recycle at work, n.d., p. 8-9). Scrap metals are collected separately and they include batteries, cars, cast iron, electrical cable, brass copper, stainless steel and radiators among other components (Recycle at work, n.d., p. 9). Also important recyclable materials are printers and cartridges to reduce the use of resources and to keep them away from landfills, while the contain metals and chemicals that can be harmful. It is possible to refill cartridges, though if not, the leftover toner can be used as pigment for new plastics the other components can be taken apart and separately recycled (Recycle at work, n.d., p. 10).

As mentioned before, like any other business a zoo creates waste, hence, they also have to bear waste that is brought along by their visitors. Waste should be approached from three angels reducing, reusing and recycling as the principles of sustainability. Paper for instance, could be reused as shredding for animal bedding or composting (Defra, n.d. p. 3-4).

The Seattle Aquarium (USA) has saved over 185 trees and 76.000 gallons of water through the recycling of almost 20 tons of paper, cardboard, glass, metal and e-waste in 2007. The café in the zoo integrated water saving techniques and appliances as well as reusable and recyclable food services into its business plan (Seattle Aquarium, 2007) (Conservation Annual Report Seattle, 2007).

There are also zoos that take responsibility for the local community, which surrounds the zoo and serve as community recycling drop-off locations. At the Smithsonian National Zoological Park (USA) visitor centre the community can bring printer cartridges, batteries, cell phones and other small electronics. The zoo also installed nearly 200 metal containers to collect cans and bottles, thereby increasing the amount of recycled materials in one season to two and a half tons as well as composing the majority of their food scraps, plant material and animal waste (Smithsonian National Zoological Park, n.d.). The zoo restaurants use 80% to 100% recycled paper products and in the stores the zoo is reducing the use of bags and provides bags from recyclable plastics and non-woven shopping bags. For the exhibits fallen logs and natural rocks from other areas of the zoo are being used and recycled rubber is used for walk-off mats (Smithsonian National Zoological Park, n.d.).

The Cincinatti Zoo in the United States works together with another company to collect old cell phones and they have collected over 5243 cell phones in one year (Cincinnati Zoo 2010 (b)). Zoos could also incorporate recycled and recyclable materials into construction of buildings and enclosures (Woollard, n.d, p. 3-4).

Manure Management

The consequence of feeding animals is a logical physical function of discharging faeces (Taylor, 2008). Manure is non-woody biowaste (Deublein, Steinhauser, 2008, p.9) which has a higher ash-free energy value than wood (Rosillo and Calle, 2007, p. 54). Since synthetic fertilisers are prohibited manure and composts are of prime importance regarding fertility in organic farming systems (Lampkin, 1990; Stockade et al, 2001).Cattle manure, for instance, is an excellent soil amendment capable of increasing soil quality. To enhance crop production sustainably, the application of cattle manure, for instance, is an economical and environmentally sustainable mechanism due to providing large inputs of nutrients and organic material manure can increase crop yields (SSCA, n.d.). Manure is a mineral that can act as a natural repellent as well as insecticide for flies due to its sharp edges which is difficult for flies, for instance, to locate on plants (Stalcup, 2010). It can be used as a dust on livestock coats instead of chemicals putting pressure on the environment (Stalcup, 2010).

For the waste industry as well as for zoos, for instance, the disposal and treatment of biological waste represents a major challenge (Ecomagination, n.d.). Depending on the amounts of animals producing dung in a zoo, the disposal cost for getting rid of the manure can be up to a few thousand dollars a year (Holleman, 2010).To save the high disposal costs by making use of the manure it is possible to implement a composting system or anaerobic fermentation system (Ecomagination, n.d.). Hence, after appropriate treatment it is permit to recycle manure to compost or to supply a biogas facility (Business Link, n.d). To make use of the anaerobic fermentation a biogas system is required. This system uses liquid manure which is transformed into methane and carbon dioxide which is a high-energy and renewable fuel by anaerobic fermentation generating energy (Ecomagination, n.d.). To supply a biogas plant the faeces of elephants are appropriate due to the fact that elephants are hay eaters and inefficient digesters, which make their faeces higher in energy content (Associated Press, 2005). According to the Rosamond Gifford zoo, their six elephant produce about 1000 tons of dung each day which makes them ideal suppliers of dung which might be used to run a biogas plant (Associated Press, 2005).

Many zoos produce own compost made from a variety of zoo herbivores which is sold in the Zoo's shops. This compost can be used as fertilizer for gardens etc. The Kansas City Zoo developed such compost product in terms of the Zoo Manoo program (Savvygardener, 2009). Under this program the zoo produces about 1500 tonnes of Zoo Manoo being composted manure from zoo herbivores animal waste for garden use each year (Savvygardener, 2009). The Memphis zoo also saves about $30.000 of disposal costs each year by selling their dung to a company making compost out of it (New York Times, 1992). Furthermore, it is investigated that manure provides higher returns than chemical fertilizers which makes compost from animal manure more attractive for consumers (Park, 2007). The Toledo Zoo is another example of zoos which composts the manure of herbivores such as elephants, giraffes or rhinoceroses (Taylor, 2008).

The Rosamond Gifford Zoo sent most of its animal waste to a local farm, where it was composted. Regarding to the transport, the composting in the local farm cost about $10.000 a year and additionally emit amounts of carbon dioxide due to transportation. At the Toledo Zoo all animal manure (excluded elephant, giraffe, and rhinoceros dung) is sent to a Toledo-area landfill (Taylor, 2008).

Water

Vision /Messages:

- Avoid, reuse, reduce and recycle water (Seneviratne)
- Treat water as a natural limited resource (WZACS)
- Use water responsibly and wisely(WAZA)
- Decrease water usage by increasing conservation and efficiency measures. (sustain ability improvement plan-lincoln zoo)

Less of one per cent of all water over the world is available for humans and ecosystems including thousands of other species (National Geographic I, n.d.). While the world's population grew up to nearly 7 billion people the water use exceeds this growth rate by 100 % in the last century (National Geographic II, n.d.). Also the institution zoo which need to supply numerous species as well as visitors require vast amounts of water each year to ensure behavioural enrichment of the animals or cleaning their enclosures as well as facilities such as toilets and drinking taps to the visitors. Due to the high water usage it is crucial to use water efficiently to eventually reduce pressure on water as a limited resource, reduce the vulnerability in times of long lasting drought and avoid significant costs that continue to rise (Auckland Zoo, n.d.). Due to rising water costs (DEFRA, n.d.) and moral obligation towards environment (WZACS, 2005, p.58) it is crucial for zoos to reduce, reuse and recycle water (DEFRA, n.d.). According to the WAZA water should be seen and used as a natural resource, which is not inexhaustible and which should be used responsibly (WZACS, 2005, p.58).

- Average water savings on audits in commercial and institutional sectors range from 20-40% (Seneviratne, 2007, p.59)
- Water saving costs of 20-50% could be realized if no water-saving measurements have so far been implemented (Seneviratne, 2007, p.59)
- Water saving costs of 20% if some water saving projects have been implemented but not applied (Seneviratne, 2007, p. 59)

Automatic Sensor Taps/ Infrared Taps

Fixtures such as taps can waste a lot of water (Seneviratne, 2007, p.64)
Installing self-closing taps which contain an automatic sensor such as an infrared sensor automatically shuts off the water when the user removes his hands from underneath the tap. After activating an Ultrasonic –sensor by putting the hands beneath the tap, for instance, the water flow stops after 10-15 seconds. But there is still the debate whether the automatic taps are more advanced compared to manually operated taps (Seneviratne, 2007, p.244).
Furthermore, automatic sensor taps can be implemented in urinals as well. Standing in the range of the sensor for 5 seconds, a passive infrared detector activates the flushing (Seneviratne, 2007, 244-246). Averagely, the return on investment for sensor devices is about 30%, whereby the amount of return depends on the water costs. The payback season for installing sensor facilities is about 3-6 month (Autotaps, n.d.) Contrarily the Alliance of Water Efficiency (n.d.)claims that there is no evidence that sensor activated flush valves save water and even goes further by stating that sensor activated flush mechanisms often result in more frequent

flushing than manual flush valves due to so called ‘phantom flushes’.
In the Australia Zoo the installation of water saving sensor taps in visitor toilets and desert cubes has reduced the water consumption in urinals of up to 98% (Australia Zoo, n.d.).
At the Perth Zoo, Australia water consumption is received by installing new taps which reduce the flow by 20% (Zoo Aquarium Association, n.d.).

Aerators

Furthermore, there is the opportunity to install aerators or flow restrictors which are low cost but highly effective options. Aerators are operating by introducing air into the water stream which eventually produces a more voluminous and whiter stream. A disadvantage of aerators is the fixed orifice whereby the volume of the stream depends on the pressure, but the ‘Neoperl’ aerator overcomes this limitation by maintaining a constant flow regardless of variations in line pressure (Seneviratne, 2007, p.243).
The Lincoln Park Zoo stated in their sustainability improvement plan to install faucet aerators to decrease water usage (Peters, 2007).

Low Water Cisterns

Comparing to older style cisterns, which use averagely 12-14 liter per flush, the dual flush technology (6/3 type) reduces 67% of water consumption by using averagely only 3,8 liter per flush. The development of new types using only 3 liter per flush saves water by offering a separate low flow setting for liquid wastes. This type of low water cistern have the potential to reduce the average flush volume even further (Seneviratne, 2007, p.242-243). There are further low flush models such as the single full flush pressure-assisted toilets which have the same flush volume (3,8 l) but compared with the dual flush model it is known to be noisier (Seneviratne, 2007, p.242-243). The costs of a dual flush mode can vary but are overall comparable with the new models being available on the market. However, it will reduce the water costs. For lower investment there is the opportunity to retrofit the old toilet by using a Dual Flush Conservation kit (The Worlds Zoo today, 2010).
The dual flush system is already implemented in numerous zoos which is an indicator of sustainable action (World Zoo today, 2010). One example of implementing dual flush cisterns regarding to water saving is presented by the Melbourne Zoo which implemented this system in staff and public toilets (Zoo Aquarium Association, n.d.). The Woodland Park,USA, developed a sustainable strategy including low-flow flush valves, fixtures and dual flush toilets which show an overall reduction of thirty per cent below the baseline standards (Woodland Park, n.d.)

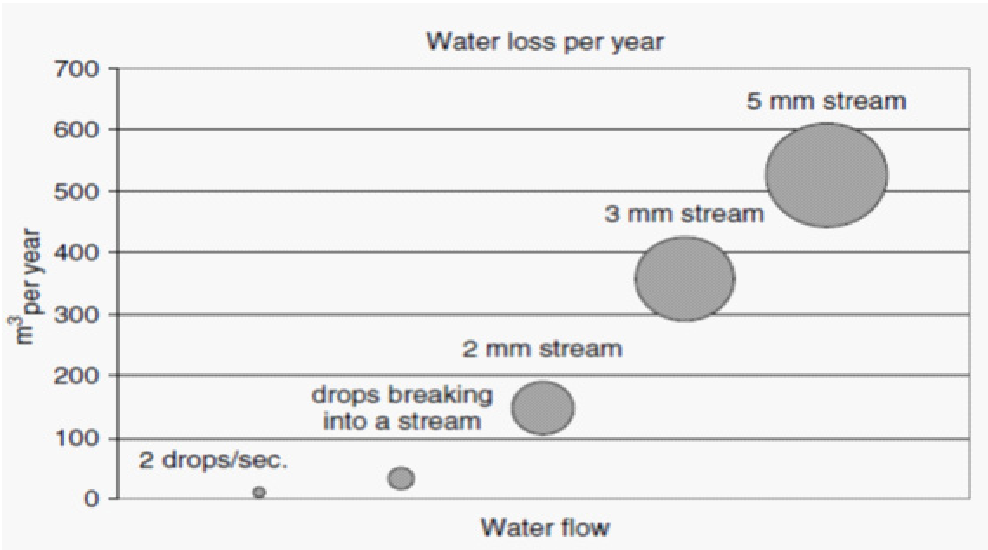
Insulation of Water Pipes for Energy Savings

Insulating water pipes for heating and process water saves money by entailing the reduction of heat loss. Furthermore, water pipes are protected against condensation water, corrosion and mechanical damages (Climapoor, n.d., p.8). In fact water pipe insulation can raise water temperature compared with un-insulated water pipes which eventually allows a lower water temperature setting. Due to the insulated pipes water needs to warm up in a shorter time period which finally leads to higher water efficiency and conservation (US department of energy, 2009, p.8). To reach these result water pipes should get covered by a self-adhesive premium isolation commonly made with polyethylene or neoprene foam (US department of energy, 2009) which is hardly inflammable and so called Felt tape for hardly accessible parts of the pipe. Additionally, to wrap the joints of the water pipes woven adhesive tape is recommended (Climapoor, n.d., p.8-9).

Repairing Leakages in Water Installation System

Over the years and the age of the infrastructure in many instances, leakage from underground pipes, urinals and taps can account for 20-30%of the usage (Seniviratne, 2007, p.59) whereas also' leakage from taps and toilets can waste significant amounts of water' (Seniviratne, 2007, p.243). But through a well-managed maintenance program leaks can be minimized (Seniviratne, 2007, 96).
The Cincinnati Zoo reduced their annual potable water usage by 50% (appr. 120 million gallons) by doing simple things like searching for and fixing leaks (Building my Green Life, 2010). Also at the Smithsonian National Zoo in they saved 110.000 gallons a day due to finding and repairing a leak in an aquatic exhibit (Smithsonian National Zoological Park, n.d.).

The following figure describes the water loss per year which can be cause by leakages in taps.



(Seneviratne, 2007, p. 64)

Waterless Urinals

In 1992, the United States published the Energy Policy Act which regulated that the use of toilet flushing water is limited to one gallon of water to save water resources. There are inventions like 'ultra low-flow' urinals, using only a half gallon of water while waterless urinals are the most efficient alternative using no water (US Army Engineer Research and Development Center, 2007).
The enterprise 'Waterless' developed a waterless urinal called 'Eco Trap®' which relies on the proven simple vertical trap principle. Within the process the urine slows down into the drain insert and passes through a floating layer of BlueSeal ®liquid, which forms a barrier preventing

sewer vapors from escaping to the restroom atmosphere. Under the barrier urine overflows into the central tube and runs down to the conventional drain line. Regarding to this type of waterless urinal three layer of the Blue Seal® liquid will last for about 1500 sanitary uses. If the liquid is off it is simply replenished within 20 seconds without touching the trap. The Eco Trap® mechanism is easily replaced two to four times a year (Waterless, 2010).
Waterless urinals reduce the consumption of water significantly by reducing sewage and maintenance expenses (US Army Engineer Research and Development Center, 2007) because it supersedes flush controllers to maintain and batteries to replace in sensor units (Seneviratne, 2007, p.247). Furthermore, lower electricity cost, eliminated infrastructure cost, and reduced septic system load and treatment time result from using waterless urinals. Generally, a waterless urinal can save up to 45,000 gallons (~170.000 litres) of water and sewage annually. Compared to a 1.0 gallon per flush unit with 75 uses per day a waterless urinal could save between 27,275 gallons (~100.000 litres) of water and sewer per year for a newer unit or even 95,812 gallons (~360.000 litres) for an older 3.5gpf urinal. A waterless urinal leaves a margin of between $130 and $830 each including maintenance costs for replacement fluid and/or cartridges which are about $45 and $120 per urinal annually. In general, the payback time for new installations and retrofit ranges between ½ and 3 years (US Army Engineer Research and Development Center, 2007).
The San Diego Zoo has installed about 50 waterless urinals in its men's restrooms while each unit saves about 40,000 gallons (~150.000 litres) of water each year (Horsley, 2007). The Cincinnati Zoo in Ohio, USA also stated to use waterless urinals and highly water-efficient toilets as well as faucets which entail a water reduction of 50% compared to standard facilities (Cincinnati Zoo, n.d.)

Granulate Material

A granulate material (f.ex. Geohumus®) is a soil additive combining efficient water absorbing polymer with mineral components having excellent water absorbing and release properties. The odorless granulate material. Maintaining its structural stability in the soil mixed with its high water absorbing function and release capacity the granulate material provides available water to more plants over an extended time period compared to untreated soils. Using the granulate material in the soil the efficiency of water use increases and intervals between irrigations extend. Furthermore, a reduction of labor and maintenance cost results. This water saving method is already used by nurseries, parks, public green areas and is employed for revegetation, reforestation as well as agriculture or even supports avoiding salinisation (Geohumus®, 2010).

Waste water treatment

To ensure a recycling and reclamation success different levels of waste water treatment are required (Committee on US–Iranian Workshop on Water Conservation and Recycling, 2005). Waste water treatment restores the wastewater to its original quality by treating the waste stream in different processes (Drinan, 2001, p.115).
The term waste water describes the flow of used water from a community including households waste, commercial and industrial waste stream flows as well as stormwater and groundwater (J.E. Drinan, 2001, p.127). Waste water can be distinguished in grey water and black water. Grey water includes all waste waters from sinks, showers, laundry facilities etc. which

contains no feces and food wastes and much lower concentration of biochemical oxygen demand, nutrients and pathogens (Committee on US–Iranian Workshop on Water Conservation and Recycling, 2005, p.57-58) . By comparison waste water from toilets is called black water which necessarily should be recycled separately from grey water due to containing nitrogen which is one of the most serious and difficult-to-remove pollutants affecting the potential potable water supply (Grey water, 2000). Accordingly, grey water reclamation process requires less treatment as black water (Committee on US–Iranian Workshop on Water Conservation and Recycling, 2005, p.57-58; Grey water, 2000).
To reuse, recycle and reclaim water efficiently it is recommendable to install a decentralized waste water treatment system which is onsite and allows the zoos to recycle and reclaim water onsite (Committee on US–Iranian Workshop on Water Conservation and Recycling, 2005, p.56). Decentralized or onsite waste water treatment generates waste water closer to the potential reuse site(Committee on US–Iranian Workshop on Water Conservation and Recycling, 2005, p.56)and is separated from effluents that require more technical treatment (Steinfeld, 2007). The available technology is capable to produce waste water which is appropriate for non-potable reuse, ranging from irrigation to toilet flushing (Committee on US–Iranian Workshop on Water Conservation and Recycling, 2005, p.56).

Treatment of Grey Water

The cost-effectiveness of a grey water treatment system depends on the volume of water which has been saved through treatment, costs of installation, running and maintaining grey water systems as well as on the price of the mains water which is replaced by recycled or reused grey water. Using a large volume of water, as it is the case for zoos and aquaria, could yet make substantial savings with very little capital investment (Environment Agency, 2008, p.16).

Rainwater Harvesting

Every year a huge amount of rainwater goes untapped into the ground (Times of India, n.d.), whereas the installation of a rainwater harvesting system as a possible cost effective sustainable manner could be beneficial due to its water restoring function which eventually ensures further water reuse (Ministry of Natural Resources and Environment Malaysia, 2010). Also in zoos which need to supply high amounts of water to a large number of species (Times of India, n.d.) as well as visitors (Auckland Zoo, n.d.) rainwater harvesting needs greater attention. The director of the Vandular Zoo in India stated that rainwater harvesting helps restoring water (Times of India, n.d.) whereas rainwater harvesting expert Raghavan even goes further. He claims that not only houses and commercial buildings but also zoos, where large number of species are maintained, should have such rainwater harvesting systems (Times of India, n.d.).
Collecting rain- or storm water through a collection and storage system increases the availability of water onsite and reduces energy consumption automatically at the same time by reducing the reticulation and processing (Zoos Victoria, 2010, p.21).
A usual rainwater harvesting system which is appropriate to non-potable use consists of a collection system, a conveyance system and a storage system whereas the system can vary from simple to more complex types depending on factors like size and nature of the catchment areas and whether the systems are located in urban or rural settings (UN-Habitat, 2005, p.12).
The main components in a simple roof water collection system are the cistern, the leading

pipe and the appurtenances within the cistern. The complexity of the whole harvesting system largely depends on the initial capital investment. There are cost effective systems consisting of cisterns made from ferro-cement. The harvested rainwater can be filtered or disinfected (UN-Habitat, 2005, p.12).
Furthermore, there is the opportunity to invest in larger systems which are more complex, for instance, by collecting rainwater from roofs and grounds of institutions whereas storages in underground reservoirs can be installed for further treatment regarding to non-potable applications (UN-Habitat, 2005, p.12). Furthermore, to produce potable water which is appropriate for human consumption filtration and some form of disinfection is the minimum recommended treatment (UN-Habitat, 2005, p.33)

At Melbourne Zoo all storm water is stored in the raw water holding tank and collected by the second tank once the plant has monitored and adjusted the Ph and chlorine levels, conductivity and turbidity of the pre-treated waste water (World Plumbing info, 2009).
The Allwetterzoo in Münster harvests rain or stormwater via the roofs. The whole flat roofs are constructed with high walls which entail water storage where water can get emitted if required (Source!!!).
The Cincinnati zoo in Ohio, USA zoo got recognized for its outstanding effort to embrace sustainable storm water management practices such as pervious paving and rain water harvesting which stores over 1 million gallons of water (Cincinnati Zoo, 2009).

Water Filtration Systems

Filtration has been used for many years in water and wastewater application whereas some improvements such as membrane technology have simplified processes and made them more feasible (Committee on US-IWWCR, 2005, p.42).
There are different reuse strategies which require different levels of treatment which range from simple upgrades to already existing treatment facilities to multiple barrier treatment (Committee on US–IWWCR, 2005, p.41). Not depending on the level every system needs a preliminary and a secondary treatment prior to any advanced treatment. Preliminary treatment includes screening and grit removal whereas secondary treatment consists of a biological treatment process such as activated sludge or trickling filters (Committee on US–IWWCR, 2005, p.41). To filter secondary effluent effectively viable media such as traditional sand and new membrane materials can be used (Committee on US-IWWCR, 2005, p.42). To reach high levels of effluent quality for non-potable reuse a tertiary treatment can be implemented increasing levels of disinfection (Committee on US–IWWCR, 2005, p.41). Furthermore, there are viable methods such as chlorine, Ultraviolet light (UV)as well as Reverse osmosis, Ozone and even boiling (UN-Habitat, 2005, p.37-38)to effectively disinfect tertiary effluent whereas the last method effectively reduces coliform and viruses without creating toxic byproducts (Committee on US-IWWCR, 2005, p. 44-45).
Also for smaller communities, hence smaller zoos, there is a broad range of technologies for treating waste water. At one end of the spectrum are technologies that use gravity flow relying on natural processes to achieve most of the treatment. These methods are characterized to be lower cost, having few or no energy requirements and require less process and maintenance. Due to the fact that this treatment system is more dependent on external climatic and environmental impacts the treatment success of recycled water varies. Additionally there are highly mechanized technologies using pumps to distribute the waste water as well as mechan-

ical equipment to provide mixing, aeration, filtration or further intensification (Water Conservation, reuse and recycling, p.59-60).

Types of filtration systems

Gravity Based Filter

There are different types of filters applicable for different levels of filtration and quality of recycled water (UN-Habitat, 2005, p.33).
For example the gravity based filter consists of layers of fine sand, coarse sand respectively and gravel. The surface of one square meter of such a filter shall facilitate approximately 60 liters per hectare of filtration of rainwater runoff. Before the rainwater runoff flows into the filtration pit a system of coarse and fine screen is essential to get installed. Gravel, sand and charcoal are the components of the filter which are easily available (UN-Habitat, 2005, p.34).

Sand Filters

Also the sand filter as the most demanded filter system represents an easy and inexpensive method which is available in a wide scale. These filters are suitable for treatment of waste water to effectively remove turbidity, which means to suspend particles like slit and clay, as well as colours and microorganisms. This simple system can also be manufactured domestically whereas the top layer consists of coarse sand followed by a layer made from gravel (5-10mm) which in turn is covered by another layer of gravel and boulders (5-25cm) (UN-Habitat, 2005, p.35).

Pressure Based Filter

Pressure based filters ensures a higher rate of filtration in a pressurized system whereas the quality of filtered water is also claimed to cope with the World Health Organisation's guidelines. This type of filter is suitable and proven to be successful for areas with limited space and larger rainwater runoff (>6 cubic meter per hectare). This system requires a siltation pit for about 6-15 cubic meters in capacity to eventually ensure sedimentation before the water gets pumped through the filter into the ground. The Pressure based filter requires a pump which has the capacity of 0.5-1 hecto pascale (hp) (UN-Habitat, 2005, p.35).
In the year 2005 the Royal Melbourne Zoological Gardens in Australia installed a water recycling plant using reverse osmosis. The grey water is stored in two large underground concrete holding tanks whereas one can carry 750 kl raw water and the other 145 kl treated water. The rainwater as well as the effluent from the wash-down of the animal enclosures is stored in a raw water holding tank and collected by the second tank once the plant has monitored and adjusted the Ph and chlorine levels, conductivity and turbidity of the pre-treated waste water. The harvested water is recycled to Class 3A1-quality by a progressive reverse osmosis process. The recycled water is used for exhibit cleaning, some pool filling, lawn, ponds as well as landscape irrigation as part of a water management program. Within 10 Month the plant produced 28.000 kl of recycled water which covers almost one third of the zoo's daily water demand for this period (World Plumbing Info, 2009).

Procurement

Sustainable procurement for an organization means to use their own buying power to give a signal to the market regarding to all facets of sustainability which combines the protection on the environment, social responsibility and progress as well as economic development (United Nations, 2010). The aim of sustainable procurement is moving towards a closed loop system whereby resources are recirculated and waste is eliminated or at least minimized (BIAZA, 2008, p.20).
The Department for Environment Food and Rural Affairs (n.d.) stated that zoos are able to improve their purchasing practices by ensuring that environmental and ethical standards are applied. Furthermore, zoos should attempt to encourage environmentally and ethically conscious behavior from their suppliers, sub-contractors as well as sponsors to contribute to a local and global sustainability (DEFRA, n.d.).
Green products such as MSC or Fair Trade items are frequently sold in zoos shops and cafés whereas it either should be used in back-of- house departments (Oliver, 2007, p.???). According to the British and Irish Association of Zoos and Aquariums (BIAZA, 2008, p.8) the lowest financial cost option will not necessarily be the 'best value' for money.
Also understanding the link between the purchased items and the effect of their production on people, animals and environment the Paignton Zoo, UK, has removed products containing palm oil due to the destroying results to the habitat of Orang Utan populations. It is possible and necessary that organizations educate and ensure that global as well as local considerations are taken into account.
Eighty nine per cent (n=18) of the respondents offer sustainable accredited products in their shops
The Bristol Zoo Gardens, UK, stated to display a constant approach to sustainable and ethical procurement across the organization particularly products promoted in shops and cafeterias (Bristol Zoo II, nd.).
Using the purchasing power sustainably and stimulating the market for more products and services that are ethically and responsibly produced the Zoos Victoria, Australia, consider it as a commitment to environmental sustainability. These zoos purchase green or environmentally preferred products which are less damaging to human health and the environment regarding to a sustainable source of raw materials, production, packaging, distribution, potential for reuse and recycling as well as maintenance or operation compared to competing products and services serving the same purpose (Zoos Victoria, 2010, p.17).

Local Procurement

To ensure sustainable procurement it is crucial to purchase local products and services due to its enormous potential to stimulate the local economy and foster associated job opportunities (City of London, n.d.) as well as to support the economic base of the community (Sustainable Connection, n.d.). Furthermore purchasing locally requires less transportation and contributes to less sprawl, congestion, habitat loss and pollution. Local procurement also entails a more efficient use of public services and requires comparatively little infrastructure investment (Sustainable Connection, n.d.).

Regarding a research about integrated sustainability components in BIAZA member zoos it is demonstrated that 82.4% of the surveyed zoos use local products such as material and food items (Streiter, 2010).

Also the Bristol Zoo Gardens, UK, realized a sustainable procurement principle by purchasing 80% of locally sourced products from within 50 miles. This 80% includes items such as building materials, fuel as well as organic, ethically and free ranged supplies and food stuffs. Reducing the transportation and stimulating the local economy the Bristol Zoo uses natural renewable materials from sustainable resources. Furthermore, local suppliers with first class sustainable credential are engaged (Bristol Zoo I, n.d.) and local sourcing and procurement policy for labour will create a substantial number of indirect employment positions in the region. Additionally, much of the construction work will be undertaken by local organisations (Bristol Zoo II, n.d.). Accommodating the landscape's existing features all buildings within the zoo will be situated properly (Bristol Zoo I, n.d.).

Fairtrade Products

Living in a world of social and economic inequalities which effects millions of people living without the basic necessities of food, water, housing, education or health care as well as millions of farmers being badly affected by the globalization and are not able to feed their families Fairtrade as alternative system counteracts this system of international free trade, corporate control and global policies by giving the farmers and workers a living wage for their work which can sustain them and also create opportunities for social and economic development (World Centric, 2010).
The Fairtrade Labelling Organisation International (FLO) is the umbrella organization behind the Fair trade products and is responsible for setting fair trade standards, supporting producers around the world, developing Fairtrade strategies as well as certifying disadvantaged producers and standardizing the fair trade(Business school Munich, n.d.; Fairtrade I, n.d.). Furthermore, the visibility of the brand in supermarket shelves, convey a dynamic, forward looking image for Fairtrade, afford cross border trade and simplify procedures for importers and traders (Business school Munich, n.d.). Fairtrade is recognized to be an alternative approach to conventional trade which is based on a fair partnership between producers and consumers. This mark aims to improve terms of trade by offering producers a better deal (Fairtrade II, n.d.) and ensures that producers and traders have met Fairtrade standards which address the imbalance of power in trading relationships, unstable markets and the injustice of conventional trade (Fairtrade I, n.d.). The price of the Fairtrade products is determined by considering that producers can cover their average costs of sustainable production (Fairtrade II, n.d.).
Fairtrade products are obtainable in form of food products, tea and coffee to fresh fruits and nuts as well as non-food products such as flowers and plants, sport balls and seed cotton (Fairtrade II, n,d,).
In the last four years global sales of fair-trade products have more than tripled and additionally hundreds more producer organizations have become certified (Fairtrade III, n.d.).
One advantage of purchasing Fairtrade products is that the farmers become economically independent and therewith are able to feed themselves and their families which ensure a rising quality of life (Business school Munich, n.d.). Fairtrade products can be slightly more expensive compared to non-certified products due to higher costs regarding independent cer-

tification, auditing as well as traceability, product licensing and labeling belong others (Oxfam, 2009). To the contribution on social and environmental sustainability it is recommendable to consume Fairtrade products (BIAZA handbook, 2008, p.21).

According to a research about sustainability components in BIAZA member zoos it is investigated that 88.2% of the surveyed zoos already use and offer Fairtrade products in their shops and cafeterias (Streiter, 2010).

One of the example zoos purchasing Fair Trade products is the Auckland Zoo, New Zealand, which made a permanent swamp to Fair Trade bananas. Each week more than 40kgs of Fair Trade bananas are consumed by the Zoo's primates, exotic birds and elephants (Fair Trade IV, n.d.). Another zoo act responsibly is the ZSL London Zoo, UK, which associated fair-trade gift items (BIAZA handbook, 2008, p.4).

Biodegradable Cleaning Products

Green procurement is about consuming products and services that are less damaging to the environment and human health than competing products and services serving the same purposes (Ecobuy, n.d.).
Green procurement also includes purchasing biodegradable cleaning products which are simply degraded by natural bacteria and enzymes located in the earth, the sea as well as in sewerage treatment plant and in septic tanks ,whereas each part will be divided and converted into more basic and smaller elements which are more environmentally acceptable. Biodegradation is a natural process to ensure self-preservation (The Planet Earth cleaning company, 2007). There are companies working towards ultimate biodegradability which means that all components used in the cleaning products are biodegradable (The Planet Earth Cleaning Company, 2007). The most conventional dish and laundry detergents consists of petroleum , which is a nonrenewable resource, whereas others contain suspected hormone disruptors which are not readily biodegradable and can threaten wildlife after running off (Grist Magazine, 2010).
Biodegradable cleaning products which are certified as 'ready biodegradable' (Standards like ISO 7827) are demonstrable less harmful for humans as well as the environment by requiring that at least 70 percent of the total ingredients must be proven. Further labels which certify the biodegradability of cleaning products are the 'Design for the Environment' (DfE label) introduced by the Environmental Protection Agency or the 'Green Seal' which certifies that products are truly biodegradable and therefore not include toxic, corrosive, carcinogens, mutagens. Using cleaning products which are certified as readily biodegradable represents a comprehensive examination in terms of environmental quality (The Planet Earth Cleaning Company, 2007).
However, biodegradable products can also have impact on the environment or human health due to containing chlorine dioxide for instance which is an element gas commonly used in cleaning products which in turn can have a hazardous effect to ecosystems in certain concentrations (Ecobuy, 2007).
An additional concern regarding biodegradable cleaning products is the intentional misuse of biodegradable-approving labels on commercial products. It can be assumed that these labels such as 'natural', 'non-toxic', 'eco-safe' or 'environmental friendly' do not reflect the actual biodegradable quality on certain products (Grist Magazine, 2010).

One example of zoos which procure biodegradable cleaning products is the Zoo Sauvage, France, which uses as well as recommends purchasing 100% biodegradable hand soap as well as cleaning products (Zoo Sauvage, n.d.). Also the Australia Zoo stated to use biological cleaning solutions (Australia, n.d.).

Forest Stewardship Council

Wood is a substantial renewable resource (US Energy Information Administration, 2008) and entails improving local air quality, reducing global warming by sequestering carbon as well as creating a habitat to numerous species (Build it Green, 2005). Wood as a potentially environmentally building material is used for timber production which accomplished by indiscriminate logging practices which entail erosion problems, damaging of habitats and biodiversity as well as reducing air and water quality (Build it Green, 2005p.1).
Avoiding these procedures sustainable forestry ensures that there is a balance between the amount of timber production and the forest's natural production without degrading the soil, watershed features or seed sources as well as attempts to avoid degrading forest in order to meet human needs (Green Building Focus, 2009). Sustainable forest management deals with considering natural vegetation, annual growth as well as the amount of trees per stand and its position (Green Building Focus, 2009). To ensure that a forest which meets sustainability standards it needs to be certified by competent organisations such as Forest Stewardship Council (FSC) or the Sustainable Forestry Initiative (SFI) (Continuing Education, 2010; Green Building Focus, 2009). If a forest meets the criteria of the certificating organisation, the final forest product receive the mark of being arisen in responsible and sustainable managed forestry (Green Building Focus, 2009). The FSC is globally recognized by its good reputation regarding its certification system for sustainable managed forests (WWF, 2001). This non-profit organisation conducts such a system by attaining environmentally suitable, socially beneficial as well as economically viable management of the world's forests (Buyer be fair, 2006). In order to guiding forest management by ensuring sustainable results the FSC standard represents the world's most credible and effective certification system (Buyer be fair, 2006; Forest Ethics, n.d.). According to FSC using the certified timber products ensures the maintenance of the forest's biodiversity, productivity and ecological processes and eventually induces a contribution to social responsibility, ecological sustainability and economic viability (FSC I, n.d.). Furthermore, buying FSC certified products will lead to even more forests being manage sustainably (FSC II, n.d.). The global increasing demand for FSC wood forces consumer to import FSC timber from abroad (WWF, 2001). Compared to conventional forests sustainably managed forests do not show higher cost-intensity, they can even have considerably reduced costs and increased profits due to less working effort which in some cases is required in a natural regeneration instead of planting (WWF, 2001). However, the FSC-certified products are generally 0-15% more expensive than non-certified timber products (Build Green, 2005, p.2).
Compared to FSC which has required annual third-party inspections, performs high standards and which is endorsed by numerous environmental councils (Build Green, 2005) other certification systems like the Sustainable Forestry Initiative (SFI) or the Program for Endorsement of Forest Certification Schemes (PEFC) partially do not meet criteria of sustainable forest management by approving the logging of Endangered Forests (Forest Ethics, n.d.). Contrarily, a Founder member of the FSC, stated in an interview that there are systematic problems within the FSC and that even in some cases certifications were being issued to companies that had a insufficient environmental and social performance (Mongabay, n.d.).

However, according to other sources supporting FSC by purchasing certified timber is obligatory to communicate sustainable forest practices protecting biodiversity, habitats as well as supporting local communities and indigenous people (Build Green, 2005).
One example of numerous zoos using FSC certified timber is the Zoomazium, USA, which earned the Materials and Resources credit by using a minimum of 72% of FSC certified wood-based materials and products for buildings. According to Zoomazium FSC products allow the zoo to offer visitors another opportunity to contribute to sustainability (Campell, 2006). Another example is the Zoological Society London, UK, which either uses FSC certified products (ZSL, n.d.).

Marine Stewardship Council

Before the initiation of the Marine Stewardship Council many fisheries have been fishing sustainably to a sufficient extent but measurable improvements have arisen under MSC certification processes (MSC, 2009, p.4).
A greater demand for confidential certification of sustainable seafood entails a positive change towards fishery of the oceans. Around the world, fisheries landing over 6 million tons of seafood annually are engaged at some level to the independent assessment process (MSC, 2009, p.3).
Founded in 1997 by the World Wildlife Fund and Unilever (Bioscience Technology, n.d.) the Marine Stewardship Council is an independent non -profit organization which was created as a market-based certification and eco-labelling program to reward environmentally sustainable fishing practices as well as empowering consumers to use MSC certified fish to support (MSC, 2009, p.3). MSC seeks to realize sustainability principles regarding seafood market by contributing to the health of the world's oceans by recognising and rewarding sustainable fishing practices (MSC, n.d.)
There is an increasing demand of purchasers such as the supermarket chains 'Aldi' or 'Lidl' which stated to have a rising demand from customers (MSC, 2009, p.66). As part of their sustainability strategy major North American grocery chains such as Wal-Mart, Whole Foods or the discounter Waitrose in Europe offer seafood containing the MSC label (Bioscience technology, n.d.).
The 'Assessment of On-Pack, Wild-Capture Seafood Sustainability Certification Programmes and Seafood Ecolabels ' ranked the MSC with a score of 95% which represents the fulfillment of all assessment's criteria requirements (WWF, n.d.). The WWF (n.d.) either stated that other certification schemes such as Naturland, Friend of the Sea or Southern Rocklobster do not comply sufficiently with the requirements which are crucial to support sustainable fishing and healthy oceans.
However, there are critical voices like from Jennifer Jacquet, lead author, are claiming that MSC methods and approaches turned against biology in favor of bureaucracy (Bioscience Technology, n.d.). Furthermore, another detractor stated that MSC should not certify fisheries that are not demonstrable sustainable or using high impact methods (Bioscience Technology, n.d.).

According to BIAZA fish which is certified by MSC is frequently sold in zoo's shops and cafés (BIAZA, 2008). By setting sustainable seafood as priority Bristol Zoo Gardens, UK, seeks to encourage their visitors to consume MSC certified seafood by providing information, events or exhibitions which belong others help visitors to identify certified sustainable seafood to eventually show that they can use their purchasing power to have positive global impact (MSC, 2008). Bristol Zoo Gardens also arranged new displays dealing with marine theme as well as including a freezer cabinet containing a display filled with MSC-labelled products and leaflets (MSC, 2008). According to the Director of the Project AWARE Foundation International the Bristol Zoo makes great effort regarding their responsible operations and point visitors to the importance of making responsible seafood choices. Additionally, the seafood which is used to feed seals is MSC-certified (MSC, 2008).

In order to preserve fish stocks for future generations the Edinburgh Zoo changes the diet of the fish-eating species into sustainable sourced fish. The penguins in the zoo only consume over 50 tonnes of fish per year and therefore Edinburgh Zoo, Scotland, changed their diet from whiting to a new eco-friendly diet of MCS certified hake. Also the diet of the Patagonian sea lions is adapted to MSC certified herring on a daily basis.

Transport

Transport is one of the most responsible sources of increasing carbon dioxide emissions to the atmosphere which in turn directly affects climate and biodiversity. Supporting to conserve the biodiversity zoos can make a contribution by reducing carbon dioxide emissions (DEFRA, n.d.).

Travel Combination Tickets

The Department of Environment, Food and Rural Affairs advices zoos to encourage visitors to use the public transport, for instance, by providing incentives such as entry discounts with evidence of using the public transport which can be ensured by showing the tickets of the used public transport (DEFRA, n.d.). Therefore, providing diverse travel combination tickets is an effective approach to promote public transportation or bikes in terms of reducing carbon emissions (DEFRA, n.d.; Bristol Zoo Gardens I, n.d.).

The Bristol Zoo Garden, UK, is one great example of having a sustainable transport policy regarding reduction of carbon emissions via transport of visitors and staff members. The zoo developed a Green Travel Plan which seeks to make their existing travel plans more sustainable and effective by meeting British Standard requirements complementing the environmental standard ISO 14001. This sustainable travel strategy is able to reduce car use and overall carbon emission in terms of staff and visitor traveling (Bristol Zoo Gardens I, n.d.).

The Bristol Zoo Gardens offers attractive incentives for visitors travelling by public transport as well as providing a free park and ride service which runs every 20 minutes throughout the day (on the busiest days) whereas visitors using the free park and ride option can get a free drink in the Zoo restaurant (Bristol Zoo Gardens II, n.d.). A further option the Bristol Zoo offers is the Zoo Safari ticket, available on the first bus, which allows a visitor to get a cheaper bus travel as well as zoo entrycan buy on the first bus. Comparatively the Paignton Zoo, UK, provides a 10% reduction on the entry price by presenting the valid bus ticket (Paignton Zoo, n.d.).

Furthermore, there is the opportunity to cooperate with rail concerns. For example the Bristol Zoo offers a two-for one Zoo ticket on production of a valid train ticket (Bristol Zoo Gardens II, n.d.)

Another combination ticket is presented by the City of Albuquerque where visitors with hybrid or fuel efficient cars can park for free (City of Albuquerque, n.d.)

A further opportunity to minimize the carbon emission of the zoo visitors is making the bike attractive to visitors as well as staff members. The Bristol Zoo Gardens promoted a special half price offer which was presented by bike riding staff members. Another half price offer was given if the visitors came on a determined day between determined times (Bristol Zoo Gardens II, n.d.).

The head of estates at Bristol Zoo stated that the half price campaign encourages people to come by bike and enjoy a cycle ride up to the Zoo (Bristol Zoo Gardens II, n.d.).

Eco-friendly Cars

According to Paignton Zoo transportation can have an extremely large impact on the environment which the zoo attempts to reduce by providing on-site electric vehicles and Liquid Petroleum Gas vehicles for off-site use which are available for the staff members (Paignton Zoo, n.d.).

Another exemplarity of zoos providing eco-friendly cars to their staff is the Whipsnade Zoo

(Zoological Society London) which purchased an electric vehicle to ensure the waste movement in the 6000 acre sized location (Bradshaw Electric Vehicles I, 2010). This special FB2 type is appropriate to collect and move waste up to 2 tonnes which means that this electric vehicle combines effectiveness and less effort (Bradshaw Electric Vehicles II, 2010). The frame design of the FB2 type allows to be customized to meet particular needs without compromising vehicle durability, safety or performance (Bradshaw Electric Vehicles II, 2010). The electric vehicles are available for sales but also for rent. A rental vehicle avoids making higher investments due to lower permanently paying rates (Bradshaw Electric Vehicles II, 2010). For some companies, long term rental can be the most efficient and effective way for some companies to manage their electric vehicle population. This type of rental can be timed to run from a weekend to several years and offer flexibility and tax advantages (Bradshaw Electric III, 2010).
The Henry Vilas Zoo owns a new Neighborhood Electric Vehicle (NEV) which is environmental friendly vehicle producing no emissions due to the through battery stored electricity. To charge this vehicle a standard electric outlet is needed. The vehicle can operate for about 40 miles before needing to recharge, which means that it can be used for a whole day at the zoo. The electric vehicle is used for transport, conservation, education, animals as well as education equipment. It reaches up to 25 miles per hour which is ideally for transportation within the zoo. On the side of the car the Zoo's logo and a variety of zoo images are featured (Henry Vilas Zoo, n.d.).

Bicycle Racks/Parking Area for Bikes

Due to reduce the carbon emission mainly produced by energy and transport zoos seek to encourage their visitors to use public transport or by bike (Bristol Zoo Gardens, n.d.). There is either small investment a zoo can conduct to engage people visiting the zoo by bike for example an attractive, eye catching bicycle rack as well as sufficient amount of bicycle parking areas to ensure a convenient park opportunity. The Seattle Aquarium for instance installed an octopus-shaped bike rack to encourage visitors to commute to the Aquarium by bike and reduce their carbon footprint (NW Zoo and Aquarium Alliance, n.d.).

References

Alliance of Water Efficiency, n.d. *Office Building Introduction.* [online] Available at: http://www.a4we.org/office_buildings.aspx > [Accessed on 4 September 2010].

Associated Press, 2005. *Zoo Eyes Elephant Poo as Energy Resouce.* [online] Available at: http://www.msnbc.msn.com/id/7678134/ > [Accessed on 5 November 2010].

Auckland Zoo, n.d. [online] Available at: http://www.aucklandzoo.co.nz/default.asp?sectionID=118 > [Accessed on 4 September 2010].

Auckland Zoo New Zealand, 2010 (a). [online] Available at: http://www.aucklandzoo.co.nz/default.asp?sectionID=118 > [Accessed on 6 November 2010].

Auckland Zoo New Zealand, 2010 (b). [online] Available at. http://www.aucklandzoo.co.nz/default.asp?sectionID=371 > [Accessed on 6 November 2010].

Australia Zoo, n.d. [online] Available at: http://www.australiazoo.com.au/conservation/footprint/ > [Accessed on 6 September 2010].

Auto Taps, n.d. *Benefits of electronic sensor water taps.* [online] Available at:http://www.autotaps.com/benefits-of-electronic-taps.html > Accessed on 11 September 2010].

Australian Bureau of Statistics, 2009. *Are households using renewable energy*? [onlinr] Available at: http://www.abs.gov.au/AUSSTATS/abs@.nsf/Lookup/4102.0Main+Features80March%202009 > [Accessed on 27 October 2010].

Australia Zoo, n.d. Carbon Footprint. [online] Available at: http://www.australiazoo.com.au/conservation/footprint/ > [Accessed on 11 September 2010].

AzO Networks, 2010. *Rockwool Insulation Helps Keep Exotic Animals at Newquay Zoo Despite Cold Climate.* [online] Available at:http://www.azom.com/news.asp?newsID=20329 > [Accessed on 31 October 2010].

Balaras, C.A., Droutsa, K., Argiriou, A.A., Asimakopoulos, D.N, 2000.
Potential for energy conservation in apartment buildings Energy and Buildings 31
Page 145.

BIAZA, n.d*. How to become a more Sustainable Zoo.* [online] Available at://www.biaza.org.uk/resources/library/images/SustChapterBIAZAHandbook_jan%2008.pdf > Accessed on 16 September 2010].

Bioscience Technology, n.d. *Seafood stewardship questionable: UBC-Scripps experts.* [online] Available at: http://www.biosciencetechnology.com/News/Feeds/2010/09/products-chemicals-and-reagents-seafood-stewardship-questionable-ubc-scripps-expe/ > Accessed on 18 September 2010].

Bradshaw Electric Vehicles I, 2010. *Zoo, park, garden.* [online] Available at: http://www.bradshawelectricvehicles.co.uk/applications/zoo_park_garden.html > [Accessed on 19 September 2010].

Bradshaw Electric Vehicles II, 2010. *Burden FB2.* [online] Available at: http://www.bradshawelectricvehicles.co.uk/burden/fb2.html > [Accessed on 19 September 2010].

Bradshaw Electric Vehicles III, 2010. *Rental.* [online] Available at: http://www.bradshawelectricvehicles.co.uk/rental.html > [Accessed on 19 September 2010].

Bristol Zoo Gardens I, n.d. *Environmental sustainability*. [online] Available at: http://www.bristolzoo.org.uk/environmental-sustainability > [Accessed on 19 September 2010].

Bristol Zoological Gardens, n.d. [online] Available at: http://www.bristolzoo.org.uk/environmental-sustainability > [Accessed on 13 September 2010].

Bristol Zoo, n.d. [online] Available at: http://www.bristolzoo.org.uk/sites/default/files/files/pdf_promos/Sustainability%20statement%20150708.pdf > [Accessed on 16 September 2010].

Bristol Zoo Gardens II, n.d. *Zoo staff take to their bikes*. [online] Available at: http://www.bristolzoo.org.uk/zoo-staff-take-to-their-bikes > [Accessed on 19 September 2010].

Brown,S., Cotton, M., Messner, S., Berry, F. & Norem, D. 2009.
Issue paper for the Climate Action Reserve: Methane avoidance from composting. [online] Available at: www.compostingcouncil.org > [Accessed on 7 November 2010].

Building, n.d. Sustainability-Thermal Insulation. [online] Available at: http://www.building.co.uk/data/sustainability-thermal-insulation/3075146.article > [Accessed on 31 October 2010].

Build it Green, 2005. *FSC Certified Wood*. [online] Available at: http://calhomedesigns.com/greensheets-pdfs/FSC%20Certified%20Woods%2073.pdf > [Accessed on 18th September 2010].

Building my green life, 2010. *Sustainability is Key at the Cincinnati Zoo.* [onlinr] Available at: http://www.buildingmygreenlife.com/sustainability-is-key-at-the-cincinnati-zoo/ > [Accessed on 4 October 2010].

Business Link, n.d. *Dealing with animal-by-products*. [online] Available at:http://www.businesslink.gov.uk/bdotg/action/detail?itemId=1082260330&type=RESOURCES > [Accessed on 5 November 2010].

Buyer be fair, 2006, *Benefits of FSC certification.* [online] Available at: http://www.buyerbefair.org/fsc_benefits.html > [Accessed on 18 September 2010].

Campell, T., 2006. *Zoomazium connects our future to the present.* [online] Available at: http://

www.ecotrust.org/forestry/markets/zoomazium.html > [Accessed on 18 September 2010].

Ceilite, 2007. *Thermal Insulation*. [online] Available at: http://ceilite-home-insulation.street-directory.com.au/ > [Accessed on 31 October 2010].

Chiras, D., 2010. *Wind Power Basics*. Canada, Gabriola Island: New Society Publishers.

Cincinnati Zoo, 2009. *The greenest Zoo in America.* [online] Available at: http://www.cincinnatizoo.org/documents/LEEDPlatinumAnnouncement09.pdf > [Accessed on 12 September 2010].

Cincinnati Zoo 2010 (a). [online] Available at: http://www.cincinnatizoo.org/savingspecies/gorilla_action.html > [Accessed on 7 November 2010].

Cincinnati Zoo 2010 (b). [online] Available at: http://www.cincinnatizoo.org/savingspecies/new.html > [Accessed on 7 November 2010].

City of Albuquerque, n.d. [online9 Available at: http://www.cabq.gov/albuquerquegreen/green-goals/transportation-options/hybrid-vehicle-parking/hybrid-vehicle-parking > [Accessed on 19 September 2010].

City of London, n.d. *Local procurement project*. [online] Available at: http://www.cityoflondon.gov.uk/Corporation/LGNL_Services/Business/Tenders_and_contracts/City_Corporations_Local_Procurement_Scheme/ > [Accessed on 16 September 2010].

Climapoor, n.d. [online] Available at: http://www.saarpor.de/pdf_Dokumente/produktseiten/climapor_d/rohrisolierung_gb.pdf > [Accessed on 5 September 2010].

Climate Austria, n.d. [online] Available at: http://www.climateaustria.at/en/home/projects/austrian_climate_protection_projects/biomassfired_heating_plant_for_alpine_zoo_sc02a918006/ > [Accessed on 13 September 2010].

Committee on Us – IWWCR- Committee on US–Iranian Workshop on Water Conservation and Recycling, 2005. *Water Conservation, Reuse, and Recycling*. Washington, D.C.: THE NATIONAL ACADEMIES PRESS:

Conservation Annual report, 2007. [online] Available at: http://www.seattleaquarium.org/NetCommunity/Document.Doc?id=579 > [Accessed on 19 September 2010].

Conservation Annual Report Seattle, 2007. [online] Available at: http://www.seattleaquarium.org/NetCommunity/Document.Doc?id=579 > [Accessed on 7 November 2010].

Continuing Education, 2010. *Wood vs. other materials.* [online] Available at: http://continuingeducation.construction.com/article.php?L=22&C=416&P=2 > [Accessed on 18 September 2010].

DEFRA-Department for Environment Food and Rural Affairs, n.d. *Sustainability Initiatives in*

UK zoos. [online] Available at: http://www.defra.gov.uk/wildlife-pets/zoos/documents/zoo-handbook/3.pdf > [Accessed on 16 September 2010].

DEFRA, 2006. *Guidance Note on the Control of Manure and Digestive Tract Content under the EU Animal-BY-Products Regulation (EC 1774/2002)*. [online] Available at: http://www.defra.gov.uk/foodfarm/byproducts/documents/manureguidancev4.pdf > [Accessed on 6 November 2010].

Denver Zoo, n.d. [online] Available at: http://www.denverzoo.org/AT/being_green/gasification/index.html > [Accessed on 13 September 2010].

Deoquino, 2009. *Good Use of Natural Lightening can reduce your energy bill.* [online] Available at:http://www.articlesbase.com/credit-articles/good-use-of-natural-lighting-can-reduce-your-energy-bill-1391871.html > [Accessed on 4 November 2010].

Department of Energy, 2008. *Insulation Fact Sheet*. [online] Available at http://www.ornl.gov/sci/roofs+walls/insulation/ins_01.html > [Accessed on 1 November 2010].

Deublein, D., Steinhauser, A., 2008. *Biogas from Waste and Renewable Resources An Introduction.* Weinheim: Wiley-VCH.

Deutsche Energie Agentur, n.d. *Wie lese ich das EU labe*l. [online] Available at http://www.stromeffizienz.de/eu-label.html > [Accessed on 2 November 2010].

Drinan, J.E., 2001. *Water and Wastewater Treatment.* Florida, Boca Raton: CRC Press, Technomic Publishing.

Ebert, J., 2008. *Solar-Powered Biomass Gasification.* Biomass Magazine. [online] Available at:http://www.biomassmagazine.com/article.jsp?article_id=1674 > [Accessed on 13 September 2010].

Ecobuy,n.d. , *About Ecobuy* . [online] Available at: http://www.ecobuy.org.au/director/about.cfm > Accessed on 16 September 2010

Ecobuy, 2007. *How degradable is your cleaning product?* [online] Available at: http://www.ecobuy.org.au/director/publications/enewsletters.cfm?itemID=09c7b139e92e8cb1bbbeaa0ca065f7c3&articleID=097BE506A163A88FF3569536FDB6FF42 > [Accessed on 16 September 2010].

Eco Generation, 2010. *Animals go for solar power.* [online] Available at:http://ecogeneration.com.au/news/animals_go_wild_for_solar_power/043467/ > [Accessed on 12 September 2010].

Ecology Global Network, 2010. McLamb, *E. Fossils Fuels vs. Renewable Energy Resources: Energy's Future Today.* [online] Available at: http://ecology.com/features/fossilvsrenewable/fossilvsrenewable.html > [Accessed on 17 September 2010].

Ecomagination, n.d . *Some Energy last for Generations*. [online] Available at:http://www.ge-power.com/prod_serv/products/recip_engines/en/downloads/as_biogas_feb08.pdf > [Accessed on 5 November 2010].

Edinburgh Zoo Blog, n.d. *From penguins and wild cats.* [online] Available at: http://rzss.wordpress.com/2010/02/04/penguins%E2%80%A6and-wild-cats/ > [Accessed on 18 September 2010].

Eere Energy, n.d. [online] Available at: http://www1.eere.energy.gov/femp/pdfs/buscase_section2.pdf#page=7, Page 16 > [Accessed on 16 September 2010].

Energy Books, 1999. [online] Available at: http://www.energybooks.com/pdf/11111112.pdf > [Accessed on 20 September 2010].

Energy Information Administration, 2009. *Energy statistics in 2007.* [online]
Available at: http://www.iea.org/stats/pdf_graphs/18TPESPI.pdf > [Accessed on 16 September 2010].

Energy Information Administration, 2010. [online] Available at: http://www.eia.doe.gov/energyexplained/index.cfm?page=hydropower_home > [Accessed on 16 September 2010].

Energy Information Administration, 2010. [online] Available at: http://www.eia.doe.gov/energyexplained/index.cfm?page=about_home > [Accessed on 16 September 2010].

Energy Saving Trust, 2010. [online] Available at. http://www.energysavingtrust.org.uk/Home-improvements-and-products/Home-insulation-glazing/Cavity-wall-insulation > [Accessed on 17 September 2010].

Energy Information Administration, 2010. [online] Available at: http://www.eia.doe.gov/energyexplained/index.cfm?page=biofuel_home > [Accessed on 16 September 2010].

Environment agency, 2008. *Grey water an information guide*, UK, Bristol.

European Commission, 2010. [online] Available at: http://europa.eu/pol/ener/index_en.htm, > [Accessed on 17 September 2010].

Eurostat, 2009. [online] Available at: http://epp.eurostat.ec.europa.eu/portal/page/portal/energy/introduction > [Accessed on 18 September 2010].

Faber, F., Green, J., Gual, M., Haas, R., Huber, C., Resch, G., Ruijgrok, W. & Twidell, J. 2000. Review report on promotion strategies for electricity from renewable energy sources in EU countries.Edited by Reinhard Haas. [online] Available at: http://www.tuuleenergia.ee/uploads/File/reviewreport.pdf, Page 32 > [Accessed on 17 September 2010].

Fairtade I , n.d. [online] Available at: http://www.fairtrade.net/what_we_do.html > [Accessed on 16th September 2010].

Fairtrade II, n.d. *About Fairtrade*. [online] Available at: http://www.transfair.org/bot/fairtrade-in-english.html > [Accessed on 16 September 2010].

Fairtrade III, n.d. [online] Available at: http://www.fairtrade.net/facts_and_figures.html > [Accessed on 16 September 2010].

Fairtrade IV, n.d. *Auckland Zoo swaps to Fairtrade bananas.* [online] Available at: http://www.fairtrade.com.au/swap/nz-goes-fairtrade-bananas?format=lightbox
Accessed on 16 September 2010

FEMP (Federal Energy Management Program), 2001. A guidebook of practical information on designing energy-efficient Federal buildings p. 6, 16, 20. [online] Available at: http://www1.eere.energy.gov/femp/pdfs/25807.pdf > [Accessed on 27 September 2010].

Fisette, n.d. Understanding Energy-Efficient Windows. [online] Available at: at: http://www.finehomebuilding.com/how-to/articles/understanding-energy-efficient-windows.aspx > [Accessed on 4 November 2010].

Forest Ethics, 2010. *Forest Stewardship Counci*l. [online] Available at: http://www.forestethics.org/forest-stewardship-council > [Accessed on 18 September 2010].

FSC, n.d. *Where can I find FSC certified products*? [online] Available at: http://www.fsc.org/buy-fsc-products.html > [Accessed on 18 September 2010].

FSC,n.d. Vision and mission. [online] Available at: http://www.fsc.org/vision_mission.html > [Accessed on 18 September 2010].

Green Building Focus, 2009. [online] Available at: http://www.greenbuildingfocus.com/default.aspx?id=42m> [Accessed on 18 September 2010].

Green CA, 2007. [online] Available at: http://www.green.ca.gov/EPP/building/sensors.htm > [Accessed on 3 October 2010].

Green-Energy-Efficient- Homes, 2010. *Advantages and Disadvantages of Geothermal Systems.* [online] Available at: http://www.green-energy-efficient-homes.com/advantage-disadvantage-geothermal.html > [Accessed on 13 September 2010].

Green Energy UK, 2010. [online] Available at: http://www.greenenergy.uk.com/OurEnergy.aspx > [Accessed on 27 October, 2010].

Green Power-Accredited Renewable Energy, n.d. [online] Available at:http://www.greenpower.gov.au/what-is-greenpower.aspx > [Accessed on 27 October, 2010].

Gregg, D and Ander, F, 2010. *Windows and Glazing*. [online] Available at: http://www.wbdg.org/resources/windows.php > [Accessed on 4 November 2010].

Grey water, 2000. [online] Available at: www.greywater.com > [Accessed on 6 September 2010].

Grist Magazine ,2010. [online] Available at: http://www.grist.org/article/possessions-cleaning/ > [Accessed on 16th September 2010].

Healthy Housing, n.d. [online] Available at : http://www.healthyhousing.org.nz/wp-content/uploads/2010/01/A-cost-benefit-evaluation-of-housing-insulation.pdf > [Accessed on 31 October 2010].

Henry Vilas Zoo, n.d. *Conservation*. [online] Available at: http://www.vilaszoo.org/conservation/index.php?category_id=4416 > [Accessed on 19th September 2010].

Hope, T., E., 1998. *Solid waste management: Critical issues for developing countries* Jamaica: Published by Canoe Press University of the West Indies. ISBN: 976 8125 43 8.

Horsley, S., 2006. *California Plumbers Stall Plans for No-Flush Urinals.* [online] Available at http://www.npr.org/templates/story/story.php?storyId=5238296 > [Accessed on 5 November 2010].

House energy, n.d. [online] Available at: http://www.house-energy.com/House/Ventilation.htm > [Accessed on 30 October 2010].

Hussain, A., Nielsen, L. L., Hansen, O. A., Canpolat, M. (n.d.). *Biogas.The Best Solution.A proposal for alternative thinking and participating in limiting the use of fossil fuels for heating.* [online] Available at: http://www.ngceurope.com/combatclimatechange/pdf/UK_Matthe_usgades%20Skole.pdf > [Accessed on 23 October 2010].

Intelligent Energy Europe project, n.d. GREENBUILDING Improved Energy Efficiency for Non-Residential Buildings. [online] Available at: http://www.eu-greenbuilding.org/index.php?id=10514 > [Accessed on 12 September 2010].

International Energy Agency, 2007. *Renewables in Global Energy Supply.* [online]Available at:http://www.iea.org/papers/2006/renewable_factsheet.pdf > [Accessed on 27 October, 2010].

IPCC, 1996. *Technologies, Policies and Measures for Mitigating Climate Change.* Edited by Watson, R.T., Zinyowera, M.C., Moss, R.H. [online] Available at: http://www.ipcc.ch/pdf/technical-papers/paper-I-en.pdf, p. 41 > [Accessed on 18 October 2010].

IREF, 2008. [online] Available at: http://www.farm-energy.ca/IReF/index.php?page=turned-windrow-ataglance > [Accessed on 1 November 2010].

Knaufinsulation, 2010. *Home Insulation 'can help reduce Energy bills'.* [online] Available at: http://www.knaufinsulation.co.uk/insulation_news/home_insulation_can_help_redu.aspx#ixzz143dSELNu > [Accessed on 31 October 2010].

Lampkin, N., 1990. *Organic Farming*. UK, Ipswich: Farming Press Books.

Leech, Eric., 2009. *More Power to Poop in Colorado's Zoos.* [online] Available at:http://www.treehugger.com/files/2009/03/more-power-topoop-in-colorados-zoos.php > [Accessed on 13 September 2010].

Lincoln Park Zoo, 2008. Jamie Peters, Coordinator of Environmental Initiatives, Lincoln Park Zoo2007 (First Edition); 2008 (Second Edition). [online] Available at: http://www.lpzoo.org/info/green/Sustainability_Improvement_Plan.pdf > [Accessed on 13 September 2010].

London Zoo, n.d. ZSL London Zoo's Environmental policy. [online] Available at. http://www.zsl.org/zsl-london-zoo/visit/ecozoo,922,AR.html > [Accessed on 18 September 2010].

Macquarie University, 2008. [online] Available at: http://www.mq.edu.au/sustainability/our-team/srn.html > [Accessed on 26 October 2010].

Maker, T.M. 2004. *Wood-Chip Heating SystemsA Guide For Institutional and Commercial Bio-mass Installations.* [online] Available at: http://www.biomasscenter.org/pdfs/Wood-Chip-Heating-Guide.pdf > [Accessed on 13 September 2010].

Marine Debris, n.d. [online] Available at: http://marinedebris.noaa.gov/info/patch.html#9) > [Accessed on 21 March 2010]-

Ministry of Natural Resources and Environment, 2010. P*RESS RELEASE RAIN HARVESTING SYS-TEM (RWH) LAUNCH AT THE NATIONAL ZOO 26JUNE 2010.* Malaysia-

Monabay, 2008. *An interview with Simon Counsell, Director of Rainforest Foundation UK.* [on-line] Available at: http://news.mongabay.com/2008/0417-hance_interview_counsell.html > [Accessed on 18 September 2010].

MSC , n.d. [online] Available at: http://www.msc.org/about-us/vision-mission > [Accessed on 18th September 2010].

MSC, 2009. *Net Benefits the first ten years of MSC certifiedsustainable fisheries.* [online] Avail-able at: http://www.msc.org/documents/fisheries-factsheets/net-benefits-report/Net-Bene-fits-report.pdf > [Accessed on 18th September 2010].

MSC , 2008. Catch our sustainable fish dinners and help ocean conservation', says Bristol Zoo Garden. [online] Available at: http://www.msc.org/cook-eat-enjoy/news/newsitem/catch-our-sustainable-fish-dinners-and-help-ocean > [Accessed on 18th September 2010].

Munich business school, n.d. F*airtrade - an analysis of the coffee market, the advantages and disadvantages and the case study Starbucks.* [online] Available at: http://www.munich-business-school.de/intercultural/index.php/Fairtrade   an_analysis_of_the_coffee_market,_the_advantages_and_disadvantages_and_the_case_study_Starbucks > [Accessed on 16 Sep-tember 2010].

National Geographic I, n.d. [online] Available at: http://environment.nationalgeographic.com/environment/freshwater/top-ten/ > [Accessed on 3 September 2010].

National Geographic II, n.d. [online] Available at: http://environment.nationalgeographic.com/environment/freshwater/freshwater-crisis > [Accessed on 3 September].

National Park Service-Pacific West Region,n.d. *Environmental Considerations of Building Insulation.* [online] Available at: http://www.doi.gov/greening/buildings/insulation.pdf > [Accessed on 31 October 2010].

National renewable energy laboratory , n.d. [online] Available at: http://www.nrel.gov/docs/fy04osti/35489.pdf > [Accessed on 12 September 2010].

National Geographic, 2009. *Plant-Covered Roofs Ease Urban Heat*. [online] Available at: http://news.nationalgeographic.com/news/2002/11/1115_021115_GreenRoofs_2.html > [Accessed on 29 October, 2010].

Natural Light, 2010. *Residential Tubular Lights.* [online] Available at: http://www.nltubular.com/product_info/residential.html > [Accessed on 4 November 2010].

NatVent, n.d. [online] Available at: http://projects.bre.co.uk/natvent/ > [Accessed on 27 October 2010].

Novinson, 2010. *Wave Energy and ist Impact on Endangered Species.* [online] Available at: http://www.ehow.com/about_6138183_wave-its-impact-endangered-species.html > [Accessed on 27 October2010].

NW Zoo Aquarium Alliance, n.d. *Green practices.* [online] Available at: http://www.nwzaa.org/project-pages/green2.html> [Accessed on 13 October 2010).

Ochsner, K., 2007. *Geothermal Heat Pumps*. *A Guide for Planning and Installing*.London: Earthscan:

Oxfam, 2009. *Fairtrade: Frequently asked questions.* http://www.oxfam.org.uk/shops/content/fairtradefaqs.html#8 > [Accessed on 16th September 2010].

Park, S., 2010. *Manure Provides Higher Returns Than Chemical Fertilizers: Study.* [online] Available at : http://www.physorg.com/news196947358.html > [Accessed on 5 November 2010].

Paul, C. 2010. *Issue 112 Pandering to Nature*. [online] Available at: http://www.hydroponics.com.au/free-articles/issue-112-pandering-to-nature/ > Accessed on 28 September 2010].

Paignton Zoo, n.d. [online] Available at: http://www.paigntonzoo.org.uk/conservation/our-environment.php > [Accessed on 19th September 2010].

Paignton Zoo, 2006. [online] Available at: http://www.paigntonzoo.org.uk/conservation/our-environment.php > [Accessed on 16th September 2010].

Paignton Zoo, 2006. [online] Available at: http://www.paigntonzoo.org.uk/visiting/getting-to-the-zoo.php > [Accessed on 19th September 2010].

Pembina Institute Canada 1, n.d. [online] Available at http://re.pembina.org/benefits > [Accessed on 16 September 2010].

Pembina Institute Canada 2, n.d. [online] Available at http://re.pembina.org/sources/wave, > [Accessed on 17 September 2010].

Peters,J., 2007. *Sustainability Improvement Plan.* L*incoln Park Zoo's Comprehensive Five-Year Plan*. [online] Available at: http://www.lpzoo.org/info/green/Sustainability_Improvement_Plan.pdf > [Accessed on 11 September 2010].

Protivin Crocodile Zoo, n.d. *Project.* [online] Available at: http://www.krokodylizoo.cz/protivin-zo > [Accessed on 13 September 2010].

Raabe, R.D., n.d. The rapid composting method, University of California, USA. Leaflet 21251 : [online] Available at: http://vric.ucdavis.edu/pdf/compost_rapidcompost.pdf > [Accessed on 1 November 2010].

Recycle at work, n.d. [online] Available at: http://www.mq.edu.au/sustainability/documents/r/RecycleAtWork.pdf > [Accessed on 7 November 2010].

Re-Energy, n.d. [online] Available at: http://www.re-energy.ca/docs/renewable-energy-basics-bg.pdf, Page 2 & 3 > [Accessed on 16 September 2010].

Roos, D., n.d. *How Energy Efficient Electronics Work.* [online] Available at http://electronics.howstuffworks.com/gadgets/high-tech-gadgets/energy-efficient-electronics.htm > [Accessed on 2 November 2010].

Rosillo-Calle, F., de Groot, P, Hemstock, S. L., Woods, J., 2007. T*he Biomass Assessment Handbook.Bioenergy for a Sustainable Environment*.Earthscan.

Ryerson University, 2005. *Report on the Environmental Benefits and Costs of Green Roof Technology for the City of Toronto*.

Sarnafil, 2010. *Green Roof Case study-Komodo Dragon House, London Zoo.* [online] Available at: http://www.livingroofs.org/green-roof-komodo.html > [Accessed on 29 October, 2010].

Savvy Gardener, 2009. [online] Available on http://www.savvygardener.com/Features/zoo_manoo.html > [Accessed on 5 November 2010].

Seattle Aquarium, n.d. *Green Practices and Climate Change.* [online] Available at: http://www.seattleaquarium.org/NetCommunity/Page.aspx?pid=266 > [Accessed on 12 September 2010].

SEAV (Sustainable Energy Authority Victoria), 2006. [online] Available at: http://www.seav.vic.gov.au/manufacturing/sustainable_manufacturing/resource.asp?action=show_resource&resourcetype=2&resourceid=34 > [Accessed on27 September 2010].

Seneviratne, M., 2007. A *Practical Approach to Water Conservation for Commercial and Industrial Facilities.* GB, Oxfort: Elsevier

Smithsonian National Zoological Park, n.d., *Green practices at the zoo.* [online] Available at: http://nationalzoo.si.edu/Publications/GreenTeam/ZooPractices.cfm > [Accessed on 11 September 2010].

Solar Power Inc , n.d., *Economic benefits of solar.* [online] Available at: http://www.solarpowerinc.net/Page.aspx?PageID=37n> [Accessed on 12 September 2010].

SSCA, n.d. *Solid Cattle Manure*. [online] Available at http://www.ssca.ca/agronomics/pdfs/cattlemanure.pdf > [Accessed on 5 November 2010].

Stalcup, L., 2010. S*wat Patro*l. [online] Available on http://www.kunafin.com/Swat_Patrol.php > [Accessed on 6 November 2010].

Steinfeld, C., 2007. *Onsite Water Treatment - the journal for decentralized wastewater treatment solutions.* [online] Available at: http://www.foresterpress.com/ow_0701_source.html > [Accessed on 6 September 2010].

Stockdale, E.A., Lampkin, N.H., Hovi, M., Keatinge, R., Lennartsson, E.K.M., MacDonald, D.W., Padel, S., Tattersall, F.H., Wolfe, M.S. and Watson, C.A., 2001. *Agronomic and Environmental Implications of Organic Farming Systems.* Advances in Agronomy 70, 261-327 .

Streiter, 2010. *Sustainability components in BIAZA member zoos.*

Sustainable Cities, n.d. *Copenhagen: Lighting the way in low-energy construction.* [online] Available at http://sustainablecities.dk/en/city-projects/cases/copenhagen-lighting-the-way-in-low-energy-construction > [Accessed on 4 November 2010].

Sustainable Connection, n.d. *Think Local First. Top Ten reasons to Think Local - Buy Local - Be Local.* [online] Available at: http://sustainableconnections.org/thinklocal/why > [Accessed on 16 September 2010].

Sustainability Victoria , n.d. *Resource smart Business.* [online] Available at: http://www.resourcesmart.vic.gov.au/documents/Natural_Ventilation_Systems.pdf > [Accessed on 30 October 2010].

Taylor, S., 2008. *Feeding Time at the Zoo.* [online] Available athttp://ourohio.org/index.php?page=feeding-time-at-the-zoo > [Accessed on 5 November 2010].

The British Hydropower Association, 2005, *A Guide to UK mini-hydro developments.* [online] Available at: http://www.british-hydro.org/mini-hydro > [Accessed on 29 October, 2010].

The New York Times, 1992. [online] Available at:http://www.nytimes.com/1992/05/12/news/fashionable-fertilizer-solves-a-disposal-problem-for-zoos.html > [Accessed on 5 November 2010].

The Planet Earth Cleaning Company, 2007. *Information about the cleaning products that we use.* [online] Available at: http://www.theplanetearth.com.au/information-about-cleaning-products-we-use > [Accessed on 12 September 2010].

The Renewable Energy Centre, n.d. *Hydroelectric Power.* [online] Available at: http://www.therenewableenergycentre.co.uk/hydroelectric-power/ > [Accessed on 27 October 2010].

The Times of India, n.d. *Rainwater harvesting systems for Vandalur zoo - Chennai – City.* [online] Available at: http://timesofindia.indiatimes.com/city/chennai/Rainwater-harvesting-systems-for-Vandalur-zoo/articleshow/6316381.cms#ixzz0yBIfOfjy > [Accessed on 6September 2010].

The State, 2010. *Zoo Wants to be No 1 in No 2.* [online] Available at: http://www.thestate.com/2010/04/28/1262772/zoo-wants-to-be-no-1-in-no-2.html > [Accessed on 5 November 2010].

Toronto Zoo, n.d. *Green Roofs*. [online] Available at: http://www.torontozoo.com/conservation/greenroof.asp > [Accessed on 30 October, 2010]

Toledo Zoo. (n.d.).*Green Practices at The Toledo Zoo.* [online] Available at: http://www.toledozoo.org/conservation/greenpractices.html > [Accessed on 16 September 2010].

Toronto Zoo, n.d. [online] Available at: http://www.torontozoo.com/conservation/macaques.asp > [Accessed on 13 September 2010].

Toronto Zoo, 2010. T**oronto Zoo issues Request for Proposals (RFP) May 3, 2010 for the construction of a Biogas Facility.** [online] Available at: http://www.torontozoo.com/pdfs/Toronto%20Zoo%20Biogas%20q%20and%20a%20-%202010-05-03.pdf > [Accessed on 13 September 2010].

Twidell J.W. and Weir A.D., 2006. *Renewable Energy Resources*, 2nd Edition, Taylor & Francis, London. As sited in: Energy for Sustainable Development: Policy Options for Africa

UN-ENERGY/Africa, A *UN collaboration mechanism and UN sub-cluster on energy in support of NEPAD*. [online] Available at: http://www.uneca.org/eca_resources/Publications/UNEA-Publication-toCSD15.pdf, page 16 > [Accessed on 17 September 2010].

UNECA, n.d., Energy for Sustainable Development: Policy Options for Africa. [online] Available at http://www.uneca.org/eca_resources/Publications/UNEA-Publication-toCSD15.pdf > [Accessed on 2 November 2010].

UN-Habitat. (2005). *Rainwater Harvesting And Utilisation.* UN-Habitat
United Nations, 2010. What is sustainable procurement. [online] Available at:http://ungm.

com/SustainableProcurement/default.aspx > [Accessed on 16th September 2010].

University of Illinois extension n.d. (a). [online] Available athttp://web.extension.illinois.edu/homecompost/materials.html > [Accessed on 1 November 2010].

University of Illinois extension n.d. (b). [online] Available at http://web.extension.illinois.edu/homecompost/science.html > [Accessed on 1 November 2010].

University of Illinois extension n.d. (c). [online] Available at http://web.extension.illinois.edu/homecompost/recycle.html > [Accessed on 1 November 2010].

University of Illinois extension n.d. (d). [online] Available at: http://web.extension.illinois.edu/homecompost/methods.html > [Accessed on 2 November 2010].

University of Illinois extension n.d. (e). [online] Available at: http://web.extension.illinois.edu/homecompost/benifits.html > [Accessed on 7 November 2010].

U.S. Army Engineer Research and Development Center, 2007. *Waterless Urinals-A Technical Evaluation. ERDC/CERL TN-06-3.*

USCC, 2008. *US Composting Council Factsheet: Compost and its benefits.* [online] Available at: www.compostingcouncil.org > [Accessed on 1 November 2010].

U.S. Department of Energy a 2009. [online] Available at: http://www.energysavers.gov/your_home/space_heating_cooling/index.cfm/mytopic=12490 > [Accessed on 12 September 2010].

U.S. Department of Energy, 2008. *Benefits of Geothermal Heat PumpSystems.* [online] Available at: http://www.energysavers.gov/your_home/space_heating_cooling/index.cfm/mytopic=12660 > [Accessed on 13 September 2010].

US Department of Energy ,2009. *Insulate water pipes for energy saving.* [online]Available at: http://www.energysavers.gov/your_home/water_heating/index.cfm/mytopic=13060 > [Accessed on 5 September 2010].

U.S. Department of Energy, 2010a. [online] Available at: http://www.energysavers.gov/your_home/lighting_daylighting/index.cfm/mytopic=12210 > [Accessed on 30 September 2010].

U.S. Department of Energy, 2010b. [online] Available at: http://www.energysavers.gov/your_home/lighting_daylighting/index.cfm/mytopic=12230 > [Accessed on 26-10-2010].

U.S. Department of Energy, 2010c. [online] Available at: http://www1.eere.energy.gov/femp/technologies/eep_light_controls.html#light > [Accessed on 26 September 2010].

U.S. Department of the Interior, n.d. *Greening the Department of the Interior.* Lighting - Occupancy Sensors. [online] Available at: http://www.doi.gov/greening/energy/occupy.html > [Accessed on 26 September 2010].

US Department of Energy, n.d. *Energy Efficient Standards for Residential Appliances.* [online] Available at: http://www.energysavers.gov/your_home/appliances/index.cfm/mytopic=10050 > [Accessed on 2 November 2010].

US Energy Information Administration, 2008. *Wood/wood waste.* [online] Available at: http://www.eia.doe.gov/cneaf/solar.renewables/page/wood/wood.html > [Accessed on 18th September 2010].

U.S. Environmental Protection Agency, 2008. [online] Available at: http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=factsheet_results&view=specific&bmp=1&minmeasure=6 > [Accessed on 7 November 2010].

U.S. Forest Service, n.d. *What is Woody Biomass Utilization***.** [online] Available at: http://www.fs.fed.us/woodybiomass/whatis.shtml > [Accessed on 23 September 2010].

Walker, A. 2010. *Natural Ventilation*. [online] Available at: http://www.wbdg.org/resources/naturalventilation.php > [Accessed on 30 September 2010].

Washington State University, 2000. [online] Available at: http://organic.tfrec.wsu.edu/compost/ImagesWeb/CompSys.html > [Accessed on 2 November 2010].

Waterless, 2010. *Ecotrap®.* [online] Available at: http://www.waterless.com/index.php?option=com_content&task=view&id=3&Itemid=55 > [Accessed on 5 November 2010].

Water Conservation, Reuse, and Recycling, n.d. Washington D. C.: THE NATIONAL ACADEMIES PRESS:

Woollard, S.P., n.d. *Zoo Education for A Sustainable Future, Bristol Zoo Gardens, UK.* [online] Available at: http://www.izea.net/education/Journal%202001%20-%20Zoo%20Education%20for%20a%20Sustainable%20Future.pdf > [Accessed on 7 November 2010].

Woodland Park Zoo, n.d. *Zoomazium- the case for Green building.* [online] Available at: http://www.thirdeyeproductions.org/samples/Zoomazium%20case%20study%20sample.pdf > [Accessed on 11 September 2010].

Woodland Park Zoo, 2010. *Zoomazium at Woodland Park Zoo.* [online] Available at http://www.zoo.org/zoomazium/green > [Accessed on 4November 2010].

World centric, 2010. *Fair Trade?* [online] Available at: http://www.worldcentric.org/consciousliving/actionstotake/fairtrade > [Accessed on 16th September 2010].

World Plumbing Info, 2009. *Water saving at Melbourne Zoo, naturally.* [online] Available at: http://www.worldplumbinginfo.com/article/water-saving-melbourne-zoo-naturally > [Accessed on 10 September 2010].

World Zoo today, 2010. *Dual flush toilets*. [online] Available at: http://www.worldzootoday.com/2010/08/29/dual-flush-toilets/ > [Accessed on 11 September 2010].

WWF, 2001. *FSC- The right choice for forest owners.* [online] Available at: http://assets.panda.org/downloads/FSC_benefits.pdf > [Accessed on 18th September 2010].

WWF, 2010. *Seafood ecolabels under the spotlight in new WWF report.* [online] Available at: http://wwf.panda.org/?186062/Seafood-ecolabels-under-the-spotlight-in-new-WWF-report > [Accessed on 18th September 2010].

WZACS, 2005. B*uilding a future for wildlife, WAZA Conservation Strategy*. ISBN 3-033-00427-X, page 56.

Zen, S., 2008. S*olar Energy Fundamentalsand ModelingTechniques. Atmosphere, Environment, Climate Change and Renewable Energy.* London: Springer.

Zoo and Aquarium Association , n.d. *Zoo, Park and Aquaria Guidelines and Education Experiences: Onsite Education Experiences -Modelling Sound Environmental Practices to Zoo staff and visitors .* [online] Available on: http://www.zooaquarium.org.au/Sound-Environmental-Practices/default.aspx > [Accessed on 11 September 2010].

Zoo and Aquarium Visitor, 2010. C*incinnati Zoo is America's Greenest Zoo and Leed award certified.* [online] Available at: http://www.zandavisitor.com/newsarticle-2434- > [Accessed on 31 October 2010].

Zoos Victoria, 2010. *Environmental and sustainability strategy.* [online] Available at: http://www.zoo.org.au/adx/aspx/adxGetMedia.aspx?DocID=318,315,33,290,Documents&MediaID=25792&Filename=ZV+Environmental+Sustainability+Strategy+January+2010.pdf > [Accessed on 12 September 2010].

Zoo News Digest, 2010. *Cincinnati Zoo Using Wind Power to Go Green.* [online] Available at: http://zoonewsdigest.blogspot.com/2010/06/cincinnati-zoo-using-wind-power-to-go.htm > [Accessed on 16 September 2010].

Zoolex 2009. Tiergarten Schönbrunn - Rainforest House
ZOOS' PRINT, Volume XXV, Number 2, February 2010
Authors: Fast, H. Hollunder, M. Schwammer, G. & Schwammer, H. [online] Available at: http://www.zoosprint.org/ZooPrintMagazine/2010/February/7-10.pdf > [Accessed on 28 October 2010].

Zoo Sauvage, n.d. [online] Available at: http://www.zoosauvage.org/page_ete_en/page/388/conservation.html > [Accessed on 16 September 2010].

Zoo Society. (n.d.). Earth-Friendly Education. [online] Available at: http://www.zoosociety.org/Education/GreenRoof.php, > [Accessed on 23 October 2010].

Zoos Victoria, 2010. *Environmental Sustainability strategy.* [online] Available at: http://www.zoo.org.au/adx/aspx/adxGetMedia.aspx?DocID=318,315,33,290,Documents&MediaID=25792&Filename=ZV+Environmental+Sustainability+Strategy+January+2010.pdf > [Accessed on 16 September 2010].

Appendix II: Zoo profiles

Allwetterzoo Münster, Germany
- Large non-profit zoo
- 991.990 visitors a year
- 30 hectares
- 2849 animals -> 290 species
- 100 staff members -> 40 animal care takers

Bristol Zoo, UK
- Relative small non-profit zoo
- 600.000 visitors a year
- 5 hectares
- 2451 animals (mostly smaller species)->450 animal species

Emmen Zoo, The Netherlands
- Relative large non-profit zoo
- 1.100.000 visitors a year
- 19 hectares
- 2200 animals (8000 with fish and insects included) -> 301 species
- 117 permanent and 260 temporary employees

Granby Zoo, (Quebec) Canada
- Non-profit zoo
- 600.000 visitors a year
- 40.5 hectares
- 1000 animals -> 200 species
- 52 permanent staff members and 48 seasonal employees

Zoo Landau in der Pfalz, Germany
- Small non-profit zoo
- 160.000 visitors a year
- 3,5 hectares
- 700 animals ->125 mostly exotic species
- 14 permanent employees and 8 temporary

Appendix III: Interviews

Interview I: Allwetterzoo Münster

1.1. Is your organisation a profit-making organisation?

- GMBH> NGO
- Mixture of profit making and charity, rather NGO to make profit
- Having a Bildungsauftrag
- Städtischer zuschuss
- Spendenbescheinigung

NGO with charity obligation

1.2. Does your zoo works sustainably?

- Yes attempts, additionally tries to improve

1.3. Does your zoo set value on integrating sustainability?

- Set value on integrating sustainability
- Moral obligation towards sustainability
- Not written down in a strategy or policy
- Acting sustainably and living sustainability within the zoo is seen as a matter of course

Climate change

2.1. Do you actively cooperate with conservation breeding programmes such as ISIS, CITES; IUCN, IZW- Leibniz Institute?

- Yes, with all
- IUCN is required now, not the case for former zoos
- ISIS yes approach> not connected to EAZA > no requirement> studbook keeper different software (ARCS)> ISIS uses this for animal registry>ISIS organization offers this information to public or members
- Software SPAKS > problem to compare with the others
- SIMS> for all
- Own studbooks> eep cojdordinator leopard
- European studbook foundation < breeding centre for turtles
- Problems to compare output
- CITES regulation> transport paper work> have to cope with it
- You don't have to be member
- But commit to laws
- Implementation of CITES > have to cope with regulations
- IUCN> personal decision
- Leibniz > project, research, phd thesis
- Cooperating with this organizations and institutes is common for zoos nowadays, particularly for bigger ones

2.8. Do you fund any conservation projects in-situ or ex-situ? Why?

- Run In-situ projects> WAPKA, Madagascar Fauna Group> M raffle > coordinator

- Vietnam, cambodia
- In-situ/ ex-situ > amphibian arch> funding
- Project staff is working on projects with locals
- High motivation> non written mission> in mind
- Concept> strategic planning > large exhibits> internal document
- Not approaching the public with this
- Involved in mission

How do you encourage animal welfare?

- Implement regular veterinary council > comply with legislation> assessment
- Legal site > announcement to keep animals in certain enclosures
- Begehung> walk through zoo> does the zoo act correctly regarding enclosures> to ensure animal welfare
- Zoo license> have to do it regularly

Conservation campaigns

- EAZA campaigns
- Decide to support amphibian arch by financial resources
- Education exhibition
- Year of … they support this events, guided tours

Research projects
- Support research projects
- Focus on strict conservation measures> otherwise the species will be extinct
- Start engaging research
- Cooperate with zoo in cologne
- Vietnam
- Cambodia
- Main focus in taxonomic and genetic, applied studbook work, husbandry, behavior
- How can we contribute to conservation of the species, husbandry, and nutrition?
- It is not related Vietnam, Cambodia> species that are researched there are not located in the zoo
- Contribute to conservation of critically endangered species in general

Cooperating with research centres or other zoos, universities?
- Zoo in Cologne
- IZAW> request and then work upon the implementaion, Van hall, Berlin, Osnabrück, Münster,

Contribute to conservation?
- Obligation to do it
- Keep species
- Moral obligation
- Popular species> others
- Have to react

Integrating sustainability

- Documentation of all used utilities water, electricity, used heating installations
- Water reduction> 1,2 ml > 75.000 > half reduced
- Integration of sustainability
- Grew
- Besteuerungs dokumentation
- Started from 1995
- Documented used utilities > started to
- ‘Ökoprofit’> for small enterprises> audit
- Certification > stadt münster, bund, nordrheinwestfalen,
- Counseling> 20-25 organisations which contribute
- 50-50 financing
- 1 bis zu 10 euro erwirtschaften
- Status quo of used utilities > later, evaluation process
- Segmentation into water, heating, electricity
- Zoology, restaurant> water provided by Stadt Münster, drink water
- Toilets, washing machine, animals> water from the 3 fountains brauchwasser >
- Pay back season> further 5 years
- Add ecological aspect
- Further 10 years ecol grundkonzept umsetzen
- In wirtschaftspänen berücksichtigt
- Sustainability concept
- 1998 first cooperation ‘ heat situation’ bachelor thesis
- Cooperation Münster and Berlin> heating
- Co2 reduction as much as possible
- Energy generation on place> target, goal
- 40 buildings, 30 hectare> heating
- First water, now heating
- Base> Co2 reduction> heating from oil to gas > reduction
- Main focus > mitigation climate change
- ISO 14001 not reached
- No susbidie
- Solar system> strom wird rückvergütet > prozentsatz an wirtschaftilichkeit
- Zoo>concept> climate change > co2 reduction
- Investing in sustainable facilities> profitability
- Conservation> investing> energy
- Münster climate project > min 30 % co2 reduction
- Kyoto> dranbleiben
- Stellenwert ab wann? 1995
- 15 years 25 % reduction
- Below 6 mln (energy) this year
- How much do they have to invest?
- EMS> Ökoprofit > messlatte>where should we act?
- Goal is defined
- EMS Is introduced but not written down as a strategic document

- Rio declaration> unbewusst teilweise integriert aber nicht explicit
- Future vision
- Reduction
- Until profitability is angetastet
- Geothermal pump > for cheetah
- Solar system: Photovoltaic
- Rainwater >foundation trenchas cisterns
- Natural building material
- German Oak: Local products
- Feeding stuff> local> reduce transportation
- Brands as FSC >
- Restaurant> pachtvertrag> no influence on sustainable acting and offering
- Symbiose, synergy, cooperation, mutuality
- Events to be influenced> bio supermarket
- Events where other people have an event> zoo provides space> catering biological
  Technique
- Zoo is networked
- Central computer
- All mobiles, walkie talkies, technique appliances, Private mobile radio> for efficient communication, navigate the visitors in the parking area
- Energy reduction
- Estate process control
- Complete type
- Also old facilities
- Top down approach > technical director > implemented it
- Director decided to make it an integrated term
- One level > high staff motivation regarding sustainability
- Ökoprofit>staff motivation> workshop> idea collection of every staff member> sug gestions> attempted to realize the suggestions> hitlist
- Ökoprofit team: zoo inspector, Kaufmann, werkstatt, einkauf, technicker
- 4 times a year there is the chance for an audit of Ökoprofit
- 100 staff members
- 1 mln visitors
- 28 ha
- 3000 animals > 300 species
  Public relations
- Presse> öffentlichkeitsspiegel> certificering
- Energy lehrfahrt
- Educational prorgramme
- Demonstrating , combination of sustainable usage of energy or water plus ecology
- Displays
- Motivation to integrate sustainability into their life style
- Only Display, demonstration> visual program , presentation of energy measures
- Later maybe didactic
- Developing

Cooperation

- Cooperation with Municipal Utility
- Cooperation
- Hochschulen, stadt münster, ökoprofit> landesministerien> stehen dahinter, zur verfügung
- Restaurant partner, stadtwerke > energy> wärmekopplung
- Münster ökogas als energyträger> zahlt mehr > geht in kasse des zoo> für insitu project (50.000 euro)
- Conservation project vietnam, flagship art, biodiversity protection, awareness, capacity building,
- Used for equipment
- Handy recycling > press> marketing, recycling company, pay back
- Richtlinien sustainability> bauliche maßnahmen
- Energy nachhaltigkeitsgesetz>>
- Evaluation by ökoprofit> wöchentlich, monatlich aufbereitet, jahresbilanz
- Segmentiert gas wasser strom> gebäudetechnisch> versorgungstechnick > daten ablesung and documentation processing> werte> spitzenverbräuche, profitability
- Energymanagement
- EAZA; WAZA > communication
- Cooperation, exchange is helpful, new ideas, improve communication
- Waste > recycled> paper > market is sold, timber, metal, mist > zentrale sammelstelle> verteilung auf äcker> costly
- Certain nutrientson crops, competition with mass production, manure processed into energy (thought), ecological energy> pellets
- Biogas plant>zoo supplies plant with manure safety > cooperation process
- Electricity for drying process and pellets > profitability > maybe subsidie

Transport

- Foreign enterprises>regional orientation, material,
- Staff>
- animals>CITES, EAZA, WAZA
- Studbook keeper, EP coordinators
- Visitors ‚Stadtwerke plus karte'>travelling cheaper by bus or train
- Bahn cooperation>connection ‚Deutsche Bahn'> offers pakages>
- Website>bus connection
- Audit
- Environmental impact assessments> audit of technique, gardeners, zoo inspectors,
- With other zoos, partners

Communication

- Corporate identity >public relations
- leitfaden> design, boards, presentation of the zoos, tiere hautnah erleben, identification,
- vorgabe,guideline> abwägung, hinweisschilder
- Zoo school: 3, 4 teacher, information material , einführungsrunde, zoo visits, theme naufarbeitung, repartoire zooschule, experience

- Events> cooperation municipal utility: redesign einer fläche im zoo, nrw aspecte> events
- Background des zoos, als platttform genutzt
- Motivation> goal, sum > zoo
- Biocity, boards, verständis für ecology> anlaufpunkt, action durch zoo generell, biodi versity, verständins fuer ecology
- Staff is motivated
- Media use>Advertisement in radio, website, zoo news, magazine>Conservation
- For visitors, get attention, attend potential visitors,
- Facebook site, viral marketing, public appearance
- Development of an app >visualized link to the web
- tiere hautnah erleben, robbenshow, lori fütterung, pinguine laufen durch den zoo
- Biocity>unique, cooperation with dolfinarium und pferdemuseum> belongs to the zoo
- Feeding elephants, without charge
- Forscherwerkstatt> zoo members supervise students and pupils with independent facharbeiten, refererate
- Courses>social systems of mammals by the institute of behavioural biology Univer sity of Münster
- Specie observation
- Communication> label symbols, yellow boards, green
- Cooperation
- Improve communication between zoos

Old buildings>
By measuring energy usage> spitzenverbräuche… where you have to reduce

Waste

- Recycling
- Glass, paper, timber, bauschutt, mist, metal,
- Manure is collected and brought to a central point>dividing to other crops> spend money
- Competition to mass production

- Problems by integrating sustainability
- Profitability, technical realization
- Old technique facilities, electrical lines, no profitability
- Everything within basements

- Payback season, solar system
- 20 earn money > 15 years > 5 years margin
- Beteiligungsgesellschaft, offenlegung des haushaltsplans
- Audit> wirtschaftsprüfer, does the zoo spend its money economical?

Recommendations

- Visitor friendly exhibits

- Zoos as platform for researchers or students

Interview II: Burgers Zoo Arnhem

1. General
Organization profile
1.5 million visitors a year.

1.1. Is your institution a profit making organisation?
Yes, not a foundation. Thinks every institutions should be. Foundations should earn money.

1.2.Does your organisation works sustainably?
Try to, but not yet.

1.3. Does your organisation set value on integrating sustainability?
Yes. The question is, what is sustainable? (Is een container begrip)
We try to show beautiful nature in this zoo. We don't want the visitors to go home without being impressed and interested in nature, biodiversity, ecosystems, flora & fauna etc.
If that's one of your goals, including help with international conservation of nature, than you should try to do it in a way that is sustainable. Your impact on environment and nature is as small as possible.
Aquarium: 8 million litres of water. Uses a lot of electricity. If your impact has to be zero, shut it down-> no more visitors and no electricity bills. In what sense can you be sustainable. Aquariums can be built the traditional way and use a lot of electricity.
Sustainability has different phases. Use the minimum electricity as possible. If you have to use it see how you can do it and where you get your electricity from. Phase 1: we have built an aquarium that uses a lot, but compared to normal aquariums it uses only 1/8.
But what is sustainable?
All electricity in zoo is green. Don't produce electricity ourselves, but we buy it. We our looking for opportunities to produce ourselves. We have looked at wind and solar energy and geothermic (warm water from 6 to 8 km deep). If we had installed geothermic 3 years ago, we would have been the first in Holland. But it did not work in Arnhem, research on it has cost 20 000 euro's.
Use cold/ warmth storage (koude/ warmte opslag) (put hot water 80 meters deep in summer and take it out in winter).
We ask ourselves all the time: Can we do it better, use less, produce own electricity?
Are we perfect? No. Are we uses a lot of electricity and water? Yes. But we try to do it as good as possible and minimise the impact. Starts with development of buildings. You can built very sustainable (big walls that you can renew) or built something that's cheap and costs a lot of energy, but we don't care. Or build for eternity (look at the whole life span of building) than you also get costs of electricity, heating etc. so what is sustainable. We try to do our best in what we can do. Therefore we have Golden Green Key (2008).
Green Key gets tougher every year to comply with. We have to keep improving and start new things.
Sustainability is a process. Improving al the time, looking for new products, different ways to generate electricity. Are we sustainable? No. are we trying? Yes.

Green key is a indicator for being kind of sustainable, so you are being sustainable….
Don’t know what you mean exactly. Green key goes for whole company whether it’s a hotel, restaurant, bungalow or else. It’s about electricity, water, gas, food, everything in a company. Golden Green Key means your on your way.

1.4. How do you rank your sustainability status?
See 1.2. and 1.3
1.5. Do you have a sustainability strategy?
Yes, because of the Green Key label we have to write down what your going to do the coming years. I don’t want the paper work. It’s one paper. Nobody asks for it or reads it. That’s the problem with NEN (1000 29) and ISO, to much paperwork.
(NEN= norm for nature)

2. **Climate change**

2.1. Do you actively cooperate with conservation breeding programmes such as ISIS, CITES, IUCN or IZW -Leibniz institute?
We have to.

2.2. Where do you get your information about species conservation> which data resource?
We have 7 to 8 Studsbook. Info about breeding etc is shared with other zoo.
We have 7 biologist working in our zoo. We are in the middle of conservation etc.
One of the employees is chair of the Ape TAG, vice chair of chimp TAG, Gorilla TAG,

2.3. Which studbooks do you use?
Studbooks: greater kudu, king vulture, Blue Duiker etc.

2.5. Do you fund any conservation projects in-situ?

Yes.
- Belize middle of America: Shipstern nature reserve. 20 years now. 50 000 euro’s a year with a Swiss company: Swiss butterfly garden Papiorama.
- Lucy Burgers Stichting: 35000 Euro’s in situ research. Basic idea: You can’t protect animals if you don’t know how they live.
- Future for nature reward: 150 000 euro’s per year for young conservationist who we want to support and put in spot light for their great work and hopefully in the spotlight more people want to support them. We do it in a different way than most zoos. Works well for us and the people who get the reward.

2.6. Do you arranged own conservation projects in-situ or ex-situ? Why?

In 1971 Frans de Waal did research on chimps. Bert Haanstra made a film.
Research on chimps, wolves when in the zoo, zebra’s, gorilla’s: All behavioral.
Now: on chorals in ocean, because we have quite a big coral tank. Sharks, rays, the bush (tropical rainforest): models on how big a population can be in a certain area.
Tigers on use of exhibit.

Done by universities of Nijmegen, Wageningen, Utrecht, Leiden.
Van Hall Larenstein.

Do you spread results of research on zoo?
That is up to researcher. We want the info of course. Research on the most famous chimp group in the world, is done since 1971, so 40 years. Because of Frans de Waal info was spread. Coral: 3 years ago we had the first international coral congress in the zoo. All researchers from over the world came here to talk about it, so we spread it. But it still is up to researchers, we provide the place, good facilities and good exhibits where animals can show natural behavior, where researcher can do his research.
Sometimes we have to improve, like with the tigers and then we can go on.

2.7. How do you encourage animal welfare?
By keeping knowledge inside the zoo and not hiring a lot of consultants.
A lot of zoo get companies from around the world to build their exhibits. You can encourage animal welfare the best when you built good exhibits. If you get all your info from far away and the people that advise you run away, than you get bad exhibits. And that's where animal welfare starts with good exhibits. We have the knowledge here in the zoo.
If we have problems or don't know how to do it. We contact a studbook about what's important and we keep asking. Than we ask our own biologist , he decides on exhibits. Not someone from far away who draws something, what they also built somewhere else and which quite often are not good exhibits. That amazes me.
Starts with Exhibits, then right animal groups, then food, enrichment. If you have the right exhibits than you hardly have to do anything with enrichment. If you have good group you hardly have to do anything with enrichment. Like in the wild, if they live in groups there, than they should here.
We contact zoos for information and not so called experts. We don't contact the companies that say the can build good exhibits, because they can't. You should have contact with the keepers who work with animals every day, not people sitting in a office saying they can design animal enclosures. Keep the lines short and go to the people who really know how to keep an animal. And then be critical: is that the way to do it or can we do it in a better way.

2.8. Do you participate in international conservation campaigns? Which?
See 2.5 & 2.6.
2.9.Which research projects do you support?
See 2.5
2.10. Do you cooperate with universities or research centers?
See 2.6

2.11. Are zoos well placed to contribute directly to conservation?
Yes, the worse it is with nature , the more important the impact of zoos is. Zoos have a place, role together with WWF and children farm and Dutch nature. Farms are for children to touch animals like goats, rabbits etc. Dutch nature around is just to see for people. WWF is there to make nice brochures and movies to tell about it. Zoos are there to get people in contact with exotic nature and have a huge impact on the way people think of nature far away. We can influence a lot.

How should we influence: tell visitors how bad nature is doing and put it on signs own every enclosure. Or building huge exhibits and let visitors emerge into tropical forest and coral reef. Stimulating positive attitude. That's the way we do it. Not signs, but build ecosystems in a large scale (ecodisplays). In the future we need a lot of volunteers to tell about it, explain it. Works the best (human to human info)

For instance what they do in Chester Zoo, Blijdorp, Frankfurt, Berlin (volunteers that teach). I think we can give visitor more than we do now in nature conservation, our zoo and what we are doing now.

Does that include sustainability?
Yes, what is sustainable and what's not, sustainability is part of conservation, so it will hit the subject.
But going to the zoo is and should stay fun and not depressing (because of how bad nature is doing).
Of course you want to teach people something, but you should involve and activate people by positive attitudes, showing how beautiful nature is, but that it can't survive by itself and that humans are destroying it and therefore need to protect it.

I'm not sure if Chester Zoo is an example for us. Many others are (Blijdorp, Apenheul, Vienna). English zoos are to focused on conservation and not enough on giving visitors an interesting day out.

The way you run your company should also be sustainable. Many zoos are not, because they get a lot subsidies.
We get no subsidies, because we are a private zoo.
By leaning on subsidies you can't be sustainable in 10 or 20 years.
Many German zoos are sustainable, because government does not give money.
We have no sponsors. But visitors want to know. Finding sponsors in this economic climate is not easy and with less subsidies many zoos in Holland are struggling. That is not sustainable.

3. Integrating sustainability

3.1. How do you assure a sustainable zoo?
See 3.2.
3.2. What was the starting point of integrating sustainability into your zoo?
With grandfather, 97 years ago. He started building spacious enclosures where animals can show there natural behavior. And that's where it starts. Animals that have a good life, can reproduce and are healthy and live their life. And visitors see that and get the message.
3.3. Did you achieve or work towards other sustainability standards such as ISO 14001? (Inzien/copy)
I don't want to work or comply with ISO and NEN. Only paperwork, filling in checklists.
Green Key is more practical. Gives more tips on saving water and how to do this and that.
Green Key goes further than ISO and NEN. So you save more electricity etc.

You now have golden green key. What is your end goal or next goal?

Keep the golden green key. It gets more difficult every year. You have the basics, obeying the law etc. And then the extra's: Green electricy->100 %.
You have to be able to say exactly what building uses which amount of gas, electricity = obligatory. There is no higher level in green key, but try to stay on this level.
It's a independent systems with independent teams that check companies. They keep improving and making it better, going further.
You have to do a new check every 1 to 2 years and prove yourself and improve your activities.

3.4. Did you integrate an Environmental Management System (EMS)?

We are in the Green Key and therefore you have to have a policy/plan for every 5 years ahead. You have to try to improve it every year.

3.5. Are you familiar with the Rio Declaration and Agenda 21? If so, is it involved or integrated in your sustainability strategy/plan?
More people live from nature than for nature. Why should I integrate it. many zoos do that so they get subsidies, If they involve it in their plans. Not sustainable.
Sustainability should come from themselves. You should as a company or ngo or etc. think about what they want with my zoo and work for it for a long time. When the government or ngo then says do this or that, then you say I go my own way.
Al the subsidies, money goes to advisors and companies that help you get subsidies. Does it really help nature and environment?
Why do I need guidelines? I have guidelines from Green Key. It doesn't matter if somebody is talking about climate change, acid rain, as long as I try to do my best and reduce energy, water etc.
Most important goal with my zoo is another 97 years of Burgers Zoo. That the zoo stays healthy in the long run.
I'll stay on top of new information about what is good and bad for nature, but not follow every trend or mainstream to get money.
Many zoos are green washing, but at the same time are doing nothing and just producing paper. And if they don't get money they do nothing.
Munster does it by themselves, not for someone else, political correct or for money.

Would your concept work for the mass?
Companies/organisations that do it for themselves, don't shout about it.
The ones that do it because that get money for it, have a big mouth and say we are so good and clever, but when the money tap closes it all stops. The question is what is more sustainable?
Are subsidies effective? What has been reached by now in nature conservation, poverty etc, with the help of subsidies. Not much. It's about merchandise and telling the world.
A lot of the goals are long term, so giving subsidies is not a good idea. And if politics changes…

Should government set rules, regulations and laws for zoos?
Not sure for zoos, but companies in general yes. Tax reduction for green cars works very well. But no subsidies. Give benefits for research.

Integrating sustainability is costing us money, but you earn investment back, because you save

energy etc.
You do it on a small scale, in your own pace and you can do what you can with the possibilities you have.
Water: perlator (maximizes water that goes trough)
Restaurant: Buffet/ food display. At the end of the day you have to throw away all your food. If you asked an incoming customer what he wants, you save a lot of many and food, because you only make what you need.
It's about small and big changes all together and the process, that you're improving.

Visitors think that the zoo they are visiting is already sustainable. You don't get extra visitors if you show your sustainable, but you'll get in trouble with media etc if you're not sustainable. It is getting normal to be sustainable.
Is education effective? I don't think so. Are there researches that show it?
Zoos should try to educate visitors. We are in the process of what we can do and how should we go on? But there is a lot to inform about and you don't want a zoo full of signs. So find a balance, find a way to talk about it so that it fits to your zoo. Visitors come for a nice day out. We do try to give them something and try to show them how beautiful nature is etc.
The question is how far should you go with sustainability?

Do you want the visitors be close to the visitors? Is that a good strategy for you?
You can get quite close in for example the bush and the tropical forest.
But we do want the animals to be able to live undisturbed and have their own natural life, show natural behaviour. But you do want the visitors to see the animals.

The nice thing about zoos is that they all do it in their all way. So you have differences in zoos. Go their own way, have their own strategy, so visitors can go to different zoos.

3.6. What is your vision and mission for the future regarding to sustainability?
We don't have one specific for sustainability.
3.7. Was your approach for integrating sustainability top down or more bottom-up?
More top-down, but also a bit bottom up.
3.11. How did the staff react on the transition process of the integration of sustainability?
It went very gradually over the years.
3.12. How did the public react on the transition process of the integration of sustainabil ity?
See 3.11.
3.13. Which partnerships and networks are useful for your zoo regarding to sustainability?

Foundations:
Lucy Burgers, future for nature.
Are member of federation of international nature conservation. Dutch network for nature conservation.
Dutch zoo conservation (NEBF)
FIN (federation international nature conservation) (smaller organizations are combined) come together here in zoo 2 to 3 times a year to exchanges information and experiences.
(Alex is board member)
Conservation organizations:

Vrienden van Stinaso, in Suriname, have a Dutch brand.
Organisation on the Azoren with whales and dolphins.

3.14. Which legislation does the zoo have to comply with in terms of sustainability? (ISO, etc)
20 inspections a year for different aspects of a zoo.

Technician of zoos they have a lot of contacts with each other for new things.
Contact between zoos and nature conservations organisations are quite diverse and we are part of that. They have their meetings, lunches, dinners here.
3.15. Do you evaluate or assess the process of integration sustainability in your zoo?
3.16. How often?
3.17. When?
3.18. Which factors are assessed?
3.19. Which assessment methods are used?
3.20. Where did you get this?
3.21. Do you report on sustainability?
3.22 Do you exchange knowledge with other zoos?
Yes.
3.23 What problems arise when integrating sustainability in your zoo?
Things need to be available. The people in the park need to be willing to participate, because sometimes it is easier to just order a different kind of wood then FSC wood. Sometimes the costs are too high and then you cannot do it.

4. Environmental performance: Utilities
4.1. Do you measure the used energy?
No

4.2. Which alternative energies do you use?
- Cold/warmth storage
- Warmth from cooling installations is used for heating
- Water from Ocean is filtered only once every 8 to 24 hours

- Geothermic does not work for this zoo
- Vergisting does not work
- Wind energy can not be done in this region
- We are busy with solar energy
- Burning wood was not interesting for us either

4.3. How do you reduce the spent energy?
Difficult to say because you build new things and buildings every year. So, the amount of used energy increases.
4.4. How much did your zoo manage to reduce the use of resources and energy? (% a year)
In the ocean 1/8 of normal energy usage. Is difficult to say.
4.5. Do you measure the waste production in the zoo?
Yes, the company that gathers our waste tells us how much it is in tons.
4.6. Do you attempt to reduce your waste production? How?

Waste of ourselves and public waste is being separated and public waste is separated by an external organization.
By composting and re-usage. Wood is composted by mixing it with waste that was eatable like fruit and veggies for better compost.
An how about your manure?
Our manure is quite thick of structure. Farmers come here to take the manure and spread it on their land. We have to pay some fees for taking away the manure.
4.7. Do you measure the used water?
Yes
4.8. How do you ensure to reduce water usage?
Catch water of roofs from bush and dessert for re-usage
4.9. Do you have a transport policy?
The employees don't get a car from the company. Many people come with public transport like busses. We are thinking to make our vehicles in the zoo drive on electricity, but this is difficult because of the difference in height in our zoo.
We work together with the Deutsche Bahn. The Dutch railway organization has banned combination tickets of busses and trains with zoos a couple of years ago.
4.10. Do you engage visitors to use environmental friendly transports? How?
No, because for visitor it is more efficient to come by car while the average number of people in a car lies above 3.5 persons a vehicle.
Than it is more efficient when it comes to CO2 and environmental taxes.

4.11. Do you get your procurement from sustainable and reliable sources such as Fair Trade, Trans Fair? Why?
Yes, because of the Green Key. We are now looking for biological meat that is Fair Trade.
We have Fair Trade coffee, sugar, sauces. But meat is difficult. Prices are higher. To high for visitors. You can't double our triple prices. Zoos have so many products. It is frustrating sometimes.
Toys: presumably no child labour in it, but is the cotton right? The rest? Producing right?
Fruits for animals: Palm oil? Soya?
Look at all products. A zoo is like little village: restaurants, shops, animals, veterinarian.
Medicines tested on animals? Can you give the drug if it is tested on animals? If not, than zoo animal dies.

4.12. Do you use sustainable material for buildings and estate?
Yes. FSC etc.

4.13. Do you attempt to make your buildings energy efficient? how?
Yes, isolation etc.
4.14. Do you have cost savings through energy and resource efficiency?
Yes, but we build new buildings as well and the cost energy. So, in the end you use more energy again.

5. Measurement of environmental impact
5.1. Do you calculate your environmental footprint? (Carbon, water, waste, etc)
No.
5.2. Do you conduct environmental audits?

The Green Key has an independent foundation that visits the zoo and checks everything your supposed to be doing.
5.4. Do you conduct environmental impact assessments?
Also done by Green Key.

6. Communication/ education

6.1. Did you integrate sustainability directly and intentionally into your corporate identity?

No. Because most visitor just assume that you as a zoo do things the right way. You don't get more visitors by showing how good your restaurant is, but when it is bad than you get less visitors. If you don't integrate sustainability it is a negative risk, but when you do integrate it you don't necessarily get more visitors.
6.2. Did you integrate sustainability directly into the corporate communication to staff and public? And what do you communicate to both groups of people?
No.
6.3. Did you integrate sustainability into your corporate visibility? (For example, design, logos, colours, architecture, letterheads)
No.
6.4. Did you integrate sustainability into your corporate behaviour > events, workshops etc.?
Sometimes. Depends on what the workshop is about.

6.5. How do you communicate sustainability to the public/ visitors and motivate them to integrate sustainability into their own life style?

6.6. How do you try to make the public attend to sustainability in the zoo?
We try to make people see the beauty of nature and that we need to be careful with it. But not sustainability in specific. We hope by building and displaying the ecosystems the best we can, we contribute to educating the message of the importance of nature.
6.7. Which media do you use the most to communicate sustainability to the public?

6.8. Do you have innovative education programs to expose sustainability to children or visitors in general?
No. We do have education programs in the park about ecosystems, nature protection etc.
6.9. What are the main features of your education programs? What is important for you to educate?
For us, it is important that visitors have a nice day out.
We do educate about ecosystems and nature protection.
6.10. What is the best way for you to educate people?

6.11. Do you attend your staff to identify with the zoos vision and mission?

6.12. How did and do you motivate your staff and employees to integrate sustainability?
We do motivate them. During work consultations and meetings we talk about it and it is on the agenda. But no extra training or workshops.

6.13. Which media do you use the most to communicate sustainability to the staff?
We have to do more and go further. Every month there are meetings for departments, safety, environment, sustainability, reduce energy, water etc.
Don't have intranet or newsletter (are thinking about it)

6.14. How do you communicate sustainability to other zoos?
We had a meeting once to interest other zoos for the environmental barometer (de milieubarometer), and FSC wood. The meeting was on our costs and we still inform each other by mail etc. When we are looking for other ways to make energy for instance, then we contact other zoos. The contacts are very intensive and close and zoos also contact us.

6.15. How do you interact with the zoos social environment?

6.16. What characteristics of the zoo appear most unique to members in terms of their ability to differentiate the organization from other zoos?
The ecosystems and eco-displays.

Additional

Kern is dat je erachter moet staan, zelf willen. Met subsidie kun je ver komen, maar als dierentuin moet je het zelf doen.
Natuurlijk kost het geld en moeten je kijken over welk tijdsbestek en met het geld dat je hebt je wat kunt doen.

Heeft u nog aanbevelingen:
Haak aan bij bestaande systemen. Als er nog niets is, beschrijf het dan.
Maak bestaande systemen interessant voor jouw bedrijf.
Hetzelfde geld voor Green Key = europees en opgebouwd vanaf de ondernemers. (NEN 1000 29 of ISO)
Wat is praktisch?
Wat is een goed systeem in Australie, Amerika, Azie, Europa, Afrika (is al heel sustainable, gebruikt minder energy als wij) etc,
Verzin het niet zelf.
Amerika: Het is belangrijk dat we als dierentuinen sustainable gaan werken of beter sustainable gaan werken. Er zijn een NEN en ISO als je wil, maar er is ook een Black Key of Green movement.
Link leggen tussen grote doel en hoe maak ik het praktisch.
Geen rapporten van 100 pagina's. Maar 1 A4tje met systemen.
Sites scannen, letten op green washing.
Motiveren en enthousiasmeren.

Appendix IV: Multi Criteria Analyses

Multi Criteria Analysis of Bristol Zoo Gardens

Organisation profile: Non-profit
Visitation figure: 600.000 visitors a year

Energy & Building

	Expenses	Environ-mental impact	Short term profit	Long term profit	Effort	Sponsoring
Solar	-2	6	-2	2	-4	6
Geother-mie	-6	6	-2	2	-6	9
Wind	-6	6	-2	2	-6	9
Pilot wp	-6	6	-2	2	-6	9
Biomass	-2	3	-2	-4	-2	9
Biogas	-4	6	-2	2	-6	9
Biofuel	2	6	2	6	4	3
Green En.s	-2	9	-1	-2	6	3
Wood	-2	6	-1	-2	4	3
Low light	-4	3	-1	4	2	9
Time Con-trol	2	3	1	2	-2	-3
Occupancy s	2	3	1	2	-2	-3
Windows	-4	3	-1	4	2	9
Insulation	-4	9	-1	4	-4	9
Nat vent. Syst	-4	3	1	4	-4	-3
Electronics	-4	3	-1	2	-2	-3

Waste

	Expenses	Environ-mental impact	Short term profit	Long term profit	Effort	Sponsoring
Compostin system	2	3	-1	-2	2	-3
Recycling materials	-2	6	-1	-2	-2	3
Reusing materials	2	6	-1	-2	-2	-3
reusing manure	-4	6	-1	4	-4	3
Yielding manure	2	3	-1	-2	2	-3
Recycling electronics	2	3	-1	-2	2	-3

Water

Expenses	Environ-mental impact	Short term profit	Long term profit	Effort	Sponsoring	
Rainwater Harvesting System	-4	3	-1	-2	-4	-3
Water Filtration System	-4	3	-1	-2	-6	3
Automatic Sensor Taps	2	3	-1	2	2	-3
Low-Water Cisterns	2	3	-1	2	2	-3
Waterless Urinals	2	3	-1	2	2	-3
Repairing Lacks	-2	6	1	4	-2	-3
Insulated Water Pipes	2	3	-1	2	-2	-3
Granulat	.	.	.			

Transport

Expenses	Environ-mental impact	Short term profit	Long term profit	Effort	Sponsoring	
Travel Combina-tion Tickets	-2	3	-1	-2	2	-3
Providing Eco-Friend-ly Cars	-2	3	-1	-2	2	-3
Providing Bicylce Stands/ Parking Area	-2	3	-1	-2	2	3

Procurement

	Expenses	Environ-mental impact	Short term profit	Long term profit	Effort	Sponsoring
Purchas-ing Local Products	-2	3	-1	-2	-2	-3
Purchasing Biological Degradable Cleaning Products	2	3	-1	-2	-2	-3
Purchasing Fair Trade Products	-2	-3	-1	-2	2	-3
Purchasing FSC	-2	6	-1	-2	-2	-3
Purchasing MSC	-2	6	-1	-2	-2	-3

Multi Criteria Analysis of Dierenpark Emmen

Organization profile: Non-profit
Visitation figure: 1.100.000 visitors a year

Energy & Building

	Expenses	Environ-mental impact	Short term profit	Long term profit	Effort	Sponsoring
Solar	3	-3	2	3	-3	-3
Geother-mie	-9	9	-6	6	-9	3
Wind	-9	3	-6	-3	-9	3
Pilot wp	-9	3	-6	3	-9	3
Biomass	-9	3	-6	6	-9	3
Biogas	-9	3	-6	6	-9	3
Biofuel	-6	3	-6	-9	3	-3
Green En.s	-3	-3	-3	-3	-3	-3
Wood	-9	6	-6	3	-9	3
Low light	-6	3	-3	3	-3	-3
Time Con-trol	-6	3	3	3	-3	-3
Occupancy s	-6	3	-3	3	-3	-3
Windows	-9	3	-4	3	-9	-3
Insulation	-9	3	-6	6	-9	-3
Nat vent. Syst	-3	3	3	6	-3	-3
Electronics	-9	3	-6	6	-9	-3
Green roofs	-3	3	3	3	-6	-3

Waste

	Expenses	Environ-mental impact	Short term profit	Long term profit	Effort	Sponsoring
Compostin system	-9	3	-6	3	-9	3
Recycling materials	-9	6	-6	3	-9	3
Reusing materials	-9	3	-6	3	-9	-3
Reusing manure	-9	3	-6	3	-3	-3
Yielding manure	-3	3	2	3	3	-3
Recycling electronics	-9	3	-6	3	-9	-3

Water

Expenses	Environ-mental impact	Short term profit	Long term profit	Effort	Sponsoring	
Rainwater Harvesting System	-6	6	2	6	-3	-3
Water Filtration System	-9	9	-2	-3	-9	-3
Automatic Sensor Taps	-9	3	-2	3	-3	-3
Low-Water Cisterns	-9	-3	2	-3	3	-3
Waterless Urinals	-6	6	2	-3	3	-3
Repairing Lacks	-9	9	2	3	-6	-3
Insulated Water Pipes	-3	3	2	3	-3	-3
Granulat	-3	6	2	3	3	-3

Transport

	Expenses	Environ-mental impact	Short term profit	Long term profit	Effort	Sponsoring
Travel Combina-tion Tickets	-6	6	-4	-6	-3	-3
Providing Eco-Friend-ly Cars	-9	3	-6	3	3	3
Providing Bicylce Stands/ Parking Area	-9	3	-2	-3	-6	-3

Procurement

Expenses	Environ-mental impact	Short term profit	Long term profit	Effort	Sponsoring	
Purchas-ing Local Products	-3	3	-2	3	3	-3
Purchasing Biological Degradable Cleaning Products	-6	6	-2	-3	3	-3
Purchasing Fair Trade Products	-6	-3	-2	-3	3	-3
Purchasing FSC	-9	6	-4	-6	3	-3
Purchasing MSC	-9	6	-6	-9	3	-3

Multi Criteria Analysis of Granby Zoo

Organisation profile: Non-profit
Visitation figure: 600,000 visitors a year

Energy & Building

Expenses	Environ-mental impact	Short term profit	Long term profit	Effort	Sponsoring	
Solar	3	3	-2	3	2	-2
Geother-mie	-3	9	2	6	-4	-2
Wind	.	.	.	.	.	.
Pilot wp	.	.	.	.	.	.
Biomass	.	.	.	.	.	.
Biogas	.	.	.	.	.	.
Biofuel	.	.	.	.	.	.
Green En.s	3	6	2	6	2	2
Wood	.	.	.	.	.	.
Low light	-3	3	-2	6	2	-2
Time Con-trol	3	3	-2	3	2	2
Occupancy s	3	3	-2	3	2	2
Windows	.	.	.	.	.	.
Insulation	-3	3	-2	6	-2	2
Nat vent. Syst	-3	3	-2	3	-2	.
Electronics	-3	3	-2	3	-2	2
Green roofs	.	.	.	.	.	.

Waste

	Expenses	Environ-mental impact	Short term profit	Long term profit	Effort	Sponsoring
Compostin system	3	3	-2	3	-2	-2
Recycling materials	-3	9	2	6	-2	-2
Reusing materials	3	6	-2	3	2	-2
Reusing manure	.	.	.	.	.	.
Yielding manure	-3	3	-2	-3	2	-2
Recycling electronics	3	3	-2	-3	2	-2

Water

	Expenses	Environ-mental impact	Short term profit	Long term profit	Effort	Sponsoring
Rainwater Harvesting System	-3	3	2	6	-4	2
Water Filtration System	-3	6	-2	3	-2	2
Automatic Sensor Taps	3	3	-2	3	-2	-2
Low-Water Cisterns	-3	6	-2	3	-2	-2
Waterless Urinals	-3	6	-2	3	-2	-2
Repairing Lacks	-3	6	2	6	-2	-2
Insulated Water Pipes	.	3	.	.	.	.
Granulat	.	.	.	.	.	.

Transport

	Expenses	Environ-mental impact	Short term profit	Long term profit	Effort	Sponsoring
Travel Combina-tion Tickets	.	.	.	.	.	.
Providing Eco-Friend-ly Cars	-3	6	-2	3	2	2
Providing Bicylce Stands/ Parking Area	3	3	-2	-3	2	-2

Procurement

	Expenses	Environ-mental impact	Short term profit	Long term profit	Effort	Sponsoring
Purchas-ing Local Products	3	6	2	6	2	-2
Purchasing Biological Degradable Cleaning Products	3	3	-2	-3	2	2
Purchasing Fair Trade Products	-3	3	-2	-3	2	-2
Purchasing FSC	-3	3	-2	-3	2	-2
Purchasing MSC	.	.	.	.	.	.

Multi Criteria Analysis of Landau Zoo

Organisation profile: Non-profit
Visitation figure: 160,000 visitors a year

Energy & Building

	Expenses	Environ-mental impact	Short term profit	Long term profit	Effort	Sponsoring
Solar	4	9	2	6	-4	2
Geother-mie	-6	6	-2	4	-6	.
Wind	.	-9	.		-6	.
Pilot wp	-6	.	-2		-6	.
Biomass	-6	.	-3	-6	-4	.
Biogas	-6	.	-3	-6	.	.
Biofuel	.	-9	.	.		.
Green En.s	.	.	.	.	.	.
Wood	-4	9	-3	4	-4	1
Low light	-6	3	1	6	6	-3
Time Con-trol	-2	3	1	6	6	-3
Occupancy s	-2	3	1	6	6	-3
Windows	-6	3	-1	4	-6	-3
Insulation	-2	9	3	6	-4	-3
Nat vent. Syst	-6	-6	-2	-4	-6	-3
Electronics	-4	6	1	6	-2	-3
Green roofs	-2	9	2	4	-2	-3

Waste

	Expenses	Environ-mental impact	Short term profit	Long term profit	Effort	Sponsoring
Compostin system	-2	3	1	2	2	-3
Recycling materials	4	9	-3	-6	6	-3
Reusing materials	-2	6	1	4	4	-3
Reusing manure	-6	6	-2	-4	-6	-3
Yielding manure	-2	6	2	4	-2	-1
Recycling electronics	-2	6	1	2	-2	-1

Water

	Expenses	Environ-mental impact	Short term profit	Long term profit	Effort	Sponsoring
Rainwater Harvesting System	-2	6	2	4	-2	-3
Water Filtration System	-2	3	1	4	-6	-3
Automatic Sensor Taps	-2	6	1	4	-2	-3
Low-Water Cisterns	-2	3	-1	2	-2	-3
Waterless Urinals	-2	3	1	4	2	-3
Repairing Lacks	-2	9	3	6	-4	-3
Insulated Water Pipes	-2	9	2	6	-2	-3
Granulat	-4	3	-1	2	-4	-3

Transport

	Expenses	Environ-mental impact	Short term profit	Long term profit	Effort	Sponsoring
Travel Combina-tion Tickets	-2	9	1	4	-2	-3
Providing Eco-Friend-ly Cars	-6	6	1	2	-6	-3
Providing Bicylce Stands/ Parking Area	-2	6	2	4	2	-2

Procurement

	Expenses	Environ-mental impact	Short term profit	Long term profit	Effort	Sponsoring
Purchas-ing Local Products	-2	9	1	4	-4	-3
Purchasing Biological Degradable Cleaning Products	-4	6	-1	2	-4	-3
Purchasing Fair Trade Products	-4	6	-1	2	-4	-3
Purchasing FSC	-4	9	2	6	-4	-3
Purchasing MSC	-2	9	2	6	-6	-3

Multi Criteria Analysis of Münster Zoo

Organisation profile: Non-profit
Visitation figure: ~1 million visitors a year

Energy & Building

	Expenses	Environ-mental impact	Short term profit	Long term profit	Effort	Sponsoring
Solar	-3	9	-3	9	2	-1
Geother-mie	-3	9	-3	9	2	-1
Wind	-9	3	-3	9	6	-1
Pilot wp	.	.	.	.	.	.
Biomass	-9	9	-3	9	6	-1
Biogas	-9	9	-3	9	6	-1
Biofuel	.	.	.	.	.	.
Green En.s	-3	9	-3	9	-6	-1
Wood	.	.	.	.	.	.
Low light	-6	3	-3	3	-2	-1
Time Con-trol	-3	9	-3	9	-2	-1
Occupancy s	-3	9	-3	9	-2	-1
Windows	3	6	-3	9	-4	-1
Insulation	-9	9	-3	9	-6	-1
Nat vent. Syst	.	.	.	.	.	.
Electronics	-3	6	-3	9	-6	-1
Green roofs	-6	3	-3	3	2	-1

Waste

	Expenses	Environ-mental impact	Short term profit	Long term profit	Effort	Sponsoring
Compostin system	-3	6	-1	3	6	-1
Recycling materials	-3	6	-1	3	6	-1
Reusing materials	-3	6	-1	3	6	-1
Reusing manure	-3	6	-1	3	6	-1
Yielding manure	-3	6	-1	3	6	-1
Recycling electronics	-3	6	-1	3	6	-1

Water

	Expenses	Environ-mental impact	Short term profit	Long term profit	Effort	Sponsoring
Rainwater Harvesting System	-3	9	-1	9	6	-1
Water Filtration System	-9	9	-1	9	-4	-1
Automatic Sensor Taps	3	3	1	-3	-2	-1
Low-Water Cisterns	.	.	.	.	.	.
Waterless Urinals	-9	9	-1	9	6	-1
Repairing Lacks	.	.	.	.	.	.
Insulated Water Pipes	-6	6	-1	9	6	-1
Granulat	.	.	.	.	.	.

Transport

	Expenses	Environ-mental impact	Short term profit	Long term profit	Effort	Sponsoring
Travel Combina-tion Tickets	-9	9	-1	9	-2	3
Providing Eco-Friend-ly Cars	-9	9	-1	-3	2	-1
Providing Bicylce Stands/ Parking Area	-3	9	-1	9	-2	-1

Procurement

	Expenses	Environ-mental impact	Short term profit	Long term profit	Effort	Sponsoring
Purchas-ing Local Products	-3	6	3	-3	6	-3
Purchasing Biological Degradable Cleaning Products	-6	9	-1	3	6	-3
Purchasing Fair Trade Products	-9	-3	-1	-3	2	-1
Purchasing FSC	-3	3	-1	-3	2	-1
Purchasing MSC	-3	6	-1	9	2	-1