Sustainability and Energy Consumption in Eco-hotels.

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1 Introduction and goals

Tourism is one of the world's largest economic sectors and one that continuous to expand very fast. Tourism development can be a powerful tool for economic growth, poverty reduction and for the conservation of natural and cultural resources. While tourism represents an important development opportunity for many of the world countries, like Costa Rica, Ecuador, Mexico, Greece and others, it can also have negative impacts like disrupting social structures, harming the social and cultural authenticity of host communities and threatening natural and cultural legacy.

Tourism is one of the growth sectors of the global economy. In the developing countries, like the countries of the South America, tourism of all types contributes roughly 70 billion dollars annually. The tourism industry has long been a lucrative industry and it has provided consumers the opportunity to experience different cultures, completely different lives and environmental settings. However, many tourists are aiding to the destruction of the places they visit. /1-2/

Tourism is truly cross-sectored, involving a wide range of issues that can include the following: /1-2/

1. Trade and investment policy
2. Employment and labor laws
3. Enterprise developments
4. Public-private partnerships
5. Community and urban planning (like transportation)
6. Infrastructure development
7. Conservation of cultural heritage, protected areas and biodiversity
8. Management of natural resources (water, energy, waste)
9. Safety and security
10. Education and workforce development

Now, let's give some clues about the tourism sector:

1. As the largest business sector in the world economy, tourism employs over 200 million people, generates 3.6 trillion dollars in economic activity and accounts for one in every 12 or 8% of jobs worldwide.
2. If tourism was a country, it would have the second largest economy in the whole world, after U.S.
3. In the year 2004, tourism contributes globally an estimated 5.5 trillion dollars of economic activity.
4. In 4 of 5 countries (over 150), tourism is one of the most export earners. In 60 countries, tourism is the number one export. /3/

What happened to the global growth?

1. In the year 1950 we had 25 million of tourist arrivals.
2. In addition with that, in the year 2004 we had 760 million of tourist arrivals, which is a rapidly growth.
3. In the year 2020 our expectations are to have 1.56 billion of tourist arrivals. /3/

What about the importance of tourism to developing countries?

1. Tourism is a principle export for 83% of developing countries and the leading exports for ⅓ of poorest countries.
2. For world's 40 poorest countries, tourism is the second most important source of foreign exchange, after oil.
3. Over last decade, tourism has been the only large sector of international trade in services, where poor countries have consistently posted a surplus. /3/

As it was mentioned before, tourism is an enormous and widespread industry. It is found all over the world, so its impacts, social, economic and environmental are also worldwide. These impacts can be positive, doing good, or negative, doing harm, both to the nature and the people. Here is where people meet sustainable tourism. Sustainable tourism aims to have minimal negative impacts so to minimize harm and to optimize economic benefits. A type of sustainable tourism is ecotourism.

Ecotourism conducted in largely untouched natural areas, which tend to be both environmentally and often socially sensitive, so its potential impacts can be even greater. Ecotourism aims to extend the positive impacts through a special focus on conservation, benefits for population and the education of visitors. It has become an important economic activity in natural areas around the world. It provides opportunities for visitors, so to experience powerful manifestations of nature and culture and to learn about the importance of biodiversity conservation and local cultures. Ecotourism also generates income for conservation and economic benefits for communities living in rural and remote areas.

According to The International Ecotourism Society (TIES) in 1990, ecotourism is: "Responsible travel to natural areas that conserves the environment and improves the well-being local people". The term "ecotourism" was first heard in the 1980s. /3/

Most recently, as the awareness to the nature and the activity of ecotourism has grown, Martha Honey proposed a more detailed version (1999): "Ecotourism is travel to fragile, pristine and usually protected areas that strives to be low impact and (usually) small scale. It helps educate the traveler, provides funds for conservation, directly benefits the economic development and political empowerment of local communities, and fosters respect for different cultures and for human rights".

In 1996, the World Conservation Union (IUCN) describes ecotourism as: "Environmentally responsible travel and visitation to natural areas in order to enjoy and appreciate nature (and any accompanying cultural features, both past and present) that promote conservation, have a low visitor impacts and provide for beneficially active socio-economic involvement of local peoples".

A comparison about the growth between the tourism and the ecotourism sector will be tried. According to the World Tourism Organization (2001), world tourism grew by an estimated 7.4% in 2000. Over 698 million people traveled to a foreign country in 2000 spending more than 476 billion U.S. dollars, an increase of 4.5% over the previous year. The fastest developing area is East Asia and the Pacific, with a growth rate of 14.5%. In the Americas, the fastest growth is in Central America (8.8%). /3/

The ecotourism sector is growing at a rate faster than that for tourism as a whole, particularly in the topics. Ceballos-Lascurian (1993) reports that nature tourism generates 7% of all international travel expenditure. The World Resources Institute found that while tourism overall has been growing at an annual rate of 4%, nature travel is increasing at an annual rate of between 10% and 30%. Some indicators explaining this growth are:

1. Visitation to Hol Chan Marine Reserve in Belize increased by two-thirds over a five-year period from 33.669 tourists in 1991 to 50.411 in 1996.
2. More than the two-thirds of tourists in Costa Rica visit protected areas and reserves.
3. A survey of U.S.-based outbound ecotourism operators shows that the number of operators grew up by 820% from 1970 to 1994, or an average of 34% per year.
4. The global destinations of U.S.-based outbound operators' clients are: Central America 39%, South America 25%, North America 18%, Mexico and Caribbean 5%, other regions 13%.
5. Ecotourism is growing at a rate of 10-15% annually, as estimated by the World Travel and Tourism Council.
6. Many countries whose attractions are natural areas are experiencing increases in tourist arrivals. For example, arrivals in Costa Rica increase from 246.737 in 1986 to 1.031.585 in 1999. Belize has seen more than a 600% visitor increase from 51.740 in 1986 to 334.699 in 1996.

7. In Honduras, experts estimate that the number of nature-loving visitors grew up nearly 15% in 1995. A 13-15% increase in visitors was anticipated for 1996. /4/

The sector of ecotourism classified to 6 levels. This measure refers to the levels of achievement, according to the principles of ecotourism. We will try to analyze the following levels.

1. Level 0: The beginning level of ecotourism requires that the travelers be exposed to or made aware of the fragility of the ecosystems they have come to enjoy. This is the very lowest "awareness". Incidental nature travel would usually qualify at this level.
2. Level 1: This level requires that a net positive flow of monetary support occur between the travelling eco-tourist and the ecosystems visited. Financial earmarks, whether airports departure taxes or designations of a portion of land travel costs, would qualify at this level.
3. Level 2: Requires that the eco-tourists engage in a personal way in supporting the environment. Some eco-tourists have planted trees other have participated in litter cleanups.
4. Level 3: Qualifying at this level requires certifying that the specific tour system is benign to the environment. The system should include the international air travel as well as on-site transports and accommodations. Requires also demonstrating that the net effect of the travelers' presence is neutral or positive.
5. Level 4: Requires demonstrating that the net effect of the travelers' is positive. On-site efforts to use appropriate technology, low energy consumption, recycling, organic agriculture, sustainable harvesting methods and make a personal contribution to ecosystem restoration can be used to balance less environmentally benign aspects of the larger travel system that might involve air travel, staying in luxury hotels and excessive energy consumption.
6. Level 5: The ''perfect'' fifth level would be a trip where the entire system was operating in an environmentally sound way. This means that the trip advertising, transport, accommodation and treatment of residual products must all be considered.

The latest version of the ecotourism was given by the Quebec declaration. According to this version, ecotourism: "embraces the principles of sustainable tourism and the following principles which distinguish it from the wider concept of sustainable tourism":

1. Contributes actively to the conservation of natural and cultural heritage.
2. Interprets the natural and cultural heritage of the destination to visitor.
3. Lends itself better to independent travelers, as well as to organized tours for small size groups.

In the 1990s, some tourist associations, consumer groups and governments began to pay attention to ecologically sound tourism. By 2001, there were about 60 environmental certificates and awards in Europe covering all types of tourism suppliers. These certificates are known as eco-labels. The oldest eco-label is the "Blue Flag" which was started in 1987 by the Federation for Environmental Education in Europe (F.E.E.E.). Recently, two new certificates have been developed for protected areas in Europe: the EUROPARC Federation has developed the European Charter for Sustainable Tourism Certification and the World Wildlife Fund (W.W.F.) International has created the PAN Park Certification. /3/

In nowadays, national environmental certificates and awards exist in Austria, Germany, Denmark, Luxemburg, England, the Netherlands, Italy, France, Spain, the Czech Republic and Switzerland. International eco-labels have been developed in the Nordic countries (Norway, Sweden, Finland, Iceland and Denmark) and the European Union is developing criteria for a single Europe-wide eco-label for accommodations.

An eco-label is a symbol awarded by the certifier to an organization. It represents the commitment or the achievement of a company to behave and supply products and services, according to some standards.

In order to characterize a hotel as "eco-hotel", the WTO report in 2002 identified over 100 eco-labels worldwide. The two-thirds of the eco-labels are issued by private organizations and NGOs. Some events that have marked the steps in the evolution of eco-labels are given above:

- 1985: First Blue Flags awarded
- 1998: Green Glove standards launched
- December 1998: UNEP publishes report on tourism eco-labels and support development of eco-labels as self-regulation methods
- April 1999: WTO concerned with quality and reliability of eco-labels, certification systems, awards
- March 2000: ITB (Berlin) eco-labeling panel organized by ECOTRANS
- January 2001: First e-conference on ecotourism certification
- March 2001: First book on eco-labels published
- June 2001: EC funds VISIT project / 10 eco-labels in Europe work together to improve criteria, certification, marketing of their products
- July 2001: WTO commissioned inventory of eco-labels and codes of practice in ecotourism /5/

This project was initiated to develop criteria for the evaluation of hotels with regards to the environmental aspects. These criteria are the energy consumption, the CO_2 production and the waste management.

The aspects are listed below:

- Growing tourism leads to a larger environmental impact
- Behavior of tourists as well can have a large impact in sustainability
- The hotel infrastructure is important for saving energy
- The local organization, including the hotel's staff members and the monitoring of sustainability.

This thesis paper is reviewing the aspects that mentioned before of the above listed points.

2 Glossary and terms

In order to understand the meanings of ecotourism, sustainable tourism and acts, and energy conservation in the eco-hotels, some useful and important terms must be comprehended. Below, we compare some of the terms that will be mentioned in the following chapters.

1. Biodiversity: the tendency in ecosystems, when undisturbed, to have a great variety of species forming a complex web of interactions. Human population pressure and resource consumption tend to reduce biodiversity dangerously. Diverse communities are less subject to catastrophic disruption.

2. Building commissioning: the startup phase of a new or remodeled building. This phase includes testing and fine-turning of the HVAC and other systems to assure proper functioning and adherence to design criteria.

3. Building pressurization: the air pressure within a building relative to the air pressure outside. Positive building pressurization is usually desirable to avoid infiltration of unconditioned and unfiltered air. Positive pressurization is maintained by providing adequate outdoor makeup air to the HVAC system to compensate for exhaust and leakage.

4. CO_2-based high-limit ventilation control: a ventilation strategy that monitors the CO_2 concentration in a building zone or in the return air duct from the zone. If the CO_2 concentration approaches a predetermined high-limit, the outdoor airflow controller is reset to provide additional ventilation. This process supplements standard ventilation-control strategies by providing additional ventilation for unexpected occupancy.

5. Demand-controlled ventilation (DVC) CO_2-based: a ventilation-control strategy in which the concentration of CO_2 is the measured variable that is controlled to a set-point by modulating outdoor airflow.

6. Economizer control: HVAC system controls that operate mixed air dampers to mix return and outdoor air to obtain air of a temperature appropriate for cooling. Economizer controls are used during periods when outdoor air requires less cooling energy than return air.

7. Ecosystem: an ecosystem is an ecological community together with its environment, functioning as a unit.

8. Fuel cell: a fuel cell is a device that converts the energy of a fuel (hydrogen, natural gas, methanol, gasoline, etc.) and an oxidant (air to oxygen) into usable electricity.

9. Greenhouse gases: some of the greenhouse gases (GHG) occur naturally in the atmosphere, while others results from human activities. Naturally occurring greenhouse gases include water vapor, carbon dioxide, methane, nitrous oxide and ozone.

10. Lead ventilation: ventilation of an unoccupied building space immediately prior to its occupancy. Lead ventilation is performed to dilute contaminants from building HVAC sources to acceptable levels by the time occupants arrive.

11. Mixed air: the mixture of outdoor air and return air in an HVAC system. When filtered and conditioned, mixed air becomes supply air.

12. Natural cooling: use of environmental phenomena to cool buildings, e.g., natural ventilation, evaporative cooling and radiative cooling.

13. Passive solar design: designing a building with efficient architectural elements to collect, store and distribute solar resources for heating, cooling and day-lighting.

14. Renewable energy: renewable energy is an energy resource that is replaced rapidly by natural processes. Some examples are sunlight, wind, geothermal, micro scale hydropower and wood.

15. Renewable energy technologies: active, passive and PV strategies integrated into building design.

16. Return air: air that has been circulated through a building as supply air and has been returned to the HVAC system for additional conditioning or release from the building.

17. Sustainable: the condition of being able to meet the needs of present generations without compromising those needs for future generations. Achieving a balance among extraction and renewal and environmental inputs and outputs, as to cause no overall net environmental burden or deficit. To be truly sustainable, a human community must not decrease biodiversity, must not consume resources faster than they renewed, must recycle and reuse virtually all materials, and must rely primarily on resources of its own region.

18. Tight buildings: buildings that are designed to let in minimal infiltration air in order to reduce heating and cooling energy costs.

19. Water reclamation: reuse of effluent from wastewater treatment facilities through irrigation, land application or other recycling methods.

20. Low-energy building: it is generally considered to be one that uses around half of the German and Swiss low-energy standards for space heating, typically in the range of 30 (KWh / m^2) to 20 (KWh / m^2).

21. Energy conservation: is the practice of decreasing the quantity of energy used. Energy conservation may results in increase of environmental value and human comfort. It reduces the energy consumption and energy demand in buildings. This reduces the rise in energy costs and can reduce the need for new power plants and energy imports. By reducing emissions, energy conservation is an important plan of lessening climate change. It is often the most economical solution to energy

shortages, and is a more environmentally benign alternative to increased energy production.

22. Ecotourism: is a form of tourism that appeals to the ecologically and socially individuals. Ecotourism focuses on volunteering personal growth and learning new ways to live on the planet. Typically, involving travel to destinations where flora, fauna and cultural heritage are the primary attractions. An integral part of ecotourism is the promotion of recycling, energy efficiency and creation of economic opportunities for the local communities.

23. Sustainable tourism: is an industry which attempts to make a low impact on the natural environment and local culture, while helping to generate income and employment for locals, as well as to promote the conservation of local ecosystems. A part of sustainable tourism is ecotourism, which “contributes” actively to the conservation of natural and cultural heritage. It includes local and indigenous communities in its planning, development and operation, contributing to their well-being and interprets the natural and cultural heritage of the destination to visitors and lends itself better to independent travelers.

3 Passive buildings and sustainable building design

The low energy and energy-efficient buildings like the eco-hotels must follow the conditions and the standards of the passive and sustainable design in their construction. Sustainable design must use an approach to traditional design. According to the sustainable building design philosophy, the sustainable design balances human needs with the capacity of the natural and cultural environments. It minimizes environmental impacts and the importation of goods and energy, as well as the generation of waste. Any development would be constructed from natural sustainable materials collected on-site, generate its own energy from renewable energy resources and manage its own waste.

With the philosophy above, three important aims could be achieved:

1. Promotion of new human values and lifestyles for a more harmonious relationship with local, regional and global resources and environments.

2. Increase public awareness about appropriate technologies and the cradle-to-grave energy and waste implications of various building and consumer materials.

3. Relay cultural and historical understanding of the site with local, regional and global relationships. /6/

The term “passive buildings” refers to the rigorous, voluntary, Passivhaus standard (in German) for energy use in buildings. Passive design is not the attachment or supplement of architectural design, but an integrated design process with the architectural design. The first Passive buildings were built in Darmstadt, Germany, in 1990. Since 1996, more than 6000 passive buildings have been constructed in Europe, most of them in Germany. /18/

The Passive building standards require that the building will be following by the requirements below:

- The building must not use more than 15 (KWh / m²) per year in the heating energy.

- With the building de-pressured to 50 (Pa) below atmospheric pressure by a blower door, the building must not leak more air than 0.6 times the house volume per hour.

- Total primary energy consumption (primary energy for heating, cooling, hot water and electricity) must not be more than 120 (KWh / m²) per year.

- The specific heat load for the heating source at design temperature is recommended to be less than 10 (W / m²). /6/

According to the Passivhaus standards, qualified buildings are able to dispence with conventional heating systems. Some type of heating will still be required and most of the passive buildings do include a system to provide supplemental space heating. This is distributed through the low-volume heat recovery ventilation system that is required to maintain air quality, rather than by a conventional hydro or high-volume forced-air heating system.

The cost savings from dispensing with the conventional heating system can be used to fund the upgrade of the building envelope and the heat recovery ventilation system. With careful design we can construct a very energy efficient building with the same cost as normal buildings.

To achieve the passive standards, a combination of low-energy building techniques is been used:

- Passive solar design: by following passive solar design, buildings are compact in shape to reduce their surface area, with windows oriented towards the equator

(south in the northern hemisphere and north in the southern hemisphere) to maximize passive solar gain. However, the use of solar gain is secondary in order to minimize the overall energy requirements. The buildings can be constructed from dense or lightweight materials, but some internal thermal mass is incorporated to reduce summer peak temperatures, maintain winter temperatures and prevent possible over-heating in spring or autumn, before normal solar shading becomes effective.

- Super-insulation: passivhaus buildings employ super-insulation to reduce the heat transfer through walls, roof and floor, compare to conventional buildings. A disadvantage resulting from the thickness of wall insulation required is that, unless the external dimensions of the building can be enlarged to compensate, the internal floor area of the building may be less compared to traditional construction.

- Advanced window technology: to follow the standards of a passive building, windows are manufactured with exceptionally high R-values, which means low U-values, typically 0.85 to 0.70 (W / (m^2K)) for the entire window. These combine triple-pane insulated glazing (with a good solar heat gain coefficient, low emissivity coatings, argon or krypton gas fill and “warm edge” insulating glass spacers) with air seals and developed thermally-broken window frames.

- Air-tightness: the passive buildings are required to be air-tight compared to conventional buildings. Air barriers, careful sealing of every construction joint in the building envelope, and sealing of all service penetration through it, are all used to achieve this. Air-tightness minimizes the amount of warm or cool air that can pass through the structure, enabling the mechanical ventilation system to recover the heat, before discharging the air externally.

- Ventilation: mechanical heat recovery ventilation systems, with a heat recovery over 80% and high-efficiency electronically commutated motors, are employed to maintain air quality and to recover sufficient heat to dispense with a conventional central heating system. Since the building is air-tight, the rate of air change can be

optimized and controlled at 0.4 air-changes per hour. All ventilations ducts are insulated and sealed against leakage.

By their design, passive buildings usually have the following traits: the air is fresh and very clean, but dry, especially in winter. Air change of 0.3 air changes per hour is recommended, otherwise the air can become "stale" (excess CO_2, flushing of indoor air pollutants) and any greater, excessively dry (lack of humidity <40%). Because of the high resistance to heat flow (high R-value insulation), there are no "outside walls", which are colder than the other walls. Since there are no radiators, there is more space on the rooms' walls. Inside temperature is homogeneous. With ventilation and heating systems switched-off, a passive building loses less than 0.5 C per day in winter, stabilizing around 15 C in the central European climate. /6/

Below, there are some natural factors for the sustainable design buildings that we must keep in mind. /4-6/

Climate

- apply natural conditioning techniques to effect appropriate comfort levels for human activities
- avoid dependence on mechanical systems to alter climate
- analyze if the climate is comfortable and then decide on mitigation of the primary climatic components of temperature, sun and wind that can make the comfort level better
- stop to isolate human needs from the environment

Temperature

- temperature is a liability in climates where it is too hot or too cold
- several ways to increase the comfort if there is too hot are: minimizing solid enclosure and thermal mass, maximizing roof ventilation, using of segmented floor plans to minimize internal heat gain and maximize exposure for ventilation, separating rooms with covered breezeways to maximize wall shading and include ventilation, isolating heat generating functions such as laundry and kitchen from living areas

- several ways to increase the comfort if there is too cold are: consolidating functions into the most compact configuration, minimizing air infiltration with barrier sheeting, weather-stripping, sealants and airlock entries, minimizing entries not oriented towards sun exposure

Sun

- sun can be an asset in cool and cold climates to provide passive heating
- design must reflects seasonal variations in solar intensity, incidence angle, cloud cover etc.
- when solar gain makes the space too hot and also uncomfortable: use overhangs to shade walls and openings, use shading devices such as louvers to block sun without blocking out natural light, use light-colored wall and roofing materials to reflect solar radiation, use site features and vegetations to provide shading to walls with eastern and western exposure
- when solar gain makes the space too cold and also uncomfortable: increase thermal mass and envelope insulation, use dark-colored building exteriors to absorb solar radiation and promote heat gain, maximize building exposure

Wind

- the wind is a liability in cold climates, because it strips heat away quicker than normal ; it can also be a liability to comfort in hot and dry climates
- it can be an asset in hot climates to provide natural ventilation, for example: using of natural ventilation whenever is possible and limit air conditioning to areas requiring special humidity or temperature control are two very good situations that explaining the meaning of wind, using wind scoops or wind turbines to include ventilation on sites with limited wind

Topography

- consider building interfaces to minimize disturbance to site character, skyline, vegetation, hydrology and soils
- consolidate functions or segment facilities to reduce footprints of individuals structures to allow sensitive placement within existing landforms

- using of the sensitive arrangement of buildings to orient visitors to building entrances, and enhance visual quality by creating a rhythm of open spaces and framed views

Cultural resources

- archeological and other sites of cultural importance should be respected and not negatively impacted
- understand the local culture and the need to avoid the introduction of socially unacceptable practices
- consult with local indigenous population for design input as well as to foster a sense of ownership and acceptance
- include local construction techniques, materials and cultural considerations in the development of few facilities
- incorporate local expressions of detailing and technology into new facility design and interior design

In a sustainable building, all the materials that used for the construction classified in three categories. These are the primary materials, secondary materials and tertiary materials. It is important to prioritize them by the origin, in order to avoid materials for non-renewable sources. Some of the local materials that can be used for the construction have a low level of energy cost and can help sustain the local economy. Nevertheless, the natural materials are less energy-intensive and polluting to produce and contribute less to indoor air pollution. We must explain the meaning of primary, secondary and tertiary materials, as we mention before. /6/

Primary materials found in the nature such as stones, wood, cotton, flora etc. some of our processes can be: ensure that the new lumber is from certified forests, and using caution that any associated treatments or additives do not contain toxins that contribute to indoor air pollution.

Secondary materials made from recycled products such as wood, aluminum and plastics. Some of our main aims are going to be: verify that production of material does not involve high levels of energy, pollution and waste, verify the functional efficiency and environmental safeness of the materials, specify aluminum from recycled materials

(because it uses less energy to produce over initial production), and be informed for new technologies and materials.

Tertiary materials are man-made materials, such as artificial, synthetic, etc. first of all we must avoid the using of materials containing chlorofluorocarbons or hydro-chlorofluorocarbons that could pollute the environment. Secondly, we must minimize the using of products made from new aluminum or other materials that are resource disruptive during extraction. At the end, we must avoid the use of concrete, steel and materials that off-gas volatile organic compounds.

An ecotourism site, such as the eco-hotels, is responsible for the use of the most advanced techniques so to reduce energy consumption, utilize local renewable sources of energy and, last but not least, to educate the visitors about environmentally responsible energy consumption and the advantages of sustainable tourism. In an “eco” site, solar applications range from hot water preheating to electric power production with photovoltaic cells. Wind-powered generators can provide electricity and pumping applications in some areas. The biogas conversion processing reduces gas or electricity costs and eliminates the release of wastewater effluent into water resources. It can be also used for water heating, cooking and refrigeration.

A passive and sustainable building must pay attention to the water resources whatever the natural distribution. In an eco-site development, where health considerations are paramount, water issues center on providing safe drinking, cooking, washing and flushing water (in toilets). Water reservation includes the use of lower quality of water such as wastewater in its applies. These uses do not require the quality of water that in needed for internal consumption. For example, with the proper wastewater treatment, sea / lake water can be used for flushing water in toilets. Visitors must always be informed about the source of water and the types of energy required to process and distribute water. The manager of the eco-site must inform them for their responsibility in achieving the goal of water conservation and the energy costs they gain.

Waste prevention requires an ideally training of the operators, including all the users of the eco-site (manager, staff, visitors, local community). Most of the waste problems are created by lack of attention. Preventing and decreasing the pollution means thinking through all of the activities and services and planning them in a way that they generate

less wastes. Waste prevention leads to thinking about materials in terms of reduce, reuse and recycle. Materials that cannot be reused directly should be recycled.

According to the Green Report Card for Evaluating Ecotourism facilities, there is a list of priorities that must be answered in every eco-site like the eco-hotels. Below, we compare some of these priorities. /7/

- Is the scale of the development appropriate for the local community and the capacity of the environment to support the facility?
- Were the members of the local community actively involved in the planning and construction of the facility?
- Does the design of the facility utilize traditional cultural building forms and materials found in the immediate area?
- Does the facility design encourage the visitor to look at the natural environment in a new way?
- Are there any contradictions to the ecotourism mission of conservation apparent in the facility?
- Is the energy sources that be used environmentally sustainable?
- Are building materials free of toxic or non-biodegradable agents?
- Are appropriate technologies employed for the treatment of organic wastes and other wastes? Is recycling practiced?
- Does the staff seem informed about ecotourism, energy conservation, recycling and the facility's design and operational features?

These are some of the questions that must always be answered by every manager who want to say that he is involved with an eco-facility.

4 Description of the construction and the energy consumption in the eco-hotels

The tourism industry spends billion of euro every year in energy. Managing the energy performance represents an opportunity for hotels all over the world to save costs. Energy savings represent the number one way of reducing costs without reducing customer satisfaction.

Energy savings means costs savings. Energy is a cost that any hotel can control. Hotel energy costs can consume from 4% to 7% of a property's revenue. If hotels improved their energy performance by an average of 30%, the worlds' annual electricity bill savings could be 1.5€ billion almost. This represents a saving of 365€ per available room night per year for every hotel room. /6/

The benefits of energy efficiency are not only financial thing. According to the Energy Star Inc. more than 43 million (KWh) of electricity per year and more than 29 million (kg) of CO_2 emissions saved in 2001. /6/

Many tourists are looking for environmentally friendly hotels. Hotels that practice energy efficiency, water conservation and recycling. That is the reason why hotels must enhance the image of their property by having visible signs of environmental management such as recycling bins or compact fluorescent lights.

In this chapter an analysis about the construction of some eco-friendly hotels will be tried and some suggestions with which we can reduce energy loss through the building envelope will be proposed.

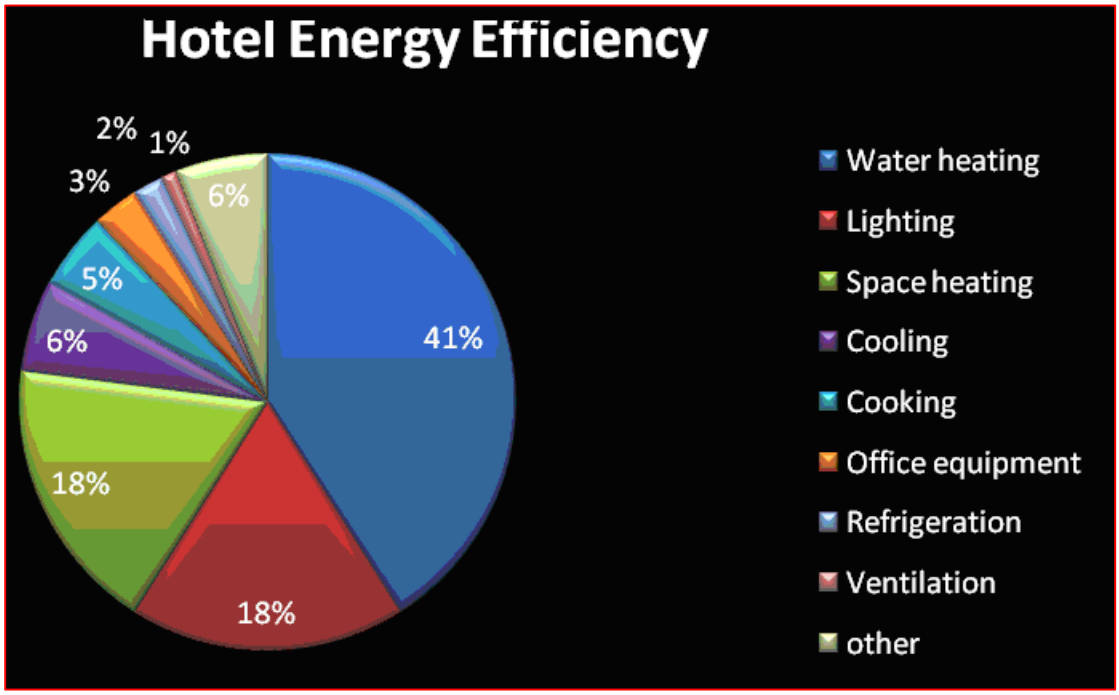

Fig. 4.1: Here we can see a drawing about the energy efficiency of a hotel.

The informed hotel staff can help to have some great results for the savings of energy.

- Turn off or reset heating and cooling systems in unoccupied rooms: this can reduce costs without affecting the comfort of guests.

- Use natural lighting when cleaning guest rooms and close the draperies when leaving guest rooms.

- Limiting the amount of hot water used for cleaning will save water heating costs.

- Report necessary equipment repairs: this will increase the performance of the using equipment and will decrease the energy consumption.

- A very important issue is to install “Energy Star” clothes washers. The “Energy Star” washers use 50% less energy and also 40% to 50% less water, which makes less water to heat and shorter drying times.

Water is the larger demand in all hotels. Reducing this demand with efficient equipments we lower the water consumption. According to many studies and experiments, hotels that use water-saving technology in their rooms, such as low-flow toilets, faucet aerators and drip irrigation, consume one-fifth of the water per guest from the similar hotels. Furthermore, guests at the more water-efficient hotels noticed no reduction in customer services. A similar non-efficient hotel can save more than 250.000€ per year from water, if it is using energy efficient equipment. /10/

We must explain what some of the above technologies mean:

- Low-flow toilets: typical toilets use between 19 and 26 liters per flush. The low-flow toilets can do the same job using no more than 3 liters per flush.

- Toilet dams: are devices that block part of the tank, so that less water is required to fill the toilet in each flush. Other water displacement devices reduce the amount of space in a toilet's holding tank, so that each flush uses less water. Sometimes, a double flush is needed, but water savings from these devices are estimated more than 10%.

- Low-flow showerheads: typical showerheads use about 17 to 30 liters per minute. Low-flow showerheads use less than 9.5 liters per minute with no reduction in quality or service.

- Efficient faucet aerators: can easily be installed on the ends of most faucet systems to replace existing operators. These devices allow less water to through the faucet. As a result of that, they can save between 12 and 65 liters per day.

Now we can propose some suggestions about the water conservation in guest rooms:

- Check for leaks in the toilets: toilets account for 50% of the water used in bathrooms. Even a small leak can cause 151 liters or more of water to go down the drain. That accounts to 3.790 liters of water per month, even if the room is unoccupied.

- Replace sticking toilets handles: the sticking handles can cause hundreds of wasting water liters per hour.

- Install variable-buoyancy flappers: with these devices we can increase the efficiency of the older toilets. According to their mechanism, the flapper closes before all water rushes from the tank onto the bowl. They maintain the same force of the water that rushes. For example, if a variable-buoyancy flapper installed in a toilet that uses 18 liters per flushing and is set at 7.5 liters, all the 18 liters will be moving downward after flushing, but the flap will be closed while 7.5 liters still remain in the tank.

- Install low-flow showerheads: showers accounts for 30% of the water use in bathroom. The old showerheads use 11 liters per minute. If the showerheads replaced with new showerheads, both water savings and cost of heating hot water are gained.

- Maintain optimal system pressure: water efficient faucets and showerheads will not operate efficiency if they have wrong pressure. If the pressure is too low, low consuming devices will not work properly. If it is too high, they will consume more than the appropriate amount of water. So, we must ensure that the pressure is between 20 and 80 psi.

- Check for leaky faucets: a leaky faucet that drips one drop of water every second can costs 10.000 liters per year. If the hot water is leaking, we have energy costs too. If we consider that 4 liters that dripping per hour consumes almost 75€ in energy, the 10.000 liters will consume around 187.500€, which is a large and very important amount.

- Install aerators: the use of aerators can reduce the water usage in faucets. By checking the amount of water that flows from each faucet, we can estimate the amount of water per minute that flows. In the bathroom, a 7.5 liters aerator will provide enough water for shaving, hand washing and other. /8-10/

In combination with the suggestions above about the water conservation, we will propose some suggestions for reducing water heating, which decrease the energy consumption:

- Consider an ozone laundry system: with these systems the clothes cleaned with cold water and fewer chemicals than the typical laundry systems.

- Consider a solar water heating system: we can have a dramatically decrease of energy and cost at hotels, which use a lot of hot water.

- Operate laundry equipment with full loads only: partial loads are inappropriate and waste hot water and energy.

- Lower water heater temperatures: the reducing of domestic hot water temperature to 43 C at the water heater is recommended.

- Reduce water temperature for hand washing from 60 C to 43 C. /9/

But what we can do so to reduce the wastes in the guest rooms? Significant amounts of waste are collected from the guest rooms each day. The items that usually collected are: paper products 45%, food related waste 40%, bathroom waste 5% and glass and plastic bottles 10%. /9/

The best way is all the recyclables to be collected by room attendants, while the room is cleaned. Some suggestions for reducing the wastes are listed below:

- Create newspaper recycling plan.
- Donate discarded or leftover materials
- Designate a recycling can in guest rooms for recyclable items.
- Use glasses and mugs instead of disposables.
- Place recycling bins in vending areas

4.1 LIGHTING

The lighting sector is an enormous energy efficiency potential. By incorporating modern and energy-efficient lamps and luminaries, we have many energy-savings opportunities. Following responsible operational practices, we also can significantly reduce our energy costs.

Lighting is a very high priority when considering hotel retrofitting. With the installation of new lighting technologies, such as dimmers, photo sensors, occupancy sensors and timers, hotels can reduce their amount in electricity consumed.

Lighting accounts for 19% of the electricity usage in hotels. There are several types of energy efficiency lighting such as compact fluorescent lights, light emitting diodes (LED) and lighting controls. Below, we have some recommendations for reducing the energy consumption by lighting:

- Replace standard incandescent bulbs with compact fluorescent: the incandescent lamps make up 48% of lamp inventory, fluorescent lamps account for 34% and compact fluorescent lamps account for 15%. Less than 5% of the energy used by incandescent lamps generates useful lights. The rest is waste heat, which increases air-conditioning costs. Compact fluorescents use much less energy than incandescent bulbs. They require one-third to one fourth the electricity of incandescent lamps and last 10 to 20 times longer.

- Consider using natural daylight where and when it is possible: this can reduce lighting energy consumption. However, heat loss may occur in winter and heat gain may occur in summer, with open draperies.

- Use energy-saving fluorescent T8 lamps over the old-style T12 lamps: the energy-saving T8 lamps are thinner than the old-style T12 lamps. The T8 lamps have a different design from the T12. For example, a T8 lamp has almost 2.5 cm diameter, in addition to the T12, which diameter is 4 cm. A typical fluorescent fixture with two T12 lamps uses 95 Watt and electronic ballast with two T8 lamps uses only 62 Watt, while producing the same amount and quality of light.

- Use dimmers controls in meeting rooms: the dimmers control light output, so that no more light than the appropriate is produced.

- Use an energy-efficient light-emitting diode (LED) night light to eliminate the need to leave bathroom lights on throughout the night: one of the largest energy-saving opportunities in guest rooms lighting is eliminating the unnecessary extended operation of the bathroom fixtures. More than 75% of the energy used by these fixtures occurs when they are left on for two hours or more.

- Replace incandescent lamps in exit signs with light-emitting diode exit signs: LEDs are estimated to last 220.000 hours. For a 10-year period, energy costs and maintenance requirements for an incandescent sign will be almost 380€, while the costs for a comparable LED sign will be almost 65€. There are also some "Energy Star" signs, which use 75% less energy.

- Utilize light colored walls and ceilings: the light colored walls and ceilings as appropriate increase in light levels by 15% to 50%.

- Installation of high pressure sodium vapor (HPSV) lamps for applications where color rendering is not critical.

- Use dimmers controls in meeting rooms: the dimmers control light output, so that no more light than the appropriate is produced

- Installation of microprocessor-based controllers.

- Installation of photocells, devices that automatically detect the natural light level in room.

The lighting and the HVAC systems have a large effect on each other. When the air-conditioning system is optimized the air-conditioning loads will be calculated based on existing lighting systems. That is the reason why, if a hotel plans to upgrade the lighting with some of the ways above, it is better to do that at the same time with the HVAC systems upgrading.

4.2 HVAC

The HVAC systems (Heating, ventilation and air-conditioning) are the largest electricity consumers in hotels. The amount of electricity used for the air-conditioning systems constitutes 30% to 56% of total costs. The HVAC systems are devices that provide heating, cooling, humidity control, filtration, fresh air, building pressure control and, the most important in hotels, comfort. They can also provide employee's productivity, because they will have to work in a pleasant and comfort environment.

The HVAC systems costs can be reduced by strategies like the "payback", which is the process of upgrading controls with more efficient systems. We have mention before that HVAC systems and lighting have a large effect on each other. When changing from less efficient lights to cooler operating, more efficient lights, the change will also reduce the amount of the heat in the air, which the HVAC system must overcome. If the HVAC systems are changed without the lighting, even if the lighting is changed later on, the whole building may become damp and uncomfortable both for guests and employees. That is the reason why the HVAC systems and the lighting should be considered as directly operations.

The followings are suggestions on how to reduce the HVAC energy consumption. We will propose energy-saving solutions, which can improve both the efficiency of the systems and also the building envelope. Some of these ways are:

- Thermostat: in the cooling season is recommended to be from 25 C to 30 C. In the heating season, the temperature in the unoccupied rooms should be from 18 C to 24 C.
- Turn off heating and cooling in unoccupied rooms: by turning off heating and cooling in the rooms and places without guests, we can easily reduce costs without affecting the comfort of the staff and the other guests.
- Use natural light when cleaning rooms. Always keep draperies closed: closing the draperies in each room will help not to lose heat in winter and to gain heat in summer.

- Check and clean HVAC filters: by checking and cleaning the HVAC filters twice a year, will help to improve the whole system efficiency.
- Connect bathroom fans to light switches to reduce excessive operation: fans that continuously remove excessive amounts of heated or cooled air from guest rooms.
- Using of shading to reduce solar heat through windows: shading is the most cost-effective way to reduce solar heat gain. It also "cuts" the air-conditioning costs.
- Installation of an Energy Management System: many hotels have started to use the Energy Management System, which is a program that allows operators to monitor the building's energy load. It can include a computer, an energy management software program, sensors and controls. It can also include a communication network. With this application, a hotel can save 10% to 40% in electric costs.
- Section off the hotel in order to close down areas that are unoccupied during periods with low occupancy: one of the most important and efficient ways to the energy-saving plan is the installation of digital thermostats. These devices can monitoring the room occupancy and automatically adjust the temperature when occupants entering or leaving the room. According to some studies, a hotel can save almost 270.000€ per year in energy costs with this application.
- Insulation: insulate all heating and cooling lines or vessels using the appropriate insulation thickness to minimize heat gains and losses.

4.3 LAUNDRY

Most of the hotels are paying almost 40% of their energy bill for heating water. According to their needs for steam and hot water, laundry is a good opportunity to increase the energy savings. Drying and finishing take the major of the process energy rather than the washing, almost 65% of the whole proceeding.

"Energy Star" appliances are one of the best ways to begin the energy-saving process. The cost of these devices might be a little bit more expensive, but the life usage costs are substantially lower. Energy Star washers use 68 to 94 liters of water per load, in addition with the typical washers, which use almost 150 liters. They extract more water from clothes during the spin cycle. This can reduces the drying time and saves energy. The top-

loading models looks like conventional machines from the outside, but these Energy Star washers use different type of washing proceeding, so to get clothes clean with less water and energy. Some of them have also sensors to monitor the incoming water temperature closely. They rinse clothes with repeated high-pressure spraying instead of soaking them in a full tub of water.

The front-loading models are similar to machines that used in laundromats. They use a horizontal or tumble-axis basket to lift and drop clothing into the water instead of rubbing clothes around a central agitator. Both top-loading and front-loading Energy Star clothes washers save water and energy. They also use faster spin speeds to extract more water from clothes, reducing drying and energy use. An Energy Star clothes washer cane save more than 150$ over its lifetime. The savings come from using less hot water than conventional models.

Below, we compare some efficient laundry technologies and practices:

- Washing machines, loads and temperature settings: horizontal-axis (H-axis) washing machines are front-loaders and more energy efficient than the conventional top-loaders, which called vertical-axis (V-axis) machines. Some soaps and detergents perform well at lower water temperatures. The water temperatures must be checked with a thermometer and equipment should be adjusted to provide the lowest acceptable temperature. Using equipment efficiently means ensuring that washers and dryers are operated with full loads. To reduce energy by washing machines, ho water heaters or boilers should be operating efficiently.

- Heat recovery opportunities for heating water: implementing heat recovery efficiency measures is one cost-effective option for reducing energy costs associated with heating water. The energy that will be lost can be recovered and used for other purposes, such as heating outdoor air used for ventilation, space heating and water heating. When the recovered heat is on high temperature, it can be used to heat water. A good source for the recovered heat is a water-cooled refrigeration system. The water goes through a heat exchanger and

transfers heat directly to where it is needed or to a hot water tank. The recovered heat preheats fresh water before it enters the domestic hot water tank, lowering the amount of energy needed to heat the water to the necessary temperature. This process has excellent results to laundries and dishwashers.

- Laundry dryer efficiency: a dryer with a moisture sensor will automatically shut off when the clothes are dry. This will save energy and it will reduce the wear and tear on laundry from over-drying. The most efficient dryers have moisture sensors in the drum for sensing dryness, while most only infer dryness by sensing the temperature of the exhaust air. Hotels can save almost 10% of energy with a temperature-sensing control and 15% with a moisture-sensing control.

- Create linen and towel program: every owner has to inform guests on how often sheets will be changed and let guests tell you if they require changes more frequently. A change of bed linens every three days and a change of towels only if they are on floor, is a good schedule.

- Create a waste reduction plan for laundry and cleaning chemicals: all laundry and cleaning chemicals should be biodegradable and as least toxic as possible. The usage of environmentally friendly cleaning agents is required. We can use products in correct concentration and only if it is recommended, and also we can use refillable containers instead of single use.

- Minimize hazardous wastes by inventory: a just-in-time inventory method can reduce the need to store chemicals and other products. A good way is to find vendors that are willing to ship products when we need them.

- Recycle old linens and towels.

4.4 RESTAURANTS

The restaurant is the most energy intense commercial room in hotels. A decrease in energy use in restaurant can reduce the CO_2 emissions by 675 million kg per year. The biggest energy user, using over 40% of the energy consumed, is the air-conditioning. Food preparation accounts for 38% of energy consumed, while refrigeration and sanitation account for 22% almost. Below, we are proposing some energy conservation measures:

- Locate outside icemakers and vending machines under cover and in shaded areas: the icemakers and vending machines operate continuously and consequently consume electricity for 8.760 hours per year. By shading them, we can reduce the amount of energy consumed to keep them cool.

- Inspect and clean icemakers and vending machines condenser coils: the efficiency of these machines can be reduced by a very thin layer of dust.

- Operate refrigeration equipment efficiently: we must not set the thermostat below necessary temperature. Let the hot food on counter before storing in the refrigerator. Do not block circulation within the refrigerator. Thaw frozen food in refrigerator, it will reduce the load on refrigerator.

- Schedule food preparation: the cooking of some items in off-peak periods is a good solution. Use more energy efficient methods when possible, like ovens, fryers and steamers. Range tops, griddles and broilers are less energy efficient.

- Install vinyl air curtains or air blowers over the doors of walk-in refrigeration: vinyl curtains and air blowers can reduce the amount of cooled air that escapes and outside air that enters through walk-in doors.

- Turn off or set back HVAC when the restaurants are closed: by turning off the systems or setting back when the hotel's restaurant in unoccupied we can save one-third of the total building energy use.

- Use exhaust fans only when is necessary and at normal speeds: exhaust fans can waste energy by pulling conditioned air out of the building. A good way to control the inappropriate use is by connecting fans to a light switch.

- Avoid using the range top if possible: the range top uses more energy and adds more heat to the kitchen than the other equipment. If we use the range top, we must use the right size pot. By keeping pots closed together and covering pots, is a good way to reduce heat loss. We must not preheat (10 to 15 minutes is sufficient time). In the end, turn off the heat early, using the residual heat on the burner.

- Operate the fryer efficiently: blanch or precook food in a steamer and dry food before frying. Keep fat above coils, because if the elements are partially exposed, 25% of heat could be wasted.

- Operate the oven efficiently: keep oven doors closed. Preheat only when is necessary. Do not set thermostat higher than necessary and do not use aluminum foil.

- Use steam whenever is possible: steam is the most efficient cooking method. Partially cook food in steamer before transferring to another method and cover steam-jacketed kettles. The clouds of steam indicate high temperatures.

- Operate dishwashers efficiently: keeping temperature at the right levels is necessary. Using with full loads only, turn off booster heaters when they are not in use and clean regularly.

- Installation of Energy Star devices: the Energy Star appliances are very useful. The Energy Star dishwashers use 25% less energy, and refrigerators and freezers are 45% more efficient. Some commercial dishwashers, called "ware washers", use 3.8 to 6 liters per minute, while conventional older washers use between 34 and 45 liters. An Energy Star qualified dishwasher saves about 100€ over its lifetime. These savings come from using less hot water.

In all hotels' restaurants, the wastes from food come in three types. They can be either edible or non-edible. Banquet scraps are edible non-contaminated leftovers from client functions. Non-edible are guest's plates and food preparation scraps, which are unusable portions of fruits and vegetables, cooking looses, spoiled leftovers packaged failures, etc.

Waste oils and grease are also leftovers from cooking. The above types of food waste can be some excellent candidates for reduction, recovery and reuse programs.

So, what we can do with all this masses of wastes? Below, there are some suggestions for reducing and make a good use of our waste:

- Composting programs: by the composting process, the organics naturally begin to decompose into smaller materials and eventually we have compost. By keeping the materials covered, while adding additional moisture, we can accelerate this process. Organic material composting programs can reduce the hotel's solid waste.

- Create a food waste reduction policy for scraps: as we mention before, banquet scraps are edible foods that may have a beneficial use. Too much food prepared or leftovers that have a short shelf time may have a secondary usage. All food must be kept at a proper temperature to be reused for spoilage.

- Develop a plan for food scraps: all plate scraps are non-edible and can be collected straight from the plates to bins labeled "food waste only". Solid food preparation scraps can be dumped into these bins, too. One of the main priorities is to enacting a food recycling program.

4.5 MECHANICAL SYSTEMS

All the mechanical systems that control HVAC, lighting, laundry etc. for guest rooms, lobbies and convention areas must be programmable and scheduled to operate. With a good and frequent schedule the reducing of hotel's energy consumption will be more efficient.

Calibration of indoor and outdoor building sensors, such as thermostats, should be checked periodically, so to ensure that they are operating within original design specifications. Otherwise, controls that operate in conjunction with all the building's systems can cause the system to operate inefficiently and unexpectedly.

Below, there are some suggestions about a good-scheduled controlling of the mechanical systems:

- Monitor boilers and cooling towers to insure optimal efficiency of the systems: boilers and steam generators use large quantities of water to make-up for amounts lost to leaks and "blow-down". The cost of water is not as significant as the cost of energy used by these devices. The other cost incurred is the cost of the chemicals used to treat the water. By the installation of make-up and blow-down meters in the cooling tower, we could have significant energy and cost savings in the hotel.

- Set up a preventative maintenance plan: a proper maintenance plan and monitoring of operations can improve the boiler's efficiency. The development and implement of a frequent inspection for steam traps, steam lines and condensate pumps is a good and efficient way to avoid problems (which include energy costs).

- Testing of boiler water treatment: every two weeks conduct a flue gas analysis on the boiler to test fuel to air ratio settings and adjust air to fuel ratio to optimize efficiency. Check all controls frequently and keep them dry and clean. Make sure the water used is treated to remove the impurities. This prevents the formation of scale and sludge deposits on the internal surfaces of boilers. Scale formations retard the heat flow and cause overheating of metal parts.

- Using a blow-down meter in the cooling tower: in the cooling tower, water is lost through the evaporative cooling process. To replace lost water, make-up water must be added to the cooling tower system. The make-up meters track the amount of water that passes through the meter as it goes to the cooling tower. The blow-down meters track the amount of water leaving the cooling tower, before it enters to the city's wastewater system.

4.6 WINDOW TECHNOLOGY

One of the most significant elements in the construction of a low-energy building, such as eco-hotels, are windows. To increase the hotel's energy efficiency it is necessary to understand the current advances in the window technology and tools for evaluating choices.

Windows account for more than 12% of energy use in commercial and residential buildings. Whether they are relatively small punched openings in the façade or a completely glazed curtain wall, windows are usually a dominant feature of the hotel's exterior appearance. Windows can appear highly reflective, darkly opaque, or transparent, revealing or hiding activity within the building. Their color and reflected patterns can change with the time of day and weather.

The entry of solar heat can be controlled by external window shading devices, such as awnings, roof overhangs, shutters and solar screens. It also can be controlled by internal shading devices, such as curtains and blinds make room "black". Curtains and blinds also let in some of the undesirable heat. Exterior shading devices are about 50% more effective and more efficient than internal devices at blocking the entry of solar heat. However, sometimes they may create problems with the building aesthetics and they are more expensive.

The weak thermal properties of clear glass window make them a target of research and development to controlling energy loss in buildings. This led to the development of low-emissivity or "low-e", as they called, coated glass that can control heat gain and loss, reduces glare and minimize the fading in carpets and upholstery. New construction and window replacement applications use glazing with these coatings. /11/

Some low-e coatings reduce solar heat gain with little impairment of visible light transmission. Spectrally selective coatings transmit visible parts of the light spectrum, while reflecting the heat portions of the spectrum. Similar thermal properties can be obtained with windows films, although with a noticeable decrease in visible light transmittance.

Laminated glass windows, which provide durability and increased protection from earthquakes, high winds, hurricanes etc., are frequently used in conjunction with low-e coating. Laminated glass is created by sealing a sturdy plastic interlayer between two panes of glass to create an imperceptible intrusion barrier with visible-light transmittance, similar to that of clear glass once the layers are bonded.

5 Ecological criteria and spread sheets

In this chapter we will compare two eco-hotels. The first eco-hotel is in Titisee-Neustadt, Germany and except the standard hotel's services offers also a wide range of eco-friendly services. Its standard services, like in the most of the hotels, are:

- 12 single-rooms, 25 double-rooms, 3 suites: occupancy of 74 beds
- Oiled solid wood beds
- Naturally with mini-bars, cable TV, fax, internet
- Solid wood floors with oiled surface, untreated fleece carpet and oiled solid wood hallways
- Bed-linen made of natural cotton from biological cultivation

The eco-hotel uses a high and energy-efficient technology. The building was built after the low-energy (Passivhaus) standards. There are also different energy savings techniques, such as:

1. High heat insulation in use of environment friendly materials, without mineral wool.

2. Wood-chip heating with a cyclone for flue gas cleaning.

3. Perlite (made of expanded volcano-rock) in the outer walls.

4. Cellulose insulation (made of recycled paper) in the whole roof area.

5. Foam glass in the area of the basement ceiling, the roof terrace, and all the critical points.

6. Controlled ventilation (direct fresh air supply from outside for the rooms), recycling of the waste air for the heating of the fresh air for the public rooms.

7. Controlled ventilation (direct fresh air supply from outside for the rooms), recycling of the waste air for the heating of the fresh air for the public rooms.

8. Computer system for the management of the energy consumption.

9. Renunciation of PVC-containing pipes, PVC-containing electric circuits, PV foam and hard-foam heats.

10. Rainwater system for the flush.

11. Central vacuum machine (prevents raising a lot of fine dust).

12. Use of environment friendly cleaning products (only recycled packages), also divided garbage disposal.

13. Composting.

The eco-hotel replaced its oil / gas heating with a modern and energy efficient wood-chip heating system with a cyclone for flue gas cleaning. Its heating output can reach 180 KW. This system covers the hotel's needs for heating and warm water, including those of the wellness area. According to the hotel management, the independence from oil and gas guided to the saving of 18000€ every year. Furthermore, the savings in CO_2 by using this system amounts to 207 tons per year. With the installation of a computer system for the management and control of the energy consumption, the energy demand was decreased by 25%.

The eco-hotel contains also a café / bar / restaurant, thermal baths and a sauna center.

In the spread sheets below, this eco-hotel will be called as "Hotel 1".

The second eco-hotel takes place in Italy. The Eco-hotel of Elba agrees to an eco-friendly project of tourism. The eco-hotel provides high level standards focusing on the surrounding nature. It contains 95 beds, with 15 single-rooms, 30 double-rooms and 5 suites.

Between the standard hotel's services, such as:

- Heated rooms
- Restaurants
- Meeting venue
- Swimming pool
- Conference room
- Garden
- Lift
- Free access for disabled persons
- Room service
- Breakfast
- Air-conditioned rooms
- Satellite TV in the rooms
- Tennis court, gym, sailing, golf

the eco-hotel offers a large number of eco-services and facilities, which mentioned below:

1. At least 60% low-energy lamps
2. Bio-architecture renovation projects
3. Breakfast with organic produce
4. Gmo-free food
5. Menu with typical "elban" cuisine

6. Gluten-free food
7. Bus tickets on-sale
8. Way-marked walks / nature paths
9. Bicycles for clients' use
10. Reduced use of plastic bottles / drink cans
11. Flow reducers to save water
12. Water treatment systems
13. Solar panels
14. Biological climate
15. Water recycling systems
16. Use of recycled materials
17. Reduced use of single-service packs
18. Use of environmental-friendly detergents
19. Hotel inside the national park

In the spread sheets below, this eco-hotel will be called as "Hotel 2".

According to the European Union, the commission established the ecological criteria for the awarding of the eco-hotels' services. The ecological criteria should be valid for a period of three years.

In order to be awarded with eco-labels by the eco-community, a campsite must comply with each of the criteria mentioned below. The campsite service must acquire at least 16.5 points for the main service. The total score required shall be increased by one additional point each for food services and for leisure activities.

The ecological criteria that are setting below aim to:

- Limit energy consumption
- Limit water consumption
- Limit waste production
- Favor the use of renewable resources and of substances which are less hazardous to the environment
- Promote environmental communication and education

Now, each of the criteria will be categorized below by sector.

In order to compare the two eco-hotels, some different criteria had been used. The criteria above set out from the European Union for the certification of the campsites and they have international value. The criteria below set out to explain each of the spread sheets. A point system has been used for an easier comparison between the eco-hotels. Every criterion has 1.0 to 4.5 points. The total score of each hotel will be discussed at the end of this chapter.

Explanation of the criteria in energy spread sheet

Photovoltaic, hydro-electric and wind generation of electricity: the eco-hotel must have a PV system, a hydro-electric system or wind generation of electricity, which will supply at least 20% of the overall electricity per year.

Heating from renewable energy resources: at least 50% of the total energy for heating should be from renewable energy resources.

Boiler energy efficiency: the eco-hotel must have a four-star boiler.

District heating: the heating of the eco-hotel should be provided by district heating.

Heat recovery system: a heat recovery system must be provided for the devices of the eco-hotel, such as refrigerators, ventilators, washing machines, etc.

Thermoregulation: in the common areas and the accommodation the temperature should be regulated.

Insulation of existing buildings: according to the "passive building" requirements and standards, the existed buildings should have the appropriate insulation.

Air-conditioning: the air-conditioning system must be Class A energy efficient.

Automatic switching off air-conditioning: an automatic system that turns-off the air-conditioning is not required.

Bioclimatic architecture: all the existed buildings must be built according to the bioclimatic architectural principles.

Energy efficient refrigerators, dishwashers, washing machines and dryers: all the devices that used by the hotels should be of Class A, Class A+ or Class A++ efficiency.

Automatic switching off lights: an automatic system that turns off the light when the guests leave the accommodation should be installed in 80% of the hotels' area.

Swimming pool heating by renewable energy resources: if there is a swimming pool in the eco-hotel, the energy used for heating should come at least 50% from RES.

Explanation of the criteria in water spread sheet

Use of rainwater: the rainwater could be collected for use in many appliances, but for non-drinking purposes.

Use of recycled water: the recycled water could be collected for the same use as the rainwater.

Water flow from taps and shower heads: the average flow from taps and shower heads should not exceed 8 (liters / minute).

WC flushing: at least the 80% of the WC flushing should not exceed 6 (liters / flush).

Dishwasher water consumption: the water consumption of the dishwasher must be less than 25 (liters / cycle). This amount can be estimated.

Washing machine water consumption: the water consumption of the washing machines must be less than 12 (liters / kg). The appropriate temperature should be at 60 C.

Shower timers: this is not an appropriate device. Nevertheless, it could be a good way to interrupt the water flow after a defined time of using.

Water-saving urinals: at least 50% of the urinals must use an electronic flushing system for single flushing.

Changing towels and sheets: the management should inform all guests for the changing of towels and sheets. The change could be either once / twice a week or after a request of each guest.

Explanation of the criteria in waste spread sheet

Composting: every eco-hotel should separate organic wastes from kitchen, garden, etc. and should ensure that they are composted according to the local authority guidelines.

Breakfast / food packaging and disposable goods: disposable equipment must not be used for breakfast or food.

Fat / oil disposal: all fat / oils should be collected and disposed in a safe and concrete place.

Used textiles, furniture and other products: all used textiles, furniture or other products, such as electronic devices should be collected and recycled.

Explanation of the criteria in dangerous chemicals spread sheet

Detergents: all detergents that been used in the eco-hotels should be awarded by ecological organizations in a percentage of 80%.

Dosage of swimming pool disinfectants: an automatic dosage system for the swimming pool that uses the minimum amount of disinfectants must be used in order to decrease the use of dangerous wastes.

Mechanical cleaning: the cleaning of all mechanical parts and devices should be chemical-free.

Explanation of the criteria in other services spread sheet

Buses / trolleys for guests: buses or trolleys should be used for the transportation of the guests from and to the eco-hotel with no charge or with a typical cost of the tickets for environmental donation.

Unsealed surfaces: at least 90% of the hotel's area must not be covered with sealing materials.

Roof landscaping: a landscaped roof can improve the environmental image of the eco-hotel.

Environmental communication and education: the management must offer to all guests communication and education for environmental issues, such as biodiversity and sustainability. This can improve the behavior of the guests to the surrounding nature.

Bicycles: a transportation system with bicycles could be a good way to decrease the use of cars to the outside area of the hotel.

Returnable or refillable bottles: all bottles should return to a recycling area.

Paper products: at least 50% of paper products used in toilets, kitchens and other sectors must be recycled and awarded with eco-labels, in order to be chemical-free.

Durable goods: at least 10% of all durable goods, such as bed linen, towels etc., should be eco-friendly and chemical-free.

Local food products: the eco-hotel can use the local way of cooking, in order to inform the guests for the local and traditional goods.

Organic foods: all food should be produced by organic farming methods.

Explanation of the criteria in general management spread sheet

EMAS registration and ISO 14001 certification of the eco-hotel: the eco-hotels should be registered under the Eco-management and audit scheme (EMAS) or certified according to ISO 14001 standard.

EMAS registration and ISO 14001 certification of the suppliers: at least one of the eco-hotel's suppliers should be registered with EMAS or certified according to ISO 14001 standard.

Additional environmental actions: the eco-hotel's management could apply or take part to some others environmental actions in order to increase its sustainability and improve its environmental performance.

Points of eco-hotels in "energy" sector:

- Hotel 1: 10.0
- Hotel 2: 16.0

Points of eco-hotels in "water" sector:

- Hotel 1: 10.5
- Hotel 2: 9.0

Points of eco-hotels in “waste” sector:

- Hotel 1: 11.0
- Hotel 2: 7.0

Points of eco-hotels in “dangerous chemicals” sector:

- Hotel 1: 5.0
- Hotel 2: 5.0

Points of eco-hotels in “other services” sector:

- Hotel 1: 16.0
- Hotel 2: 19.5

Points of eco-hotels in general management sector:

- Hotel 1: 4.5
- Hotel 2: 7.5

These are the results of the eco-hotels, according to their eco-services and technologies. The total score of each hotel is: 57.0 points for Hotel 1 and 64.0 points for Hotel 2.

The related CO_2 emissions of the hotels are estimated below.

Related Hotel Emissions = (Number of guests) * (Number of overnights) * (Emissions per guest)

According to my search and corporation, the average CO_2 emissions per guest per night are equivalent to 0.0136 (tons) = 13.6 (kg) per night.

Regarding that the minimum overnight per guest in hotels are three nights, the next results are estimated:

For Hotel 1: Related Hotel Emissions = 74 * 3 * 13.6 = 3019.2 (kg) = 3.019 (tons) for a minimum staying of 3 nights and 74 guests (full occupancy).

For Hotel 2: Related Hotel Emissions = 95 * 3 * 13.6 = 3876 (kg) = 3.876 (tons) for a minimum staying of 3 nights and 95 guests (full occupancy).

Both the German and the Italian eco-hotel are 4-star rated. That means, according to international measurements) that in the energy sector, the average annual consumption at any hotel is 1.781.000 (KWh). In 4-star rated eco-hotels, as the hotels above, the average energy consumption per overnight stay is 33.7 (KWh), and the average amount of energy per m^2 is 185.6 (KWh).

A comparison between a common hotel and an eco-hotel for the specific consumption per heated area was estimated. For the common hotel, the energy consumption per heated area rises to 360 (KWh / m^2), in addition to the same consumption of the eco-hotel, which rises from 170 to 210 (KWh / m^2). A difference of 48% is obvious.

The big differences in energy costs are obvious, too. The average energy costs for the common hotel are estimated to be at 6% of their annual turnover. At the same time, the average costs for the eco-hotel are at 2.2%.

The average water consumption per year in an eco-hotel is 9.713 (m^3) for all of its needs, with an average of 213 (liters) per overnight stay. Considering that the cost is 3.70€ per (m^3), the eco-hotel has to pay 36.000€ annually.

In addition with the eco-hotels, the water consumption in a conventional hotel is about 13.640 (m^3), with an average of 335 (liters) per overnight stay. The estimated costs are 51.000€ annually.

We can easily compare the difference between the amounts, which is 15.000€ higher in the conventional hotel.

Apart from dishwashers and washing machines, other relevant water consumers are swimming pools. In hotels with swimming pool, almost 358 (liters) of water are consumed, instead of just 213 (liters) per overnight stay.

The average volume of waste is 6.03 (liters) per overnight stay. The separation between that is:

- Residual: 3.31 (liters)
- Paper: 1.38 (liters)
- Glass: 0.30 (liters)
- Plastic and metal: 0.48 (liters)
- Organic: 0.57 (liters)

The cost of wastes is 0.28€ per overnight stay.

Total points in spread sheets:

- Energy spread sheet: 26 points
- Water spread sheet: 13 points
- Waste spread sheet: 11 points
- Dangerous chemicals spread sheet: 6 points
- Other services spread sheet: 22.5 points
- General management spread sheet: 10 points

A research on how much each of the two eco-hotels "agrees" with the ecological criteria of European Union is listed below. The research has done with the same way in both the six spread sheets. First of all, we estimate how many points the eco-hotels have completed and how many points they have loose. For example, in the energy spread sheet, the "Hotel 1" looses 16 from the 26 points. According to this, we can easily find out the percentage of "agreement" of each hotel with the standards of European Union.

Energy spread sheet:

- Hotel 1: 39%
- Hotel 2: 61%

Water spread sheet:

- Hotel 1: 80%
- Hotel 2: 69%

Waste spread sheet:

- Hotel 1: 100%
- Hotel 2: 63%

Dangerous chemicals spread sheet:

- Hotel 1: 83%
- Hotel 2: 83%

Other services spread sheet:

- Hotel 1: 71%
- Hotel 2: 86%

General management spread sheet:

- Hotel 1: 45%
- Hotel 2: 75%

A separation between the six sectors with percentages is indispensable. This separation has done according to my research. The percentages are:

Energy sector: 35%

Water sector: 20%

Waste sector: 15%

Dangerous chemicals sector: 5%

Other services sector: 10%

General management sector: 15%

First of all, the points that the two eco-hotels take in every spread sheet have been estimated. Secondly, according to the previous points of the hotels, new percentages will be estimated. Our goal is to find a new percentage. This new percentage declares the ranking of the hotels, according to the percentages that each of the sectors have.

Energy spread sheet:

- Hotel 1: 13% completed of the total 35%
- Hotel 2: 21% completed of the total 35%

Water spread sheet:

- Hotel 1: 16% completed of the total 20%
- Hotel 2: 14% completed of the total 20%

Waste spread sheet:

- Hotel 1: 15% completed of the total 15%
- Hotel 2: 9% completed of the total 15%

Dangerous chemicals spread sheet:

- Hotel 1: 4% completed of the total 5%
- Hotel 2: 4% completed of the total 5%

Other services spread sheet:

- Hotel 1: 7.2% completed of the total 10%
- Hotel 2: 8.6% completed of the total 10%

General management spread sheet:

- Hotel 1: 6% completed of the total 15%
- Hotel 2: 11% competed of the total 15%

ENERGY	POINTS	HOTEL 1	HOTEL 2
PV solar panel	2	—	•
Heating from renewable energy sources	1,5	•	•
Boiler energy efficiency	1	—	•
Hydroelectric	2	—	—
District heating	1	•	•
Wind energy	2	—	—
Heat recovery	2	•	•
Thermoregulation	1,5	•	•
Insulation of existing buildings	2	•	•
Air-conditioning	1,5	—	•
Automatic switching-off air-conditioning	1	—	—
Bioclimatic architecture	2	•	•
Energy efficiency refrigerators	1	—	—
Dishwashers	1	—	—
Washing machines	1	—	—
Dryers / tumblers	1	—	—
Automatic switching-off lights	1	—	—
Swimming pool heating with RES	1,5	—	•

WATER	POINTS	HOTEL 1	HOTEL 2
Use of rainwater	1,5	•	—
Use of recycled water	1,5	•	•
Water flow from taps and shower heads	1,5	•	•
WC flushing	1,5	•	•
Dishwasher water consumption	1	•	•
Washing machine water consumption	1	•	•
Showers timers	1,5	—	—
Indications on water hardness	1	—	—
Water-saving urinals	1,5	•	•
Changing towels and sheets	1	•	•

WASTE	POINTS	HOTEL 1	HOTEL 2
Composting (garden waste)	1	●	—
Composting (kitchen waste)	2	●	●
Breakfast / food packaging and disposable goods	2	●	●
Fat / oil disposal	3	●	●
Used textiles , furnitures and other products	3	●	—

DANGEROUS CHEMICALS	POINTS	HOTEL 1	HOTEL 2
Detergents dishwashers	2	●	●
Detergents laundry	2	●	●
Dosage of swimming pool disinfectant	1	—	—
Mechanical cleaning	1	●	●

OTHER SERVICES	POINTS	HOTEL 1	HOTEL 2
Buses / trolleys for guests on the ecohotel	1	—	●
Unsealed surfaces	1	—	—
Roof landscaping	1,5	●	●
Environmental communicaion and education	3	—	●
Bicycles	1,5	—	●
Returnable or refillable bottles	3	●	●
Paper products	2	●	—
Durable goods	3	●	●
Local food products	4,5	●	●
Organic foods	2	●	●

GENERAL MANAGEMENT	POINTS	HOTEL 1	HOTEL 2
EMAS registration of the campsite	3	●	●
ISO 14001 certification of the campsite	1,5	—	●
EMAS registration of suppliers	1,5	●	—
ISO 14001 certification of suppliers	1	—	—
Additional environmental actions	3	—	●

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