

ENVIRONMENTAL SUSTAINABILITY IN NORTH EUROPEAN HOTEL BUSINESS

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Abstract <p>Environmental issues are becoming increasingly important in modern day society, and environmental sustainability is one issue to be considered in hotel business. Global temperatures have been increasing during the recent years and the emissions of carbon dioxide have a big role in the issue. Hotels can affect the situation for their part by trying to run their businesses in an environmentally sustainable fashion. Concentrating on environmental issues can also result in financial savings in the long-term. Investments in more environmentally sustainable solutions and techniques can result in improved energy-efficiency and savings in the operating expenses.</p> <p>This thesis concentrates on finding current and upcoming solutions and techniques to improve environmental sustainability in the hotel business. The solutions presented can provide big environmental benefits, but at the same time, might require substantial investments. The areas of specific importance include lighting, laundry handling, water efficiency, heating and air conditioning and electricity. The research target is limited to Northern Europe, which guides the research objective especially in the heating and air conditioning section.</p> <p>The Internet was used as the main information source to find relevant solutions and techniques to be utilized in hotels. Literature sources were used for background information and to deepen the topic. Environmental management standards were used as a basis for the research. Hotels can utilize them to achieve more environmentally sustainable operations. They can also be used as marketing tools to attract guests interested in environmental issues. The solutions presented vary in the amount of investment needed, but even the smallest establishments are able to utilize some of the solutions with very little investment required.</p>		
Keywords Environmental sustainability, accommodation, tourism, hotel business, environmental management		
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Tiivistelmä <p>Ympäristöasiat ovat korostumassa enenevässä määrin nyky-yhteiskunnassa ja ekologinen kestävyys on yksi huomioonotettava asia hotelliliiketoiminnassa. Lämpötilat ovat olleet maailmanlaajuisesti nousussa viimeisinä vuosina ja suurena syynä tähän on hiilidioksidipäästöjen pääsy ilmakehään. Hotellit voivat omalta osaltaan vaikuttaa tilanteeseen pyrkimällä toimimaan ekologisesti kestäväällä tavalla. Ympäristöasioihin keskittymisestä voi seurata pitkällä tähtäimellä myös taloudellisia hyötyjä. Investoinnit ekologisesti kestäviin ratkaisuihin ja tekniikoihin voivat parantaa energiatehokkuutta, sekä vähentää käyttökustannuksia.</p> <p>Tämä opinnäytetyö keskittyy löytämään nykyisiä ja tulevia ratkaisuja sekä tekniikoita, joiden avulla hotelliliiketoiminnan ekologista kestävyttä voidaan parantaa. Esitetyt ratkaisut voivat taata suuria ympäristöhyötyjä, mutta samaan aikaan saattavat vaatia suuria investointeja toteutuakseen. Aihealueisiin joihin keskitytään tarkemmin kuuluvat valaistus, pyykinkäsittely, vesitehokkuus, lämmitys ja ilmastointi, sekä sähkö. Tutkimuksen kohde on rajattu Pohjois-Eurooppaan, mikä vaikuttaa tutkimustähtäimeen erityisesti lämmityksen ja ilmastoinnin osalta.</p> <p>Internet toimi pääasiallisena tiedonlähteenä etsittäessä asiaankuuluvia ratkaisuja ja tekniikoita hyödynnettäviksi hotelleissa. Kirjallisuuslähteitä käytettiin taustatiedon hankkimiseen ja aiheen syventämiseen. Ympäristöasioiden hallintaan käytettäviä standardeja käytettiin tutkimuksen perustana ja hotellit voivat käyttää näitä saavuttaakseen ekologisesti kestävämpiä toimintatapoja. Standardit toimivat myös markkinointityökaluna ja hotellit voivat käyttää näitä houkutelakseen ympäristöasioista kiinnostuneita vieraita. Esitetyt ratkaisuihin tarvittavat investoinnit vaihtelevat, mutta myös pienimmät yritykset pystyvät hyödyntämään osaa niistä hyvin pienillä tarvittavilla investoinneilla.</p>		
Avainsanat (asiasanat) Ekologinen kestävyys, majoitus, matkailu, hotelliliiketoiminta, ympäristöasioiden hallinta		
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1 INTRODUCTION

Environmental sustainability in the North European hotel business was chosen as the topic because it is very current and interesting to the author. The main idea of the thesis is to research environmental sustainability from a viewpoint of an individual hotel and to find practical solutions and techniques to help to improve hotels' environmental sustainability. One reason behind the topic is the increasing environmental awareness caused by global warming and the reactions it causes in people, politics and companies. The hotel business is one section where global warming affects decision making on the future development of an individual hotel.

The main research target of the thesis is to find and present existing and new solutions and techniques to be utilized in hotels in order to improve their environmental sustainability. The dialogue with hotel Yöpuu in Jyväskylä is one factor contributing to which areas to concentrate more specifically. The more specific areas to be researched include waste management, laundry handling, lighting, water adjustment, heating, air conditioning and electricity. The internet is used as the main information source as the most up to date information on latest trends and techniques can be found on the internet.

The topic is defined to cover the hotel side of the business only, excluding restaurant operations. Geographically, the topic is limited to Northern Europe and especially Finland. As the topic is limited to Finland and Northern Europe, the official Nordic Ecolabel the Swan used in Scandinavia is used as a basis to give guidelines on which areas to concentrate on more specifically. However, the solutions used in the other parts of the world that can be utilized in Northern Europe will also be presented. Most of the techniques and solutions can also be applied to other facilities which aim to improve their environmental sustainability.

2 ENVIRONMENTAL SUSTAINABILITY

Sustainability and sustainable development as terms are widely used and can be interpreted in many different ways. In short United Nations' Brundtland Commission has defined sustainable development as finding ways and means to meet the needs of today, without compromising the ability of future generations to meet their needs. (United Nations, 1987) In addition to the environmental aspect, sustainability includes social and economic aspects. This thesis will concentrate on the environmental aspect of sustainability from the viewpoint of an individual hotel. However, social and economic dimensions will also be touched as these dimensions closely interact with the environmental sustainability as can be seen on figure 1. (The World Conservation Union 2006) The economic aspect will be important for the smaller establishments as they might simply not afford to use the most environmentally sustainable options available for them.

Environmental sustainability alone can be defined as systemic conditions where human actions will not disturb planetary cycles more than planetary resilience allows and at the same time do not impoverish the natural capital that has to be shared with future generations. (Vezzoli, Manzini, 2007, 6) Another way to describe the environmental sustainability would be the ability to maintain qualities that are valued in the physical environment. The qualities to be maintained can include human life, living conditions, renewable resources, functioning society and quality of life. (The State of Victoria 2010)



FIGURE 1. Relations between environmental, social and economic aspects of sustainability (Architecture Student Chronicles 2009)

Massive population growth and the rising standard of living in developing areas are setting new challenges for the environmental sustainability in tourism and services industry. Increased standard of living in the developing areas will increase tourism and leisure travelling, putting more pressure on the environment. World Tourism Organization predicts international tourist arrivals in Europe to increase from 527.3 million in 2010 to 717.0 million in 2020. (World Tourism Organization 2000)

Increase of around 36% in the European tourist arrivals naturally sees hotels receiving more guests and therefore creates more pressure on the environment. Table 1 shows the amount of guest arrivals and the amount guest nights in Finnish hotel to have an increasing trend during the past 15 years. Guest arrivals have increased around 40% and the amount of hotel nights stayed around 38% in 2010 when comparing to 1995. (Tilastokeskus 2011)

Year	Amount of arrivals		
	Overall	Finland	From abroad
1995	6 141 726	4 554 840	1 586 886
2000	7 002 414	5 267 036	1 735 378
2005	7 571 642	5 778 911	1 792 731
2010*	8 619 677	6 603 531	2 016 146

Year	Amount of hotel nights		
	Overall	Finland	From abroad
1995	11 102 493	8 189 727	2 912 766
2000	12 857 376	9 345 929	3 511 447
2005	13 741 712	9 956 365	3 785 347
2010*	15 303 921	11 101 377	4 202 544

*Preliminary information

TABLE 1. Guest arrivals and guest nights in Finnish hotels between 1995 and 2010. (Tilastokeskus 2011)

During the comparison period the world population has increased around 20% and the population growth is expected to continue, but with a slower growth rate. (U.S. Census Bureau 2010) This will set challenges for hotels to deal with the increased amount of tourist arrivals and guest nights occupied with environmentally sustainable fashion.

3 GLOBAL WARMING AND HOTEL BUSINESS

The recent discussion and data on global warming is one factor contributing to the increased awareness and popularity of environmentally sustainable solutions for individual homes and businesses. The situation is unlikely to change in the future, and environmental issues will be more and more important to various businesses, including the hotel business.

Carbon dioxide (CO₂) is the main greenhouse gas claimed to be responsible for global warming. During the past 200 years, the levels of carbon dioxide emitted into the atmosphere have been rising and the process has been accelerating even more during the past 50 years. (Houghton 2009, 13) Carbon dioxide is emitted from burning fossil fuels and thus hotel business is usually only indirectly responsible for increased CO₂ levels, through transport and other industrial processes emitting CO₂. Major part of carbon dioxide emissions are created through energy production, industrial processes and transport. (Maslin 2004, 11) One big contributor of CO₂ emissions closely tied to hotel business is travelling by airplane. Flying causes by far the biggest CO₂ emissions when comparing to trains and buses. (Planet Green 2009)

The data collected from over 30 centuries shows a significant increase in average temperatures in Finland as seen on figure 2. Predictions on how global warming will affect long-term temperatures vary, but in Finland the rise is predicted to be anywhere from 2 to 7 degree Centigrade over the next 70 years and around 1-3 degrees over the next ten years. The amount greenhouse gas emissions can be reduced is the main factor affecting the variation in the estimates. (Ilmasto.org 2011) Rising temperatures caused by global warming can make the hotels face situations where rooms will need to be cooled down more, thus creating more costs and more stress on the environment. Rising temperatures can also force budget establishments to installing air conditioning systems as they might have not seen them necessary when the climate was cooler.

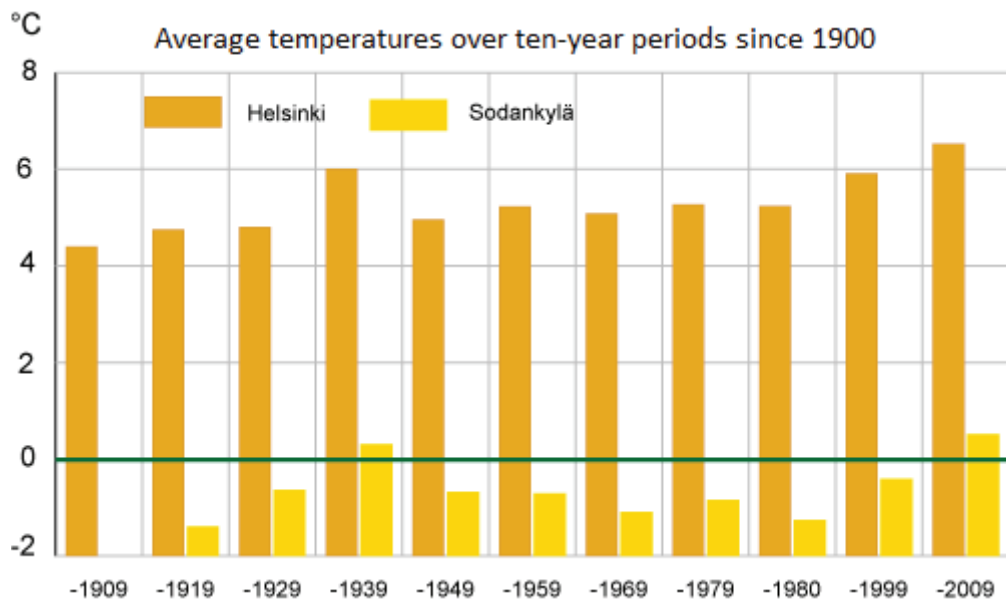


FIGURE 2. Average temperatures over ten-year periods in Helsinki and Sodankylä since 20th century. (Ilmatieteenlaitos 2010)

In Finland and other parts of the world affected by the Gulf Stream, global warming can also have a reverse effect on temperatures, causing them to drop. If the Gulf Stream were to stop completely, it is estimated that this could create average temperature drops of 4 to 6 degree Celsius over UK and Northwestern Europe. (Skywatch Media News and Entertainment 2010) Again, this can be seen as a challenge for hotels as the rooms will need to be heated up more during the winter, thus creating more costs and putting more stress on the environment.

4 ENVIROMENTAL MANAGEMENT STANDARDS

4.1 The Nordic Ecolabel

In the Nordic countries the Swan label is popular and unified certificate measuring sustainability across different products and services including the hotel business. At the moment, the Swan label is voluntary and can be applied in Finland by sending an application form to the Finnish Standards Association SFS. In order to acquire the Swan label a hotel must meet a set limit value for energy consumption and meet at least one limit value for water consumption, chemical products or waste management. The label also requires the usage of renewable energy sources and has a checklist of mandatory and more specific requirements. (Ympäristömerkintä 2010)

As the Swan label is currently voluntary, it can not only help a hotel with its environmental goals, but also act as a powerful marketing tool to help a hotel differentiate from its competitors. The Swan label website mentions Radisson Blu to be the first hotel chain in Finland to achieve the Swan label for all of its hotels and that it has started to widely utilize the Swan label in its marketing and communications. Hotels belonging to Scandic, Hilton, Best Western and Sokos chains also hold the Swan label in Finland. As of 2011, only three non-chain hotels are holding the Swan label, these include Hotel GreenStar in Joensuu, Hotel Krapu in Tuusula and The Putikko Estate in Punkaharju. The first application for the label costs 2000 euros, and the label has yearly fees based on hotel revenue. (Ympäristömerkintä 2011) These fees can be seen as problematic to smaller establishments as consumers might not know the reasons behind a hotel not having the Swan label. This can give bigger chain hotels competitive advantage for their marketing efforts. Fees paired with possible new investments required for greener hotel will make it harder for smaller hotels to receive the label. However the Swan label has 50% discount in application fee for establishments employing less than 10 employees. Out of the three non-chain hotels holding the Swan label, Hotel Krapu and The Putikko Estate mention the label on their websites, while Hotel GreenStar website has an entire section dedicated to environmental issues.

4.2 ISO 14001 and EMAS

Other environmental management standards that can be used in Scandinavia include the ISO 14001 standard and EMAS initiative. ISO 14001 is an international standard, which can be achieved by meeting certain criteria and by conducting an audit held by an external and accredited auditor. The system has strict criteria and is suitable for big establishments looking for a long-term standard. EMAS system can be seen as even a stricter one, and it requires a public environmental review and following of environmental legislation. (Travelcon 2011) Choice Hotels is an example of a big organization applying for ISO 14001. At the same time, it is the first Scandinavian hotel chain to have received ISO 14001 standard. The company is aiming to measure its carbon footprint for its entire operations and will use the ISO certificate to improve and control its environmental impact. (Det Norske Veritas 2009) On the other hand, individual establishments can also apply for ISO 14001 and Bucuti Beach Resort in Aruba Island is one example of a single establishment holding and maintaining ISO 14001 standard. According to Bucuti Beach resort owner, Ewald Biemans, the hotels' guests are also aware of the environmental benefits that can be achieved by using ISO 14001 standardized hotels. Biemans comments the large initial investment for the program to take up to 6 to 18 months to be paid back, but the impact on conservation to be the most important aspect of the investment. (Green Lodging News 2011)

5 ENVIRONMENTALLY SUSTAINABLE HOTEL

5.1 Lighting

Lighting is among the first things guests will notice when stepping into a hotel, either consciously or subconsciously. It also plays a big role when considering energy savings and the optimal solution would be to achieve energy efficient, but functional lighting. Winters in Northern Europe provide very little natural daylight, so hotels must rely heavily on artificial lighting for the darker periods of the year. In the summer time, big windows equipped with shades or blinds can come handy. This way hotel guests can get well-lit rooms with the ability to control the light levels.

The Swan label application has checklists including more specific requirements for hotels' lighting. The checklist can be used as a good starting point when designing energy efficient and environmentally sustainable lighting solutions. For outdoor lighting, the list specifies that the lighting must have a timer or on-demand control and that low-energy lamps must be used if the lighting is on during night time. Overall, extra points are awarded for the usage of low-energy lamps or LED spotlights in the building. Newly purchased lights need to be ecolabelled or alternatively are required to have a lifetime of 10 000 hours for single socket lamps/fluorescent tubes or 20 000 hours for double socket models. Inside the rooms, presence controlled lighting gives extra points for the Swan label application. (Nordic Ecolabelling 2008)

Ilkka Pekanheimo has specified some common lighting tips for individual homes in his book. (2009, 3) These can also be applied into hotel business as individual homes have the same aim of energy savings and functional lighting. Pekanheimo urges people to try daylight lighting solutions and possibly to switch light bulbs to full spectrum daylight models. However, not all daylight light bulbs in the market provide full spectrum. Traditional incandescent light bulbs and halogen lights should be avoided due to their high electricity consumption. In addition, newly purchased lamps should be able to fit daylight bulbs and they should include anti-flicker electronics. Outdoor lighting should not have electronic attachments, as they might cause problems during cold weather.

When choosing the light bulbs, daylight lighting should be considered as one alternative. Daylight provides real colors and it has physical benefits for human beings. Almost everyone who has tried artificial daylight sees it as beneficial; however homes are still often equipped with lighting providing warm and yellow colors. The best artificial daylight bulbs can provide similar outcome as real daylight and flickering can be removed with modern lighting electronics. (Pekanheimo 2009, 5)

European Union is acting on banning traditional incandescent light bulbs in favor of more energy-efficient options. The old incandescent light bulbs will be phased out by the end of 2012 when they are replaced by more energy efficient alternatives in the market. (European Union 2009) Currently, the most popular options to replace incandescent light bulbs are compact fluorescent lamps (CFL) and LED lights. Compact fluorescent lights originate from larger fluorescent tubes, which are common in bigger spaces such as hotel lobbies. Figure 3 shows how different lighting alternatives typically look like. Daylight models can be found with both CFL and LED techniques.



FIGURE 3. LED, incandescent and CFL light bulbs. (Electronic Recyclers International 2011)

At the moment LED lights are still held back by higher prices and worse energy efficiency than CFL lights, but are promised to provide longer lifetime. However, when considering environmental sustainability, CFL light bulbs still contain small amounts of mercury and are therefore classified as hazardous waste, which has to be recycled properly. (Group C Media 2010)

When making decision between CFL and LED lights, the economical aspect of sustainability comes into play as the prices of LED lights are still relatively high comparing to CFL technique. Figure 4 shows that LED lights' energy efficiency is still dragging behind fluorescent lighting. Chart also shows the ratio between power of light and price for LED and fluorescent lights.

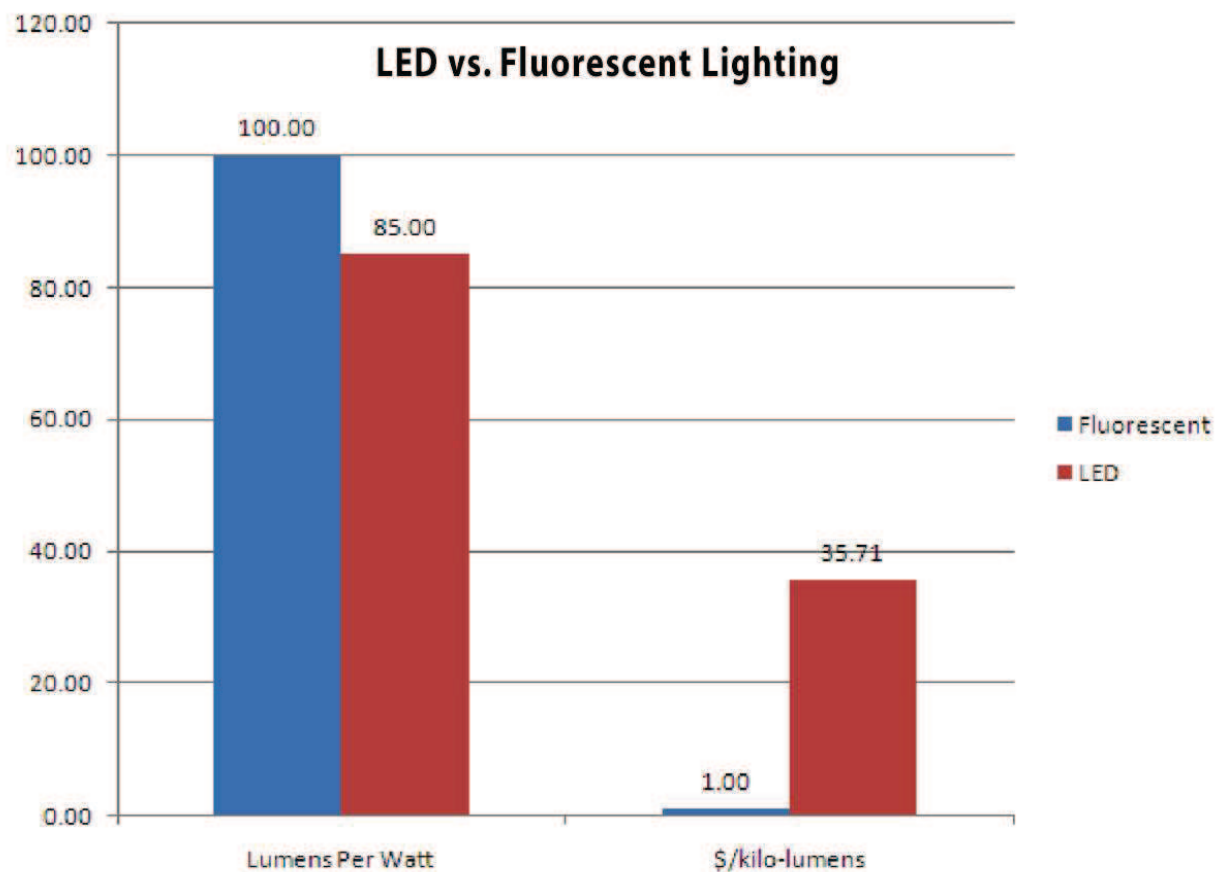


FIGURE 4. LED vs. fluorescent lighting efficiency. (Group C Media 2010)

When comparing the current market situation for traditional E27 socket bulbs at Claes Ohlson website, a LED light bulb with the power of light of 470 lumens, similar to that of traditional 40 watt incandescent light bulb, can be purchased for 19,95 euros. Same website offers 650 lumen CFL light bulb for 2,95 euros. Website promises

lifetime of 15 000 hours for the LED light and 10 000 hours for the CFL light. (Claes Ohlson 2011) When comparing the figures, it is obvious that in the current situation CFL lights provide more cost effective option out of the two. With proper recycling CFL lights are currently better alternative for hotels with traditional E27 sockets. On the other hand, Pekanheimo (2009, 15) predicts that the prices of LED lights will come down in the future and paired with improved energy efficiency, they might be the best choice in the future.

Presence controlled lights are one way to save energy inside hotel rooms. They will make sure that the lights are only used when guests are actually inside the rooms. This can be implemented with motion sensors or with keycard slots, where the guests have to insert their keycards in order to use the lights.

When pairing motion presence control with the energy saving CFL lights, there are some features in the new technology that should be taken into account. One eye-catching feature of some of the CFL light bulbs is their slow starting up time, while other CFL models turn on instantly after switching on lights. Instant starting up comes with a price and models utilizing this technique last shorter, especially when turned on and off regularly. Figure 5 shows a comparison between lamp life and starting cycle for instantly starting (instant start) and slowly starting (rapid start) models of the same lamp. (Madison Gas and Electric Company 2011)

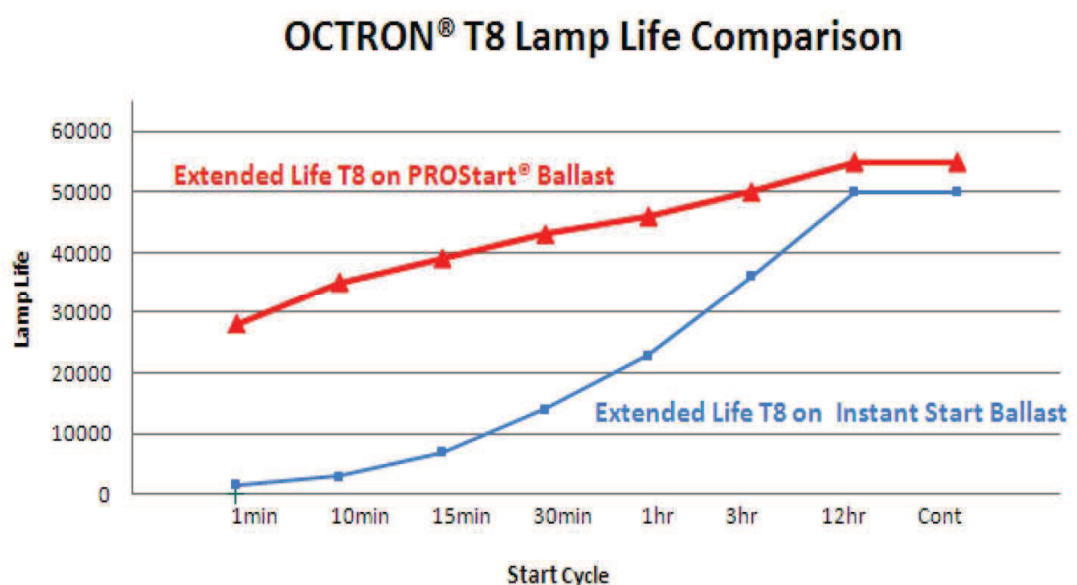


FIGURE 5. Comparison between lamp life and start cycle. (Group C Media 2010)

The starting cycles should be considered when deciding which type of model to choose for hotel use. The guest behavior in the hotel rooms can be unpredictable, and it can never be said for sure how long start cycle the lamps will have. Nevertheless, the rapid start models would provide the longest lifetime regardless of how often the lights are turned on and off. However, the instant start models are more functional as the guests do not have to wait for them to start-up. Overall, the decision is a matter of preference and it is up to an individual hotel to decide which kinds of lamps to switch for the hotel rooms.

With the extended lifetime of the new energy saving lamps, installation of presence control outside the hotel rooms should be carefully considered as the lamp lifetime takes a drastic downturn with high starting cycle activity. Having the lights constantly turned on could guarantee up to 50000 hours of use, while having them on presence control on regularly accessed places could bring the lifetime down significantly, creating more costs due to the shorter light bulb switching intervals. When considering regularly accessed places such as corridors, more durable but slowly starting rapid start models might not be the best choice as the lights are needed to be turned on instantly as people are only passing by.

LED lights are predicted to be the choice of the future, but currently there are issues which limit the usage of the LED lights in commercial and hotel usage. When thinking purely from an environmental point of view and when money is not an object, the LED lights come up as winners. LED lights contain no mercury, are easily recyclable, create less heat and have longer lifetime than CFL lights. (Greenzer 2009) On the other hand, Pekanheimo (2009, 40) points out that drawbacks of the LED lights include worse power of light than the CFL lights, and that they don't spread the light the similar way than the traditional incandescent and the energy saving CFL lights do. This will limit the usage of the LED lights for spotlight purposes and for smaller spaces. One possible destination would be the bathroom, where the lights are not necessarily needed to spread for the whole room. Other uses could be individual reading lights for the hotel beds.

Due to their narrower lights stream, one way to install the LED lights in bigger spaces is to install several LED lights in the ceiling of the room. Pekanheimo (2009, 10) states that this type of installation is very common, but not recommended. Several

LED lights in the ceiling of the room require special installation and consume relatively much energy comparing to the power of light they provide. Despite of the downsides, LED lights are already used in the hotel business. Newly built Levi Hotel Panorama has installed several LED lights in the ceiling of their corridors and hallways. (Easy Led Oy 2007) This requires multiple individual LED lights to be placed side by side in the ceiling in order to provide efficient lighting with the narrow light streams they provide. Another possible destination for the LED lights would be the exit signs and other lights which are always on, but don't require big lighting power.

5.2 Waste management

Hotels with restaurants naturally generate more waste than hotels without them. As this thesis concentrates more on the hotel side of the business, restaurant functions and waste created through them can be overlooked. The waste created purely by the hotel functions include package materials, papers, waste created by hotel guests, furniture and other items inside the hotel rooms. A case study on waste reduction conducted by Solana Recyclers has investigated the waste created by hotel guests more closely. Paper (35%), plastics (22%) and organics (17%) were the top three waste categories that were found in hotel guests' trash bins. (Solana Recyclers 1999) Items inside the hotel rooms, such as beds, mattresses, carpets, general furniture, televisions and other electronic devices can create waste when renovating the rooms.

When aiming for more sustainable and environmentally sustainable waste management, the Swan label application form can be used as background information on which areas to concentrate on. The Swan label specifies that class A establishment must not create more than 1,35 kg of waste per guest night, class B not more than 0,9 kg and class C not more than 0,45 kg. The application gives extra points for the usage of shampoo and soap dispensers in the bathrooms. These will help to reduce waste as they can be refilled from bigger containers, thus reducing package material waste from the empty shampoo and soap bottles. Points are also given for reusable glasses, mugs and drink containers. Bathrooms without disposable items and with waste paper bins also give extra points. (Nordic Ecolabelling 2008)

For recycling and waste sorting the application gives a set of mandatory requirements. These include sorting and disposing in the best possible way for the following items: paints, solvents, waste oil, batteries, lights containing heavy metals and electronic waste. The waste must also be sorted into minimum of four fractions and more fractions will give extra points. Points are also awarded if at least three suppliers supply goods in returnable packages at least twice a month. For organic waste points are given, if the organic waste is composted, organically rotted or used for biogas. (Nordic Ecolabelling 2008)

When purchasing goods, several choices can be made which can help to reduce the amount of waste an individual hotel creates. Buying products in bigger packages and quantities will help to reduce the waste created from the empty packaging materials. This will also help to reduce the cargo traffic and therefore help to reduce the emissions created from the traffic. Problem with buying in big quantities might be the storage space, as hotels located in downtown area might have limited storage space available for them. Smaller establishments might also prefer smaller quantities for economic reasons. Plastic as a package material should be avoided as it can be difficult to sort and recycle due to the amount of different types of plastics in circulation. (Kurtelius 2001, 59) When choosing the products and supplies needed in hotels, more long-lasting versions will naturally take more time to turn into waste. Purchasing products and supplies that are ecolabelled and are made from recycled materials might not help to reduce the waste generation, but overall they can have less impact on environment than non-ecolabelled versions of the same products. The Swan label application specifies more closely that 90% of the newly purchased tissue products must be eco-labelled. (Nordic Ecolabelling 2008) Several different battery models are also available in rechargeable versions and switching regular batteries for the rechargeable models would reduce the amount of empty batteries needed to be recycled.

As paper products are the biggest individual area of waste generated by the hotel guests, this can be taken into account with separate paper collection bins. The bins can be located inside the hotel rooms or alternatively in the common areas of the hotel. For hotels accommodation a lot of business guests, paper shredders could be useful and could again be located inside the rooms or in the common areas. The shredders would have two functions; they would increase hotel guests' security and privacy as

they could properly get rid of their unneeded documents, and using the shredders would also decrease the paper trash emptying cycle as the paper trash would fit in a smaller space when shredded. Again when considering installing paper shredders and paper collection bins the economical aspect of sustainability has to be considered. Installing the paper shredders in every single room can cost a lot of money and they might need to be serviced at regular intervals. Alternatively placing bigger paper collection bins or a bigger shredder in common areas could turn out to be inconvenient and cause the guests to start using their mixed trash bins inside their rooms for paper trash as well. One simple way for hotel staff to reduce their paper usage is to print papers on both sides when printing documents.

The two other items often found in hotel guests' trash include plastics and organic waste. The plastics can include plastic bottles and package material. The organic waste can include food remains for example. Sorting these individually inside the hotel rooms could prove to be too complicated for the hotel and the guests. However, there are solutions in the market for multi-purpose containers which can be used to collect the different types of trash generated by the hotel guests. Figure 6 shows an example of multi-purpose container collecting paper, organics, cans, bottles and general trash. This specific container is available in models with the capacity of around 91 liters (width 40cm, depth 40cm, height 76.2cm) or around 30 liters (width 40cm, depth 20cm, height 20cm). (Recycle Away, LLC 2011) The smaller model could prove to be enough for individual hotel room usage and would fit in a smaller space as well.



FIGURE 6. Example of multi-purpose recycling container. (Recycle Away, LLC 2011)

Alternative way to deal with the issue would be to have single waste bins inside the hotel rooms and to instruct the hotel room cleaners to sort out the trash left by hotel guests. Cleaners would then sort out the trash to the compost and hotel's bigger central recycling containers for plastics, paper and other trash. Hotel GreenStar in Joensuu has solved the recycling issue by having a recycling point for guests at the street level. (GreenStar 2011)

Upon renovating the hotel rooms, items such as beds, mattresses, carpets, furniture, televisions and other electronic devices might have to be replaced. These used items inside the hotel rooms can be recycled in various reuse centers, making sure that they don't end up in landfill sites. As an example, Helsinki Metropolitan Area Recycle Centre mentions to have the capacity to receive large amounts of cupboards, tables and class cabinets. (Pääkaupunkiseudun Kierrätyskeskus Oy 2010) When choosing the materials for the new furniture, wood can be used as an environmentally sustainable option. Wood is considered especially environmentally sustainable when it's transferred from close by and from forests which follow sustainable forestry principles. (Valtion ympäristöhallinto 2009) The Swan label especially discourages the use of halogenic plastics such as PVC and requires that they are not used in fittings

and fixtures in hotels. One hotel holding the Swan label, Hotel GreenStar in Joensuu, is utilizing furniture made entirely from wood. (Hotel GreenStar 2011)

Luxury hotel Rafayel in London is combining environmental sustainability with high-class accommodation. Rafayel has approached the waste reduction from several different angles in their purchasing decisions. The hotel has luxury beds made from recycled materials, which can be recycled again when renewing the beds. The hotel has also eliminated 500 000 kg of glass bottle deliveries over 5 years by switching bottled glass water into Vivreau bottling system. The system is used to create sparkling water in re-usable bottles in order to eliminate the water bottle deliveries and recycling. In addition to this, Hotel Rafayel follows non-plastic policy, where the consumables such as bathroom products come in refillable bottles and containers. (Hotel Rafayel 2011)

5.3 Laundry handling

Hotels' laundry handling is one contributor to the overall picture of an environmentally sustainable hotel. Laundry operations consume large amounts of water, electricity, steam, chemicals and generate waste water in the process. (Development Alternatives 2002) Nowadays more and more companies are starting to outsource their support functions, with laundry handling no exception to this. Cities of Kotka and Jyväskylä are following the trend and have made a decision to outsource their laundry handling to a company located in Estonia. (Taloussanommat 2011) This might be the most cost-effective solution in some cases, but it can be seen as the least environmentally sustainable option as the laundry needs to be transported back and forth between Estonia and Finland. Outsourcing can however be an environmentally sustainable option if the distance between the buyer and the supplier is not too long.

Sokos Hotel Vaakuna in Mikkeli is among the hotels who have decided to outsource their laundry handling operations. Hotel Vaakuna is using Rusanen Tekstiilipalvelut Oy as their partner for completely outsourcing their textile operations and laundry services. (Savon Voima 2010) Savon Voima yearly report (2010, 13) mentions Rusanen Tekstiilipalvelut Oy to have a laundromat based on the latest and

environmentally friendly techniques. It is utilizing steamless low-energy technology, reusing the washing water several times, making use of the lost heat generated by the machines and cleaning the waste water in-house. In addition to this, the company is using green energy to power their operations. Professional laundry companies such as Rusanen Tekstiilipalvelut Oy can concentrate on their core business and achieve more environmentally sustainable laundry handling than the hotels utilizing older techniques in-house. However, logistics can be a problem and transporting the laundry for long distances will also cause stress on the environment. In this case, Sokos Hotel Vaakuna is located in Mikkeli and Rusanen Tekstiilipalvelut Oy in Pieksämäki, around 77 kilometers from Mikkeli.

The Nordic Ecolabel specifies a set of requirements to the hotels applying for the Swan label for their cleaning and laundry handling operations. The laundry detergents must be 70% ecolabelled and non-ecolabelled detergents must meet a set of requirements specified separately. Extra points are given if Nordic Ecolabelled laundry is used for the bed linen and the towel cleaning. (Nordic Ecolabelling 2008)

When acting on improving the laundry handling's environmental sustainability, one option to consider is to try to cut down the actual amount of laundry created and needed to be washed. Solana Recyclers' case study on waste reduction is quoting survey results, where 87.2 percent of the hotel guests would appreciate the option to use towels and linens more than once in order to save water, energy, and laundering costs. (Solana Recyclers 1999) Same survey shows that the number of days guests would be comfortable with the same towels to be 2.58 days and with the same bed sheets 3.20 days. Hotels are nowadays increasingly aiming towards this type of optional housekeeping. USA Today reports how the Best Western chain is handling the issue:

“Best Western asks guests to specify their choice of housekeeping: no service, replace towels/empty trash/quick vacuum, or full clean. Guests can check their choice and specify the cleaning hour on a card hung on the door knob. Since the program began late last year, about 40% of guests chose no or limited cleaning, says Ron Pohl of Best Western.”

(ABC News 2010)

Luxury hotel Rafayel is informing their customers about the effects of laundry washing on the environment with a tag which can be placed on top of the bed. With

the tag in place the housekeepers will only make the bed, but not change the sheets. This way the hotel gives the guests information on environmental issues together with the possibility to choose for themselves whether or not to change the sheets. (Hotel Rafayel 2011) Some hotels have opted to go a step further and are offering discounts, vouchers or loyalty points for declining housekeeping. Figure 7 shows a hangtag from Westin Peachtree Plaza in Atlanta, which is offering 5 US dollars or 500 Starwood Preferred Guest points for declining the housekeeping service for a day. (Upgrade: Travel Better 2011)



FIGURE 7. Westin Peachtree Plaza hangtag for declining housekeeping. (Upgrade: Travel Better 2011)

Hotel chain easyHotel has taken another approach on how to cut down on housekeeping and laundry services. As an example EasyHotel Earl's Court in London is charging 10 pounds for the cleaning and linen change together with an additional

one pound for extra towels. In easyHotel's model, the housekeeping services have to be booked separately. (easyHotel 2011)

The hotels handling their laundry themselves have to consider what kind of equipment to use when aiming for environmentally sustainable laundry handling. One up and coming new technique is ozone based laundry handling, where the ozone is inserted in the laundry water for improved efficiency. The process offers various benefits when comparing to the conventional techniques. Washing systems based on ozone work on cold water, thus reducing hot water and energy usage. They also have a shorter wash cycles, use environmentally friendly chemicals and provide superior cleaning power comparing to traditional techniques. Linen life is also extended with the use of ozone based laundry handling. (Ozone Laundry Systems 2011)

Aramark's Denali National Park in Alaska, holding four hotels with 986 guest rooms, is among the establishments who have decided to opt for an ozone based laundry handling system. Aramark decided to install the ozone based laundry handling system in 2008 and has since noticed significant environmental benefits from the new system. Table 2 shows the significant savings made in both water and propane usage in 2008 when comparing to 2007. (Green Star 2010)

	2007	2008	Difference	Savings
Rooms Sold	100,647	101,906	1.25% increase	
Terry & Linen Used	1,050,850 lbs	1,112,255 lbs	5.84% increase	
Water Used	2,364,413 gallons	1,590,319 gallons	32.74% decrease	774,094 gallons
Propane Used	44,008 gallons	26,122 gallons	40.64% decrease	17,886 gallons

TABLE 2. Aramark's Denali National Park water and propane usage comparison. (Green Star 2010)

Propane is used for laundry dryers and the use of ozone based technique can help to reduce propane usage as the laundry will come out dryer after washing. Denali Park Resorts General Manager Craig Pester comments the drying time to have decreased by 50% due to the use of ozone based system. Pester also notes that the chemical consumption has decreased 33% and that the washed linen come up as softer and in better quality. (Green Star 2010) Based on these figures, installing an ozone based laundry handling systems would offer impressive results from the environmental point of view. Green Star report (Green Star 2010, 2), states that a 200 to 300 room hotel

would recover the initial investment for the equipment in one year. Naturally the situation is different for smaller establishments, but when thinking about environmental sustainability, the solutions based on ozone technology are a sure way to achieve better results.

Apple Farm Inn and Suites in California are another establishment showing interest in the new type of ozone laundry handling systems. Ozone equipment supplier ClearWater Tech, LLC has conducted a case study on Apple Farm Inn and Suites' laundry handling. Traditional laundry handling methods were used for one month and the ozone technique for one month. Figure 8 shows the calculated savings achieved by using EcoTex laundry oxidation system when comparing to the traditional methods. Target hotel holds 104 rooms and the laundry processed include bedding and towels. (ClearWater Tech, LLC 2009)

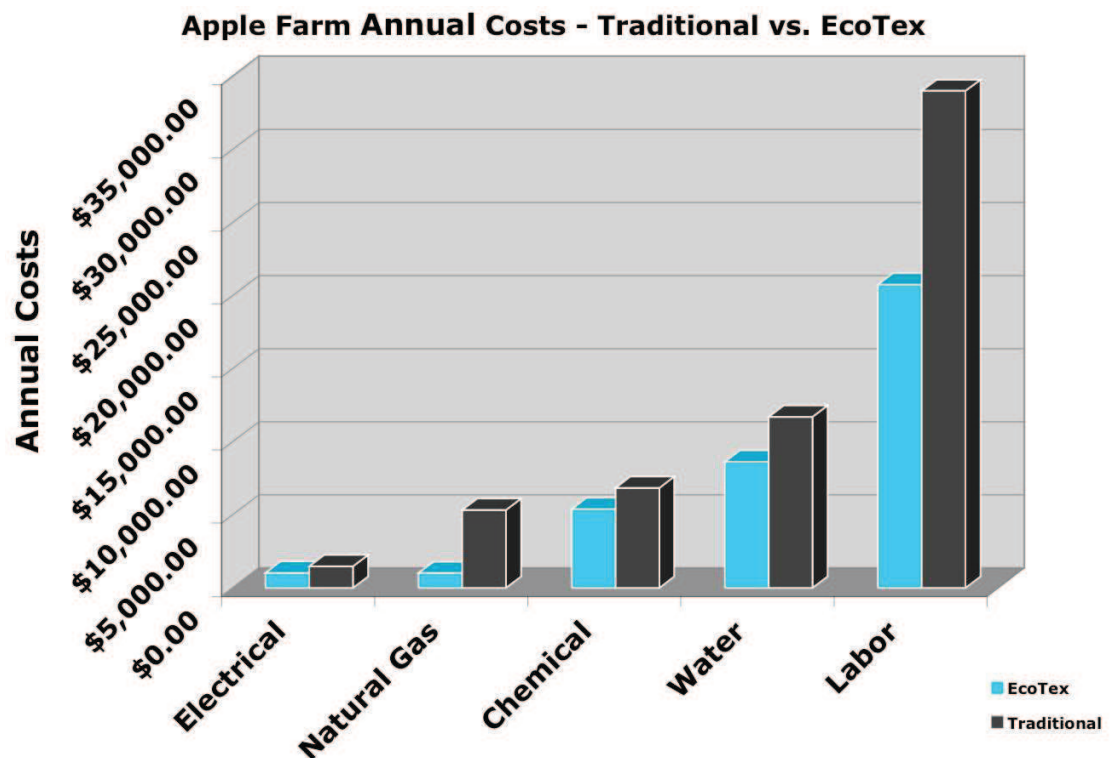


FIGURE 8. Savings achieved through oxidation system in Apple Farm Inn (ClearWater Tech, LLC 2009)

These figures are in line with the earlier Anmark case where similar savings were achieved. Not only are the oxidation techniques saving money through improved

efficiency, but are also helping with the hotels' environmental goals through improved energy-efficiency, water savings and improved chemical usage.

5.4 Water efficiency

Population growth and industrialization are factors contributing to increased water usage, and improving water efficiency will play a role when aiming to cut back on ever increasing water usage. Northern Europe is still holding vast fresh water resources, but overall around the world 1.1 billion people are living without clean drinking water. (World Water Council 2010) When considering an environmentally sustainable hotel, earlier suggestions on hotel laundry handling can already help to reduce the water usage. Ozone based laundry handling can help to significantly cut back on water used when washing laundry in-house. Water leaks can be one contributor to increased water usage. This can be prevented by periodically checking for possible leaks and by guiding housekeepers to check the rooms for visual or audible leaks.

The Swan label defines the limit values for water usage to be 300 liters/guest night for class A establishments, 250 liters/guest night for class B and 100 liters/guest night for class C. Extra points are given if WC's use less than 6 liters of water per flush and if they are holding double flush functions. Water-saving taps with a maximum flow rate of 8 liter/minute, single-lever or sensor controlled mixer taps and water-saving showers also give extra points. (Nordic Ecolabelling 2008)

Individual guests use water in the bathroom with toilets, taps, showers and bathtubs. Thus controlling the water flow in the bathroom will help to reduce the amount of water consumed. Environmentally sustainable dual-flush toilets are a good start when aiming for improved water efficiency. The environmentally sustainable Good Hotel in San Francisco has taken toilet water savings a step further and has adopted a new type of toilet top sink system, which can be seen on figure 9. The system combines a toilet with a sink for hand washing to achieve improved water efficiency. (Oyster Travel Corp 2010)



FIGURE 9. Water-saving toilet top sink system. (Oyster Travel Corp 2010)

The tap for hand washing is automatically started after flushing the toilet, and the fresh water used for hand washing is then used to fill the toilet tank and reused for the next flush. This will encourage hotel guests to wash their hands, while saving water at the same time by using the same water twice. The system also improves hygiene as hand washing water is turned off automatically without needing to touch any taps; also no batteries are needed unlike in automatic systems based on sensor technology. Another water saving feature is the detection of possible leaks. In traditional toilets the tank refill happens inside the tank, making it harder to detect possible leaks. In the toilet top system possible leaks can be seen as the refill happens through the hand washing tap. (Oyster Travel Corp 2010)

Even with a toilet top sink system installed, the traditional sink and tap are still needed for other purposes than hand washing. Sensor controlled water saving taps are a way to decrease water usage compared to traditional taps. Automatic sensor tap supplier Autotap advertises up to 70% savings in water and energy usage comparing to regular taps. Other advantages include increased hygiene as guests don't need to touch the taps in order to get the water running. (Autotaps 2010) Low-flow shower heads are a way to decrease water usage from showers. Table 3 shows a comparison between two traditional showerhead and two high efficiency showerheads. Over five-fold savings

in water usage can be achieved from using new and more efficient model. The Newest models also hold the ability to save water but increase the water pressure at the same time by mixing air into the water flow. (Lower-My-EnergyBill.com 2011) As shown by the table, choosing high efficiency showerhead alone might not result in the best possible waters savings as different high efficiency models can have significant differences in water usage. A comparison between different high efficiency showerheads available in the market should be made in order to achieve the best possible results.

<u>Water Pressure (kPa)</u>	<u>Traditional Free Flow Showerhead Type A</u>	<u>Traditional Free Flow Showerhead Type B</u>	<u>Earth Massage High Efficiency Showerhead</u>	<u>Wonder High Efficiency Showerhead</u>
30	11	12	3.6	1.9
50	14.4	15.3	4.5	2.5
100	20.1	20.8	6.7	3.4
200	27.3	27.5	9.1	4.7
300	36.6	34.9	9.5	5.7
400	41.1	39.5	9.5	7
500	48.4	44.1	9.5	7.1

TABLE 3. Comparison between regular and low-flow showerheads. (The CCCC Organisation 2008)

With new techniques providing increased water pressure together with water savings, there should be no reason for hotels to stick with traditional shower heads. Environmental benefits can be substantial in high-volume establishments when switching for low-flow models. When comparing taking a shower to taking a bath, the bathtub dimensions can be used to count the water efficiency. E.g. a bathtub with dimensions of 150x70x63 cm will consume around 200 liters of water when filled. (Nord Bauen OY 2011) With this information a bathtub can be compared with a high efficiency shower head model consuming 1,9 liters of water in a minute. As a result filling a bathtub accounts to 105 minutes of shower usage (200 liters / 1,9 liters/minute = 105 minutes). As guests might not know the difference in water consumption between taking a bathtub and taking a shower, there could be an

informative sign in the bathroom comparing the difference between the two. The sign could also notify guests to turn off the shower while soaping in order to save water.

Rain water harvesting is one possible solution to reduce fresh water usage. A new environmentally sustainable hotel being built at East Midlands airport in England is starting to use the technique, which can be then used for example as washing water or for toilet flushing. (OASIS Rain Water Harvesting 2011) Luxury hotel Rafayel is utilizing similar system, where rainwater is gathered from terraces, stored in tanks in the basement and then reused to water plants and to feed the fountains. (Hotel Rafayel 2011) Figure 10 shows a design of rainwater harvesting system used to gather water for toilet, garden and laundry usage.

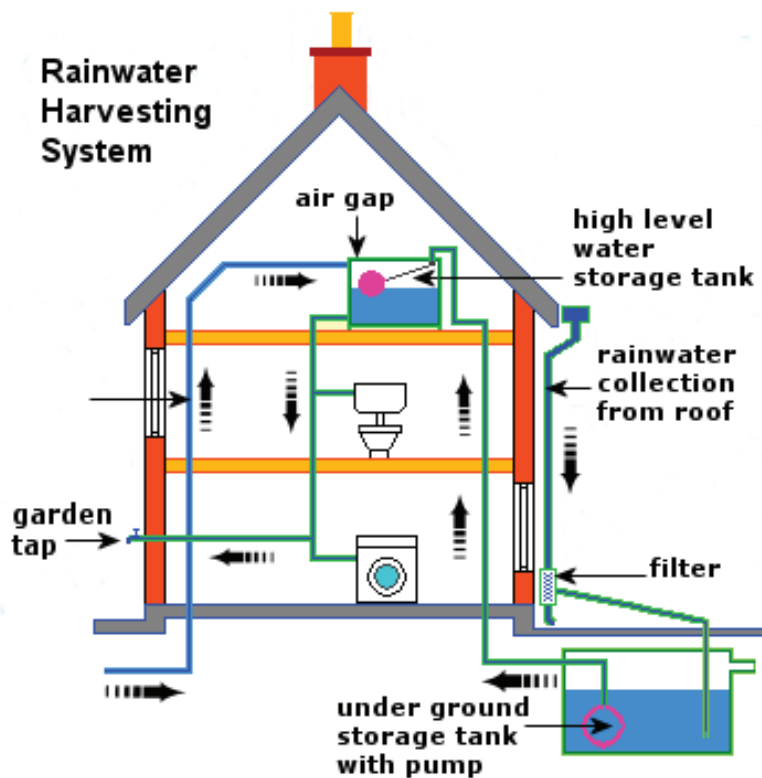


FIGURE 10. Rainwater harvesting system. (Quality Domains 2011)

Rainwater is harvested from the roof to a big storage tank to be placed somewhere nearby the premises. This can turn out to be problematic for establishments located at the city center as they might have limited space available for the water storage tank.

5.5 Heating and air conditioning

Heating can be a big part of facilities' running expenses in North Europe during the winter time, but it also plays a role when considering environmental sustainability of an individual building. Choosing the right heating method will help to reduce the environmental impact hotel's heating will cause. Air conditioning does not play as big role as in warmer countries, but comes useful in the summer time to increase guests' comfort with the ability to choose the most comfortable room temperatures.

The Swan label has defined extra points for the usage of renewable energy sources, industrial waste heat or heat pumps for heating. Points are also given if a certain amount of ventilation is connected to a heat recovery system or if the heat from waste water or refrigeration appliances is used. If using heat pumps, they must not include chlorofluorocarbon (CFC) or hydrochlorofluorocarbon (HCFC) refrigerants. (Nordic Ecolabelling 2008)

The current renewable energy sources (RES) used for heating and their growth rate in Finland can be seen on table 4. Biomass heat is used the most in kilo tonnes of oil equivalent (ktoe), but the growth rate between 1997 and 2005 is fastest for geothermal heat and heat pumps. (European Commission 2008)

RES Technology	1997 [ktoe]	2005 [ktoe]	Av. Annual growth [%]
Biomass heat	4,718	5,361	2%
Solar thermal heat	0	0	-
Geothermal heat incl. heat pumps	7	52	32%
Total	4,726	5,413	2%

TABLE 4. Renewable heat source usage in Finland. (European Commission 2008)

In Austria some hotels have abandoned their old oil heating systems in favor of more environmentally sustainable biomass based district heating systems. The Krimmlerfälle Hotel in Salzburg is counted to save 53 000 liters of oil per year in addition to 2,100 tonnes of CO₂ saved during the lifetime of the plant. Another hotel, Wanderhotel Gassner in Neuenkirchen, has counted to save around 2,000 tonnes of

CO₂ emissions due to the transition from oil to a biomass based district heating system. Hotel Krausler in eastern Styria has taken an alternative approach and has replaced its old oil boiler with its own biomass based boiler. This will result in reduction of 700 tonnes of CO₂ during the lifetime of the plant. (Climate Austria 2011)

District heating is the most popular heating method in Finland and it is widely used in urban areas in apartments and office buildings. The district heat can be produced entirely from renewable energy sources, making sure it will be an environmentally sustainable option for heating. (Kuopion Energia 2008) Thus, district heating can be seen as a good alternative for hotels located in its distribution area. However, overall environmental sustainability of the district heating is depending entirely on individual power stations and the methods they use to produce the heat. (Energiatohokas koti 2011)

Geothermal heat is another renewable energy source and together with heat pumps is increasing its popularity in Finland. Ideal target for the geothermal heat can be hotels located outside district heating distribution areas, which are holding their own heating system and are located nearby water which can be used as a heat source. As an example Hotel Haiko Manor in Porvoo is utilizing three geothermal heat pumps paired with a natural gas and oil heating systems as a backup. Haiko Manor uses the natural gas system only during the coldest temperatures and is using the oil system only as a backup. (Suomen Lämpöpumppuyhdistys ry 2011)

Air-source heat pumps have become increasingly popular during the recent years in Finland and their amount exceeded 100 000 in 2007. They are an environmentally sustainable and effective way to accompany the existing heating systems, such as oil heating or electric heating. (Jäähdytinpalvelu RefGroup Oy 2011) On the other hand, hotels with heating based on the district heating or geothermal heating hand don't necessarily require additional heating systems in order to provide efficient and environmentally sustainable heating. In hotel usage, the air-source heat pumps could be used in place of a regular air conditioning system to cool down the individual rooms. They could also be used to provide a part of the room heating, while part is provided by existing system. The problem with installing the heat pumps in hotel rooms comes from the big initial investment and the maintenance needed. Installing the external units on the outside walls of the building might also be problematic.

When considering how to save on hotel heating and air conditioning expenses, heat loss is one thing to consider. Taking a thermal image of the building will help to determine which parts of the building are losing heat the most. A proper insulation will decrease the heating expenses, but tearing up the walls and installing new insulation material can become costly. Hotel's windows are more easily replaceable and are responsible for big part of the heat lost during the winter. Properly isolated windows can also help to keep the temperatures down in the summer time. Older windows can be replaced with more energy efficient models or they can be insulated better. The windows are graded from class G to class A depending on their energy efficiency, with class A holding the highest energy efficiency. The newest class A windows can have 4 window layers, have a selective window film and can be filled with insulating gas for improved energy efficiency. (Energiatehokas koti 2011)

Unoccupied hotel rooms don't necessarily need to be warmed up and savings can be achieved by having the heating on only in rooms which are in use or which are reserved and soon to be occupied. A hotel belonging to the Hilton Hotels Corporation has installed a digital thermostat system in all of their rooms to monitor the room occupancy. The temperatures are then adjusted when the guests enter or exit the rooms. The hotel has managed to achieve nearly \$270 000 annual savings with the use of the monitoring system. (Energy Star 2011)

Another cost-effective way to increase windows' energy efficiency is to install shades or blinds. They can decrease the heat loss in the winter and by closing them for the windows facing the sun, room temperatures can be kept down in the summer time. The proper use of shades or blinds paired with curtains is a simple and cost-effective way to control the heat loss from the windows in the hotel rooms. (Green Energy Efficient Homes 2010) Figure 11 shows how curtain placement will also affect the heat loss from the windows.

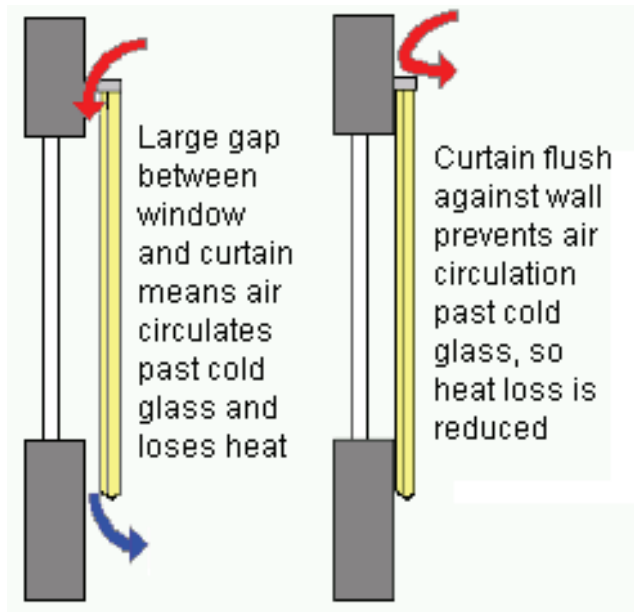


FIGURE 11. Heat loss reduction with proper curtain placement. (Green Energy Efficient Homes 2010)

Blinds, shades and curtains are also available in models specially designed to offer increased insulation features. Using either blinds or shades paired with the curtains will give guests the possibility to choose which one use in their room, while providing increased insulation when the room is not in use. As figure 11 shows the heat loss can be decreased by having as little gaps as possible between the wall and the curtain. The effect can be further increased by having the shades touch the wall from both sides as well as from above and below. (Green Energy Efficient Homes 2010) This can be done by installing the shades with a side track system shown on figure 12.



FIGURE 12. Window shades sidetrack system. (ShadesShuttersBlinds.com 2010)

This type of sidetrack system can not only improve the insulation by sealing air leaks, but can also increase the guests' comfort by making the room darker by blocking more outside light. This can help to improve sleeping conditions especially in the summer time when the days are long in Northern Europe. While hotels' heating system might have very little alternative options, a lot can be done for the insulation by simply concentrating on the windows and their energy efficiency.

Avoiding too high room temperatures is one way to achieve savings on the heating expenses. Every Centigrade dropped in room temperatures will result in approximately 5% savings in the heating expenses. Generally 20 to 22 Centigrade is considered comfortable and healthy room temperature. (Kurtelius 2001, 52) As people have different preferences on comfortable room temperature, one way to deal with the issue would be to set the room temperatures at around 20 Centigrade and give the guests the ability to control their room temperature with an air conditioning system, a heat pump or a radiator control.

5.6 Electricity

Electricity is one factor responsible for the global warming through the ways the electricity is created. Electricity created by burning fossil fuels creates carbon dioxide and therefore has a negative effect on the global warming. (Woodbank Communications 2005) An individual hotel aiming for more environmentally sustainable operations can control their carbon footprint by choosing environmentally sustainable energy sources and by aiming for energy savings. Earlier suggestions on lighting and laundry handling will help to reduce the energy consumption with energy saving light bulbs and with more energy efficient laundry handling.

In addition to the energy usage limit values per guest night, the Swam label defines more specific requirements for electricity and electronic devices. Points are given according to how big percentage of the electricity consumed comes from renewable energy sources. An energy analysis carried out by an independent energy expert during the past five years or during the next six months will grant extra points. Office machines with a standby functions or with a connection to an auto power-off socket will also give points for the application. For TV-sets, a passive standby consuming maximum of 1 watt of electricity and an active standby consuming maximum of 9 watts of electricity will give extra points. Minibars consuming at most 0,8 kWh/day will be given more points than the versions consuming more electricity. (Nordic Ecolabelling 2008)

When deciding which electricity contract to get, the price is a big factor but the cheapest option might not be the most environmentally sustainable one. Fortum is one energy company offering electricity contracts, where the electricity is produced entirely from sustainable energy sources. The company charges 0,2 cents/kWh extra for an electricity contract based on hydropower. Overall, a general two-year electricity contract for companies, based on entirely renewable hydropower, costs 5 euros a month and 5,88 cents/kWh. (Fortum 2011) However, Fortum as a company produces energy also from non-renewable energy sources. Other alternatives for environmentally sustainable energy sources are companies selling only electricity produced entirely from renewable energy sources. Ekosähkö Oy is one Finnish company offering electricity produced entirely from renewable energy sources. The

price for a two-year electricity contract with Ekosähkö Oy is 1,92 euros a month and 7,19 cents/kWh. Companies choosing Ekosähkö Oy's electricity receive a diploma to be placed in the premises and a banner that can be used on the internet page. Other benefits include promotional material that can be used to inform customers and partners about the greener energy used. (Ekosähkö Oy 2011) Hotels using lots of electricity might find the price difference between Ekosähkö Oy and Fortum too big to justify, especially as Fortum promises the electricity to be based entirely on renewable source as well.

Solar panels are one environmentally sustainable way for hotels to create electricity themselves, but the dark winters in Finland will limit the solar panel performance compared to the more southern countries. However, the recent development in solar panel technology has made it possible for solar panels to store energy even in the dark, increasing the panel efficiency from around 25% to 46%. This is achieved by putting invisible infrared light in use in addition to visible light. (Tekniikka&Talous 2010) In Finland, Levi Hotel Panorama opened in 2009 in skiing center Levi, has solar power technology providing part of its electricity. Solar panels located at the roof of Levi Hotel Panorama are currently used in the summer time to heat up service water for around 30 rooms. Jukka Luukkinen from YIT Rakennus Oy Lappi comments there to be a possibility to increase the usage of solar power in the hotel by installing 100 to 120 square meters of solar panels in the south façade. However, he comments this to be expensive and the efficiency to be poor at the moment. (RPT Docu Oy 2009)

When considering how to save energy in hotels, state-owned Motiva Oy can be used to conduct a state supported energy audit where hotel's current energy usage is examined and ways to improve it are given. The audit helps customers to reduce their unneeded energy, water and heating expenses with the help of HPAC and electrical engineering experts. (Motiva 2009) Inside the hotel rooms, lighting and electronic devices such as mini-bars and televisions are responsible for the electricity usage. Television sets have achieved considerably lower energy usage with the new LCD technology replacing the old CRT technology. However, even when the different LCD TV's are looking the same and are the same sized, the energy usage might vary between them. Table 5 shows an example how the different LCD TV models have different power consumption figures when used with their factory default settings. Models from different manufacturers vary greatly in energy consumption. Similar

sized screen from one manufacturer can consume twice the energy as a model from another manufacturer. (CBS Interactive 2011)

Model	HDTV type	Screen size ↓	Default settings (watts)	Model	HDTV type	Screen size ↓	Default settings (watts)
Vizio VP322	plasma	32	122.97	Vizio VO320E	LCD	32	87.404
Insignia NS-LCD32	LCD	32	143.20	Samsung LN32B360	LCD	32	75.108
Sony KDL-32M4000	LCD	32	112.94	Westinghouse SK-32H640G	LCD	32	89.279
Panasonic TC-L32X1	LCD	32	92.10	Sharp LC-32D47UT	LCD	32	71.683
Samsung LN32A450	LCD	32	130.65	Hitachi UT37X902	LCD	37	183.73

TABLE 5. LCD TV energy consumption comparison. (CBS Interactive 2011)

Newer LCD TV's based on LED backlight technology generally consume less energy than the regular LCD models, but are more expensive acquire. (Gigantti 2011)

Changing the existing LCD TV models for newer models or buying high-end LED based TV's might turn out to be too expensive, but hotels can still achieve power savings with their existing models. Reducing the TV light output from the default settings will help to save on the energy consumed by the TV. Unplugging TV's for the rooms not in use will also save electricity as the TV's still consume some amount of energy in standby mode. Smaller TV size will also help with the energy consumption and individual hotels should consider how big TV's are needed for the regular rooms.

Minibars inside the rooms can consume a lot of energy and hotels should pay attention to how much energy different minibar models consume upon installing or renewing the minibars. Company called Bartech is supplying new a type of high-efficiency minibars, which can be remotely controlled and monitored. Hotel staff can remotely monitor the minibar status and temperature levels. The system reports which products need to be replaced and it can be used to control the minibar temperatures based on room occupancy. (Green Lodging News 2008) If possible, hotels could even consider not having minibars at all. As an example hotel Holiday Club Saimaa being built in

Imatra is concentrating in minimizing its carbon footprint and has decided not to install minibars at all inside the hotel rooms. (Holiday Club 2010)

Hotel Rafayel in London has equipped their rooms with VDA Micromaster cost control system. The system allows remote control of areas such as heating, air conditioning and lighting, making it easy to control the energy usage of individual hotel rooms. When a certain room becomes unoccupied, the system can be used for example to instantly lower the room temperature in order to save in the heating expenses. (Hotel Rafayel 2011) These type remote controlled systems can come in handy when aiming to reduce the energy usage from the individual rooms. There should be no reason to have any electricity consuming devices on when a room becomes unoccupied. In hotels where the occupancy percentage stays under 100 percent for long periods of time, rooms can be chosen which are not given to the guests. The rooms can then have heating and all the electronic devices turned off in order to save energy.

6 RESULTS

Many of the measures presented require investments for new equipment. This might not be financially possible for smaller establishments, and bigger establishments with lots of rooms might have to consider which areas to concentrate on. However, when establishing a new hotel or renovating an existing one, environmental issues should be carefully considered when making purchasing decisions. Buying more environmentally sustainable equipment and devices might cost little bit more, but has the potential to pay the investment back in saved energy and saved expenses from more environmentally sustainable operations.

Certain goals can be set, to keep the hotel running in a more environmentally sustainable fashion. The Swan label has defined the limit values, which can be used as a guideline when aiming for a more environmentally sustainable hotel. Figure 13 shows the limit values for energy consumption, which are divided geographically and can be chosen between yearly heating and electricity consumption per square meter or yearly consumption per guest night. In the Jyväskylä area the values range from 330 to 375 kWh/m² or from 60 to 65 kWh/guest night. (Nordic Ecolabelling 2008)

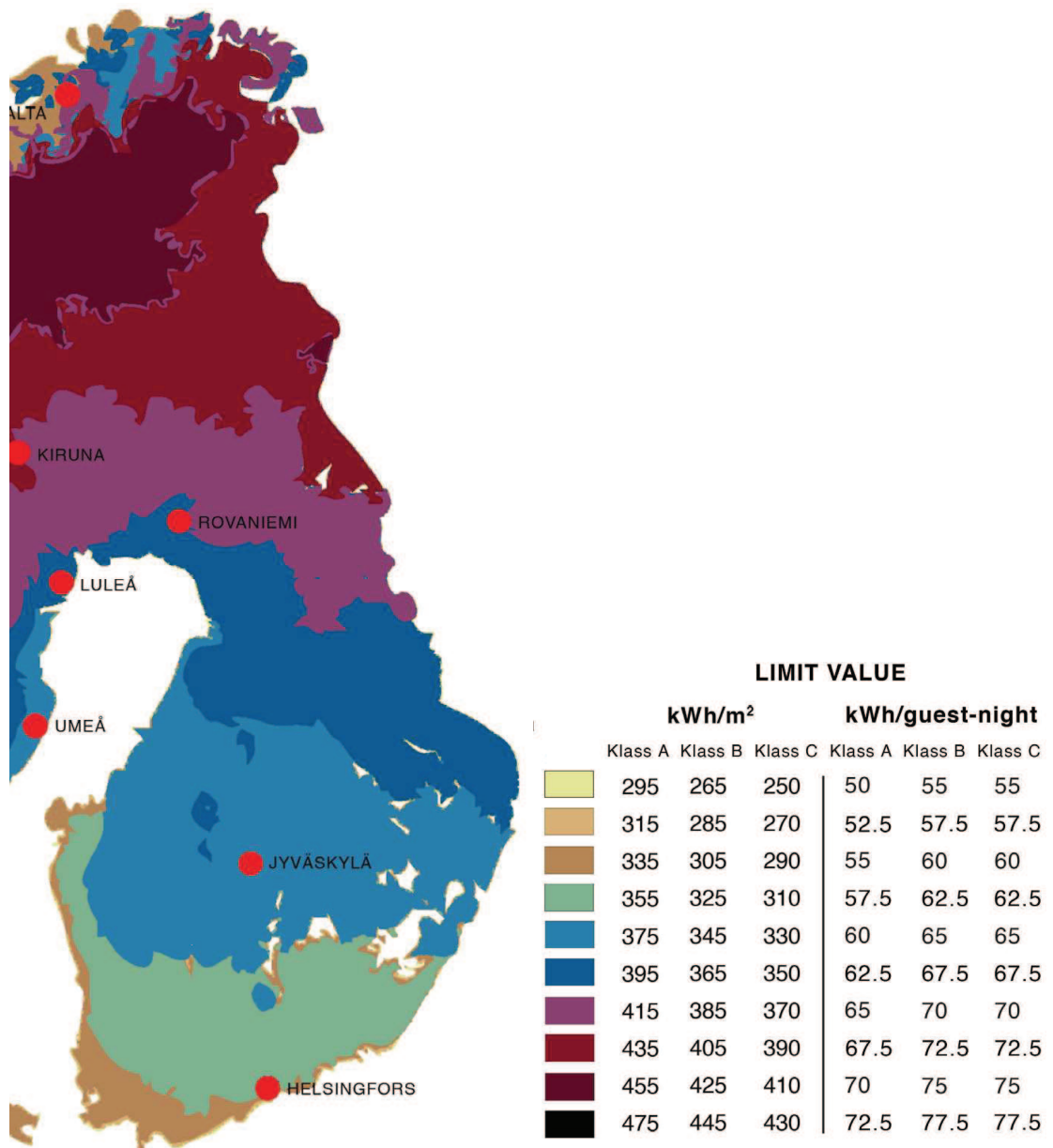


FIGURE 13. Swan label limit values for energy consumption. (Nordic Ecolabelling 2008)

The values are divided into three classes depending on the hotel in question. Class A allows the highest consumption and it requires restaurant turnover of greater than 45% of total establishment turnover or lodging occupancy of greater than 60%. Class B includes establishments where restaurant turnover accounts to 15-45% of total turnover or lodging capacity falls between 40 to 60%. Hotels with a pool can also be included in it. All the other establishments are included in class C.

Other limit values include water consumption, usage of chemical products and the amount of waste generated. Limit values for water consumption range between 200 to 300 liters/guest night, chemical products usage between 25 to 35 grams/guest night and waste management between 0,45 to 1,35 kg/guest night.

Meeting the limit values can act as starting point for a more environmentally sustainable hotel, but shouldn't be the only criteria to aim at. Environmental sustainability can be improved even with small measures such as keeping the room temperatures at sensible levels or by guiding guests into more environmentally sustainable behavior.

Table 6 shows an example comparison between different solutions and techniques and the amount of investment they require.

Focus area	Smallest investment	Medium investment	Biggest investment
Lighting	Replacing the existing lighting with CFL technology.	Replacing the existing lighting with LED technology.	Installing timer or presence controlled lighting.
Waste management	Sorting and recycling the waste from the hotel rooms.	Purchasing ecolabelled goods and purchasing in big quantities.	Installing multi-purpose recycling containers or paper shredders in the hotel rooms.
Laundry handling	Co-operating with the guests in order to reduce the amount of laundry created.	Outsourcing the laundry handling.	Installing ozone based laundry handling system.
Water efficiency	Checking periodically for water leaks. Informative signs encouraging guests to save water.	Installing low-flow taps or low-flow shower heads.	Installing dual flush toilets, toilet top sink system or rainwater harvesting system.
Heating and air conditioning	Keeping room temperatures at sensible level. Not heating unoccupied rooms.	Installing energy efficient windows. Installing energy efficient blinds or shades.	Installing air-source heat pumps. Installing geothermal heating.
Electricity	Conducting an energy audit. Purchasing electricity created from renewable energy sources.	Purchasing energy efficient electronic devices.	Installing cost control system to monitor the hotel rooms. Installing solar panels.

TABLE 6. Comparison between different solutions and techniques

As can be seen from table 6, hotels have many different options available for them when aiming for more environmentally sustainable operations. Upon renovating hotels and renewing equipment, environmental aspect should always be one part of the purchasing decision. Hotels not ready to make big investments can still consider other alternatives to increase their environmental sustainability.

7 DISCUSSION

Writing of this thesis has been a great learning experience, giving the author new information on how to battle environmental issues in the hotel business and in private houses as well. The issues and solutions are closely related to Facility Management and can be applied to other facilities outside the hotel business as well. Many of the findings prove that environmental sustainability can be increased in different ways, not only with the most common options people tend to think of.

One factor contributing to the overall environmental sustainability of a hotel is the guest behavior. Guests' behavior cannot be predicted, but a hotel can try to impact guests' carbon footprint by leaving informative notes and messages in the room. Declining housekeeping is one way to save the environment and in addition to informing guests about the environmental impacts, they can also give bonuses or discounts for declining housekeeping.

The carbon footprint created by an individual hotel can be controlled by concentrating on the areas which are responsible for creating carbon dioxide emission in the atmosphere. All the individual areas researched can be seen to have an effect on the global warming, either directly or indirectly. Electricity usage is on big factor contributing to the global warming and it can be decreased in several ways with more efficient lighting, heating, air conditioning and laundry handling solutions.

Purchasing ecolabelled goods is one way to control how much stress an individual hotel will create on the environment indirectly. Non-ecolabelled goods might be manufactured and transported in a way that creates massive amounts of carbon dioxide emissions in to the process. Transportation is on factor responsible for indirect emissions the hotel business creates and should be taken into account when making decision on outsourcing services such as laundry handling.

Overall, concentrating on improving hotel's environmental sustainability can only be seen as beneficial for the hotel, the environment and the guests. Hotels acting on limited budget can concentrate on solutions requiring little investments and hotels ready to make bigger investment can expect the investment to be paid back in the future in saved operating expenses.

REFERENCES

ABC News 2010. Budget-conscious hotels turn to optional housekeeping. Accessed 19 January 2011. <http://abcnews.go.com/Travel/budget-conscious-hotels-turn-optional-housekeeping/story?id=10986815>

Architecture Student Chronicles 2009. Three dimensions of Sustainable Environmental Architecture. Accessed 1 February 2011. <http://www.architecture-student.com/sustainable-design/three-dimensions-of-sustainable-environmental-architecture/>

Autotaps 2010. Why electronic taps? Accessed 21 January 2011. <http://www.autotaps.com/why-electronic-taps.html>

CBS Interactive 2011. The chart: HDTV power consumption compared. Accessed 31 January 2011. <http://reviews.cnet.com/green-tech/tv-consumption-chart/>

City of Tampa 2011. Water Efficiency Checklist for Hotels & Motels 2011. Accessed 21 January 2011. http://www.tampagov.net/dept_water/information_resources/Efficiency_checklists/Hotel_water_efficiency_checklist.asp

Claes Ohlson 2011. Energiansäästölamput. Accessed 13 January 2011. http://www.clasohlson.fi/product/category.aspx?category=lamput:energians%C3%A4%C3%A4st%C3%B6lamput&id=88601373&_path=251882;85177594;88601372;88601373

Climate Austria 2011. Austrian Climate Protection Projects Examples. Accessed 25 January 2011. http://www.climateaustria.at/en/home/projects/austrian_climate_protection_projects/

COUNTRY PROFILES. Accessed 25 January 2011. http://ec.europa.eu/energy/renewables/doc/progress_country_profiles_february_2008_final.pdf

Det Norske Veritas 2009. Scandinavian Hotel Chain to be ISO 14001 certified. Accessed 14 February 2001. http://www.dnv.com/news_events/news/2009/scandinavianhotelchaintobeiso14001certified.asp

Development Alternatives 2002. Energy and Environment Benchmark for Hotel Industry. Accessed 19 January 2011. <http://www.dainet.org/benchmarking/Laundry.asp>

Easy Led Oy 2007. Toimisto- ja yleisvalaistus. Accessed 15 February 2011. <http://www.led1.fi/index.php?page=300&lang=1>

easyHotel 2010. Earl's Court, London. Accessed 19 January 2011 http://www.easyhotel.com/hotels/london_earls_court.html

Ekosähkö Oy 2011. Hinnasto. Accessed 27 January 2011.
<http://ekosahko.julkaisee.fi/katsonama/107>

Electronic Recyclers International 2011. The CFL-LED Comparison. Accessed 13 January 2011. <http://1800recycling.com/wp-content/uploads/2010/08/LED-CFL-compact-flourescent-incandescent-light-bulbs.jpg>

Energiatehokas koti 2011. A-luokan ikkunat. Accessed 26 January 2011.
http://www.energiatehokaskoti.fi/perustietoa/miten_tehdaan_energiatehokas_koti/a-luokan_ikkunat

Energiatehokas koti 2011. Kaukolämpö Accessed 25 January 2011.
http://www.energiatehokaskoti.fi/suunnittelu/talotekniikka_suunnittelu/lammitys/kaukolampo

Energy Star 2011. ENERGY STAR Success Story: Hilton Hotels Corporation. Accessed 27 January 2011.
http://www.energystar.gov/index.cfm?c=hospitality.bus_hospitality_hilton

European Commission 2008. RENEWABLE ENERGY
 European Union, 2009. Commission adopts two regulations to progressively remove from the market non-efficient light bulbs. Accessed 14. December 2010.
<http://europa.eu/rapid/pressReleasesAction.do?reference=IP/09/411>

Fortum 2011. Laske tarjous ja tee sähkö sopimus. Accessed 27 January 2011.
<http://www.fortum.fi/document.asp?path=14020;14028;14030;35987;36011;36016;26820>

Gigantti 2011. Televisiot 32"-39". Accessed 31 January 2011.
http://www.gigantti.fi/catalog/tv-ja-aani/taulutelevisiot/fi_flat_tv_medium/televisiot-32-39?CatalogCategoryID=Z7YKeQuvt.gAAAEoRPBewBap&group_3=Tyyppi_is_LED-TV

Green Energy Efficient Homes 2010. Energy saving window coverings. Accessed 26 January 2011. <http://www.green-energy-efficient-homes.com/energy-saving-window-coverings.html>

Green Lodging News 2008. Bartech Teams Up with Ember to Boost Minibar Efficiency. Accessed 1 February 2011. <http://www.greenlodgingnews.com/Bartech-Teams-Up-with-Ember-Boost-Minibar-Efficiency>

Green Lodging News 2011. ISO 14001 Certification in the Hospitality Industry. Accessed 14 February 2011. <http://www.greenlodgingnews.com/ISO-14001-Certification-Hospitality-Industry>

Green Star 2010. Alaska Hospitality P2 Success. Accessed 20 January 2011.
<http://www.greenstarinc.org/files/PDFs/Aramark%20Ozone%20Success.pdf>

Greenzer 2009. CFL vs LED. Accessed January 14 2011.
http://www.greenzer.com/face-off_5

Group C Media 2010. WEB EXCLUSIVE: The Latest In Lighting Efficiency Might Surprise You. Accessed 13 January 2011.

<http://www.todaysfacilitymanager.com/facilityblog/wp-content/uploads/LEDvsFluorescent.jpg>

Group C Media 2010. WEB EXCLUSIVE: The Latest In Lighting Efficiency Might Surprise You. Accessed 14 January 2011.

http://www.todaysfacilitymanager.com/facilityblog/wp-content/uploads/OCTRON-T8_LampLife.jpg

Holiday Club 2010. Holiday Club Saimaa - suurtyöllistäjä jo ennen avajaisia.

Accessed 31 January 2011. http://www.hcsaimaa.com/news/7/holiday_club_saimaa_-_suurtyollistaja_jo_ennen_avajaisia/

Hotel GreenStar 2011. Vihreys. Accessed 18 January 2011. <http://www.greenstar.fi/>

Hotel Rafayel 2011. Where being green doesn't mean you have to compromise on style, luxury or comfort. Accessed 24 January 2011.

<http://rafayelshotel.blogspot.com/2010/12/sure-to-lead-way-in-eco-hotels-rafayel.html>

Hotels and Youth Hostels. Accessed 12 January 2011.

<http://www.svanen.nu/SISMABModules/Criteria/GetCriteriaFile.aspx?pgr=72&v=3&l=e>

Houghton, Sir John. 2009. Global Warming The Complete Briefing. Cambridge, United Kingdom: Cambridge University Press.

Ilmasto.org 2011. Vaikutukset Suomessa. Accessed 10. January 2011.

<http://www.ilmasto.org/ilmastonmuutos/seuraukset/suomessa.html>

Ilmatieteenlaitos 2010. Ilmastollinen vertailukausi 1971-2000. Accessed 10 January

2011. http://ilmatieteenlaitos.fi/kuvat/hjs_10liukuma.gif

Jäähdytinpalvelu RefGroup Oy 2011. Tilastotietoa ilmalämpöpumpuista. Accessed 25

January 2011. http://www.ilmalampopumput.fi/index.php?node_id=10196

Kuopion Energia 2008. Kaukolämpöä pientaloalueille ja pientaajamiin. Accessed 25

January 2011. <http://www.kuopionenergia.fi/fi/?id=36&selArticle=141>

Kurtelius, Jari. 2001. Kestävä kehitys kiinteistöalalla. Jyväskylä, Finland: Gummerus Kirjapaino Oy.

Lower-My-EnergyBill.com 2011. Accessed 21 January 2011. <http://www.lower-my-energybill.com/water-saving-shower-heads.html>

Madison Gas and Electric Company 2011. Compact Fluorescent Lamps. Accessed 14

January 2011. http://www.mge.com/business/saving/madison/pa_2.html

Maslin, Mark 2004. Global Warming A Very Short Introduction. Cambridge, United Kingdom: Cambridge University Press.

Motiva 2009. Katselmustoiminta. Accessed 31 January 2011.
<http://www.motiva.fi/yritykset/katselmustoiminta>

Nord Bauen OY 2011. BALTECO kylpyamme Primo 15. Accessed 24 January 2011.
<http://interbauen.fi/balteco-kylpyamme-primol-15.html>

Nordic Ecolabelling 2008. Nordic Ecolabelling of OASIS Rain Water Harvesting 2011. New ECO Hotel with Rainwater Harvesting for East Midlands Airport. Accessed 24 January 2011. http://oasis-rainharvesting.co.uk/new_eco_hotel_for_east_midlands_airport

Oyster Travel Corp. 2009. An eco-friendly hotel room toilet that won't let you get away without washing your hands. Accessed 21 January 2011.
<http://blog.oyster.com/an-eco-friendly-hotel-room-toilet-that-wont-let-you-get-away-without-washing-your-hands-4126/>

Ozone Laundry Systems 2011. Save Money. Accessed 20 January 2011.
<http://www.ozonelaundrysystems.com/savings-benefits.html>

Pääkaupunkiseudun Kierrätyskeskus Oy 2010. Palvelut yrityksille. Accessed 18 January 2011. http://www.kierratyskeskus.fi/palvelut/palvelut_yrityksille

Pekanneimo, Ilkka. 2009. Kodin valaistusopas. Turku, Finland: Ad-Lux Oy.

Planet Green 2009. Planes, Trains, Automobiles (and Buses): Which is the Greenest Way to Travel Long Distance in the US? Accessed 02 December 2010.
<http://planetgreen.discovery.com/tech-transport/plane-train-automobile-travel.html>

Quality Domains 2011. Low Energy House - Rainwater Harvesting - Water Collection. Accessed 24 January 2011. <http://www.lowenergyhouse.com/rainwater-harvesting.html>

Recycle Away, LLC 2011. Custom Recycling Stations with Kaleidoscope Collection. Accessed 18 January 2011. http://www.recycleaway.com/Kaleidoscope-24-Gallon-Square-Recycling-Container_p_4.html

RPT Docu Oy 2009. Levi Hotel Panorama. Accessed 28 January 2011.
<http://www.projektiiutiset.fi/fi/artikkelit/levi-hotel-panorama>

Savon Voima 2010. Vuosikertomus 2009. Accessed 19 January 2011.
http://www.savonvoima.fi/SiteCollectionDocuments/SV_Vuosikertomus_2009.pdf

ShadesShuttersBlinds.com 2010. ComforTrack Side Track System. Accessed 27 January 2011. <http://www.shadesshuttersblinds.com/side-track-cells.asp>

Skywatch Media News and Entertainment 2010. Reports of dramatic weakening of Gulf Stream. Accessed 10 January 2011. <http://www.earthfrenzyradio.com/planet-in-peril/reports-of-dramatic-weakening-of-gulf-stream>

Solana Recyclers, Inc. 1999. Hotel Waste Reduction Recommendation Report. Accessed 17 January 2011. http://www.solanacenter.org/1casestudy_hotel.pdf

Suomen Lämpöpumppuyhdistys ry 2011. Maalämpöä suuriinkin kiinteistöihin. Accessed 25 January 2011.

http://www.sulpu.fi/index.php?option=com_content&task=view&id=44&Itemid=123

Taloussanommat 2011. Romukuningattaren poika pesee pyykkiä Suomessa. Accessed 19 January 2011.

<http://www.taloussanommat.fi/ihmiset/2011/01/18/romukuningattaren-poika-pesee-pyykkia-suomessa/2011789/137>

Tekniikka&Talous 2010. Aurinkopaneeli, joka tuottaa energiaa - myös pimeässä.

Accessed 28 January 2011. <http://www.tekniikkatalous.fi/energia/article550997.ece>

The CCCC Organisation 2008. Introducing High Efficiency Showerheads. Accessed 24 January 2011.

<http://www.waterefficiencysa.co.za/files/Savingwaterusinghigh efficiencyshowerheads.pdf>

The State of Victoria 2010. A Perspective on environmental sustainability? Accessed 15 February 2011.

[http://www.ces.vic.gov.au/ces/wcmn301.nsf/obj/cesplan/\\$file/A+Perspective+on+environmental+sustainability.pdf](http://www.ces.vic.gov.au/ces/wcmn301.nsf/obj/cesplan/$file/A+Perspective+on+environmental+sustainability.pdf)

The World Conservation Union 2006. The Future of Sustainability. Accessed 7 March 2011. http://cmsdata.iucn.org/downloads/iucn_future_of_sustainability.pdf

Tilastokeskus 2011. Saapuneet vieraat ja yöpymiset hotelleissa. Accessed 15 February 2011.

http://pxweb2.stat.fi/Dialog/varval.asp?ma=020_matk_tau_102_fi&ti=Saapuneet+vieraat+ja+y%F6pymiset+hotelleissa&path=../Database/StatFin/lii/matk/&lang=3&multilang=fi

Travelcon 2011. Ympäristömerkit. Accessed 14 February 2011

<http://www.travelcon.fi/ymparistotietous.php?osa=merkit>

U.S. Census Bureau 2010. Total Midyear Population for the World: 1950-2050.

Accessed 15 February 2011. <http://www.census.gov/ipc/www/idb/worldpop.php>

United Nations 1987. Report of the World Commission on Environment and

Development. Accessed 7 March 2011. <http://www.un-documents.net/a42r187.htm>

Upgrade: Travel Better 2011. Would you accept a cash credit or loyalty points to decline housekeeping? Accessed January 19 2011.

<http://www.upgradetravelbetter.com/2010/09/15/would-you-accept-a-cash-credit-or-loyalty-points-to-decline-housekeeping/>

Valtion ympäristöhallinto 2009. Huonekalujen laatu- ja ympäristökriteerit.. Accessed 18 January 2011. <http://www.ymparisto.fi/default.asp?node=16213&lan=fi>

Vezzoli, C., Manzini, E. 2008. Design and Innovation for Sustainability. Milan, Italy: Springer.

Woodbank Communications 2005. Electricity Generation from Fossil Fuels. Accessed 27 January 2011. http://www.mpoweruk.com/fossil_fuels.htm

World Tourism organization, 2010. Long-term Prospects: Tourism 2020 Vision. Accessed 09 December 2010. http://www.world-tourism.org/market_research/facts/market_trends.htm

World Water Council 2010. Water Crisis. Accessed 21 January 2011. <http://worldwatercouncil.org/index.php?id=25&L=0>

Ympäristömerkintä 2011. Merkin hyödyntäminen. Accessed 12 January 2011 <http://joutsenmerkki.fi/merkinhyodyntaminen/>

Ympäristömerkintä 2010. Creating the future now. Accessed 10 January 2011. <http://www.ymparistomerkki.fi/english>