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GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES

MASTER THESIS

ACCORDING TO SUSTAINABLE PERSPECTIVES REDESIGN OF AN EXISTING HOTEL: GÜRAL TEKIROVA

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2016

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ABSTRACT

ACCORDING TO SUSTAINABLE PERSPECTIVES REDESIGN OF AN EXISTING HOTEL: GÜRAL PREMIER TEKIROVA

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Due to the rapid development of the world, utilizing energy resources in an efficient way becomes one of the most controversial topics in today's area. In the light of this not only using alternative renewable energy resources but also consuming overall energy efficiently should be considered. As most of our lives continue in closed environments, such as factories, offices and residential areas, efficient energy consumption in buildings plays a great role in this aspect. From this point of view both architecture and interior architecture try to propose various solutions to the problem such as using waste management, water conservation, energy efficiency and indoor air quality in accepted levels.

Considering these facts, this thesis focuses on one of the weakest links in efficient energy consumption as existing hotels due to high amount of circulation. During this thesis, after describing the precautions that should be taken in buildings to reduce energy and water consumption, to improve waste management and indoor air quality in one of the biggest hotel chains in Turkey, "Güral Premier Tekirova" will be analyzed with respect to the related 2013-2014 date received from the Hotel officials and solutions will be proposed to improve sustainability measures.

Keywords: Sustainable design, existing hotel, energy efficiency in hotel, indoor air quality.

ÖZET

SÜRDÜRÜLEBİLİRLİK BAKIŞ AÇISIYLA MEVCUT OTELLERİN YENİDEN TASARLANMASI: GÜRAL PREMİER TEKİROVA

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Varolan enerji kaynaklarının verimli olarak değerlendirilebilmesi, hızla gelişen dünyamız nedeni ile günümüzün en tartışmalı konularından biri olmuştur. Bu bağlamda sadece ek alternatif enerji kaynaklarına yönelmek değil, aynı zamanda varolan enerji kaynaklarının verimli olarak kullanılması da göz önüne alınmalıdır. Zamanımızın büyük bir bölümünü iş yeri, ev, okul gibi kapalı alanlarda geçirdiğimizden bu gibi alanların enerji verimliliği önemli bir hale gelmiştir. Bu nedenle, mimarlar ve iç mimarlar kapalı alanlarda enerji verimliliğini arttırmak için birçok öneri geliştirmektedirler. Bu önerileri elektirik ve su tüketiminin kontrolü, atık yönetimi ve iç hava kalitesi olarak ele alırlar. Kapalı alanlarda enerji tüketiminin en yoğun olduğu alanlardan biri de otellerdir. Bu tezde mevcut otel yapıları enerji verimliliği açısından ele alınarak enerji kullanımının daha verimli hale getirilmesi için öneriler geliştirilmesi amaçlanmıştır.

Öncelikle binalarda ve otellerde enerji verimliliği ele alınmış, enerji ve su tüketimi, atık yönetimi konuları incelenmiş, daha sonra da binalarda iç hava kalitesi tartışılmıştır. Bu tezde incelenmek üzere seçilen otel Güral Premier Tekirova otelidir. Bu Otelin 2013 ve 2014 yılına ait tahmini ve gerçekleşen verileri ele alınarak elektirik tüketimi, su tüketimi, atıklara ilişkin veriler değerlendirilmiş, tahmin edilen değerlerin geçerkleştirilemeyen durumlarında nedenleri analiz edilerek öneriler geliştirilmiştir.

Anahtar Kelimeler: Enerji verimliği, mevcut oteller, iç hava kalitesi, otellerde enerji verimliliği.

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Finally, I must express my very profound gratitude to my family providing me with unfailing support and continuous encouragement throughout my years of study and through the process of researching and writing this thesis. This accomplishment would not have been possible without them. Thank you.

TEXT OF OATH

I declare and honestly confirm that my study, titled "According to sustainable perspectives redesign of the existing building" and presented as a Master's Thesis, has been written without applying to any assistance inconsistent with scientific ethics and traditions, that all sources from which I have benefited are listed in the bibliography, and that I have benefited from these sources by means of making references.

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1 INTRODUCTION

Due to the rapid consumption of known natural resources in the world, many disciplines begin to search and investigate new possible energy sources while trying to reduce their overall energy consumption for efficiency. In the light of this, the term energy sustainability (Figure 1.1) has shined through many areas. In a common definition the term sustainability points out the long term viabilities, thus when mentioned along with the energy the idea becomes the efficient utilization of the energy sources for prolonged usage.

Figure 1.1: Energy sustainability can be seen as one of the most controversial topics of the current era

As the population grows fast every year, demand for the energy increases rapidly. In order to compensate this demand, mostly new investments for energy sources have been established. On the other hand, it needs to be realized that this approach should not become the only solution to the problem, thus efficient utilization of existing energy resources should also be considered. This utilization might differ with respect to the various disciplines, yet being its main focus; this thesis will only deal with the perspective of interior architecture.

Winchip (2007) dealt with this issue in residential and commercial interiors. In 2007, he explored some strategies for these interiors. The strategies consist of designing spaces that can easily adapt to the changes with respect to the space activities, employees, and technology while conserving resources, giving occupants access to the thermal comfort controls, and outdoor views. Some of the key topics in his works include all but not limited to the daylighting, design for minimal heat gain or loss, centralized energy management units, energy-efficient lighting systems, efficient usage of space to conserve energy and materials, and specifying low-flow fixtures to conserve water. Moreover in this study while working to utilize efficiency in energy, other factors were also be, automatically considered such as waste management and water consumption (Figure 1.2).

Figure 1.2: Waste management and water conservation should be considered along with the energy efficiency in order to assure optimal performance in sustainability

It should be noted that, although they are different issues, energy consumption, waste management and water consumption serves for the same sole purpose that is to create a sustainable environment.

1.1 Problem Definition and Aims of the Study

As noted before, this thesis will approach the sustainability by means of interior architecture perspective. As a result, the main targets are interior and closed environments. Influenced from the technological development most of the human beings have started to spend their times at indoors. Thus, in order to achieve an optimal and efficient sustainable environment, indoors have the greatest importance.

One of the most important attempts about this topic was done about the problem of hospitality specific environmental strategies. After 2008 due to the financial crises, energy consumption in hotels have been started to be taken into consideration much more. In fact there has been a challenge in hotel industry about the concept of sustainability, due to the fact that; they generally operates 24 hours a day, 7 days a week or 365 full days a year, with guests expecting certain luxuries, such as restaurants, fitness centres, and spas. This poses the problem of how the industry can be sustainable but still maintain the level of luxury that every guest expects when staying at the hotel. This question should constitute one of the main ideas of the thesis that needs to be answered. In the light of this, one of the weakest links in sustainability, hotels, have been chosen as the main target of this thesis. In other words, this thesis concerns about the hotel industries and their energy efficiency.

Figure 1.3: Rapid human circulation in hotels makes it difficult to preserve homogeneous sustainability through seasons

If the studies on sustainability and energy efficiency for hotels are investigated, three categories of studies can be observed. The first category includes the statistical or psychological analysis of energy and water usage and waste products in industries. Lee, W.S (2008), Beccali, M., La Gennusa, M., Lo Coco, L., Rizzo, G (2009), Becken, S., Frampton, C., Simmons, D. (2001), Shiming, D., Burnett, J. (2002), Rahman, I., Reynolds, D., Svaren, S. (2011), Li, W., Liu, Y. (2010), Deng, S.M., and Burnett, J (2002) have studies in this topic. The second category includes the studies of Bohdanowicz, P., Churie-Kallhauge, A., Martinac (2001), Simmons, M.L., Gibino, D.J (2002), Shiming, D., Burnett, J. (2002), Chun-feng, L (2009), Doukas, H., Nychtis, C., Psarras, J. (2009), Zografakis, N., Gillas, K., Pollaki, A., Profylienou, M., Bounialetou, F., Tsagarakis, K.P. (2010), Petkov, P., Köbler, F., Foth, M., Medland, R., Krcmar, H. (2011) where they discuss different technologies for energy saving in hotels. Lastly the third category addresses some case studies on energy saving in different hotels around the world. Studies of Tooman, H., Sloan, P., Legrand, W., Fendt, J. (2009), Bohdanowicz, P., Churie-Kallhauge, A., Martinac, I (2011), Simmons, M.L., Gibino, D.J (2002), Li, W., Liu, Y.(2010), Zografakis, N., Gillas, K., Pollaki, A., Profylienou, M., Bounialetou, F. (2010), and Li, R(2011) can be given as examples to this category.

Developing the performance of our existing building stock is very important. Existing buildings can generally be developed by lower expenses than the costs that would be necessary to destroy and replace them. One of the big differences between creating new constructions and developing existing buildings are the fact that, during the preliminary design phase of remodels and modifications, the existing building structures needs to be restudied more in detail and a whole set of design constraints should be introduced. Although the same design strategies mostly will apply to both, designers do not have much attitude to reshape existing buildings. It should also be considered that amongst the existing buildings, hotels consume more energy than the residential buildings. Because of these facts and difficulties, this thesis focuses on the existing hotels.

When the amount of human circulation is considered, hotels are the weakest links in terms of human related energy conservations, waste managements and water consumptions. Changing human profiles throughout the seasons makes it difficult to control human habits so that precautions that assume efficient usage of sources by visitors are prone to fail. From this point of view solid measures should be taken such as using efficient equipment or tools that provides predefined conservations free from variable human habits.

Figure 1.4: Precautions that assume efficient usage of resources by visitors of hotels are prone to fail due to the changing habits

During this thesis, after the basic information is given in terms of indoor sustainability titles, hotel complexes will be covered in detail. As a case study one of the most premium hotels in Turkey, Güral Premier Tekirova, will be analysed in terms of its energy utilization, waste management and water consumption by using the related statistical data provided by the hotel officials. After the sustainability conditions are examined, alternative solutions will be proposed in order to reduce excessive consumptions, increase energy efficiency, and remove unnecessary applications. After completion, this thesis will be proposed to Güral Premier Tekirova as a base knowledge and alternative study to improve their sustainability conditions.

1.2 Structure of the Study

As mentioned previously, during this thesis basic information was given in terms of indoor sustainability titles.

For this matter chapter 2 of the thesis was devoted to the sustainability in buildings. Inside the chapter buildings were analysed with respect to the energy efficiency, water consumption and waste management. Energy efficiency was considered by means of lighting and HVAC systems. In chapter 3 buildings were taken into consideration in terms of indoor air quality that has direct relation with energy conservation and waste management. Inside the chapter sources of biological and chemical indoor pollutants were discussed, sick building syndrome was explained and reasons of indoor air pollution were introduced in detail. In chapter 4 previous subjects were reconsidered by specifying the subject for the Hotels. While the sustainability issues in hotels were mentioned in general, sustainability strategies of selected two hotel chains, Marriott and Hilton were also introduced and explained in detail. Being the most important section, chapter 5 was devoted to a case study. One of the most premium hotels in Turkey, Güral Premier Tekirova, was analysed with respect to the scope of this study. Acquired energy, water and waste management data from the officials were tabulated and explained in well-defined charts. Using these charts deficiencies of the hotels in sustainability were found and various possible solutions were proposed to overcome these defects. Moreover as the most energy consumption throughout the season is observed in the two storey restaurant section, detailed information such as the seating and ceiling plans including lighting equipment of the restaurant was given and some solutions were also additionally provided.

At the end of this thesis conclusions were given to address issues observed in the study and solutions were summarized.

2 SUSTAINABILITY IN BUILDINGS

2.1 Introduction

This chapter concentrates on energy efficiency by considering four different parts. In the first section, “lighting saving energy opportunities” will be focused, that is followed by the discussion of saving energy opportunities in HVACs. After that, energy efficiency will be discussed by considering water conservation and finally the topic of waste management will be argued.

2.2 Energy Efficiency in Buildings

2.2.1 **Lighting Saving Energy Opportunities**

Throughout the history human beings have needed lighting in their whole lives. Fires, candles, and oil lamps were the first tools to reach artificial lighting and these appliances have been replaced in today’s modern life by their technologically advanced versions. Besides these artificial lights, human beings still trust mostly daylight as it presents enough lighting for daily responsibilities. In the light of this from the beginning architects and builders should take daylight into consideration on their design processes. For instance carrying out construction orientations, configurations, and interior finishes by considering daylight should be very crucial. If these are used in design processes, it is clear that daylighting will be one of the most effective approaches to reduce energy consumption and way to decrease electricity budgets.

It is vital to know that daylighting offers giant opportunities for power conservation, and by this way the finances for lighting operations will have chance to cover small portion of total building expenses over its entire lifespan. On the other hand, it is clear that solely daylight cannot be enough at every time and after sunset artificial lighting will be needed when the daylight does not present. In this part of the chapter the topic of lighting will be divided into the subjects of artificial lighting and daylighting.

2.1.1.1 **Design for the Daylighting**

There are different ways to consider daylight in many design processes. Basically, daylighting can be described as passive solar design where it includes the awareness of constructing paperwork for optimum illumination and overall thermal performance. As a result, daylight designs have to be important for the architects and the designers. However, it should be taken into consideration that daylight design has different objectives at each stage of the building design procedures. These procedures can be explained in four different stages of daylight design. The first one is conceptual design. In that phase building shape, proportion and apertures are influenced by daylight. Second step is design phase. In this phase the daylight influences the decision of the facades, interior finishing and also integration systems. Third phase can be named as construction planning. In this phase the selection of materials and products become significant. Final daylight planning phase is commissioning and post-occupancy. This phase is related with the after construction period. Another important term for daylight design is daylight factor (DF). Daylight factor simply means the ratio of internal illuminance to the unobstructed horizontal illuminance under standard CIE overcast sky condition. Design guidelines in worldwide currently recommend daylight factor which is proposed in the UK in the early 1900s and formalized into building standard today (Hopkins 1960). In fact the relationship between daylight and architectural design is a complicated and wide area that includes many researchers with their unique studies. However, this thesis will not discuss them deeply. In the following part, some of the relationships between daylight and architectural building design will be discussed by considering examples.

Daylight influence on the design processes of buildings is actually extremely old. One of the most important examples can be seen in ancient Egyptian cities. The Paranoiac city of Iunu, referred by the Greeks as Heliopolis or ‘the city of the sun, represented the geographical center of the sun cult that existed in ancient Egypt. The importance of this city is the fact that, it is built along an east - west axis that acknowledges the movement of the sun. The winter solstice sunrise appears in the east in the archway of the axis and the city celebrating the sun god Ra through its majestic pillars (Boubekri, 2008) (Figure 2.1 - 2.2).

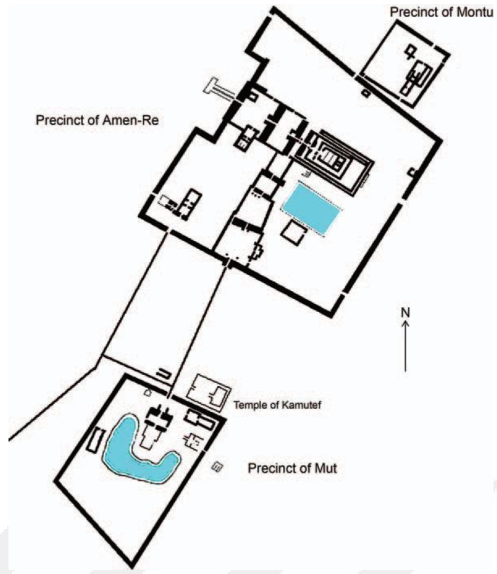


Figure 2.1: Plan of Karnak Temple that is laid out with winter and Summer solstices in mind such that the winter solstice sunrise appears in the archway of the main axis of the temple (graphics by Charles Miller)

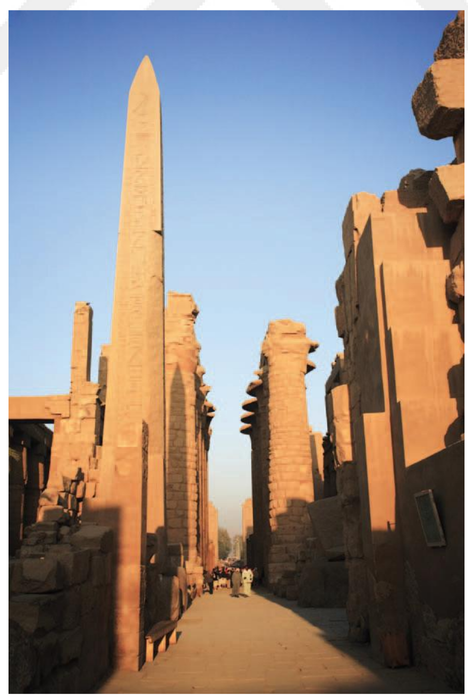


Figure 2.2: The main axis of the temple Karnak with the hypostyle hall at midpoint along the axis (photo by Dreamstime)

Although daylight design has very practical and available source, it still have chances to cause thermal problem in the buildings. Thus, the designs for daylight change according to the climatic conditions. For instance, in a daylighting design, heat and mild temperatures are managed through the shape of the buildings. For example, in a Middle Eastern mosque staying in a sunny weather, confined daylight enters the construction through small windows and due to big decorated ceilings, it bounces to the interior surfaces. On the other hand, in Western European cathedral, the daylight floods the interior with the mild, colored and stained glass from the huge windows. In order to take the advantage of daylight without an excess of heat or glare, the building must be oriented so that the windows will stay on the north and south facets. One of the most important examples can be seen in one of the works of pioneer architect of Modern Architecture, Frank Lloyd Wright. Frank Lloyd Wright shaded the west and south sides from the most excessive solar rays with deep overhangs (Stellman, 1998).

Also sunlight hours are very important for the architectural designs. Sunlight hours vary through the season, the time of the day, and the weather conditions. Greater sunlight is available in summers compared with winters, and through the day solar rays peak at midday. Direct solar rays can be suited for solar heating in suitable weathers, but the glare from direct solar rays have to be managed. Oblique sunlight produces illumination degrees 10 and 20 percent as brilliant as direct sun; however it is still better than the desired interior lightning. Everyday modifications in daytime controls and seasonal modifications inside the period of daylight times may additionally assist accommodation to the converting nature of daylight and prevent from the overabundance of solar rays. Direct sunshine bleaches colors, and the warmth from direct solar rays in buildings is frequently insupportable, especially in summers. In every season, cloudy weather often obscures the solar glare either partly or absolutely. The bottom line of daylighting design is to attain the minimal appropriate amount of herbal illumination when daytime conditions are at their worst, and to screen out extra illumination at other times. For example, the daylight desired to be had at 9:00 inside the morning in December is used as the premise for the worst-case situations.

Daylighting is based totally on subtle daylight or reflected indirect daylight to illuminate interiors. The quantity of herbal mild heating to achieve within a room depends on how plenty of sky is at once seen through windows from a given point in that room. The amount of indirect mild heating from the sky additionally depends on how shiny the visible areas of sky are. The sky at the horizon is not as bright as the sky at the top, so that the nearer the window is to the ceiling, the more extra advantage it's going to get from the daylight as much as possible because solar rays will not be blocked through bushes or buildings. Skylights are very powerful for collecting the brightest light. In figure 2.3 several ways of daylight collecting designs can be seen in building.

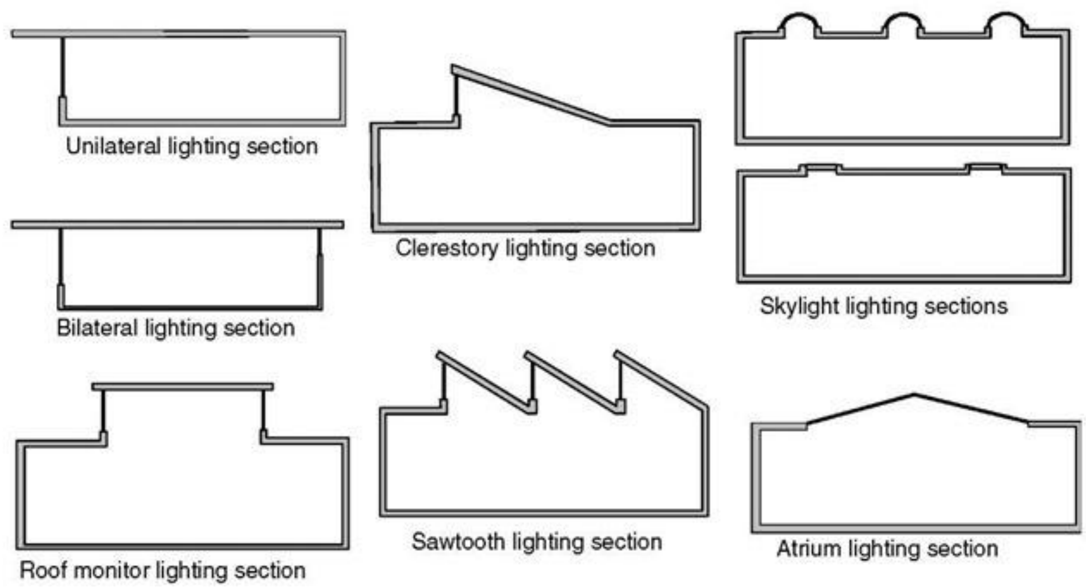


Figure 2.3: Section views of several ways daylight collecting designs in buildings Source; http://what-when-how.com/energy-engineering/daylighting-energy-engineering/ acced date 16.03.2016

In addition to aforementioned effect of daylight to the energy efficiency, another advantage of daylight is its positive effects for the people's health. It is believed that working for an extended time under artificial light may cause harmful effects to human health. On the contrary to this, daylight is believed to relieve people from the stress. In the literature, there are many studies that are related with these additional advantages. Many studies claim that daylight decreases the occurrence of headaches, improves the mood and motivation (Fornto and Anstead, 1994) (Edwards and Torcellini, 2002).

2.1.1.2 **Artificial Light**

By utilizing daylight effectively, energy efficiency can be achieved easily for any building. However, due to the lack of daylight at night time, artificial light sources have to be furnished as well. Thus it is clear that daylighting and artificial lighting should be considered together in each design. Majoros said that, the internal visual environment comes into being by illuminating a room. To reach this, there exist two different components. These two components can be divided into passive and active ones. While furnished room with surfaces reflecting light to a greater or lesser extent is called passive, active components are the sources of light that make the room visible (Majoros, 2011).

Architects and designers generally focus on the aesthetics of lighting in other words art of lighting. However, while the art of lighting is very important in any design, technical knowledge of lighting should also be considered. It is clear that in any design, user needs, visual quality, health issues and also aesthetics should be dealt together.

There exist many criteria about the lighting quality and visibility that any designer should consider. Basically appearance of space and luminaries, color appearance, daylighting integration and control, glare, light distribution, luminance of room surface, modelling of faces or objects, points of interests, shadows, source/task/eye geometry, desirable reflected highlights, surface characteristic, system control, solution flexibility and level of illumination can be listed as these criteria (Rae, M. (Ed.) (2000).

In order to understand lighting in detail, some terminology should also be discussed. Firstly, light is the visible part of the electromagnetic spectrum between the wavelengths of l = 380 - 780 nm. Each wavelength corresponds to a given color. Colors at shorter wavelengths are called cool (colors like purple and blue), while the colors at longer wavelengths are called warm (like orange and red). Figure 2.4 displays the visible radiation (Majoros, 2011).

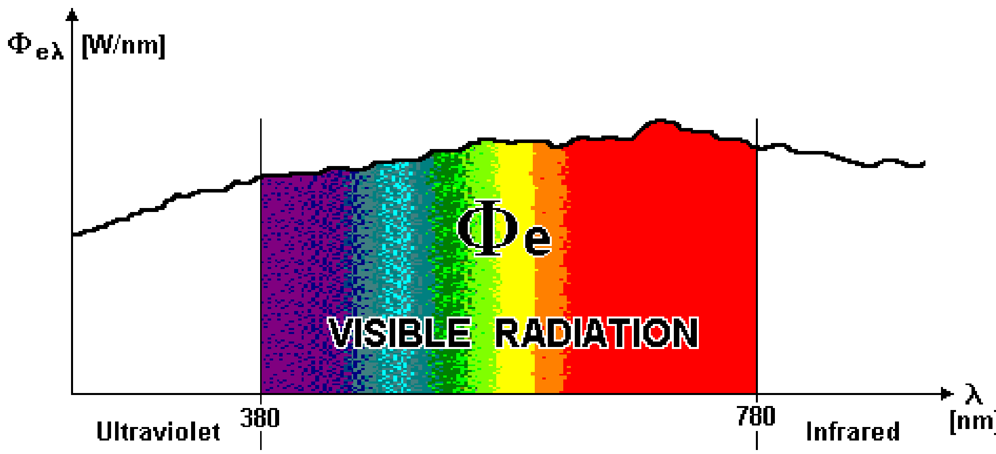


Figure 2.4: Visible Radiation (Majoros, 2011)

The quantity of light emitted by a light source is called as luminous flux. The luminous efficiency is the ratio of the luminous flux to the electrical power consumed (lm/W). It is a measure of a bulb's economic efficiency (Figure 2.5).

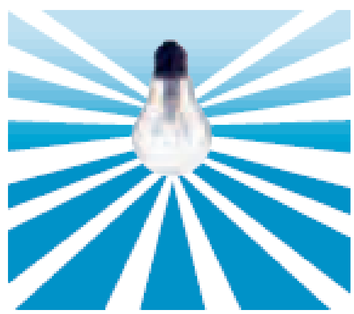


Figure 2.5: Luminous flux

The quantity of light that is radiated in a particular direction is called Luminous intensity. This is a useful measurement for direct lighting elements such as reflectors. It is represented by the luminous intensity distribution curve (LDC) (Figure 2.6).

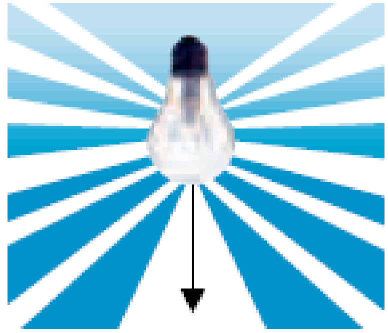


Figure 2.6: Luminous İntensity

Illuminance (Figure 2.7) describes the quantity of luminous flux falling on a surface. It decreases by the square of the distance (inverse square law). Relevant standards specify the required illuminance (e.g. EN 12464 “Lighting of indoor workplaces”).

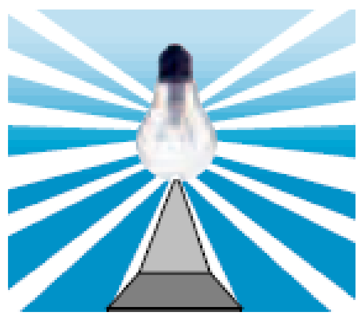


Figure 2.7: Illuminance

The luminance (Figure 2.8) is the only basic lighting parameter that is perceived by the eye. It specifies the brightness of a surface and is essentially dependent on its reflectance (finish and color) (aisrounicamp.br, 2004).

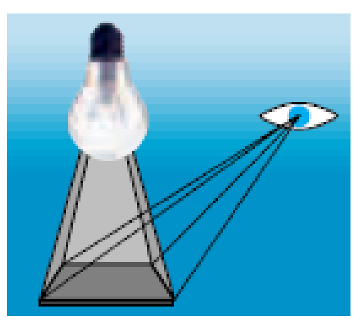
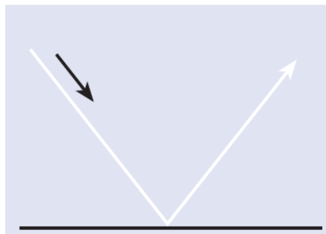


Figure 2.8: Luminance

Reflection is also an important parameter for the lighting. There are three general types of reflections as specular, spread, and diffuse, as shown in figure 2.9-2.11. Specular reflection is the light that reflects at the same angle as the incoming lights. This reflection is occurred in polished surfaces. If the light touches uneven surfaces, it is reflected in many angles this is called spread reflection. A diffuse reflection occurs when rough surfaces reflect light in every direction (Taylor,1990).



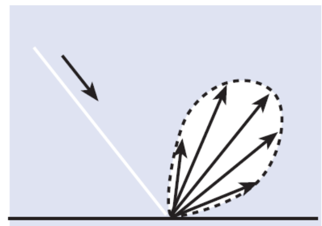


Figure 2.9: Specularreflection **Figure 2.10: Spread Reflection**

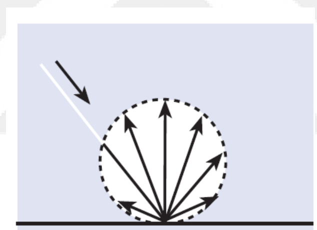


Figure 2.11: Diffuse Reflection

2.2.1.3 **Light source**

2.2.1.3.1 **Incandescent lamps**

Incandescent lamps have been used since Thomas Edison's first carbon filament lamp. At the first days of its invention, it had a lifespan about 40 hours. However, today, incandescent lamps have average lifespans between 750 and 2000 hours (Taylor, 1990).

Incandescent lighting has fewer wavelengths, and therefore seems redder than daylight. As much as 90 percent of the electrical energy used by an incandescent lamp is misplaced to warmth, and the last 10 percent is emitted as a light source. The delivered warmness will increase the building's cooling load. Incandescent lamps typically have short lifespan, approximately 750 hours. Today usage of general incandescent lamps is common in every area. However, the method of using one larger bulb instead of several smaller ones is preferred. One 100 W-incandescent bulb produces more lighting than three 40-W lamps, and uses 20 W less power. Incandescent lamps are strongly affected by the input voltages also. Voltage variations throughout the day also affect their light output (lumens), power (watts), and efficiency (lumens per watt).

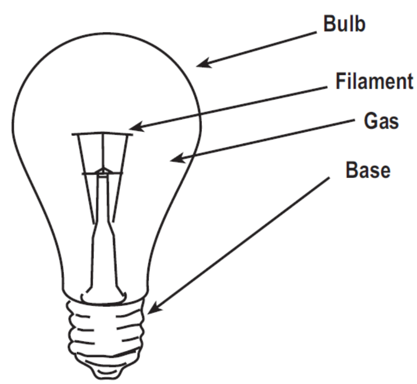


Figure 2.12: Incandescent Lamps

2.2.1.3.2 **Fluorescent lamps**

Similar to incandescent lamps, fluorescent lamps have also very common usage. Fluorescent lamps are sealed glass tubes filled with mercury. An electrical discharge among the ends of the tube vaporizes the mercury vapor and excites it into discharging ultraviolet (UV) light to a phosphor coated internal floor of the tube. Fluorescent mild usually lacks the longer, hotter wavelengths, and for that reason seems bluer than daylight.

Trichromic phosphor fluorescent lamps integrate blue, and red for a highly efficient white light. They can be made cooler or warmer by using conversions of the proportions of primary colorings. Fluorescent ballasts modify the electric current flowing through the fluorescent. This activates the gas within the fluorescent tube. Self-ballasted compact fluorescents have digital ballast as the part of the lamp that screws into the bulb socket. A fluorescent lamp will last about 10,000 hours, even the fluorescent ballast can last for 50,000 hours or more. Fluorescent lamps offer three to five times greater mild for the equal amount of strength than any conventional incandescent lamps, thus lowering application bills. Fluorescent lambs are divided into two types, as Linear Fluorescent Lamps and Compact Fluorescent Lamps (Figure 2.13-2.14).

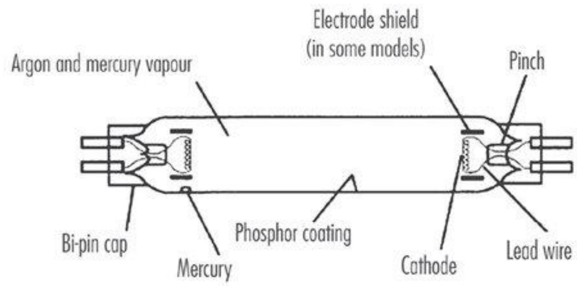


Figure 2.13: Linear Fluorescent Lamb (http://lighting-guide.wikidot.com/h8-fluorescent-lamps-and-ballasts)

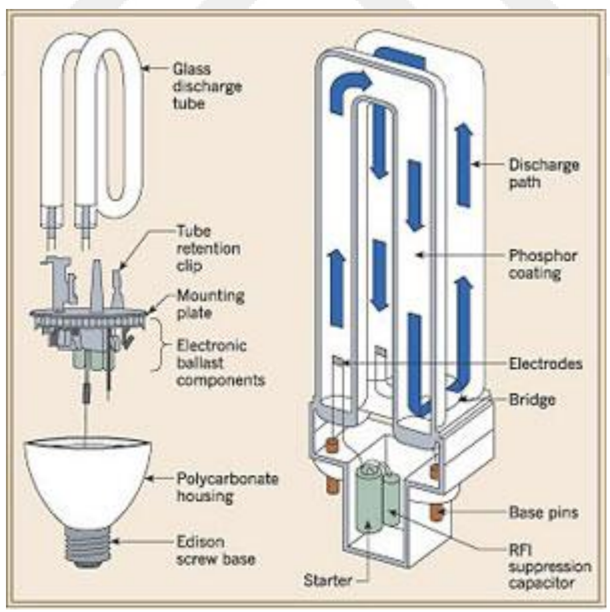


Figure 2.14: Compact Fluorescent Lamb http://www.bulbs.com/learning/cfl.aspx

2.2.1.3.3 **Halogen lamps**

Halogen lamps use a halogen gas fill (typically iodine or bromine), to produce what is called a “halogen cycle” inside the lamp. Tungsten-halogen lamps (usually known as halogen lamps) (Figure 2.15) are an efficient, lightweight, compact light sources that last about 2000 hours. A halogen lamp produces light by means of heating a filament like a standard incandescent lamp. These lamps are available in popular or low-voltage designs, with the standard layout that has around 20 percent more efficiency than a popular incandescent lamp.

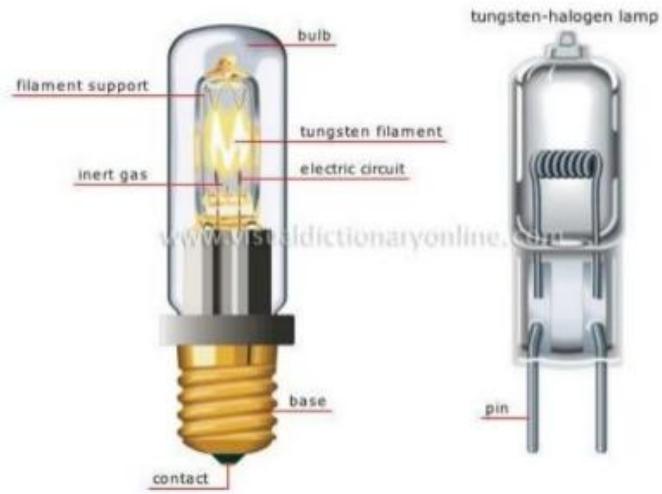


Figure 2.15: Halogen lamps

2.2.1.3.4 High-intensity discharge (HID) lamps

Discharge lamps produce light by passing an electric current through a gas that emits light when ionized by the current. It is known that Excessive-intensity discharge (hid) lamps (Figure 2.16) are even greener than fluorescent lamps, and have 24,000 hours of lifespan. One of the most important properties of High-Intensity-Discharge Lamps is their usability in both outdoors and indoor spaces. There exist four types of high-intensity discharged lamps. These are, high-pressure mercury vapor lamps, metal-halide lamps, high-pressure sodium lamps, and xenon lamps. Mercury vapor lamps have limited usage due to their older technology. They are usually used in road lighting. Metal-halide lamps have improved color rendering, with CRI ratings from 65 to 90 and choices of color temperatures are available. This makes their usage area wider then mercury vapor lamps. Retail stores, atriums, warehouses, airport terminals, street lightings, sport stadiums, building facades, and tunnels are the common places of HID lamp utilization.

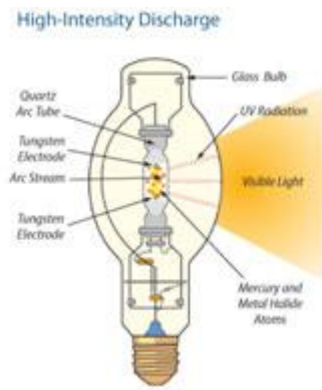


Figure 2.16: High-Intensity Discharge (HID) Lamps
Source http://www.vaklighting.com/hid.html

2.2.1.4 **Lighting controls**

A good lighting design and lighting control result in the achievement of energy efficiency. True lighting control permits the diffusion of lights in a desired workspace with desired light patterns while saving energy. By using control techniques anyone can reduce the consumption of energy by as much as 60 percentages without lowering lighting fixture effectiveness. Reducing energy consumption also means to reduce electricity usages by decreasing unnecessary use of air-conditioning systems and artificial lights by utilizing control automation. These structures can be operated by using computerized and guided tools. Occupancy sensors and automated daytime repayment controls can be given as important examples. Using occupancy sensors and automated daytime repayment controls where suitable, anyone can help to conserve energy. However, dimming, stepped switching, and programmable controls are occasionally used in the applications of agencies.

Management system selections should be made at the same time as the lighting design in an environment to guarantee that controls are appropriate for the light supplies, as well as the system arrangements and accessories are coordinated with the manipulating scheme. During the design many light zones are defined to deal with the scheduling and capabilities of various spaces. Ambient, mission, and accent lighting fixtures are considered in laying out the zones. Each area must be one at a time circuited, and every mission light must have its own switch. Traffic patterns are analyzed, and on/off transfers are positioned at every entrance. Handy lights controls inspire the usage of all feasible lighting combos. The result is ideal illumination where wished, and no wasted energy where any lower light stage will serve simply as nicely. Also user needs and user choices are crucial. For instance, consider a study where a kind of resort ceremonial dinner room should be designed, it is crucial to talk with the individuals who will use the space every day to find how the space should be used. It should also be noted that automatic controls are more powerful than manual controls that depend on one character to select lights tiers for others, specifically in open office areas.

2.2.2 **Energy efficient HVAC systems**

Basically, HVAC systems are used to provide fresh filtered air, humidity control, adequate heating and cooling to the environment in any building individually or collectively by using air conditioning systems and usually it refers to the equipment distribution.

In order to understand the HVAC designs and energy opportunities firstly, the term of air conditioning and ventilation should be discussed. Air conditioning refers treating the air for optimal temperature, humidity and also cleanliness. There exist three basic types of air conditioners as evaporative coolers, chilled water systems, and direct expansion coolers. Direct expansion coolers include window air conditioners, heat pumps and packaged or rooftop units. Chilled water systems use water that is cooled by a refrigeration machine. Unlike the other systems evaporative coolers are usually appropriate in hot and dry climates to let hot air contact with a water spray or damped surface

Ventilation is a process that either supplies or removes air from a space by naturally or mechanically. Crucial point in ventilation is the fact that air must be brought to a certain temperature by makeup air units used throughout the building. If not, it will cause heating instead of cooling. Many methods can be found to control ventilation and the systems around it. (Guide to Industrial Assessments for Pollution Prevention and Energy Efficiency, 2001).

There are many different types of HVAC systems. One of them is a single system that serves as a temperature-controlled zone. Found in small shops or computer rooms where the environment and usage routines generally remain the same. In addition to single zone system, multi zone-systems deliver conditioned air to several zones from a single, central air handling unit. The zones that are served should have similar thermal load requirements such as offices or classrooms. Conditions in each space are maintained by temperature controllers, which control the amount of heated or cooled air to be delivered. Constant volume systems are another example. In these systems the volume of air is delivered to an occupied zone. The temperature is controlled in the zone by a temperature controller that activates heating/or cooling coils. Another system is VAV which also called Variable Air Volume system. In this system VAV boxes exist and air volume in a zone is adjusted via a damper that responds to the zone thermostat that controls heating and cooling coils. Heat pumps are also a type of refrigeration system that draws out heated indoor air in the warm weather to keep the occupied space cool, and removes heat from the outdoor air and transfers it to the inside during cold weather periods. Unit ventilator system is a single, self-contained system in which individual room environment must be maintained separately. This system generally used in hotel rooms, and schools (TSI, 2013)

In picture 2.17 one of the basic HVAC systems is displayed for the homes. In this system fresh and cool air gets drawn into the home and heated by the furnace or boiler. After the air has been heated, it travels through a series air ducts and filters thoroughout the home (green living ideas.)

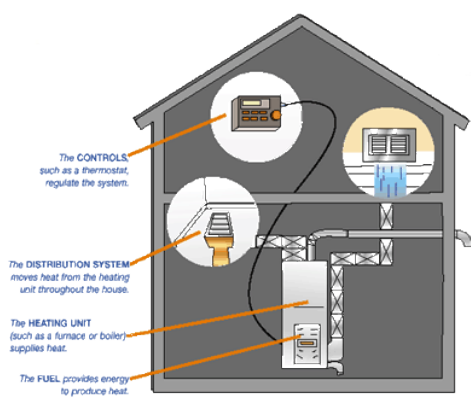


Figure 2.17: HVAC in Homes
http://greenlivingideas.com/2014/09/26/the-basics-of-hvac/ accessed 9.5.2016

2.2.2.1 **Heat recovery and energy conservation**

Energy efficiency is very important for any HVAC design, thus in the literature there are many researches that deal with this topic. To achieve energy efficiency, different controls and optimization strategies have been developed (Ma et all, 2016). On the other hand, these approaches are either expensive or very complicated to implement, and require constant monitoring (Vakiloroaya and Ha, 2013) yet some researchers were able to combine the different HVAC components to create energy-efficient configurations (Vakiloroaya et all, 2014).

Now that each mechanical heating and cooling systems was reviewed, it is time to have a look at how they should be used collectively. A heating, ventilating, and air conditioning (HVAC) machine integrates mechanical equipment into one complex device that is designed to provide thermal air to a construction. The problem of doing this is apparent that a construction may be warm from the sun on one facet, chillier on the other, or equally balanced on a wintery weather day. Keeping people inside the building by maintaining the energy efficiency is very important. In the sixties, when energy fees were low, architects, engineers, and building owners didn't fear about how effortlessly heat is transmitted through the building envelope. Dramatic architectural effects like any-glass buildings took precedence over electricity conservation. Omitting roof and wall insulations were also minimized preliminary building charges.

HVAC designers made the constructions cozy with the aid of mechanical gadgets. Due to the expanded gasoline expenses, power has end up being considered one of the largest expenses in any constructs running price range. A few electricity conservation strategies got here at the rate of consolation. The more building interior is remote from severe outside situations, the cozier the occupants will be. The layout of the building envelope influences comfort in a manner of the fact that it transmits warmth to the surfaces and slowly adjusts air temperature. Air and floor temperatures can frequently be controlled via passive layout techniques. Air movement and air humidity make contributions to the cozy cooling. Access to the outdoor air improves air exceptionally, and additionally it offers daytime view and solar heat on suitable days. There are limits of completions without mechanical structures. It's far hard to get the construction itself to offer good enough air motion for consolation whilst temperatures exceed 31°C (88°F). Without some way to cast off humidity from the air, similar to the North American buildings mold becomes a serious trouble. It is hard to filter out air without the usage of equipment. All of these leave the mechanical designer with the process of identifying whether a mechanical system will complement and modify the conditions from time to time, constantly adjust and manage indoor surroundings, or completely exclude the outside surroundings. The temperature, humidity, purity, distribution, and motion of air inside the interior construction spaces can be all controlled concurrently through an HVAC machine. These systems use air, water, or both to distribute heating and cooling by using electricity. Structures include furnaces that deliver hot air and boilers where warmth water or steam is produced. Some structures include electric warmers that use electrical resistance to transform electric power to heat.

The most effective form of energy conservation is insulating heating pipes with foam or fiberglass. Pipe insulation expenses cost approximately \$0.30 to \$0. Fiberglass pipe insulation must be 19 mm and foam insulation must be 13 mm thick as minimum. One manner to preserve air quality in a building is to use a heat exchanger, which keeps an adequate delivery of heating, ventilating, and air-conditioning. Heat exchangers are regularly covered within heating and cooling equipment, as a part of other gadgets or as separate devices. In tightly constructed small buildings, the incoming and outgoing air streams are regularly adjacent to one another. By means of the usage of a heat exchanger, 70 percent extra of the warmth in the exhausted air can be extracted and used to preheat incoming air. For the first-rate diffusion of fresh air, the heat exchanger should be positioned at the principal pressured-air fan. If there are not any, the heat exchanger should have its very own fan. There are a ramification of kinds of heat exchangers, each with its very own blessings and boundaries. Air-to-air heat exchangers are not to be used on exhaust air streams with grease, lint or immoderate moisture, as from cooking or garments drying, due to chance of clogging, frosting, and health hazards. An integrated defroster that uses power (and accordingly reduces the energy saved through the heat exchanger) is needed for cold winter situations. The outside air consumption has to be cautiously placed, as far as from the exhaust air outlet and far from pollution sources along with vehicle exhaust, furnace flues, dryer and exhaust fan vents, and plumbing vents. Another form of heat exchanger is the recuperation ventilator (ERV), which attracts air out beside a bathroom, and exchanges 85 percent of the heat in this warmed air with incoming sparkling air. The sparkling air is blended with a few returned air, fed to a warmth pump above the ERV, then to different rooms, retaining bad stress inside the bathroom. The ERV gadget has been used in student flats in Greensboro, North Carolina. Power switch wheels are heat exchangers that recover heat from exhausted air in wintery weather and funky dehumidify incoming air in summer season. Each incoming and outgoing streams of air pass through a wheel, wherein they are stored separately by using seals and by using the airflow sample itself. Power switch wheels are about 70 to 80 percent effective in reusing heating or cooling strength. The heat pipe is a heat exchanger that makes use of a refrigerant to dehumidifying and cooling incoming air earlier than it reaches the evaporating coil of the air conditioner, and adds warmth back in after without any extra electricity. Refrigerant is sealed in a bundle of internal tubes with radiating fins. The refrigerant alternately evaporates, condenses, and migrates with the aid of capillary action through a porous wick, inside a self-contained unit. Warmth pipes are 50 to 70 percent efficient, do not have any moving elements so require no protection, and feature incredibly long useful lifestyles. Every other heat recuperation machine makes use of closed-loop runaround coils within the incoming and exhaust airstreams to heat a fluid that is circulated by a pump. Run-around coils transfer heat among consumption and exhaust air. Run-around coils are smooth to retrofit in present homes, and recover approximately 1/2 of the exhaust heat. Open run-around coils use fluid sprayed on the airstreams to take heat and moisture from heated areas and releases it to the cool regions. An economizer cycle makes use of cool air for neutralizing indoor heat gains rather than mechanical cooling. Economizer cycles use routinely establishing dampers to attract big amount of outside air to the ventilating gadget when needed to offset indoors heat. Boiler flue economizers pass the recent gases from a boiler’s stack via the heat exchanger. The heat is then used to preheat incoming boiler water.

2.3 Water Management in Buildings

Water is the source of life. Although the world seems to be surrounded by the water, most of the water (97%) is found in the oceans. In the light of this it can easily be calculated that only 3% of the water is freshwater. On the other hand two-thirds of 3% is tied up as an ice in glaciers. Thus just 1% freshwater exists in rivers, lakes, and underground sources. As many things in the life depend on water, the conservation issue of water is very crucial.

In the past, efforts to improve water and energy efficiency have been widely pursued separately. On the contrary to this water conservation today causes energy savings directly. Water utilities use energy to pump and treat the water, the customers use energy to heat, cool or pressurize the water, and waste water utilities use energy to treat and discharge wastewater. Thus each of these operations is possible targets to consider in saving energy. True water conservation causes important benefits. Not only it causes to save water and energy but also prevents water supplies from harm and extinction.

Many communities use groundwater for their water supplies, and they view groundwater pumping as an ideal resource because it is convenient and groundwater is readily available. However, it is known that this is not valid for many countries. Water table levels are dropping across the countries as groundwater recharge is exceeded by groundwater pumping (Glennon, 2002) Today, about 8% of energy is being used for freshwater withdrawn worldwide and as much as 40% of the freshwater is withdrawn in some developed countries (WEF, 2011; IRP, 2012). Energy demand on present trends will increase by one-third from 2010 to 2035, with 90% happening in non-OECD countries (IEA, 2012). Water needs for energy production are set to grow at twice the rate of energy demands (IEA, 2012; National Geographic, 2013).

Water conservation should be considered both personally and publicly. For example, as personal precautions replacing regular shower heads with low-flow shower heads or flow restrictors, taking shorter showers by one to two minutes, taxing leaky faucets or pipe joints will save nearly 20 gallons per day, fixing or shutting-off dripping faucets will save about 15 gallons each day. Also selecting the proper water level for laundry since many clothe washers of today allow the control the amount of water to be used (www.ripuc.org).

In public, one of the most important things should be the variety of policies and programs that can be implemented by communities to encourage efficient water use (U.S. EPA 2000, pp. 1-2). Glennon claim that some programs are easier and less costly to use for water–efficient technologies (Glennon 2005,). On the other hand, water use regulations should be developed. Some restrictions, bans or standards should be constituted (Arnold 2009). Also, water pricing and metering are very important. According to Thomsan, communities that begin metering after charging a flat rate for water, regardless of the amount used, have seen water use reduced by approximately a third (Thomsan,2005)

On the other hand water utility measures have also important for the water conservation. There are many things that can be done for the water utility measures. Water accounting and loss control, water use audits, information and education, replacements and promotions, recycling municipal effluent, and pressure management can be given as examples (U.S. EPA 1998,and Glennon 2005).

2.3.1 Water conservation in buildings

The first important things for the water conservation can be described as the understanding water usage as dynamically and identifying improvement options. Improvement options are depend on the function of the type of the building.

	Toilets	Showers	Sinks	Laundry	Kitchen	Heating/Cooling	Landscaping	Pools	Sterilization
Residential	x	x	x						
Hotels	x	x	x	x	x	x	x	x	
Hospitals	x	x	x			x	x		x
Schools	x		x		x		x		
Offices	x		x			x	x		
Shopping centres	x		x		x	x	x	x	

Table 2.1: Areas of main improvement potential in different types of buildings (Source: www.afedonline.org/)

Water leakage from toilets, faucets, and plumbing fixtures are responsible for as much as 10 to 30% of water losses (www.ec.gc.ca). Therefore, detecting and repairing leaking fixtures forms a good starting point for efficiency improvements. In addition to these, dripping taps, faucets, and shower heads, leakage in toilet flushes, a misplaced or broken flap, continuous overflow, storage tanks, pipes, joints, and valves are also important.

In buildings, toilets and urinals are one of the main important considerations for the water conservation. Let's consider the simplest solution to decrease the water usage in toilets. If the toilet is an older model, a simple but effective measure to conserve water is to place a displacement object inside the toilet cistern. By the help of this system, a volume displacement object can save up to 30% water. If the toilet is a modern one, low-volume or dual mode flush systems should be used. While the conventional flush system uses more than 11 liters of water per flush, modern low-volume, dual-mode flush systems use approximately 3 - 4,5 liters per flush (Figure 2.18-19). Another potential solution is to use vacuum-toilets. These systems operate by the help of a pump so they use minimal water. Using such systems water consumption can be reduced to as low as 0.5 liter per flush.

Figure 2.18 A volume displacement **Figure 2.19: A volume displacement**

In addition to these, grey water is also alternative system for the water conservation. In this system the collected water is filtered, disinfected and stored ready for the next toilet flush (Figure 2.20).

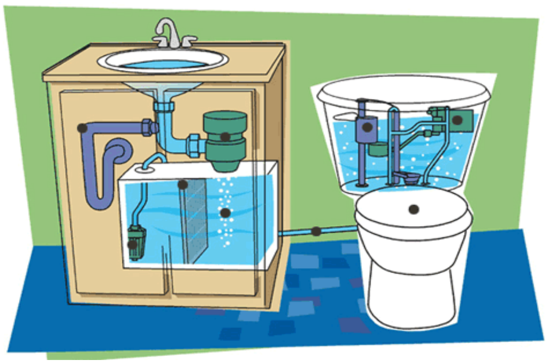


Figure 2.20: Greywater System

Greywater system has many advantages. Implementing grey water systems may result in a substantial cost savings, both in fresh water and sewage costs. Using grey water lessens stress on the municipal sewage systems and water supplies, which is especially important in times of drought or water rationing. Grey water systems can be implemented in new homes, and also retrofitted into older homes. Moreover, some new devices may be added to these systems to capture and utilize heat from grey water such as hot water from shower. Today many countries and municipalities offer tax incentives for implementing grey water system. However, this system has many drawbacks also. They may cause some health hazards, so expensive permits are required to build legal grey water systems (www.nachi.org).

Another useful system can also be added to the grey water system. This system is called water harvesting system. Landscape irrigation is often well-suited using alternative sources of water, such as grey water, harvested rainwater or even treated wastewater (Figure 2.21).

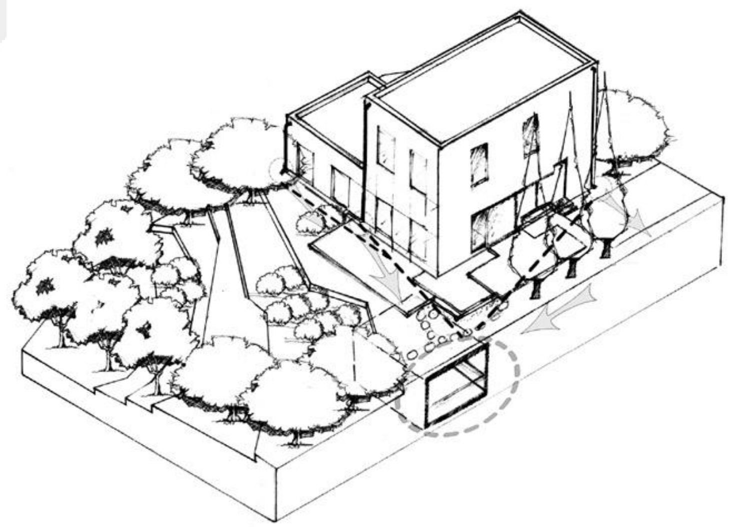


Figure 2.21: An active water harvesting system

2.4 Waste Management in Buildings

Waste Management is an interdisciplinary area between engineering and ecology. It is an important and crucial topic for the developing countries. Before discussing the waste management, the term “waste” should firstly be focused on. The Environmental Protection Act, 1990 defined the waste as a wide ranging term encompassing most unwanted materials. This definition includes any scrap materials surplus, broken or spoiled goods (defra.gov.uk).

The Environment Agency divides wastes into two groups. The first one is controlled waste which includes household, industrial and commercial wastes. This category is also divided into two groups as special/hazardous waste and regular waste. The second one is non-controlled waste that includes wastes of agriculture, mines and quarries. Hazardous wastes are substances which are potentially hazardous to human health and/or the environment. Thus, hazardous wastes need special disposal techniques to eliminate or reduce the hazards posed (Meakin, 1992).

Waste management methods cannot be uniform across regions and sectors because individual waste management methods cannot deal with all potential waste materials in a sustainable manner (Staniškis, 2005).

In waste management the three R is commonly used terms that refer to "reduce, reuse and recycle". Mainly the waste management hierarchy needs to reduce the amount of waste created then reuse these wastes, recover them and at the final step disposal. (El-Haggar, 2007; Seadon, 2006; Suttibak & Nitivattananon, 2008; Tudor et al., 2011).

REDUCE AMOUNT PRODUCED
REUSE WASTE
RECOVER WASTE (recycling, composting, waste to energy)
Send to Landfill

Table 2.2: Waste Management Hierarchy

Waste reduction and reuse are both methods that are related with waste prevention. Both methods aim to eliminate the production of waste and reduce the demands for larger scale treatment. All of the methods of waste prevention that are mentioned require public participation. Training and educational programs should be organized by the governments in order to get the public onboard.

Recycling refers to removal of items from the waste stream to be used as raw materials in the manufacturing of new products. Recycling includes three phases as collection of the wastes, generation of raw materials, using those materials for new products (Figure 2.22).

Figure 2. 22: Colour coded recycling bins for waste separation at the source of production

In some instances, additional R`s can be added to the basic three. Some organizations have chosen to add a fourth R (Concordia University, Davis 2008). The fourth R can represent different words including rebuy (UC Davis, 2008), rethink (Concordia University, U of T, 2008), and recover. Rethink refers to changing our behavior and our actions for the improvements in waste management. Rebuy refers to the consumer purchasing decisions to buy recycled or used products.

3 HEALTY BUILINGS

3.1 Introduction

Although many of us consider air quality and air contamination as mostly open air issues, they are turning out to be progressively regular in advanced structures. One of the proofs of this can be given as sick building syndrome (SBS). SBS can be described as a situation in which inhabitants of the constrained spaces especially buildings experience health problems and discomfort issues (Figure 3.1).

Figure 3.1: Sick building syndrome can be seen in terms of various symptoms in the inhabitants of the buildings (Sources: Confortok, RTK, Zepter)

Despite no specific disease or illness can be identified, symptoms increases directly proportional to the time spent in a particular zone or the whole building. Headache, dizziness, nausea, eye, nose or throat irritation, dry cough, dry or itching skin, difficulty in concentration, fatigue, sensitivity to odors, hoarseness of voice, allergies, cold, flu-like symptoms, increased incidence of asthma attacks and even personality changes are some of the symptoms of SBS (Joshi, 2008).

Despite of the fact that SBS is a common situation nowadays, the main reason of it has yet to be found. On the other hand some of the factors that might be primarily responsible for SBS (Figure 3.2) can be listed here as,

- ***Chemical contaminants:*** As mentioned in previous sections chemical contaminants can be originated from both outdoor and indoor sources. Traffic around the buildings, industry zones, paints and synthetic materials used as decorations are some of the sources that have increasing effect on SBS

- ***Biological contaminants:*** Biological contaminants can be pollens of the flowers, bacteria and viruses reproduced in filthy locations, fungus and moulds in humid environments, etc. These contaminants can breed in every section of the building such as stagnant water that has accumulated in humidifiers, drainpipes and ducts or where water has collected on ceiling tiles, insulation, carpets and upholstery (Joshi, 2008). Moreover, in closed and crowded environments airborne diseases can also spread rapidly from one person to another causing mass infestation. It should also be noted that unless filtered, air-conditioning systems can recirculate pathogens and spread them throughout the building.

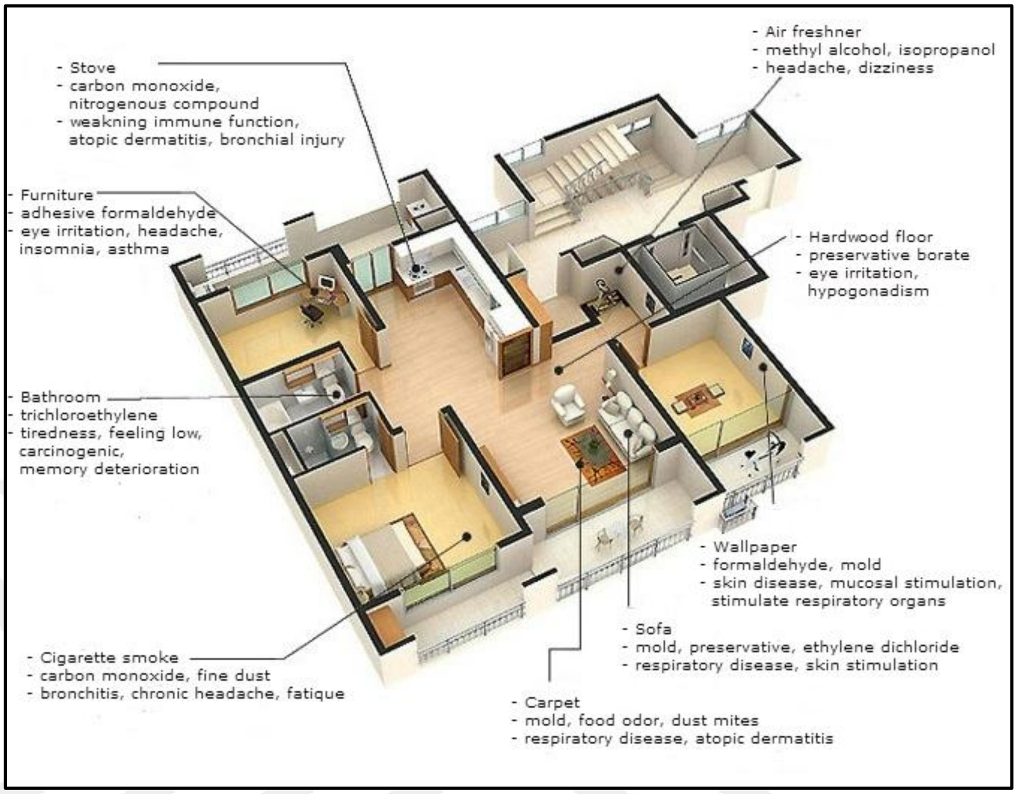


Figure 3.2: Some of the chemical and biological sources of sick building syndrome in a regular home. (Source: Unitedonegroup)

- ***Inadequate ventilation:*** From the beginning of early 1970's designers have been started to create air tight buildings due to the importance of energy efficiency. Although energy losses are reduced by the help of isolation from outdoors, amount of ventilation per single inhabitant in these buildings are reduced. This factor has been multiplied in case of inadequate air ventilations that are caused by malfunctioning filtering equipment, heating and ventilating systems.

- ***Electromagnetic radiation:*** By the help of technological development, most of our environments are filled with wired or wireless devices that are the sources of electromagnetic radiation such as, microwaves, wireless modems, excessive wirings, cell phones, etc.

- ***Inappropriate lightning and location of the offices:*** Researches related with SBS have revealed that, the symptoms are seen mostly in people with clerical jobs other than the people with managerial jobs. The reason behind this is the fact that managerial offices are mostly well lit and conditioned places by the help of sunlight and personal windows for natural ventilation. On the other hand public sectors of the buildings are mostly air conditioned without natural ventilation and lit by the help of artificial lightning.

In order to prevent the inhabitants of the buildings from the sick building syndrome, many precautions and prevention measures can be taken as:

- Increasing the ventilation rates using adequate air ventilation with respect to the standards and building designs.
- Carrying out the maintenance of the ventilation systems regularly.
- Separating or isolating the rooms that include chemical pollutant sources such as copier machines, cleaning materials, etc. using appropriate standards for their ventilation.
- Replacing the filthy or used materials from the air conditioning systems regularly within their life span.
- Increasing the usage of glass between the offices that helps the sunlight entering indoors.
- Increasing the usage of indoor plants that can absorb harmful chemicals from the air.
- Ventilating the overall system with fresh air in regular intervals.
- Banning of smoking in closed environments, etc.

3.2 Healthy Indoor Environments

3.2.1 Indoor air quality

Proportional to the technological advancements in the world, most of our lives continue in closed environments as factories, offices, residential areas etc. As human beings spend most of their times in these places indoor air quality gains great importance to preserve healthy living conditions.

As it was mentioned in the study of Ağca (2005), environmental problems will be enlarged by the increasing population in the future, thus all of these people will start being exposed to the risks of chemical and physical agents in their homes and work places. Combining this idea with the fact that in recent years people spend about 80 percent of their time at indoors (Figure 3.3) such as, sport centres, shopping malls, work places and their homes where they can mostly accomplish their needs by the help of world wide web, it can be easily seen that preservation of the indoor air quality in healthy levels will reduce the risks of health issues. In the light of this, interior designers have great responsibility in the choice of materials, objects and systems to help improving indoor air quality. Therefore the quest to reach a sustainable and healthy environment is crucial (OSHA, 2011).

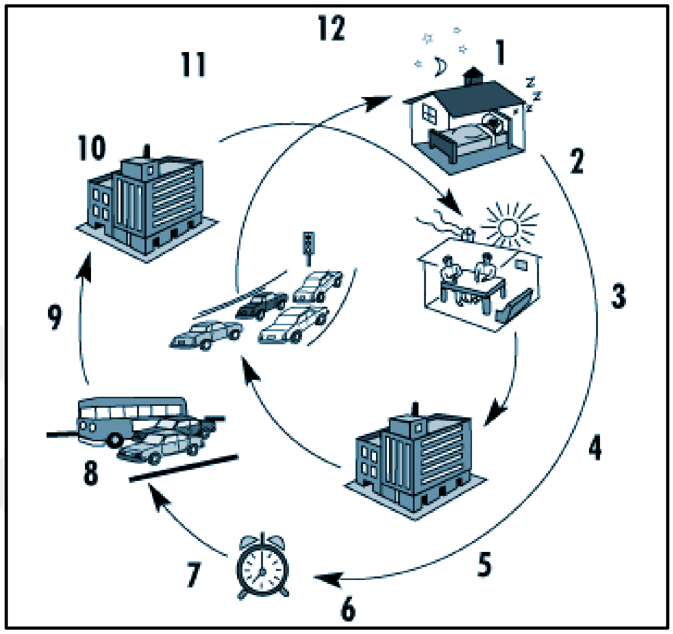


Figure 3.3: In today's era People spend most of their time in closed spaces. (Source: Encyclopedia of occupational health and safety)

In order to create comfortable indoor environmental conditions that are independent of the changing outdoor climates, the air within these spaces have to be conditioned. Although preserving air quality in these environments are number one priority, efficiency and cost effectiveness should also be considered. Thus, it is necessary to control the unconditioned air entering the buildings from the outside. The result was increasingly airtight buildings and more stringent control of the amount of ambient air that was used to renew stagnant indoor air (Calleja 1998).

The quality of indoor air can be measured among three aspects as satisfying thermal requirements, removing unhealthy pollutants, and finally creating a healthy environment. Utilization of these indicators enables optimum quality of indoor spaces. As mentioned before, unhealthy pollutants are one of the main concerns in preserving air quality. There are enormous indoor pollutants being both biological and chemical that are spreading through closed spaces due to combustion, wastes, chemicals used in furniture, materials used in decorations and furnishings. When these toxic pollutant concentrations increase within the closed spaces, they start risking human health greatly. In order to clarify the seriousness of the risk, some of the illnesses associated with indoor air quality were depicted in figure 3.4

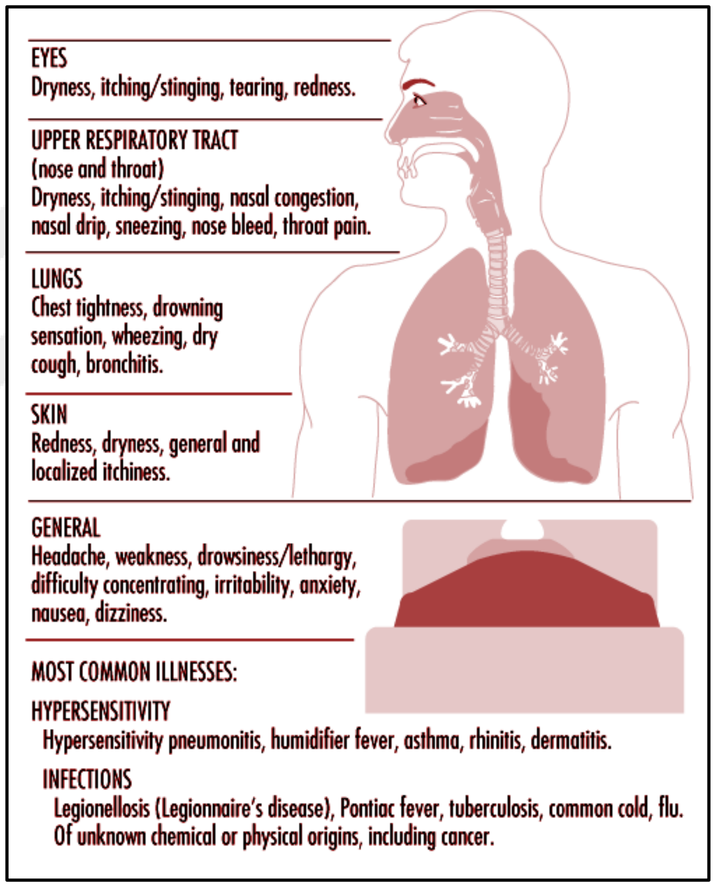


Figure 3.4: Some of the illnesses associated with indoor air quality (Source: Imgarcade)

In order to decrease these health risks and provide necessary indoor air quality, closed spaces should also be refreshed by using conditioned outdoor air rather than being air tight. By this way concentration levels of the pollutants in these spaces can be held within legal limits.

3.2.2 Source of indoor air pollution

Most of the time human beings think that outdoor air pollutants are more critical when compared with indoor air pollutants. On the other hand indoor environments including but not limited to theatres, dancehalls, workplaces, shopping malls, hotels and accommodations have more negative impacts to human health when compared with outdoor environments. Most of the time in closed spaces indoor air quality becomes inferior to outdoor air quality if precautions are not to be taken. There are more than 300 varieties of contaminants that may be detected in interior spaces. As a result nearly 60 percent of the human sicknesses are related to indoor air pollutants. The most common sources of indoor air pollution are smoking, decoration materials, cooking fumes, microorganisms and viruses (Figure 3.5).

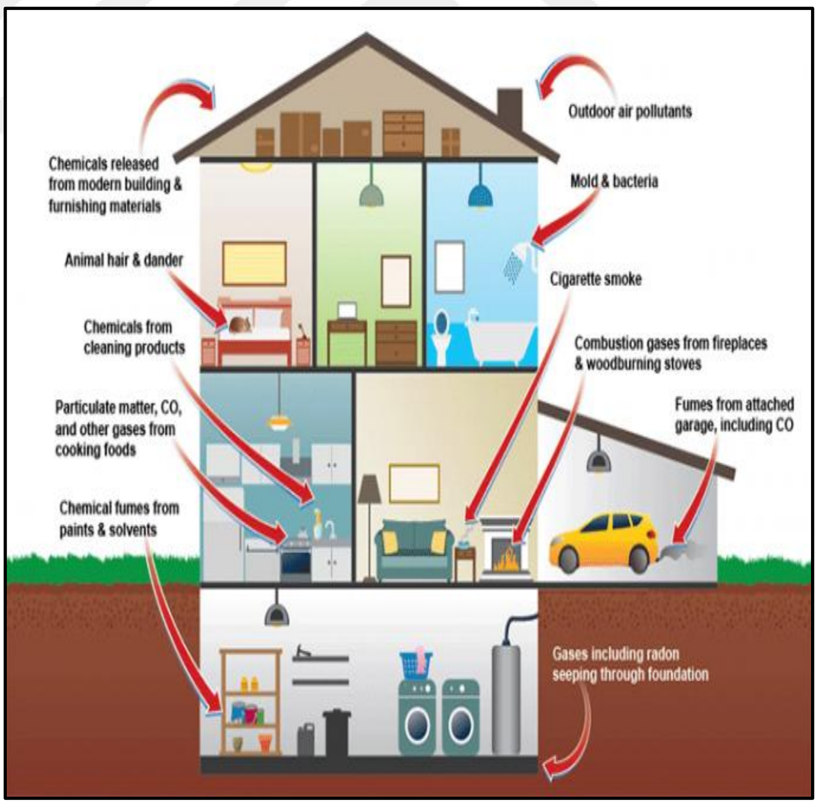


Figure 3.5: The most common sources of indoor air pollution (Source: National dwellings survey)

These sources can be accumulated by the human body through respiration in the long term in severe limits that results in serious health problems.

3.2.2.1 **Respiration & smoke**

One of the most neglected indoor pollutants is actually due to human metabolic processes. During these processes human body produces more than 500 distinct chemical substances and nearly one third of them are discharged by the help of exhaling (Figure 3.6). Taking this into account and considering the remaining one third that is discharged by the skin, it is not difficult to understand the severity of the problem. If the closed spaces are poorly conditioned, concentration of these chemicals are quickly increased that will result in biological pollution affecting human health negatively.

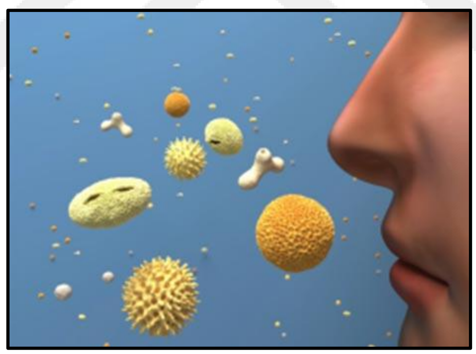


Figure 3.6: Nearly one third of the biological pollutants and chemicals are discharged through exhaling

Smoking can also be seen as one of the major indoor air pollutants as the number of smokers in the world cannot be underestimated. Due to the fact that various chemicals are discharged to the air during smoking in tobaccos and its flavor chemicals burning process, excessive concentrations of them in air are proved to increase the chances of cardiovascular diseases and cancer on human beings via inhaling (Figure 3.7).

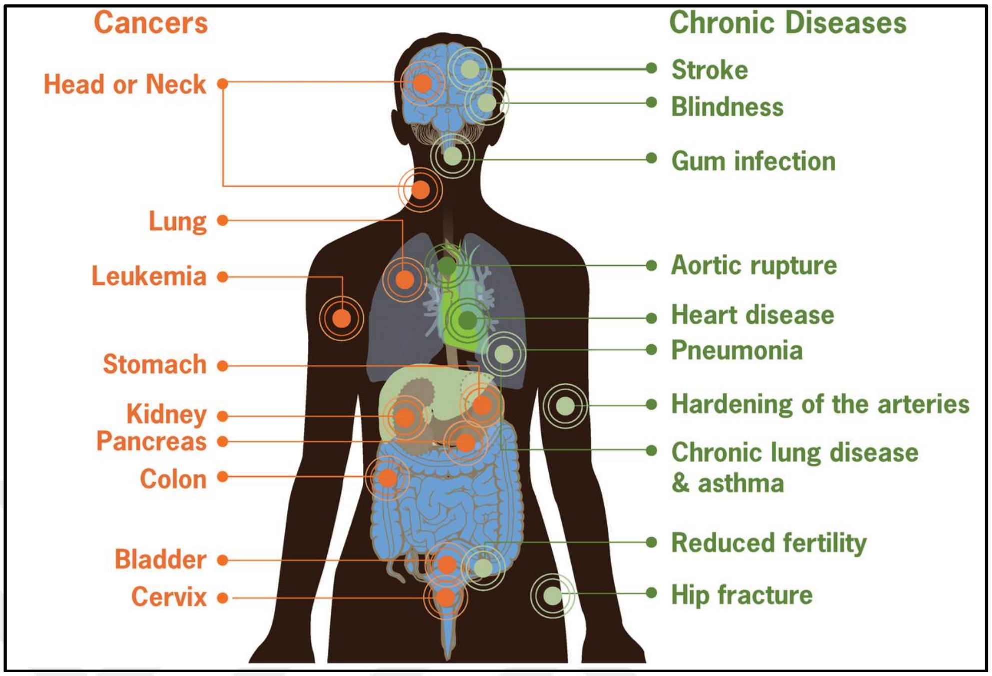


Figure 3.7: Places in human body that smoking may cause damage (Source: Wikimedia Commons)

3.2.2.2 Smoke in kitchen spaces

Although they are underestimated, kitchens are the worst places in terms of air pollution in our homes especially under bad ventilation. Due to the excessive kitchen smoke, gasoline combustion, high temperature oil oxidation and decomposition (Figure 3.8), there exists an increased chance of lung cancer in those who spends most of their times at the kitchens unless the environment is well ventilated. Also in pure air ventilation increased concentration levels of carbon monoxide, and nitrogen oxide produced by the fuel equipment have harmful effects on human body.

Figure 3.8: Kitchens are the most underestimated places that cause air pollution due to pure ventilation (Source: Pixabay)

In order to emphasize the fact, a research was carried out to find the reasons of increased lung cancer (adenocarcinoma) rates in urban women although this cancer type has small link to the smoking. Further investigation of the subjects revealed that most of the cases spend their times at kitchens with limited or neglected air conditioning and exposed to the air pollution in kitchens excessively.

3.2.3 Indoor air pollutions in buildings

As mentioned before, there are various indoor pollutant sources located in our vicinities that may cause both biological and chemical air pollution. In the light of this, World Health Organization (WHO) published a scientific guideline in 2010 for public health professionals. In this guideline, the most common hazardous indoor sourced chemicals that induce health risks were listed and explained in detail.

3.2.3.1 Bezene

The reasons of the concentrations of benzene in indoor air can be classified into two groups as indoor and outdoor sources (Figure 3.9). Indoor sources include but not limited to the building materials, decorative components, furniture, paint, wood panelling, PVC and rubber materials, garages, heating and cooking systems, and stored solvents inside the buildings. Due to the fact that indoor air usually exchanged with outdoor air via either forced or natural ventilation, concentration levels at outdoors are also contributes to the indoor concentrations. The main sources of outdoor benzene concentrations are related with the traffic, petrol stations and exhausts of industries that deal with coal, oil, natural gas, steel etc. With respect to the climate conditions and the locational properties these sources contributes negatively to the indoor air quality.

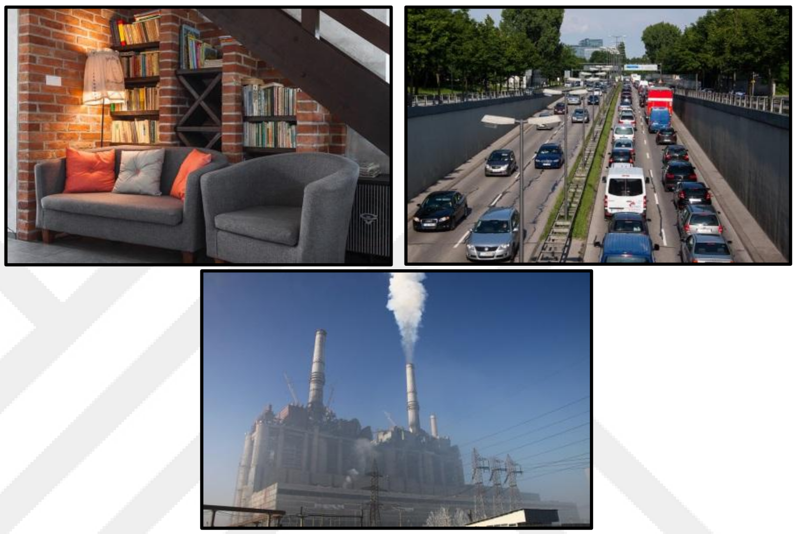


Figure 3.9: There are both indoor and outdoor sources that contribute to indoor benzene concentrations (Source: Pixabay)

It should be noted that benzene is a genotoxic carcinogen to the humans that can cause leukaemia and there exist no safe exposure levels to it for this reason. Exposure to benzene at outdoors has the same risk levels with the indoor exposure so that the same precautions should also be taken in indoors as well as outdoors. These precautions include reducing or eliminating the usage of materials at indoors that releases benzene in short or long terms, avoid using solvents for cleaning or hobbies, avoid smoking in indoors, and ensure adequate air ventilation.

3.2.3.2 Carbon monoxide

Carbon monoxide (CO) is a colourless, non-irritant, odourless and tasteless toxic gas. It's mostly produced via the unfinished combustion of carbonaceous fuels including timber, petrol, coal, herbal gasoline and kerosene. Due to the fact that molecular weight of carbon monoxide is similar to the air, it can mix freely with air in any proportion. It's flammable, reacts vigorously with oxygen, acetylene, chlorine, fluorine and nitrous oxide. Carbon monoxide cannot be detected by humans either by sight, or taste and smell. It's slightly soluble in water, blood serum and plasma and may react with haemoglobin to form carboxyhaemoglobin (COHb). Carbon monoxide is produced indoors via combustion sources during cooking and heating. Similar to the benzene, it is also brought from outside air into the indoor surroundings.

In evolved countries, the main critical source of carbon monoxide exposure in indoor air is the emissions from faulty, incorrectly placed, poorly maintained or poorly ventilated cooking or heating home equipment that burn fossil fuels. In developing countries, the burning of biomass fuels and tobacco smoke are the most important sources of carbon monoxide. Clogged chimneys, wood-burning fireplaces, ornamental fireplaces, gasoline burners and supplementary heaters without safety features always vent carbon monoxide into indoor areas (Figure 3.10). Incomplete oxidation at some point of combustion in these sources may additionally cause excessive concentrations of carbon monoxide in indoor air. Tobacco smoke can also be a main supply of indoor carbon monoxide exposures.

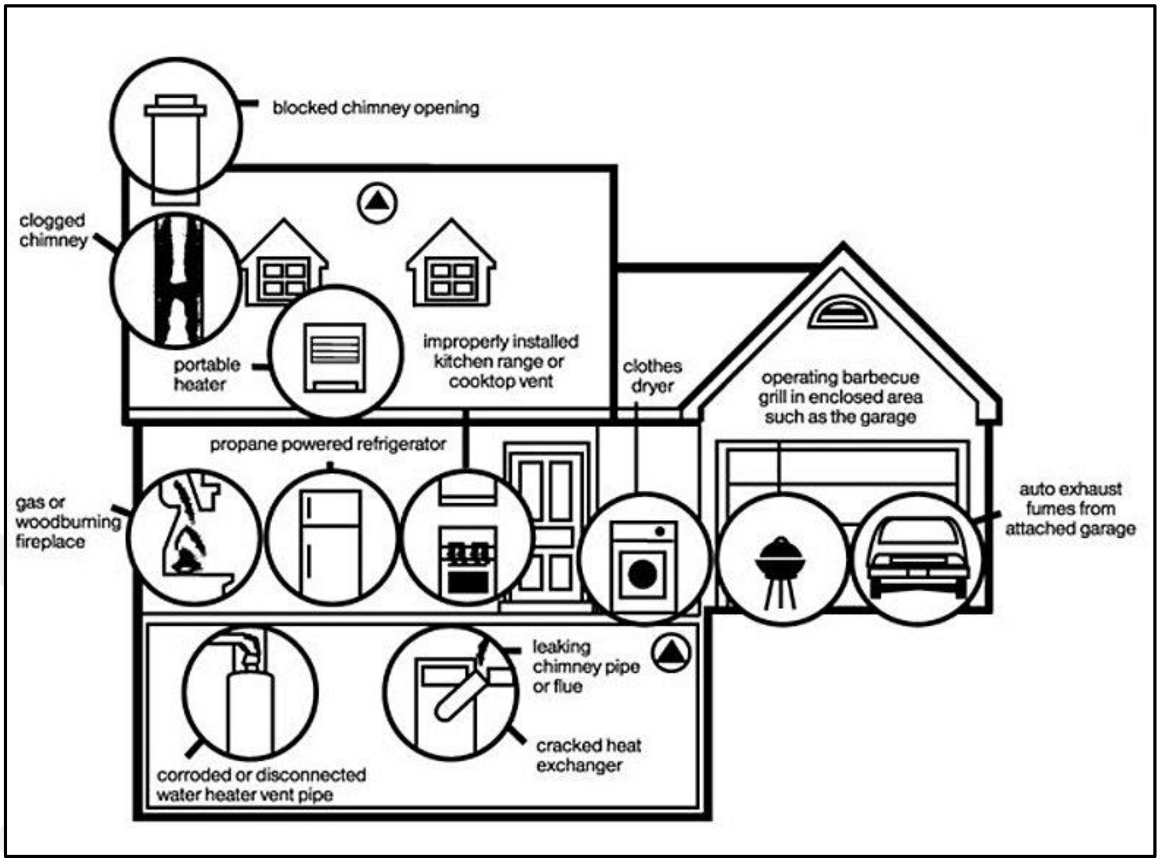


Figure 3.10: Common sources of carbon monoxide pollution at indoors (Source: CNX)

3.2.3.3 Formaldehyde

Formaldehyde is a colourless gas that is flammable and highly reactive at room temperatures. In ambient air, formaldehyde is quickly photo-oxidized in carbon dioxide. It also reacts right away with the hydroxyl radicals to form formic acid. The half-life estimated for these reactions is about one hour depending on the environmental conditions.

According to Salthammer, Mentese, and Marutzky (2008), indoor sources of formaldehyde are combustions in case of smoking, heating, cooking, or incense burning. However, fundamental resources in combustion free environments are building substances and customer merchandise that emit formaldehyde (Kelly, Smith, Satola, 1999). Although emissions due to furniture and materials apply mostly to the new products, emissions can last several months in situations with excessive relative humidity and excessive indoor temperatures (Hodgson, Beal, McIlvaine, 2002).

Formaldehyde sources in indoor environments also encompass: wood products containing formaldehyde based resins which includes particleboard, plywood and medium-density fibreboard; insulating materials; textiles; do-it-yourself products consisting of paints, wallpapers, glues, adhesives, varnishes and lacquers; household cleansing merchandise inclusive of detergents, disinfectants, softeners, carpet cleaners and shoe merchandise; cosmetics inclusive of liquid soaps, shampoos, nail varnishes and nail hardeners; electronic equipment, consisting of computers and photocopiers; and different client items which include insecticides and paper product. Figure 3.11 shows the sources of formaldehyde in indoors.

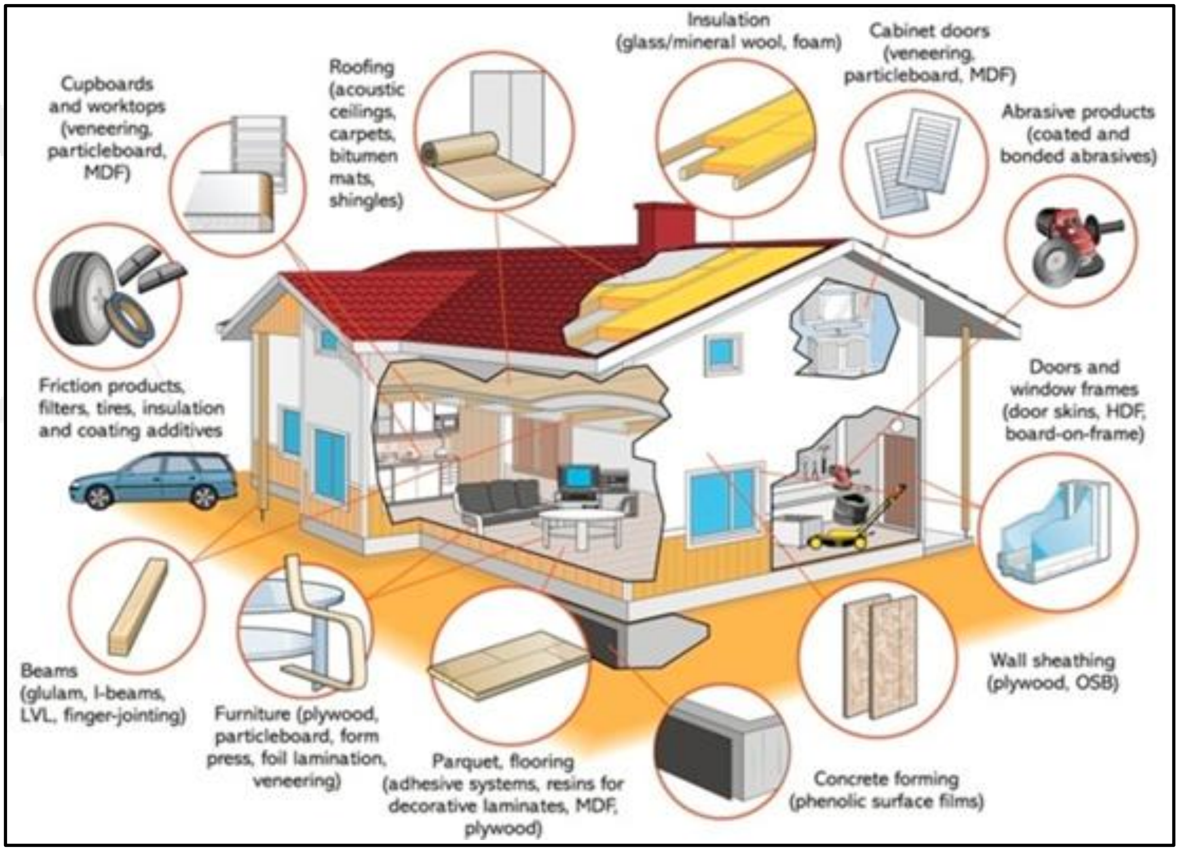


Figure 3.11: Common sources of formaldehyde pollution at indoors (Source: Graphic Courtesy of Dynea)

3.2.3.4 Radon

Radon gas is an important source of ionizing radiation of natural origin and a major contributor to the ionizing radiation dose received by the general population. It comes mainly from exposure to radon and its airborne decay products in the homes of the general population. Radon, which has a number of isotopes, is a naturally occurring colourless and odourless radioactive noble gas (WHO, 2010). Radon can be found in the earth everywhere. The main supply of radon in indoors is the actual land where the actual building locates and the construction materials. Side sources can be given as natural gases, water, and air with respect to the increasing order (Figure 3.12).

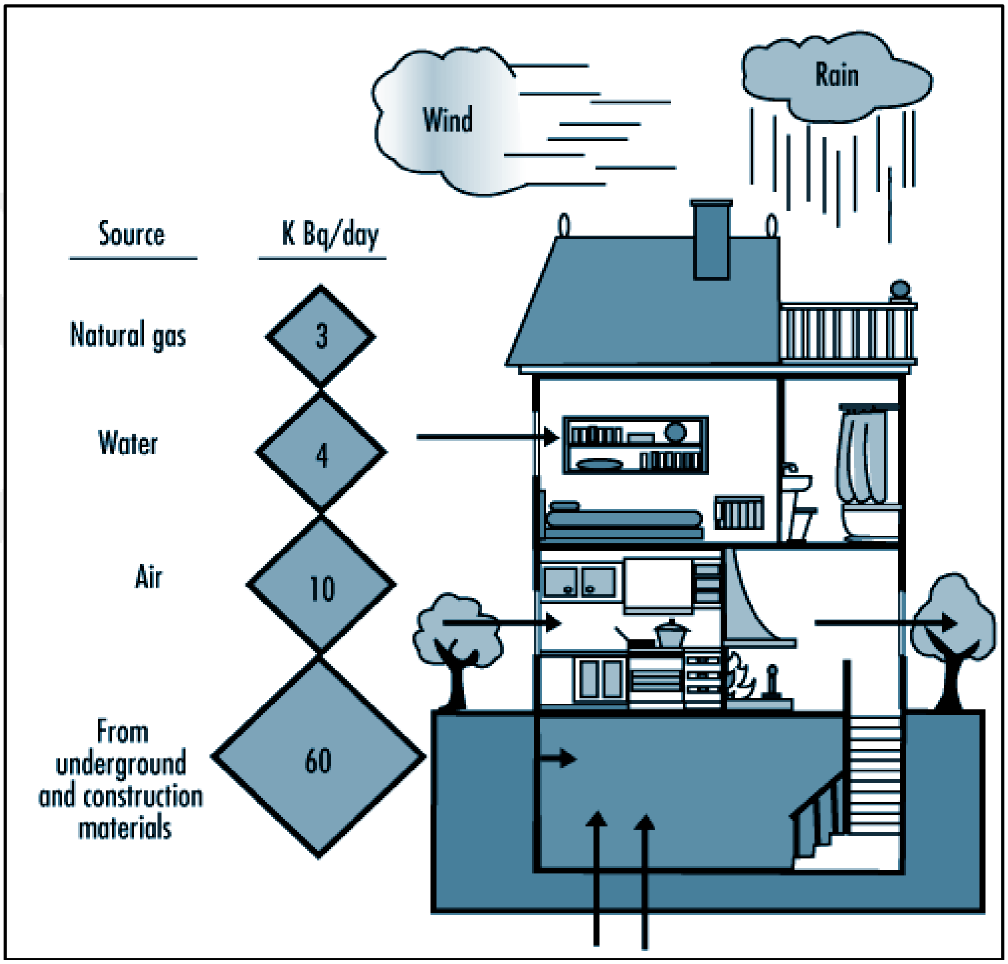


Figure 3.12: Common sources of radon at indoors
(Source: Ilocis)

In the light of this, in order to create radon free indoor air, it is very important to construct the buildings in to the suitable landscapes.

4 SUSTAINABLE HOTEL COMPLEXES

4.1 Introduction

The tourism sector has grown up more than many other sectors such as oil, automotive and weapon industries (Bajracharya, 1998). In 2010, approximately, 940 million tourists were counted and it is estimated that this number will reach to 1.8 billion by 2030. Considering this numbers, it can be said that tourism industry is one of the most important sectors for economic growth in worldwide (UNWTO,2011). In the light of this, it is clear that this sector also causes the larger depletion of natural resources especially water, usage of energy, creation of greenhouse gases and waste production. As a result of these, it gives a negative impact to the environment. In fact there are many criteria and factors for high energy consumption in these sectors. Unsuitable hotel designs, lack of water conservation or waste management systems, wrong selection of lighting type or HVAC system can be given as examples for the reasons. By considering these factors truly, it can be possible to decrease energy consumption in tourism sector.

In order to focus on the idea, this chapter deals with the energy efficiency in hotels by considering lighting, water conservation, HVAC and waste management. Following these, sustainability system in important hotel chains is analyzed and Hilton and Marriot Hotels are considered as an example.

4.2 Sustainability and Hotel Design

4.2.1 Energy efficient hotel lighting strategies

Lighting covers about 30% of total electricity usage in Hotels. There are many strategies to use lighting in hotels however some key strategies can be summarized in five stages. The first one is utilizing the most energy efficient lamp/luminaire combination, maximizing the use of daylight, segregating circuits to provide great control, using light colored ceilings and finally getting staff involved in energy saving planning.

The first strategies about using artificial daylight are about choosing true lamp/luminaire combination. Due to the fact that artificial lights are used in many part of the hotel such as corridors, public spaces, rooms etc., this strategies are most parts of the hotel they should be included in the first chosen strategies to save energy. Thus, to choose proper electronic equipment and systems is crucial (Bardi, 2010). For instance, choosing compact fluorescent light bulbs or CFLs instead of incandescent lights cause 75% less energy usage and also they last up to 10 times longer. According to the American Hotel & Lodging Association Guidelines, if a 300-room hotel were to install CFLs in each guestroom containing 5 lamps, there could be a potential savings of 141,912 kWh, which leads to an annual savings of $17,029 (Benson, 2013). Also to reduce energy usage more LED lamps can be used in some areas. However, LEDs cannot be used in every place such as restaurants or bars because dimming is not possible. At outdoors high pressure sodium lamps (HPSV) can be used. HPSVs are rated to be the most efficient on a lumen/watt scale. However, it should be noted that, new technology LED lamps are started to be more energy efficient than HPSV.

In addition to this, having guests turn off lights while the room is unoccupied is an important part of this strategy. As indicated below table 4.1 compares the traditional lighting and LED alternatives in Hotels. The first part shows the watt, lumens and life in hours of traditional lighting while the second part shows the watt, lumens and life in hours of LED lighting. Final part shows the savings per lamb.

	Traditional Lighting			LED Lighting			Savings
	Watts	Lumens	Life in Hours	Watts	Lumens	Life in Hours	Per Lamp
Frosted A19 Bulb	60	550	1,000	6	550	30,000	$108
Candle	25	210	1,500	5	250	30,000	$106
MR16	50	550	1,500	7	550	30,000	$156
PAR20	50	530	1,500	8	550	40,000	$176
PAR30	75	960	1,000	14	890	40,000	$217
PAR38	120	1500	1,000	19	1320	40,000	$335
Fluorescent Troffers	160	4800	10,000	60	6000	94,000	$683
Mounted Garage	400	****	15,000	100	****	100,000	$2,603
Shoe Box Parking	400	****	15,000	95	****	100,000	$3,270

**** Lumens vary by fixture

Table 4.1: Led alternatives to traditional lighting technology in Hotels

Source: http://energywise.co/hotels/ **accessed date 15.05.2016**

Another strategy is about the control of lighting. One of the simplest and most useful approaches is reminder cards (Figure 4.1) in each guestroom that turn of the light when the guest leaves the guestroom. In addition to card systems, occupancy sensors can also be used in guest rooms as well as conference areas. The lighting can be activated when the room is occupied and disabled when it is unoccupied. These systems are eliminating the responsibility of guests as much as possible.

Figure 4.1: Key card systems to switch off electricity in guestrooms

Source : http://www.evolvecontrols.com/devices/occupancy/card-reader access date 15.05.2016

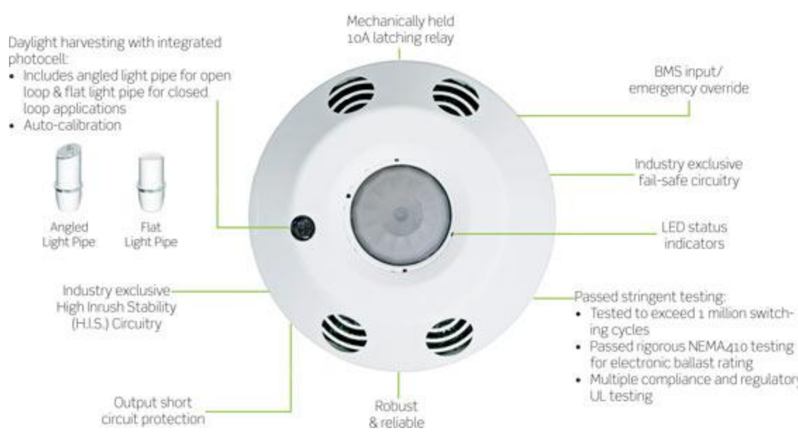


Figure 4.2: Leviton ODC Ultrasonic Ceiling

Source : http://www.homecontrols.com/Leviton-ODC-Ultrasonic-Ceiling-Mount-Occupancy-Sensor-LVODCxxUDW access date 15.05.2016

Generally most of the hotels have use efforts to utilize daylight to reduce the energy consumption. In fact this strategy should actually be followed effectively during the design processes of the hotel buildings. By this way especially bathroom designs, open areas, lobbies and hallways can benefit from the daylight. In these designs daylight can be achieved by using clerestory window or light shelves.

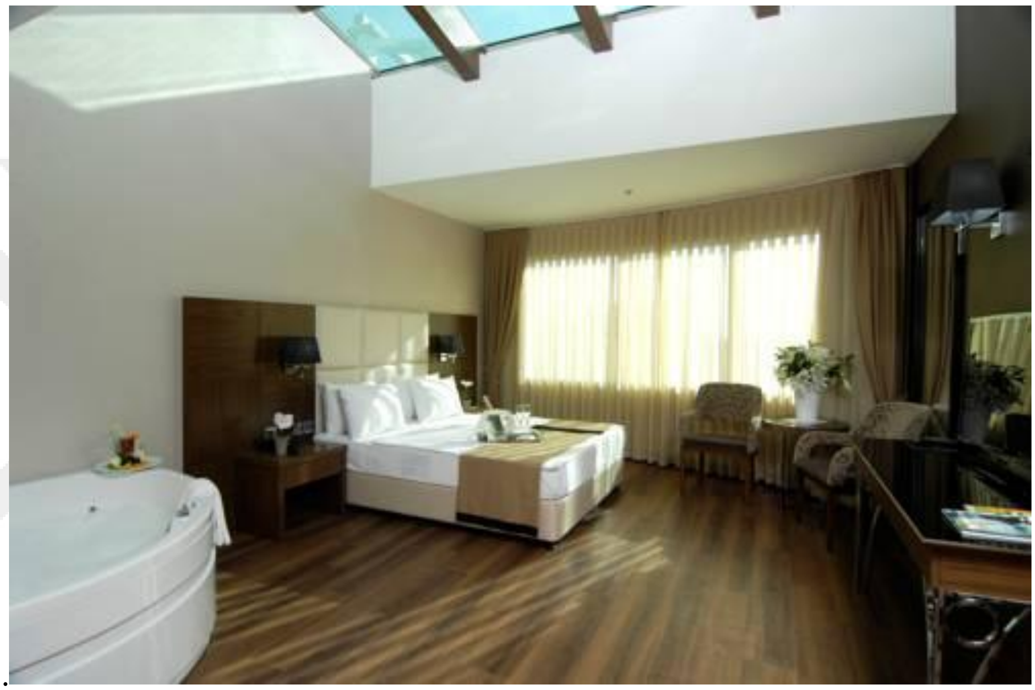


Figure 4.3: Skylight examples in hotel, Asia Princess Hotel in Turkey
Source : http://www.channels.nl/445278b.html access date 15.05.2016

Properly designed daylighting utilization reduces the amount of electricity needed for lighting, “good daylighting design could save from 15 to 75 percent of the energy used for electric lighting in a hotel building” (Day-lighting, 2010).

Figure 4.4: Daylight examples in HILTON PARIS LA DEFENSE

Source:http://www3.hilton.com/en/hotels/france/hilton-paris-la-defense-PARLDHI/index.html accessed date 15.05.2016

4.2.2 Energy efficient hvac systems in hotels

One of the main energy consumption of hotels arises from the heating, ventilation or air conditioning problems. Depending on the hotel's geographical location, the HVAC system may responsible for 50% of hotel's total utility cost (Baker, 2005). Thus, efficient HVAC system usage is perhaps the most beneficial sustainable strategies.

In the hotels there are many simple strategies that can be used. One of the simple approaches is to use digital thermostats in all the guestrooms. According to The American Hotel & Lodging Association (AH&LA) calculations, installing digital thermostats in a 300-room hotel could save 298,961 kWh and $35,478 annually on electrical and natural gas costs (www.ahla.com). The second one is occupancy sensors that can be installed to detect the rooms occupancy thus the thermostat will be able to automatically adjust the temperature to reduce unnecessary and unbeneficial actions. Similar to the occupancy sensors, guestroom key cards also another alternative for the energy control. By the help of guestroom key cards the room mode can be seen occupied or unoccupied. When guests insert their keys to gain access to their rooms, this signals to the system to go into occupied mode which signals the

HVAC system to switch from an economy setting to a comfort setting. When the guest is not in the room the setting reverts back to a more economical operation.

Aforementioned strategies show us the importance of controlling and monitoring the system. BMS means building management system and based on computer controls. By the help of BMS, lighting, HVAC and electricals system can easily be controlled. For the HVAC system, BMS improves efficiency by monitoring the room occupancy and adjusting the temperature levels accordingly (Managing, 2004).

Air condition is also crucial for the energy consumption. It is known that modern air-conditioning systems need 30% less energy than the old ones manufactured 20 years before, as they are capable of reusing the generated heat for preheating water for swimming pools or laundry (Green hotelier, 2004).

Additionally, if they are available, geothermal systems are also having important potential as the renewable heating and cooling source. Geothermal systems rely on the heat coming directly from the Earth through the use of pumps.

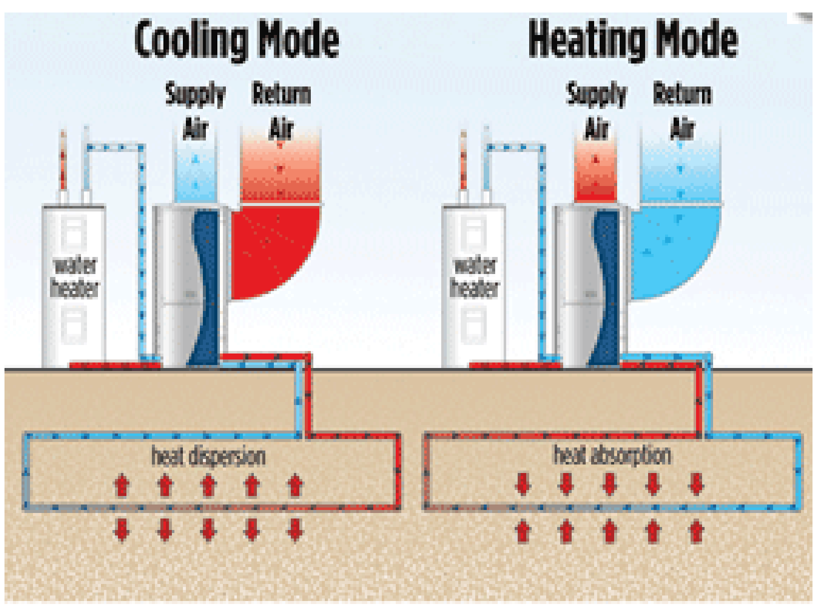


Figure 4.5: Geothermal Heat Pumps

4.2.3 Water management and conservation in hotels

Hotel industries use water in many applications such as laundry, landscaping, cooling and heating, yet the largest percentage of water use occurs in guest rooms. Thus some water conservation approach should be used to reduce water in those areas.

One of the common strategies is the usage of low flow showerheads to reduce the water consumption. AH&LA claims that installing these low flow shower heads could save 1,182,600 gallons of water with savings of $11,826 and an energy hot water savings of $23,652 per year (www.ahla.com). In addition to this, if installed in all sinks by aerator, it can reduce the amount of water used by 50%.

Moreover using dual flush toilet is also very important. Due to the fact that toilets are responsible for the 15% to 40% of the total water usage, utilization of smart systems in these areas can save a great deal of water. In addition to the toilets, saving water in urinals is important too. The simple urinal can be changed with entire fixture with high-efficiency urinal (HEU) that includes both flushing and non-water urinals. It should be noted that non-water urinals are considered compliant by most, but not all plumbing code authorities. The Uniform Plumbing Code and the International Plumbing code allow the urinals, but some local cities and counties have not yet approved the devices. Thus, it must be checked if there exist any permissions or not.

Figure 4.6: High-efficiency urinals

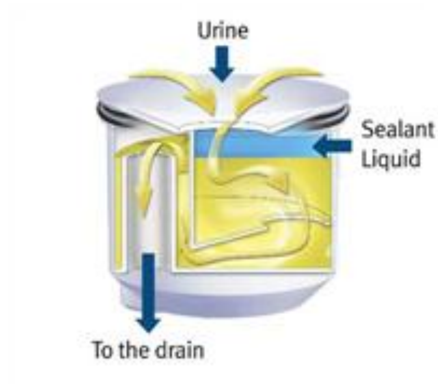


Figure 4.7: Non-water

http://wetlandstudies.com/newsletters/2013/september/urinals.html

Some shower flow rates can be found flowing in excess of 5 GPM (gallons per minute). On the other hand there are new models of showerheads that flow less than 2.5 GPM and also have high levels of consumer satisfaction. Thus these types of showerheads should be choosen in order to reduce water usage in bathrooms.

Another area for water conservation is laundry services. According to an article by the Alliance for Water Efficiency, a set of bed sheets requires six to eight gallons of water to launder and a towel set requires another six to eight gallons. To save water one of the important strategies is to suggest costumer to use one towell or bed sheet during the staying.

There are also some systems that reuse the water. Reclaimed water system is a kind of this. Hotels provide an opportunity to supplant potable use with reclaimed water use. Reclaimed water can be used for irrigationing toilets and urinals. Also, depending on the water quality requairement, many cooling towers can also use reclaimed water than potable water. However, applying this system to the existing builidings is very expensive compared with new design costs from scratch. The reason behind that is the fact that it requieres a clear seperation of pipes supplying water to the end use. This sytem is also called greywater system. Many sustainable hotels are using the greywater in the irrigation of landscape, reducing the amount of treated water that is used and reducing the water bill. In the figure 4.10 a diagram of greywater system is displayed.

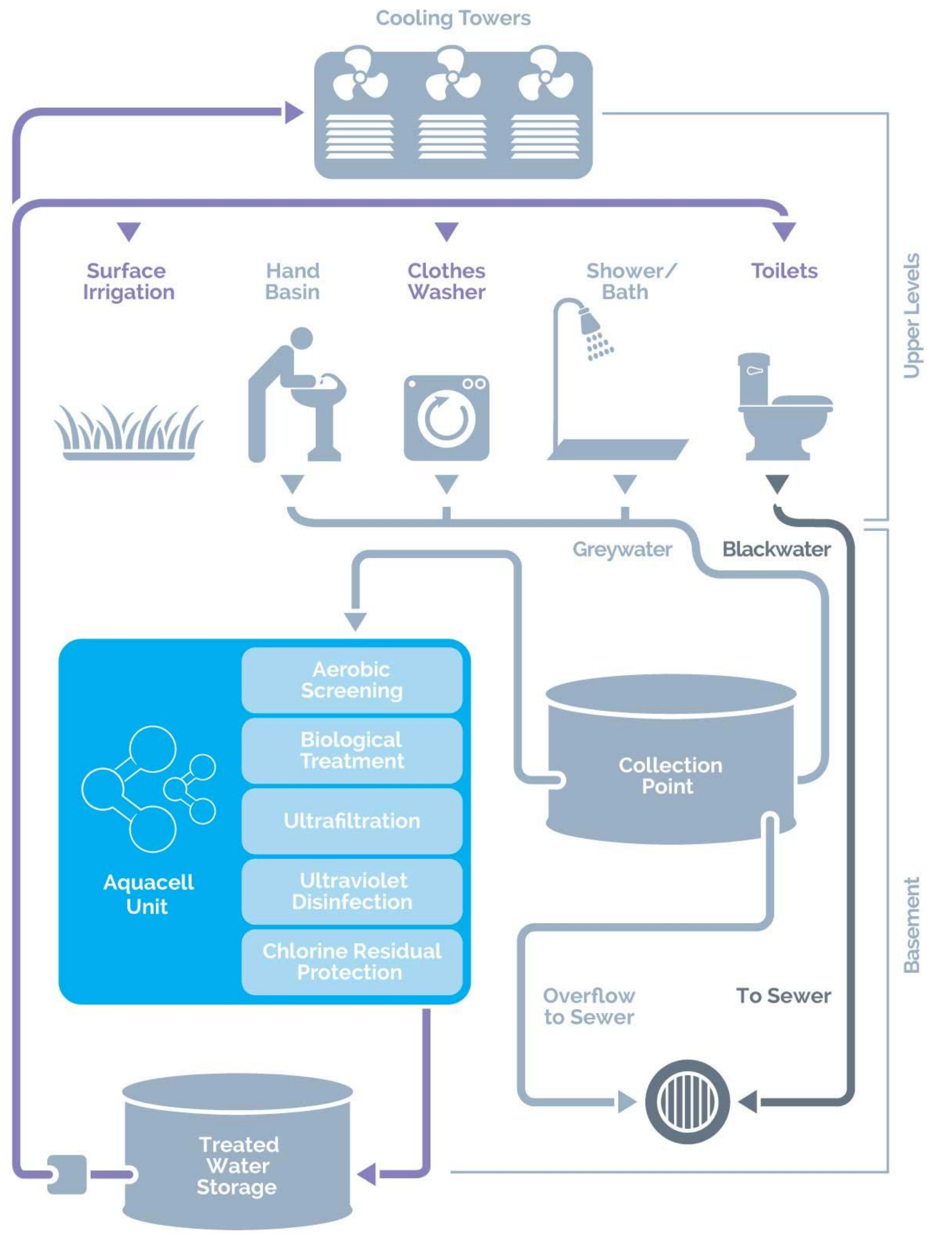


Figure 4.8: Greywater system

http://www.dewater.com/water_recycling/greywater.html

4.2.4 **Waste management in hotels**

As it is mentioned in chapter 2 the simplest strategy for waste management is to follow three R's, reduce, reuse, and recycle. As the hotel industry produces an exorbitant amount of waste, waste management is crucial for the hotel industry. Waste management strategy in hotels should be started with the determination of type and amount of waste the hotels produces and the costs for waste disposal. After this step, hotels should consider purchasing products with less packaging or with packaging that are biodegradable and can be composted. The third step is to find products that can be reused such as rechargeable batteries, cloth laundry bags, and soap and shampoo dispensers as opposed to individually wrapped soaps and shampoo. The important point is a recycling program that can be utilized in many areas as possible in the hotels such as guest rooms, offices, kitchens etc. Bohdanowicz is said that "50-60 percent of the waste materials in an accommodation facility can be recycled or reused," (Bohdanowicz, 2005). As an example to a recycling program, the Westin San Francisco Airport Hotel recycled 22 tons of materials and saved $6.000 annually (Alexander, 2002).

In order to use the system, it is important that guests should be willing to participate. According to Wilfong, guests are more willing to participate if bins are located right in the rooms instead of having to find bins in the hall (Wilfong, 2009). Also this system can be successful through the right kind of education and motivation of guests and staff.

4.3 Hotel Chains' Sustainable Strategy

In this part of the chapter, the strategies about the sustainability in the chain hotels will be analyzed.

Sustainability and becoming environmental is very important for many big hotel chains. According to Sloan et al. (2009) shareholders, employees and customers are constantly increasing expectations of the tourism industry in terms of responsible behavior concerning economic, social and environmental factors. Thus, many big hotels are developing some strategies to enhance sustainable business strategies and pollution free workflows. In fact this result of government role is setting to preserve the eco system (World Travel & Tourism Council, 1995). In the following table some hotel chains and their sustainability strategies are represented. Then two hotels which are Hilton and Marriot have been discussed.

	Sustainability Systems						
HOTEL NAME	Energy / Lighting System	Water	Waste	HVAC-Climate	Recycle	Insulation	Indoor Air Quality
Kempinski Hotels		X					X
Marriot	X	X	X	X			X
Hyatt	X	X		X		X	
Fourseasons Hotel / Resort	X	X	X		X		
Jumeirah Group						X	
Wynolhom Worldwide	X						
Hilton Worldwide	X	X	X	X	X		X
Starwood Hotel Resort							
nH Hotel Group		X	X	X			
Fairmpnt Hotel / Resort	X	X	X	X			

Table 4.2: Suitability System of Hotel Chains

4.3.1 HILTON environmental sustainability policy

The Hilton Family of Hotels claim that on their sustainability policy, they focus upon some key environments. These can be introduced as energy efficiency, CO2 reduction, water efficiency, waste reduction, chemical reduction and more sustainable buildings to design.

Several years ago, Hilton implemented an energy efficient lighting retrofit program for its guest rooms. By using state-of-the-art compact fluorescent and other lighting technology, they provide an environment that the guests desire while significantly reducing their use of the natural resources that are utilized to power these products.

In order to reach energy efficiency by considering lighting, Hilton use compact fluorescent and some lighting technology for the guest rooms. They claim that, the guestrooms had 750 watts of lighting usage. After utilizing compact fluorescents instead of incandescent bulbs the rooms have approximately 220 watts of lighting usage. In other words reduction of energy is 70%. In addition to this, this reduction does not cause discomfort to the guest, on the contrary to this, level of light increased in the guest rooms.

Another important strategy is about the water conservation. According to Hilton, the most water consumption is caused by the sheet and towel change. Millions of gallons fresh water is used to clean them. To solve this problem Hilton developed the linen program. The linen program enables the guests to decide when the room attendant will change the bed linens. The guest is informed by a card. Normally, the sheets changed on each third night of their stay, but if the guest requests their sheets changed daily by simply placing the card on the bed or calling housekeeping. Likewise, this system can be applied to place on the towels to. In addition to these strategies, restricted-flow showers, automated faucets and toilets are also use in guestrooms and public areas of hotels.

Recycling is also important for the Hilton hotels too. In early, 1990's, Hilton instituted the initial company recycling program guidelines. Then this program incorporated into Hilton's both engineering and housekeeping manual. According to this program first important thing is in-room recycling. Most of the materials collected in guest room as recyclable items such as cans, bottles, newspapers, magazines, and Office paper. In addition to this they take attention to impact the environment reducing the waste stream to landfills and related energy usage transporting and processing these products.

Since 2008, Hilton Hotels began to use to-go packaging and eco-friendly system. For instance, the Hilton Food To-Go Box is 6x9x4 and is made from 100% recycled board, and the inks and varnishes are biodegradable. Additionally, it is poly-coated on the inside and is FDA approved for direct food contact. Also, eco-friendly

Hilton Food To-Go Bag measuring 13x7 and made from a revolutionary new product called TerraSkin. A tree-free paper made of stone minerals degrades back into its original source, the powder of stone. TerraSkin uses 20-30% less ink and all inks are environmentally friendly (non-toxic).Also Terra skin bag is waterproof.

In some of the hotels air-quality is also important. For example, The Hilton Chicago O'Hare Airport, Conrad Miami and Doubletree Hotel Tucson at Reid Park hotels have created allergy resistant rooms and the Conrad and Doubletree use pure air purification systems. In many hotels uses pillow covers that protect the users from dust and bacteria. Some Hotels uses a cork-underplayed hardwood floor. In these hotels real time monitoring systems are also controlling the air quality changes during the 24-hour.

4.3.2 MARRIOT environmental sustainability policy

Marriott hotels are also the other important hotel chains that develop some suitability strategies. Generally they focus on to reduce energy usage, water consumption and waste. The importance of their strategies is dividing their strategies in many categorizations such as renewable energy, carbon measurement, greening furniture, energy performance, water conservation and always having a partnership with a professional company or group. Thus each category is dealt with deeply and professionally. The primary important strategies is about, energy consumption, renewable energy and water conservation.

One of the important strategies of Marriot is developing Energy and Environmental Action Plan (EEAP). This plan is used in America since 2011. Firstly, this plan was focused on the energy and water reduction goal but in 2012 reuse of materials and waste reduction equipment upgrades have been added to the plan. Secondly Marriot hotels use another energy projects which is called “Signature”. According to Marriot document, by the help of this project, approximately, more than 20 million kilowatt-hours of electricity is saved.

In addition to these, Marriott is the first lodging company to partner with Constellation Energy to manage peak period energy use and participate in demand response (DR) markets. In 2012 they continue an energy management program under the Global Superior Energy Performance Partnership (GSEP) with the U.S. Department of Energy (DOE). The JW Marriott in Washington, D.C. has developed and implemented the ISO 50001 energy management system (EnMS) standard and is expected to be the first hotel in the U.S. to achieve the ISO 50001 certification

Renewable energy is another energy strategy of this hotel. For example heat water for pools and spa operation, or solar panels and wind turbines are one of their renewable energy attempts. The Courtyard by Marriott Hannover Maschsee in Germany is the first hotel in the city to have an electric vehicle charging station.

Likewise the energy consumption, Marriot Hotels, developed some partnership about the water conservation. They have partnership with Ecolab® and became a piloted aquanomic in 2010. They claimed that the combined water savings was more than 100 million gallons in 2012. Marriot hotel also pays attention to monitoring systems. They use monitoring equipment and innovative water treatment chemistry. This system helps to water treatment for cooling towers and reduce the need for fresh water in the system.

Waste management is also an important strategy of Marriot Hotels. In terms of waste management Marriot became an official hotel partner of Clean the World, a nonprofit that collects, recycles and distributes partially used soaps and other hygiene amenities globally to the communities in need. Almost all the hotel participate this system and they have collected more than 75.000 pounds of soap and 50.000 pounds of amenities because of this. Marriott claims that they are the number one hotel chain in the Clean the World portfolio. In the U.K., they have partnered with Convert2Green and 3663 and by the help of this partnership they collect waste oil and refine it into biodiesel. In 2012 they recycled 40.000 liters of cooking oil.

Carbon measurement is another strategy of this Hotel. In 2012, Marriott rolled out an online environmental sustainability dashboard, the Green Hotels Global tool, which utilizes the new industry methodology. Another partnership of the hotel is about the greening furniture. This partner is the Hospitality Sustainable Purchasing Consortium (HSPC), facilitated by Mind Click SGM. The furniture that are used in hotel are chosen by the determined criteria.

5 CASE STUDY: GURAL PREMIER HOTEL

5.1 Introduction

Güral hotels are one of the biggest hotel chains that are located in many places in Turkey. Güral Premier Tekirova Hotel is one of the most important hotels amongst them. One of the key points of this hotel is the fact that it considers energy efficiency issue strictly. Güral Premier Tekirova is one of the first hotels that are established with the Green Key award. Green Key Program is an international eco-label which aims preventing climate change and contributing to the sustainable tourism by awarding the attempts towards protecting the environment. This program is started in 1994 and up to date there are currently 59 hotel establishments with Green Key award in Turkey.

As it is mentioned above, Güral Premier Tekirova Hotel is one of the hotels which have a Green Key program. However, when the hotels logs of electric consumption, water consumption, and waste management analysis are investigated it can easily be seen that there are many over consumptions in terms of electric usage and water consumption. Because of this, this thesis firstly tries to understand the reason behind this consumption even though it is one of the Green Key Hotels. After this this study will offer some solutions to decrease the electric and water consumption as well as to improve waste management.

In this theses, data of 2013 and 2014 that is about the logs of water consumption, electric consumption and waste management are obtained from the Quality and Education Coordinator of Güral Premier Tekirova Hotel at 31.12.2014. In this chapter the hotel Güral Premier Tekirova is mentioned briefly first, and then the logs will be analysed and some recommendations will be proposed.

5.2 Architecture

Güral Premier Tekirova is located in Kemer, Antalya. Güral Premier Tekirova facility is built on an area of 200.000 m^2 based on Turkish Architecture style. Güral premier Tekirova facility consists of various two and three floored buildings. From some rooms of the hotel there exists an access to the pools. In hotels design, the aqua park, and swimming pools take an important place in terms of the total area. Aqua park is built on an area of 22.000 square meters. In aqua park, a baby beach, an entertainment and adventure pool, and also water slide pools exist. Also there are two swimming pools for common usage. Restaurants and patisserie services also have a huge area considering the other places in hotel. For instance, kids club is built on an area of 3.600 m², Quu Spa centre built on an area of 3.500 m², and fitness centre has 500 m² space. The other parts of the hotels consist from shopping centres, mini market, many shops, Irish pub, hairdresser and beauty salon, towel service, laundry service, and amphitheatre. Also, in this hotel, there are 650 rooms, and 1600 beds exist. This facility is opened during seven months in a year.

Figure 5.1: Güral Premier Tekirova

Figure 5.2: Güral Premier Tekirova

Figure 5.3: Güral Premier Tekirova

5.3 Sustainability Issues in Güral Premier Hotel for Restaurant

Before analysing the data this part of the chapter deals with the sustainability issues in Güral Premier Hotel.

In this hotel, there are 650 rooms, 1600 beds and 45 different units exist. As said before this facility stays open for seven moths per year. In the light of these, this hotel needs 8.500.000 kWh electricity during the year. In the high season it needs 7.000.000 kWh electricity. Monthly, the energy consumption is 1.000.000 kWh and per capita consumption of energy is 35 kWh. Total energy consumption of individual places can be measured in terms of electricity. Amongst the measured percent consumption of electricity during a day, the restaurant-bar constitute % 4,6 (1.850 kWh), aqua park % 9,4 (3.500 kWh), spa %1,2 (528 kWh), technical services %17, kitchen %18,5 (8.080 kWh) and animation %0,5. The other parts of the hotel such as consumption of guest room or outdoor lighting are not measured individually. For energy consumption, energy efficient machines (steam generator, hot water boiler, washing machine, and coolant) are chosen. In standard guest rooms total number of 22 artificial lighting are being used. Also, card systems are used for activating lighting of guest rooms. Minibar and television is always working. All windows have selected as double-glazing and in many areas air baffles exist. Exterior lightings work by benefiting the solar energy.

Some parts of the hotel use electricity individually such as spa, aqua-park or bars, however, main routines such as cooling, heating and fumigators are always working. Thus, the main routines must use electricity as long as the hotel opens.

For indoor air quality, they do not use wallpapers to be able to check dampness of the walls easily. In addition to this, the air conditioners are cleaned regularly to protect the customers from legionella pneumophilia sickness.

In favour of water consumption, energy efficient tap mixers, and showerheads are preferred. Also, in the guest rooms bathtubs are used instead of shower stalls. Additionally dual flush toilets are being used. Another important attempt in terms of water consumption is about reducing the usage of washing machines. To achieve this, sheets and towels are being cleaned in every three days. Also in the guest rooms there is an information card about the sheet cleaning. If customers want to change the sheets every other day they can use this information card. However, there is not any restriction about using beach towels. Landscape is irrigated after the sun goes down to protect the evaporation.

For waste management, the waste categorize while they are being stored. For example yellow colour represents plastic materials, blue colour represents papers, and white colour represents glass materials. Chemical waste and kitchen waste are thrown out twice a day by the municipality. Also oil wastes are stored as there exist a discriminator machine to eliminate the oil waste from the water pipe.

Acquired logs are focused on the six months, April, May, June, July, August, and September. This quantitative data give the goals of 2013, and annal of 2014. This logs are about:The quantity of water consumed throughout the facility

- The amount of water consumed per single person
- The quantity of electric consumed throughout the facility
- The amount of electric consumed per single person

- The quantity of LNG consumed throughout the facility
- The amount of LNG consumed per single person
- The quantity of Hazardous waste consumed throughout the facility
- The amount of Hazardous waste consumed per single person
- The quantity of plantal waste consumed throughout the facility
- The amount of plantal waste consumed per single person
- The quantity of paper waste consumed throughout the facility
- The amount of paper waste consumed per single person
- The quantity of glass waste consumed throughout the facility
- The amount of glass waste consumed per single person
- The quantity of plastic waste consumed throughout the facility
- The amount of plastic waste consumed per single person
- The quantity of metal waste consumed throughout the facility
- The amount of metal waste consumed per single person

5.3.1 **Energy efficiency**

In this part of the chapter firstly, the data of electric consumption will be analysed. The goal and the annal of the quantity of electric consumption throughout the facility and amount of the energy consumed per single person will be given. Afterwards, this consumption will be considered with respect to the individual areas of the Hotel.

TOTAL QUALITY GOAL FORM				
ENVIROMENTAL MANAGEMENT SYSTEM: THROUGH OUT THE FACILITY				
THROUGH OUT THE FACILITY				
MONTHS	The quantity of electric consumed through out the facility - 2013 (kWh)		Amount of electric consumed per single person in 2013 (kWh)	
	2013 (Goal)	2014 (annal)	2013 (Goal)	2014 (annal)
JANUARY	-	-	-	-
FEBRUARY	-	-	-	-
MARCH	-	-	-	-
APRIL	548.520	632.857	92	175
MAY	894.707	797.410	32	33
JUNE	1.127.000	1.102.957	24	28
JULY	1.318.000	1.289.717	29	34
AUGUST	1.338.782	1.465.166	26	25
SEPTEMBER	1.120.737	1.136.977	28	31
OCTOBER	-	-	-	-
NOVEMBER	-	-	-	-
DECEMBER	-	-	-	-
TOTAL	**6.347.746**	**6.425.084**	**230**	**327**

Table 5.1: Electric Consumption

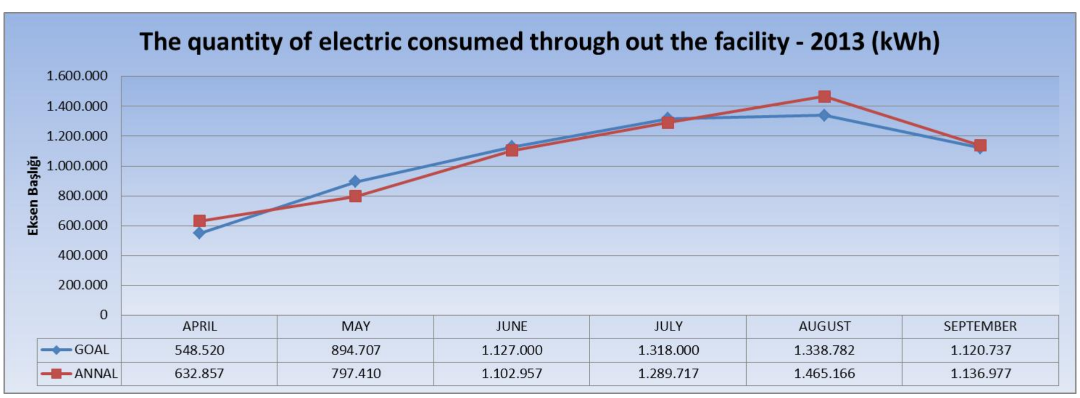


Table 5.2: The quantity of electric consumed throughout the facility

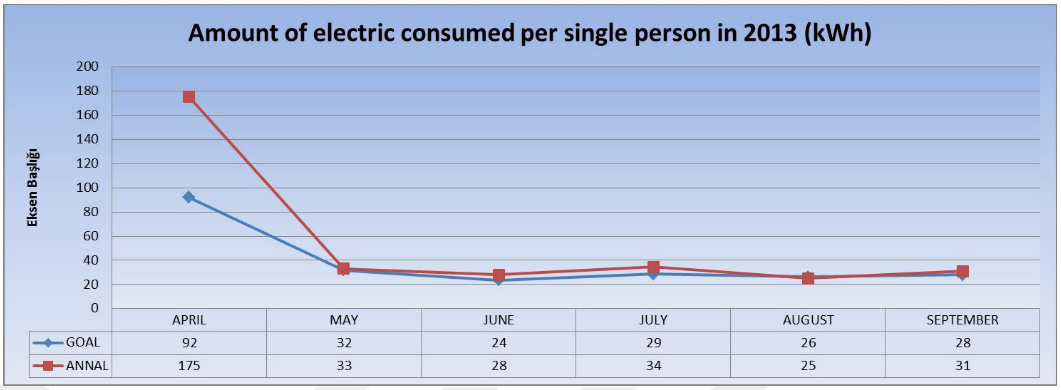


Table 5.3: The amount of electric consumed per single person

As it is seen from the table 5.1, 5.2 and 5.3 the goal of energy consumption was achieved in May, June and July; however, in April, August and September the target was not achieved.

As a second step, the electric consumption will be analysed according to the individual areas of the hotel on a monthly basis.

Below, table 5.4 displays April, 5.5 displays May, 5.6 displays June, 5.7 displays July, 5.8 displays August and 5.9 displays the consumption of electricity in individual areas for September.

As it is seen from the table 5.4 the maximum electric consumption throughout the facility in April occurred in main restaurants first floor with 59.803 kWh, main restaurants ground floor with 50.770 kWh and at boiler room with 50.101 kWh. The minimum energy consumptions occurred firstly at Irish pub with 137 kWh, secondly mansion-14 with 214 kWh, and cooling tower with 388 kWh. In May the maximum electric consumption occurred in main restaurants first floor with 82.190 kWh, main restaurants ground floor with 60.424 and aqua park with 31.611 kWh. The minimum energy consumptions occurred at cooling unit 3 with 60 kWh, Irish pub with 147 kWh, and cooling unit with 99 kWh. In June the maximum electric consumption occurred in boiler room with 114.420 kWh main restaurants first floor with 89.954 kWh and main restaurants ground floor 65.723 kWh. The minimum energy consumptions occurred in cooling unit-2 with 99 kWh, Irish pub with 139 kWh, and mansion-14 with 240 kWh. In July, the maximum electric consumption occurred in boiler room with 160.672 kWh, main restaurants first floor with 90.125 kWh and main restaurant ground floor with 62.212 kWh. In August the maximum electric consumption occurred in boiler room with 175.393 kWh, main restaurants first floor with 102.089 kWh and main restaurants ground floor with 76.418 kWh. In September the maximum electric consumption occurred in boiler room with 140.746 kWh, main restaurants first floor with 85.486 kWh and main restaurant ground floor with 61.113kWh.

As it seen from the table 5.4 the maximum electric consumption for the amount of electric consumed per single person in April occurred in main restaurants first floor with 62.383 kWh, main restaurants ground floor with 52.838 kWh and at boiler Room with 51.232 kWh. The minimum energy consumptions occurred in Irish Pub with 142 kWh, cooling tower with 390 kWh, and fitness centre with 1.674 kWh. In May the maximum electric consumption occurred in staff lodgement 28A-Blok with 32.056 kWh, fitness centre with 29.312 and the staff lodgement 4(B-blok) with 26.782 kWh. The minimum energy consumption is occurred at the stage with 62 kWh, air conditioning plant with 169 kWh, spa with 228 kWh. In June the maximum electric consumption occurred in boiler room with 119.787 kWh, main restaurants first floor with 92.855 kWh. The minimum energy consumptions occurred in cooling unit-2 with 102 kWh, Irish pub with 143 kWh, and cooling unit-3 with 962 kWh. In July, the maximum electric consumption occurred in boiler room with 172.226, main restaurants first floor with 96.982 kWh and main restaurant ground floor with 69.846 kWh. The minimum energy consumptions occurred in Irish pub with 80 kWh, fitness centre with 2.183 kWh and administrative lodgement with 3.376 kWh. In August the maximum electric consumption occurred in stuff lodgement with 52.251 kWh, aqua park with 38.118 kWh and stuff lodgement-2 with 33.741 kWh. In September the maximum electric consumption occurred in boiler room with 144.081 kWh, main restaurants first floor with 88.127 kWh and main restaurants ground floor with 63.082 kWh.

Looking displayed tables above, it can be seen that electric consumption in 2014, reaches the target value sometimes however in some months it cannot. Also the table 5.4-5.9 displays that the maximum electric consumption is occurred in the boiler room or the main restaurants upstairs and the main restaurants floor. As an example, when the lighting of main restaurants ground floor and first floor are considered, 57 pieces 500w-1100 h chandelier, 28 pieces 1350 W-1500 chandeliers and 29 pieces 500 w-1100h chandelier, 5 pieces 600w-690h chandelier exist respectively. In the following picture, the main restaurants upstairs and main restaurants floor illustrations are displayed.

Figure 5.4: Main restaurants ground floor

Figure 5.5: main restaurants first floor

Figure 5.6: Main restaurants first floor

As it is mentioned above, electric consumptions can be measured individually in restaurant, staff lodgement, boiler room, and etc. Yet, some spaces that constitute a large part of the electricity consumption such as guest rooms are not logged or documented. Thus, following part of the chapter two individual areas are selected. These are the restaurant (consumption measured) and the guest room (consumption do not measured) and afterwards artificial lighting is analysed.

Figure 5.7: Room Plan

Figure 5.8: Room perspectives view

Figure 5.9: Rooms exterior perspectives view

Room Type	Room Lighting Fixture	Brand / Style	kWh/per unit	pcs
Std Room	Enterence Spotlights	Osram Dulux D/E	13	1
	Reading Spotlights		1	3
	Wall lambs on Bedheads	Philips Tornado	8	2
	Wall lambs on Dresser	Osram	12	1
	Leds on Bedheads	Unicom	3	5
	Leds on Marquerty	Unicom	3	2
	Spotlights in Rooms	Osram	10	2
	Wall lambs in Baths	Osram	18	2
	Spotlighs in Baths	Osram	10	1
	Spotlights in Mini Bars		1	1
	Night Lambs	Osram	5	1
	Balcony Lambs	Osram	5	1
Corner Room	Enterence Spotlights	Osram Dulux D/E	13	1
	Reading Spotlights		1	4
	Wall lambs on Bedheads	Philips	8	4
	Wall lambs on Dresser	Osram	12	2
	Leds on Bedheads	Unicom	3	10
	Leds on Marquerty	Unicom	3	4
	Spotlights in Rooms	Osram	10	4
	Wall lambs in Baths	Osram	18	4
	Spotlighs in Baths	Osram	10	2
	Spotlights in Mini Bars		1	2
	Night Lambs	Osram	5	1
	Balcony Lambs	Osram	5	2

Table 5.10: Room lightings brand-name and counts.

Troom Type	Energy consuption of device name	Brand / Style	Watt/per unit	pcs
Stdart Room	TV	LG 32LH201C	120	1
	Fan Coil	Carrier 42NF50	3270	1
	Mini Bar	Kleo/ KMB45	75	1
	Kettle	Crown	2000	1
	Blow-dryer	Valera 533.05	1600	1
Corner Room	TV	LG 32LH201C	120	2
	Fan Coil	Carrier 42NF60	3820	1
	Fan Coil	Carrier 42NF50	3270	1
	Mini Bar	Kleo/ KMB45	75	1
	Kettle	Crown	2000	1
	Blow-dryer	Valera 533.05	1600	1
Tempered Room	TV			
	Fan Coil	Carrier 42NF75	4100	
	Refrigerator			
	Microwave oven			
	Blow-dryer			
Pavilions	TV	LG 55LX341C	54 Watt	3
	Split Air Conditioner	Carrier/42QHF018DST-18.000 btü	5,1 kw	3
	Refrigerator	Altus		
	Blow-dryer	Valera 533.05	1600	3

Table 5.11: Energy consumption of device name in the rooms.

Location	Name of the Light	Brand / Style	kWh/per unit	pcs
MAIN RESTAURANT OUTSIDE	Tower Lighting		20	32
	Column Spots		7	4
	Pipe-type ground spot leds , Disco		17	10
	Cage Lamb	Osram	10	2
	Ground spot leds	Philips	17	43
	3 m Environmental Lighting		45	16
	Main restaurang terrace lambs	Osram	5	53
	Ceiling Light	Osram	5	79
	Torch	Osram	5	18

Table 5.12: Main restaurant outside lighting

As it seen from the table, in restaurant façade 257 artificial lighting elements are used totally, in standard room 22 artificial lights and in corner room 40 artificial lights are used.

5.3.2 Water conservation

TOTAL QUALITY GOAL FORM				
ENVIROMENTAL MANAGEMENT SYSTEM: THROUGH OUT THE FACILITY				
THROUGH OUT THE FACILITY				
MONTHS	The quantity of water consumed through out the facility - 2013 (lt)		Amount of water consumed per single person in 2013 (lt)	
	2013 (Goal)	2014 (annal)	2013 (Goal)	2014 (annal)
JANUARY	-	-	-	-
FEBRUARY	-	-	-	-
MARCH	-	-	-	-
APRIL	5.468	8.487	0,92	2,26
MAY	20.446	15.073	0,73	0,71
JUNE	24.602	21.277	0,52	0,60
JULY	21.205	19.627	0,46	0,53
AUGUST	22.681	24.447	0,44	0,38
SEPTEMBER	16.193	18.639	0,40	0,51
OCTOBER	-	-	-	-
NOVEMBER	-	-	-	-
DECEMBER	-	-	-	-
TOTAL	**110.595**	**107.550**	**0,58**	**5**

The table 5.13: Water Consumption

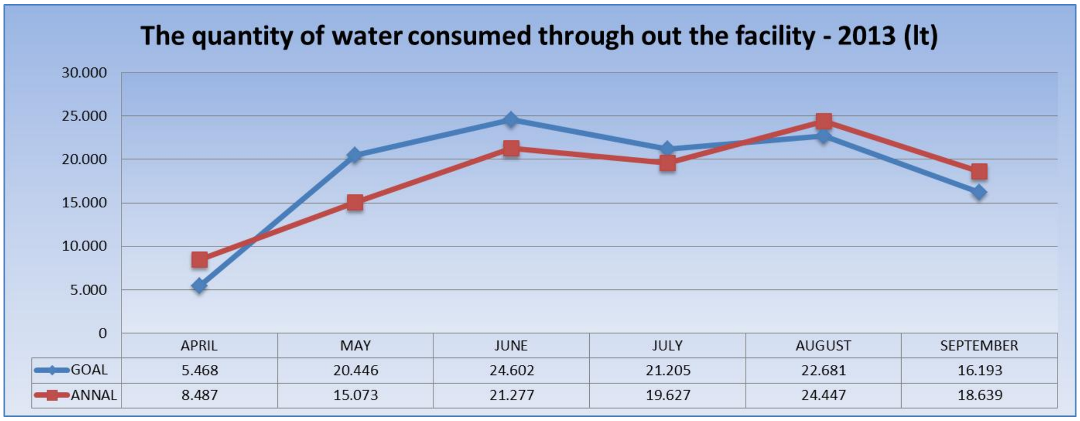


Table 5.14: The quantity of water consumed throughout the facility

As it can be seen from the table 5.11 with respect to the quantity of water consumed throughout the facility, the goal of the water consumed was not achieved in half of the season. Only in April, August and September targets were achieved.

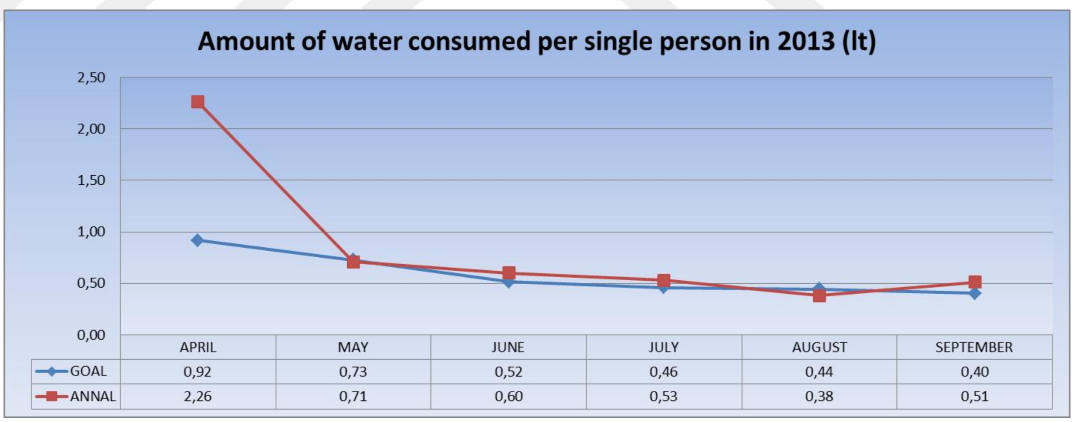


Table 5.15: The amount of water consumed per single person

Also it can be seen from the table 5.12 with respect to the quantity of water consumed per single person, the goal of the water consumed was achieved approximately all months. Only in August target was not achieved.

5.3.3 **Waste management**

TOTAL QUALITY GOAL FORM				
ENVIROMENTAL MANAGEMENT SYSTEM: THROUGH OUT THE FACILITY				
THROUGH OUT THE FACILITY				
MONTHS	The quantity of paper waste consumed through out the facility - 2013 (kg)		Amount of paper waste consumed per single person in 2013 (kg)	
	2013 (Goal)	2014 (annal)	2013 (Goal)	2014 (annal)
JANUARY	-	-	-	-
FEBRUARY	-	-	-	-
MARCH	-	-	-	-
APRIL	3.758	3.194	0,63	0,23
MAY	4.044	3.699	0,14	0,92
JUNE	6.077	5.305	0,13	0,11
JULY	8.051	6.843	0,17	0,15
AUGUST	9.259	6.713	0,18	0,11
SEPTEMBER	8.199	4.284	0,20	0,12
OCTOBER	-	-	-	-
NOVEMBER	-	-	-	-
DECEMBER	-	-	-	-
TOTAL	**39.388**	**30.038**	**1**	**2**

Table 5.16: Paper waste consumption

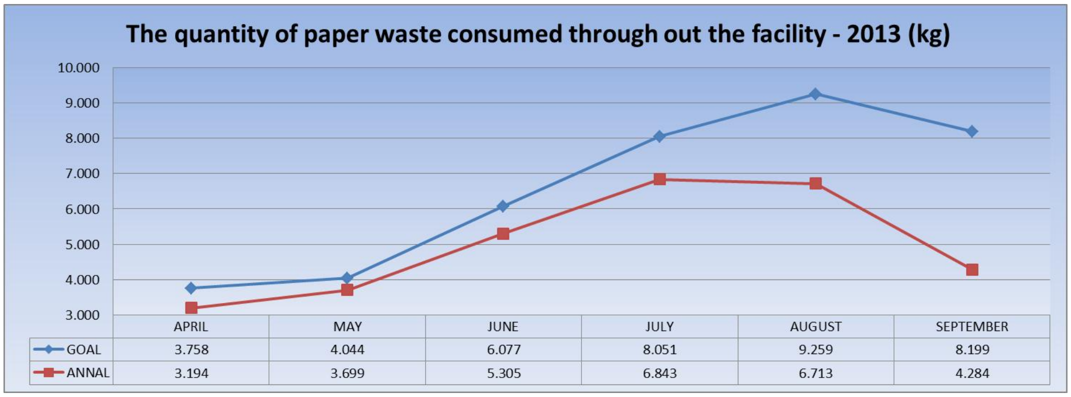


Table 5.17: The quantity of paper waste consumed throughout the facility

As it can be seen from the table 5.14 with respect to the quantity of paper waste consumed throughout the facility, the goal of the paper waste consumed was not achieved in approximately all months.

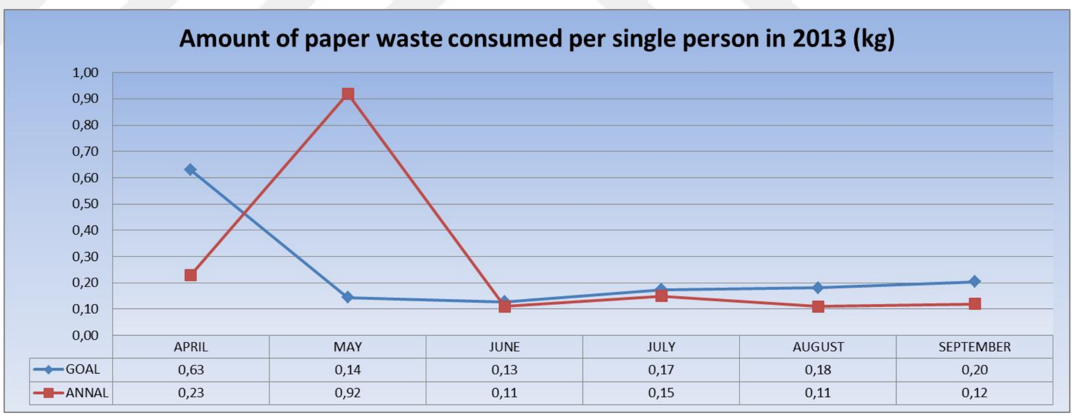


Table 5.18: The amount of paper waste consumed per single person

Also it can be seen from the table 5.15 with respect to the quantity of waste consumed per single person, the goal of the paper waste consumed was not achieved in approximately all months. Only in May the target was achieved.

TOTAL QUALITY GOAL FORM				
ENVIROMENTAL MANAGEMENT SYSTEM: THROUGH OUT THE FACILITY				
THROUGH OUT THE FACILITY				
MONTHS	The quantity of glass waste consumed through out the facility - 2013 (kg)		Amount of glass waste consumed per single person in 2013 (kg)	
	2013 (Goal)	2014 (annal)	2013 (Goal)	2014 (annal)
JANUARY	-	-	-	-
FEBRUARY	-	-	-	-
MARCH	-	-	-	-
APRIL	8.942	7.493	1,50	0,54
MAY	18.151	16.569	0,65	0,49
JUNE	19.545	16.963	0,41	0,32
JULY	24.445	20.778	0,53	0,48
AUGUST	27.685	23.237	0,54	0,39
SEPTEMBER	21.532	15.776	0,54	0,43
OCTOBER	-	-	-	-
NOVEMBER	-	-	-	-
DECEMBER	-	-	-	-
TOTAL	**120.300**	**100.816**	**4**	**3**

Table 5.19: Glass waste consumption

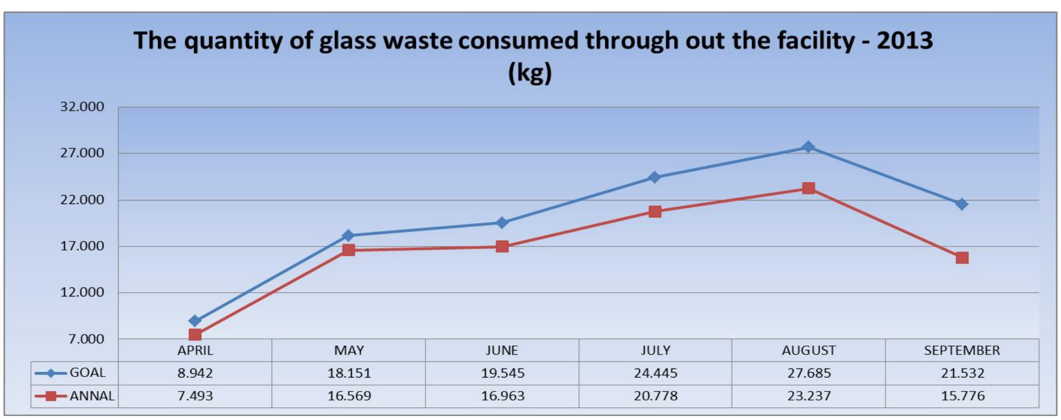


Table 5.20: The quantity of glass waste consumed throughout the facility

As it can be seen from the table 5.17 with respect to the quantity of glass waste consumed throughout the facility, the goal of the glass waste consumed was not achieved in approximately all months.

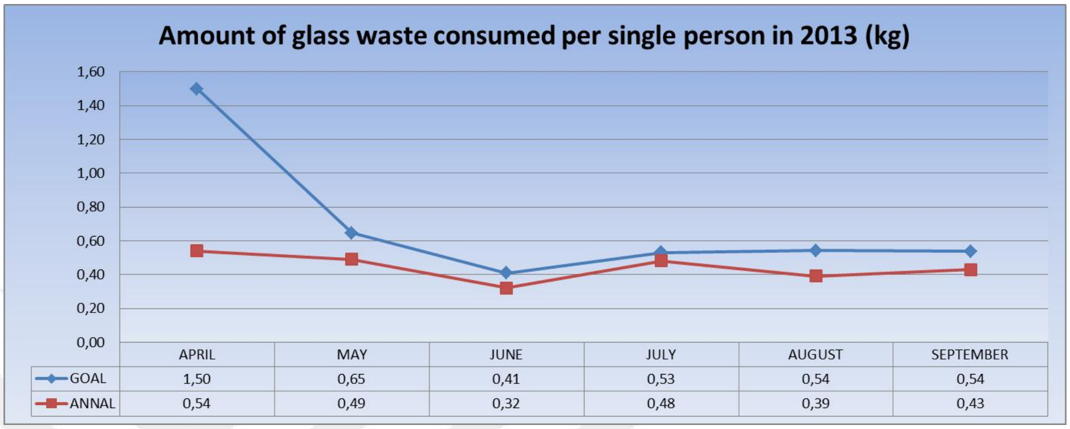


Table 5.21: The quantity of glass waste consumed per single person

As it is seen from the table 5.18 the goal of glass waste consumption the target was not achieved.

TOTAL QUALITY GOAL FORM				
ENVIROMENTAL MANAGEMENT SYSTEM: THROUGH OUT THE FACILITY				
THROUGH OUT THE FACILITY				
MONTHS	The quantity of plastic waste consumed through out the facility - 2013 (kg)		Amount of plastic waste consumed per single person in 2013 (kg)	
	2013 (Goal)	2014 (annal)	2013 (Goal)	2014 (annal)
JANUARY	-	-	-	-
FEBRUARY	-	-	-	-
MARCH	-	-	-	-
APRIL	2.012	1.710	0,34	0,12
MAY	1.803	1.545	0,06	0,04
JUNE	1.640	1.445	0,03	0,03
JULY	1.204	1.023	0,03	0,02
AUGUST	1.120	933	0,02	0,02
SEPTEMBER	1.014	337	0,03	0,01
OCTOBER	-	-	-	-
NOVEMBER	-	-	-	-
DECEMBER	-	-	-	-
TOTAL	**8.793**	**6.993**	**1**	**0**

Table 5.22: Plastic waste consumption

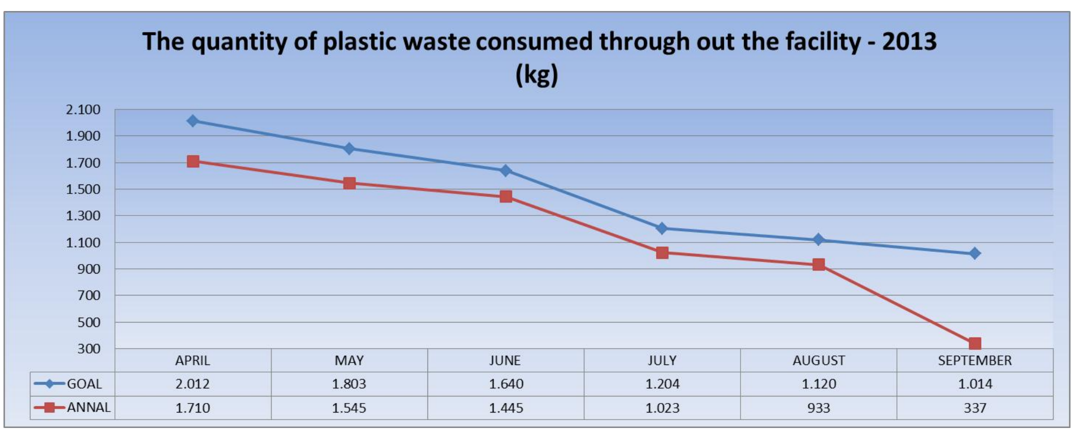


Table 5.23: The quantity of plastic waste consumed throughout the facility

As it can be seen from the table 5.20 with respect to the quantity of plastic waste consumed throughout the facility, the goal of plastic waste consumed was not achieved in approximately all months.

Table 5.24: The quantity of plastic waste consumed per single person

As it can be seen from the table 5.21 with respect to the quantity of plastic waste consumed per single person, the goal of plastic waste consumed was not achieved in approximately all months.

TOTAL QUALITY GOAL FORM				
ENVIROMENTAL MANAGEMENT SYSTEM: THROUGH OUT THE FACILITY				
THROUGH OUT THE FACILITY				
MONTHS	The quantity of metal waste consumed through out the facility - 2013 (kg)		Amount of metal waste consumed per single person in 2013 (kg)	
	2013 (Goal)	2014 (annal)	2013 (Goal)	2014 (annal)
JANUARY	-	-	-	-
FEBRUARY	-	-	-	-
MARCH	-	-	-	-
APRIL	212	180	0,04	0,01
MAY	259	240	0,01	0,01
JUNE	347	305	0,01	0,01
JULY	280	238	0,01	0,01
AUGUST	345	245	0,01	0,01
SEPTEMBER	274	106	0,01	0,01
OCTOBER	-	-	-	-
NOVEMBER	-	-	-	-
DECEMBER	-	-	-	-
TOTAL	**1.717**	**1.314**	**0**	**0**

Table 5.25: Metal waste consumption

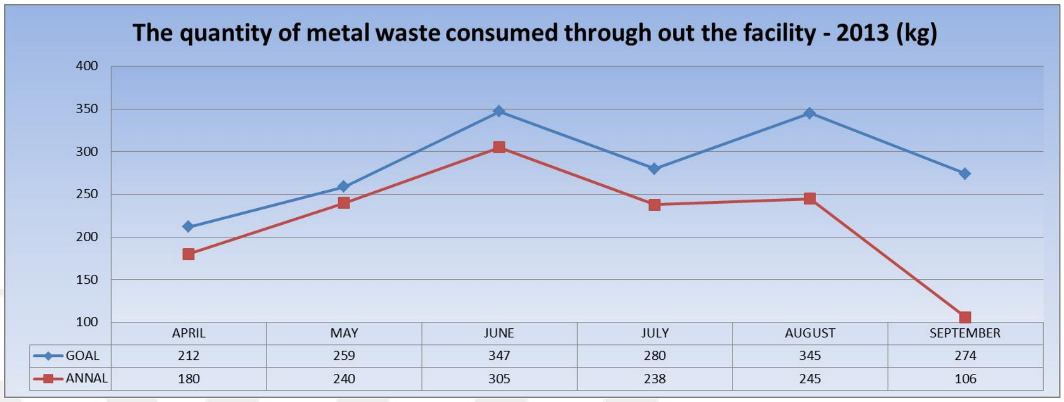


Table 5.26: The quantity of metal waste consumed throughout the facility

As it can be seen from the table 5.23 with respect to the quantity of metal waste consumed throughout the facility, the goal of metal waste consumed was not achieved in approximately all months

Table 5.27: The quantity of metal waste consumed per single person

As it can be seen from the table 5.24 with respect to the quantity of metal waste consumed per single person, the goal of the metal waste consumed was achieved approximately in all months. Only in April target was not achieved.

TOTAL QUALITY GOAL FORM				
ENVIROMENTAL MANAGEMENT SYSTEM: THROUGH OUT THE FACILITY				
THROUGH OUT THE FACILITY				
MONTHS	The quantity of plantal waste consumed through out the facility - 2013 (kg)		Amount of plantal waste consumed per single person in 2013 (kg)	
	2013 (Goal)	2014 (annal)	2013 (Goal)	2014 (annal)
JANUARY	-	-	-	-
FEBRUARY	-	-	-	-
MARCH	-	-	-	-
APRIL	350	380	0,06	0,03
MAY	770	890	0,03	0,02
JUNE	1.130	1.450	0,02	0,03
JULY	1.450	1.080	0,03	0,02
AUGUST	1.010	500	0,02	0,00
SEPTEMBER	1.280	910	0,03	0,02
OCTOBER	-	-	-	-
NOVEMBER	-	-	-	-
DECEMBER	-	-	-	-
TOTAL	**5.990**	**5.210**	**0,19**	**0**

Table 5.28: Plantal waste consumption

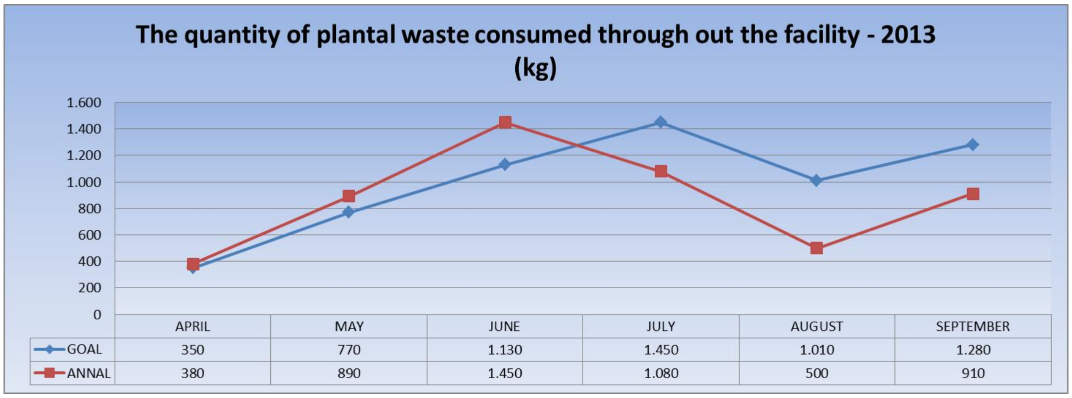


Table 5.29: The quantity of plantal waste consumed throughout the facility

As it can be seen from the table 5.26 with respect to the quantity of plantal waste consumed throughout the facility, the goal of plantal waste consumed was not achieved approximately in all months.

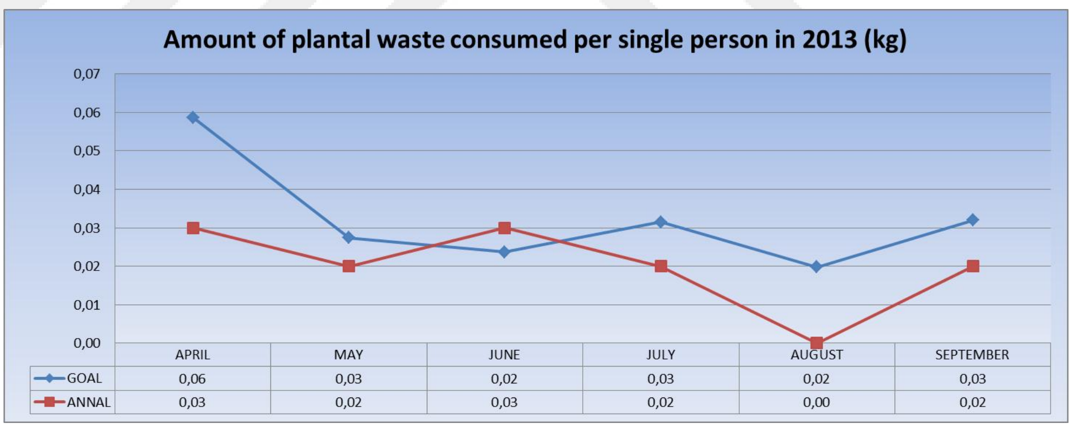


Table 5.30: The quantity of plantal waste consumed per single person

As it can be seen from the table 5.27 with respect to the quantity of plantal waste consumed per single person, the goal of the plantal waste consumed was not achieved approximately in all months. Only in June the target was achieved.

TOTAL QUALITY GOAL FORM				
ENVIROMENTAL MANAGEMENT SYSTEM: THROUGH OUT THE FACILITY				
THROUGH OUT THE FACILITY				
MONTHS	The quantity of hazardous waste consumed through out the facility - 2013 (kg)		Amount of hazardous waste consumed per single person in 2013 (kg)	
	2013 (Goal)	2014 (annal)	2013 (Goal)	2014 (annal)
JANUARY	-	-	-	-
FEBRUARY	-	-	-	-
MARCH	-	250	-	-
APRIL	1.468	1.581	0,25	0,11
MAY	250	306	0,01	0,01
JUNE	214	299	0,00	0,00
JULY	172	329	0,00	0,01
AUGUST	525	194	0,01	0,00
SEPTEMBER	256	11	0,01	0,00
OCTOBER	-	-	-	
NOVEMBER	-	-	-	
DECEMBER	-	-	-	
TOTAL	**2.884**	**2.970**	**0,28**	**0**

Table 5.31: Hazardous waste consumption

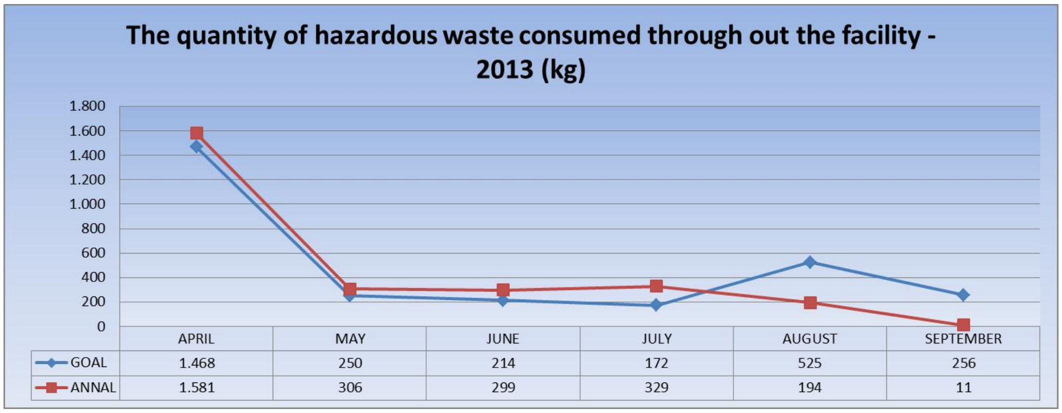


Table 5.32: The quantity of hazardous waste consumed throughout the facility

As it can be seen from the table 5.29 with respect to the quantity of hazardous waste consumed throughout the facility, the goal of hazardous waste consumed was not achieved in approximately all months, Only in August and September target was achieved.

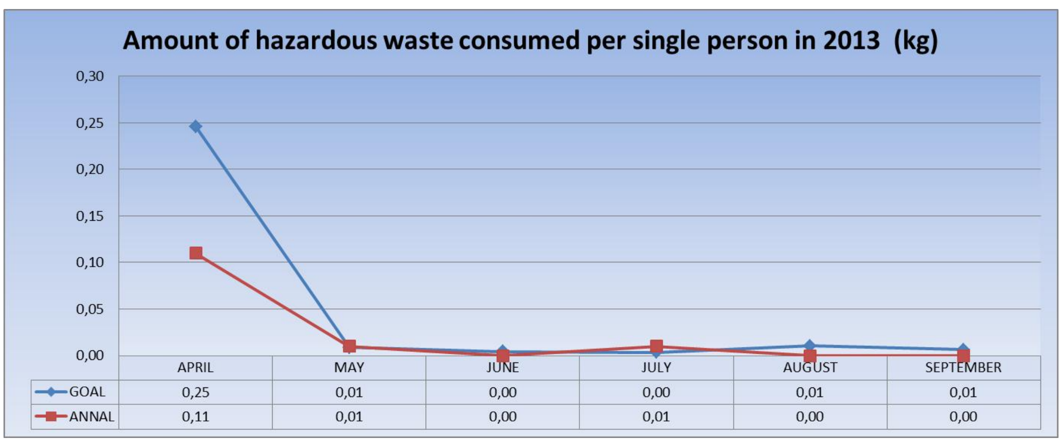


Table 5.33: The quantity of hazardous waste consumed per single person

As it can be seen from the table 5.30 with respect to the quantity of hazardous waste consumed per single person, the goal of the hazardous waste consumed was not achieved in approximately all months. Only in July target was achieved.

TOTAL QUALITY GOAL FORM				
ENVIROMENTAL MANAGEMENT SYSTEM: THROUGH OUT THE FACILITY				
THROUGH OUT THE FACILITY				
MONTHS	The quantity of LNG consumed through out the facility - 2013 (kg)		Amount of LNG consumed per single person in 2013 (kg)	
	2013 (Goal)	2014 (annal)	2013 (Goal)	2014 (annal)
JANUARY	-	6.680	-	-
FEBRUARY	-	7.200	-	-
MARCH	-	10.791	-	-
APRIL	56.120	53.006	9,40	1,76
MAY	44.566	44.510	1,58	1,48
JUNE	47.096	45.965	0,99	1,53
JULY	39.644	43.354	0,86	1,44
AUGUST	44.602	47.304	0,87	0,79
SEPTEMBER	42.970	43.315	1,07	1,17
OCTOBER	-	-	-	-
NOVEMBER	-	-	-	-
DECEMBER	-	-	-	-
TOTAL	**274.998**	**277.455**	**2,46**	**8**

Table 5.34: LNG consumption

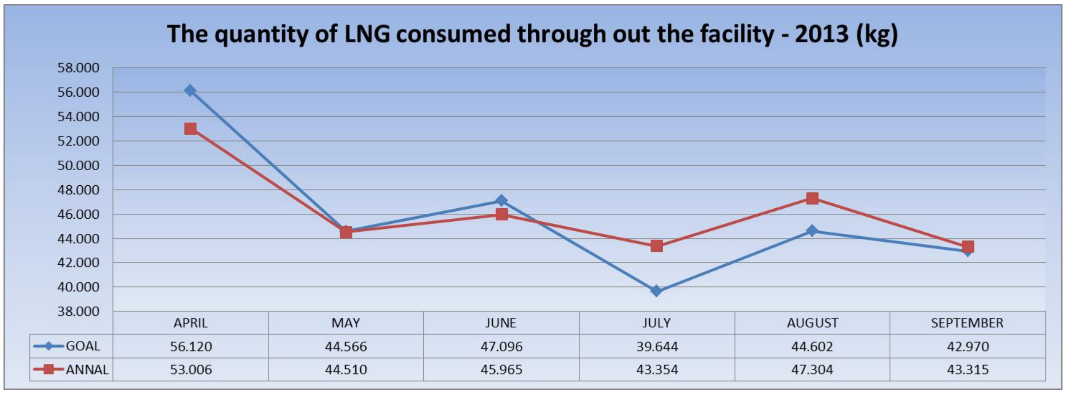


Table 5.35: The quantity of LNG consumed throughout the facility

As it can be seen from the table 5.32 with respect to the quantity of LNG consumed throughout the facility, the goal of LNG consumed was achieved in July, August, and September. In April, May, June the target was not achieved.

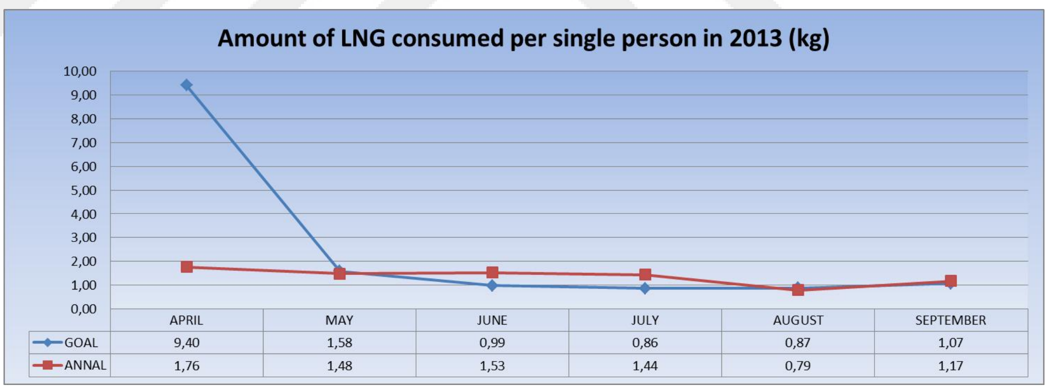


Table 5.36: The quantity of LNG consumed per single person

As it can be seen from the table 5.33 with respect to the quantity of LNG consumed per single person, the goal of the LNG consumed was not achieved in approximately all months. Only in June, and July the target was achieved.

6 CONCULUSION

Due to the rapid consumption of natural energy resources in the world, many disciplines have to find out both new energy resources and new solutions to block or reduce the consumption of natural resources. In the light of this important problem, the new term of ‘’sustainability’’ have gain importance in many areas.

Hotel industry generally operates 24 hours a day, 7 days a week, 365 days a year, dealing with the guests expecting certain luxuries, such as restaurants, fitness centers, and special areas. From this point of view it can be easily seen that sustainability in hotels has a great deal of influence on conservation of resources thus this thesis focused on the sustainability in hotels. One of the main aims of this thesis was to investigate and find clues about the idea of sustainability in hotels, and solutions for its preservation while maintaining the level of luxury that guests expect when staying at a hotel. As a result, this thesis focused on the existing hotel industries and their sustainability issues.

During this thesis, sustainability issue was considered into four different parts. The first part was energy consumption and this part was divided into two subparts as lighting and HVAC systems. The second part was water conservation, third part was waste management and the final part was indoor air quality systems.

During the first chapters of the study energy consumption, water conservation, and waste management in buildings were considered. Afterwards, indoor air quality concept was introduced and all these issues were discussed by considering hotels while illustrating two distinct examples. In chapter 5 sustainability issues in Güral Premier Hotel was discussed. After the architecture of the hotel was briefly mentioned, sustainability issues were discussed with respect to the field observation and related logs/data received from the Hotel officials. Following this, the data related with water consumption, electric consumption, LNG consumption, Hazardous material consumption, plantal waste consumption, paper waste consumption, glass waste consumption, plastic waste consumption and metal waste consumption that is based on the hotels 2013 goals and 2014 annals were analysed. After analysing the data, it was seen that although Güral Premier Tekirova hotels is one of the green key hotels, on some months the goas were not achieved and sustainability issues hold. Thus, from this point this thesis will present some suggestions to decrease the energy consumption, increase the quality of water and waste management at the same time by preserving indoor air quality.

Before focusing on the suggestions of the sustainability issues for the hotel Güral Premier Tekirova, it should be emphasized that while using sustainability procedures the equilibrium between energy efficiency and utilizing comfort/hygiene should be considered at the same time.

As mentioned before one of the problems comes from the logs such a way that there still exist areas of interest where energy consumption did not fully determined. While the total of 51, 2% of electric consumption can be known from the logs, 49, 8% of it cannot be measured. Thus in order to decrease the energy consumption, the first measure should be the extension of the data logging into the areas by monitoring tools during the season. This is especially important for guest rooms that are not monitored right now. As it can be seen from the previous chapter, and hotel documents, only the types and the number of artificial lights are known. There exist no data about the energy consumption in guest rooms. From this point of view, firstly it needs to be discussed and investigated if all the artificial lights located in guest rooms are needed while there is a chance to utilize the daylighting. After this the consumption of the rooms should be measured with respect to the placement of the rooms in the hotel (north, south, west, east or the storey). As a starting point, it is known that this hotel uses card system. Except minibar and TV the artificial lights are opened only when the card system is activated. However, unless the artificial lights in guest rooms are chosen to be energy efficient lamps, there will still be a great deal of energy consumption. So, it is suggested to decrease the number of artificial lighting that is activated in conjunction with the card system. For instance, when the card system is activated, only corridor and reading lamps should be opened. In addition to this, the amount of artificial lights that will be activated with card systems can be arranged according to the possibilities of daylighting on the guest rooms. In order to reduce energy consumption due to artificial lighting, 257 artificial lamps on restaurant façade should be reduced as they contribute most crucially to the energy consumption.

Energy consumption originated from the cooling is also very important as the weather of the Antalya is strictly hot during the season. On the other hand, again there exist no documents about the insulation characteristics of the hotel. So, it is suggested that insulating values should be controlled throughout the architecture and if necessary it should be enhanced. In addition to this there are no sun shading systems that can be found throughout the hotel. For the protection from the sun shine the hotel employers close the dark drape of the rooms when the guest rooms are empty. Using drapes depends on the guests otherwise. Thus it is suggested that on the façade of the building sun shading systems should be used.

Another crucial point is the fact that, Güral Premier Tekirova hotel is not using any renewable energy methods to generate electricity. As the most potential type of the renewable energy for the hotel is solar, let's discuss the applicability whether it is possible to utilize solar energy effectively or not.

In the hotel garden there are not enough empty areas to place the solar panels. Thus the most potentially available areas for solar panel placements become the roofs. This hotel consists of triplex and duplex buildings. As it is measured from the roof plan of the hotel, there exists a total of 14.000 m2 effective roof space. As it is known that, to generate 1 kWatt solar energy per hour, 7 m^2 roof space is needed. Thus, if the entire roofs are utilized, 2.000 kWatts of electrical energy can be generated. By considering the climatic conditions of the Antalya, approximately solar energy can be used effectively for 5 hours a day. Thus in a day maximum of 10.000 kWh electrical energy can be generated. If the costs are considered by the information 1.300 € are needed to cover 7 m^2, to generate 10.000kWh electric energy per day 18 million € are needed. It can be seen that to integrate solar energy to the hotel is very expensive and it is not cost efficient for current price ranges. Also, 10.000 kWh of electrical energy is not enough to provide all the energy needs. Because of this, this thesis suggests utilizing solar energy in some specific areas such as aqua parks, bar etc. The technical departments such as cooling, steam engine works should not utilize solar energy unless the establishment costs are reduced.

For water management, this thesis suggests to apply greywater system to the hotel complex. Also, some educations and information should be given both to the guests and workers.

The weakest sustainable issue about the Güral Premier Tekirova is indoor air-quality. Unfortunately there is not any specific strategy related with the problem exists. It is suggested that all the materials of furniture, painting and etc. should be checked whether there exist any hazardous chemicals or not that induce health risks. In addition to this, air purification systems should also be integrated to the hotels in conjunction with the monitoring systems that monitors the air quality changes during the 24 hours.

As it is seen from the previous part, there are many attempts about the waste management. On the contrary to this, the results display that in many months the target could not be achieved. In Güral Premier Tekirova hotel, waste management strategies are only restricted with collection phase. It is suggested that firstly guests, and employees should be educated and informed. In addition to this it is also suggested to collect waste oil and refine it into biodiesel.

As it mentioned above, hotel industry generally operates 24 hours a day, 7 days a week, 365 days a year, with guests expecting certain luxuries, such as restaurants, fitness centres, and spas. By considering this, main problem is; how can the industry be sustainable but still maintain the level of luxury that guests expect when staying at a hotel. This thesis focus on the existing hotel and choose Güral Premier Tekirova Hotel as a case study. By the analysing the date from 2013 and 2014 about the electric consumption, water management, waste management and observation from the side, some problem determined and some suggestion offer. As it seen that electric consumption from the guest room is not considering from the hotel manager thus, in the future work, electric consumption of the guestroom will be measured and some suggestion offer to decrease the electric consumption.

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