

**A contribution to sustainability in the hospitality industry -  
Energetic analysis in a four star hotel**

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Degree Programme in Hotel, Restaurant and Tourism Management

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<p><b>The title of your thesis</b> A contribution to sustainability in the hospitality industry - Energetic analysis in a four star hotel</p>	<p><b>Number of pages and appendices</b> 59 + 7</p>
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<p>The aim of this research based thesis is to analyse the energy saving issues within the hospitality industry. The thesis is based on the fact that the energy costs of around 6-8 % of the total turnover, are often perceived as unimportant and do not stay in high focus of a hotel manager. However they do represent a great number of controllable costs.</p> <p>In order to get a general understanding about the current situation in the travel- and hospitality business as well as the negative effects of this resource intensive industry, the theoretical framework introduces the field of energy and sustainability. Based on the findings of the secondary research, this chapter begins with an overall definition of sustainability by focusing on the three pillars. As it is mandatory to know the composition of energy costs, in order to analyse the current situation of a hotel, the second part of this chapter gives an insight in the field of energy consumption. Furthermore an introduction of which certificates are currently recognized in the tourism industry is followed. Finally this part ends with possible energy sources and technologies, which can be applied within a hotel.</p> <p>Within the empirical part of the thesis, energy costs of an existing hotel are analysed and evaluated. As a large hotel within Germany is chosen, the energy cost pool is very high and further cost saving methods are introduced. Therefore the thesis provides two calculation examples for adapting a photovoltaic module for decreasing the high electrical costs, and a Combined Heat and Power (CHP) plant in order to lower costs for electricity and gas. As investments depend very much on the financial situation of the hotel, further best practice methods are introduced. Therefore the thesis provides improvements within the field of waste, water and electricity management in order to reach a green certificate.</p> <p>The results of the calculations and methods for the selected hotel are clarified within the conclusion of the thesis. This part describes the authors approach as well as a recommendation for decreasing energy costs as well as increasing the hotel's visibility by adapting a suitable certificate.</p>	
<p><b>Key words:</b> sustainability, energy, renewable, efficient technologies, certificates, sustainable development</p>	

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# 1 Introduction

The aim of this research based thesis is to provide the reader with detailed information about an important topic of the public. As in the last couple of years the word “sustainability” is known from everybody in the world, the society is forced to act sustainable in almost every way. Starting from thinking sustainable as an individual person, in changing the own behaviour in terms of waste (food production), electricity (lightning) and water use. Furthermore companies cannot anymore succeed in business without implementing corporate social responsibility in their strategy. Being affected by all these terms makes the public think and start to deal with these major changes.

The authors’ motivation to research this topic is the personal interest in sustainability with regard to the change of the world’s society. As in the next years this topic will be popular in every business, even the hospitality industry is influenced. Based on the fact that changes and re-thinking of the society can change the hotel industry as well, every staff member should be informed about the effects. Therefore this research is relevant for the author to develop and educate oneself within the topic of sustainability.

Within the following parts the author introduces the topic of the thesis. Starting with the importance and also the high dependence of the tourism industry, it has also its negative impacts on the world’s resources. Based on this current situation within the tourism industry, the problem statement is formulated. Main focus of the authors research is the scarcity of resources notably in the hospitality industry.

Further analysis shows the necessity and the importance of the thesis. In the end of chapter one the thesis structure is explained and gives a general overview about the authors basic idea. Furthermore it provides details regarding the chosen hotel and how it is analysed within the thesis.

## 1.1 Problem statement

The excessive demand for energy in today's society is immense. (Umweltbroschüre 2013) According to the US Energy Information Administration (EIA) the recently released International Energy Outlook 2013 states, that the world's energy consumption is projected to grow by 56 % between 2010 and 2040. The EIA estimates that most of this growth is the result of strong economic growth of developing countries. (EIA 2013) Figure 1 shows the average energy consumption of the world per capita by Angus Maddison.

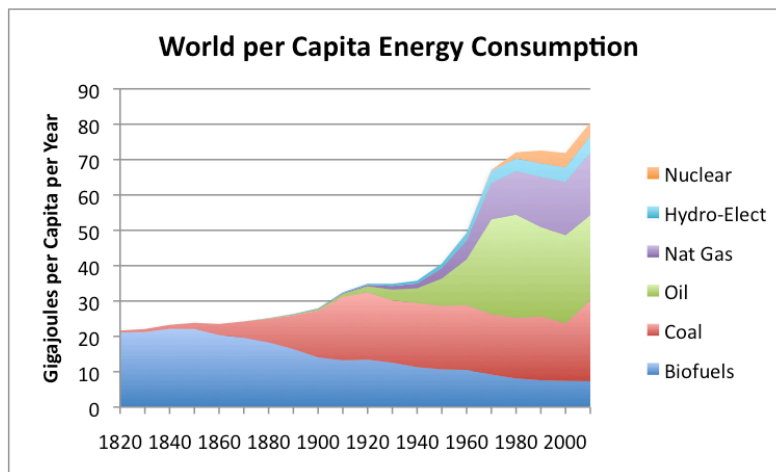


Figure 1: World per Capita Energy Consumption (Our Finite World 2013)

As energy consumption has risen rapidly in the last 100 years, the world's resources will no longer manage to provide energy for everybody. (Bohdanowicz 2001)

One reason for this is the ever-growing population, which influences the high demand of energy worldwide. Besides this population growth, also a change in consumer behaviour is recognized. This change of behaviour as well as traveling opportunities because of globalisation, implicates the negative process of dwindling resources. These aspects enforce the impact on the described initial situation of total energy demand. (Bohdanowicz 2001)

As shown in figure 2 tourism has increased worldwide since 1970 and is a globally booming sector. Especially in Europe, Asia and the Pacific tourist arrivals will continue to grow enormously. (Intracen 2012) Furthermore the number of international tourists has more than doubled in less than 20 years. The World Tourism Organization forecasts that the number of international tourists could rise to 1.6 billion people by 2020. (Unesco 2013)

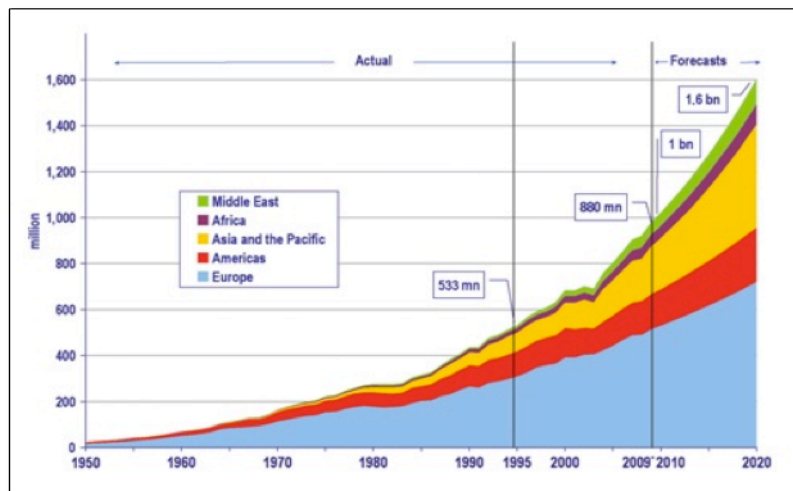


Figure 2: International Tourist Arrivals by Region in million (Intracem 2012)

However in the last decades, the international hotel industry has rapidly grown to become the largest employer of the world, by providing jobs for more than 200 million people. In the EU more than 6 % of the population is employed in tourism, which generates around 5 % of the EU gross domestic product (GDP) and foreign trade revenue. (Bohdanowicz 2001) The impact of tourism to the GDP ranges from around 2 % for nations where tourism is a relatively small sector, to over 10 % for nations where tourism is an important part of the economy. (Unesco 2013)

With over 300.000 hotels worldwide, providing more than 11 million rooms, the fast growth in international travel has additionally caused in a constant growth of the hospitality industry. (Bohdanowicz 2001) Especially in the hospitality industry, which is one of the most energy consuming branches in the world, sustainability is not anymore a loanword. But as it uses substantial amounts of energy in order to provide comfort and high services to its guests, there is a disturbing low level of energy efficiency. (Bohdanowicz 2001)

Although the growth in tourism provides improvement to local and national markets. Especially mass-tourism shows that it causes significant environmental and socio-cultural threats in its environment. (Bohdanowicz 2001)

First of all a negative impact on the environment appears once the number of travellers in a country or destination is greater than the environments ability to manage with this use within the adequate limits of change. (Unep 2013)

As globalisation leads the people in travelling and reaching almost every country in the world, one of the biggest threats of tourism is the output of greenhouse gases.

The most significant of these gases is carbon dioxide (CO<sub>2</sub>), which occurs when fossil fuels (coal, oil) and natural gases are burned. Furthermore the effects on the environment are caused by the massive consumption of local or imported resources (water, food, electricity, fuels), as well as by emissions linked to air, water and soil. (Bohdanowicz 2001)

Moreover the physical impacts on the environment need to be taken into consideration as well. Especially attractive areas like beautiful landscape sites; mountains, beaches and lakes etc. are harmed because of tourism development. These negative effects are caused by construction activities and infrastructure development, which means the progress of building tourism facilities for example accommodation as well as restaurants. Moreover building hotels or tourism related facilities could cause enormous problems in wastewater, which damages lakes and seas, animal habitat, as well as the flora and fauna. (Unep 2013) Therefore the most problematic effect on the environment is caused by the massive production of waste and resource consumption. (lighthouse foundation 2013)

Many impacts have highly influenced the hotel industry in the last years. Supported by global warming the public is forced to increasingly think about responsibilities. Therefore a need of rethinking in the world's population is indispensable. (Umweltbroschüre 2013)

Nowadays businesses should act in a sustainable way, as in today's society they are judged on their accountability, business ethics, transparency, as well as socio-economic awareness and resource-efficiency as well as their financial performance. Additionally as every human being is aware of the term "sustainability", the peoples knowledge and understanding about issues like global warming, climate change, the cause of poverty and human rights injustices is constantly growing. (Tourismpartnership 2013)

Companies are under external inspection, as they are expected to be ideal across the "triple bottom line" of economic, environmental and social management. If they are not, shareholders, investors, customers, employees as well as ethical groups and the media are able to picture the businesses' weaknesses. As the world stares at all businesses, they are forced to meet these expectations and offer sustainable approaches, because they do not have other choices.

(Tourismpartnership 2013)

Consequently developing sustainable actions will be vital for a successful future business. (environment.nau 2012) As sustainability is becoming a more and more common practice of a hotels operation, it not only acknowledges the benefits to the planet and humanity. Environmental practices seek to competitive advantage and moreover are facing the potential governmental regulations, which are going to increase in the next years.

In the hospitality industry it is a strategy that addresses rising resource scarcity and costs. (Houdré 2008) Concerning the German Hotel and Restaurant Industry (DEHOGA) brochure for energy, the protection of the environment and cultural landscape will be a challenge in the coming years. (Umweltbroschüre 2013)

Nevertheless, from a hotel industry and investor perspective, energy saving is usually associated with very high investment costs. As a result of this view, efficient energy supply or even renewable energy resources and technologies are definitely not the key topics in a hotel's business. Regularly the energy costs are only slightly perceived and painfully accepted without any ability or effort to change the situation. (Bohdanowicz 2001)

## **1.2 Aim**

As there is a common misconception in the hospitality business, that manager need to invest quite a lot of money in high efficient and advanced technologies, this thesis will give energy efficient solutions for businesses to save energy costs, with regards to the financial situation. (Bohdanowicz 2001)

Therefore the thesis provides an overview about the introduction of renewable energy technologies to reduce dependency because of rising energy prices. In the first case the author calculates a photovoltaic system with the aim to reduce the high electricity costs. The aim of the second case is to reduce electricity as well as gas costs with the purchase of a Combined Heat and Power (CHP) plant. In both cases the focus is to maintain high self-sufficiency of a plant, so that the hotel is not entirely dependent on network purchases. Therefore the efficient technology of the photovoltaic module and the Combined Heat and Power plant are analysed.

To minimize the fear of high investment costs in renewable energies, immediate actions are introduced in the followed chapter. These best practice examples show steps which can be adapted with minimum effort and a low payback period as of low investments. These examples are relevant for businesses which are forced to act sustainable, but are not in the best financial situation of spending a lot of money.

In order to improve the hotel's image to the public, the author recommends an application of a green certificate in which the hotel shows its achievements. Therefore the best practice examples show cost savings only in the fields of: electricity, water, waste and energy management programs. These fields are relevant for aiming a green certificate and are analysed in terms of cost savings.

### 1.3 Concept

To get an overview about the topic, the author decided to analyse an existing hotel with high-energy requirements. Therefore a big hotel in Saxony, Germany is selected and facts and figures are evaluated in detail.

The author selected the hotel by himself according to size, room number and location. The hotel manager was contacted per email and after explaining the thesis topic as well as the aim and concept of the thesis an interview date has been agreed. The author was provided with the energy and resource demand of last year, therefore the rest of the research was conducted completely by the author as well as supported with the literature findings. Consequently the thesis is not commissioned by the hotel. Additionally the hotel does not want to be namely mentioned, therefore the author did not specify on hotel's details, like for example classification, type, occupancy as well as brand or name of the hotel.

Within the literature review the thesis informs the reader about the topic in general. Starting with an impression about the definition of sustainability and the explanation of the important topic of corporate social responsibility. Furthermore the different alternatives of green certificates are explained in order to get an insight of the current situation and opportunities within energy savings. In terms of positively effecting the energy supply, renewable as well as efficient energy technologies are introduced.

In the fourth chapter of the thesis the corresponding outcome of the given energy data is evaluated. Based on the current state analysis the thesis provides two recommendations for energy saving technologies. These methods are calculated on the basis of the given data of the chosen hotel as well as relevant local parameter.

Within the following chapter the reader gets an overview about different variants of energy saving methods. Furthermore this chapter is informing the reader about easy and quick methods to increase energy efficiency and gentle resources within different cost pools like electricity, water, waste and moreover with a short payback time. Finally the author gives fundamental recommendations about what is the appropriate technology with regard to the financial situation of the hotel.

In summary, the aim of the thesis is to assist hoteliers in rethinking and help to ensure that energy-saving measures in the coming years become an essential part of a hotel's business.

## 2 Literature Review

The following chapter is divided into four parts. In the first instance, the author introduces the topic sustainability in order to get a basic understanding about its meaning. Since the costs for energy saving methods are often perceived as too high, the compositions of the energy consumption in a hotel is generally analysed.

Thereby influences on the composition of the energy consumption are presented and the author informs especially about the high electricity costs in Germany due to the governmental energy law (EEG). The aim of this part is to show the dependency of businesses to the governmental regulations and further price adjustments.

Afterwards the author presents possible certificates which support the investment in energy saving methods due to higher visibility to the public. Therefore diverse certification which refer to degree of popularity and fields of specialization are introduced.

Within the last phase of the chapter several technologies, on the one hand energy saving methods and on the other hand the implementation of renewable energies, are presented in order to get an general overview about the potential of adapting these techniques in a hotel.

## 2.1 Definition of sustainability

The idea of sustainability originated in the 1970s, when the first international UN Stockholm Conference on Human Environment faced the influence of human behaviour as well as the impact on the planet.

In 1987 one of the first definition of sustainability was composed in the Brundtland report “Our Common Future” and is one of the most common definition nowadays:

*"Meeting the needs of the present without compromising the ability to meet the needs of future generations."*

(United Nation's 1987)

The Brundtland report demonstrates general concerns about the environment and poverty in many parts of the world. One important content of the Brundtland report is: “Economic development cannot stop, but it must change course to fit within the planets ecological limits.” Moreover it introduced the basic message of the word ‘Sustainable Development’. An easy way to understand the basic message of sustainable development is the simple model of the 3P’s (profit, people and planet), which will be explained more detailed in the following chapter. (sustainability challenge 2013)

The concept of sustainability is built on the fact that the world has limited resources and is not able to provide these resources to a continuously rising human population and consumption. The urgency of sustainable development is growing day by day. Climate change, species extinction, famine as well as natural disasters cause that it is becoming increasingly important and need to be integrated in humans lives. Furthermore sustainability is critical for the constant survival and wealth of all global systems. (environment.nau 2012)

In recent years the word sustainability has increased peoples awareness in many ways. Sustainability is popular in media, vocabulary and life. In order to prepare future leaders (for example students) working productively concerning a more sustainable civilisation, sustainability is integrated in schools and universities to improve behaviours and thoughts of all people in the world. (Borowske 2013)

In order to be a green company, sustainable thinking in decision making in all organizational levels is needed. As nowadays companies are under external scrutiny and are judged on their accountability, transparency, business ethics, socio-economic awareness as well as financial results, the public expects companies to consider all aspects of the “three pillars”: economic (profit), social (people) and environmental (planet) management. Furthermore the public’s understanding of the current situation regarding issues like global warming, climate change, human rights as well as the cause of human poverty is constantly rising. (environment.nau 2012) Consequently businesses are in the critical situation of being able to train themselves as well as their employees, suppliers, clients and partners about sustainability, in order to organise capital and large numbers of people to follow the goal of sustainable development. If they do not, pressure groups and the media are able to show a companies threats. (sustainability challenge 2013)

Therefore the goal of sustainable development is simple: secure economic development, social equity and environmental protection, which is called the “triple bottom line”.

A simple model shows the three interlocking cycles of economic “sustainable, innovative, productive, high levels of employment” environment “protection, efficient use of resources as well as energy” and social “justice, social inclusion, personal well being”. (Houdré 2008)



**Figure 3: The three pillars of sustainability (PennState - College of Engineering 2013)**

Hotels need to find ways to operate according to the idea of the “triple bottom line”, which represents profitable operation merged with consideration to the people who work in the business as well as a focus on responsible use of resources. (Houdré 2008)

### **2.1.1 Environmental**

*"A sustainable corporation is one that creates profit for its shareholders while protecting the environment and improving the lives of those with whom it interacts."*

(Savitz 2006, 46.)

In order to improve the business's impact on the local and global environment, different certificates have been developed to support acting sustainable. These certificates measure of how environmental friendly the business is and how responsible they were acting.

The strategy they are using is simple: reducing waste, electricity use, packaging costs, energy, water and avoiding pollution, and moreover maximizing efficiency as well as purchasing goods, which do not threaten the world's natural resources. (Houdré 2008)

Furthermore to protect our planet from corporate exploitation and neglect, companies need to focus on reducing the carbon footprint. By focusing on these few key principles as well as the strict ethics, businesses have the chance to grow their revenues and saving costs, which will create higher shareholder value. (Houdré 2008)

### **2.1.2 Economical**

In order to be sustainable, a company must be profitable. The impression of that is, that a business need to follow strict ethics while conducting business and use sustainable development principles to increase profits as well as saving on expenses, hence creating higher shareholding value. In order to increase revenues, the business can enter new markets, for example in sustainable travel accommodations. Additionally a good starting point is to reduce operational costs by developing an approach to optimize resource consumption and use. (Houdré 2008)

To ensures that the economic growth retains the healthy balance with the ecosystem, hotels have the possibility to apply for several certifications or awards. A company should select an appropriate association with a well-known organization to benefit from a good existing infrastructure as well as to ensure the accurate and ethical application of the resources or actions they take. (Houdré 2008)

### 2.1.3 Social

The two most important factors of a business are employees and the community. By acting social responsible, companies want to be recognized as a fair employer who ensure that all employees are satisfied and somehow connected to the business they are working for. Furthermore companies should create experiences which inspire their guests as well as their staff. With these experiences guests should be attracted and actively perceive the sustainable development principles of the company. However the organization should select their causes according to their goals and community. (Houdré 2008)

Crucial is that everyone from top to bottom must be involved in the course of action the company is focusing on. It is important that the strategy is fully assembled in the hotel's culture. The most successful way to engage all employees, is by showing the success of initial projects, share aims as well as the vision and mission of the business and inform them about news. The goal of this tactic is that every member of staff will bring his own ideas and input into the strategy and fully 'live' sustainable development. (Houdré 2008)

Therefore companies should focus on different tactics like: developing the employees well-being and their quality of life, additionally the employees skills and capacity should be developed, therefore they must be involved in community service actions. Besides that a company should ensure competitiveness in employee compensation and benefits, as these supports a good work-life-balance. A company should also focus on strengthen diversity and inclusion as well as feature a save and healthy work-environment. In order to act social with a companies community and suppliers, a regular communication and involvement in different actions with clients is necessary as well. Guests should be informed about a companies' initiatives and projects, so that they feel concerned regarding sustainable development. Furthermore it is crucial to share a businesses' actions not only face to face, the media is the most important source to communicate your activities to a wide range of clients. (Houdré 2008)

## 2.2 Energy use and costs

Energy costs of an average hotel vary between 6-8 % of total turnover. An energy-friendly business for example has only average energy costs of 2-3 % of total turnover. (Umweltbroschüre 2013) According to this comparatively low number, energy costs are therefore often seen as too unimportant to care about. However they do represent a substantial proportion of controllable costs. (Bohdanowicz 2001)

As it is a basic task of entrepreneurial activity to increase energy efficiency in order to increase the profitability of a business, it is mandatory to be aware about energy consumption and its composition. Considering the general energy consumption of a hotel it can be divided in about 30 % energy which is used for heating, around 17 % for water heating, approximately 15 % for cooling, 12 % for lighting and around 5 % for cooking. (ISPEX AG 2009)

However these overall composition of energy use differs significantly between different restrictions and factors in the hospitality industry. It is affected by hotel size and number of rooms and buildings, classification, amount of restaurant or size of wellness area, target group (business or leisure), location (rural or urban), climate zone, occupancy as well as types of services and amenities provided in guest rooms. (Bohdanowicz 2001)

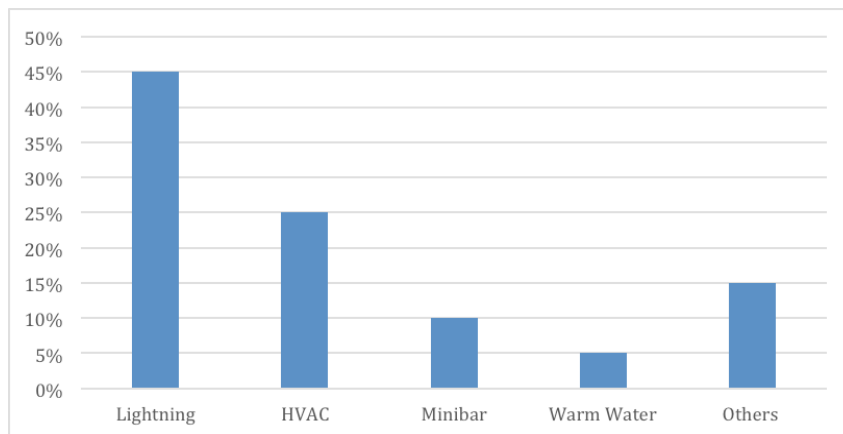
Furthermore is also relevant to identify the key areas in which energy demand is intense. Therefore a current state analysis can create potential.

Every hotel can be divided into three separate areas, which all serve different purposes:

- Guest room area: bedrooms, bathrooms
- Public area: reception area, lobby, bars, restaurants, wellness area, meeting rooms, floors, elevators
- Service area: kitchen, offices, laundry, staff area, technical sector

As these three key areas have very different energy flows, hotels need to create costs' transparency as well as keep attention on a hotel's energy expenses in order to define and handle energy costs accordingly. The guest room area is utilized very different and has varying energy requirements, as it depends on the room structure as of extensive glazing for example. A typically energy-intensive area is the service area, as it requires high amount of energy in terms of cooling, ventilation, heating for technical equipment. (Bohdanowicz 2001)

Besides these key areas in which energy demand is analysed to be intense, additionally the type of energy which is consumed is an important point. Past investigations have shown that electricity is the primary source of energy in the hospitality industry.



**Figure 4: Total electricity costs in a hotel (ISPEX AG 2009)**

As shown in figure 4 the electricity use of a hotel can be divided into: 45 % electric lightning, 25 % heating /ventilation/air conditioning, 10 % minibar and 5 % warm water supply, 15 % rest. Depending on the mentioned factors (size, category etc.), the field of heating, ventilation and air condition (HVAC) may account from 25 % to 40 % of total electricity usage. For example the heating of vacant guestrooms in order to assure a good atmosphere, are causing to enormous costs. The total energy usage increases with almost 6 % by rising only one degree of room temperature. (Umweltbroschüre 2013)

By analysing not only the electricity costs of a hotel, a research of the Cornell University shows that costs for water supply should also be taken into consideration. According to this study hotels use between 200 and 450 litres of water per guest each day. This amounts up to 70,000 - 160,000 litres of water per room per year. This figure is a substantial expense, given that water charges in Germany range from 3.00 € to 4.00 € per 1,000 litres. (Umweltbroschüre 2013)

Consequently green business is no longer a possibility, the future depends on it. (sustainability in hospitality 2012)

## 2.3 Green Certificates

With a growing rate of 5 % worldwide, ecotourism is the fastest growing market in the tourism industry. (Prolog 2013) According to the non profit International Ecotourism Society, more than two-thirds of U.S. and Australian travellers, and 90 % of British travellers, consider protection of the ecosystem as well as support of local communities.

Ray Hobbs, a member of EcoRooms & EcoSuites' Board of Advisors and a certified auditor for Green Globe International said:

“The public's demand for these types of facilities is certainly growing”. “People want to spend their money with businesses that share their same personal beliefs and values. The hotels that achieve certification identify themselves as leaders in green practices, energy conservation and a sustainable future.” (Ecogreenhotel 2013)

By earning a green certificate, industries do not only encourage the environment, they also improve their bottom line. It reflects a healthier bank account as well as a clear conscience. (Ecogreenhotel 2013)

As there exists a variety of energy user in the hospitality industry and correspondingly many starting points for the sustainable use of energy, many certifications (around 50 certificates within Europe) were developed and present a wide range of possible savings. (Verträglich Reisen 2013) Within the fields of electricity- and water use, waste management, food and beverage and sustainable management different questionnaires have been developed in order to reduce high energy costs. (Eckart 2012)

In order to communicate the environmental- and climate-friendly offer to the guest, environmental-, ecological-, or sustainability-certifications have been introduced. Many of these certificates are especially tailored to the hospitality industry and evaluate primarily the environmental impact in detail. The goal of these certificates is to help the hotels on focusing in its way regarding a sustainable development strategy. (Houdré 2008)

Therefore the efficiency of the building and associated resource consumption is hardly considered. Going one step further, systems such as Viabono, Green Globe, and VDR are checking energy consumption as well as energy-savings additionally and take it as an important criteria. (Bernard & Voss 2012)

In order to obtain such a certificate, hotels need to take the first step and answering energy-related questions for every hotel department. Only when they fulfil the requirements regarding sustainability they will be “awarded” with the desired certificate. The certificates are granted for a specified period, so that exposure must be shown again. As there is a variety of different certificates and organisations, hotels need to make sure which certificate is appropriate to their target group. Even though there is not even one global sustainable development certification known, which is presently recognized worldwide. (Bernard & Voss 2012)

However the following chapter describes three different certification known in Germany as well as in Europe. These certificates have different requirements and criteria's, which are important decision factors when deciding which is the appropriate for each individual company.

### 2.3.1 Viabono

The eco-label Viabono was founded in 2001 as an initiative of the German Federal Ministry for the environment and the Federal Environmental Agency and is therefore a very known certificate in Germany. It certifies accommodation businesses like hotels, apartments, hostels, conference centres etc. as well as destinations and other tourism businesses like nature parks in Germany. Essential for Viabono's “natural enjoyment” is an intact environment and natural world, plus a high-quality tourist product. (Destinet 2012) (Ecolable index 2012). The requirements of Viabono's quality concept are deliberately created and focus on four selected categories:

<b>(sewage) water</b>	- litre/accommodation
<b>waste</b>	- litre/accommodation
<b>energy / climate</b>	- kWh/accommodation + kg CO <sub>2</sub> /accommodation
<b>groceries</b>	- number of product line (regional, organic, fair trade)

The list of practical measures is based on a serious, comprehensive database of several hundred prestigious hotel businesses. In order to pass Viabono's quality approach businesses need to reach at least 30 % “better” than the respective calculated average hotel operation within the fields of waste-water, waste, energy & climate. In the field of "groceries" businesses are expected to use at least ten products/ product groups of regional origin. (Viabono 2013)

There is a maximum key figure of 10 %, which should to be never below this limit. Otherwise if a hotels business is not reaching the 10 % “better” than the respective calculated average, the company must establish its particular situation and represent plausible statements regarding its optimization measures in the special field. (Viabono 2013)

To ensure a fair comparison of all applicants, specifics or local peculiarities of a hotel’s business, are considered as well. The Viabono indicator depends not only on the total consumption figures of a hotel per night, the analysis tool calculates possible features such as spa area, meeting facilities, restaurant area or climatic conditions in order to provide accurate results. (Viabono 2013)

### **2.3.2 Green Globe 21**

Currently the most recognized initiative within the travel and tourism industry is called the Green Globe 21 certificate. As a result of the 1992 Earth Summit in Rio, the organisation was founded in 1992 by the World Tourism and Travel Council (WTTC) and the International Hotel and Restaurant Association (IH&RA). (Bohdanowicz 2001)

The aim of the international known benchmarking and certification program is saving energy and water resources, reducing operational costs, furthermore positively contributing to local communities as well as meeting the high expectation of green travellers.

Moreover it is dedicated to improve the environmental performance of all travel and tourism businesses, regardless of size, area, location or level of eco-friendly action. Green Globe 21 is based on Agenda 21 principles for Sustainable Development authorized by 182 governments at the above mentioned United Nations Rio de Janeiro Earth Summit in 1992. (Bohdanowicz 2001)

Green Globe 21 is a worldwide benchmarking and certification program, which enables environmental friendly travel for consumers, businesses and communities. The certification program delivers a report to the business on where its environmental and social performance is positioned comparative to the environmental and social benchmarks. (Green Globe Leaflet 2013) These results are compared with the relevant baseline and best practice levels, which are developed for each country/ facility-type and are based on the data which is published world wide in industry surveys and audits etc. Additionally these indicator benchmark values are based on regional and national resource consumption data and environmental practices. (Bohdanowicz 2001)

Every year recommendations are provided in order to prove whether an operation has enhanced or maintained its performance concerning the former benchmarking evaluation. (Green Globe Leaflet 2013)

This benchmarking guide can be purchased for approximately US \$ 20. By taking part of the whole Green Globe 21 program, industries have to pay about US \$ 225 to US \$ 6,000 varying on the size and operational scale. (Bohdanowicz 2001)

### **2.3.3 Certified Green Hotel (VDR)**

Founded 1974 in Germany, The German Business Travel Association “Verband Deutsches Reisemanagement” (VDR) is a business association. It is committed to represent the interests of the German economy for business travel management. The VDR is a networking platform as well as a knowledge database for businesses. The association represents its interests and provides technical expertise to professionalize business travel and mobility management. It supports travel managers in the complex tasks of strategic purchasing of travel services in increasing revenue and the process management. Quality and safety of travel services as well as good service and flexibility in travel arrangements are as much as important for the VDR as the quantifiable economic benefits. (VDR 2013)

Therefore different certification in the hospitality industry are developed:

- Certified Business Hotel
- Certified Conference Hotel
- Certified Conference Ship
- Certified Green Hotel

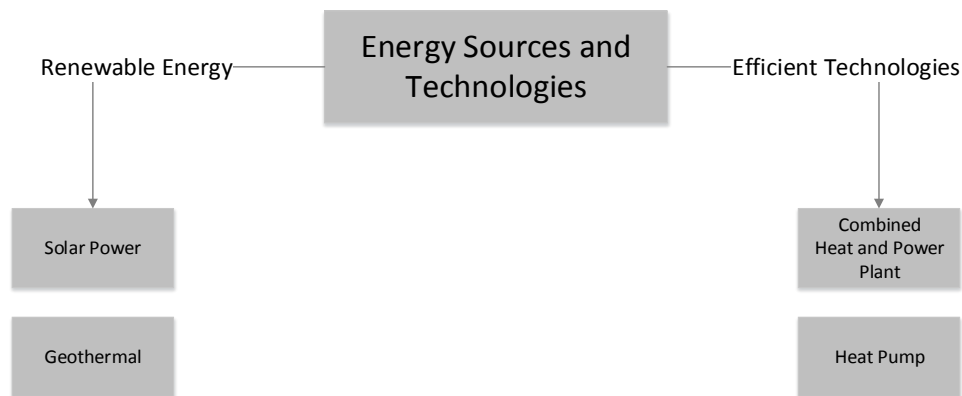
In terms of “Certified Green Hotel” the VDR developed an inspection catalogue with 65 questions regarding sustainability. Comparable to Viabono the VDR provides a criteria catalogue within the fields of energy and water usage, waste management, food and beverage, corporate social responsibility as well as sustainable management. After the evaluation and analysis of these criteria, hotels are certified. According to VDR most of these criteria can be perceived directly by the guest. In 2012 around 500 hotels are approved “Certified Green Hotels”, the VDR counts themselves as a quite famous certification with high visibility around Germany and Europe. (VDR 2013)

## 2.4 Renewable and efficient energy

Energy prices are predicted to raise in the next years, therefore hotels need to develop their own energy concepts and need to meet the complex energy requirements of the government and therefore invest in renewable and efficient technologies.

The following chapter describes two different energy sources as well as technologies, which could be adapted in the hospitality industry. It is important that especially businesses start to develop renewable energy concepts, as well as supporting this additionally with adapting efficient technologies.

Therefore figure 5 shows the authors approach in this field. As there is a distinction between renewable energies and efficient technologies, this part is explaining the difference. Furthermore the following section describes the three main renewable energy sources: Solar Power as well as geothermal energy. Additionally the author explains two important efficient technologies; Combined Heat and Power Plant (CHP) and Water Heat Pump.



**Figure 5: Breakdown of renewable and efficient technologies**

Renewable energy can be described as a unit of technologies that capture energy from existing currents of energy, from constant natural processes such as sunlight, wind, water, biotic processes, and geothermal heat flows. (Ourclimate 2013)

As renewables energy sources became equally popular; sun, wind, water, as well as biomass and geothermal energy are increasingly used for power and heat generation. With an optimum use and drawdown of available governmental funds for renewable energies, companies can achieve a couple of economic benefits. However investment for renewable energy technologies is usually quite long and pay for themselves only after a few years.

Nevertheless, there are many reasons to focus on renewable energies. The following sections give a general overview about today's technical capabilities. (Ourclimate 2013)

There are quite a few advantages related with renewable energy. By looking at the name "renewable" energy, the first advantage is actually its endless use, as it is "renewable". It arises from naturally occurring processes like water and wind energy and is therefore abundance. Secondly the production and usage of renewable energy, is more environmental friendly, as there occurs less polluting emissions. By creating more active use of renewable energy, it helps to reduce the society's heavy reliance on fossil fuels. This will bring greater energy security for the worlds population. (Hond et al. 2007, 46.)

When implementing responsible practices in a hospitality business, it positively affects the operation in many ways. By addressing environmental management, companies attract investors, enjoy better guest and customer loyalty. Moreover motivation of employees decreases staff turnover. It furthermore enhances the competitiveness of the destination as well as the financial profits of a hotel's business. It leads to personal commitment as well as identifying areas for improvements, it can extend the total quality management and furthermore the product innovation. Additionally a rising number of audience, knowing about the businesses' practices, effects visibility in a positive way. External benefit is the improved guest loyalty, as the company gets access to new markets, it attracts new employees, prevents negative social and environmental impacts as well as future governmental actions. In addition hotel directors and owner that recognize the environmental and socio-economic situation in which they operate are able to manage risks and maintain their licence to work. (Hond et al. 2007, 81.) (tourismpartnership 2013)

As renewable energy has a lot of positive affects, the disadvantages should be taken into consideration as well. The following section introduces different sustainable methods and their negative side, which needs to be considered as well. (Green Electriciy Guide 2013) By installing for example solar power, substantial space may be required in order to get the best solar array. Furthermore solar power relies on the effects of pollution, which can be found in the air, it may harm the amount of sun which reaches the panels. Due to non consistent sun light, there is also some further storage technologies required, as there need to be steady power supply. This can cause to additional loss of efficiency and infrastructure costs, especially in cold periods. Another problem can be seen in the production of photovoltaic systems, as significant amounts of energy, water as well as chemicals are required during manufacture.

In order to recover the amount of energy consumed in the production, a photovoltaic system should be operated approximately 1.5 to 3.5 years to recover the amount of energy it used. However as the lifetime of the solar panels is between 20 and 40 years, the total balance remains positive. (Green Electricity Guide 2013)

The problematic of wind power, can be seen in generating a constant amount of electricity. As wind is very unpredictable and can start from calm to hurricane force, costs for initial deployment can be enormous. Additionally the energy output of a wind turbine is rather small. Therefore lots of turbines need to be adapted in order to power the amount needed. Also the protection of animals is jeopardized as birds may fly into the moving blades of a vertical wind turbine. Furthermore there is an optimal amount of wind required to power all wind turbines. Therefore quite a lot of space is necessary to operate the turbines. As wind power is quite unlikely and rarely used in the lodging industry, the author decided to put no attention into this field. (Green Electricity Guide 2013)

However there is a difference between renewable energy sources and efficient energy technologies. When it comes to energy saving, many people automatically think about renewable energy. However energy efficiency is just as important as renewable energy. The principle is simple; as energy, which is not needed, there is no production or generation of it needed. Therefore the global energy change is based on a dual strategy: The energy demand should be reduced by increasing the energy efficiency and the remaining requirements should primarily be covered by future renewable energy sources. (Dena 2013)

Whether in private households, medium-sized companies, travel industry, in buildings or in heavy industries, the efficiency in all different areas should be increased. Buildings play a key role in the energy revolution, as around 40 % of total German energy consumption comes from the building sector, 25 % from residential buildings. The proportion for hot water and space heating is around 80 %. According to a study by the Environmental Protection Agency, emissions can be reduced by increasing efficiency by about 20 to 30 million tons of CO<sub>2</sub> in the building sector. Further examples include efficient technologies like Combined Heat and Power Plant (CHP) and heat pump, which are explained in the next two parts. (PNNL 2013)

## 2.4.1 Solar Power

According to Ranft, F., & Haas-Arndt, D. (2004) solar energy is the most popular and cost effective energy source on the planet. Solar energy is created when the power of the sun is used in order to produce energy. This energy source is simple, as this source is not only clean, but renewable and without any expenses. It is also considered as a renewable source of energy as it can be used as long as the sun is existing. Furthermore it is described as a clean energy source, as it does not create negative by-products like pollutants (CO<sub>2</sub>) which damage the ecosystem. (ifpaenergyconference 2013)

There are two important distinctions within solar power. The first is solar thermal conversion, which uses light to generate heat. The second is photovoltaic conversion, which uses sheets of special materials (solar panels) to create electrical power. Therefore the word photovoltaic can be defined in: “Photo” means “light” and “voltaic” means “producing electricity.” (Stone, A. 2009) Thermal energy storage is one of the main technologies in energy conservation and therefore an important module. Overall it is modifying the variance between the supply and demand of energy. (Dincer & Rosen 2002, 96.)

Figure 6 shows how thermal energy storage is being used. When sunlight hits the tube, the water inside will be heated and the warm steam rises to the top, and the cold steam liquefies and returns to the bottom, in order to repeat the cycle. The hot water (steam) is stored and used for hot water preparation and heating support. Advantage of this technology is that heated water is supported by the heat content of the system and due to the lower temperature difference the energy demand decreases. (Wordpress 2009)

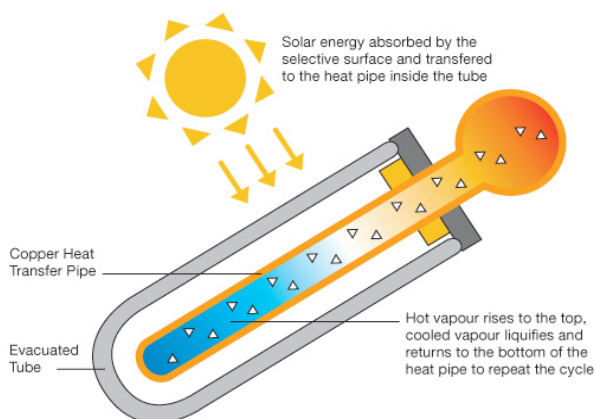


Figure 6: Thermal Energy Module 2013 (Wordpress 2009)

Figure 7 shows the production of energy with the use of photovoltaic cells, which are placed in direct sunlight. When sunlight hits a solar cell, a chemical reaction occurs and the energy is converted to direct or alternate current electricity, which can be stored into batteries. (ifpaenergyconference 2013)

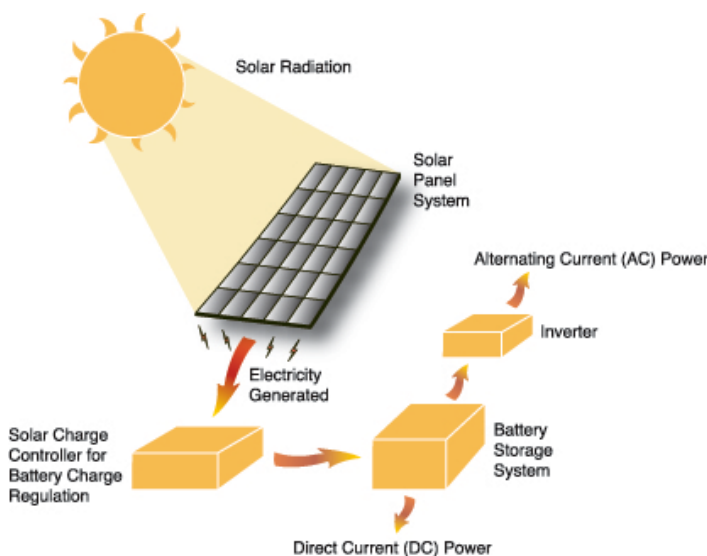


Figure 7: Solar Radiation (Technology Breakthrough 2013)

Since the energy turnaround in Germany is very dependent on the political overall conditions, in future the self-supply from photovoltaic systems will stay in the foreground. Therefore batteries to store the over-produced energy can be used, which is important especially for times of non-production of energy. Consequently a dependency of funds is minimized and seek to a stronger self supply of energy.

One negative point of using the photovoltaic model is the unsteady energy production. As the sun is not “available” 24 hours, and furthermore not the whole year, the efficiency of solar energy is not given constantly. Additionally the high production costs of silicium lead the industries to import materials from other countries (especially China) where solar panels are produced less expensive. (Solar Energy International 2004, 127.)

## 2.4.2 Geothermal Energy

Geothermal energy is the utilization of thermal water and thermal energy in the earth's insight, as the surface temperature is measured about 10° C and increases towards the insight of the earth by about 3° C per 100 m depth (see figure 8). (Umweltdatenbank 2013) Therefore plants are necessary in order to transfer heat, in order to produce electricity. During this process water is heated until it converts to steam and with the aid of electric generators electricity is produced. (Aggeliki 2011)

According to Tester (2007, 58.) the global demand of electricity is supplied with 0.3 % geothermal power and this sector increases with around 3 % every year, because of new constructions and highly developed technologies. Furthermore geothermal energy can be used for heating, cooling or storage of heat and cold. Moreover it is important that the location is proved by professionals if thermal water exists, which is only regionally possible. This construction and operation requires a wide knowledge of the extracting- and water-law. (Umweltdatenbank 2013)

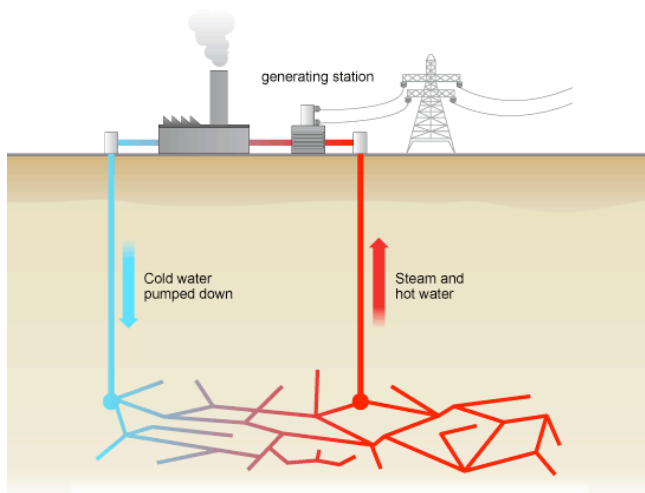


Figure 8: Geothermal energy (BBC 2013)

Geothermal energy is not defined as a renewable form of energy, as it is not renewed. However it can be used for millions of years, so it is a human-scale source of renewable energy. The key advantage of geothermal energy is the base load capacity. Geothermal energy is not dependent on the seasons, as it is available the whole year and is particularly climate-friendly. (Umweltdatenbank 2013)

### **2.4.3 Combined Heat and Power Plant (CHP)**

When integrating the production of usable heat and power in one single, highly efficient process, it is called Combined Heat and Power Plant (CHP). It is not only capturing usable heat, it converts natural gas into electrical and thermal energy. While up to two third of the overall energy consumed is lost in today's coal and gas fired power stations, the process of CHP is the most effective one. The overall efficiency of CHP plants can reach an excess of 80 % at the point of use, which is a high difference comparing to other plants. Furthermore CHP is fuel neutral, which means that fossil fuels as well as biogas can be used. Overall the CHP technology offers the capability to create more efficient and effective use of primary energy resources. (Chpa 2013)

The plant should be adjusted to the energy consumption of the building. Furthermore short-term overproduction can be kept in a heat storage facility or the plant can transfer the energy into the public grid. As the cost-effectiveness is growing with its life duration, it can be seen as a very attractive energy model for the hospitality industry because of the enormous electricity and warm water consumption. (Schmid 2004, 21.)

### **2.4.4 Heat Pump**

By providing heating and cooling in many applications, heat pumps offer the most energy-efficient method, as they can use renewable heat sources in our atmospheres. (Heatpumpcentre 2013) A heat pump system consists of three parts: the heat source system, which removes the area of energy required, the actual heat pump, which makes the recovered energy heat usable and the heat distribution and storage system, which distributes or stores the heat energy in the room. The technical process of a heat pump is the same as the process of a overall known method in the principle of the refrigerator. While the fridge removes the heat from inside and releases it to the outside, the heat pump extracts the heat outside and releases it as heat energy to the house. (Bwp 2013)

The heat pumps have a large potential world wide. The global CO<sub>2</sub> emissions amounted up to 22 billion tonnes in 1997, thus heating in building causes 30 % and industrial activities cause 35 %. The heat pump potential of reducing CO<sub>2</sub> emissions, is calculated as follows:

- 6.6 billion tonnes CO<sub>2</sub> from heating buildings, which is 30 % of total emissions.
- 1.0 billion tonnes can be saved by domestic and commercial heat pumps, assuming that they can provide 30 % of the heating for buildings, through an emission decrease of 50 %.
- Minimum 0.2 billion tonnes can be saved by industrial heat pumps (estimation based on a study by Annex 21). (heatpumpcentre 2013)

This equals to a total CO<sub>2</sub> decrease of 1.2 billion tonnes, which amounts up to 6 % of the global emissions. (heatpumpcentre 2013) Due to the increasing interest for own consumption with the use of photovoltaic systems to power a house or building. Overproduced power can not only be stored for example by a battery, it can be used for operating a heat pump. Therefore efficiencies can be increased, plants combined as well as raising profitability. (Bwp 2013)

### **3 Methodology**

According to Burns (1997), research can be described as “a systematic investigation or examination whereby data is collected, evaluated and interpreted in order to comprehend, define and predict or control an educational or psychological phenomenon or to empower individuals in such contexts”. (Mertens 2005, 2.)

In this chapter, the author represents the research strategy and methods which are used for this thesis. Furthermore this chapter describes different research techniques and how these techniques have logically been analysed. The author explains why different techniques are chosen and why they are relevant for the study.

#### **3.1 Exploratory Research**

Exploratory Research is a suitable strategy for getting ideas and an insight of the topic. It is helpful for the author to gain a broad idea about the problem or issue of the topic and furthermore it is the basic foundation of a good study (Churchill & Brown 2007, 89.). This is important in order to formulate a “problem”.

The information in order to compose the thesis is selected via literature research through surveys and studies, interviews or already existing case studies. According to Churchill and Brown (2007, 89.) exploratory research can be described that the main emphasis for the author is gaining ideas and insights, which are helpful in braking broad imprecise problem statements into smaller more specific problems.

The thesis was guided mainly through literature review and current case studies, as this was the appropriate method to gain a basic overview about the topic and therefore formulate the hypothesis. Furthermore these methods are easy and fast to organise and moreover a not expensive approach.

### **3.2 Secondary Research**

Regarding to Churchill and Brown (2007, 78.) secondary research can be described as “statistics not gathered for the immediate study but for another purpose.”

It can be separated to internal data, which is for example a statistics from the organisation the research has to be done, or external data, which is a statistic from a different company.

For this thesis external data and statistics are used and analysed as these are very fast and cost saving techniques. According to Churchill and Brown (2007, 79.) the disadvantage of this technique is mostly the missing accuracy of the data, because of the fast moving field of technology. Therefore the author purposeful decided to research and analyse especially online academic journals and electronic books as well case studies.

### **3.3 Primary Research**

This research technique can be described as detailed information particularly composed for writing the thesis. As there mostly exists an overload of information of data through previous research, the author evaluated these data according to literature.

Furthermore the author chose an existing hotel in Germany and contacted the hotel manager regarding the thesis topic. The author conducted an interview with the hotel manager in order to get a holistic overview of the current situation. Therefore the author was able to ask specific questions regarding the energy consumption of the hotel, as well as if energy saving methods are already implemented or if trainings for employees are already adapted. Concerning these details as well as the given data from the hotel manager, the author was able to analyse real numbers and figures which directly related to the research hypothesis and even more these facts are ensured to be accurate.

### 3.4 Reliability and validity

An important part of the thesis is the research concept of reliability and validity. For the thesis it is important, that the collected data is reliable and truthful. Furthermore it can be defined as an relevant concept of quantitative research. Both validity and reliability aim, while researching, to understand the extend of what the data contains. (Green 2007, 99)

Reliability can be defined as the consistency of the data. However this can be affected by the change of time, technological bias or misunderstanding of questioning or surveys. An example of reliability is that the author collected the hotel's energy data during the interview with the hotel manager as a print out. This data arises from the hotel's software where all the costs and demands are collected the whole year. Therefore the author can be sure that the given data is reliable and truthful.

Validity is the result, which the author is taking by analysing and evaluating different sources. Therefore a wide range of figures and data are analysed through books, journals and also internet webpages. According to Churchill and Brown (2007, 80) credibility of the thesis is reached through the use of different sources. Therefore the certain sources show a wide range of findings and the author selected the appropriate data through the average findings, which narrow the results. (Green 207, 99)

## 4 Calculation Photovoltaic and CHP

This thesis evaluates a four-star superior hotel in Saxony, eastern Germany. Offering more than 500 rooms, as well as a 1,000 m<sup>2</sup> wellness area, two restaurants, bars and a enormous conference area, with few fully air-conditioned meeting rooms, boardrooms and a foyer for up to 1,100 people. This hotel is a ideal example for high energy demands. Furthermore it gives the author a possibility to analyse figures for different energy cost pools and even more important, give feasible suggestions in terms of sustainable development and energy saving methods.

According to Brebbia and Pineda (2004) hotel operators who can maximize their efficiency will be more cost-effective than their competitors. Without negatively affecting performance, a hotel can reduce its energy consumption by 20-40 %. (Gracie & Kuehnel 2010)

To evaluate and study the hotel's energy use, an interview with the general manager of the selected hotel is conducted in April 2013. Therefore the author has the possibility to get an insight of facts and figures of the hotels energy consumption in 2012 and furthermore an overview about the current situation of the hotel. Within the following part the author evaluates the given information and the outcome is explained in detail.

Within the first step of the evaluation the author analyses the different energy prices and makes assumptions according to different sources. The existing data of the selected hotel is analysed and the total energy and resources costs are calculated for the year 2012. Consequently three different cost pools are the basis for further evaluation (see figure 9).

Electricity is the greatest cost pool for the hotel and is the main focus of the authors work. Within the field of energy, the costs per room are calculated and analysed. Through the selected case of a photovoltaic module, merely room energy and resources costs are saved. By analysing the second large costs pool gas, the thesis gives calculations regarding a CHP plant and further suggestions regarding electricity savings.

Within the calculation of the two cases the earlier described technology of a heat pump is not considered. Through the high cost pool of electricity in the hotel, a heat pump is not constructive, as it is generated with electricity and generates heat. Therefore the author does not put any effort in analysing the possibility of installing a heat pump within the hotel.

In terms of the geothermal energy, experts are necessary to prove the hotel's location as well the existence of thermal water. As this is only locally possible as well as requires a wide knowledge of the water- and extraction- law, the author decided to put no more effort within this method.

In order to get a general overview about the topic the following figure demonstrates the steps, which are done through the empirical part of the thesis.

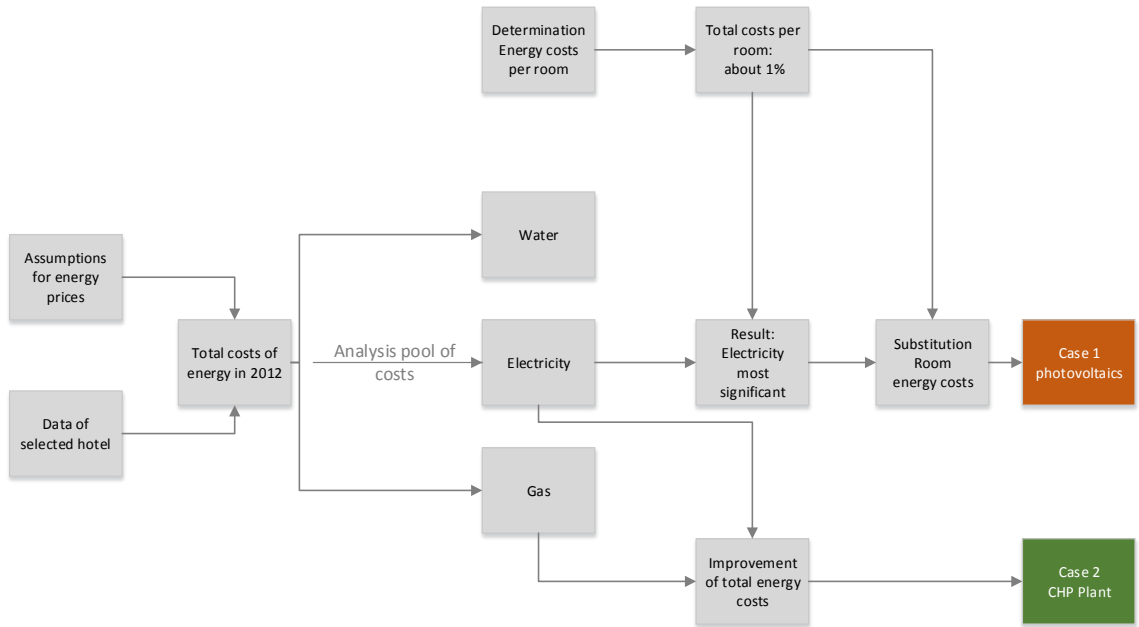


Figure 9: Overview of data analysis and cost pools

## 4.1 Case implementation

In April 2013 an interview with the hotel manager was conducted in the selected hotel. Subsequently the following energy and resources data from the year 2012 are presented:

**Table 1: Energy and resources data from selected hotel in 2012 (Interview 2013)**

kWh/a Electricity	3,587,710.00
kWh/a Electricity per Room	42
kWh/a Gas	5,301,580.00
kWh/a Gas per Room	62
m <sup>3</sup> Water	33,902.00
litre Water per Guest	244

For further analysis the calculations refer to an 44 % occupancy (average occupancy in 2012) with 576 available rooms, through the year 2012.

In order to get an insight about volume and prices of these figures, the author decided to collect energy prices comparable to large industry businesses and households (appendix 2).

Within the thesis the author calculates with the electricity price of 0.14 €/kWh. This amount is determined as an average based on different findings. As the electricity price for households in 2013 is around 0.25 €/kWh and for industry user about 0.10 €/kWh, a price of 0.14 €/kWh is chosen as a hotel is more comparable with industry business. (BDEW 2013)

In terms of the amount of gas, which is consumed through the year 2012, the author calculates an average value concerning different findings. In Germany the price of gas for households is about 0.07 €/kWh in 2013, beside there is no discount for large-scale businesses, further calculations are made with the gas price for private consumers. (Umwelt Ministerium 2012)

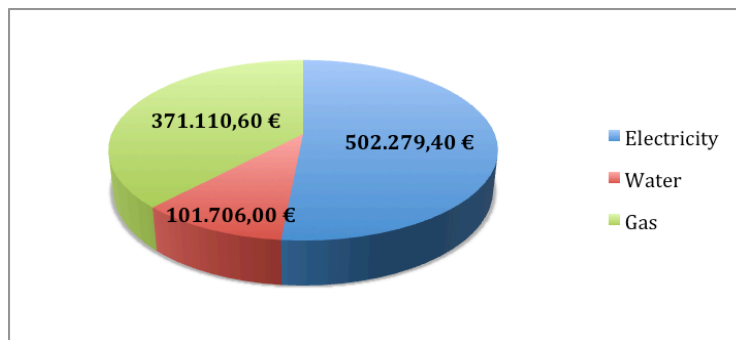
In the third step the consumption of water in 2012 is calculated with the price of large industry businesses. According to the Weißenberger (2013) the price of water for households is calculated with around 4.00 €/m<sup>3</sup>, however the price for large-scale consumer is 3.00 €/m<sup>3</sup>. As a hotel is classified as a great water consumer, further calculations are based on 3.00 €/m<sup>3</sup>.

**Table 2: Assumed energy prices**

Energy	Price	Unit
Electricity	0.14	€/kWh
Gas	0.07	€/kWh
Water	3.00	€/m <sup>3</sup>

According to these different assumptions of energy prices, in 2012 energy and resources costs are calculated with a total of 975,096.00 € (electricity, water, gas).

Significant are the high costs of electricity, which account of the enormous need of electricity through the use of air conditioning, heating as well as lighting in guest areas. The following diagram shows detailed numbers of the three different cost pools.



**Figure 10: Total energy and resources costs 2012**

Additionally a calculation of the total energy and resources costs per room/ per day is done, throughout a better understanding of which amount is considered in room pricing. Noticeable is that the costs for water are the most significant comparable to electricity and gas. As the total energy and resources costs of 0.79 € per night/ per room are very low, it should be noticed that the electricity costs of 42 kWh per room do not contain the costs for warm water supply as well as HVAC systems. Through the relatively high costs for water supply, chapter 5 gives best practice recommendations.

**Table 3: Total energy and resources costs per night/room**

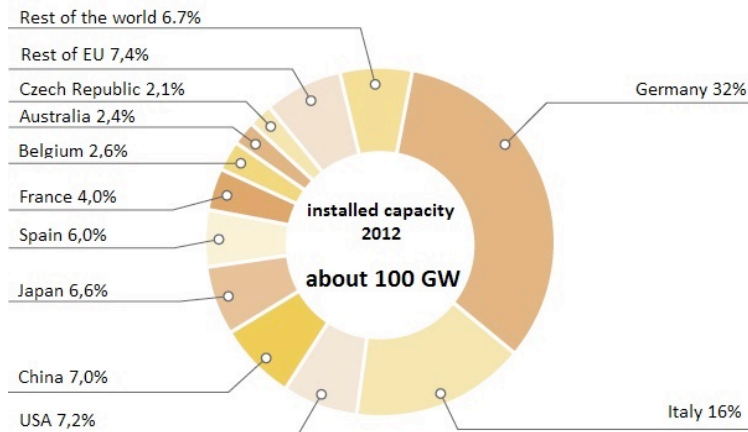
<b>Electricity</b> per night/room	0.04 €
<b>Water</b> per night/room	0.73 €
<b>Gas</b> per night/room	0.02 €
<b>Total energy and resources costs per night/room</b>	0.79 €

Considering the total electricity costs for all 576 rooms/ per year, an amount of 3,386.88 € is paid in 2012. This accounts only to about 0.67 % of total electricity costs (3,587,710.00 €).

As electricity costs of over half a million euro, shown in figure 10 are the most significant, the author decided to analyse these costs in more detail and furthermore gives suitable suggestions in order to drop expenses. Therefore the following cases are introduced and show a calculation for suitable cost saving methods.

## 4.2 Case one - Photovoltaic

As described in chapter 2.4.1, solar power is one of the most popular energy source in Germany. Furthermore it is subsidized as it does not produce emissions, such as power plants and is therefore protecting the climate. Additionally the development of the installed capacity of solar energy in 2012 was growing to 32 GW (shown in figure 11) and is the highest one of the world.



Vgl. REN21, Renewables 2013 - Global Status Report, S.45, Stand Juni 2013

**Figure 11: Global status report 2012 (amended)**

Figure 11 shows the importance and relevance of solar energy in Germany, however this exceeds the planned figures of the Federal Government. The result is that the government is minimizing public support for solar installations significantly. (Energierechner 2013)

On the other side there is a huge difference when consuming the generated electricity by a photovoltaic module. Furthermore the saved costs for electricity consumptions are much better than the compensation for electricity fed into the grid. The higher the consumption of self generated electricity, the more economical a photovoltaic system will be in future. As the electricity costs of the hotel is analysed as significant high, in the first case a substitution calculation is shown in order to reduce electricity costs in the selected hotel.

Concerning to various assumptions shown detailed in appendix 4, the photovoltaic module is calculated with an amount of 13,200.00 kWh/a by plant. Assuming 20 years of funding, an enormous output of 264,000.00 kWh can be reached. (EEG 2013) In 2012 the average funding of a photovoltaic module is calculated with 0.25 €/kWh, which amounts up to 3,300 € per year. (Fraunhofer 2013) Additionally the calculation of the photovoltaic module is based on three different cost pools, which is shown in the following table:

**Table 4: Total costs and returns for a photovoltaic module**

Capital costs (60m <sup>2</sup> *500 €)	Additional electricity costs 0.14 € kWh/a	Governmental funding 0.25 € kWh/a
30,000 €	30,777 €	66,000 €

The hotel should invest 30,000.00 € in total for the construction of a 60 m<sup>2</sup> (according to the interview, appendix 1) photovoltaic system. According to photovoltaic funding (2013) 500.00 € per square meter is calculated. Furthermore the module is not able to produce all electricity needed in one year (42 kWh/a per room \* 567 rooms). Therefore the solar fraction is around 55 % as the plant is not able to produce the total needed amount. Solar fraction is the share of energy consumption, which is covered by the energy that is produced by the photovoltaic model. Therefore it is necessary to purchase additional 45 % electricity with the assumed amount of 0.14 € in order to cover the total electricity needed. However there are a few investments which need to be taken, the governmental funding is quite high. As 0.25 € kWh/a is paid through the government, the hotel earns an amount of 3,300.00 € per year for the produced 13,200 kWh/a.

Concerning the EEG the compensation is paid over a period of 20 years to private and commercial power generators, which generates a total amount of 66,000.00 €. However the author does not consider cost digression within this calculation.

This accounts to a total turnover of 5,222.40 € within 20 years use of the photovoltaic system. Conclusion of this calculation is a yearly plus of 261.12 € by covering all electricity costs for a room within one year.

### 4.3 Case two - Combined Heat and Power plant (CHP)

Concerning the amount of energy, which the selected hotel needed in 2012, the author analyses two significant cost pools; electricity and gas. In the first case the author specializes in minimizing electricity, however this case will focus on the production of either thermal and electrical energy with a Combined Heat and Power plant.

For the calculation following facts are considered: First of all the performance of the plant is calculated with 400 kW. Considering operating hours of 8,760 h/a the module generates an output of 3,504,000 kWh per year. Investment costs of 400.00 € per kW are measured, which amount to 160,000.00 € acquisition costs for the CHP plant. (ASUE 2011)

As electricity is the largest cost pool, the plant is divided in 2/3 electrical and 1/3 thermal power. The efficiency factor is an important detail, electricity is calculated with a factor of 35 % and thermal energy with 60 %. These figures generate an total amount of energy: (ASUE 2011)

**Table 5: Total energy production via CHP**

Total production of energy <b>3,504,000 kWh/a</b>	
2/3 electrical energy	1/3 thermal energy
2,335,766.40 kWh/a	1,167,988.32 kWh/a
Efficiency factor 35 %	Efficiency factor 60 %
817,518.24 kWh/a	700,792.99 kWh/a

Assuming that there is a constant need of electricity with around 3,500,000 kW, the calculation of the CHP is scheduled for three years in order to obtain a positive outcome.

Starting with the electrical inspection with a requirement of the above mentioned 3,504,000 kWh/a. The CHP is able to produce an outcome of 817,518.24 kWh/a, as of the efficiency factor of 35 %. With regard to Appendix 6 a CHP plant with around 400 kW performance and operation hours of more than 8,000 h/a, generates a total of 0.06 €/kWh production costs.

In order to get the required amount of 3,504,000 kWh/a, it is necessary to purchase further electricity of 2,770,191.76 kWh/a with a price of 0.14 €.

**Table 6: Overview electricity generated via CHP and further electricity approval of the grid**

Electricity through CHP	Electricity approval of the grid
817,518.24 kWh/a * 0.06 €/kWh	2,770,191.76 kWh/a * 0.14 €/kWh
49,051.09 €/a	387,826.85 €/a

Furthermore within the thermal energy inspection, the total thermal consumption is assumed to be equal 5,301,580.00 kWh/a for the next years. The produced amount of 700,792.99 kW/a is free of charge, as the thermal energy is generated as a by-product of the CHP plant.

As this amount is not reaching the high need of thermal energy in the selected hotel, further thermal energy of 4,600,787.01 kWh/a need to be purchased, with a price of 0.07 €/kWh.

**Table 7: Overview thermal energy via CHP and further thermal energy approval of the grid**

Thermal energy through CHP	Thermal energy approval of the grid
700,792.99 kWh/a	4,600,787.01 kWh/a * 0.07 €/kWh
By-product of the CHP – free of charge	322,055.09 €/a

Thereby the demand of electricity and gas through the combination of the CHP plant and further purchases is totally covered. For comparison the following table shows the energy costs before using the CHP plant as well as the calculation with a CHP plant.

**Table 8: Comparison of typical energy costs in 2012 and energy costs via CHP**

Year	Typical Energy costs 2012	Using a CHP plant
1	975,096.00 €	1,069,694.54 €
2	975,096.00 €	907,988.54 €
3	975,096.00 €	907,988.54 €

By evaluating these figures, the CHP plant is able to produce a positive outcome of 39,616.38 € in the third year. As the acquisition costs of the plant are quite high in the first year, the second year has a great output so that the investments are already reduced (shown in table 9).

**Table 9: Total cost opposition for 3 years**

Year	Total turnover after 3 years
1	- 45,543.03 €
2	68,913.94 €
3	183,370.91 €

#### **4.4 Case evaluation**

In this chapter the key findings and results of the two cases are evaluated in order to get the basic understanding out of the calculations.

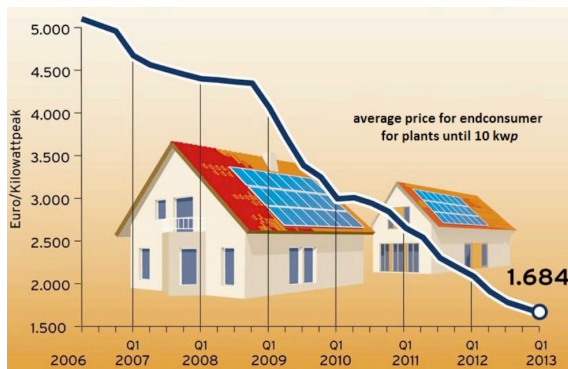
Case one – Photovoltaic:

Due to the very high cost of electricity with over half a million in 2012 shown in figure 10, the photovoltaic module is chosen to reduce these costs. The fact is that the system is not able to cover a sufficient percentage of electricity. Although the bill from this case leads to a saving of the total electricity costs per room, this share is only 0.67 % of total electricity costs 2012. These assumptions lead to the conclusion that a photovoltaic system provides low cost savings by relatively high investment costs.

Furthermore the photovoltaic founding should be taken into consideration. This is committed to the law for renewable energy sources", called the Renewable Energy Sources Act (EEG). This Act and its predecessor, the Electricity Founding Act, serve to achieve political climate and environmental protection goals and reducing the use of fossil fuels.

In the past half-yearly cuts in funding have been made. Since the EEG 2012, the monthly payment is reduced (usually around 1.8 to 2.5 %) compared to the previous month. Additional reductions in the founding have been made through the beginning of 2013. Which causes from the amount of newly installed photovoltaic modules in Germany. (Solaranlagen Portal 2013) With considering these cost limitations, an installation is not recommended.

However a decline in investment costs for a photovoltaic module, which is shown in figure 12, have a positive effect on the returns. This price decline is further accompanied by an increase in performance of the solar modules. So that they require less space to produce a kWh and businesses are able to implement a larger photovoltaic system at low investment costs on the roof surfaces. (Solaranlage 2013)



**Figure 12: Average price for photovoltaics (amended 2013)**

In conclusion a photovoltaic system especially for the selected hotel is not recommended. The photovoltaic system is influenced by many conditions like the amount of governmental founding as well as the decrease in investment costs, effected by the amount of new implemented photovoltaic systems in Germany. It is furthermore depending on Germany's energy law (EEG), as the founding can be influenced negatively due to the election results 2013 in Germany. As the financial savings regarding the photovoltaic system are not enormously high, more approaches need to be done for sustainable development of a business.

#### Case two – Combined Heat and Power plant:

By evaluating the second case of developing a CHP plant in the selected hotel following conclusion can be made. The financial efforts which are reached through the CHP plant, are effecting not only the electricity costs, furthermore it positively effects the thermal costs. It is moreover not depending on governmental funding.

However the high investment costs of 160,000.00 € should be considered as well. Additionally the plant generates only 23 % electricity and 12 % thermal energy for self supply. As therefore the amount of energy, which need to be purchased in addition is very high. These figures may be influenced by future price increases. Therefore the hotel highly depends on energy prices of the market. In general the CHP plant is highly recommended as with an prepayment of 183,370.91 € in the third year, the total energy costs of 975,096.00 € can be reduced by 18,8 %.

## 5 Immediate Actions

As there exists a misconception in the hospitality industry that substantial reductions in the energy use can only be achieved by installing advanced, high technological and expensive machineries, many hotels are afraid in investing such high amounts of money. But in the majority of cases, significant energy savings can be achieved by adopting common approaches, which require neither advanced expertise nor excessive investments. It is not necessary to change the whole building, hotels can actually save a lot of money by changing for example lighting, heating and cooling systems, recycling of waste as well as laundry. (Bohdanowicz 2001)

The following chapter informs about easy and quick methods in terms of energy and resource savings. Furthermore it gives suggestions for improving businesses efficiency, without investing large amounts of money. The author describes different energy cost pools where possible savings can be achieved and in total the energy consumption of a hotel can be reduced by adapting a few techniques. The field of environmental management system, waste, electricity and water are analysed in order to reach a green certificate in future.

## 5.1 Environmental Management System

There are numerous reasons why companies should implement an environmental management system. Through the active involvement of the employees, the identification with the increased environmental corporate goals and the entire company, the staff is additionally motivated.

The visible implementation of environmental responsibility also leads to an image improvement in public, as guests usually react positive on environmental friendly behaviour. This not only reduces the environmental risks, but also increases the legal certainty and thus represents an improvement the position in liability, insurance and credit issues. Thus, an environmental management system may also affect the ranking of the banks positively. (Umweltbroschüre 2013) For the construction of an effective energy management system three important points should be considered.

### 1. Formulate environmental policy

The introduction of an energy management system begins with the anchoring of the company's environmental policy in which the operation documented its environmental responsibility. This includes the formulation of environmental guiding ethics and principles of action, as well as the obligation to comply with all relevant environmental legislation.

### 2. Setting up an environmental program

Starting with an analysis of the current environmental situation of the company and taking into account all relevant environmental aspects, which result to concrete improvements and are part of the environmental program. This program contains of objectives and concrete (organizational and technical) measures as well as appropriate timelines. Some example measures are:

- Annual data collection of energy, water, chemicals and waste
- Purchase of eco-labelled products (paints, inks, detergents, etc.)
- Purchase of agricultural and local products

### 3. Organisation and responsibility

An environmental management system also provides the capture of the organizational structure, the main responsibilities as well as procedures of the company. This includes the selection of an environmental management officer, building an emergency and hazardous substance management, who creates training plans and documentation of implementation. A special focus should be placed on raising awareness by training of employees. The success or failure in the implementation of an environmental management system depends not only on the company's management, it is also relevant for the motivation of the workforce. In large companies a reduction of up to 30 % in energy and water consumption through good and recurrent employee training is quite possible (Umweltbroschüre 2013)

Furthermore energy consumption in hotels depends not only on employee behaviour, even customer behaviour is an important part. Therefore it is significant to include customer in energy saving processes and tactics. Nowadays room-key controlled energy and towel reuse programs are mostly common in a hotels business. Additionally a mechanism which turns off the ventilation as soon as a window is open should be adapted as well and can enormously affect the total energy consumption. (Umweltbroschüre 2013)

## 5.2 Waste Management

In Germany around 37.6 million tons of waste are produced every year. Thereof 16.3 million tons are removed and 21.3 million tons are recycled. This is comparable to an yearly per capita volume of about 450 kg. An average hotel businesses produces almost 2 kg or 6 litres waste per night/ per guest, the disposal costs for that amount account up to 30 cents per night - mainly for residual waste (63 %) and organic waste (28 %). (Bundesministerium für Forschung und Bildung 2013)

According to Forbes, White, Franke & Hindle (2008, 18.) waste must be managed in a way that minimizes risks for human being. Furthermore it has to be sustainable, which means it should be:

- Economically affordable
- Socially acceptable
- Environmentally effective

Therefore waste management can be defined as the practice of collecting and disposing the waste produced by human activities. Furthermore it is vital for the healthy functioning of the environment. An environmental friendly way of utilizing waste is recycling or reusing materials, which have already been used once. (Ecomii 2013)

In terms of waste management, following practical steps should be taken into consideration, in order to reduce the amount of waste in a company:

- First of all it is relevant to identify the different departments which are responsible for how much waste and which kind of waste is produced
- It needs to be analysed how the waste is currently being handled
- Calculations are necessary in order to identify the amount of waste and therefore measures to reduce, reuse or recycle each one
- A waste management plan should help to reduce waste in a specific time set
- Ensure that own waste water systems like reuse of water for gardening for example, complies with governmental and regional quality standards
- Monitor results constantly and take actions if necessary

For more and more companies whose disposal costs depend on the volume of waste, a trash or waste compactor can be used as well. Within this compactor, the volume of waste can be reduced by 75 %. This results in less waste or smaller waste containers.

However, the measure of compaction must be discussed with the relevant disposal company. If the investigation of such a trash compactor is worth, a multiple-cost-benefit-analysis needs to be made. (Umweltbroschüre 2013)

### 5.3 Water conservation

The use of natural water resources in regions where water is rare, often leads to conflicts and environmental problems. Travellers consume more water as opposed to the locals. As a hotel guest needs about 300 litres per day, the average consumption in a household varies from only 80 to 150 litres. For example a 5-star hotel with a golf course consumes close to 900 litres per overnight guest. A dripping faucet can mean an annual water loss of up to 9,000 litres. Therefore the cost of water should always be taken into account. (Umweltbroschüre 2013)

However the water consumption in the selected hotel is quite low (245 litre per guest/per day) in comparison to the average consumption. Therefore the author did not mainly focused on reducing water costs, but gives a few easy and simple suggestions in order to reduce water consumption slightly.

The water consumption of a hotel is mainly caused by three main areas: the kitchen with dishwasher, laundry or pool and the guest rooms (hand wash basin and shower).

A hotel should consider following steps in order to analyse and reduce the total water consumption per year:

- First of all the key areas of water use need to be analysed and possible reductions need to be achieved
- Implementing changes in routine (employee processes)
- Regularly check if cisterns, taps, pipes have leaks and if plugs in basins fit properly
- Installing sensors, low-flow or water saving fittings in guest rooms, washrooms and kitchen
- Capture rainwater or recycle “grey water” (recycled water from baths, sinks or kitchen) for gardening, washing floors or toilet flushes
- Observe results continuously and take actions if necessary

A calculation example illustrates how much money per year is saved only by adapting new shower heads which reduce the water flow by 8 litre per minute.

For example the chosen hotel with 92,505 room nights (576 rooms, with 44 % occupancy, average allocation of 1.6 guests), replaced the old shower heads by new shower heads, with a price of 20.00 € each. In principle, experts estimate that the average shower time of a hotel guest is about 15 minutes per day.

**Table 10: Calculation for replacing shower heads within the selected hotel**

Capital costs	576 rooms* 20.00 €	11,520.00 €
Water savings	10 litre/min* 15 min shower	150 litres
Guests	576 rooms* 0.44 % *1.6	148,009 guests per year
<b>Total savings</b>	Guests* saved water * assumed water price of 3.00 €/m <sup>3</sup> - capital costs	66,603.60 € <u>- 11,520.00 €</u> <b>55,083.60 €</b>

Even at a reduced power of 10 litres per minute of water, which is not noticed by a guest, the exchange of all shower heads would recoup within a year. The calculation shows total savings of over 55,000 € per year, which is a enormous amount.

Therefore the selected hotel was able to drop total water consumption to 244 litre per guest (appendix 1), which is under the average consumption of 300 litres.

Additionally energy saving can be reached with the use of flow reducing shower heads. By heating a cubic meter (1,000 litres) of water from 10° C to 37° C , about 30 kWh of heat is required. By assuming 7 cents per kWh of gas heating leads to the water savings of the above calculation example and also saves energy and resources costs of approximately 1,554.09 €. (Umweltbroschüre 2013)

**Table 11: Calculation for warm water savings - assuming heating via gas**

Water consumption	150 litres * guests per year	22,201.35 litres/m <sup>3</sup>
Gas price	0.07 €/kWh gas (2.1 € for 30 kWh)	<u>46,622.84 € savings</u>

As there is no unified system for the warm water supply existing in the selected hotel, the calculation is made with either the above assumed 0.07 €/kWh gas and the following 0.14 €/kWh electricity costs for the electrical warm water supply.

**Table 12: Calculation for warm water savings- assuming heating via electricity**

Water consumption	150 litres * guests per year	22,201.35 m <sup>3</sup>
Electricity price	0.14€/kWh electricity (4.20€ for 30 kWh)	<u>93,245.67€ savings</u>

Even though as it is not clear if the hotel applies warm water supply through gas or through electrical energy, in conclusion both methods lead to high energy savings.

Moreover hot water from bath, showers or kitchen is mostly lost, as the heat is not used further. One example for efficient water conservation can be received through the recovery of this warm water, with the help of heat exchangers. The principle of this is simple, as they catch the heat out of the sewage and reuse this energy in order to heat new water. (Umweltbroschüre 2013)

Furthermore the food and beverage department should be taken into consideration, as the kitchen is energy intensive as well. The water which is used for preparing food varies from 2 % until 10 % of total water use in a hotel. (Webster 2000) By optimizing culinary processes and techniques a business can save enormous energy savings.

## 5.4 Electricity

As mentioned in chapter four the total electricity cost of the selected hotel is analysed to be very high. This amount is reached through many different departments and areas with high consumption. Therefore examples and suggestions are given in order to reduce costs in many fields as possible.

Energy-saving lamps are already implemented in the selected hotel and are significant in order to reduce electricity costs. The payback period, depending on the duration of use is usually lower than 1.5 years. For a hotelier, the biggest advantage is the longer life span of an energy saving lamp, which means less broken lamps (higher quality) and reduced changeover times. (Umweltbroschüre 2013) As energy saving lamps are already implemented within the selected hotel, the author does not put any more attention to this field.

However following table shows the total savings of energy which can be reached through a use of energy saving lamps.

**Table 13: Comparison energy costs with a typical light bulb and an energy saving lamp**

Light bulb (lifetime: 1,000 hours)	Energy Saving Lamp (lifetime: 15,000 hours)	Energy Savings per Lamp (after 10,000 hours for 0.14 €/kWh)
25 W	4 W	29.00 €
30 W	6 W	34.00 €
40 W	9 W	43.00 €
60 W	11 W	69.00 €
75 W	15 W	84.00 €
100 W	20 W	112.00 €

In the selected hotel a lot of energy is being used through space conditioning. With zoning or using autonomous temperature control systems in individual rooms, up to 30 % savings of the energy can be achieved. By controlling the use of air conditioning, further amounts of energy can be decreased. For example by switching on the air conditioning at a temperature of 28° C instead of 26° C, 25 % electricity can be saved. (Humm & Jehle 1996) This process can easily be achieved through the help of employees and hotel management.

Additionally by installing occupancy sensors a hotel can save 35-45 % of the lighting costs. Furthermore in public areas, like in corridors, toilets, refrigerators and closets light is burning

most of the time, although it is rarely needed. Replacing the light switch in these areas with this motion detector can be worthwhile.

Investments for energy efficient lighting equipment can be paid back usually in less than three year's time. (Bohdanowicz 2001)

In hotels refrigerators are major energy consumers. Generally a temperature of 2-7° C for cooling meat is required, for the refrigerated storage a temperature of -18 ° C is necessary. By setting the cooling temperature only 1° C higher, for example -19° C, around 4-6 % more energy is needed. Therefore it is recommended to recheck these temperatures regularly. Moreover a well-stocked refrigerator is important, as almost empty refrigerators do not work efficiently. To reduce the volume of air in the unit if necessary, foam blocks can be used as well. (Dehoga Bundesverband 2012a, 17.)

Furthermore a great energy consumption accounts from the use of mini bars in the guest rooms. According to Schulze, G. (2010) a mini bar requires 5-15 % from a total energy consumption of a hotel. Nowadays minibars are using different operating principles, however they manage the required cooling temperature of 8° to 12° C. A typical hotel absorption model is usually found with 30 to 40 litres filling volume and an average consumption of 1.2 kWh per day. Peltier devices are recognized by the rear panel mini-chilled beams running at normal operation at low speed and are nearly soundless. They work without refrigerant and are therefore to be disposed free of charge. As they run with only 0.4 kWh per day, they are a very energy saving alternative. (Energiekonsens 2013)

For example a stock unit with 1.2 kWh per day in 10 years will cost 613.20 € (at 0.14 €/kWh). A Peltier device with 0.4 kWh per day, only 204.40 euros. By changing to Peltier devices, about 400 € can be saved. Assuming typical purchase price for new equipment from 400 to 500 €, an exchange remains to be economically. (Umweltbroschüre 2013)

Additionally it is recommended to provide mini bars only for guests wishes. An alternative for hoteliers could be providing bigger refrigerators on the floors for everybody's use. Therefore further energy costs can be saved.

Another cost intensive section in a hotel is the energy consumption of stand-by equipment. Nowadays there is a huge difference in energy consumption of for example television. As an older model with high power consumes 0.24 kW for 20 hours in standby mode, an efficient model in comparison consumes only 0.02 kW for 20 hours. By a price of 0.14 €/kWh savings of 11.20 € per room per year can be reached. By calculating this amount with the number of

rooms (chosen hotel: 576 rooms), total energy savings of 6,451.20 € can be achieved. However high investments should be taken into consideration, as the price of approximately 400 to 500 € per television for 576 rooms is very high. (Umweltbroschüre 2013)

Alternatively to avoid such high capital costs, is the application of occupancy sensors, which switch of the whole electricity in a room as soon as the guest is leaving. A even simpler method is the use of power stripes with a main switch off for all electrical devices. However it should be trained that employees act accordingly.

Furthermore laundry is one of the biggest energy consumers in a hotel, with a consumption from 15 to 30 % of the energy. Slightly dirtied laundry should be sorted and washed with short wash cycles at low temperatures. For this, a special detergent should be used to guarantee sterility and cleanness at lower temperatures. Thus, the washing machine should be connected to the hot water pipes, as this will save further energy and resources costs, as the water will not be heated before washing. (Umweltbroschüre 2013)

Additionally guests should decide whether the linen or towels are changed daily or not. Therefore advices should be found in every guest room. A study shows that 70 % of guests notice this type of sustainable behaviour and participate without feeling uncomfortable. This normally leads to a laundry reduction of 40-60 % varying on the type and size of the hotel. (Lipinski 1993)

However the selected hotel has outsourced its laundry, as it would cause to enormous energy and personnel costs, as of the high amount of guests and rooms. Therefore the saving technique is only recommended to small hotel businesses with a low amount of laundry. Large hotel businesses however should consider outsourcing as an alternative.

(Dehoga Bundesverband 2012b, 29.)

## **5.5 Actions to reach green certificate**

As the immediate actions are profitable as well as are not affiliated with high costs of investment, they can be further supported through the visibility of a green certificate. Throughout the selection of a hotel in Germany, with mostly domestic hotel guests, it is recommended to apply for the “Viabono” certificate. Viabono is Germany’s most recognised certificate and therefore quite popular.

Additionally by comparing the total costs for receiving a green certificate shown in table 14, high cost differences can be recognized. For the selected hotel total costs of around 1,300.00 euros are calculated and are therefore proved to be economical. Even though the Green Globe 21 certificate is worldwide recognized, the high investment costs of 4,500.00 € should be taken into consideration as well. For the selected hotel a certificate which is known and popular in Germany with the lowest investment costs, is highly recommended.

**Table 14: Compare total costs for green certificates (Viabono 2013) (Bohdanowicz 2001) (VDR 2013)**

<b>Viabono</b>	<b>Green Globe 21</b>	<b>VDR</b>
Application fee: 250.00 €	Application fee: n/a	Application fee 175.00 €
Annual fee: 650.00 €	Annual fee: 4,500.00 €	Annual fee: 1,350.00 €
Other costs: 4.00 € per room (maximum of 400.00 € total)	Other costs: n/a	Other costs: 1,300.00 € (checkup)
<b>Total: 1,300.00 €</b>	<b>Total: 4,500.00 €</b>	<b>Total: 2,825.00 €</b>

In order to reach a green certificate the aim of a hotel's business is to reduce the operating figures. This can only be achieved through immediate actions. As Viabono presumes a cost reduction of 30 % better than the average key figures they have calculated, the hotel need to show their cost reduction within the field of: water, waste, energy / climate, groceries. Within the immediate actions for the selected hotel a substantial amount of water savings per guest can be reached by adopting only the recommended methods of new shower heads. By adopting the suggested method within the field of waste management, a reduction of up to 75 % volume can be reached, which accounts to further cost savings. Furthermore the field of energy and climate, the selected hotel can also feature a decrease of electricity costs and consumption due to the recommendation of immediate actions. Due to missing information within the field of groceries, the author can not state out if the hotel is able reach the limited 30 % better.

However the three important parts of the Viabono certification can be reached through the development of the immediate actions. Therefore an application and participation of the green certificate is reasonable and can further support the social responsibility of the hotel's business to the community.

## 6 Conclusion

In conclusion the thesis results from the issues of energy and resource savings within the hotel industry. The ever-growing energy demands as well as the effects from globalisation and the increase of the travel industry lead the hospitality industry to one of the most resource intensive branches in the world. This is causing to great environmental problems and scarcity of resources. As businesses are forced to act sustainable, because of the people's growing awareness of corporate social responsibility as well as environmental protection. Sustainable steps need to be adapted as well as energy saving modules should be part of every business. However these steps are often associated with high investments as well as time intensive methods, hoteliers often do not take these into consideration. The fact is, that energy costs account up to around 6-8 % of the total turnover, which definitely can be reduced.

To prove this statement the author analysed an individually selected hotel with high energy consumption. After an interview with the hotel manager as well as receiving indicators of the energy costs of the hotel, the given figures have been identified and quantified. The current state analysis shows the composition and extend of the costs. The author identified the cost of electricity as significantly high. Consequently the thesis shows a calculation for two different types of alternate energy technologies. In order to improve the electricity costs, the thesis shows a calculation for investing in a photovoltaic system. In addition the high gas costs of the hotel need to be taken into consideration as well, therefore a second case is calculated for an investment in a combined heat and power plant.

Both case studies are proved to be economical. However when investing in a photovoltaic system, total energy costs cannot be covered. Moreover in terms of political decisions and the ever decreasing founding for photovoltaic systems, an investment is not recommended. Generally case two proved to be more recommendable, as the CHP plant has a very low payback time as well as already a turnover of almost 70,000.00 € after the first year. Even though the high investment costs need to be taken into account the plant shows a good outcome after a short time period and is therefore highly recommended with a total energy and resource saving of 18,8 % in the third year. With regard to the relatively low self supply of 23 % electricity and 13 % gas, further research can be made through extending the CHP plant and therefore achieving higher percentage for the self consumption.

The subsequent steps about immediate actions in the field of energy saving support, informs the reader about further emergency measures. Calculations approve their low investment costs and short payback period. Furthermore they are simple and quick applicable and convince of

high potency for hotels. This increase in efficiency is supported in the last step by the recommendation of a green certificate. As environmental practices will soon become essential for all hotels in the world, it is important to take these “green”-steps in advance. This will create a lot of benefits for the business in future. Therefore the thesis recommends to apply for a green certificate in order to show this sustainable behaviour to the public, which will also appeal to new customer segments in the future.

In conclusion the author recommends, with regards to the financial and economical situation of the hospitality business, that it is possible to make some minor investments with great outcomes. However if the financial situation of the hotelier is limited, they are able to focus on the second step of the research, the adaption of immediate action with a combination of a green certificate, which further supports the hotel’s visibility and therefore can be part of a good sustainable development.

As the thesis is not commissioned by the hotel and was affected through time limitation, further research can be achieved by focusing on the implementation of the recommended modules in practice. Therefore interest in this topic can be useful by continue on this topic and analyse the implementation process in a hotel as well as the positive aspects in a long term of the actions, and furthermore the negative effects which arise from technological complexity.

Nevertheless the thesis does not refer to a trend which is predicted to further influence the business of hospitality industry in future: The development of wireless energy management technologies. However this can be elaborated in future research as technologies are developed further. Through advances in wireless technology, data collection as well as automation energy management systems contribute to enhanced and smarter hotels. (white paper hospitality 2013) The system contains of a set of components, which cooperate and communicate with one another as part of the overall system in order to reduce hotel energy consumption. (green star savings 2013, 3.)

Furthermore through an already existing Internet Protocol (IP) structure of a hotels business, hoteliers as well as staff members are able to control, monitor and configure the property in order to increase energy efficiency and moreover improve the overall guest experience. In conclusion by comparing the energy management system with traditional wired solutions, the wireless technology offers more flexibility and convenience in hotel automation and can therefore be analysed also within future research. (white paper hospitality 2013, 4.)

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Appendix 1: Interview with the hotel manager (name not mentioned) in the selected hotel.  
(01.04.2013)

**1. What can you report about the energy supply of the hotel?**

Hotel manager: We are purchasing electricity completely off the grid, while we ensure our heat supply via gas.

**2. What equipment is used to convert gas into heat?**

Hotel manager: We do this in different ways. In the main house we work with a condensing boiler and in the villas with a boiler as well as a condensing boiler. Besides the main house and the villas have a hot water tank.

**3. Accordingly, municipal energy supplier does not supply the hotel with district heating?**

Hotel manager: That is right. We have no contract about district heat, because we are not supplied with district heat tubes.

**4. The hotel is also not served by any renewable energies such as photovoltaic or solar thermal energy?**

Hotel manager: No. Due to the high investment costs, we didn't consider this. But we the hotel offers a rooftop space of around 60 to 70 square meters.

**5. After I was able to make me a picture of the current situation of supply, I would like to know what steps you have already taken to reduce the consumption of resources and energy. Do you use energy-saving light bulbs, power strips or flowreducer in the guest rooms?**

Hotel manager: We have replaced the bulbs in the rooms of our guests and the public sector this year and expect the positive outcome of this until next year. The current supply of the hotel rooms is controlled by the key card, so that the electricity is only usable if the guest is in the room. Flow reducer we only installed in the taps, but not yet on the shower head.

**6. Are you planning to replace the shower heads?**

Hotel manager: Yes, we would like to. But the investment cost for almost 580 rooms are very high.

**7. You said that the key cards allow the power consumption only if the guest in the room. How is the heating controlled in the hotel room?**

Hotel manager: We use the opportunity of the night temperature. If the room is not occupied, it is not continuously heated. We reduce the temperature down to around 17 degrees.

**8. In addition to the consumption in the hotel rooms the behaviour of the employees is mainly important to a reduced energy consumption. Participate the employees in trainings?**

Hotel manager: Currently, no. We would welcome such measures in future.

**9. I would now like to talk to you about ratios or consumption levels. Does the hotel have an energy certificate?**

Hotel manager: No.

**10. Could you let me know about the energy data of the year 2012?**

Hotel manager:

Statistics	2012
kWh/a Electricity	3,587,710
kWh/a Electricity per Room	42
kWh/a Gas	5,301,580
kWh/a Gas per Room	62
m <sup>3</sup> Water	33,902
Ltr. Water per Guest	244

**11. So in total you only know the key figures of water consumption per guest in liters, the consumption of electricity and gas per room.**

Hotel manager: That's right. We did not use more metrics.

## Appendix 2: Total energy consumption and assumptions

**Statistics 2012**

kWh Electricity	3.587.710,00
kWh Electricity per Room	42
kWh Gas	5.301.580,00
kWh Gas per Room	62
m <sup>3</sup> Water	33.902,00
ltr. Water per Guest	244

**Assumptions**

	price	unit
Price Electricity in €	0,14	€/kWh
Price Gas in €	0,07	€/kWh
Price Water in €	3	€/m <sup>3</sup>

		unit
Business days per year	365	days
occupancy rate	44	%
rooms	576	room

Comments
Price for households in 2013 about 0,25€/kWh, for industry user about 0,10 €/kWh Price for households is about 0,07 €/kWh in 2013 in Germany, there is no discount for large-scale consumer Price for households is about 4 €/m <sup>3</sup> , Assumption for lage-scale consumer 3€/m <sup>3</sup>

## Appendix 3: Total energy and resources costs 2012 and costs per room night

total costs for energy in 2012	
<b>Electricity</b>	502.279,40 €
<b>Water</b>	101.706,00 €
<b>Gas</b>	371.110,60 €
<b>total</b>	<b>975.096,00 €</b>

costs for one roomnight						
<b>Electricity</b>	42 kWh per Room	0,115 kWh per room per day	considering the occupancy	0,262 kWh per night	costs per night for a guest	0,04 €
<b>Water</b>	244 ltr. Per Guest				costs per night for a guest	0,73 €
<b>Gas</b>	62 kWh Gas per Room	0,170 kWh per room per day	considering the occupancy	0,386 kWh per night	costs per night for a guest	0,02 €
					<b>costs per night for a guest</b>	<b>0,79 €</b>

Table including formulas:

costs for one roomnight									
<b>Electricity</b>	42 kWh per Room	=42/365	kWh per room per day	considering the occupancy	=H3/0,44	kWh per night	costs per night for a guest	=M3*0,14	€
<b>Water</b>	244 ltr. Per Guest						costs per night for a guest	=0,244*3	€
<b>Gas</b>	62 kWh Gas per Room	=62/365	kWh per room per day	considering the occupancy	=0,17/0,44	kWh per night	costs per night for a guest	=0,309*0,07	€
							<b>costs per night for a guest</b>	<b>=SUMME(R3:R5)</b>	<b>€</b>

Appendix 4: Calculation – Case one: Photovoltaic

Electricity for all room in 2012	24192,00 kWh	<b>target: substitutions of room electricity costs</b>
costs for all rooms in 2012	3386,88 €	
partial costs for room concerning Electricity	0,67%	

Case 1 - photovoltaics		
<b>Assumptions case 1</b> photovoltaics 60m2 costs per qm <sup>2</sup> 500 €/m <sup>2</sup> efficiency factor 22% orientation south solar constant 1000 kWh/m <sup>2</sup> /a funding 0,25 €/kWh (installation 2012) time of funding 20 years	Solar Fracktion 55% Adjustment 3648	
production of electricity by plant 13.200,00 kWh/a	production in 20 years <u>264.000,00 kWh/a</u>	capital costs <u>30.000,00 €</u>
Funding per year 3300 €	Funding in 20 years <u>66.000,00 €</u>	
saved Electricity 1848 €	saved electricity in 20 years <u>36.960,00 €</u>	30.777,60 € <u>Further purchasing costs</u>
Calculation for 1 year 261,12 €	Calculation for 20 years <u>5.222,40 €</u>	

Table including formulas:

Electricity for all room in 2012	=A2*576	kWh
costs for all rooms in 2012	=C2*0,14	€
partial costs for room concerning Electricity	=C3/Data for Consumption in 2012!B3	

Case 1 - photovoltaics		
<b>Assumptions case 1</b> photovoltaics 60m2 costs per qm <sup>2</sup> 500 €/m <sup>2</sup> efficiency factor 0,22 orientation south solar constant 1000 kWh/m <sup>2</sup> /a funding 0,25 €/kWh (installation 2012) time of funding 20 years	Solar Fracktion =A23/C2 Adjustment =C3+A33	
production of electricity by plant =60*0,22*1000 kWh/a	production in 20 years <u>=A23*20 kWh/a</u>	capital costs <u>=60*500 €</u>
Funding per year =0,25*A23 €	Funding in 20 years <u>=20*A26 €</u>	
saved Electricity =A23*Consumption & Assumptions!B14 €	saved electricity in 20 years <u>=A29*20 €</u>	<u>=(C2-A23)*0,14*20</u> <u>Further purchasing costs</u>
Calculation for 1 year =E33/20 €	Calculation for 20 years <u>=E26-H23-H28 €</u>	

Appendix 5: Calculation – Case two: Combined Heat and Power plant (CHP)

<b>Statistic of 2012 (needs)</b>	
kWh Electricity	3.587.710,00 kWh
kWh Gas	5.301.580,00 kWh
<b>Assumption</b>	
Plant CHP	400 kW
Hours of operation	8.760 h/a
efficiency factor (electrical)	35 %
efficiency factor (thermal)	60 %
<b>Production of energy within a year</b>	
3.504.000,00 kwh/a	
<b>2/3 electrical usage</b>	<b>1/3 thermal usage</b>
2.335.766,40	1.167.988,32 kWh
<b>electrical efficiency factor in kWh</b>	<b>thermal efficiency factor in kWh</b>
817.518,24	700.792,99
<b>capital costs</b>	
Assumption	each kW will cost about 400 €
	<u>160.000,00 €</u>
<b>calculation of energy costs (electricity, water, gas)</b>	
1 year	<u>1.020.639,03 €</u>
2 year	<u>860.639,03 €</u>
3 year	<u>860.639,03 €</u>
<b>costs of energy bevor using a CHP plant</b>	
1 year	<u>975.096,00 €</u>
2 year	<u>975.096,00 €</u>
3 year	<u>975.096,00 €</u>
1 year	<u>-45.543,03 €</u> - 45.543,03 €
2 year	<u>68.913,94 €</u> 114.456,97 €
3 year	<u>183.370,91 €</u> 114.456,97 €

Table with formulas:

<b>Statistic of 2012 (needs)</b>	
kWh Electricity	3587710 kWh
kWh Gas	5301580 kWh
<b>Assumption</b>	
Plant CHP	400 kW
Hours of operation	8760 h/a
efficiency factor (electrical)	35 %
efficiency factor (thermal)	60 %
<b>Production of energy within a year</b>	
=C10*C11 kwh/a	
<b>2/3 electrical usage</b>	<b>1/3 thermal usage</b>
=0,6666*B17	=0,33333*B17 kWh
<b>electrical efficiency factor in kWh</b>	<b>thermal efficiency factor in kWh</b>
=0,35*B21	=0,6*C21
<b>capital costs</b>	
Assumption	each kW will cost about 400 €
	<u>=400*C10 €</u>
<b>calculation of energy costs (electricity, water, gas)</b>	
1 year	=Data for Consumption in 2012! €
2 year	=Data for Consumption in 2012! €
3 year	=C35 €
<b>costs of energy bevor using a CHP plant</b>	
1 year	=Data for Consumption €
2 year	=I34 €
3 year	=I35 €
=I34-C €	=I34-C34 =H40/975000
=F39+ €	=I35-C35
=F40+ €	=I36-C36

Appendix 6: Manufacturing costs electricity – by using a Combined Heat and Power plant  
(bhkw-jetzt 2013)

