The development of a model to find energy conservation opportunities in hotels in Costa Rica a case-study in four hotels in La Fortuna de San Carlos

van Bemmelen, A.W.M.

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The Development of a Model to find Energy Conservation Opportunities in Hotels in Costa Rica

A case-study in four hotels in La Fortuna de San Carlos

Arnoud van Bemmelen

Supervisors:
Dr. Ir. E.v.Egmond-de Wilde de Ligny: Faculty of Technology Management, TU Eindhoven, The Netherlands
Prof.dr.K.K. Prasad: Faculty of Electrical Engineering , TU Eindhoven, The Netherlands
Dr.P.E. Lapperre: Faculty of Technology Management, TU Eindhoven, The Netherlands
Dr. R.Pujol.: ProDUS, Faculty of Civil Engineering, University of Costa Rica, Costa Rica

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Faculty of Technology Management
Eindhoven University of Technology

Preface

This thesis is the result of a research done with the help of many people without which it would have been impossible. First of all I want to thank Dr.Rosendo Pujol for inviting me to Costa Rica and making it possible for me to carry out my research at the Programa de Investigación en Desarrollo Urbano Sostenible (ProDUS). Second I want to thank Emilia van Egmond who has been very patient with me and pushed me in the right direction many times. I also want to thank Prof. K. Prasad who especially in the final stages of the research has been giving me welcome advise. Fourth I want to thank Paul Lapperre who, although I didn't ask for his advise much, has helped me whenever I did so. Also I want to thank all the people at ProDUS for helping me in Costa Rica, especially Doña Lorena and Silvia Magaly who have helped me with writing my letters and the questionnaire in Spanish and for helping me contacting people by phone more then once.
Of course I also want to thank my family and friends for the support while I was in Costa Rica and telling me what I missed in the Netherlands.
But most of all I want to thank my girlfriend. Over the last few years Tamara has constantly supported me in many, many ways impossible to describe in one page. Therefore I won't even try. I guess that in the next period I will have to show her how much it has meant to me. I must say that this is a wonderful prospect.

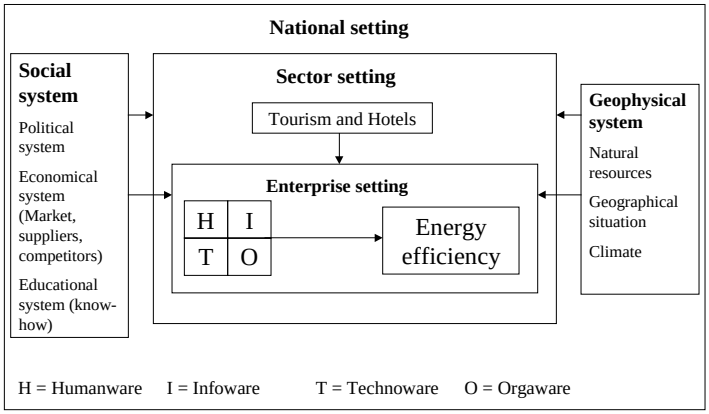
Arnoud van Bemmelen
June 2001

Summary

This thesis is the result of an attempt to develop a model to find opportunities and constraints for energy conservation in hotels in Costa Rica. The research was carried out in co-operation with the Programa de Investigación en Desarrollo Urbano Sostenible (PRoDUS) from the faculty of Civil Engineering of the University of Costa Rica, located in San Pedro. The field research was carried out in the period from July 2000 until December 2000. The research has been split up into the following stages.
The first part of the research focused on the development of the theoretical model which formed the base of the rest of the research. This stage of the research was carried out in the Netherlands as preparation of the field study. The theoretical framework was used during the second and third part of the research carried out in Costa Rica. The second part of the research concentrated at finding the opportunities and constraints for energy conservation in hotels at national setting level and sector setting level. The third part of the research concentrated at the enterprise level. In this stage four hotels were examined by carrying out an energy audit. The hotels that were examined were located in the region around La Fortuna de San Carlos.
Conclusions were derived from the field research and recommendations given to create better opportunities for energy conservation in hotels.

The Theoretical Model

The theoretical model that was found to be most appropriate to use for this research is presented in the figure below. According to this model the energy efficiency and thereby the energy consumption in hotels is considered to be influenced by three levels (1) the national setting, which can be divided into the social and the geophysical system, (2) the sector setting in this case represented by the tourist sector and hotels and (3) the enterprise setting where the process technology is represented by the four components Humanware, Orgaware, Infoware and Technoware.



Results from the National Setting Research

The social system

Costa Rica is a Central American country located between Nicaragua on the North and Panama on the South. It has about 3.7 million inhabitants. It is a middle income country with a small national industry. Traditionally bananas and coffee are the main export products, but since 1998 the Intel company has started production and has significantly contributed to export since that year. Tourism is also an important economic sector providing about 7% of GDP. Nonetheless Costa Rica is still a net importing country. Inflation was about 10% and interest rates 15% in the year 2000, which both is relatively high.

The national policy related to energy conservation in general in Costa Rica is embedded in the national program of the rational use of energy. The general target of this policy is to decrease the demand of energy without damaging the economic growth, the quality of life of the Costa Ricans and the environment, and to maintain an effective and efficient supply of energy.
A law resulting from this policy that is interesting for energy conservation in hotels is law 7447 which is called the 'law of ration energy use'. This law provides tax exemptions for equipment related to efficient and sustainable energy consumption.
The most important organisations in relation to energy consumption in hotels are the Instituto Costarricense de Turismo (ICT) and the electricity companies which are mostly state owned. The ICT is founded by the government in 1955 to stimulate tourism in Costa Rica. This organisation does not have a program for hotels concerning energy consumption. The electricity companies have several programs on energy conservation but none of them are specifically for hotels.
Electricity is generated for 90% by using renewable energy sources. Hydropower is responsible for the greater part of the electricity production.

The Geophysical System

Costa Rica has little or no fossil fuel resources.
There are many micro climates in Costa Rica. In general however there are four main climates: A wet tropical climate, a tropical climate with a dry season, a moderate climate and a cold climate.

Results from the Sector Setting Research

The tourist Sector

The tourist sector in Costa Rica has grown by about 10% per year in the last ten years, becoming the motor behind economic growth in Costa Rica. In 1999 for the first time more then 1 million tourists visited the country earning the country over 1 billion US dollars. Tourists come from all over the world and travel around the entire country. The largest age group of the tourists is between 30 and 45 years of age. Tourist stay an average 11.1 days in the country. Most tourists start there vacation in the central Valley area, because the international airport is located in that region. That is also why about 80% of all the tourists sleep at least one night in the central valley area. In the other areas 10-30% of the tourists sleep at least one night.

Hotels

The research showed that in May 2000 there were 365 hotels with a tourist accreditation in Costa Rica. In the last decade over 100 new hotels were opened. Of the 365 hotels over 50% received a 2 or 3 star classification. Almost a quarter of the hotels had between 20 and 40 rooms. Next to the 365 hotels with a tourist accreditation there are another 1400 hotels without accreditation. These hotels are however significantly smaller. The 365 hotels with accreditation provide almost an equal amount of rooms as the 1400 hotels without. In total there were about 28000 rooms in May 2000.
An indication of the occupation rate of hotels is given by a research from the ICT. This research showed that for 23 hotels in the Central Valley the average occupation rate for 1998 and 1999 was 52%.
Facilities provided by hotels related to energy consumption are the following (year 1993): Hot water (>80%), Launderette (>80%), Restaurant or Cafeteria (>80%), Fan (>60%), Swimming Pool (>50%) Air Conditioner (>40%)

Results from the Enterprise Setting Research

The four hotels that were examined were located in or near La Fortuna de San Carlos. They were chosen based on the main characteristics of hotels in Costa Rica and national factors that influence the operation of hotels like climatic conditions. All four hotels had between 20 and 40 rooms. The three hotels with tourist accreditation had 2 or 3 stars. The most important results from the energy audit were:

- There was a great variety of education level between the employees. Of the hotel owners two got a bachelor degree. From the other employees most of them had secondary or primary education.
- Acceptable pay-back periods for investments for the four hotels were 4 to 5 years.
- No logbook of the maintenance that was carried out was kept.
- The main energy sources consumed by the hotels were electricity and gas.
- Electricity consumption varied significantly between the four hotels. No direct relation between the facilities and the level of consumption was found.
- The three hotels with air conditioners all had single unit air conditioners installed.
- The cabins in the hotel without air conditioners were designed in such a way that natural ventilation should provide the necessary cooling.
- Hot water was provided in three hotels by a centralised system of which two operated on gas and one on electricity. The fourth hotel had a decentralised system operating on electricity.
- The distribution pipes from the centralised hot water systems were not insulated.
- In all four hotels there were Incandescent lights installed.
- Two of the four hotels had an area for natural drying of the laundry.
- A lot of the equipment in the restaurants lacked a label with information about the energy consumption.

Recommendations

National and Sector Setting

Recommendations regarding the development of a energy conservation program are:

- The most obvious organisations to develop and implement such a program are the ICT and the electricity companies, of which the most important are the ICE and CNFL. The ICT has the knowledge about the tourist sector. The electricity companies have the knowledge about energy conservation in general. Co-operation between these government organisations, thereby combining their knowledge, can be even more effective.
- For hotel owners it is interesting to know the possibilities of tax exemptions that exist for energy efficient equipment. This could stimulate investments related to energy conservation. Informing hotel owners should be included in a program on energy conservation in hotels.
- It is likely that due to the growth of the tourist sector, a lot of new hotels are going to be constructed in the next few years. The development of a manual for the construction of an energy efficient hotel which becomes available to starting entrepreneurs could help the rational consumption of energy. The possibilities of passive cooling should be taken into account when developing such a manual.
- In the hotels examined much of the equipment was still without labels. Labelling of equipment and providing valuable information in manuals about capacity and other information related to energy consumption allows purchasers to compare different types and decide whether one product is better than the other in terms of energy consumption.

Recommendations for further research are:

- Occupation rates influence the energy efficiency of equipment in hotels. In theory centralised systems might be more efficient than decentralised system, in practise low capacity utilisation can diminish this advantage or even make the centralised systems less efficient. The energy efficiency of decentralised systems is not influenced by lower occupation rates. Research has to be done about the effect of capacity utilisation on energy efficiency of centralised systems. In such a research the consumption pattern of the tourists over a day can also be included.
- Research about the state of the art technologies available to hotels in Costa Rica related to energy consumption gives better insight into energy conservation opportunities. Because the economy has an open structure it can be expected that international state of the art technologies can also be purchased in Costa Rica. The results of such a research should be available to the hotel sector.

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Enterprise Setting

The most important recommendation on enterprise level is:

- From this research is has become evident that measuring energy flows is essential for giving accurate and valuable recommendations on energy conservation. The measurements of the energy flows for units as small as possible should take place during a period of high occupation and a period of low occupation. It would be ideal to measure energy flows of the different units at the same time.

Other recommendations were:

- All hotels: Make the guests aware of the importance of energy conservation by informing them in a friendly way, e.g. by an information tabloid in the room. This can lead to energy conservation, because if guests know how to operate the equipment (see air conditioners) right the equipment will operate more efficient.

Air conditioners

- All hotels with air conditioners: Informing guests about thermostat settings corresponding to comfortable temperature settings can help lower energy consumption by air conditioners. To get to know the right settings the hotel owners could find out what settings correspond with what temperatures operating an air conditioner himself with a thermometer.
- All hotels with air conditioners: Strips at the bottom of the door improve the operating conditions of the air conditioners. It keeps warm air from entering the room.
- Hotel no1 SB: Removing obstacles in front of air inlets can lower energy consumption of the air conditioners.
- Hotel No1 SB and hotel No4 AC: Protecting air conditioners against direct sunlight will improve the operating conditions for these air conditioners.

Water heaters

- All hotels: Replacing inefficient shower heads by efficient ones will lead to a hot water consumption reduction in the shower. This leads to an lower energy consumption.
- All hotels with a centralised heater system: Insulation of the distribution pipes leads to lower heat losses. This will lead to a lower demand for hot water. A lower demand for hot water leads to lower energy consumption

Lighting

- All hotels: Replacement of incandescent lights that are on for at least 4 hours continuously per day by their equivalent type of CFL leads to considerable energy conservation.

Launderette

Hotel no2 CR and hotel no3 AR: An area for laundry to dry naturally can help energy consumption go down.

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Chapter 1: Introduction

1.1 Costa Rica

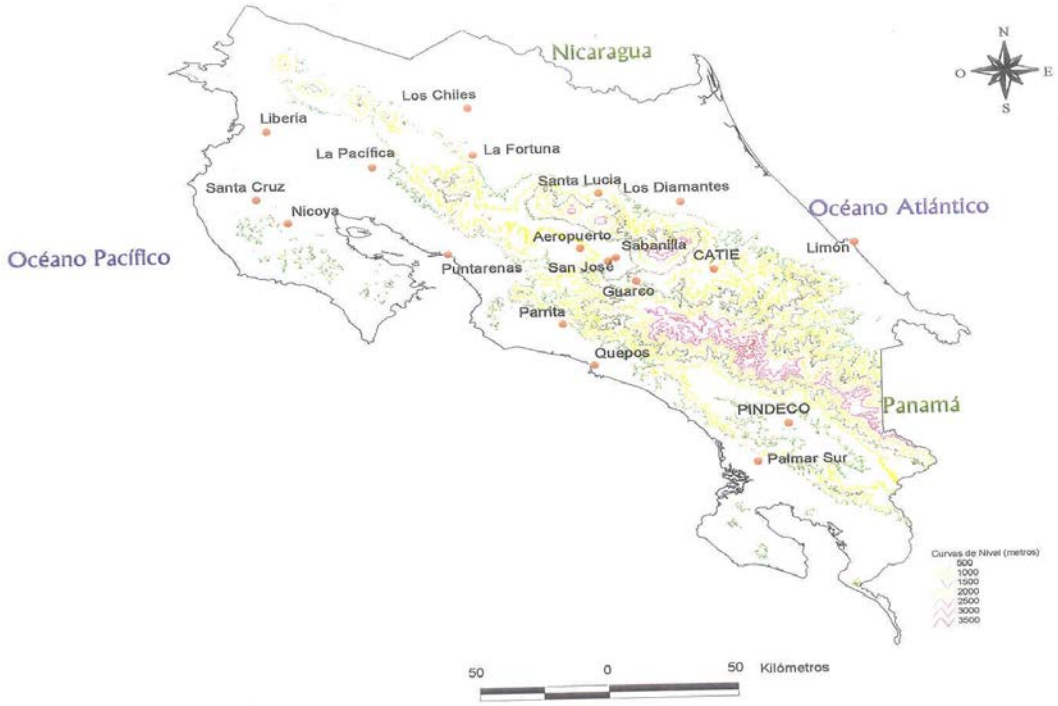


Figure 1.1 Map of Costa Rica. Source: Instituto Meteorologica Nacional

Costa Rica lies in Central America with Nicaragua on the North, Panama on the South, the Pacific Ocean on the West and the Atlantic Ocean on the East. San José, the capital of Costa Rica is located on a plateau in the centre of Costa Rica called the Meseta Central (Central Valley). Approximately 60% of the 3.7 million Costa Ricans live in this area. 50% of the Costa Rican people live in urban areas. Important cities besides San José are Cartago, Heredía, Alajuela and Puntarenas. Of the Costa Rican people 87% is of Spanish origin and around 8% is mestizo, which is a mix of Spanish, African and Indigenous. Another 2% originates from Afro-Caribbean countries, 2% is from Asian background and less than 1% is native American (or Indigenous)[1]. Because of the background of the people the culture and traditions of Costa Rica are strongly influenced by Spanish culture and traditions. In table 1.1 more geographical information is presented.

Table 1.1 Costa Rican Geographical Data			
Area		**Boundaries**	
Total	51,100 sq. km	Total Land	639 km
Land	50,660 sq. km	Nicaraguan Border	309 km
Water	440 sq. km	Panamese Border	330 km
Land Use		Coastline	1,290 km
Arable Land	3,040 sq. km	**Elevation Extremes**	
Permanent Crops	2,532 sq. km	Lowest Point	0 m
Permanent Pastures	23,303 sq. km	Highest Point	3,810 m
Forests and Woodland	15,705 sq. km	**Geographic Co-ordinates**	
Other	6,080 sq. km	N	8º00 – 11º13
Irrigated Land	1,200 sq. km	W	82º33 – 85º58

Source: http:/www/cia.gov/publications/factbook/cs.html and World Bank, Internet, 2000

[1] O'Bryan, Linda en Zaglitsch, 1997

Compared with the surrounding countries Panama and Nicaragua, Costa Rica has a high level of economic development. Nonetheless Costa Rica is still confronted with some economical problems, like for instance a large balance of payments deficit and debt service. Costa Rica is trying to liberalise its economy with the help of the World Bank. By stimulating the export of non-traditional products they hope to achieve a more diversified economy. Unlike a lot of the other Central American countries, Cost Rica has experienced a stable political situation since 1948.
In table 1.2 an overview of the economic structure of Costa Rica is presented.

Table 1.2 Economic structure of Costa Rica

% of GDP	1978	1988	1997	1998
Agriculture	20.4	15.8	15.1	15.0
Industry	26.1	23.9	24.4	24.0
of which Manufacturing	18.7	21.3	18.9	18.5
Services	53.5	60.3	60.5	61.0
Average annual growth				
Agriculture	2.1	3.1	-0.1	5.3
Industry	1.4	3.9	5.5	7.9
of which Manufacturing	-6.4	3.9	5.1	7.2
Services	1.8	4.5	4.1	6.6

Source: World Bank, internet, 2000

The main part of the Costa Rican industry consists of food processing, textile and clothing, construction materials, fertiliser and plastic products[2]. The agricultural sector consists for an important part out of the production of coffee and bananas and to a lesser extent sugar. Tourism is the main sector in services.

1.2 The Costa Rican Energy Situation

Electricity in Costa Rica is generated using comparatively little fossil fuel. The production of electricity in Costa Rica depends to a large extent on hydropower as can be seen in table 1.3.

Table 1. 3 Share of Electricity Production by Energy Source, 1996

Energy source	Share of electricity production (%)
Fossil fuel	14.11
Hydro	75.44
Nuclear	0
Other	10.45

Source: http://www.cia.gov/cia/publications/factbook/cs.html

This low fossil fuel percentage is in favour of a low CO_2 emission. However, carbon dioxide production in Costa Rica has grown rapidly from 1.0 to 1.4 metric tons per capita in 7 years. This can be partially explained by the growth in the number of cars driven around in Costa Rica. During the last four or five years the number of cars in the country increased by approximately 10% per year.

[2] http://www.cia.gov/cia/publications/factbook/cs.html

Table 1.4. Energy and electricity data for Costa Rica			
Electricity consumption (1996)	4.931 billion kWh		
Electricity exports (1996)	44 million kWh		
Electricity imports (1996)	190 million kWh		
	1990	1997	
CO_2 emissions (metric tons per capita)	1.0	1.4	
Energy use per capita (kg of oil equivalent)	676	769	
Electricity use per capita (kWh)	1,111	1,353	
	1988	**1997**	**1998**
Fuel and energy imports (c.i.f. US$ millions)	134	222	261

Source: http://www.cia.gov/cia/publications/factbook/cs.html and World Bank, 2000

Electricity demand has increased by 2.8% per capita per year in Costa Rica between 1990 and 1997. Together with an average population growth of 2.3% between 1990 and 1995 this results in a doubling of the electricity demand in Costa Rica every 14 years. This increased demand can either be met by a higher local production or higher import.
To meet this higher demand, building new hydropower plants is an important option. The potential of hydropower in Costa Rica is tremendous, but building new hydropower plants requires considerable investments. Another reason against constructing new hydropower plants in Costa Rica is of socio-economic nature: It might be necessary for villages to move and hydropower plants can influence the possibilities for economic activities in the area around the plant. Hydropower plants can also have a negative impact on the ecosystem. Rivers change and part of the land is flooded causing damage to the forests and threatening animals.
Other technologies for the application of renewable energy sources are in an early stage of development in the country or not available yet on a large scale. It will probably also take some years before these will be economically competitive with the technology behind fossil fuel electricity generation.
Since an increased consumption of fossil fuels is undesirable, it can be concluded that there is a case for energy conservation research in Costa Rica to keep the energy demand from growing too fast.

1.3 Investigating Energy Efficiency

In this researchproject the Costa Rican hotel sector was selected to investigate for energy conservation opportunities. The selection of the sector took place in Costa Rica based upon the following indicators:
The sector's share of GDP (%); the sector's share of national energy demand (%); expected growth of the sector (%); expected energy conservation opportunities (%);
Factors that supported the relevance of the investigation of energy conservation opportunities in hotels in Costa Rica are the following:
A Costa Rican law that became effective in 1996 is called 'la Ley de Uso Racional de la Energía[3]'. It was developed by the ministry of energy and mining (MIRENEM). This law applies to enterprises consuming more than 240,000 kWh or 360,000 litres of hydrocarbons (all fuels derived from petroleum) or the equivalent of 12 TJ per year. These enterprises have the obligation to carry out an energy audit in order to look for energy conservation opportunities in their production process. This means that the companies with a high energy consumption already have to perform an audit since the implementation of this law.
A second important point is related to the ownership of the enterprises. A lot of the large enterprises in Costa Rica are owned by foreign organisations and can probably carry out an energy audit

[3] Ley 7447 del 13 de Diciembre de 1994.

themselves[4]. Locally owned enterprises more often lack the capital[5] and/or the knowledge to perform an energy efficiency analysis or analysis of any kind at all. In order to lower the increase in energy demand it is important for these enterprises to have high energy efficiency performances as well. Neglecting them and only concentrating on the large consuming enterprises would mean an incomplete approach to the energy problem.
A third point that was in favour of the selection of the tourist sector, is also related with the ownership because of the socio-economic situation of the population. The sector under research should be important for Costa Rican people. This means that the sector should contribute to the Costa Rican socio-economic situation in a positive manner. Large foreign owned companies contribute to the Costa Rican economy, but to a lesser extent than locally owned enterprises because often profits earned by foreign owned companies (Multi National Organisations) are directed out of the country.
Altogether these points justify the selection of the tourist sector. This sector represents an important part of the GDP in Costa Rica of around 7% and in the last decade tourism in Costa Rica has grown about three times faster than most other sectors (around 10% per year) [6]. This growth rate will likely be the same in the near future. With respect to the contribution to the Costa Rican socio-economic situation: a lot of the hotels are owned by the local population. A third point is that most of the hotels are not very big (as is shown in chapter 3). Their energy consumption probably stays below the level for which an energy audit is obligatory[7], meaning that probably no energy audit has been performed.
Looking at the energy consumption in Costa Rica, table 1.1 shows that the general category, which is equivalent to the commerce sector, including tourism, is responsible for only slightly less than one quarter of total consumption.

Table 1.5 Electricity Consumption per Sector of Consumption (GWh)

Year	Residential		General		Industrial		Public lighting		Total
1983	977	45.5%	512	23.8%	586	27.3%	74	3.4%	2149
1988	1406	47.4%	681	22.9%	789	26.6%	92	3.1%	2968
1993	1792	46.1%	817	21.0%	1174	30.2%	108	2.8%	3891
1998	2273	44.5%	1234	24.1%	1472	28.8%	133	2.6%	5112
1999	2380	43.8%	1310	24.1%	1588	29.2%	157	2.9%	5435

Source: Electricity demand, CENPE, 2000

Although the share of energy consumption in the tourist sector is not among the highest in Costa Rica per enterprise[8], these points give reason to justify looking for energy consumption in the tourist sector.
With this said the objective of this research can become more specific.

1.4 Problem Definition

The objective of this research is to discover the energy conservation opportunities in the tourist sector of Costa Rica. The problem definition should then be: What are the energy conservation

[4] The energy audit is an instrument to find energy conservation opportunities and is explained later on in chapter 2.
[5] Remark: An energy efficiency analysis (or energy audit) has the objective to find energy conservation opportunities. According to Paul Hawken it is a misunderstanding that more energy efficient machinery are automatically more expensive. Or as he puts it in his book Natural Capital: “there is no correlation between energy efficiency and price”. Maybe this research can underpin this hypothesis.
[6] The INTEL enterprise, which started production in 1998, is not included in this argumentation. However, with or without INTEL the tourist sector is still one of the largest sectors in Costa Rica.
[7] E.g. a hotel containing 21 rooms has a yearly electricity consumption of 120.000 kWh.
[8] Figures from MIRENEM about energy consumption exclude the tourist sector, because their share per enterprise in energy demand is not large enough.

opportunities and constraints in the Costa Rican tourist sector? A research for the whole tourist sector would have been too extensive, and therefore a selection within the tourist sector has been made. Since hotels are ssumed to be responsible for a large part of the energy consumption in the tourist sector they are the centre of this research. Thus the problem is defined as:

What are the opportunities and constraints of energy conservation in Costa Rican hotels?

1.5 The Structure of the Report

The structure of the report is as follows. In chapter two first the theory behind energy efficiency is explained after which the theoretical framework is presented. From the theoretical framework it becomes clear that there are three levels that need to be looked at: The national setting, the sector setting and the enterprise setting. Also in chapter two the research structure and the research model are presented. In chapter three first the national setting is reviewed. The second part of chapter three is the result of the research on sector setting level. In chapter 4 the main characteristics of the hotels are presented to get a first impression of the hotels. Chapter 5 shows the results of the research conducted at enterprise level. In this chapter the different processes in the hotels are reviewed per energy consuming facility.

In the final chapter 6 first a summary is presented of the research that has been done. After that the conclusions from the research for all three levels of investigation are presented. In the final part of chapter six the recommendations are presented.

After chapter six an epilogue containing a short evaluation of the energy audit as it was carried out in this research is presented.

Chapter 2: The Theoretical Approach

Before presenting the theoretical framework and the research structure in this chapter, first an introduction to the theory behind energy efficiency improvement is presented. In section 2.4 the method of data collection on enterprise level is presented and reviewed. In the final section the selection of the hotels is presented based on the empirical aspects that were taken into account.

2.1 The Theory Behind Energy Efficiency Improvement

The definitions of some basic concepts related to this research are presented below.

Energy Conservation Opportunities (ECO) are the possibilities of decreasing energy consumption in a production process by improving the energy efficiency or changing the production process without affecting the quality and quantity of the product.

Sustainable Energy Conservation Opportunities (SECO) are the possibilities of decreasing energy consumption in a production process by improving the energy efficiency or changing the production process without affecting the quality and quantity of the product and also without decreasing the possibilities for future generations.

Economic Feasibility of an ECO (EFECO) is the financial consequence of the energy conservation opportunities for the enterprise under research measured in investment costs and pay-back period;

Energy efficiency is measured as the ratio between energy consumption and the amount of activity that is achieved by this consumption. These data are measured in kWh per unit of production;

Energy Efficiency Improvement is defined as the decreasing use of energy per unit activity without substantially affecting the level or structure of these activities, i.e. the performance should be the same;

There are different indicators for energy efficiency, but the important one for this research is the ***Specific Energy Consumption (SEC)*** It is the amount of energy (in terms of enthalpy) per unit of human activity measured in physical terms, starting from the primary energy carriers. An example of an activity is the heating of an area[9].

According to literature the theoretical possible efficiency improvement can be divided into the following levels[10]:

I. The ***theoretical potential*** of energy efficiency improvement. Thermodynamic laws determine the attainable energy efficiency of the process. It is defined as the difference between the current specific energy consumption and the thermodynamic minimum specific energy consumption. Because the speed at which the process takes place would become infinitely low this is not a practicable situation.

II. The ***technical potential***: the achievable savings resulting from the most effective combination of the efficiency improvement options available in the period under investigation. The process speed is at an acceptable level. In an energy efficiency analysis these improvements would be the energy conservation opportunities that could be reached without affecting the process quality.

III. The ***economic potential*** is the potential savings that can be achieved at a net positive economic effect, that is, when benefits are greater than the costs. In general a cost benefit analysis of the ECOs will show if they are economically achievable.

IV. The ***market potential*** is the potential saving that is expected to be realised in practice. Prevailing market conditions determine investment decisions taken by investors or in other words the willingness to invest is determined by prevailing market conditions.

This situation is presented in figure 2.1.

[9] Jansen, J.C., 1995
[10] Worrell, E., 1994

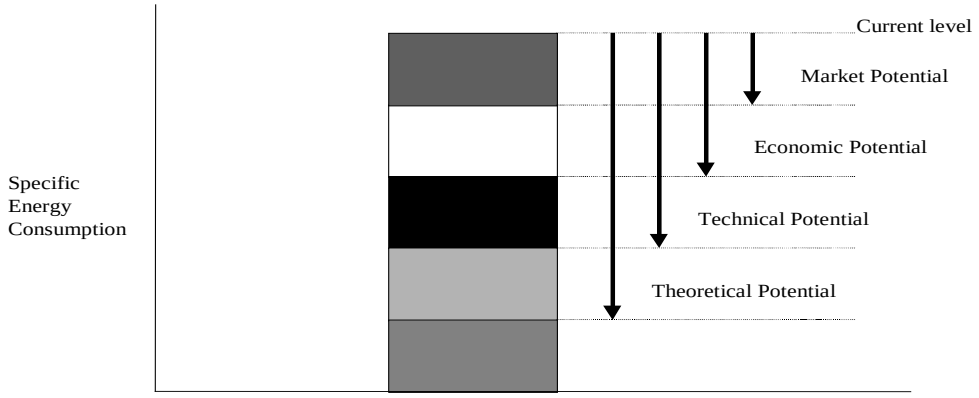


Figure 2.1: Schematic diagram showing the various potentials for energy efficiency improvement
Source Worrel , Ernest, 1994

Putting energy in perspective of a production process it can be seen as an input component. The tourist sector, including the hotels, utilises energy in its enterprises, alike the production processes in any other industry. Although the tourist sector is not considered an industrial sector, the assumption is made that the processes consuming energy in the hotels can be described in the same way. Figure 2.2 is representation of a model of a production process.

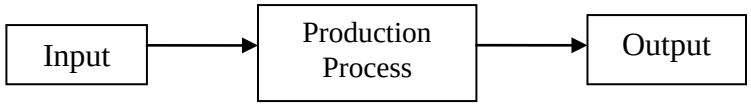


Figure 2.2 Representation of a production process

The three components are defined as follows.

- Input: raw materials, intermediate products and energy to be used during the production process.
- Production process: Takes place by making use of process technologies. The process technologies consist out of Humanware (H)-persons representing the manpower, Orgaware (O)- the organisational framework, serving to guide and control the production processes in the desired directions, Infoware (I)- documented facts, which serve as a source of information and Technoware (T), artefacts, like tools and equipment[11].
  For the hotels this results in:
  Humanware: All persons operating or working with the equipment installed at the hotels:
  The employees at the hotel including the owner.
  The tourists spending the night in the hotels.
  Possible external people involved.
  Orgaware: The organisational structure of the hotel, e.g. the organisation of maintenance, responsible persons and possible external people involved.

[11] Egmond-de Wilde Coligny, E.L.C. van, 1999

Infoware: The availability, accessibility and quality of information to the people involved related to the energy efficient use of the equipment and availability of energy efficient equipment in the hotels.
Technoware: Characteristics of the installed equipment, type of processes used, energy efficiency and energy consumption in the hotels

- Output: The (desired) product or service. For the hotel sector these include hot water, lighting, a comfortable internal climate and so on.

2.2 The Theoretical Framework

In the former section the theory behind energy efficiency improvement and its role in a production process has been described briefly. In this section two theoretical models will be discussed regarding their applicability for this research.

2.2.1 The First Theoretical Framework

The first theoretical framework is assumed to be useful for purposes of mapping the status of technologies utilised in production[12].

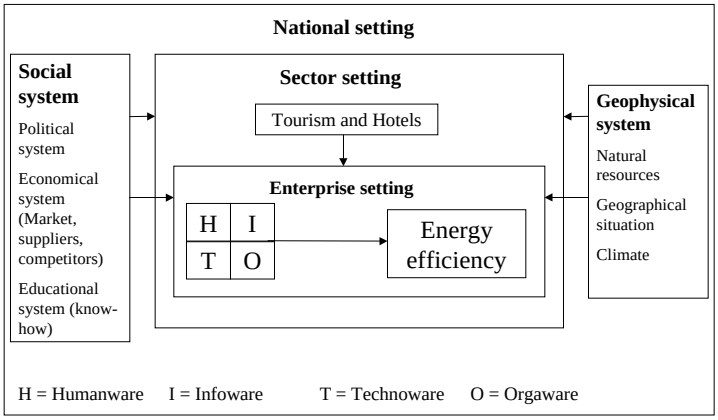


Figure 2.3 The first theoretical framework

According to this theoretical framework three different levels affect the energy efficiency in hotels. At the level of the enterprise setting the energy efficiency depends on the process technology as described in the former section.
The sector setting also has an influence on the energy efficiency. The demand for a certain product and competition from other enterprises within the sector influence the energy consumption in an enterprise. It also gives insight into the total energy demand in a sector. In this research the sector setting consists out of the tourist sector in general and the hotel sector more specific.
The national setting is defined as that part of the social and geophysical system in Costa Rica that is of influence on the tourist sector in general and on energy consumption in hotels in particular. In this framework this would be:

- Political system: government policies related to the tourist sector
- Economical system: The economic situation in a country is an indicator for things like the technology status of the country and the investment climate. This is again related to the energy efficiency of equipment.
- The energy setting: The production of electricity and the market for energy is an aspect that influences the need and the possibilities for energy conservation.

[12] Egmond-de Wilde Coligny, E.L.C. van, 1999

- Education system: It is assumed that the education level of a person has an influence on the skills and knowledge of that person concerning energy consumption.
- Climatic conditions: Climatic conditions influence the energy consumption of processes and also the demand for certain facilities.
- Natural resources: The existence of natural resources in a country can influence the choice of technology and thereby the energy consumption level. In this research the availability of energy resources is considered to be the most important resource.

2.2.2 Factors Influencing Energy Consumption in an Industrial Enterprise

This theoretical framework looks at the situation from another perspective. It defines factors influencing the energy consumption in an enterprise which in this case would be a hotel. This framework is originally developed for energy efficiency performance in an industrial enterprise.
According to this theory there are two types of factors influencing the energy consumption[13]. These are the **internal factors** and the **external factors.** Figure 2.3 is a representation of the theoretical framework.

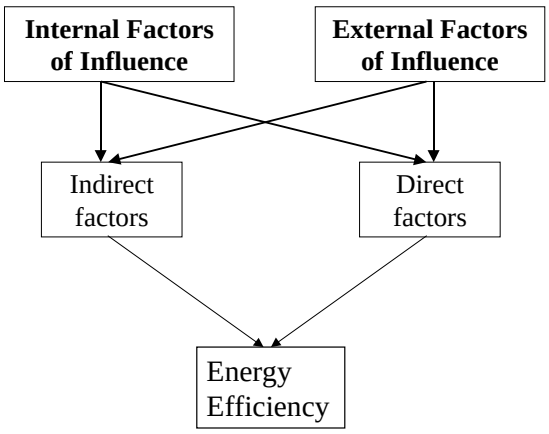


Figure 2.4 The 2nd theoretical Framework

The Internal Factors of Influence

Following Toussaint the internal factors can be subdivided into the ones with a direct influence on energy efficiency, the direct factors, and the ones having only indirect influence on the energy efficiency, the indirect factors of influence. These factors are presented in the following table.

[13] Tousaint Dick, 1994

Table 2.1 Internal Factors: Direct Factors and Indirect Factors of Influence	
Direct factors of influence	*Capacity utilisation;* *Production losses;* *Energy efficiency of equipment;* *Management of energy;* *Objectives of a company;* *Behaviour of people.*
Indirect factors of influence	*Applied technology;* *Maintenance;* *Know how;* *Organisational structure;* *Investment possibilities and priorities.*

Direct Factors

- *Capacity utilisation:*

An optimal capacity utilisation will lead to the lowest specific energy use. Supply side and demand side influences determine optimal utilisation. An important internal supply side factor is available machine hours.

An example of a demand side factor is excess capacity caused by either fluctuations in demand or installed in order to be able to meet expected demand in the future. Economies of scale do play an important role here.

- *Production losses:*

Production losses increase the specific energy use and should therefore be minimised.

- *Energy efficiency of the equipment:*

The characteristics of the equipment used for the processes influences the use of the energy. The higher the energy efficiency of the equipment the lower the energy use will be.

- *Energy management:*

Not only measuring and monitoring, but also promotion, planning and implementation of programmes, preparation of progress reports and feedback influence energy consumption. Energy management can be defined as the strategy and systematic controlling of energy flows with the final goal to lower energy costs now and in the future[14].

- *Objectives of an enterprise:*

Objectives at enterprise level are of an economic nature. Effectiveness and efficiency are minimal requirements to obtain profitability and continuity. Goals that are set should not only be achievable but also measurable and specific. Energy management plays an important role in this. Setting an energy goal can help obtain a lower specific energy consumption.

- *Behaviour/attitude towards energy efficiency:*

Awareness of the use of energy influences the energy consumption. Again energy management has an important role to play here. Informing people on the use of machinery and energy is essential in this.

Indirect Factors

- *Choice of technology:*

The technology can be energy intensive or energy saving.

- *Maintenance:*

Secured continuous production cannot be achieved without proper maintenance. Availability of engineers and technicians with the right skills is important in this.

[14] Claus J., 1992

- *Know how:*

Lack of know-how in a company influences the energy use in several ways, e.g. through management, maintenance, and identification of ECO's.

- *Organisation-structure:*

The better the structure of an enterprise the lower will be the energy use in that enterprise, because it improves e.g. logistics and the use of raw materials.

- *Investment possibilities and priorities*

Decisions to invest or not in energy conserving measures are determined by availability of capital and of manpower. Priorities in an enterprise are often safeguarding of production before other activities in the enterprise. When capital is scarce possible ECO's will not be utilised.

External Factors of Iinfluence

Just as with the internal factors of influence the external factors can also be divided into direct factors and indirect factors of influence.

Table 2.2 External Factors: Direct and Indirect Factors of Influence

Direct factors of influence	*Energy prices, tariffs and supply* *Climatic conditions*
Indirect factors of influence	*Demand side factors* *Government policies* *Spare parts supply* *Availability and quality of raw materials* *The sector market*

Direct Factors

- *Energy prices, tariffs and supply*

Capacity utilisation is influenced by the reliability of the energy supply. Availability and prices play an important role in this.

- *Climatic conditions*

Climate circumstances influence the specific energy consumption of a production process. Temperature is the most important aspect of the climate, but other weather conditions like humidity and rainfall should not be neglected.

Indirect Factors

- *Demand side factors*

Reference is made to the capacity utilisation for this factor.

- *Government policies*

Regulations and legislature influence the behaviour of enterprises and therefore also the energy consumption.

- *Spare parts supply*

Availability of spare parts when needed influences the capacity utilisation and thereby the energy consumption.

- *Availability and quality of raw materials*

Influences the capacity utilisation in a negative manner when not optimal.

- *The sector market*

The demand for a certain product determines whether there is excess in capacity and influences the energy consumption. Competitors also play a role in this. In this case the tourist market is the sector and other hotels are the competitors.

2.2.3 Evaluation and Choice of Framework

Looking at the second framework by Toussaint, no indicaton is given how he determined which factors are of direct and which of indirect influence. The framework does however use a more detailed approach, using more variables compared to the first theoretical framework.
When comparing the two frameworks further the conclusion can be made that the internal factors mentioned by Toussaint are equivalent to the enterprise level factors from the first framework and the external factors can be placed within the sector or national setting. Therefore the decision is taken to use a combination of the two frameworks for this research, with the internal factors mentioned by Toussaint embedded in the enterprise level factors from the first framework and the external factors in sector or national level factors.

2.3 The Research Structure

2.3.1 The Research Questions

With the theoretical framework in hand questions related to the problem definition were answered in this research. These questions are presented in the table below.

Table 2.3 Research Questions for the Different Settings

National setting	• What is the present role of the Costa Rican government and other organisations influencing the performance of hotels and what can they do to stimulate energy conservation opportunities for hotels? • What are the social constraints and opportunities for energy conservation opportunities in Costa Rica? • What are the economic constraints and opportunities for energy conservation opportunities? • What is the influence of the geophysical conditions on the energy consumption in hotels in Costa Rica?
Sector setting	• What are the main characteristics of the tourist sector in Costa Rica in relation with energy consumption? • What are the main characteristics of the hotel sector and hotels in Costa Rica in relation with energy consumption? • What are the most important processes in a hotel in Costa Rica? • What are the best practise situations of the main processes in hotels in Costa Rica?
Enterprise setting	• What are the general characteristics of the investigated hotels? • What are the characteristics of the equipment installed in the investigated hotels? • What is the current state of performance of the processes in the investigated hotels? • What are the socio-economic characteristics of the investigated hotels?

The answers to these questions should lead to the energy conservation opportunities and constraints in hotels. Because the theoretical framework consists of different levels the research instrument is presented according to these different levels in the next section.

2.3.2 The Research Model

The research model is presented in the figure 2.5. The three different levels as already mentioned in the theoretical framework together create a group of constraints and opportunities in Costa Rica in relation with energy conservation in hotels. In the figure the different methods of data collection are also mentioned. From the constraints and opportunities recommendations can be derived to obtain the energy conservation that is aimed for.

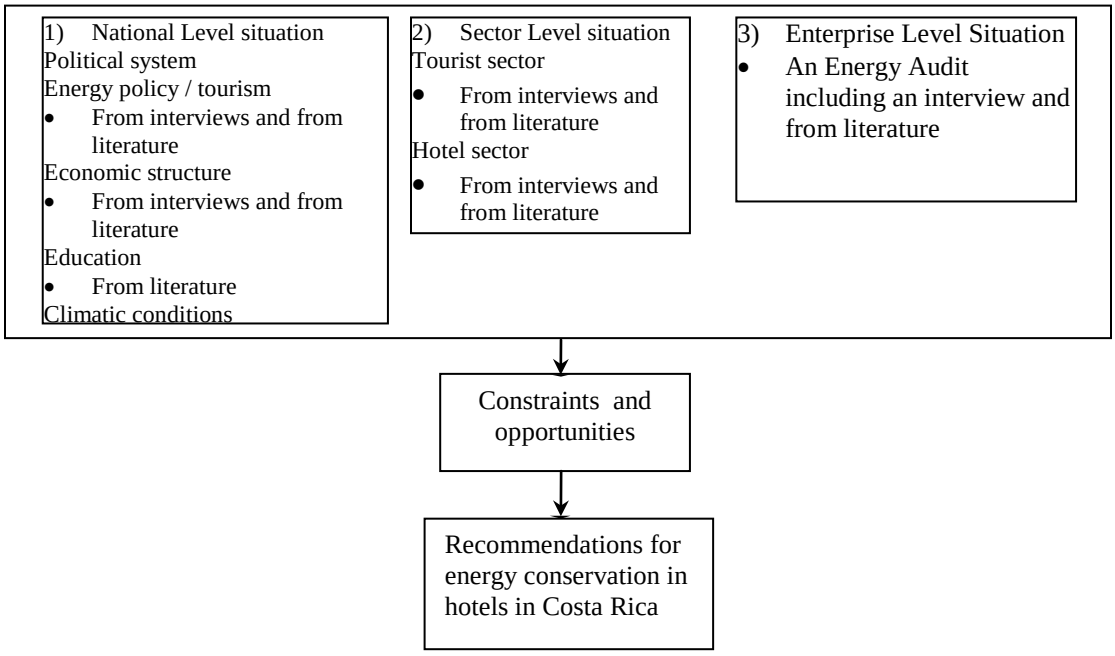


Figure 2.5 The research model

National Setting

The following elements of the national setting have been examined.

- The political setting: The government is an important actor that can give guidelines or make rules for the tourist sector concerning energy consumption.

The following questions were raised:

- ❖ If the government tries to stimulate the tourist sector how does it try?
- ❖ Which channels are used to try to stimulate and regulate the tourist sector?
- ❖ What is the attitude of the government related to energy consumption in general?
- ❖ What kind of regulations and laws are there, which are related to energy conservation opportunities and how do they come in to play for the tourist sector in general and hotels in particular?

- The economic setting: To get an insight into the possible solutions regarding energy conservation opportunities the economic setting has been described. The economic data that will be presented are the share of the sector in GDP, share of manufactured exports as well as the economic structure, the GDP/capita and the inflation rate.
- The energy setting:. The national energy setting has been examined. What have been the recent developments concerning the energy consumption in the country and what are the primary energy sources?
- Education: The educational system of Costa Rica has been described briefly through enrolment figures.
- Climatic conditions: For instance the consumption of hot water, the use of air conditioning and room heating are influenced by climatic conditions. This means that the energy consumption of the equipment concerned is influenced by climatic conditions. Therefore the climate has been described.
- Natural resources: In this research only the energy resources are described briefly. Other resources are considered to be unimportant because they are assumed to have little or no influence on the energy consumption in the hotels.

Data for the national setting have been collected through literature, interviews and information from statistical data. The results have been evaluated and conclusions have been made in relation with the

energy consumption in hotels in Costa Rica. The elements have been reviewed in terms of opportunities and constraints for hotels.

Sector Setting: The tourist sector and hotels in Costa Rica

The tourist sector in general and the hotel sector were investigated. The results included:

- Characteristics of the tourists visiting Costa Rica and staying at the hotels. The information will include number of tourists, origin and other important aspects.
- To get an insight into the competition in the hotel sector the number of hotels, facilities in the hotels, location of the hotels and scale of the hotels are presented.

The information has been gathered through literature and interviews with people from tourist organisations in Costa Rica. In section 2.5 the empirical aspects are presented partially based on this part of the research.

Enterprise Setting

The enterprise level, the individual hotels, is the level where the energy is actually consumed. To get hold of the factors that influence the energy consumptionon on this level, the four process technology contents were investigated. To do so the following information was gathered on this level of research:

- General characteristics of the hotels, like e.g. the number of rooms, facilities, employers, organisational aspects and other factors influencing the energy consumption in hotels. Also the attitude of the owner towards investments and energy consumption were investigated.
- Characteristics of the facilities and equipment related to energy consumption, e.g. capacity and location of installation.

The data collection took place by means of an energy audit. The energy audit will be described in section 2.4. Integrated in the energy audit was an interview with the manager, for which a questionnairre was made. This questionnaire is presented in Appendix II.

2.4 Method of Data Collection at Enterprise Level

2.4.1 Introducing the Energy Audit

The energy audit is an examination of a specific process, or enterprise with the objective of identifying and analysing the energy use of a building or a production area and identifying the most favourable savings possibilities. More specific an energy audit[15] is an in-depth study of an energy consuming system or facility to:

- Determine how and where energy is being used or converted from one form to another
- Identify opportunities to reduce energy usage
- Evaluate the economics and technical practicability of implementing these reductions
- Formulate prioritised recommendations for implementing process improvements to save energy

There are three different levels of energy audit activities:

1) The ***preliminary*** or ***walk-through audit***. This takes about 1-3 days depending on the plant complexity. It consists in recording and analysing the energy use by cost centre over a fixed period of time. A walk-through of the facility, amongst others for visual inspection of energy savings opportunities and an analysis of the utility and fuel bills are sufficient. It can also be used to establish the need for a more detailed analysis;
2) The ***mini-audit***. A more comprehensive view at the energy use of the facility and its cost centres. It consists of the identification of obvious wastage situations and recommending measures through improved maintenance and operating practices. Measurements of energy uses and losses are necessary for this. It should result in recommendations involving energy

[15]: Witte L.C., P.S. Schmidt & D.R. Brown, 1988

conservation opportunities requiring minor expense or major capital investments. Another name for this audit is a plant survey;

3) The ***maxi-audit*** or ***detailed audit***. More intensive then the mini-audit. It consists in recording complete energy use data for every cost centre over a fixed period of time and calculating energy balances and efficiencies. This audit takes weeks or longer to finish.

A special audit is the building audit that focuses on the heating, ventilation and lighting of a building. An industrial audit focuses more on processes[16].Considering the time and scale of this research a mini-audit was considered the most suitable.
Common elements for an energy audit are presented in table 2.4. These elements will be described next.

Table 2.4 Common elements of an Energy Audit.

- Historical review of energy-related records to establish a baseline against which progress can be measured
- Preplanning walk-through of the plant to identify major energy-using components, to familiarise the audit team with the general energy and material flows through the process, and to identify obvious sources of energy waste, such as leaks and uninsulated systems.
- Detailed definitions of the data requirements.
- Computation of mass and energy flows and estimation of energy losses.
- Enumeration of energy conservation opportunities.
- Estimation of energy savings potentials for each opportunity.
- Determination of cost and profitability potential for the implementation of the opportunities.
- Establishment of priority recommendations for the implementation of opportunities.
- Establishment of a continuous monitoring effort for major energy-using systems.

- **The Historical Review**

Records of energy consumption can provide valuable insight into the nature of energy usage and can be used to provide a baseline from which the future consumption can be gauged. Billing records must be analysed carefully to ensure that energy consumption is actually the quantity being determined. It is necessary to normalise energy data to reflect changes in production rate and possible other variables. Kilowatt-hours per unit of production and even per degree-day could be the expressions

- **Walk through process familiarisation**

Before embarking on a detailed data acquisition and analysis, it is important to develop a thorough familiarity with the process and its associated mass and energy flows. Process sheets and engineering drawings may be available to help in this task. The location of temperature, pressure and flow sensors and their typical readings should be noted. Conversations with operators can be very revealing

- **Definitions of data requirements**

The audit must be based on actual, not hypothetical, operating data. Process measurements will be required. Several questions should be kept in mind: What data are already available from existing research and or instrumentation and what is their reliability? How can you place instrumentation without interfering with the process? How much time do you need and what equipment is necessary?
Process flow sheets can be helpful by indication of the location of existing instrumentation and nominal flows, temperatures and pressures.

[16] Gottschalk, Charles M., 1996 & TDO, 1999

Nameplate specifications of equipment can be useful in conjunction with the measured quantities. Equipment operating load profiles provide insight into the operation time of the equipment: load cycles and loads.
When information is incomplete it will be necessary to make estimates for purposes of comprehensive evaluation.
Viability of the result rest on the reliability of the data required.

- **Mass and energy balances**

The basic principles of conservation of mass and energy provide the basis for determining where energy is used in a system and where losses occur. The mass and energy balances convert basic thermodynamic information, such as temperatures, pressure and flow rates into energy terms. They also provide additional resources to allow us to infer information from incomplete data as well as they provide a check on the consistency among different sets of data.

- **Enumerating energy conservation opportunities**

The next important phase in the audit is to identify ways of decreasing the loss and to evaluate the energy savings and profitability potential of implementing changes.

- **Evaluation of energy conservation opportunities**

The evaluation procedure consists of recalculating the energy and mass balances for each item for those places where a modification has been made. The cost of the modification must be considered and a lifetime economic evaluation must be carried out to determine the profitability of the measure

- **Presentation of the energy audit results**

This is an important phase in the sense that the report is crucial for convincing the people concerned. An energy audit is only as good as the quality of the report. It is a sales document and it must be concise, direct and convincing.

2.4.2 The Energy Audit Modified for Hotels

Since the energy audit was conducted in hotels the energy audit had to be adjusted for the characteristics of processes in hotels and the available resources described earlier for doing the energy audit.

- **Historical review of energy-related records**

Information about the most important energy sources like electricity and gas were collected for as many years as possible including the company/ies that provide the energy and also in what form (voltage, type of gas, etc.). The minimum is the energy consumption of the last year[17].

- **Walk-through of the hotel to identify major energy-using components**

Information has been gathered about the systems/facilities (capacity, type of system, date of acquirement, supplier) and the main characteristics of the hotel, like the number of rooms, people working at the hotel and so on. Also adjustments in the systems and the kind of maintenance that has been performed in the past has been investigated as far as information was available.
Other things that were done in this stage of the energy audit were:

- Drawing of a map of the hotel with information about facilities.
- The taking of pictures of the most important facilities and systems as well as the hotel in general.
- Description of the kind of conditions at the location, for instance the climate and road access.

[17] According to Herrera Corrales one year is the minimum requirement of information about the energy consumption in the hotels, Herrera Corrales, F. 1996

  - Description of the rooms, e.g. the colours of the walls, insulation of the rooms and available facilities in the rooms.
- Getting an impression of the vicinity of the hotel to get an impression of the circumstances/environment.
- An interview was held with the owners/managers for which a questionnaire was made. Part of the objective of this interview was to get information of their objectives in relation with energy consumption and their willingness to invest.

- **Detailed definitions of the data requirements**

From the former two steps the most important data was derived. A description of the processes related to the different facilities was made. An example is the functioning of the air conditioning systems in the hotels. In this research the technologies involved are presented in chapter 5. From this the data requirements can be derived.

- **Estimate of energy consumption and possible energy losses**

The hotels were divided into energy consumption centres as small as possible, meaning that it was still possible to determine the energy consumption of the separate centres. Because resources for this were not available it was impossible to measure the actual energy flows during a certain period of time representative for the hotel. This is however recommended for future research in hotels[18]. In this research the estimation of energy consumption was based on the system characteristics together with the operation characteristics. The data about the system characteristics was collected by searching for information on the equipment or in their manuals.

- **Enumeration of energy conservation opportunities and estimation of energy savings potentials for each opportunity**

In this stage the energy conservation opportunities per facility were investigated and the actual energy conservation that can be reached. Because of possible interdependency between different facilities, energy conservation might be different from expected. For example replacing incandescent lights for fluorescent lights reduces heat production in a room and as a consequence less air conditioning capacity might be necessary.

- **Determination of cost and profitability potential for the implementation of the opportunities**

After the listing of the possible opportunities, the economic feasibility has been looked at. Important information here is the lifetime of the equipment, investment and maintenance costs. Pay-back times and net present value (NPV) give insight into the economic feasibility of the opportunities.

- **Establishment of priority recommendations for the opportunities implementation**

From the first two steps recommendations need to be given. The result will be a list of recommendations with their energy savings and financial feasibility.

- **Establishment of a continuous monitoring effort for major energy-using systems**

An optional point to prevent the energy consumption to grow in the future is the monitoring of the major energy-using systems that can keep energy use low and also find out when something is wrong with the system. This is a general recommendation that can be included in the energy conservation opportunities.

[18] Because hotels are dealing with high and low seasons, meaning high and low occupation, it would have been ideal when measurements of the energy consumption during one day of higher occupation and one of lower occupation could have been done.

2.5 Empirical Aspects

Because of the large amount of hotels in Costa Rica criteria for selecting hotels had to be made. The choice of hotels has been made on some important characteristics related to hotels and energy consumption in Costa Rica:

- *1. Scale of the hotels (number of rooms):* Differences between scale of hotels might lead to different energy consumption constraints and opportunities. In section 3.4 there is a description of the hotels and the stratification according to their number of rooms. This information shows that the category of hotels with 20 to 40 rooms represents an important percentage of hotels in Costa Rica (24.7% of all rooms in 2000). Therefore the hotels studied all had between 20 and 40 rooms.
- *2. The facilities in the hotels:* From former research it was shown that the following equipment and facilities are responsible for a large part of the installed capacity in hotels[19]. Therefore the hotels were selected based on the presence of these facilities:
    - A restaurant and/or kitchen.
    - A swimming pool.
    - Air conditioning.
    - A laundrette.
    - Water heating.
- *3. The classification according to the international hotel institute*: Hotels can be classified according to their number of stars. As a hotel provides better service it receives more stars. In this research hotels with 2 or 3 stars were studied, because this category is the main group within the 20-40 rooms category (53%) and they are also assumed to provide (most) of the facilities mentioned in point two[20].
- *4. Hotels with the above characteristics:* Figure 2.5 on page 18 shows the number of hotels in the different cantons with 2 or 3 stars in the category of 20-40 with tourist certificate[21]. This picture shows that there were 5 cantons with 6 or more hotels: Santa Cruz, Carrillo, San Carlos, Aguirre and San José.
- *5. Climatic conditions:* Climate conditions influence energy consumption in houses and hotels. In Costa Rica there are large differences in climatic conditions between areas. As can be seen in section 3.1.2.1 there are four principal climates in Costa Rica. Because warmer climate conditions create a higher demand for air conditioning and air conditioners showed to be an important part of capacity installed in hotels the canton San José with a relatively cool climate, implying that air conditioning is not necessary, was abandoned as possible research area.
- *6. Logistical conditions:* Due to logistical reasons San Carlos was selected out of the remaining four cantons to conduct the research.
- *7. Canton San Carlos*: There were 6 hotels with 20-40 rooms, 2 or 3 stars and a tourist certificate at the beginning of the year 2000 in the canton of San Carlos. Three of these hotels were situated in higher regions eperiencing cooler climate conditions. The remaining three hotels, located in or close to the small town of La Fortuna de San Carlos were selected. The area around La Fortuna de San Carlos has a wet tropical climate.

  Because of a possible difference in energy consumption performance between hotels with or without tourist certificate one additional hotel without a tourist certificate was included in this study. Because this hotel did not receive a star classification point one and two were used as selection criteria. The hotel was selected after visiting several hotels in the area without certification.

[19] Mora Arias, November 1999, research among 5 hotels.

[20] The level of service that is provided by a hotel is likely to be measured by things as friendliness and efficiency of employees, the amount of services in the hotel and the quality of these services. The amount of services is assumed to be related to the number of facilities in the hotel.

[21] See chapter 3

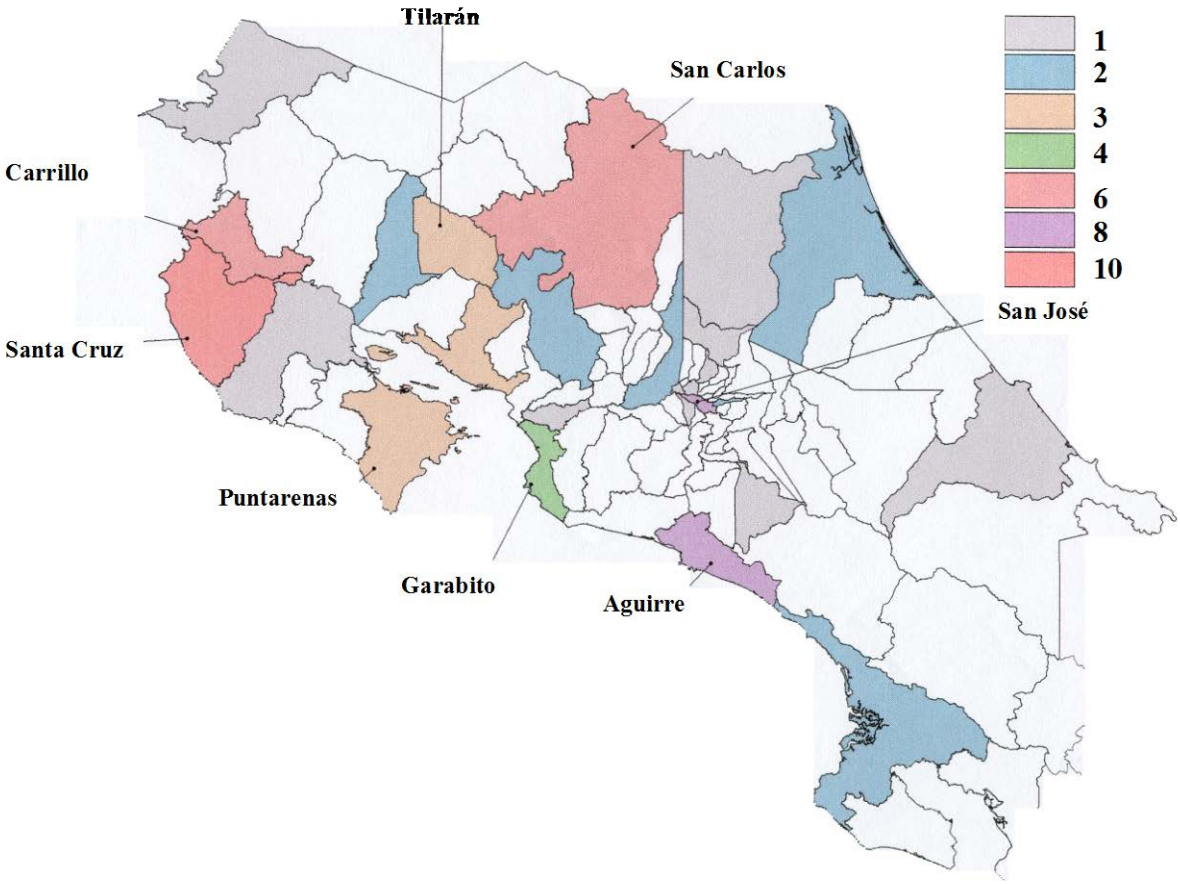
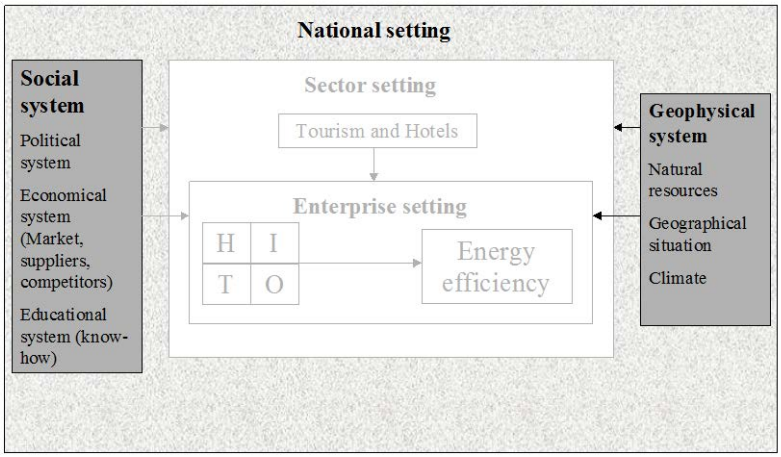


Figure 2.6 The number of hotels with 2 or 3 stars and 20-40 rooms in the different cantons of Costa Rica

Chapter 3: The National and Sector Setting

3.1 The National Setting

In this section the national setting will be described in order to be able to answer the research questions related to this level. First the data on the social system and then those on the geophysical system will be presented. The part about the geophysical system will focus on climate conditions. Other important geophysical data is already presented in chapter one.



3.1.1 Possible Impacts of the Social System on Energy Conservation in Hotels

3.1.1.1 The Political Impacts

National Policies and Tourism

- ***The Instituto Costarricense de Turismo***

The Instituto Costarricense de Turismo (ICT) is the government organisation through which the government tries to regulate and stimulate the tourist sector in Costa Rica. The ICT was founded by the Costa Rican government in 1955, according to Law number 1917[22]. The main objective of the ICT is to increase tourist activities in Costa Rica. This objective can be divided into four parts[23]:

1. To stimulate and to improve Costa Rican tourism so more foreigners will visit the country for their vacation.
2. The promotion, construction and maintenance of recreational and sleeping locations.
3. The promotion of Costa Rica in other countries to attract tourists to visit the country with the purpose of increasing tourism in Costa Rica.
4. The promotion and safe guarding of private investment in tourism.

Additional to this the ICT tries to develop a more sustainable tourist sector. They are the initiators behind the "Certificación para la Sostenibilidad de Turística" (CST, the Certification for Sustainable Tourism), of which the purpose is to stimulate hotels and other tourist enterprises to operate in a more sustainable way. This is done by giving qualifications according to an evaluation of the working procedures and the effects of these working procedures on the environment.

[22] ICT, Normas que regulan, 1997
[23] ICT, Normas que regulan, 1997

The evaluation focusses at four main aspects:

- The physical-biological environment: An evaluation of the interaction between the enterprise and the immediate natural surrounding.
- Operational functioning: An evaluation of management and internal operating systems at a production or service level.
- External clients: An evaluation of the interaction between the enterprise and the external clients and tourists. What are the incentives of the enterprise towards external clients to participate in its sustainable policy?
- Social economic environment: An evaluation between the enterprise and the local inhabitants and community in general. What is the impact of the hotel on its immediate environment?

The outcome of these evaluations determines how the enterprise is doing in terms of sustainability. The different enterprises are then classified into 'categories of sustainability' going from 0 to 5, similar to the number of stars a hotel can receive.
Evaluating the project leads to two points of criticism:

- The certificate is based upon voluntary co-operation. Enterprises which don't care about sustainability will not be interested in the certificate.
- The evaluation is only once a year. Therefore the results might not be representative for the situation all year round. A more frequent evaluation would be more appropriate.

National Policies and Energy Consumption

The policy in Costa Rica directed at energy is embedded in the 'National Plan for Conservation of Energy.' The general target of this policy is to decrease the demand of energy without damaging the economic growth, the quality of life of the Costa Ricans and the environment, and to maintain an effective and efficient supply of energy. This policy was initiated in 1990 and is continued for the period of 2000-2015.
The policy objectives include:

- The conservation of natural resources and the minimisation of environmental damage that result from energy projects and processes.
- The development of new technologies for a more efficient use of energy and to increase the energy efficiency of exsisting equipment and plants in various sectors.
- The change of the energy consumption pattern of consumers to a lower level.

To achieve these objectives the following strategies were developed:

- The promotion of the conservation and efficient use of energy by the consumers.
- The financing of energy conservation related projects.
- The assessment of an encouragement system to achieve energy conservation.
- The implementation of energy standards for the production and import of consumer products.
- Energy consumption labels for the most important consumer products.
- The increase of import taxes and tariffs for products that do not meet the energy standards.
- The exemption of energy related sustainable products and equipment from taxes and tariffs.
- The promotion of local energy sources in favour of imported energy.
- The obligation for large consumers to give an explanation for the level of energy consumption as well as the obligation for these consumers to develop and implement an energy conservation program. There is a possibility to get government support to develop such a program.

An important sector being responsible for the implementation of these strategies is the electricity sector. This sector will be reviewed later on in this section.

Laws and Energy Conservation

A possibility to influence the energy demand downwards is the implementation of laws that force or stimulate consumers to behave in such a way that they consume less energy. Two important laws that are implemented to help achieving the objectives are presented and reviewed here.

- ***Law no. 7200 (1990)***

This law applies to the generation of electricity by hydropower, solar systems, wind or any other non conventional technology. There are two different import taxes to promote these technologies:

- *Exemption of import taxes*: Exemption of taxes for equipment made to generate electricity in a non-conventional way. Non-conventional refers to the use of sustainable energy sources.
- *Compensation for generation of electricity*: The principle used is called "avoiding investment costs for the generation of electricity" foreign enterprises would make. Calculations are based upon prices of electricity supplied by the Instituto Costarricense de Electricidad (ICE). These prices are based upon thermal electricity generation or prices charged by the ICE for imported electricity. The government compensates the investor the amount of money calculated in this way.

- ***Law no. 7447 'Uso Racional de energía'***

As the name already implies this law aims at a rational use of energy in Costa Rica to achieve energy conservation. This law is built up of three main parts:

- Enterprises in the sectors of production and assembly of equipment, machinery and of transportation vehicles can get tax exemption on import and value added tax for energy efficient equipment or parts. Each application will be assessed individually for the amount of tax exemption that will be granted.
- Enterprises consuming above 240.000 KWh or 360.000 litre of petroleum or an equivalent amount of energy a year have to develop a program containing guidelines for a rational consumption of energy. When the costs of the implementation of the program are higher than 15% of the yearly energy costs the enterprise can get exemption of consumer product taxes and import tariffs.
  Enterprises can also get a subsidy of 50% of the total investment costs or 20% of the total yearly savings on energy resulting from the program.
- Consumers can get exemption from taxes for equipment that can contribute to energy conservation.

Later on in this chapter can be seen that there are many small hotels in Costa Rica. Most of the hotels will therefore stay below the level of energy consumption mentioned above. The exemption from taxes for energy efficient equipment can be interesting for the hotels. The law does include a list of equipment and products that is tax-free[24]. Examples of items present on the list are a solar water heater, fluorescent lighting and insulation material. These are items that can help to decrease the energy demand in hotels. Depending on the market situation in the countries these products might have become an economically interesting option.

Organisations involved in Energy Conservation

- ***The Electricity Production and Distribution Sector***

Most of the electricity in Costa Rica is generated and distributed by the Instituto Costarricense de Electricidad (ICE) and the Compañia Nacionál de Fuerza y Luz (CNFL). Both of them are state owned enterprises. Other smaller companies distribute and generate electricity in small areas of the country[25]. Private production of electricity is limited by law. At the moment there are discussions about the liberalisation of the energy market. The objective is to allow more production from

[24] This list is presented in Appendix IV Law 7447.

[25] The other electricity companies responsible for distribution in Costa Rica are Coopeguanacaste, Coopelesca, Coopesantos, Coopealfaro, JASEC and ESPH.

private companies. At the time of writing it was unknown what the results of these discussions were.
The electricity companies have several programs with the objective to reach energy conservation. The CNFL had the most information about its programs and therefore was used for the following part.
The CNFL has developed the following two objectives related to energy conservation:

- To inform, educate and make people aware of the necessity to use electricity in a rational way.
- To investigate and promote the use of new technologies dealing with conservation of energy.

To reach these objectives, several projects are implemented, should have been developed, or research was conducted related to the rational use of energy:

- In order to find out which equipment is responsible for the main part of the demand for electricity, the CNFL has been doing research in the different sectors. Part of the results were that in the residential sector, the lighting, refrigeration and cooking aspects are the most important usages of electric energy (68% of the residential consumption) and in the commercial sector the principal usages are the air conditioner and lighting.
- A campaign of measures of promotion for the rational usage and conservation of energy through brochures with advises to save energy.
- A permanent center for the education on the conservation of energy.
- Pilot demonstrations aimed at the rational use of energy for cooking, refrigerating, water heating.
- The promotion of fluorescent lights in the residential sector. Fluorescent lights are sold to the people by all the electricity companies in order to replace the incandescent bulbs. This should lead to lower electricity demand.

These projects can have a positive effect on the energy efficiency in hotels in Costa Rica. The research that has been conducted shows that the equipment that is likely to be installed in many hotels as well is responsible for a large part of the electicity consumption in the residential and commercial sector.

3.1.1.2 The Economic Setting

The structure of the economy is presented in table 1.2 of chapter one. More detailed information[26] tells us that in 1999 industry is responsible for 22% of GDP, agriculture is responsible for 13% and the commercial sector (including tourism) for 40% of GDP. These figures show the importance of tourism for the economy of Costa Rica. Economic growth has been 6.2% in 1998 and 8.3% in 1999. Almost half of the growth in 1999 can be attributed to the production of Intel Corporation's microprocessor assembly and testing plant[27]. This company might attract other high technology enterprises to Costa Rica. Such a development would improve the technological capability of the country if not immediately, surely after some time.
The assumption is made that there is a positive correlation between the level of GDP per capita and the technological advancement in a country. The level of technological advancement is assumed to be positively correlated with the energy efficiency of available equipment. The GDP level in Costa Rica shows that it is a middle income country. GDP per capita has grown in the last 6 years but high inflation has made growth measured in US$ lower. The interest rate in Costa Rica is also high, but has decreased significantly in the last few years. A high interest rate is generally assumed to discourage investments thereby causing a negative effect on the energy conservation opportunities in hotels.

[26] Presented in Appendix I
[27] Source: http://www.state.gov/ background_notes/costa_rica_0600_bgn.html (Background Notes: Costa Rica, June 2000). The commercial sector consists out of hotels, restaurants, tourist services, banks and insurance.

The trade balance shows that Costa Rica is a net import country, which is an indication that the country is a technology importing country. More detailed information about the exports shows that traditionally a large part of the exports income consists out of bananas and coffee, although since 1999 Intel has become responsible for a large part of the export as well. This is an indication that the industry of Costa Rica is small and that there is a dependence on foreign technology.

Table 3.1 Economic Indicators of Costa Rica						
Year	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**
GDP per Capita (US$)	3338	3290	3483	3739	4055	3943
Inflation (%)	17.4	14.5	11.8	10.9	9.2	9.6
Basic Interest Rate, december (%)				24.5	18.75	15.5
Exports – Imports (FOB, Millions US$)	-322.3	-249.1	-479.6	-399.0	618.6	-241.0

Source: Banco Central de Costa Rica

- ***The Costa Rican Chamber of Industry***

An organisation that can influence the energy consumption from the supply side is the Costa Rican Chamber of Industry. The Chamber of Industry was founded in 1943 with the objective to support and stimulate (new) industries. They have developed a program with the objective to increase the competetiveness of the industrial enterprises through the decrease of the energy costs and the optimisation of the auxiliary services. This program includes the possibility of the execution of an energy audit to find energy conservation opportunities. They can assist enterprises in the development of an energy conservation plan, look for finance to implement energy efficiency improvement projects and perform feasibility studies on energy conservation possibilities. The impact of this program on energy consumption in hotels could be a result from the production of more energy efficient equipment by national industries.

3.1.1.3 The Educational System

In table 3.2 the primary and secondary enrolment percentages are presented for 1990 and 1997. It shows that the net enrolment has risen 3% and 4% respectively in 7 years. The secondary enrolment in 1997 however is only 40% of the relevant age group. The net enrolment ratio is the ratio of the number of children of official school age (as defined by the education system) enrolled in school to the number of children of official school age in the population.
Relating these numbers with energy consumption, it can be expected that a low education level has a negative effect on energy efficiency, resulting in a higher consumption. The idea behind this is that lower education levels make people less capable in choosing the most appropriate technology as well as they are less capable of working with the equipment.

Table 3.2 Education in Costa Rica		
Year	**1990**	**1997**
Net primary enrolment (% of relevant age group)	86	89
Net secondary enrolment (% of relevant age group)	36	40
Illitarecy rate, adult total (% of people ages 15 and above, 1999)		4.5
Gross secondary school enrolment (%, 1996)		48.4[28]

Source: Worldbank, 2000

[28] For the Netherlands this was 131.5% in 1996.

3.1.2 The Geophysical System.

3.1.2.1 The Climate in Costa Rica[29].

One of the characteristics of the climate in Costa Rica is that there is a large diversity of climatic areas and that there are several micro climates. The principal climate conditions in Costa Rica can be classified as:

a) A wet tropical climate, characteristic for the low parts on the Caribbean side: A wet tropical climate means high temperatures and high humidity. This will make the demand for good ventilation or air conditioning (cooling and dehumidification) in hotels higher. Demand for warm water will be lower than in cold areas and heating of the rooms is not required.
b) A tropical climate with a dry season, characteristic for the low parts on the pacific side: A dry and a wet season makes the demand for air conditioning season dependent. The need for warm water and heating of the rooms is assumed the same as for the wet tropical climate.
c) A moderate climate, which can be found in areas at altitudes approximately between 1000 and 2000 meters: In this region the need for air conditioning can be zero, except maybe for relatively warm days. The demand for warm water will increase however. There is no need for heating in the rooms.
d) A cold climate, to be found at altitudes higher than 2000 meters: Here heating of the rooms can be required. The consumption of warm water is also likely to be higher. On the other hand air conditioning is not necessary at all.

These differences in climatic conditions result in different requirements for hotels. Facilities required in one region are not necessary in other regions. It also influences the possible ways to meet these requirements.

This makes it impossible to come with general solutions and energy conservation opportunities for all hotels in Costa Rica for the facilities and equipment influenced by climatic conditions. However, research can lead to an indication of the different requirements in the hotels for different climate conditions.

To give an example, Baruch Givoni[30] has developed a diagram presented in figure 3.1 for different climate circumstances and the necessary internal climate conditioning. This model can be used as a guideline for the necessity of air conditioning. Climatic conditions will be discussed in more detail when necessary for the research. For general information about the weather conditions in Costa Rica, Appendix V Climatic Conditions presents four maps with information on temperatures, humidity, precipitation and information about sun hours and intensity.

[29] Partly from: Silvia Magaly Mora Arias, Noviembre 1999
[30] Source: Givoni, B., 1998

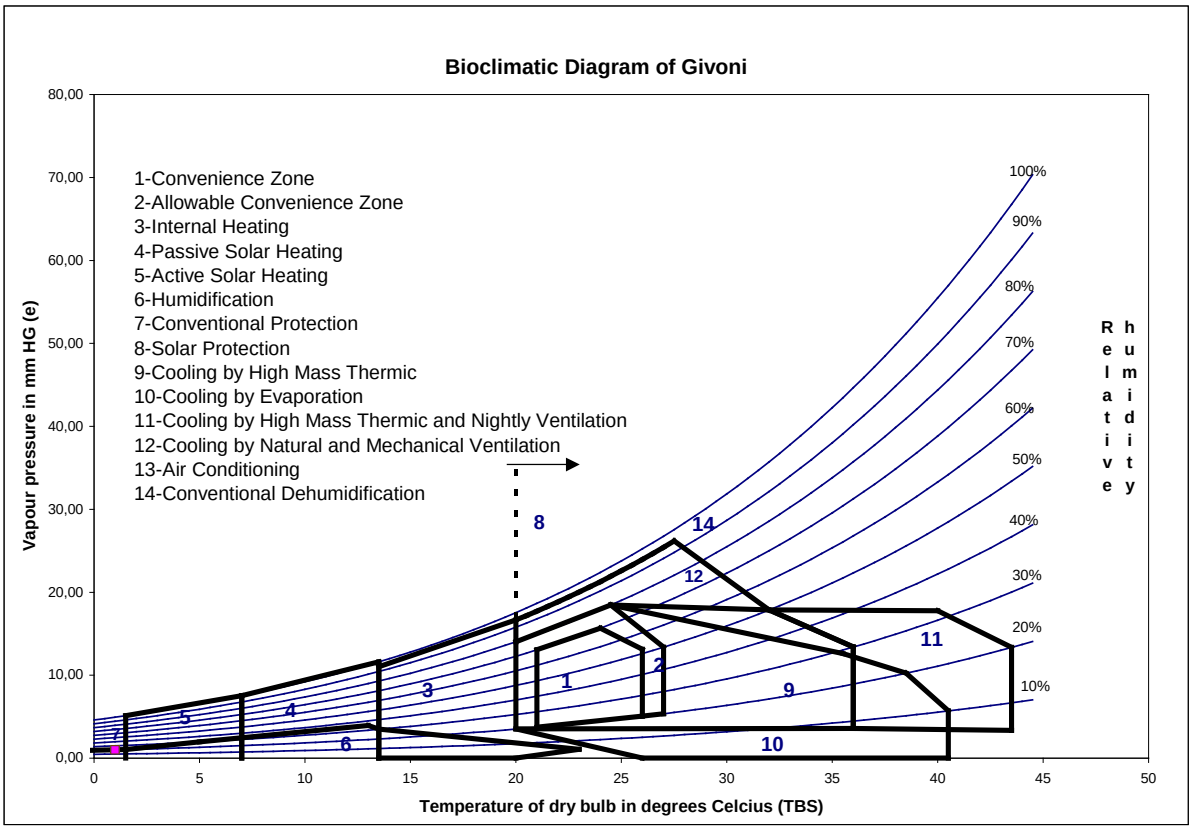


Figure 3.1 The different climate conditions and required air conditioning according to B. Givoni

3.2 Evaluation of the National Setting

In this section data of the previous section will be related to the research questions on national level out of section 2.4.

The present role of the government: From government side laws are implemented to help energy conservation and sustainability of the energy consumption. Especially law no.7447 is a very interesting law for hotels, because this law offers the opportunity of tax exemptions for products and equipment related to efficient energy use. Besides tax exemptions and higher taxes another instrument that is used to lower energy consumption is subsidising energy conservation projects.

The Instituto Costarricense de Turismo (ICT) is the government organisation responsible for the regulation of the hotels in the country. At the moment, the program they have on sustainability is not obligatory. It should be taken into consideration to make it obligatory, however the effect of the program is debatable in terms of energy conservation. A program with the specific objective of energy conservation in hotels might have to be developed for that.

An important sector related with the consumption of energy in hotels is the energy sector. Here the government has a large influence, because the most important enterprises are state owned. These companies try to lower the energy demand in Costa Rica in general by several programs. At the moment there aren't any programs specificcaly for the hotels, but the programs there are can have a positive effect on the energy efficiency in this sector. A program to sell efficient lights to hotels just as they had for the residential sector might be very effective in terms of energy conservation.

Research conducted by the electricity companies made clear that lighting, air conditioning, cooking and refrigeration, which facilities are present in the majority of the hotels, are responsible for a large percentage of the energy consumption in residential and commercial areas. A program on energy conservation for hotels could result in to an even higher decrease in energy demand in that sector.

Co-operation between the ICT and the electricity companies to increase the energy efficiency and reach a lowering of the energy demand in the hotel sector is an option that can be considered. The

ICT has a good insight in the structure of hotels and the electricity companies have expertise on the subject of energy conservation.

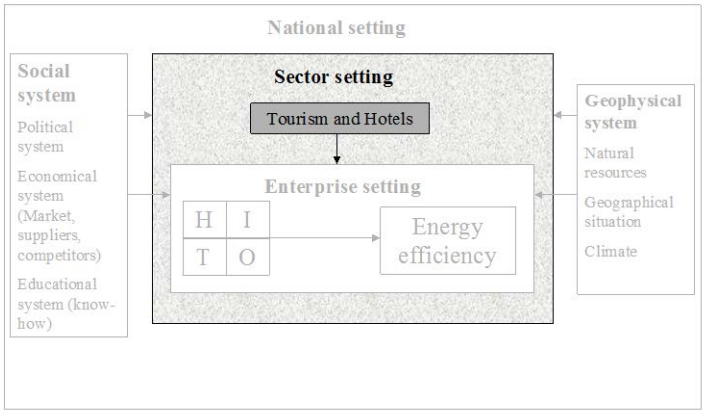
Other organisations: The chamber of industry can have an influence on the energy consumption of the equipment installed in the hotels. The programs implemented by this organisation related to energy conservation will likely have a positive effect on the energy efficiency of the available equipment.

Socio-economic setting: The economic characteristics of the country indicate that there is still too much dependence on the import of foreign technologies. The economic structure of the country indicates further that the large sectors are Coffee, Bananas and Tourism. The status of the educational setting indicates a negative affects on the energy efficiency in hotels.
High interest rates and inflation discourage investments, which makes energy conservation opportunities economically less feasible.

Geophysical conditions: Because of a big variety in climatic conditions in Costa Rica it is very difficult to reach a general advise for all hotels at one time. Hotels in different regions will ask for a different solution to obtain the lowest energy consumption level possible.

3.3 The Sector Level: Characteristics of the Tourist Sector and Hotels in Costa Rica

In this section the tourist sector and hotel business will be described, after which the information will be placed in perspective of the research questions and energy consumption in the hotels.



3.3.1 Tourism in Costa Rica

The increase of the number of people visiting Costa Rica has been tremendous in the last decade (1989-1999). The growth of the sector has been very high in these years and predictions are that this will remain so for at least the next couple of years.

In the middle of the 1980's between 250,000 and 300,000 tourists visited Costa Rica. Due to the unstable political situation in the surrounding countries, tourism in Costa Rica did not grow. After the political stabilisation of the region at the end of the 1980's tourism in Costa Rica was no longer hampered. The number of tourists increased rapidly to 684,000 in 1993. Although 1996 and 1997 showed some stagnation, in 1998 and 1999 the growth turned again to the pace of the early 90's. In 1999 there were over one million tourist arrivals earning Costa Rica US$971.9 million, which is about 7% of the country's GDP[31]. The following figure shows the increase of tourist arrivals from 1989 till 1999.

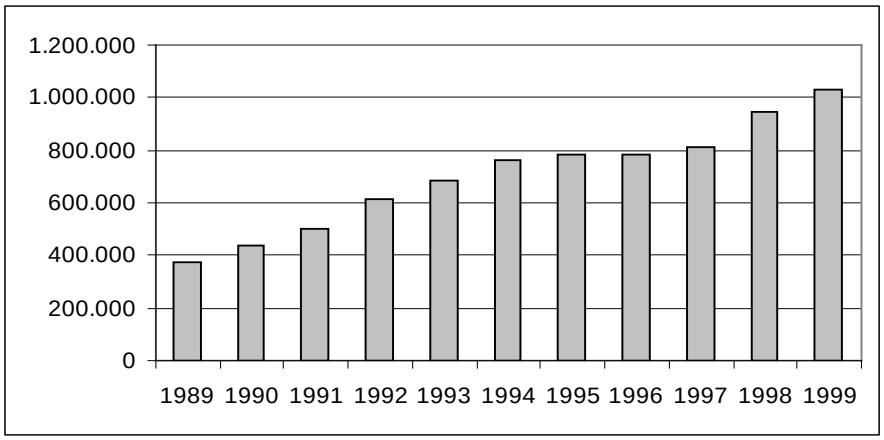


Figure 3.2 Tourist arrivals, 1989-1999
source: Instituto Costarricense de Turismo

There has also been a change in the pattern of nationalities of the tourists. In the 1980's around 45% had a Central-American passport. In 1992 this number had decreased to around 30%. The growth in

[31] ICT statistics, Tico Times, 7 July 2000

tourists arriving at the end of the 80's and beginning of the 90's has been caused for a large part by an increase in tourists from the USA, Canada and several European countries. This has made the tourist sector a more stable source of income for Costa Rica, but probably also true is that people from more wealthy countries expect higher levels of comfort leading to higher energy consumption in the tourist sector.
The age of the tourists visiting the country is also related to energy consumption. It is assumed that older people consume more energy than younger people because they request (and can also afford) higher levels of comfort. The table below shows that almost three quarter of the tourists coming to Costa Rica is 30 years or older. One third of all the tourists is 45 years or older.

Table 3.3 The age structure of the tourists

Age	%
15 - 30	26,0
30 - 45	40,8
45 - 60	24,4
60 and older	8,8

Source: ICT report, 2000

The longer tourists stay in the country the higher the demand for the tourist sector will be and that means a higher energy consumption in the hotels. The average stay of tourists in Costa Rica is 9 to 14 days (1993 information). A recent study by ICT[32] gave an average of 11,1 days for 1500 tourists interviewed indicating that the length of stay hasn't changed significantly. Europeans tend to stay a few more days than people from other areas.
In addition to knowing how many and what kind of people visit Costa Rica it is also important to see which areas they go to. This doesn't influence the total level of energy demand, but it can indicate regional differences in energy demand. The next table shows that of the tourists visiting the country more than 80% sleep at least one night in the Central Valley region. All other regions get visited overnight by just 5 to somewhat over 30 percent of the tourists. This is probably related to how people arrive in the country. Most tourists arrive by air on the international airport in the Central Valley region.

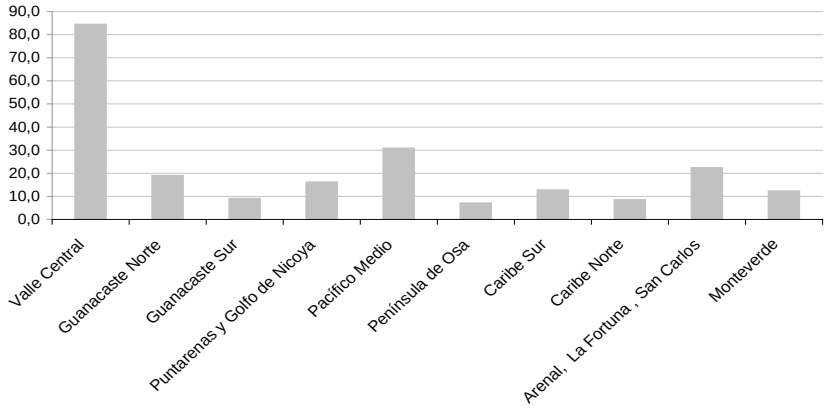


Figure 3.3 Region of stay (%, at least sleeping one night)

When looking at the figure representing the average nights spent in a certain region it can also be seen that when people stay in a certain region they stay at the hotel for a longer period of time. 7 out

[32] ICT survey on 1,500 tourists, 400 U.S., 400 Europe, 400 other parts of Latin America, 200 Canada, 100 other parts of the world over the period February, March 2000.

of the 10 regions have an average stay of more then 4 nights, with Guanacaste Sur even having an average of more then 8 nights.

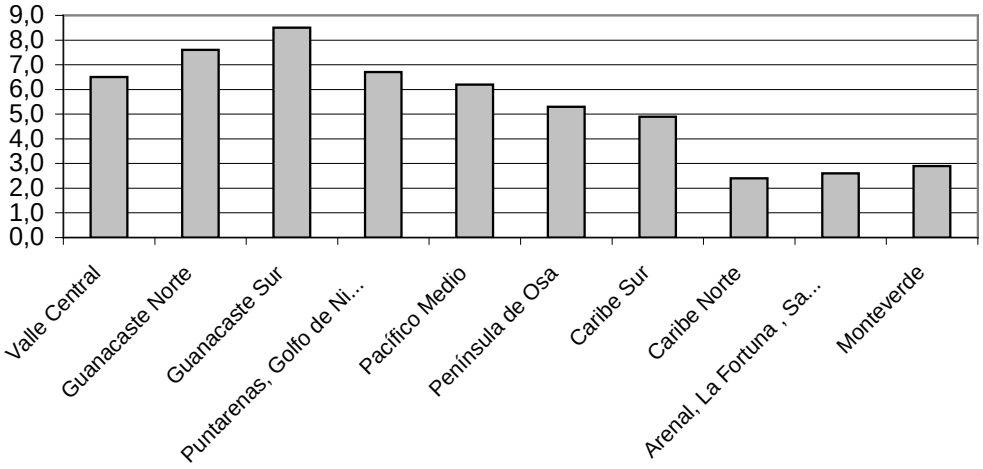


Figure 3.4 The average period for staying in a certain region at a hotel

The other 3 regions below 4 nights average are between 2 and 3 nights. An explanation for this is that are two groups of people. One group sleeps in San José making day trips after which they spend a few extra nights somewhere else. The second group of people arrive by air in the Central Valley, then stay there one or two nights after which they go to their place of destination for a longer period.

3.4 Hotels in Costa Rica

The Cámara Costarricense de Hoteles (CCH)

The CCH or in English the Costa Rican Hotel Association was founded in 1940. Today the organisation represents between 30 and 40% of the hotels listed under the hotels with a tourist accreditation[33]. The organisation tries to promote the continuing improvement and expansion of the Costa Rican hospitality industry through special interest programs, training activities, marketing initiatives, an annual congress and publications.

The organisation is active in some governmental committees, such as the National Tourist Assocation (Cámara Nacional de Turismo or CANATUR), the UCCAEP (Unión Costarricense de Cámaras y Asociación de Empresas Privadas) and the Commission on Tourist Human Resource Training (CHRT) to strengthen the position of the hotels in Costa Rica. Further it holds close contacts with the Instituto Costarricense de Turismo (ICT).

It is a member of international organisations related to tourism as well, of which the most important are the International Hotel & Restaurant Association (IH&RA) and the Central American Federation of Hotel Associations (FCAH).

A programme that has been developed by the CCH is the "Save the Planet" programme, which helps the owners of hotels to get their guests to save and recycle resources. This can have a positive effect on the conservation of energy in the hotels, but the program does not focus on energy consumption.

Characteristics of the Hotels in Costa Rica

Looking at the energy consumption in hotels in Costa Rica it is interesting to see what the characteristics of the hotel sector is. The number of hotels, the size and their location can give a valuable indication of the energy consumption in the hotel sector. Out of data from the ICT the following part can be derived.

The increase in the number of tourists stimulated the construction of many new hotels in the last 10 years. The number of rooms available in hotels with tourist accreditation increased from 5,289 in 1988 to 9,740 rooms in 1993 in 267 hotels and 13,388 at the end of 1997 in 345 hotels. In March 2000 there were 14,269 rooms in 365 hotels[34]. In 1998 there were another 1,400 hotels without tourist accreditation holding 14,671 rooms.

Table 3.4 below on hotel figures within different classifications tells that there has been an increase of hotels in all classifications[35]. The three smallest hotel categories increased by 102 where the three bigger categories increased by 22 hotel enterprises. The share in the number of rooms of the three largest categories has grown by 7.3% since 1992. In 2000 the three largest hotel categories held 46.5% of the total number of rooms.

Table 3.4 Data on the number of hotels and percentage of rooms within the different classifications.

Hotel figures	The size of the **241** hotels in 1992 (numbers / rooms (%))	The size of the **345** hotels end of 1997 (numbers / rooms (%))	The size of the **365** hotels in March 2000 (numbers / rooms (%))
Less then 20 rooms	109 / 16.5	148 / 16.0	153 / 14.1
20-40 rooms	75 / 25.1	117 / 25.3	122 / 24.7
41-60 rooms	33 / 19.2	38 / 14.0	44 / 14.8
61-100 rooms	10 / 8.4	18 / 10.3	19 / 10.7
101-200 rooms	8 / 13.6	14 / 13.4	17 / 16.5
More then 200 rooms	6 / 17.2	10 / 20.9	10 / 19.3

[33] A certificate handed out by the ICT to enterprises related to tourism that meet up to certain requirements. These rules don't involve any energy related items. In Spanish: Hospedaje con declaratoria turística

[34] Source: ICT, Hospedaje con declaratoria turística a Marzo 2000.

[35] Not a lot of information about hotels without accreditation was available, therefore from hereon the discussion concentrates only on the hotels with tourist accreditation.

Hotels can also be categorised according to the number of stars they have received. The number of stars is an indication for the level of service a hotel provides. The result of this is presented in table 3.5. This table shows that the biggest group is the group of hotels with 3 stars followed by hotels with 2 stars. There are only 10 hotels with 5 stars. The group 'other' refers to hotels that are closed temporarily because of renovation.

Table 3.5 Classification according to the number of stars (March 2000)

Number of stars	Number of hotels	Percentage of total
0	30	8,2%
1	66	18,1%
2	75	20,5%
3	120	32,9%
4	46	12,6%
5	10	2,7%
Other	18	4,9%
Total	365	100,0%

Looking at the location of the hotels table 3.6 shows that since 1997 no real significant changes have occurred.

Table 3.6 The percentage of hotels per province.

Province	Percentage of the hotels in 1997	Percentage of the hotels in 2000
San José	24.1%	22.7%
Alajuela	10.4%	12.1%
Cartago	1.5%	1.4%
Heredia	6.7%	6.3%
Guanacaste	24.4%	24.9%
Puntarenas	26.4%	25.8%
Limón	6.7%	6.9%

Comparing the number of rooms in the different provinces presented in table 3.7 with the number of hotels there some points can be said. San José and Heredia, two provinces in the Central Valley area, have percentage wise more rooms than hotels which means that in these provinces on an average the hotels are larger than in the other provinces. In Alajuela are the smallest hotels, because they represent 4% less in rooms than in hotels. Nevertheless the general picture remains the same. Three provinces, San José, Puntarenas and Guanacaste, are holding comparably more capacity than the others do.

Table 3.7 The percentage of rooms per province.

Province	Percentage of rooms in 1997	Percentage of rooms in 2000
San José	31.4%	29.0%
Alajuela	6.6%	8.1%
Cartago	0.7%	0.5%
Heredia	9.4%	9.4%
Guanacaste	21.2%	23.1%
Puntarenas	25.7%	25.0%
Limón	5.0%	4.9%

An important aspect that influences the energy consumption level in hotels is the occupation level, which is the number of rooms occupied relative to the number of rooms in a hotel. In figure 3.5 the

occupation rate of 23 hotels for the year 1998 and 1999 is presented. The average occupation rate over these two years was 52.0%. The period from January up till March shows higher occupation rates. This is the period in Costa Rica of the dry season, also called the summer season. This generally is said to be the high season for tourism.

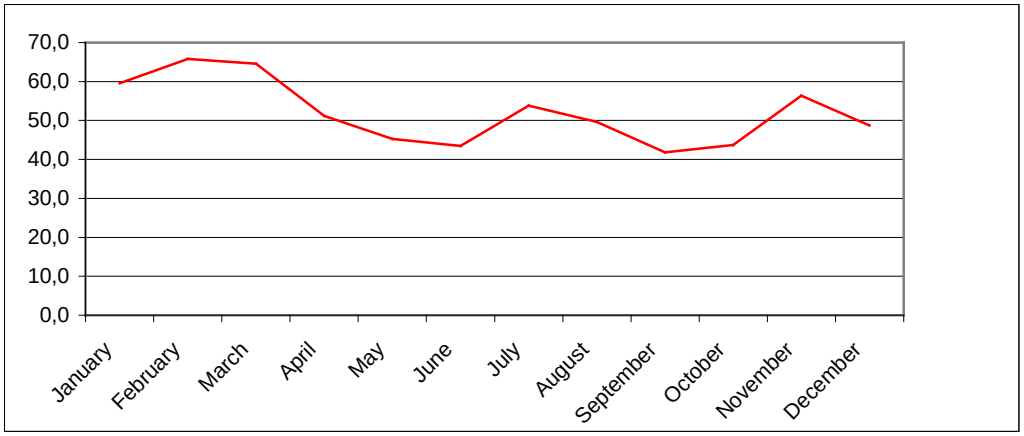


Figure 3.5 Occupation rate of 23 hotels in Costa Rica for 1998 and 1999

Holding energy consumption in mind, maybe even more important than knowing how many hotels there are and where they are located is knowing what type of facilities the hotels provide. It is assumed that there is a positive correlation between the number of facilities and the energy consumption.
Figure 3.7 shows the main facilities available in hotels in Costa Rica in 1993. The figure shows that hot water, a private bath, a laundrette and a restaurant or cafeteria are present in 80% or more of the hotels. In more than 60% of the hotels there is a fan in the rooms. Around 40% of the hotels provide air conditioning. It is probably safe to say that most of these hotels are located in the warmer areas of Costa Rica and that most of the hotels without air conditioning are located in the higher regions. Around 50% of the hotels have one or more swimming pools. Around 40% of the hotels provide a television, a conference room and a souvenir shop. Few hotels have a Jacuzzi or Sauna and even fewer have a gymnasium.

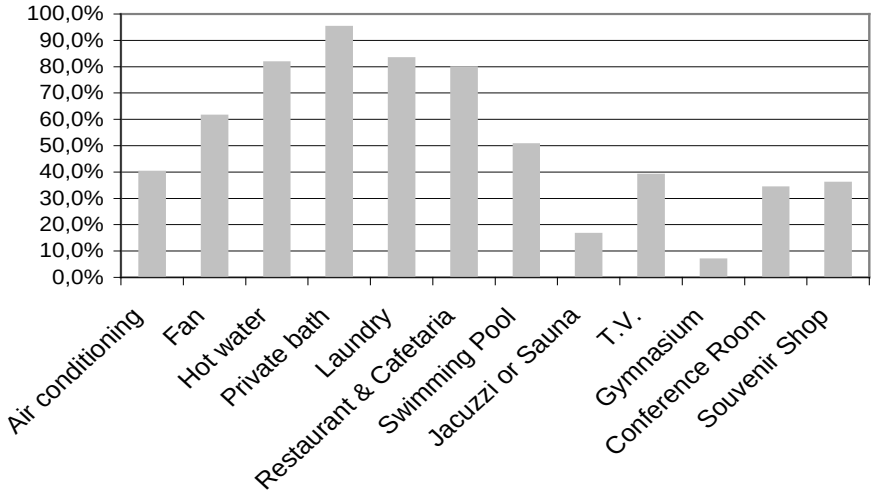


Figure 3.4 The percentage of hotels with the facility
Source: ICT, 1993

Air Conditioning in Hotels in Costa Rica

When inside conditions like temperature, humidity and purity of the air are not naturally what is desired it can be made that way by mechanical use. Such a mechanical system is called an air conditioning system. The primary function of air conditioning is to maintain conditions that are (1) conducive to human comfort, or (2) required by a product, or process within a space[36].
In an air conditioner, the air is cooled when it passes over refrigerant coils, which has fins similar to an automobile radiator. The compressor sends the cooled refrigerant through the coils, and cools the air as it is forced over the coils. A modern air conditioning system has a thermal efficiency or **E**nergy **E**fficiency **R**atio of between 2,64 and 2,93 which is defined as[37]:

EER = Heat absorbed by the air conditioner (Watts) / Energy use of the Air conditioner

A higher EER means higher energy efficiency so the purpose is to reach the highest achievable EER. According to literature in Costa Rica there are two main systems of air conditioning installed in hotels[38].

1. **The single unit**: The requirements of the unit depend on the amount of heat that has to be absorbed from an internal room in a certain period in a certain area. The consumption of electrical energy is amongst others related to the air temperature, the air circulation and thermal insulation of the room.

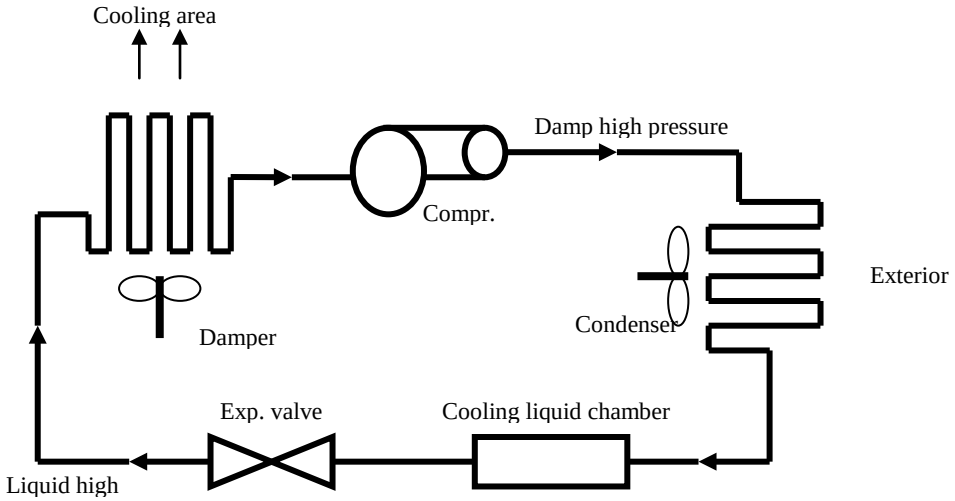


Figure 3.8 Single unit Air conditioning system
Source: Umaña, Alvaro y Selvo, Guillermo. Admnistración de la Energía. INCAE-BID EDUCA, Centro América, 1988

2. **A centralised unit**: A system where the cooling liquid water is cooled to low temperatures and is pumped around to the different places that need to be conditioned. The water goes through pipelines absorbing heat from air flowing around them. The system can be described by the following functions: Generation, a process of condensation, a process of cooling water and a process of air distribution.

36 Carrier corporation, 1960
37 For some situations in the USA an higher EER is already demanded.
38 Source: Paniagua Lopez, Claudia, Diciembre 1996

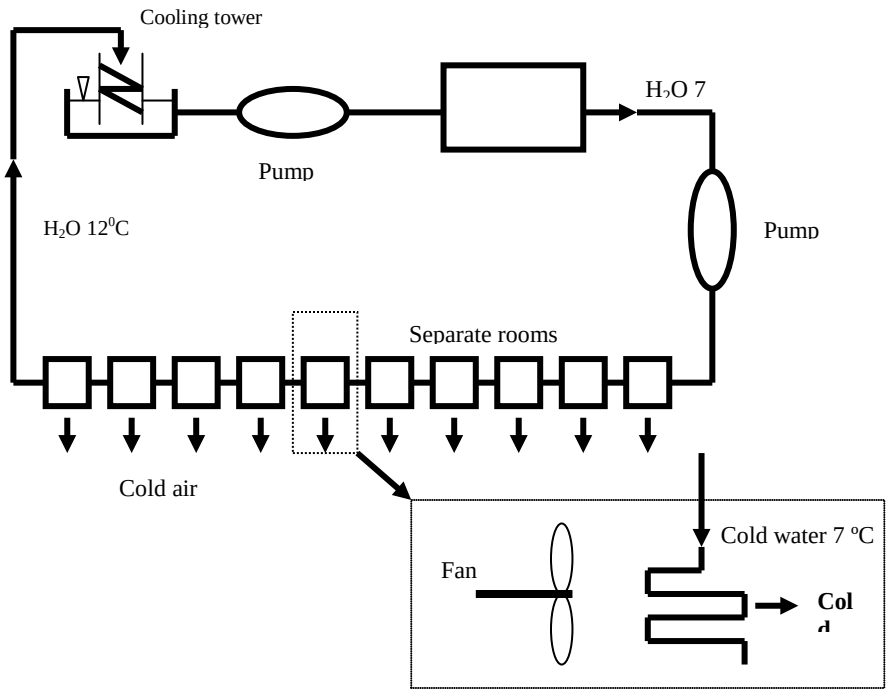


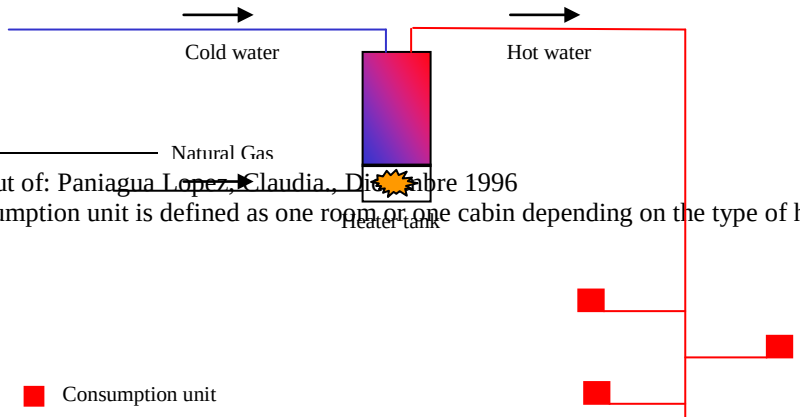
Figure 3.9 Centralised air conditioning unit
Source: Umaña, Alvaro y Selvo, Guillermo. Admnistración de la Energía. INCAE-BID EDUCA, Centro América, 1988

Water heating systems in hotels in Costa Rica[39]

Water consumption in hotels is concentrated especially in the rooms, the laundry areas and the kitchen. At these same locations warm water is consumed. Looking at the possible technologies of water heating, one way of categorising them is by looking at the energy source. Three important energy sources related to water heating are:

- **Electricity**: Electricity is often related to decentralised heating of water, but it is also used for centralised heating. Because of the high share of sustainable electricity generation in Costa Rica it is considered as a relatively clean way of producing heated water.
- **Gas**: The use of gas as the source of energy in Costa Rica has some advantages when comparing it with electricity. It is cheaper, it works quicker and maintenance of the system is easier. A disadvantage of using gas is that it is can not be considered as a sustainable production method.
- **Solar energy**: This is a sustainable solution that resets energy use other than solar to a minimum, especially when additional heating is not needed. Solar water heaters will be discussed in a separate section in this chapter more detailed.

Another way of classifying water heaters is by dividing them into centralised or decentralised water heaters. A decentralised water heater provides heated water to one consumption unit were a centralised unit provides heated water for more than one unit. The figure below is a representation of the principle behind a centralised heating system operating on gas[40].



[39] Parts were taken out of: Paniagua Lopez, Claudia., Diciembre 1996
[40] In this case a consumption unit is defined as one room or one cabin depending on the type of hotel

Figure 3.10 Centralised water heater on gas: more consumption units per heater

3.5 Evaluation of the Tourist Sector and Hotels in Costa Rica

In section 3.3 and 3.4 we saw that from 1989 to 1999 the tourist sector in Costa Rica has been growing tremendously. Due to the growth of the number of tourists more and more hotels are constructed. Almost 80% of all the hotels in 2000 do not have a tourist accreditation however. The 20% of the hotels with accreditation represent around 50% of all the rooms available in the country. The fact that so many hotels don't have a tourist accreditation might indicate that a lot of the hotels don't want to be forced by regulations related with the accreditation.

Information from 23 hotels about their occupation rate shows that these hotels operate at an average of half their capacity. Most machinery and equipment is designed to operate optimal for a certain capacity. Lower capacity utilisation might lead to lower energy efficiencies. This is important when choosing between a centralised or decentralised system, e.g. for air conditioning or water heating.

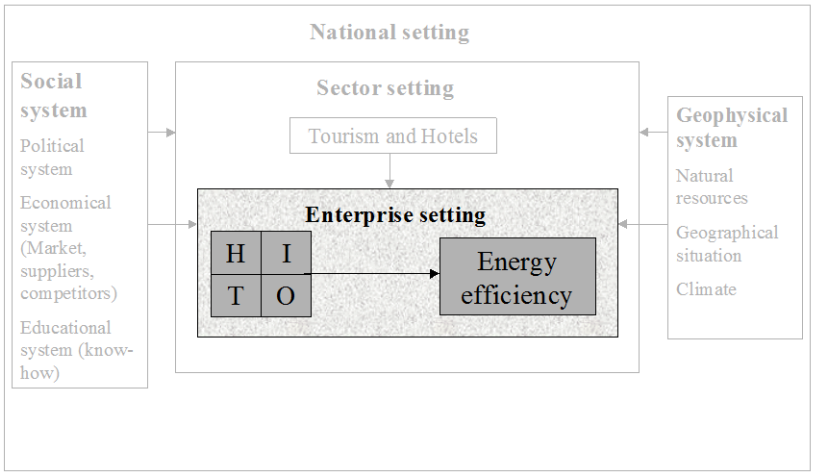
The information on the facilities gives an insight in the equipment that is responsible for the consumption of energy in the hotels. Combining this with the information on energy consumption in the residential and commercial sector leads to the conclusion that air conditioning, lighting and the restaurant and cafeteria together with the lighting (installed in every hotel) will be responsible for the main part of the electricity consumption in hotels. Closer investigation on enterprise level could affirm this. Information about refrigeration in hotels, responsible for significant part of residential and commercial energy consumption, is not available.

Water heating for showering or bathing (not for cooking), according to the CNFL does not represent a big percentage of electricity consumption. This might be because water heating in hotels is operated on gas more often than electricity.

One final remark is related to the young age of many hotels. Because many hotels are constructed in the last decade, installed equipment will be relatively new. The conclusion could be that modern technologies are installed. However, this also depends on whether the most appropriate technology is installed.

Chapter 4: Introduction to the Enterprise Level

After the introduction of the hotels in this chapter, the research results on enterprise level are presented in the next chapter. Before introducing the hotels, La Fortuna de San Carlos is introduced briefly to give an idea about the location of the hotels and local conditions. Also data is presented about the prices of energy in the region.



4.1 La Fortuna de San Carlos

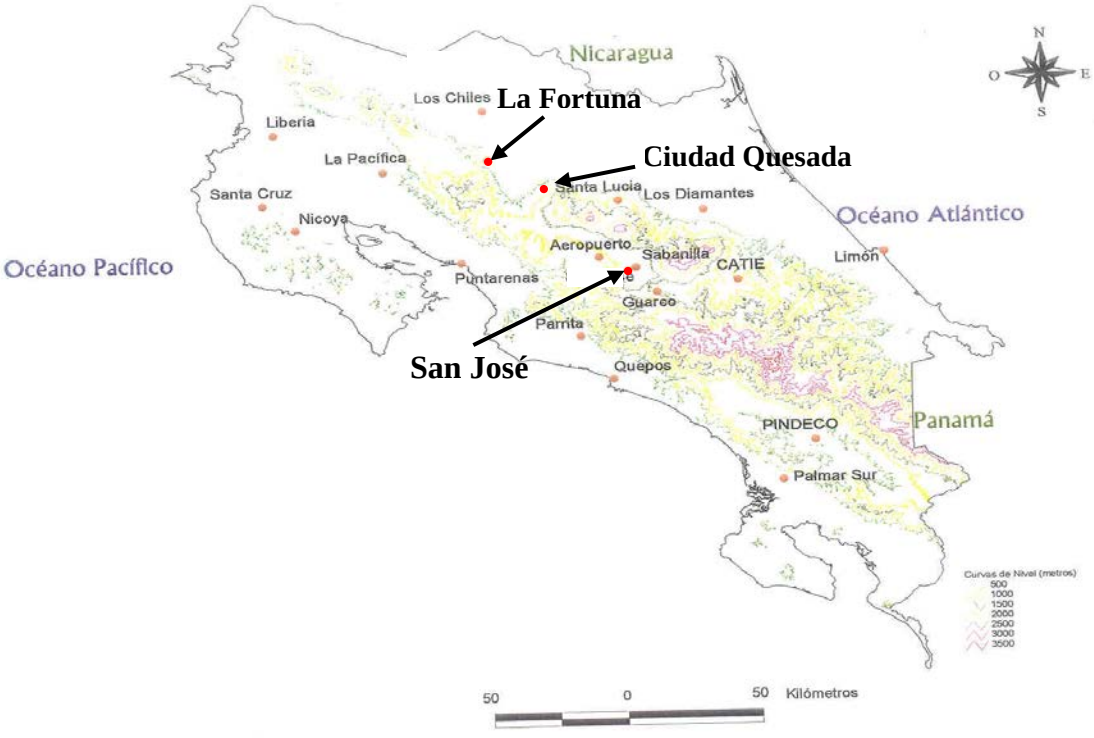


Figure 4.1 La Fortuna in Costa Rica. Source: Instituto Meteorologica Nacional

As can be seen on the map on the previous page La Fortuna is lying in the North of the country. It is in the canton San Carlos[41] of which the capital is Ciudad Quesada, a small city with around 50,000 inhabitants. La Fortuna itself has about 3000 inhabitants. It is located around 130 km North West of the capital of Costa Rica San José, at an elevation of 250 meters. On the East of La Fortuna there are the low lands, which go on all the way to the coast. On the West, at about 7km, is the volcano Arenál, which is part of the mountain range (the cordillera) that crosses Costa Rica from North to South. The volcano together with other sights has made this a very popular area for both Ticos[42] and foreigners. The town provides all facilities needed on a holiday. Road access to La Fortuna is good.

4.1.2 Energy Prices in La Fortuna de San Carlos

Coopelesca is the company distributing electricity in this area. Coopelesca has divided the electricity consumers into three main consumer types[43]:

- Residential: For houses and apartments that only serve as private living area.
- General: All consumers not being industrial or residential. Hotels should be classified into this category.
- Industrial: All consumers which have the objective of producing goods.

Prices for electricity are presented in table 4.1. It shows that prices for general consumers are the highest.

Table 4.1 Electricity Prices according to COOPELESCA R. L.

RESIDENTIAL	
First 30 kWh (colon)	375.00
Next 170 kWh (colon/kWh)	12.50
Next 200 kWh (colon/kWh)	18.40
Each additional kWh (colon/kWh)	31.00
GENERAL	
Consumer less than 3000 kWh per month	
First 30 kWh (colon)	995.09
Each additional kWh (colon/kWh)	33.17
Consumer higher than 3000 kWh per month	
For peak demand at one period of time during that month	
First 15kW (colon)	45,808.08
Each additional kW (colon/kW)	3,053.87
For each kWh consumed	
First 3000 kWh (colon)	61,236.20
Each additional kWh (colon/kWh)	20.41
INDUSTRIAL	
Consumer less than 3000 kWh per month	
First (colon)	859.01
Each additional kWh (colon/kWh)	28.63
Consumer higher than 3000 kWh per month	
For peak demand at one period of time during that month	
First 15kW	39,044.45
Each additional kW	2,602.96
For each kWh consumed	
First 3000 kWh (colon)	52,731.17
Each additional kWh	17.58

Source: Coopelesca, 2000

[41] Costa Rica is divided into 7 provinces in total consisting out of 81 cantons
[42] The popular name for Costa Ricans
[43] Source: Coopelesca, 2000

For the region around La Fortuna there are two main gas suppliers, Tropigas and Gazeta. Gas prices are presented in table 4.2. Prices differ little between the two suppliers.

Table 4.2 LPG prices	
Tropigas de Costa Rica S.A. (colon/litre)	104.82
Gas Nacional Zeta (colon/litre)	101.32

Source: Tropigas and Gazeta, 2000

4.1.3 Climate Conditions in La Fortuna de San Carlos

As mentioned, climate conditions have a big influence on energy consumption in hotels. According to data from the Intituto Meteorologica Nacional maximum temperatures in La Fortuna are an average of 29.7º C. From March till October it is slightly warmer, from November till February it is a little less warm. Minimum temperatures during the night are around 21º C, with slightly lower temperatures from December till April and slightly higher temperatures from May till November. Total average temperatures are 25.4º C.

The average yearly rainfall in La Fortuna is around 3500 mm. There is no real dry season in La Fortuna but the dryer period starts in January and ends at the end of April. The wet season lasts around 8 months, from March up till December with an average of more then 250 mm rainfall per month. Exceptional months are months with a rainfall of over 900 mm. This occurs only once every decade however.

There is an average 4 to 4.5 hours sun per day in La Fortuna. The map with information about the sun intensity in the appendix shows that La Fortuna is located in a region where the average sun intensity is between 1400 and 1500 kWh/m^2. The data about the sun intensity and hours of sun per day are important because it is essential for the feasibility of energy conservation opportunities like solar water heaters that they are high enough.

Because no data was available about humidity in the area of La Fortuna measurements have been taken during a week to get an indication of the humidity. During that week in November the relative humidity fluctuated between 50 and 100%. Maximum humidity periods occurred during day time and in the evening, while humidity went down during night time. More detailed information of these measurements is presented in section 4.7 and in Appendix VIII.

4.2 Introduction of the Hotels

Before presenting the hotels one by one some general information is given about the four hotels. The data presented in this and the following four sections is the result of the first and second step of the energy audit.

All hotels are located in or close to La Fortuna. The hotel furthest away from La Fortuna is located at a distance of 2 km from the town centre. In the table 4.1 the most important features of the hotels are presented.

Table 4.1 General Characteristics of the Four Hotels

	Hotel No.1 SB	Hotel No.2 CR	Hotel No.3 AR	Hotel No.4 AC
Number of stars	2	3	None[44]	3
Number of rooms	33 (and 2 in construction)	31 (6 more planned)	25	20
Private Bathroom	Yes	Yes	Yes	Yes
Laundrette	Yes	Yes	Yes	Yes
Swimming pool	Yes	Yes	Yes	Yes
Jacuzzi	Yes	-	-	-
Restaurant/bar	-	Yes	Yes	Yes
Souvenir shop	Yes	Yes	Yes	-
Prices per room per night (US$)	35-55	80 single, 12 for each additional person	30-50	70 single, 12 for each additional person

The main equipment installed in the rooms of the four hotels is presented in table 4.2.

Table 4.2 Facilities Available in the Rooms

	Hotel No.1 SB	Hotel No.2 CR	Hotel No.3 AR	Hotel No.4 AC
Warm water	All rooms	All rooms	All rooms	All rooms
Air Conditioning	20	-	17	All rooms
Fans	All rooms	All rooms	All rooms	-
TV	6	-	All rooms	-
Refrigerator	5	-	All rooms	All rooms

Numbers indicate the amount of rooms with the facility.

The data in the two tables gives an indication of the most important energy consumption centres in the hotels. Air conditioners are installed in three of the four hotels and three of the four hotels have a restaurant/bar. Also three of the four hotels have fans available in the rooms and three out of the four hotels have a refrigerator in the room. Only one hotel has a Jacuzzi. All the hotels provide warm water and have private bathrooms. With this information it is time to look at the hotels one by one.

[44] This hotel does not have a tourist accreditation. Hotels without it can not obtain stars for their level of service.

4.3 Hotel No1 SB

The first hotel is lying within the town of La Fortuna. The hotel owns two stars for their service level. The hotel consists of 7 buildings (5 can be seen on the map presented below). The reception, souvenir shop and two rooms on the second floor are located in the building close to the road south of the hotel (1). Another building contains 11 rooms (2) and there is a building with two floors holding in total 16 rooms and a Volcano watch on the third floor (4 & 5). At the back of the terrain there is a building with two small rooms and the launderette. At the time of visit a second floor was built on top of the launderette for two extra rooms and a conference/TV room. Near the swimming pool there is a building with a gym area.. Two houses belonging to the hotel are not on the map because they are located somewhat apart from the rest of the location. These two houses are for larger groups up to 8 people and are fully equipped with kitchen, living room and bathroom. In total this counts up to 31 rooms, 2 rooms in construction and two houses. All the buildings are constructed with concrete blocks.
The warm water is provided by a system of four water heaters operating on gas. The hotels was constructed in several stages. The first building dates from 1988.

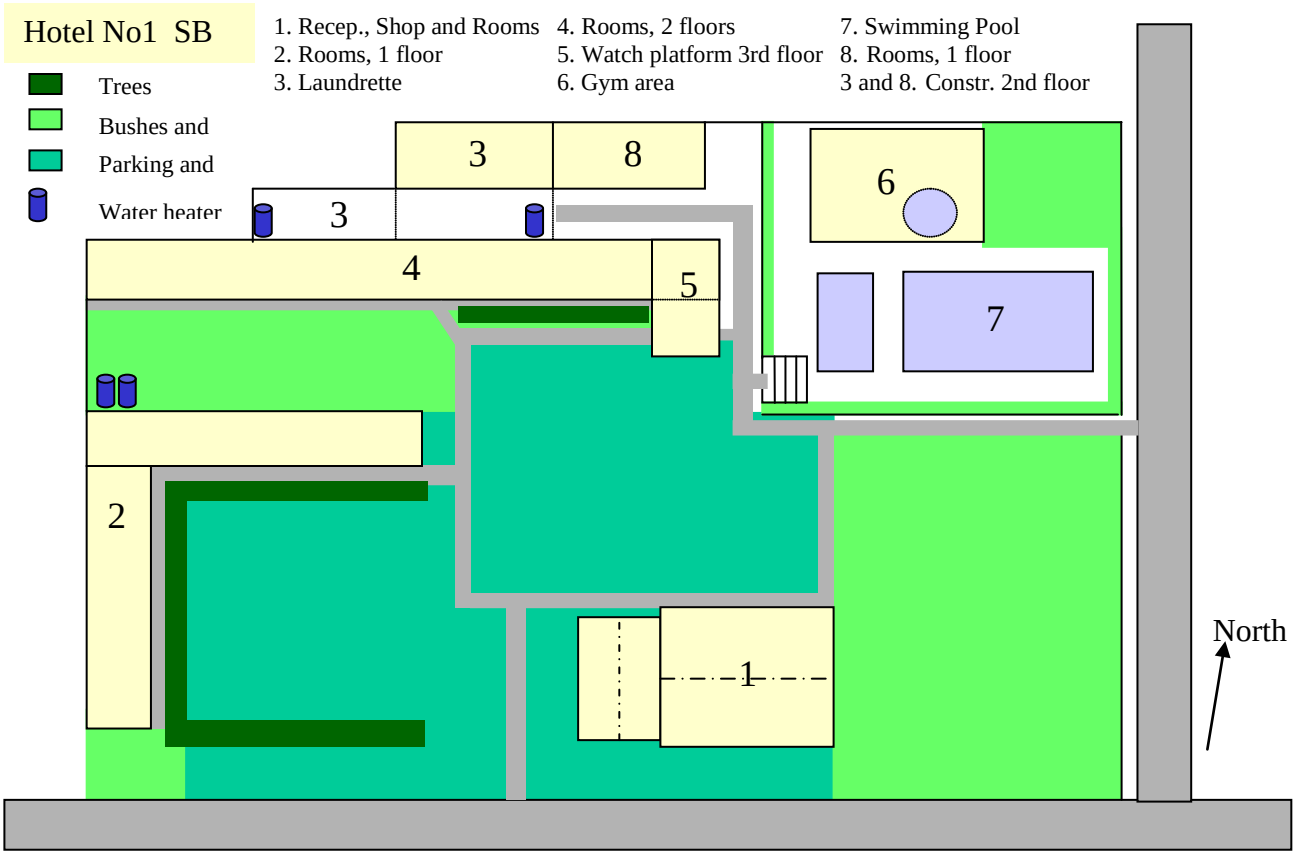


Figure 4.2 Map of Hotel No1 SB

Information about the electricity consumption of the hotel is presented in table 4.3. The number of groups refers to the number of meters the hotel has. All groups are registered separately by the electricity company. Not all groups of the hotel are classified into the same group of consumer type. Two groups are registered ‘general’ consumer and two groups as ‘residential’. More detailed information about the energy consumption is presented in appendix ‘energy consumption in the hotels’.

Table 4.3 Electricity Consumption by Hotel No1 SB (kWh)	
Average monthly consumption[A](kWh)	4008
Highest consumption (kWh)	5117
Lowest consumption (kWh)	3087
Number of groups	4

A: based upon 11 months of data given by Coopelesca.

The gas the hotel consumes is bought from the enterprise Gazeta. The hotel has a big gas tank with a capacity of 1500 litres. The average monthly gas consumption is about 977 litres, which is equal to about 330 US$. According to the owner there is little other energy consumption than electricity or gas.

4.4 Hotel No2 CR

This hotel is located west of La Fortuna and consists out of 31 cabins all standing apart from each other as presented on the map. The hotel opened in 1993 and was built in several stages.
There are plans to build an additional 6 in the near future just as a Jacuzzi. The plans for this project are almost ready and predictions are that in the year 2001 construction will start. Some characteristics of the hotel are: The facilities are located in several buildings. The restaurant is located near the entrance (1). The reception is located somewhat in the middle of the property in a building together with the souvenir shop and a volcano watch platform (2). The swimming pool area is right next to it. The cabins, in two sizes, can hold 4 to 6 people. Close to the swimming pool there is also a bar for drinks and where meetings can be held.
The cabins are all naturally ventilated, but do have a fan hanging on the ceiling. The warm water is produced by a system of water heaters operating on gas located as presented on the map.

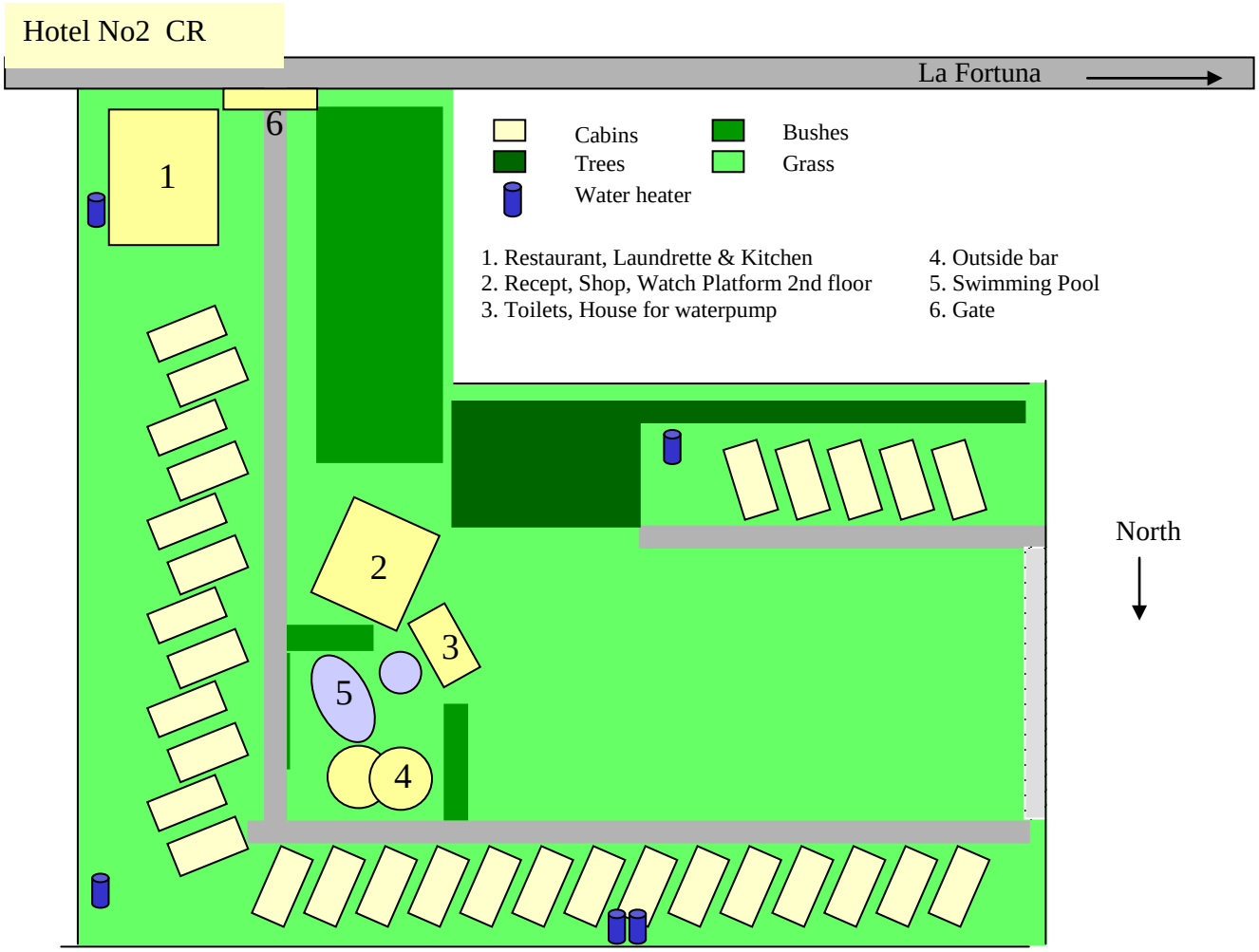


Figure 4.3 Map of Hotel No2 CR

This hotel has one electrical group, of which the data is presented in table 4.4. The group is registered as an industrial, which means that the owner has to pay industrial electricity prices. Because the electricity consumption is above 3000 kWh per month the maximum demand at one point of time during that month is also important. The price that has to be paid is based upon total demand (kWh) and maximum demand (kW).

Table 4.4 Electricity Consumption Hotel No2 CR	
Average monthly consumption[A](kWh)	10745
Highest consumption (kWh)	13137
Lowest consumption (kWh)	8404
Number of groups	1

A: based upon 13 months of data given by Coopelesca.

The gas that is consumed is supplied by Gazeta. The average gas consumption of the hotel is approximately 700 litres per month.

4.5 Hotel No3 AR

Hotel no.3 is located at 2 km east of town. This hotel does not have a tourist certification. The hotel was first opened in 1988. Just as the former two hotels it was built in several stages. The area consists of several buildings all with only one floor except for the platform. At the time of visiting construction of two rooms was taking place. The restaurant is located west of the area close to the road (2). The swimming area is on the back of the location (3). The hotel also has a small platform to watch the volcano (6).
There are 25 rooms. There are different room sizes. Part of the rooms have air conditioning. All of the rooms have a fan. The water is heated by a system of four water heaters operating on electricity.

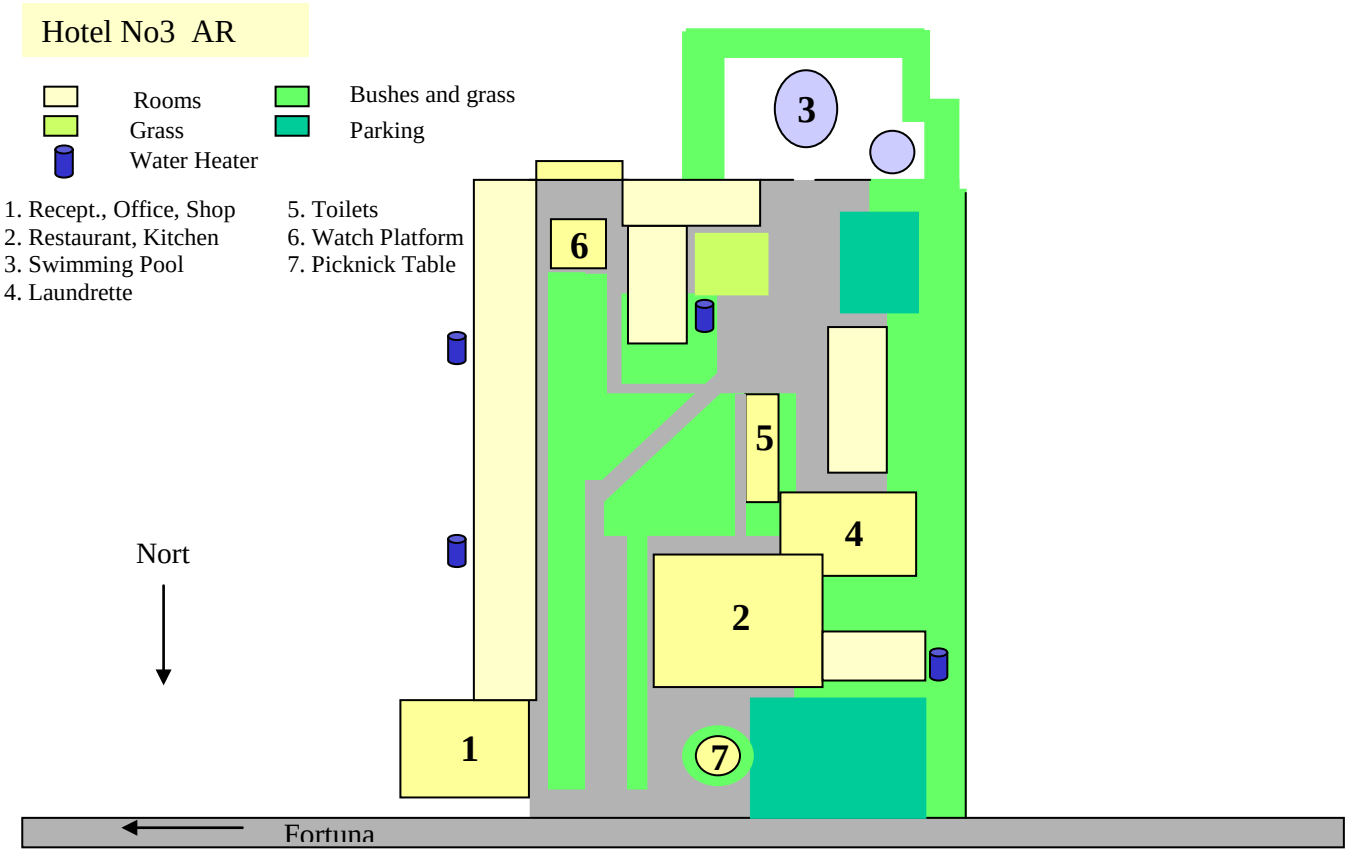


Figure 4.4 Hotel No3 AR

This hotel has four electrical groups. Table 4.5 is showing the consumption level of the hotel. One of the groups is registered as residential consumer and three groups are registered as general consumer. Because consumption stays below 3000 kWh for the individual groups the maximum demand at one period of time is not important.

Table 4.5 Electricity Consumption in Hotel No3 AR	
Average monthly consumption[A](kWh)	3168
Highest consumption (kWh)	4255
Lowest consumption (kWh)	2408
Number of groups	4

A: based upon 13 months of data given by Coopelesca.

Because the hotel has a water heating system operating on electricity the gas is consumed mainly in the kitchen and by the dryers for the laundry. The hotel has one tank of 450 litres. The gas is supplied by Tropigas. Monthly consumption in the hotel is about 84 US$, which is equivalent to 240 litres of gas.

4.6 Hotel No4 AC

This hotel started operation in 1999 and the cabins and conference building were all constructed in 1998. The terrain originally was a farm and the buildings containing kitchen, laundry, reception etc. are from that time (1, 2 & 3). The conference room can hold up to 40 people (6). The cabins all hold two rooms. The rooms are equipped with an air conditioner and all the bathrooms have their own electrical water heating system. All the rooms are exactly the same. Up to four people can sleep in one room.

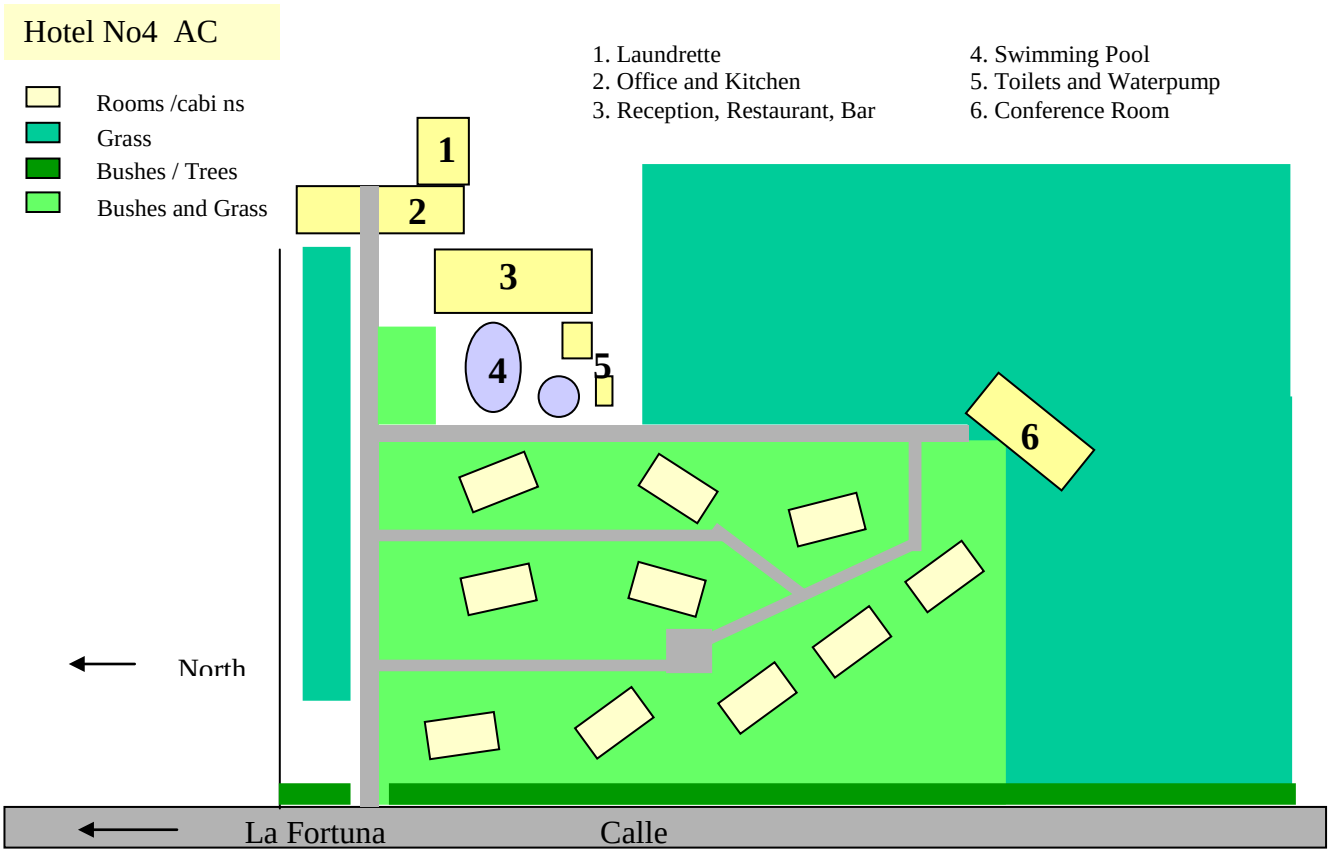


Figure 4.4 Hotel No4 AC

This hotel has four electrical groups. Data about the consumption is presented in table 4.6. Two of the four groups are registered as residential and two are registered as general. None of the groups has an average monthly consumption above 3000 kWh, which makes the maximum demand unimportant. The hotel is consuming gas only for cooking. Tropigas is supplying the gas

Table 4.6 Electricity Consumption in Hotel No4 AC	
Average monthly consumption[A](kWh)	5762
Highest consumption (kWh)	7594
Lowest consumption (kWh)	3730
Number of groups	4

A: based upon 10 months of data given by the hotel.

4.7 Measurements of Climatic Conditions in and Around the Hotels

During the visit of the hotels measurements were taken of internal and external climatic conditions to find out what type of conditions there were in and around the hotels. This was done with a climatic station called the Monitor II. External climate conditions were measured at the hotel terrain in the shadow at a height of 1.5 meters. Measurements taken in hotel no1 SB were lost because of power failure. A description of the measurements is presented in this section. In Appendix VIII the figures resulting from the measurements are presented.

4.7.1 Hotel No2 CR

Outside relative humidity[45] stayed between 70 and 100%. Inside humidity stayed between 74 and 100%. Higher humidity occurred during night time and in the morning.
Outside temperatures varied between 29 ^{o}C and 21 ^{o}C juste as inside temperatures.
The barometer showed a sinus rhythm between 744 and 740.5 mm Hg pressure with a period of 12 hours.
During the two days of measurement it was raining a lot of the time and there was no sun.

4.7.2 Hotel No3 AR

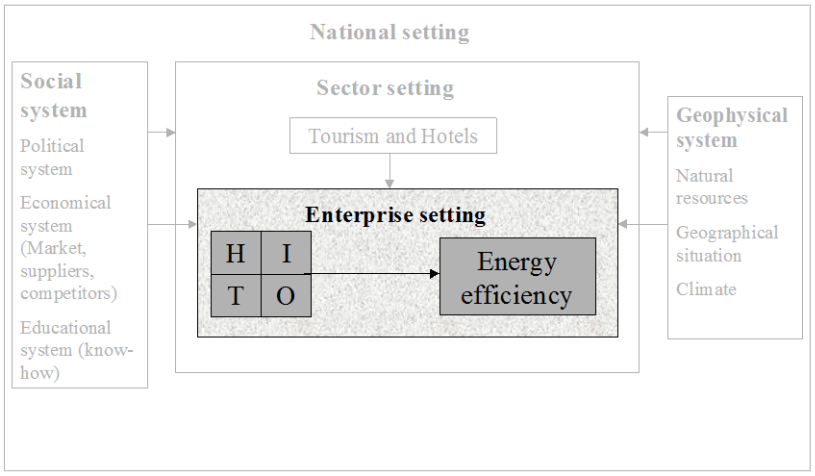
The outside relative humidity stayed between 98 and 81%. Inside humidity stayed between 94 and 81% staying behind the trend of outside humidity.
The outside temperature profile varied from 26.5^{o} C to 22 ^{o}C where the inside temperature stayed between 26.5 ^{o}C and 23.5 ^{o}C.
The barometer measurements showed a sinus rhythm between 734.5 and 730.5 mm Hg.
During the two days of measurement there was little sun and it rained frequently.

4.7.3 Hotel No4 AC

Outside of relative humidity during two days of measurements balanced between 51 and 93%. Inside humidity stayed between 64 and 87%. Higher humidity occurred during night time and in the morning.
Outside temperatures varied between 34^{o} C during daytime and 23^{o} C at 5:00 am. Inside temperatures stayed between 31^{o}C and 26 ^{o}C.
The barometer stayed between 740 and 736 mm Hg. The barometer moved up and down with a period of 12 hours.
It was dry during the two days of measurements and there was a lot of sun.

[45] Relative humidity: The amount of water vapour in the air, divided by the maximum amount of water vapour the air can hold, given the current temperature.

Chapter 5 The Enterprise Setting



In this chapter the results of the research on enterprise level are presented. The four process technology components out of the theoretical framework are reviewed. In the first section the results of the research about the humanware, infoware and orgaware are presented. In section 5.2 the technoware results are presented. The four process technologies are already defined in chapter two, but for convenience they are mentioned again:

Humanware: All persons operating or working with the equipment installed at the hotels:

- The employees at the hotel including the owner.
- The tourists spending the night in the hotels.
- Possible external people involved.

Orgaware: The organisation structure of the hotel, e.g. the organisation of maintenance, responsible persons and possible external people involved.

Infoware: The availability, accessibility and quality of information to the people involved related to the energy efficient use of the equipment and availability of energy efficient equipment.

Technoware: Characteristics of the installed equipment, type of processes used, energy efficiency, energy consumption.

5.1 The Humanware, Orgaware and Infoware

An overview of the three factors of the process technology is presented in the table below. In Appendix IX a more elaborate description of these three factors is given.

Table 5.1 Overview of the Humanware, Orgaware and Infoware in the Hotels

	Hotel No.1 SB	Hotel No.2 CR	Hotel No.3 AR	Hotel No.4 AC
Humanware	• 12 employees • manager: Primary education • Others: Secondary or primary education • On the job training	• 24 employees • manager: Tertiary education • Others: From primary to tertiary education • Courses for personnel	• 9 employees • manager: Secondary education • Others: Secondary or primary education • On the job training	• 10 employees • manager: Tertiary education • Others: Secondary or primary education
Orgaware	• Low organisation structure. • Personnel responsible for more than one task • Maintenance internal	• Higher level of organisation. • Management and administration separate from other work. • Maintenance partially external	• Low organisation structure. • Personnel responsible for more than one task • Maintenance internal	• Higher level of organisation. • Separation between management type of work and other work • Maintenance internal
Infoware	• Computer, entrance to Internet • No maintenance registration • Manuals hardly used or kept	• Computer, entrance to Internet • Participates in a sustainability program • No maintenance registration • Manuals kept after installing equipment but not used much	• Computers, entrance to Internet • No maintenance registration • Manuals kept after installing equipment but not used much	• Computers, entrance to Internet • No maintenance registration • No manuals (very new equipment)

To find out what the attitude of the manager was towards energy conservation opportunities the following two questions were asked:

- They were asked about the acceptable pay-back periods for an investment. As can be seen in table 5.2 three out of the four hotels expected an investment to pay itself back within four years. The fourth manager expected a pay-back period within 5 years.

Table 5.2 Acceptable Payback Periods

	Hotel 1 SB	Hotel 2 CR	Hotel 3 AR	Hotel 4 AC
Acceptable payback period	< 4 years	< 4 years	< 5 years	< 4 years

- The were also asked what the objective of the hotel enterprise was in relation with energy. In table 5.3 the results are presented.

Table 5.3 The Importance of Energy Consumption in the Hotels				
	Hotel 1 SB	Hotel 2 CR	Hotel 3 AR	Hotel 4 AC
Objective in relation with energy consumption	To optimise the consumption in order to lower the costs	To lower the costs of energy consumption by replacing inefficient equipment	To save on energy as much as possible	Energy consumption is considered a key element for the hotel from economic point of view

Because good maintenance is considered to have a positive effect on energy consumption, information was gathered during the interview about the different types of maintenance performed, by whom, on what equipment and how often. Before presenting the results, the three different types of maintenance are defined.

- Corrective maintenance: Maintenance performed when actual malfunction has occurred. Only the actual malfunction is repaired.
- Preventive maintenance: Maintenance performed to prevent malfunctioning and to prolong the lifetime of equipment. An example of this type of maintenance is cleaning and checking of parts. This type of maintenance is done regularly, e.g. once or twice a month.
- Predictive maintenance: When equipment or parts of equipment is replaced after a certain amount of operating hours determined based upon historical performance.

The results of these questions are presented in table 5.4

Table 5.4 Maintenance Performed in the Hotels				
	Hotel no.1 SB	Hotel no.2 CR	Hotel no.3 AR	Hotel no.4 AC
Responsible person[a]	Internal	Part internal part external	Internal	Internal
Corrective maintenance	Repaired within 7 days	Repaired the same day	Repaired the same day	Repaired the same day
Preventive maintenance	- The pump for the Jacuzzi 4 times a year - Air conditioners once a year	Once a month per type of equipment	Once a month per type of equipment	- Showers: twice a month - Air conditioners once a year
Predictive maintenance	No	No	No	No

a: internal refers to employers working at the hotel, external refers to an external contract

5.2 The Technoware

In this section of chapter 5 the technoware related to the different processes is presented. They are presented one facility at a time.

5.2.1 Air Conditioning

In table 5.1 the most important data directly corresponding to the air conditioners in the four hotels is presented. Information about energy consumption was taken from the air conditioners labels or manuals available at the hotels. The table shows that most air conditioners were purchased in the second half of the 1990s. Most of the air conditioners have a cooling capacity of 2,93 kW.

Table 5.5 The Air Conditioners in the Hotels

	Hotel No1 SB	**Hotel No2 CR**	**Hotel No3 AR**	**Hotel No4 AC**
Quantity	20	0	17	20
Brand name and cooling capacity (number between brackets)	Carrier (12): 2,93 kW Amana (8): 2,93 kW		Sharp (3) : 2,93 kW LG (6) : 2,34 kW Daewoo (3) : 2,64 kW Panasonic (2): 3,22 kW Goldstar[a] (3) : 2,49 kW	York: 2,93 kW
Type	Single Unit window air conditioners		Single Unit window air conditioners	Single Unit window air conditioners
Energy Consumption when operating at maximum (kW)	Carrier: 1,1 Amana: 1,2		Sharp: 1,1 LG: 0,9 Daewoo: Na Panasonic: Na Goldstar: 1,0	1,1
Year of purchase	Carrier: 1996 Amana: 1995		Sharp: 1998 LG: 1997 Daewoo: 1995 Panasonic: <1994 Goldstar: <1994	York: 1998
Location features	• In the walls. • Some catch direct sunlight during parts of the day. • Different installation heights: close to floor and close to ceiling • Air inlets are obstructed by furniture		• In the top of a window frame • All are protected by an overhanging roof from direct sunlight sun	• In the bottom of a window frame • During parts of the day they catch direct sunlight

Na = no data available
a: Goldstar is the old brand name of LG

From the table it can be seen that all three hotels had the same type of air conditioner. In figure 5.1 the most important parts of these air conditioners is presented.

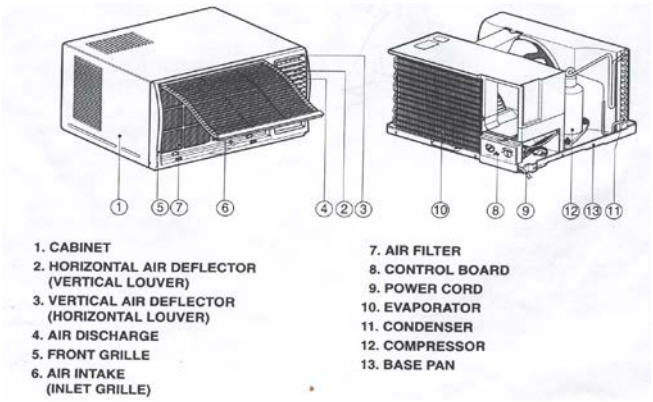


Figure 5.3 Parts of a window type air conditioner as installed in the hotels in La Fortuna de San Carlos. Source: LG manual, 1996

In table 5.5 the EER of the air conditioners is presented. The table tells us that 3 out of the 6 air conditioners for which data is available has an EER higher than 2,64.

Table 5.6 Air Conditioners Energy Efficiency Ratio	
Air conditioner type	**EER**
Carrier (hotel no1 SB)	2,66
Amana (hotel no1 SB)	2,44
Sharp (hotel no3 AR)	2,66
LG (hotel no3 AR)	2,60
Daewoo (hotel no3 AR)	NA
Panasonic (hotel no3 AR)	NA
Goldstar (hotel no3 AR)	2,49
York (hotel no4 AC)	2,66
NA = not available	

The air conditioners can be operated the same way. They all have a control panel with two control knobs:

- Thermostat control knob: The thermostat can be set higher or lower where higher numbers are related to lower temperatures. None of the air conditioners indicate real temperature settings.
- Selector control knob: With the selector knob the air conditioner can be put in only fan or fan and cooling. All air conditioners have three cooling settings: low, medium and high speed. All the air conditioners except the York and the LG, have two fan speed settings without cooling. The York air conditioners have three fan speed settings and the LG in hotel no3 AR have only one.

In table 5.6 the conditions influencing the demand for air conditioners is presented. The hotel without air conditioners has constructed the cabins in such a way that according to the manager natural ventilation creates enough cooling. Especially the windows without the glass influence the inside conditions, because they create natural ventilation.

Table 5.7 Characteristics of the Rooms in the Hotels related to Air Conditioning Demand				
	Hotel no.1 SB	Hotel no.2 CR	Hotel no.3 AR	Hotel no.4 AC
Smallest room-largest room (m^2)	12-17	13-17	12-17	17-17
Colours of Wall/ ceiling	White/white	Brown/Brown	White/Brown and white	Yellow and white/White
Construction material	Concrete blocks	Wood, bathroom concrete blocks	Concrete blocks	Concrete blocks
Roof type	Corrugated plastic/iron	Clay roof tiles	Corrugated iron	Corrugated iron
Number of windows	1	>5	1-2	4
Type of windows	Single layer and as presented in figure 5.1	No glass, just mosquito protection	Single and as presented in figure 5.1	Single and as presented in figure 5.1
Total surface area windows (m^2)	2.5	>5	2-4	5
Doors	1	1	1	1
Other characteristics	• Fan • Overhanging roof • Natural shadow by trees • No window or door insulation	• Fan • Overhanging roof • No window or door insulation • Standing on concrete pillars	• Fan • Overhanging roof • No window or door insulation	• Overhanging roof • Thick curtains • No window or door insulation

All three hotels have the same type of windows. The mechanism to open these windows is presented in figure 5.4.

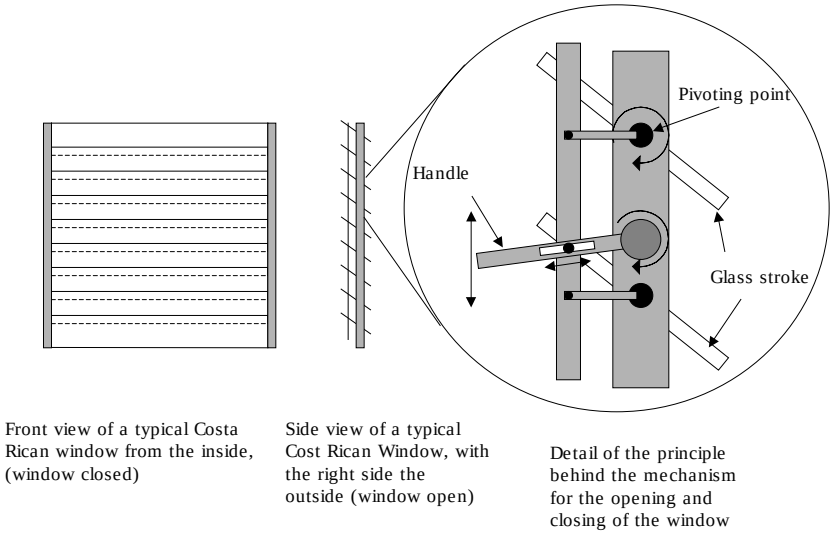


Figure 5.4 The window mechanisms for opening the windows.

5.2.2 Water Heating in the Hotels

When looking at the warm water supply in the hotels, three of the four hotels use a centralised heating system with tanks where the water is heated. These three hotels have 1 tank per 6-8 rooms with a capacity varying between 106 and 200 litres. One hotel has decentralised water heating. Every single room has its own heater unit and the water is heated at the point of demand without a reservoir tank. The energy sources used are electricity or gas. The decentralised system operates on electricity.

As can be seen in table 5.8 is that none of the water pipes are insulated.

According to the owners the showers in the bathrooms in all four hotels are water inefficient. Efficient showers use up to 30% less water and thus 30% less heated water as well. The two hotels that provide heated water in the lavatory have inefficient faucets. The same efficiency improvement as for showers applies for faucets[46].

[46] Efficiency here is related to the level of comfort. Efficient faucets use less water than inefficient faucets but produce the same comfort level. The same applies to showers.

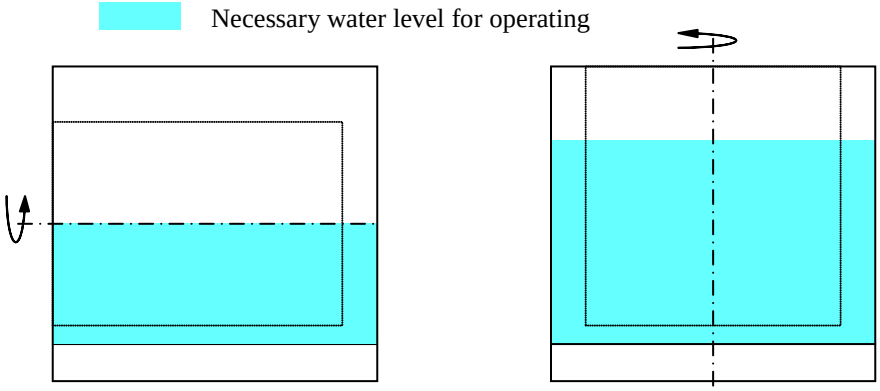
Table 5.8 The Water Heating Systems in the Hotels				
	Hotel No1 SB	Hotel No2 CR	Hotel No3 AR	Hotel No4 AC
Brand	Cal-o-Rex	Cal-o-Rex	Trav-o-Matic	Atmor
System	Centralised	Centralised	Centralised	Decentralised
Year of purchase	1995	1996	1988 / 1992	1998
Energy source	LPG (gas)	LPG (gas)	Electricity	Electricity
Water heaters	4	5	4	20
Energy consumption per water heater	12000 kcal/hour = 13.9 kW	8900 kcal/hour = 10.3 kW	3 kW	3 kW
Maximum hydrostatic operating pressure	6.5 kgf/cm^2	6.5 kgf/cm^2	100-120 PSI	/
Minimum operating efficiency	65%	65%		
Water tank capacity per heater system (litres)	200	106-132	114-152	/
Other features	- No insulation water pipes - Inefficient shower - Inefficient faucet	- No insulation water pipes - Inefficient shower - Inefficient faucet	- No insulation water pipes - Inefficient shower	- Inefficient shower

5.2.3 The Launderette

A facility that many hotels have is a launderette. In this research two types of processes in launderettes were examined: washing and drying of laundry.

Washing machines

Washing machines can be classified into Front loaders and top loaders. Another classification is into Horizontal axis or Vertical axis washing machines after the axis of rotation. The principal is presented in the picture below. Research has shown that average water saving lies between 30 and 40 percent and when hot or warm water is used to do the washing around 1 kWh per wash load is saved[47]. When only cold water is used the energy savings are no longer significant.



Horizontal Axis or Front load Washing machine

Vertical Axis or Top load Washing machine

Figure 5.6 The principal behind the two different types of cloth washers

[47] Lawrence Berkeley National Laboratory, Environmental Energy Technologies Division Technology and Market Assessment Group prepared for U.S. department of energy, April 1998.

Drying of the Laundry

When looking at drying of the laundry it can be done in two ways:

Mechanically, by producing heated air which then is blown over the wet laundry.

- Naturally by hanging the laundry on a line.

Research in the United States has shown that there is little difference between the different types of mechanical dryers from energy consumption point of view. However the difference between mechanically and naturally drying is of course tremendous.

5.2.3.1 The Launderettes in the Hotels

The Washing Machines

All the hotels have a launderette with two or more washing machines. In the table below an overview of the type of washing machines in the hotels is presented.

Table 5.9 Washing Machines in the Hotels

	Hotel 1 SB	Hotel 2 CR	Hotel 3 AR	Hotel 4 AC
Horizontal axis	1	1	-	2
Vertical axis	3	1	2	-

Two of the vertical axis washing machines in hotel 1 are working with cold water only. In Costa Rica many of the washing detergents are appropriate for cold water use. The detergents are made in such a way that when getting in contact with water a reaction takes place that produces heat that makes the detergent active.

Figure 5.10 Washing MachineCharacteristics

Hotel	**Washing machine**	**Maximum load (kg)**	**Maximum power demand**	**Other information**
Hotel no.1 SB	Electrolux wascator	23	2,8 kW	- Front loader
	No data available	No data available	No data available	No data available
	General Electric	6	0.5 kW	- Top loader - Cold water
	Goldstar	6	0.7 kW	- Top loader - Cold water
Hotel no.2 CR	Unimac tipo Unimat 25	11	1.7 kW	- Front Loader
	Whirlpool Heavy Duty	9.8	1.4 kW	-Top Loader
Hotel no.3 AR	Magic Chef Heavy Duty	9.8	1.4 kW	- Top Loaders
Hotel no.4 AC	Whirlpool	0.85 m^3	1.2 kW	- Top loaders - Only wash with cold water according to manager

Drying of Laundry in the Hotels

Two of the four hotels have an area were they can dry the laundry naturally. Both of these areas are roofed-in. One owner built this area especially for the drying of the clothes. He used corrugated iron as a roof to capture the heat so the drying time is very quick. The areas are used as often as possible. Because of very humid seasons however the laundry does not always dry quick enough. Therefore these two hotels also have tumble driers as the other two hotels. Information about the driers is presented in table 5.11.

Table 5.11 Data about the Driers				
	Drier	Capacity (kg)	Energy demand	Others
Hotel no.1 SB	Prodry Cook	?	1.9 kW	Front loader
Hotel no.2 CR	Cissell	?	0.8 kW	Front loader
Hotel no.3 AR	Magic Chef Heavy Duty	9.8	1.0 kW electricity or 18,9 MJ/hr gas	Top loaders
Hotel no.4 AC	Whirlpool	?	1.2 kW	Top loaders

5.2.4 Lighting[48]

Lighting is responsible for a significant percentage of the electricity consumption in households and commercial sectors[49]. Before looking at the lighting in the hotels some theory behind lighting is explained.

To light a space we can either use natural sunlight or artificial light. Light is a type of electromagnetic radiation with a certain wavelength and frequency, just like radio waves or microwaves. The spectrum human beings can see is called "visible light". This light falls between infrared and ultraviolet light has a wavelength of between 400 and 700 nanometers (10^{-9}) approximately. The main colours of visible light are the same as in a rainbow: red, orange, yellow, green, blue, indigo and violet. White light is a mixture of these lights.

Light intensity is measured in Lumen. Lamps are also rated in lumen. How much wattage a lamp consumes to produce this amount of lumen is a matter of the efficacy (defined somewhat further). The distribution of light on a horizontal surface is called its illumination and is measured in meter-candles.

A meter-candle of illumination is a lumen of light distributed over a 1-square-meter area.

According to the Illuminating Engineering Society the following amounts of illumination are sufficient for the following situations:

- 2.7-4.5 meter-candles: most home and office work
- 18-45 meter-candles: difficult and lengthy visual tasks
- 0.5-1.8 meter-candles: for security, safety or visual comfort, when no seeing task needs to be performed.

Another categorisation related to the use of light is the one into ambient, task and accent lighting. Ambient lighting provides security and safety, but is also good for performing daily activities. It is more or less equivalent to 0.5-4.5 meter-candles range.

When we have enough lighting to complete tasks accurately without illuminating entire areas we can talk about task lighting. This is the 18-45 meter-candles category.

Accent lighting is for illuminating walls to blend more closely with naturally bright areas like ceilings and windows.

Another unit of measurement is efficacy, which is the ratio of light output from a lamp to the electric power it consumes and is measured in lumens per watt (LPW). In formula

Efficacy = Lumen produced by the lamp / Electrical power consumed by the lamp [LPW]

At the moment there are four basic types of lights on the market:

- **Incandescent lamps**

These are the most generally used lamps. In general they are also the least expensive to buy, but have the lowest efficacy of all types. Another shortcoming of these lamps is that their lifetime is shorter than of all the other types. The three most common types of incandescent lamps are the

[48] Partially from the source: http://www.eren.doe.gov/erec/factsheets/eelight/html

[49] Research in the USA confirms this because research showed that in the USA lighting is responsible for 5 to 10% of the households energy budget, while commercial establishments consume 20 to 30% of their total energy just for lighting.

standard incandescent (the A-type), tungsten halogen and reflector lamps. A tiny coil of tungsten wire that glows when it is heated by an electrical current produces the light in this type of lamp. Only around 10% of the electricity is actually being transformed into visible light. The other 90% is converted into heat, making it actually more a heat source than a light source.

- **Fluorescent Lamps**

Fluorescent lamps last about ten times longer than incandescent. The most common place to use fluorescent lamps is indoors. They are about 3 to 4 times as efficient as incandescent lamps, and they are especially more efficient at places where light is needed for several hours in a row. Letting them on for fewer hours in a row actually shortens their lifetime, measured in hours of working. To use fluorescent lights you also need an energy consuming ballast, which is a device controlling the electricity used by the lamp, for starting and circuit protection. The modern ballasts switch the light on and off more than 25,000 times per second making it look like a serene light. An electric current conducted through mercury and inert gases produces the light. By using three different phosphors the fluorescent lamps produce a natural, white looking light. Because of the mercury the fluorescent lamps need to be gathered separately from other garbage.
There are several types of fluorescent lamps of which the tube is the most popular. The compact fluorescent lamp (CFL) is the most significant lighting development in recent decades. These lamps use incandescent fixtures but have the high fluorescent efficiency and lifetimes of 10 to 15 times that of the incandescent type. This means that CFLs can replace incandescents that are roughly 3 to 4 times their wattage, resulting in an energy saving of up to 75% of the initial lighting energy. The size of CFLs has been decreasing to almost as small as the incandescent lamps in the last decade. Purchase costs are 10 to 20 times more than for the incandescent lamps but are getting lower slowly. This means that depending on the prices of energy relative to the purchase costs, CFLs will be cheaper or more expensive from an economical point of view.
CFLs can be bought with the ballast included in the lamp or with separate ballast. The last is actually more efficient, because ballasts tend to have lifetimes of 2 to 3 times as long as CFLs. The fixture needs to be adjusted however.

- **High-Intensity Discharge (HID)**

These lamps have the highest efficacy and longest service life of all. The general use of these types of lamps is for outdoor lighting and large indoor areas. HID lamps need a ballast to produce the electric arc through which the lamps produce intense light.
There are three general types of HID being the mercury vapour, metal hide and the high-pressure sodium lamp. These lamps can save up to 95% of the energy costs when replacing incandescent lights. When replacing old mercury vapour lamps by metal hide or high-pressure sodium lamps, also some significant energy saving can be achieved.

- **Low-Pressure Sodium**

This type of lamps look a bit like the fluorescent type in their working. The use of this type of lamp is mainly appropriate in areas where colour is not important, e.g. highways and security lighting. They are the most efficient artificial lighting, have a long service life and maintain their light output better than any other lamp type.

5.2.4.1 Lighting in the Hotels

First the lighting in the rooms is looked at. In the table below an overview of the different types of lighting in the rooms is presented. In all hotels 5 rooms were checked and the average number and type of lights per room are shown in table 5.11. The lights in the bathrooms were included in the number of lights in the room. Only in hotel no.4 all rooms were exactly the same.

Table 5.11 Lighting in the Rooms

Type of lamps	Hotel 1 SB	Hotel 2 CR	Hotel 3 AR	Hotel 4 AC
Incandescent	4 bulbs 75 Watt	5 bulbs 50 Watt	1 bulb 50 Watt	3 bulbs 25 Watt
Fluorescent	1 CFL 18 watt	1 Tube 20 Watt	4 CFLs 18 Watt	0
Other				3 halogen 50 Watt

All the hotels had reading-lamps hanging above the beds as well as a ceiling lamp. In the bathrooms there were two lights: one at the ceiling and one above the lavatory. In Hotel 2 there was an additional lamp above the mirror in the room and in Hotel no.4 there was an additional lamp above the table.
The data about the other lighting in the hotel is presented in table 5.12.

Table 5.12 Number of Lights and their Wattage in the hotels

Location	Hotel 1 SB	Hotel 2 CR	Hotel 3 AR	Hotel 4 AC
Outside area	Incandescent: 35 75 Watt CFL: 27 18 Watt Halogen: 5 50 watt	Incandescent: 80 25 Watt Halogen: 10 50 Watt	Tube Fluorescent: 13 20 Watt CFL: 5 18 Watt LED: 40 5 Watt	Incandescent: 28 Average 62 Watt Metal Halide: 10 150 Watt
Others (Kitchen, restaurant reception, launderette, souvenir shop)	CFL: 5 18 Watt Incandescent: 5 75 Watt	Incandescent: 20 60 Watt Tube fluorescent: 8 20 Watt	Incandescent: 17 12: 60 watt 5: 25 Watt Fluorescent: 17 20 Watt	Incandescent: 18 25 Watt Fluorescent: 10 9: 20 Watt 1: 18 Watt

Outside lighting is the second most important type of lighting in the hotels from energy consumption perspective. Table 5.12 shows the percentage of wattage installed for the hotels.

5.12 The Percentage of Lights as Percentage of Watt Installed

	Hotel no1 SB	Hotel no2 CR	Hotel no3 AR	Hotel no4 AC
Rooms	75%	68%	64%	54%
Outside	22%	21%	11%	39%
Others	3%	11%	25%	8%

Outside lighting in the hotels is turned on by the employees as soon as it gets dark.
In hotel no.1 the outside lights are turned of around midnight except for 5 or 6 lights.
In hotel no.2 the halogen lighting is on the whole night. The other lights can only be operated by the guests from inside the cabin.
In hotel no.3 only the led network of lighting is on the whole night. The other lighting is turned of around midnight.

In hotel no4 AC a light sensitive mechanism regulates the outside lighting. Light switches on when it gets dark and of when there is enough light. In Costa Rica it generally gets dark between 17: and 18:00 hour and it gets light between 5:00 and 6:00 am.

5.2.5 The Water Pumps and the Swimming Pools

Water in the swimming pools has to be pumped around through a network including a filter to keep the swimming pool clean. The information about the pumps is presented in table 5.13.

5.13 The Pumps for the Swimming Pool			
Hotel 1 SB	**Hotel 2 CR**	**Hotel 3 AR**	**Hotel 4 AC**
Brand: Pinnacle high flow pump Power: 1800 watt and 1400 watt 3450 rpm Working hours per day: 6 hours	Brand: Hayward water pump Power: no label Working hours per day: 8 hours	Brand: Jaccuzi Novia Power: 1000 Watt 3450 rpm Working hours per day: 2 times 4 hours	Brand: Aquatools Power: 1500 Watt 3450 rpm Working hours per day: 6 hours

Hotel no1 has two pumps installed because it also had one for the jacuzzi. The six hours of working in this hotel applies to the 1800 watt pump. The other hotels all had one water pump. In two of the hotels the pumps were working 8 hours a day. The pump in hotel AC worked 6 hours.

5.2.6 The Restaurant and Kitchen

An important aspect of energy consumption will probably take place in the restaurant and the kitchen.
The three hotels with a restaurant all prepared the meals on gas stoves. The information about the energy consumption of these stoves could however not be obtained. The same applied to the gas extractors that were installed in the kitchens. Main characteristics of the restaurants are presented in table 5.14.

Table 5.14 Characteristics of the Restaurant			
	Hotel no2 CR	Hotel no3 AR	Hotel no4 AC
Capacity restaurant (no. of people)	60	50	30
Type of restaurant	Breakfast, lunch and dinner	Breakfast lunch and dinner	Breakfast and dinner
Eaters	Hotel guests and outside guests	Hotel guests and outside guests	Hotel guests

Other important energy consumption centres in the kitchen and restaurant are refrigerators and freezers. Information about this equipment is presented in table 5.15. when no data about the capacity of the equipment is mentioned no data was available.

Table 5.15 Equipment in the Kitchen and Restaurant			
	Hotel no2 CR	Hotel no3 AR	Hotel no4 AC
Refrigerators	2 with single glass door, Fogel 1 with double glass door, keith & ramirez 1 with double top slide doors 1 with single door	3 with single glass door, Fogel 1 with single door	1 freezer/refrigerator, two front doors, Cetron, 374 W
Freezers	2 freezer/refrigerating rooms, Wilmington, 750 W per room.	1 Freezer, top loader, 5 doors	
Cooking equipment	1 gas stove with 4 burners and an oven, Wolf 1 cooking plate 1 deep frier, two parts 1 Eletrical pan, 1.5 kW 1 microwave oven, Daewoo, 1300 Watt maximum	1 gas stove with 7 burners 1 cooking plate 1 deep frier, two parts 1 microwave oven, Sharp, 1.2 kW 1 Au bain marie systems, 3 baths	2 gas stoves with 4 burners per stove 1 cooking plate 1 electrical pan, Black & Decker, 1.1 kW 1 Microwave oven, Goldstar, 1.3 kW 1 toastmaker, 2.0-2.6 kW
Others	1 Ice maker, Scotsman 1 coffee maker, 1kW 1 TV 1 Stereo 4 Fans	1 TV, Toshiba 60 W average 1 Stereo 1 cash drawer 1 coffee maker, Bunn	1 Ice maker, Manitowoc, 1.3 kW 1 TV, RCA, 120 W max 1 VCR, Sony, 18 W 1 Stereo, Aiwa, 18 W 3 coffee makers, Proctor, West Bend, Regal, average 1.2 kW

5.2.7 Other Locations and Equipment

Other locations in the hotels were the souvenir shop, the reception and the office. In two of the hotels with a souvenir shop this was located in the same area as the reception. In the third hotel the souvenirshop was only separated from the reception by a window and a door. The following equipment consumed energy in these locations:

- Lighting, included in section 5.2.4
- Refrigerators: Three of the four hotels had a refrigerator in the reception. These refrigerators with glass doors
- Computers and communication equipment: All four hotels had at least 1 computer. Hotel no3 AR had 2 and hotel no2 CR had 3. Other important equipment were printers and telephones.
- Hotel no4 AC had 2 additional air conditioners in the office (consisting out of two rooms).

5.3 An Introduction to Energy Conservation and Economic Feasibility

Investments become economically interesting if financial benefits occur within an acceptable period of time. For the four hotels that are examined pay-back periods were accepted within 4 and 5 years. The pay-back period is defined as the period required to recover the original investment outlay through the accumulated net cash flows earned by the project[50]. In this research accumulated cash flows are caused by energy conservation due to higher energy efficiency of new equipment. When comparing new equipment with each other the investment difference has to be overcome by accumulated net cash flows earned by the more efficient equipment. Calculation have been limited to Air conditioners, Water heaters and lighting.

5.3.1 Air conditioners

In table 7.1 an indication of air conditioners available in Costa Rica is presented. Three brands are presented, because they were installed in the three hotels visited. Only single unit air conditioners are mentioned because it was assumed that in the hotels examined, installing a centralised system was not an option because this would mean an investment other than the purchase of the air conditioners alone, e.g. reconstruction of room walls or ceilings.

Table 5.16 Window/Wall Air Conditioners

Brand and type	Carrier Siesta II Series	Carrier Siesta Series	Carrier G Series	Carrier II G Series	Sharp	Panasonic CW-C100AU	Panasonic -	Panasonic CW-XC100AU
Wall/Window	Window	Window	Wall/window	Wall/window	Window	Window	Window	Window
Cooling capacity (kW)	2.93	2.93	3.08	3.08	2.93	3.37	2.93	2.93
EER	2.64	2.87	3.08	3.17	2.93	3.02	3.08	3.08
Price (US$)	339	335	379	499	449	490	440	470

Source: Carrier, Sharp and Panasonic importer advice prices, 2000

Some assumptions have been made before looking at pay-back periods.

- It is assumed that the average occupation rate of the hotels was 50% similar to what has been found for the 23 hotels in the Central Valley. The air conditioners are thus only used 15 days per month.
- Air conditioning is required all year long.
- When a room is occupied the air conditioners are utilised 6 hours a day.
- When air conditioners are on they are working on full capacity.
- Calculations are done for an air conditioner still functioning properly with an EER of 2.66 that is going to be replaced by a new air conditioner with equivalent cooling capacity (situation A) and for an air conditioner where the old air conditioner is at the end of its lifetime and new air conditioners are compared with a new air conditioner with an EER of 2.66 costing 339 US$ (Situation B).
- Prices per kWh are 0.11 US$ (Coopelesca prices).

[50] W. Behrens, Unido, 1991

Table 5.17 Pay-back Periods for Air Conditioners							
	Carrier II, 2.93	Carrier G, 3.08	Carrier II G, 3.08	Sharp, 2.93	Panasonic , 3.37	Panasonic , 2.93	Panasonic CW, 2.93
Consumption per month (kWh)	90	90	87.3	90	100.8	85.5	85.5
Operation costs difference savings per month (US$)	1	1.5	1.8	1	1.45	1.5	1.5
Pay- back period situation A (months)	335	253	277	449	338	294	314
Pay- back period situation B (months)	-4	27	89	110	104	67	88

The results presented in table 6.2 show that replacing a good operating air conditioner by a more efficient one is far from economically interesting for hotel owners.
The results also show that when an air conditioner is at the end of its lifetime purchasing an energy efficient air conditioner which costs more than a less efficient one can pay itself back within an acceptable period if the right one is selected. Good shopping is required however.

5.3.2 Water Heaters

Table 6.2 and 6.3 show that electrical heaters are the cheapest type of water heaters to invest in, but because these type of heaters have high operating costs, gas heaters are more attractive from an economical point of view. Gas heaters are most likely to be economically attractive. The price of a solar water heater is very high compared to the other which might be a disadvantage. Pay-back periods are within 4 years when compared with other heaters. The question however is whether solar heaters also operate at a good efficiency as they should in the La Fortuna area. Closer research on this should be done.

Table 5.18 Water Heating Systems			
	Electrical heater	**Gas heater**	**Solar heater**
Capacity (liters of water)	151.6	151.6	151.6
Rooms provided by heated water	3	3	3
Costs per unit (US$)	119	159	748
Energy consumption (kWh)	3.00	7.13	-
Costs/kWh (US$)	0.11	0.03	-
Hours operated per day	3.00	3.00	3.00
Consumption per month (kWh)	270.00	641.70	-
Operating costs per month (US$)	29.7	19.3	-
Savings per month (US$)	-	10.4	29.7

Source equipment prices and capacity: Trav-o-Matic, Información Técnica y Precios, 1996

Table 5.19 Pay-back Periods for Water Heaters	
Description	**Pay-back period in months**
Gas system replacing an electrical system at the end of service life	4
Gas system replacing an electrical system still operating properly	16
Solar system replacing an electrical system at the end of service life	21
Solar system replacing an electrical system still operating properly	25
Solar system replacing a gas system at the end of service life	31
Solar system replacing a gas system still operating properly	38

5.3.3 Lighting

Looking at table 6.14 shows all important information about two different types of light: Incandescent and CFLs. This information shows that the pay-back period for investing in CFL lights is well within 4 years. The lights on time of 5 hours per day were taken because CFLs have a lifetime of 10,000 hours when working longer periods of time after each other. However the calculation shows that with shorter lifetimes the profitability of CFLs still is there.

Table 5.20 Lighting and costs						
Type of Lighting	Wattage	Lumen	Lifetime (hours)	Average price (US$)	Cheapest (US$)	Most Expensive (US$)
CFL	15- 20	900-1200	10000	8,86	7,02	11,07
Incandescent	60-75	900-1200	1000	0,43		
Electricity costs per month when lights are on 5 hours per day (US$)						
CFL 20 Watt	3 kWh	0.33	CFL 15 Watt	2.25 kWh	0.25	
Incandescent 75 Watt	11.25 kWh	1.24	Incandescent 60 Watt	9.0 kWh	0.99	
Price differences (CFL- Incandescent, US$)						
	CFL 20 vs. Incandescent 75		CFL 15 vs. Incandescent 60			
Investment costs	8.43		8.43			
Operation costs per month	-0.91		-0.74			
Pay back period (months)	9.3		11.4			

Note: Prices for electricity are based upon Coopelesca prices for general consumers, which are 0.11 US$/kWh

When hotels have an occupation rate of 50%, pay-back periods become twice as long. These remain acceptable pay-back periods for the four hotels that were examined.

Chapter 6 Conclusions and Recommendations

In section 6.1 a summary is presented of the steps that have been taken during this research. After that in section 2 the conclusions are presented resulting from the research. Conclusions have been divided into the ones that can stimulate energy efficiency and energy conservation in hotels, the ones that constrain energy efficiency and energy conservation in hotels and remaining conclusions. After the presentation of these conclusions the energy audit as it was executed in this research is evaluated. In the final section the recommendations are presented.

6.1 Summary of the Research

The research as it was conducted consisted out of three stages.

The first stage was the literature study done that resulted into the theoretical framework as presented in chapter 2. The framework was used for the other two stages that took place in Costa Rica at the research centre 'Programa de Investigación en Desarrollo Urbano Sostenible' (ProDUS, The Program to Investigate Urban Sustainable Development) of the faculty of civil engineering of the University of Costa Rica. The research was conducted as a part of the project 'Producción más Limpia en Instalaciones Turísticas' (Cleaner operation of tourist enterprises). The objective of this research was to minimise the negative effects on the environment by tourist enterprises in general and hotels specifically.

The second stage of the research concentrated on the national and sector setting conditions that have an influence on energy consumption in hotels. This part consisted out of a literature study and interviews held with several people from different organisations, like the ICT, the CCH and the department of environment and energy (MINAE). These interviews had an open structure and were held without a questionnaire.

Important information related to energy consumption as for example climatic conditions and characteristics related to energy consumption of equipment could be gathered by contacting and visiting organisations and suppliers (stores, importers) of this information and/or equipment.

The third stage of the research was the research on enterprise level. For this stage of the research four hotels were examined that were chosen based upon the criteria presented in section 2.5. An energy audit was executed at these four hotels to gather the information that is presented in chapter four and five. To gather this information a questionnaire was made to interview the hotel owner and collect all the information of the installed equipment related to energy consumption. As part of the energy audit measurements were taken of climatic conditions at the hotels to get an indication of the internal conditions in the hotel rooms.

All the information together has lead to the conclusions that are presented in the next two sections,

6.2 Conclusions

6.2.1 National Setting Conclusions

In table 6.1 the national setting conditions that can stimulate efficient energy consumption or energy conservation in hotels are presented.

Table 6.1 National Setting Conditions in Favour of Energy Efficiency and Conservation in Hotels	
Government policies and organisations	• The rational use of energy is the main objective of Costa Rican policy in relation to energy consumption. Programs that are developed to reach this objective can have a positive influence on energy consumption in hotels. • Laws related to energy conservation involve tax exemptions and subsidies to execute energy audits and implement energy conservation programs. These laws were developed by the Department of Environment and Energy (MINAE which used to be MIRENEM). Enterprises consuming more than a certain amount of energy are obligatory to carry out such an energy audit. • The electricity sector, which is largely state owned, is an important sector in relation to energy conservation opportunities in hotels. The two largest companies are the Instituto Costarricense de Electricidad (ICE) and the Compañia Nacional de Fuerza y Luz (CNFL). These companies are responsible for the implementation of several programs related to energy conservation in Costa Rica. Programs implemented by these organisations can have a positive effect on energy consumption in hotels
Geophysical	• There are little or no fossil energy sources in Costa Rica. A high dependence on the import of fossil fuels is undesirable. This can create a demand for the development of renewable energy sources and energy efficient products. This can have a positive effect on energy conservation in hotels.

Conclusions from national level related to constraints on energy conservation in hotels are presented in table 6.2.

Table 6.2 National Setting Conditions Constraining Energy Efficiency and Conservation in Hotels	
Government policies and organisations	• The Instituto Costarricense de Turismo (ICT) is the government organisation founded to stimulate tourism in Costa Rica. They do not have a program related directly to energy conservation in hotels. • There are several national programs with the objective of energy conservation in general, but a program with the objective to reduce energy consumption in hotels has not been developed yet.
Economic System	• Coffee, Bananas and since the 90's Tourism are the most important economic sectors in the country. When Intel started production in 1998 it immediately became one of the most important economic sectors. This indicates that the scale of the industry in Costa Rica is small. • Costa Rica is also a net importing country. This and the former point indicates a dependence on foreign technology. • High inflation and high interest rates discourage investments. Investments are necessary to implement energy conservation opportunities. This means that energy conservation opportunities are discouraged by high inflation and high interest rates.
Social System	• Costa Rica has a 48.4% gross secondary enrolment. Low education levels can be a constraint for selecting the most appropriate technology related to energy consumption. A low education level will respond to higher energy consumption in hotels.

In table 6.3 the remaining conclusions that have been drawn from the research on national setting level have been presented.

Table 6.3 Other Conclusions Related to Energy Consumption in Hotels	
Government policies and organisations	• Electricity in Costa Rica is generated for the greater part by hydropower. In total about 90% of the electricity is generated by renewable energy sources.
Economical System	• The GDP per capita indicates that Costa Rica is a middle income country. This is an indication for the level of technological advancement of the country.
Geophysical	• Although Costa Rica is a relatively small country, the climate displays large differences between different regions and there are many micro climates. In general there are four main climatic regions. Differences in climatic conditions influence energy consumption in hotels because of differences in demand for facilities like air conditioning and water heating.

6.2.2 Sector Setting Conclusions

In table 6.4 the sector conditions are presented that stimulate efficient energy consumption and conservation in hotels.

Table 6.4 Sector Setting Conditions in Favour of Energy Efficiency and Conservation in Hotels	
Tourist Sector	• Since 1999 the tourist sector earns Costa Rica over 1 billion dollars per year, about 7% of GDP, contributing significantly to economic growth in Cost Rica. A growth of the economy can result in a higher technological advancement which benefits the efficiency of energy consumption in general and therefore also in hotels.
Hotels	• Around one third of the hotels in Costa Rica opened in the last 10 years. Equipment in new hotels is likely to be more energy efficient than equipment installed in old hotels.

In table 6.5 the sector conditions are presented that have a constraining effect on energy efficiency and conservation in hotels.

Table 6.5 Sector Setting Conditions Constraining Energy Efficiency and Conservation in Hotels	
Tourist Sector	• The tourist sector in Costa Rica has increased by about 10% per year in the last 10 years. This growth will have caused an increased energy consumption of the sector. • 40.8% of the people visiting the country is between 30 and 45 years old and 33.2% is older then 45 years. Older people are able to afford more money on comfort than younger people. A higher demand in comfort leads to higher energy consumption.
Hotels	• Occupation rates influence the energy efficiency of centralised systems. Systems in hotels that can either be centralised or decentralised are water heaters and air conditioners. The average occupation rate of 23 hotels located in the Central Valley of Costa Rica over the years 1998 and 1999 was 52%. This indicates a low capacity utilisation of centralised systems. • Data about the facilities in hotels and research done by the CNFL indicate that lighting, air conditioners, water heaters, a restaurant, a swimming pool and launderette are the main energy consumption centres in hotels. These are also the facilities that most of the hotels in Costa Rica provide.

The remaining sector setting conclusions in relation with energy consumption in hotels are presented in table 6.6

Table 6.6 Other Sector Setting Conclusions Related to Energy Consumption in Hotels	
Tourist Sector	• Tourists in Costa Rica come from all over the world, but people from the United States, Canada and some Western Europe countries brought about the main increase in the number of tourists. • Tourists visit the entire country, but often start and end their vacation in the Central Valley area, because the only international airport of the country is located there. About 80% of all tourists sleep at least one night in a hotel located in the Central Valley, compared to 10 to 30% in all the other areas. • Tourists spend an average 11.1 days in Costa Rica. The average time spent in Costa Rica hasn't changed significantly in the last decade.
Hotels	• Next to the 365 hotels with a tourist accreditation in 1998 there were another 1400 hotels without tourist accreditation. Hotels with a tourist accreditation provide about ½ of all the hotel rooms in the country. • Looking only at the hotels with tourist accreditation in the last nine years the percentage of hotels with more than 60 rooms has increased by 7.3% measured in the percentage of rooms. The category of hotels with 20-40 hotels remained the largest category in the 90's with 24.7% of the rooms in 1999. • Over 50% of the hotels with a tourist accreditation has received two or three stars. Only 15.3% has 4 or 5 stars. Assuming the number of stars is related to quality and quantity of service, more stars indicate a higher level of energy consumption. Higher quality of service can also indicate higher energy efficiency. • When looking at the equipment in the hotels related to energy consumption, data from 1993 shows that the majority of the hotels provide: • Heated water and a private bathroom • Ventilation by Fans in the rooms • A restaurant/kitchen • A swimming pool • A launderette Other important equipment are air conditioners and televisions that are installed in about 40% of the rooms. More facilities means higher energy consumption • Former research has shown that there are basically two types of air conditioners in hotels in Costa Rica: The single unit and the central unit air conditioner systems. The energy efficiency ratio, which is the ratio of cooling capacity to energy consumption, of modern air conditioners should be above 2,64[51]. • Because in Costa Rica electricity is generated for 90% using sustainable energy sources, solar heaters are not automatically more sustainable than electrical water heater systems, especially since additional heating is necessary in many cases. • Former research showed that in most of the hotels water heaters operate on gas, but also electrical heaters are installed in a lot of hotels[52].

[51] Source: Paniagua Lopez, Claudia, Diciembre 1996
[52] Source: Paniagua Lopez, Claudia, Diciembre 1996

6.2.3 Enterprise Setting Conclusions

The conclusions for this level of research can only be used for the four hotels that were examined in this research. In table 6.7 the stimulating conditions for the examined hotels are presented.

Table 6.7 Enterprise Setting Conditions in Favour of Energy Efficiency and Conservation	
General	• All four hotels carry out preventive maintenance. • Hotel no2 CR had an external contract to perform preventive maintenance on installed equipment. The other three hotels carried out maintenance themselves.
Lighting	• Hotel no3 AR has an outdoor lighting system with low wattage lights. • In hotel no4 AC a light sensor regulates outdoor lighting. When it gets dark, lights are turned on automatically and they turn of again when there is enough daylight. • When incandescent lights are compared with CFLs from an economic point of view the pay-back period of a CFL is shorter then a year.
Launderette	• In hotel no4 AC the laundry is washed without using warm water[53]. In hotel no1 SB two of the four machines don't heat the water. • In hotel no1 SB and hotel no4 AC there is a drying area were the laundry can dry naturally.

In table 6.8 the constraining conditions on the enterprise level for energy conservation are presented.

Table 6.8 Enterprise Setting Conditions Constraining Energy Efficiency and Conservation	
General	• None of the four hotels kept a logbook of the maintenance executed on the equipment. • None of the hotels carry out predictive maintenance.
Air Conditioners	• Only three out of the nine different air conditioners had an EER of above 2.64 according to information from their label or manual. • The thermostat control knobs indicated only numbers, no temperature settings. • In hotel no1 SB and hotel no4 AC some air conditioners were installed in such a way that they are exposed to direct sunlight. • In hotel no1 SB some air conditioners were installed close to floor level and most of these air conditioners air inlets were obstructed by objects. • In none of the three hotels with air conditioning the doors were insulated with strips and wind could come in underneath the door. • When windows are closed wind can still get through slides. The type of windows makes it possible for heat to enter the room by convection when the air conditioner is on. • In hotel no1 SB there was only one window, which makes cross ventilation impossible.
Water Heaters	• In the three hotels with a centralised system water distribution pipelines for distribution of the hot water are not insulated. • All the showers are inefficient in using water.
Lighting	• All four hotels have (at least partially) incandescent lights at every location.

[53] In Costa Rica most of the detergents are developed for washing with cold water. The detergents contain a chemical that reacts when it gets in contact with water. This produces heat making the detergent active.

In table 6.9 the remaining conclusions are presented.

Table 6.9 Other Enterprise Setting Conditions Related to Energy Consumption in Hotels	
General	• There are considerable differences in the level of energy consumption between the four hotels. Hotel no 2 CR has an electricity consumption around two to three times higher than the other hotels. There appears to be no direct relation between the energy consumption and the facilities • The registration of the electrical meters show that the different hotels pay different electricity prices, but also within one hotel different prices are paid depending on the group where the electricity is consumed. Hotels should be registered as General consumers. • Two of the four managers received tertiary education. One received secondary education and one only primary education. • There was also a large variety in education between the rest of the employees in the different hotels. Some got tertiary education and some only received primary education. • 3 out of the four hotel owners accepted pay-back period of up to four years. The hotel owner from hotel no3 AR accepted a pay-back period of up to 5 years. Longer acceptable pay-back periods are related to higher energy conservation opportunities. • Three of the hotels repaired malfunctions the same day as discovered. Only in hotel no1 SB repairs took place a week after the discovery of the malfunction. • No actual measurements of energy consumption and performance have been performed during this research. Therefore it is not possible to tell whether the systems operated according to the data presented on the labels.
Water Heaters	• Three out of the four hotel had partially centralised water heater systems. Four or five water heaters provided the water in these hotels. With total occupation of the hotels centralised heater are assumed to be more efficient than decentralised systems. • Two of the centralised heaters operated on gas. The other centralised heater used electricity. • In hotel no4 AC decentralised heaters were installed operating on electricity.
Launderette	• Hotel no1 SB has a variety of washing machines, with one front loader washer and 3 top load washers.
Swimming Pool	• The water pumps for filtering the water operated between 6 and 8 hours per day.
Kitchen and Restaurant	• Hotel no2 CR, hotel no3 AR and hotel no4 AC have a restaurant. • All three hotels cook on gas. • A lot of the equipment, especially refrigerators, lacked the labels containing information about capacity and other energy related information. Also no data was available about the type of equipment.

6.3 Recommendations

6.3.1 National and Sector Setting

Government policies have shown that energy conservation is an important issue in Costa Rica. The target of the National Energy Conservation Program is to decrease the demand of energy without damaging the economic growth, the quality of life of the Costa Ricans and the environment, and to maintain an effective and efficient supply of energy.

Tourism has proven in the last decade to have become an important sector for Costa Rica. By growing at about 10% a year tourism has contributed to economic growth in the country tremendously. The energy demand of the sector is likely to have increased as well because of this growth. The activities related to tourism likely to be responsible for the greater part of the energy consumption are:

- Travelling around of the tourists: To visit different sights and places tourists are travelling around the country. To do so they rent cars, drive around in groups in buses or take public transport.
- The stay in the hotels: The tourists use the facilities in the hotels, like a swimming pool and the air conditioners. Many hotels also provide a restaurant where tourists both staying at the hotel and from outside can have dinner.

Knowing that energy conservation is an important national policy and tourism is an important sector the government could look at the relation between this sector and the growth of energy demand in Costa Rica. The consumption of energy due to travelling around of tourists is likely to be influenced by the national conditions of the infrastructure and the conditions of the transportation means available. When looking at the consumption of energy by hotels, the 'General' group of electricity consumers in Costa Rica is responsible for almost a quarter of total electricity consumption. Hotels are likely to consume a significant part of this electricity. To get more insight into this, research has to be done to find out what the exact energy consumption level of hotels is.
When developing a program on energy conservation in hotels the following recommendations can be given:

Table 6.10 Recommendations for Energy Conservation Programs in Hotels
• The most obvious organisations to develop and implement such a program are the ICT and the electricity companies, of which the most important are the ICE and CNFL. The ICT has the knowledge about the tourist sector. The electricity companies have the knowledge about energy conservation in general. Co-operation between these government organisations, thereby combining their knowledge, can be even more effective.
• For hotel owners it is interesting to know the possibilities of tax exemptions that exist for energy efficient equipment. This could stimulate investments related to energy conservation. Informing hotel owners should be included in a program on energy conservation in hotels.
• It is likely that due to the growth of the tourist sector, a lot of new hotels are going to be constructed in the next few years. The development of a manual for the construction of an energy efficient hotel which becomes available to starting entrepreneurs could help the rational consumption of energy. The possibilities of passive cooling should be taken into account when developing such a manual.
• In the hotels examined much of the equipment was still without labels. Labelling of equipment and providing valuable information in manuals about capacity and other information related to energy consumption allows purchasers to compare different types and decide whether one product is better than the other in terms of energy consumption.

Recommendations for further research are presented in table 6.11 .

Table 6.11 Recommendations for further Research
• Occupation rates influence the energy efficiency of equipment in hotels. In theory centralised systems might be more efficient than decentralised system, in practise low capacity utilisation can diminish this advantage or even make the centralised systems less efficient. The energy efficiency of decentralised systems is not influenced by lower occupation rates. Research has to be done about the effect of capacity utilisation on energy efficiency of centralised systems. In such a research the consumption pattern of the tourists over a day can also be included.
• Research about the state of the art technologies available to hotels in Costa Rica related to energy consumption gives better insight into energy conservation opportunities. Because the economy has an open structure it can be expected that international state of the art technologies can also be purchased in Costa Rica. The results of such a research should be available to the hotel sector.
• Research about energy consumption in hotels in the four main climatic regions of Costa Rica can give insight into the energy consumption of hotels and the influence of climatic conditions. Measurements of the energy flows in the hotels also gives information about energy consumption patterns and the responsible equipment.

6.3.2 Enterprise Setting

Recommendations for the four hotels are listed per type of equipment.

General

- All hotels: From this research is has become evident that measuring energy flows is essential for giving accurate and valuable recommendations on energy conservation. The measurements of the energy flows for units as small as possible should take place during a period of high occupation and a period of low occupation. It would be ideal to measure energy flows of the different units at the same time.
- All hotels: Make the guests aware of the importance of energy conservation by informing them in a friendly way, e.g. by an information tabloid in the room. This can lead to energy conservation, because if guests know how to operate the equipment (see air conditioners) right the equipment will operate more efficient.

Air conditioners

- All hotels with air conditioners: Informing guests about thermostat settings corresponding to comfortable temperature settings can help lower energy consumption by air conditioners. To get to know the right settings the hotel owners could find out what settings correspond with what temperatures operating an air conditioner himself with a thermometer.
- All hotels with air conditioners: Strips at the bottom of the door improve the operating conditions of the air conditioners. It keeps warm air from entering the room.
- Hotel no1 SB: Removing obstacles in front of air inlets can lower energy consumption of the air conditioners.
- Hotel No1 SB and hotel No4 AC: Protecting air conditioners against direct sunlight will improve the operating conditions for these air conditioners.

Water heaters

- All hotels: Replacing inefficient shower heads by efficient ones will lead to a hot water consumption reduction in the shower. This leads to an lower energy consumption.
- All hotels with a centralised heater system: Insulation of the distribution pipes leads to lower heat losses. This will lead to a lower demand for hot water. A lower demand for hot water leads to lower energy consumption

Lighting

- All hotels: Replacement of incandescent lights that are on for at least 4 hours continuously per day by their equivalent type of CFL leads to considerable energy conservation. From table 6.11 it can be seen that a 75 Watt incandescent should be replaced by an 18 Watt CFL.

6.11 Incandescent versus CFL			
Incandescent	75 Watt	60 Watt	50 Watt
CFL	18 Watt	15 Watt	12 Watt

Launderette

- Hotel no2 CR and hotel no3 AR: An area for laundry to dry naturally helps energy consumption go down.

Epilogue: The Energy Audit

The main instrument of this research was the energy audit. Looking at the energy audit as it was carried out step by step the following can be said.

- **Historical review of energy-related records**

The objective was to collect data about the energy consumption for as many years as possible. Because the electrical company implemented a new registration system during the year 1999 data was available for only one year. When reliable energy consumption for more then one year would have been available this could have given more information about a pattern of consumption over a period of a year.
It would also have been interesting to have information about the occupation rates of the hotels, to be able to compare the two data and see if there is a direct relation between occupation rate and energy consumption.

- **Walk-through of the hotel to identify major energy-using components**

Because not all the equipment that was installed in the hotels had labels attached to them and manuals often did not give information about the capacity, energy consumption and other data related to energy consumption, it was difficult or sometimes even impossible to obtain the correct information. This is something that can hardly be overcome in future research. A solution could be to try to achieve this information at the supplier or company that built the equipment. However for older equipment information might not always be available, or at least very difficult to obtain.
Information about maintenance that was performed was difficult to obtain as well, because no logbook was kept in the hotels.
Photos that were taken when visiting the hotels gave valuable information afterwards and worked very well as a memory bank.

- **Detailed definitions of the data requirements**

Generally processes in the hotels were found out to be basic. There appeared to be no direct relation between different processes.

- **Estimation of energy consumption and possible energy losses**

As already mentioned in section 5 of chapter 2 the equipment for measuring of energy flows was not available during this research. This meant that capacities of equipment found in step 2 of the energy audit could not be compared with actual energy consumption and no information could be gathered about energy flows. It was also impossible to get information about energy flow patterns during a 24 hour period. It would have been interesting to see the demand of energy during a day by different equipment. This could have given valuable information about when different equipment is utilised and to what extent.

- **Enumeration of energy conservation opportunities and estimation of energy savings potentials for each opportunity and determination of cost and profitability potential for the implementation of the opportunities**

Energy conservation opportunities have been derived from the research. However no figures on energy savings could be presented because of the lack of energy consumption data. Therefore the energy conservation opportunities only indicate what can be done, not the energy effect in kWh or other units.
For Air conditioners, water heaters and lighting some calculations have been made based on general information about capacity and prices. However these calculations can only be seen as indications of a economic feasibility.

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Appendix I Overview of the socio-economic Data[54]

People	**1990**	**1997**	**1998**
Life expectancy (years)	75	77	77
Fertility Rate (births per women)	3	3	3
Infant mortality rate (per 1,000 live births)	15	14	13
Under 5 mortality rate (per 1,000 children)	16	15	15
Child malnutrition (% of children under 5)	..	5	..
Urban population (% of total)	46	47	47
Rural population density (per sq. km of arable land)	624	813	..
Illiteracy - male (% of people 15 and above)	6	5	5
Illiteracy - female (% of people 15 and above)	6	5	5
Net primary enrolment (% of relevant age group)	86	89	..
Net secondary enrolment (% of relevant age group)	36	40	..
Girls in primary school (% of enrolment)	49	49	..
Girls in secondary school (% of enrolment)	50	..	..
Technology and infrastructure			
Telephone mainlines (per 1,000 people)	101	161	172
Cost of 3 min local call ($)	0.06	0.03	..
Personal Computers (per 1,000 people)	..	35	39
Internet hosts (per 1,000 people), 1998 refers to Jul99	..	12.30	10.41
Paved roads (% of total)	15	17	21
Aircraft departures (thousands)	13	24	37
Economy			
GDP ($ millions)	5,713	9,718	10,749
GDP growth (annual %)	3.6	3.7	6.2
GDP implicit price deflator (annual % growth)	18.6	14.4	12.3

	1978-1988	**1988-1998**	**1997**	**1998**	**1998-2002**
GDP growth (average annual)	1.7	4.1	3.7	6.7	5.5
GNP per capita growth (average annual)	..	2.2	1.3	1.3	3.3
Exports of goods and services growth (average annual)	3.3	9.5	4.1	15.0	4.9
Structure of the Economy		**1978**	**1988**	**1997**	**1998**
Agriculture (% of GDP)		20.4	15.8	15.1	15.0
Industry (% of GDP)		26.1	23.9	24.4	24.0
Manufacturing (% of GDP)		18.7	21.3	18.9	18.5
Services (% of GDP)		53.5	60.3	60.5	61.0
Private consumption (% of GDP)		67.6	61.8	57.6	55.9
General government consumption (% of GDP)		16.8	15.6	16.7	16.4
Imports of goods and services (% of GDP)		36.0	37.0	47.1	50.1
		1978-1988	**1988-1998**	**1997**	**1998**
Agriculture growth (average annual)		2.1	3.1	-0.1	5.3
Industry growth (average annual)		1.4	3.9	5.5	7.9
Manufacturing growth (average annual)		-6.4	3.9	5.1	7.2
Services growth (average annual)		1.8	4.5	4.1	6.6
Private consumption growth (average annual)		0.9	3.3	2.9	4.6
General government consumpt. growth (average annual)		0.3	2.4	1.6	2.4
Gross domestic consumption growth (average annual)		1.2	3.4	11.5	17.2
Growth of imports of goods and services (average annual)		1.1	8.8	5.6	17.5
Gross national product growth (average annual)		1.4	4.5	3.5	3.5
Prices and Government Finance		**1978**	**1988**	**1997**	**1998**
Domestic prices (% change)					
Consumer prices, average		..	20.8	13.2	11.7
Implicit GDP deflator		7.9	18.9	14.4	13.1
Government finance (% of GDP, includes current grants)					
Current revenue		..	..	16.7	16.8
Current budget balance		..	..	-1.7	-2.0
Overall surplus/deficit		..	..	-3.9	-3.8
Balance of Payments (US$ millions)					
Exports of goods and services		1,008	1,620	5,492	6,892
Imports of goods and services		1,274	1,708	5,629	6,990

[54] Source: Worldbank, 2000

Resource balance	-267	-87	-137	-98
Net income	-113	-337	-192	-468
Net current transfers	16	40	114	105
Current account balance	-364	-384	-215	-460

Poverty and Social	**Costa Rica**	**Latin America & Carib.**	**Lower middle income**
Average annual growth, 1992-1998			
Population (%)	2.1	1.6	1.1
Labour force (%)	2.7	2.3	1.5
Most recent estimate (latest year available, 1992-1998)			
Poverty (% of population below national poverty line)	22	..	..
Urban population (% of total population)	51	75	58
Life expectancy at birth (years)	77	70	68
Infant mortality (per 1,000 live births)	12	32	38
Child malnutrition (% of children under 5)	5	8	..
Access to safe water (% of population)	100	75	75
Illiteracy (% of population age 15+)	5	13	14
Gross primary enrolment (% of school-age population)	103	113	103
Male	104	..	105
Female	103	..	100

Gross National product per Industry (US$)[55]	1996		1997		1998		1999	
		%		%		%		%
Gross National Product at market prices	2455535		2982440		3624318		4467183	
Taxes minus the subsidies for products	224056		264849		308072		374290	
Gross National Product at basic prices	2231479	100,0	2717590	100,0	3316245	100,0	4092892	100,0
Agriculture, forestry and fishing	287255	12,9	351464	12,9	424803	12,8	431192	10,5
Mining and quarrying	2762	0,1	3758	0,1	4796	0,1	6171	0,2
Manufacturing Industry	494266	22,1	608919	22,4	764384	23,0	1196813	29,2
Construction	84287	3,8	102443	3,8	136781	4,1	152459	3,7
Electricity and Water	67779	3,0	82166	3,0	90496	2,7	94733	2,3
Commerce, restaurants and hotels	445996	20,0	542225	20,0	667777	20,1	765955	18,7
Transport, storage and communications	198445	8,9	242761	8,9	285962	8,6	315207	7,7
Financial services and insurance	105610	4,7	127474	4,7	145661	4,4	178809	4,4
Mortgages (Immovable activities)	114552	5,1	136352	5,0	156553	4,7	178335	4,4
Other services for enterprises	59151	2,7	72538	2,7	85828	2,6	105228	2,6
Public administration services	89133	4,0	104826	3,9	121874	3,7	146112	3,6
Community, social and personal services	351010	15,7	425836	15,7	530774	16,0	660781	16,1
Less: Intermediary services through indirect financing	68770	3,1	83176	3,1	99427	3,0	128908	3,1

Gross National Product per industry (%)[56]	1995	1996	1997	1998	1999	2000
Market prices	100,0	100,0	100,0	100,0	100,0	100,0
Taxes minus subsidies for products	9,4	9,9	10,0	10,0	9,4	10,3
Gross national product at basic prices	90,6	90,1	90,0	90,0	90,6	91,1
Agriculture forestry and fishing	11,6	11,7	11,2	11,2	10,9	10,5
Mining and quarrying	0,1	0,1	0,1	0,1	0,1	0,1
Manufacturing Industry	21,1	21,1	21,5	22,1	25,4	24,6
Construction	4,3	3,5	3,5	3,8	3,4	3,4
Electricity and Water	2,7	2,7	2,7	2,7	2,7	2,9
Commerce, restaurants and hotels	18,9	18,6	18,7	18,6	17,8	18,0
Transport, storage and communications	8,5	8,8	9,2	9,2	9,0	9,7
Financial services and insurance	3,5	3,5	3,6	3,5	3,6	3,7
Mortgages (Immovable activities)	5,5	5,6	5,5	5,2	5,0	5,0
Other services for enterprises	2,4	2,4	2,4	2,3	2,4	2,5
Public administration services	3,0	2,9	2,8	2,6	2,4	2,4
Community, social and personal services	11,0	11,1	11,0	10,7	10,2	10,4
Less: Intermediary services through indirect financing	2,0	2,1	2,1	2,1	2,1	2,1

[55] Source: Banco Central de Costa Rica
[56] Source: Banco Central de Costa Rica

Appendix II Questionnaire

Cuestionario para obtener información sobre hoteles ubicados en La Fortuna de San Carlos

1. Información general

Nombre del hotel: _____
¿Tiene Hospedaje con Declaratoria Turística? Sí ( ) No ( )
¿Miembro de Cámara Costarricense de Hoteles (CCH)? Sí ( ) No ( )
Tipo de hotel: _____ Número de estrellas: _____
Nombre del dueño/gerente: _____
Ubicación Física: _____
Tel: _____ Fax: _____ Correo Electrónico: _____

Descripción general del o los edificios

Número de edificios: _____
Año de construcción: _____
Tipo de construcción: _____
Otra información: _____
_____
_____
_____
_

Información sobre el personal

Personal	Cantidad (Tiempo Completo + Tiempo Parcial)	Horas de trabajo	Actividad específica	Nivel de educación
Botones	+			
Recepcionista	+			
Camarera	+			
Limpieza	+			
Mantenimiento	+			
Jardineros	+			
Instructores	+			
Guías Turísticos	+			
Cocineros	+			
Bartenders	+			
Saloneros	+			
Otros	+			

Información sobre el consumo de energía y agua

¿Puede usted describir/especificar el objeto del hotel en relación con el consumo de energía?

_____
_____
_____

Antes de comunicarme con COOPELESCA (distribuidor de electricidad en La Fortuna??) y con la empresa que distribuye el agua potable en San Carlos yo necesito obtener alguna información sobre el consumo de electricidad de su hotel para poder realizar este estudio.

1.1 ¿Cuántos medidores de electricidad hay en el hotel? _____
Los números de los medidores son: _____
_____

(1.1 a ¿Cuánto es el consumo de electricidad promedio? Mensual: _____ Anual: _____ (colones o Kwh)**)**

1.2 Tiene tanques de gas? **_____** ¿En que lugares tiene tanques de gas? _____
1.2 a ¿Qué tamaño o capacidad tienen los diferentes tanques de gas?
_____
_____
1.2 b ¿Dónde adquieren o compran los tanques de gas? _____
1.2 c ¿Cuánto es el consumo de gas en el hotel? Mensual: _____ Anual: _____(litros / m^3 / Joules)

1.3 ¿Cuánto es el consumo de
diesel ? Mensual: _____ Anual: _____ (litros)
gasolina? Mensual: _____ Anual: _____ (litros)
otro _____? Mensual: _____ Anual: _____ (litros)

1.4 ¿Cuánto Agua consume el hotel? Mensual: _____ Anual: _____ (m^3 o colones)

Información sobre la distribución del Hotel

1.5	Número de habitaciones _____		
1.6	¿Tiene Restaurante?	Sí ( )	No ( )
1.7	¿Cocina?	Sí ( )	No ( )
1.8	¿Piscina(s)	Sí ( ): Cantidad _____	No ( )
1.9	¿Jacuzzi?	Sí ( ): Cantidad _____	No ( )
1.10	¿Sauna Seco o húmedo?	Sí ( ): Cantidad _____	No ( )
1.11	¿Zona para Deportes?	Sí ( )	No ( )
1.12	¿Salón de Juegos?	Sí ( )	No ( )
1.13	¿Jardín ó áreas verdes?	Sí ( )	No ( )
1.14	¿Sala de Conferencias?	Sí ( ): Cantidad _____	No ( )
1.15	¿Tienda de Artesanías?	Sí ( )	No ( )
1.16	¿Lavandería y Servicio de planchado?	Sí ( )	No ( )
1.17	¿Otras facilidades no mencionadas?	*Sí ( )	No ( )

* Si su respuesta es afirmativa anótelas por favor:
_____
_
1.18 **Descripción general del sistema de calefacción y distribución de agua:**
1.19 a ¿Conoce usted La Certificación para la Sostenibilidad Turística?
Sí ( ) No ( )
1.19 b ¿Participa usted en La Certificación para la Sostenibilidad Turística?
Sí ( ) → 1.20 No ( )
1.19 c ¿Por qué no participa usted en este programa?
_____
_____
__

1.20 ¿Participa usted de otras programas externos relacionado con el ahorrar o la sostenibilidad de energía?
No ( )
Sí ( ) a saber, _____
_____

La próxima pregunta va sobre la inversión y el tiempo de recuperación
1.21 A continuación se mencionan diferentes clases de inversiones y le pregunto el máximo tiempo de recuperación por esta inversión que usted cree es aceptable.

	Tiempo de recuperación (años)	>10	10-9	9-8	8-7	7-6	6-5	5-4	4-3	3-2	2-1	1-0	No deseo invertir tanto
Clase de Inversión		↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
Menos de 100.000 colones	→												
Entre 100.000 y 250.000 colones	→												
Entre 250.000 y 500.000 colones	→												
Entre 500.000 y 1.000.000 colones	→												
Entre 1.000.000 y 2.500.000 colones	→												
Entre 2.500.000 y 5.000.000 colones	→												
Entre 5.000.000 y 10.000.000 colones	→												
Más de 10.000.000 colones	→												

2. Mantenimiento de los equipos
Introducción: *En general hay tres tipos de mantenimiento, a saber:*

- **Mantenimiento Correctivo**: Mantenimiento de los equipos con problemas actuales. Sólo los problemas actuales son reparados.
- **Mantenimiento Preventivo**: Mantenimiento para evitar problemas y para prolongar la vida útil de los equipos, por ejemplo a través de limpiar partes de los equipos. Este mantenimiento es un tipo de mantenimiento ejecutado regular, por ejemplo una o dos veces en un mes.
- **Mantenimiento Predictivo**: Partes de equipos o equipos completos que se reemplazan después un número de horas o meses determinado, para prevenir problemas con estas partes de los equipos.

Preguntas sobre el mantenimiento:
2.1 ¿Cualquier persona(s) ejecuta(n) el mantenimiento?
( ) Un(os) empleado(s) del hotel, a saber __ números de personas
( ) Una(s) persona(s) a través de un contracto con una(s) empresa(s) externa.
Información sobre los contractos:
_____
_____
_____
( ) Diferente, a saber _____

2.2 En relación con el mantenimiento correctivo: ¿Cuantos días hay entre el aviso del problema y el ejecutar del mantenimiento?
( ) 0, ejecuta el mantenimiento en el mismo día
( ) 1-6 días, ejecuta el mantenimiento dentro de una semana
( ) 7-13 días, ejecuta el mantenimiento dentro de dos semanas
( ) Más de 13 días.
( ) No lo sabe.

2.3 a ¿Ejecuta el hotel mantenimiento preventivo?
Sí ( ) No ( ) (Pase a la pregunta 2.4)
2.3 b ¿Cuantos veces en un mes ejecuta el hotel mantenimiento preventivo?
( ) Menos de una vez, a saber ___ veces a un año
( ) 1 vez al mes
( ) 2 veces al mes
( ) Más de dos veces, a saber ___ veces a un mes
2.3 c ¿A cuales equipos o partes de equipos ejecuta el hotel mantenimiento preventivo?
_____
_____
__**2.4 a** ¿Ejecuta el hotel mantenimiento predictivo?
Sí ( ) No ( ) (Pase a la pregunta 2.5)
2.4 b ¿A cuales equipos o partes de equipos ejecuta el hotel mantenimiento predictivo y después de cuantas horas de funcionamiento?
_____
_____
__

2.5 a ¿Tiene el hotel un sistema de registro de los problemas y de las partes reemplazadas de los equipos?
Sí ( ) No ( )
2.5 b ¿Por qué no?
( ) No lo creo importante
( ) No he pensado en un sistema de registro de este tipo
( ) Un sistema de registros es demasiado caro
( ) Diferente, a saber _____

3. Las Habitaciones
Descripción general de las habitaciones (Descripción de los cuadros):

3.1 ¿Hay Aire Acondicionado en las habitaciones?
No ( )) (Pase a la pregunta 3.2)
Sí a ___ (número de las habitaciones con aire acondicionado)
Descripción general del sistema de aire acondicionado
La Marca del Sistema: _____
La Capacidad: _____
El Proveedor: _____
La Fecha de compra: _____
La Ubicación: _____
Otra Información[57]: _____

3.2 ¿Hay una Sistema de abanico en las habitaciones?
No ( ) (Pase a la pregunta 3.3)
Sí ( )
Descripción general del sistema de abanico
La Marca del Sistema: _____
La Capacidad: _____
El Proveedor: _____
La Fecha de compra: _____
La Ubicación: _____
Otra Información: _____

[57] Otra información es por ejemplo el precio, la vida útil. Esta información depende en la información que el dueño tiene sobre los equipos.

3.3 ¿Hay agua caliente en las habitaciones?
No ( ) (Pase a la pregunta 3.4)
Sí ( )
Descripción general del sistema de calefacción
La Marca del Sistema: _____
La Capacidad: _____
El Proveedor: _____
La Fecha de compra: _____
La Ubicación: _____
Otra Información: _____

3.4 ¿Hay televisor en las habitaciones?
No ( ) (Pase a la pregunta 3.5)
Sí ( )
La Marca del Sistema: _____
La Capacidad: _____
La Fecha de compra: _____

3.5 ¿Hay un refrigerador en las habitaciones?
La Marca del Sistema: _____
La Capacidad: _____
La Fecha de compra: _____

3.6 ¿Cuántas lámparas hay en una habitación (incluído el baño)? _____
Información sobre los lámparas (Ubicación, Vatio, Marca).

Descripción general de los cuartos de baño

_____
_____
__

3.7 ¿Hay una ducha en el cuarto de baño?
No ( ) (Pase a la pregunta 3.8)
Sí ( )
La Marca del Cabeza de ducha: _____
La Capacidad (litros / minuto): _____
La Fecha de compra: _____

3.8 ¿Hay una lavabo en el cuarto de baño?
No ( ) (Pase a la pregunta 3.9)
Sí ( )
La Marca del grifo: _____
La Capacidad (litros / minuto): _____
La Fecha de compra: _____
3.9 Descripción del servicio

_____
_____
__

4. El Restaurante
Descripción general del restaurante
(El color de las paredes, las ventanas y otras aberturas, número de mesas, capacidad (desayuno, almuerzo, cena))

_____
_____
__

4.1 ¿Hay aire acondicionado en el restaurante?
No ( ) (Pase a la pregunta 4.2)
Sí ( )
Descripción general del aire acondicionado
La Marca del Sistema: _____
La Capacidad: _____
El Proveedor: _____
La Fecha de compra: _____
La Ubicación: _____
Otra Información: _____

4.2 ¿Hay un sistema de abanico en el restaurante?
No ( ) (Pase a la pregunta 4.3)
Sí ( )
Descripción general del sistema abanico/ventiladores
La Marca del Sistema: _____
La Capacidad: _____
El Proveedor: _____
La Fecha de compra: _____
La Ubicación: _____
Otra Información: _____

4.3 ¿Cuántos lámparas hay en el restaurante? _____
Información sobre los lámparas (Ubicación, Vatio, Marca)
_____
_____
___

5. La Cocina
Descripción general de la Cocina
_____
_____
__

5.1 ¿Hay un Horno en la cocina?
No ( ) (Pase a la pregunta 5.2)
Sí ( )
Descripción general del horno
La Marca del Sistema: _____
La Capacidad: _____
El Proveedor: _____
La Fecha de compra: _____
Otra Información: _____

5.2 ¿Hay una Cocina en la cocina?
No ( ) pregunta 5.3
Sí ( )
Descripción general de la Cocina
La Marca del Sistema: _____
El Proveedor: _____
La Fecha de compra: _____
Otra Información: _____

5.3 ¿Hay un Microondas en la cocina?
No ( ) pregunta 5.4
Sí ( )
Descripción general del Microondas
La Marca del Sistema: _____
La Capacidad: _____
El Proveedor: _____
La Fecha de compra: _____
Otra Información: _____

5.4 ¿Hay un Lavavajillas en la cocina?
No ( ) (Pase a la pregunta 5.5)
Sí ( )
Descripción general del Lavavajillas
La Marca del Sistema: _____
La Capacidad: _____
El Proveedor: _____
La Fecha de compra: _____
Otra Información: _____

5.5 ¿Hay un Refrigerador en la cocina?
No ( ) (Pase a la pregunta 5.6)
Sí ( ) a saber ___ (número de refrigeradores)
Descripción general de los refrigeradores (Cuando hay más que uno describe todos)
La Marca del Sistema: _____
La Capacidad: _____
El Proveedor: _____
La Fecha de compra: _____
Otra Información: _____

5.6 ¿Hay un Purificador de Grasa en la cocina?
No ( ) (Pase a la pregunta 5.7)
Sí ( )
Descripción general de Purificado de Grasa
La Marca del Sistema: _____
La Capacidad: _____
El Proveedor: _____
La Fecha de compra: _____
Otra Información: _____

5.7 ¿Cuántas lámparas hay en la cocina? _____
Información sobre los lámparas (Ubicación, Vatio, Marca)

5.8 Descripción de los grifos
_____
_____
—

6. La Lavandería
Descripción general de la lavandería
_____
_____
—

6.1 ¿Cuántas lavadoras hay en la lavandería? _____
Descripción general de las lavanderías
La Marca del Sistema: _____
La Capacidad: _____
El Proveedor: _____
La Fecha de compra: _____
Otra Información: _____

6.2 ¿Hay secadoras de ropa en la lavandería?
No ( )
Sí ( ) ¿Cuántas? _____
Descripción general de los secadoras
La Marca del Sistema: _____
La Capacidad: _____
El Proveedor: _____
La Fecha de compra: _____
Otra Información: _____

6.3 ¿Cuántas lámparas hay en la lavandería? _____
Información sobre los lámparas (Ubicación, Vatio, Marca).
_____
_____
—

6.4 Descripción de los grifos
_____
_____
—

7. La Piscina
Descripción general de la Piscina
(cantidad de piscinas, las dimensiones de las piscinas, la frecuencia del cambio del agua, la ubicación (fuera o dentro), etc.)

7.1 ¿Cuáles son las características de la bomba?
La Marca del Sistema: _____
La Capacidad: _____
El Proveedor: _____
La Fecha de compra: _____
Otra Información: _____

8. El Jacuzzi
Descripción general del jacuzzi
_____
_____
—

8.1 ¿Cuáles son las características de la bomba?
La Marca del Sistema: _____
La Capacidad: _____
El Proveedor: _____
La Fecha de compra: _____
Otra Información: _____

8.2 ¿Cuáles son las características del calentador?
La Marca del Sistema: _____
La Capacidad: _____
El Proveedor: _____
La Fecha de compra: _____
Otra Información: _____

9. El Jardín
Descripción general del jardín (número de lamparas, horas de funcionar, etc.)
_____
_____
__

10. **La Recepción**
Descripción general de la Recepción
_____
_____
__

11. Tienda de Artesanías
Descripción general de la Tienda de Artesanías
_____
_____
____

12. Otros lugares en el hotel
_____
_____
____

Appendix III Checklist Used at the Hotels

Air conditioning Area to be cooled (shape and m^3) Capacity Control mechanism Insulation of area to be cooled --» box rooms Leakage Location Maintenance Sun and shades Things blocking air inlet or outlet Tubes (for centralised system) Type of air conditioning system	**Bathroom** General description Colours of walls and ceiling Construction material of walls and ceiling Shower heads --» box water taps… Toilet --» box water taps… Water taps --» box water taps…
Buildings General description Construction material(s) Number of floors Outside colours of the buildings Purpose of the buildings Type of buildings	**Electricity network** Number of electrical groups Network overview of the different groups Electricity consumption per group Number and type of equipment per group Possible additional electrical connections
Garden General description Use of natural protection (e.g. trees for shadow to protect buildings from the sun)	**Jacuzzi and energy consumption** Type of water heater Capacity of water heater Isolation of tubes Leakage Water circulation pump capacity Water circulation time
Kitchen and energy consumption General description *Amount, capacity, energy source and other features of the following equipment*: Air conditioning--» box air conditioning Dishwasher Freezers (Electrical) frying pan Microwave oven Oven Refrigerators Stove Ventilation --» box ventilators Other equipment	**Launderette and energy consumption** General description Amount of dryers Type and capacity of dryers Amount of washers Type and capacity of washers (Watts and kg/wash) Other equipment
Lighting Amount per area Amount of lumen per lamp Capacity (Wattage) Lifetime Maintenance Type Control mechanism Hours of fixed working	**Reception** General description Colour of walls and ceilings Construction material of walls and ceilings Doors, windows and isolation Computer Ventilation --» box ventilators Air conditioning --» box air conditioning Other equipment
Restaurant/Bar General description Air conditioning --» box air conditioning Colours of walls and ceiling	**Rooms** General description Air conditioning --» box air conditioning Additional possible electrical contacts that can be

Construction material of walls and ceiling Doors, windows and isolation Equipment related to the bar Music installation Number of tables and chairs Refrigerators/freezers TV Ventilation --» box ventilators Other equipment	used by guests Colours of walls and ceilings Construction material of walls and ceilings Doors, windows and isolation Information tabloid about efficient use of facilities Refrigerator TV Ventilation --» box ventilators Other equipment
Swimming Pool and energy consumption General description Isolation of tubes Maintenance (also applicable to water consumption) Water circulation pump capacity Water circulation time Water heater	**Souvenir shop** General description Air conditioning --» box air conditioning Colours of walls and ceilings Construction material of walls and ceilings Doors, windows and insulation Ventilation --» box ventilators Other equipment
Ventilators Capacity Control mechanism Location Type	**Water taps and showers** Control mechanism Maximum water flow and comfort
Water heating and transport of heated water Capacity of the water heater Leakage Maintenance Pump capacity Reservoir tank capacity and insulation Type and different parts of the water heater Type of energy source and energy consumption Tubes and insulation	**Others** General description Capacity Brand Location

--» box "name" = refers to the box with that particular name.

- ***General information and features of the hotel:***

  Through a questionnaire and a walk through of the hotels I will gather e.g. the following information:

  - General features like the number of stars, membership of CCH and others
  - Capacity (number of rooms and beds)
  - Machinery and equipment in the hotel
  - Building features
  - Type of facilities
  - Employers and their characteristics
  - Objectives of the owner
  - Maintenance management and energy management programs

  Blueprints of the buildings can be useful and therefore if there are blueprints they are very helpful otherwise make a map of the area.

- ***The gathering of the consumption of energy and water of the hotel in the last years***

  - *Electricity consumption* → Probably through Coopelesca, the company in San Carlos (Quesada) and the numbers of the electricity groups (the numbers on the

actual meter). Maybe the hotel has information about the energy consumption but this is often not the case according to Rosendo Pujol.
- *Gas consumption* → through the receipts of the supplier and the hotel manager
- *Diesel consumption* → the same way as the gas consumption
- *Other energy consumption* → the same way as the gas consumption

❖ ***The gathering of the capacity of the different machinery and equipment***

Try to find the information at the hotel by looking at the equipment itself or maybe by taking a look at the manual (if there is any). If it is not possible to gain the information this way, try to write down the different brands and types of the equipment and get in contact with the company concerned or the supplier of the equipment. Then hope they can give the information

Checklist for general features of the hotel

- Describe all the separate buildings and main locations (Colours, roofs, etc.) e.g.
  - Reception
  - Restaurant/kitchen
  - Building with the rooms
  - Swimming pool area
  - Souvenir shop
  - Other
- Make a drawing of how the buildings/main locations are located/situated
- Make more pictures of the important locations and equipment
- Describe the terrain (gardens, walking areas, use of nature, count number of outside lights, their wattage and type)
- Look at the number of electrical groups and note down their numbers for retrieving the energy bills of the electrical company.

Checklist for the rooms

- Describe the room in general (size, shape, atmosphere, etc., draw the room)
- Count number of lights
- Look at wattage of the lights and the type of lights
- Check other electrical equipment (brand, capacity etc.) e.g.
  - Air conditioner
  - Ventilator
  - TV
  - Refrigerator
  - Other
- Check structure of the walls, note down the colours and the material (if you can find it out)
- Describe the window (size, type, colour, possibility to open, isolation)
- Describe the door (type, colour and isolation)
- Close door and look at how much light there is in the room without the lights on (artificial light needed?)
- From the outside look at the overhanging of the roof and the shadow working
- Look at the direction of the windows (North, East etc.)

Checklist for the bathrooms

- Describe bathroom in general (size, shape of room, colours of walls, tiles, make drawing)
- Count number and look at wattage and type of lights
- Check other present equipment consuming energy (not water)

- Look at the type and isolation of possible windows
- Describe the water consuming units (brand, capacity, etc.) e.g.
    - Shower(head)
    - Toilet
    - Lavatory tap point
    - Other

Checklist for the restaurant/bar

- Describe the restaurant in general (Size, shape, open or closed structure, colour of the walls, number of tables, make a drawing)
- Count the number and look at wattage and type of the lights
- Check other electrical equipment e.g.
    - Ventilator
    - Stereo (Music)
    - Television
    - Refrigerators
    - Other

Checklist for the kitchen

- Describe the kitchen in general
- Count the number and look at the wattage and type of the lights
- Check other electrical equipment e.g.
    - Ventilator
    - Refrigerator(s)
    - Freezer(s)
    - Microwave oven
    - Oven
    - Electrical Stove
    - Other
- Check the gas consuming equipment in the kitchen e.g.
    - Gas stove
    - Gas oven
    - Other

Checklist for the swimming pool(s)

- Describe the swimming pool(s) in general (draw picture)
- Check the electrical equipment related to the swimming pool e.g.
    - Lighting in the swimming pool
    - Heater for heating the swimming pool
    - Pump for pumping around the water
    - Other
- Check possible shower by the swimming pool

Checklist for the Jacuzzi

- Describe the Jacuzzi
- Check the electrical equipment e.g.
    - Lighting
    - Pump
    - Other
- Check the equipment running on gas e.g.
    - Water heater

- Other

Checklist for the reception and the souvenir shop

- Describe the reception and souvenir shop (they are put together, because I know they are located in the same area in the hotels that have both)
- Count number, look at wattage the type of the lights
- Check other electrical equipment e.g.
  - Computer
  - Ventilator
  - Air conditioning
  - Refrigerator
  - Other
- If there is an air conditioner describe the windows and doors accurately

Appendix IV Law 7447: Tax Free Equipment

LEY 7447 LA ASAMBLEA LEGISLATIVA DE LA REPUBLICA DE COSTA RICA
DECRETA:
REGULACION DEL USO RACIONAL DE LA ENERGIA

CAPITULO IX INCENTIVOS

ARTICULO 38.- Exoneraciones

Se eximen del pago de los impuestos selectivo de consumo, ad valórem, de ventas y el estipulado en la Ley No.6946, del 14 de enero de 1984, los siguientes equipos y materiales, tanto importados como de fabricación nacional:

- Calentadores solares de agua para todo uso, con certificación de eficiencia expedida por un laboratorio acreditado.
- Tanques de almacenamiento de agua para sistemas de calentamiento solar del tipo termosifón.
- Paneles de generación eléctrica fotovoltaica, de cualquier capacidad.
- Sistemas de control para paneles fotovoltaicos, generadores eólicos e hidroeléctricos de corriente directa.
- Convertidores estáticos de corriente directa en alterna para sistemas
- fotovoltaicos, eólicos y generadores hidroeléctricos de corriente directa. .Baterfas de plomo ácido de ciclo profundo y baterfas de nfquel-cadmio y nfquel-hierro, con capacidades mayores de 50 amperios-hora.
- Cabezales economizadores de agua caliente para duchas y fregaderos, con consumo inferior a 9,5 litros/minuto.
- Luminarias fluorescentes y halógenos eficientes.
- Generadores eólicos e hidroeléctricos para uso no relacionado con la
- generación privada de electricidad, que selÏala la Ley No.7200, del 28 de setiembre de 1990.
- Equipos de control de voltaje y frecuencia para generadores eólicos e hidroeléctricos.
- Equipos electrodomésticos de corriente directa, para utilizarse con paneles totovoltaicos, generadores eólicos e hidroeléctricos de corriente directa.
- Materiales para construir equipos para aprovechar las energlas renovables. .Vidrio atemperado con menos de 0,02% de contenido de hierro.
- Aislantes térmicos para colectores solares como polisocianurato y poliuretano, los aditivos para elaborarlos o ambos.
- Placas absorbentes y tubos aleteados para calentadores de agua.
- Perfiles de aluminio especlficos para construir calentadores solares de agua.
- Aislantes térmicos para tuberlas de agua.
- Cualquier aislante térmico util para mejorar el aislamiento de tanques de almacenamiento de agua calentada con sistemas solares.
- Instrumentos de medición de variables relacionadas con las energlas
- renovables, tales como: medidores de temperatura, medidores de presión
- de fluidos, anemómetros para medir la dirección y la velocidad del viento y medidores de la radiación solar.
- Sistemas de bombeo alimentados con sistemas totovoltaicos y eólicos. Retrigeradores y cocinas solares. Bombas de ariete.

ARTICULO 39.- Requisito para la exención

Para beneficiarse con la exención a que se refiere el articulo anterior, los equipos y los materiales, deberán mostrar necesariamente, en un lugar visible y destacado, el numero de la licencia de tabricación ode importación.

ARTICULO 40.- Licencia para fabricar sistemas de aprovechamiento de energias renovables

El MIRENEM expedirá una licencia de tabricación de sistemas de aprovechamiento de las energias renovables. Esta permitirá eximir de impuestos los materiales y los componentes especificados en el articulo 38 de esta Ley y evitará que se destinen a usos diterentes. Para gozar de la exención, el MIRENEM deberá aprobar los equipos y los materiales que se importen.

ARTICULO 41.- Requisito para la exención

En las tacturas por la compra de sistemas de aprovechamiento de las energías renovables, las personas, tanto fisicas como jurídicas, deberán obtener un sello del MIRENEM para acreditar la exención de los impuestos.

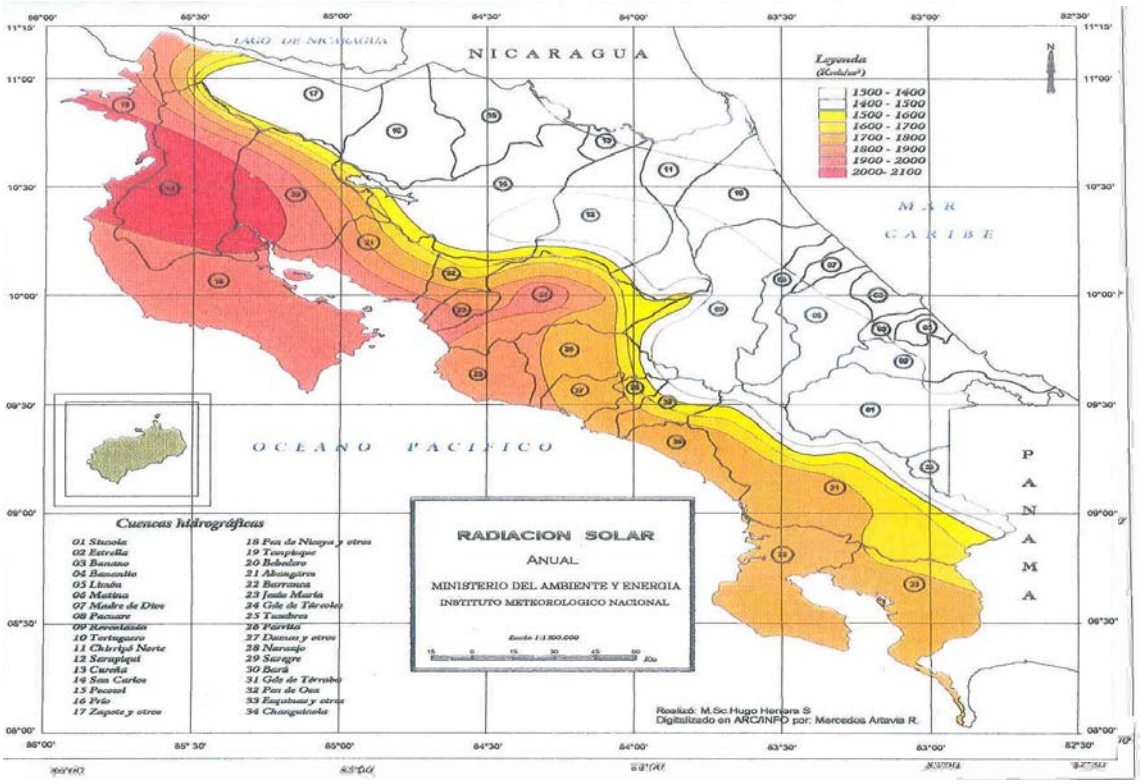
ARTICULO 42.- Dependencia ejecutora

EI MIRENEM designará la dependencia encargada de cumplir con 10 dispuesto en el presente capítulo.

Appendix V Climatic Conditions[58]

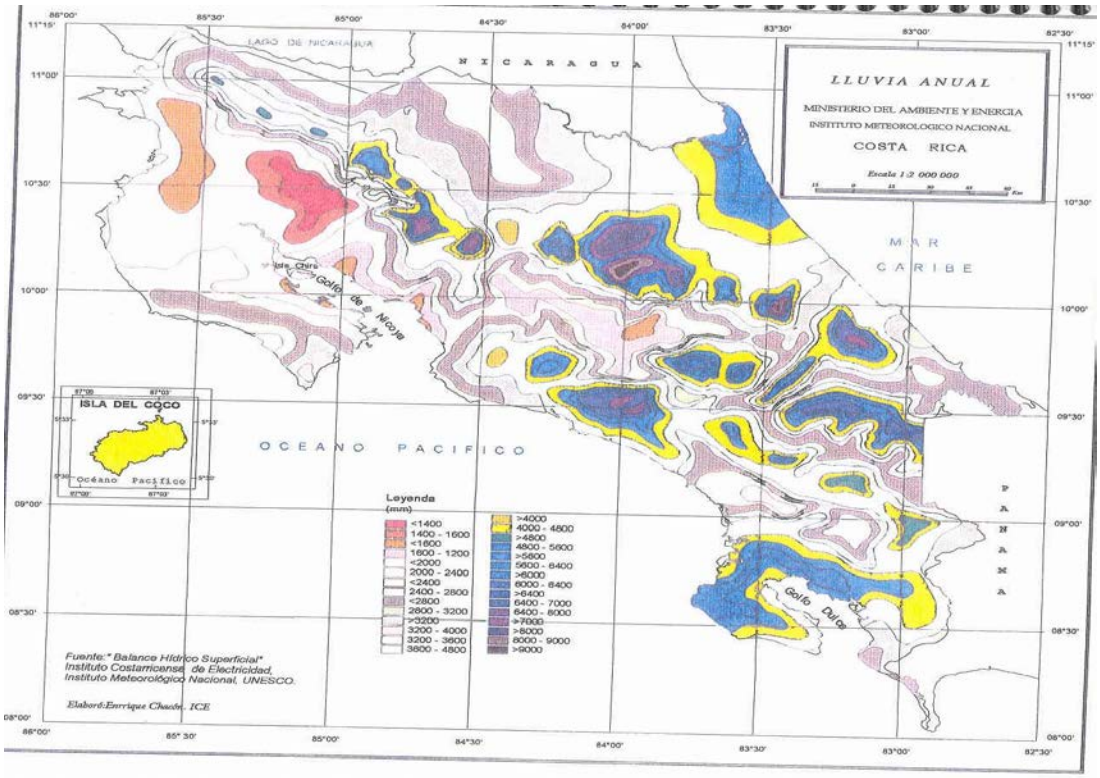
Climatic Conditions in Costa Rica

Hours of sun in Costa Rica

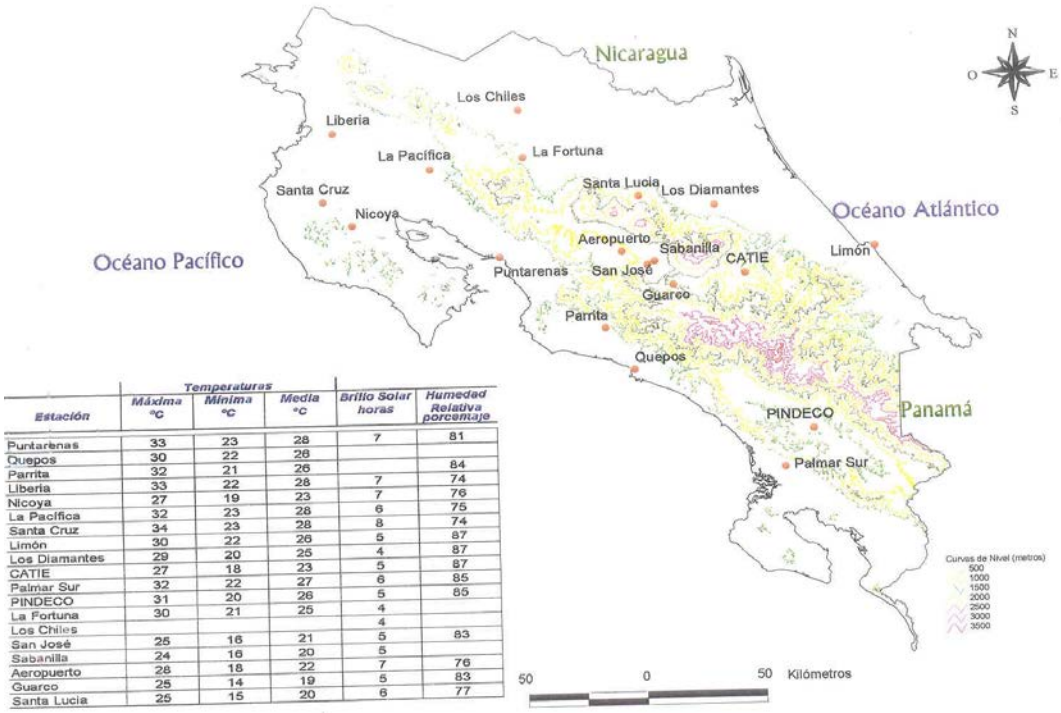


Sun Intensity in Costa Rica

[58] Source: Instituto Meteorologica Nacional



Rainfall in Costa Rica



Estación	Temperaturas Máxima °C	Mínima °C	Media °C	Brillo Solar horas	Humedad Relativa porcentaje
Puntarenas	33	23	28	7	81
Quepos	30	22	26		
Parrita	32	21	26		84
Liberia	33	22	28	7	74
Nicoya	27	19	23	7	76
La Pacífica	32	23	28	6	75
Santa Cruz	34	23	28	8	74
Limón	30	22	26	5	87
Los Diamantes	29	20	25	4	87
CATIE	27	18	23	5	87
Palmar Sur	32	22	27	6	85
PINDECO	31	20	26	5	85
La Fortuna	30	21	25	4	
Los Chiles				4	
San José	25	16	21	5	83
Sabanilla	24	16	20	5	
Aeropuerto	28	18	22	7	76
Guarco	25	14	19	5	83
Santa Lucia	25	15	20	6	77

Temperatures in Costa Rica

Climatic Conditions in La Fortuna de San Carlos[59]

La Estación de La Fortuna de San Carlos

10o28 latitud Norte, 84o39 longitud Oeste y a una elevacíon de 250 m

Promedio Mensual de Mínima del Termometro

Año	Enero	Febrero	Marzo	Abril	Mayo	Junio	Julio	Agosto	Septiembre	Octobre	Noviembre	Diciembre	Promedio
1981			23,0	23,7	25,3	25,2	24,9	22,8	24,9	25,8	24,9	21,0	24,2
1982	19,3	18,0	16,8	17,3	17,8	18,0	18,5	18,6	18,2	17,6			18,0
1983				23,5	22,0	22,5	23,2	22,3	20,7	19,9	19,7		21,7
1984								23,2	20,5	20,5		20,6	21,2
1985	19,5	19,3	19,7	20,4	20,5	19,7							19,9
1986	18,6	18,4	19,3	20,7	20,9	21,5	21,6	21,9	21,5	21,1	21,5	20,2	20,6
1987	19,7	20,8	20,4	20,1	21,8	21,5	22,2	22,0	22,0	21,7	21,4	21,0	21,2
1988	20,4	21,0		19,0	18,7		19,9						19,8
1989													
1990			21,1		22,0	22,2	21,8	22,4	21,9	21,1	22,0	20,4	21,7
1991	20,4		20,6	21,4	22,4	22,6	22,2	21,9	21,9	21,4	21,3	20,7	21,5
Promedio	19,7	19,5	20,1	20,8	21,3	21,7	21,8	21,9	21,5	21,1	21,8	20,7	21,0
Máximo	20,4	21,0	23,0	23,7	25,3	25,2	24,9	23,2	24,9	25,8	24,9	21,0	
Minimo	18,6	18,0	16,8	17,3	17,8	18,0	18,5	18,6	18,2	17,6	19,7	20,2	

Promedio Mensual de Máxima del Termometro

Año	Enero	Febrero	Marzo	Abril	Mayo	Junio	Julio	Agosto	Septiembre	Octobre	Noviembre	Diciembre	Promedio
1981	25,2	29,2	29,3	29,5	30,7	30,3	29,6	29,9	30,3	29,9	28,1	27,7	29,1
1982	28,9	29,7	30,3	31,1	31,6	30,7	29,4	29,6	30,0	29,6			30,1
1983				32,8	31,1	32,0	29,5	30,3	30,6	29,8	29,8		30,7
1984								29,5	30,4	29,3		28,4	29,4
1985	28,7	29,2	30,9	32,1	32,7	31,2	30,5	31,9					30,9
1986	31,4	32,5	30,0	30,2	30,8	28,8	28,3	28,9	29,4	29,1	29,1	29,1	29,8
1987	27,9	27,7	31,5	29,4	30,8	30,9	29,5	29,5	30,4	29,6	29,5	29,4	29,7
1988	28,6	28,5		31,1	32,3		30,6						30,2
1989													
1990		28,8	28,9		29,1	28,5	28,1	28,3	29,2	29,5	28,6	27,6	28,7
1991	28,2	27,6	29,9	30,5	29,2	29,3	28,1	28,4	29,1	29,2	26,5	26,8	28,6
Promedio	28,4	29,2	30,1	30,8	30,9	30,2	29,3	29,6	29,9	29,5	28,6	28,2	29,7
Máximo	31,4	32,5	31,5	32,8	32,7	32,0	30,6	31,9	30,6	29,9	29,8	29,4	
Minimo	25,2	27,6	28,9	29,4	29,1	28,5	28,1	28,3	29,1	29,1	26,5	26,8	

Temperaturas Extremas, Resumen anual de los promedias

Media en función a los termometros de máxima y mínima

Año	Enero	Febrero	Marzo	Abril	Mayo	Junio	Julio	Agosto	Septiembre	Octobre	Noviembre	Diciembre	Promedio
1981			26,1	26,6	28,0	27,7	27,2			27,8		24,3	26,8
1982	24,1		23,6	24,2	24,7	24,4	23,9	24,1	24,1	23,6			24,1
1983				28,1	26,4	27,2	26,4	26,3			24,8		26,5
1984								26,3	25,4	24,8		24,5	25,3
1985	24,1	24,3	25,3	26,2	26,6	25,4							25,3
1986	25,0			25,4	25,9	25,2	24,9	25,5	25,5	25,1	25,3	24,7	25,3
1987	23,8	24,2	26,0	24,8	26,3	26,2	25,9	25,8	26,2	25,7	25,5	25,2	25,5
1988	24,5	24,8		25,0	25,5	25,3							25,0
1989													
1990			25,0		25,5	25,3	25,0	25,3	25,6	25,4	25,3	23,9	25,1
1991	24,3		25,3	25,9	25,8	25,9	25,2	25,2	25,5	25,3	23,9	23,7	25,1
Promedio	24,3	24,4	25,2	25,8	26,1	25,8	25,5	25,5	25,4	25,4	25,0	24,4	25,4
Máximo	25,0	24,8	26,1	28,1	28,0	27,7	27,2	26,3	26,2	27,8	25,5	25,2	
Minimo	23,8	24,2	23,6	24,2	24,7	24,4	23,9	24,1	24,1	23,6	23,9	23,7	

[59] Source: Department of Environment and Energy, National Meteorological Institute

Resumen Mensual de Precipitación

Año	Enero	Febrero	Marzo	Abril	Mayo	Junio	Julio	Agosto	Septiembre	Octubre	Noviembre	Diciembre	Promedio	Total
1981	374,4	225,0	121,7	232,8	593,7	497,3	422,9	355,1	201,5	488,6	317,9	355,6	348,9	4186,5
1982	133,4	72,6	49,0	51,0	224,3	393,1	976,7	458,2	331,5	537,6	97,9	266,2	299,3	3591,5
1983	402,3	84,7	95,3	18,5	245,8	251,9	403,3	312,4	277,4	525,4	234,0		259,2	2851,0
1984								614,4	412,7	584,0		274,6	471,4	
1985	129,5	235,5	106,0	41,0	207,0	489,9	557,4	379,9	242,5	228,8	241,7	146,5	250,5	3005,7
1986	120,2	53,8	149,7	91,2	131,2	478,4	463,6	465,1	406,2	351,8	350,2	213,3	272,9	3274,7
1987	199,4	87,5	55,6	125,4	226,0	497,6	443,0	427,8	358,1	466,0	287,6	272,3	287,2	3446,3
1988	197,8	320,6	115,4	31,1	312,2	234,7	428,0						234,3	
1989										462,6	408,7	194,6	355,3	
1990	260,0	33,0	237,2	35,4	397,3	460,9	595,8	595,9	431,0	411,8	313,2	227,1	333,2	3998,6
1991	60	239	28	47,9	355,8	471,3	480,2	613,6	536,3	346,2	385,6	303,6	322,3	3867,5
1992	125,2	91,9				323,3	644,9	234,5	394,1		225,4	369,1	301,1	
1993	182,9	36,7	110,8	57	243,6	433,4							177,4	
1994	77,9	39,3											58,6	
1995											135,8		135,8	
Promedio	188,6	126,6	106,9	73,1	293,7	412,0	541,6	445,7	359,1	440,3	272,5	262,3	273,8	3527,7
Máximo	402,3	320,6	237,2	232,8	593,7	497,6	976,7	614,4	536,3	584,0	408,7	369,1	481,1	
Minimo	60,0	33,0	28,0	18,5	131,2	234,7	403,3	234,5	201,5	228,8	97,9	146,5	151,5	

Appendix VI Information about Tourism in Costa Rica[60]

INTERNATIONAL TOURIST ARRIVALS BY NATIONALITY (1989-1999)

REGIONS	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
TOTAL	**375.951**	**435.037**	**504.649**	**610.591**	**684.005**	**761.448**	**784.610**	**781.127**	**811.490**	**942.853**	**1.027.462**
NORTHERN AMERICA	**153.112**	**191.284**	**223.126**	**274.061**	**302.741**	**332.602**	**349.307**	**329.917**	**347.740**	**419.648**	**467.851**
Canada	20.285	30.892	37.187	42.029	44.236	49.091	41.898	36.271	37.032	42.097	43.662
USA	124.264	150.224	173.626	217.693	242.546	263.568	287.434	271.320	285.361	347.442	392.217
Mexico	8.563	10.168	12.313	14.339	15.959	19.943	19.975	22.326	25.347	30.109	31.972
CENTRAL AMERICA	**135.376**	**139.913**	**164.809**	**187.790**	**193.512**	**221.384**	**218.023**	**234.326**	**247.039**	**293.810**	**309.338**
Guatemala	14.977	14.695	16.079	19.010	22.664	22.207	24.305	25.138	26.360	30.982	34.064
El Salvador	8.359	8.986	11.299	15.668	18.248	21.755	22.340	24.141	24.166	24.741	28.752
Honduras	10.066	8.894	10.475	13.238	12.930	14.925	15.876	16.475	18.319	19.380	26.762
Nicaragua	38.812	49.395	73.558	78.011	81.875	107.851	102.557	119.995	129.333	170.059	166.511
Panama	63.162	57.943	53.398	61.863	57.795	54.646	52.945	48.577	48.861	48.648	53.249
CARIBBEAN	**4.387**	**4.192**	**4.679**	**5.344**	**6.442**	**7.425**	**7.125**	**6.704**	**7.765**	**8.910**	**9.566**
SOUTHERN AMERICA	**28.644**	**32.575**	**32.891**	**42.657**	**52.921**	**54.043**	**58.600**	**58.932**	**59.030**	**68.851**	**73.574**
EUROPE	**45.355**	**57.177**	**67.319**	**88.301**	**113.943**	**129.580**	**132.057**	**129.478**	**126.706**	**127.491**	**139.823**
OTHERS	**9.077**	**9.896**	**11.825**	**12.438**	**14.446**	**16.414**	**19.498**	**21.770**	**23.210**	**24.143**	**27.310**

LENGTH OF STAY AND AVERAGE DAILY EXPENDITURES PER VISITOR (US$)

REGION	1996		1997		1998	
	Length of stay (nights)	AVERAGE daily spent	Length of stay (nights)	AVERAGE daily spent	Length of stay (nights)	AVERAGE daily spent
United States	10,32	111,71	9,47	128,74	9,71	118,64
Canada	11,93	na	12,91	101,16	10,64	92,32
Europe	13,5	100,95	13,78	102,8	13,56	104,91
Others	9,67	101,75	7,75	109,62	7,34	129,66
TOTAl BY AIR	**10,88**	**106,6**	**10,01**	**116,65**	**9,74**	**117,9**
LAND AND SEA	**9**	**35**	**9**	**35**	**9**	**35**
TOTAL	**10,35**	**86,33**	**9,73**	**93,44**	**9,52**	**93,86**

ACCOMMODATION CAPACITY (number of rooms) AND TOURIST ARRIVALS
1987-1998

YEAR	No. of rooms	% Change	Tourist arrivals	% Change
1988	5.289	5,4	329.386	18,5
1989	5.456	3,2	375.951	14,1
1990	6.713	23,0	435.037	15,7
1991	7.196	7,2	504.649	16,0
1992	8.549	18,8	610.549	21,0
1993	9.479	10,9	684.005	12,0
1994	10.794	13,9	761.448	11,3
1995	11.862	9,9	784.610	3,0
1996	13.128	10,7	781.127	-0,4
1997	13.437	2,4	811.490	3,9
1998	13.413	-0,2	942.853	16,2
1999	14.269	6,4	1.027.462	9,0

SOURCE: Área de Empresas y Servicios Turísticos

[60] Source: ICT, 2000

COSTA RICA: EXPORTS OF MAIN PRODUCTS. 1992-1998 (millions of US $)

YEAR	COFFEE	BANANA	MEAT	SUGAR
1992	201,6	562,6	44,0	29,5
1993	201,6	564,8	63,7	27,9
1994	307,6	561,0	51,0	28,6
1995	417,1	680,2	43,6	46,1
1996	385,4	631,1	42,2	44,4
1997	416,9	570,7	28,4	41,3
1998	405,2	664,8	22,7	39,2

TRENDS OF EXPORTS AND TOURISM RECEIPS.1991-1998*(millions of US$)*

YEAR	EXPORTS	TOURIST RECEIPS	RECEIPTS AS% OF EXPORTS
1991	1.899,3	330,6	17,4
1992	2.385,2	431,1	18,1
1993	2.625,5	577,4	22
1994	2.878,2	625,7	21,7
1995	3.475,9	659,6	19,0
1996	3.758,4	688,6	18,3
1997	4.334,5	719,3	16,6
1998	5.576,7	883,5	15,8

SOURCE: Departamento Monetario, Banco Central de Costa Rica
Area de Estadísticas, Instituto Costarricense de Turismo

ACCOMMODATION CAPACITY (number of hotels) AND TOURIST ARRIVALS. 1998

REGIONS	HOTELS WITH DECLARATORIA	HOTELS WITHIN DECLARATORIA	TOTAL
San José	82	177	259
Alajuela	39	124	163
Cartago	5	31	36
Heredia	23	42	65
Guanacaste	89	182	271
Puntarenas	88	592	680
Limón	24	252	276
TOTAL	**350**	**1.400**	**1.750**

SOURCE: Área de Empresas y Servicios Turísticos
Departamento de Fomento.ICT

ACCOMMODATION CAPACITY (number of rooms) BY REGIONS. 1998

REGIONS	ROOMS WITH DECLARATORIA	ROOMS WITHIN DECLARATORIA	OFERTA TOTAL
San José	4.156	4.110	8.266
Alajuela	954	1.211	2.165
Cartago	77	308	385
Heredia	1.337	409	1.746
Guanacaste	2.859	1.771	4.630
Puntarenas	3.351	4.614	7.965
Limón	679	2.248	2.927
TOTAL	**13.413**	**14.671**	**28.084**

SOURCE: Área de Empresas y Servicios Turísticos
Departamento de Fomento.

ACCOMMODATION CAPACITY WITH,"DECLARATORIA TURÍSTICA BY CATEGORY (No. OF STARS). 1998

	Number of stars					
Provincia	Zero	One	Two	Five	Without category	Total
San José	262	392	357	622	0	4.156
Alajuela	121	126	75	0	32	954
Cartago	7	45	9	0	0	77
Heredia	47	52	75	348	0	1.337
Guanacaste	260	245	541	434	51	2.859
Puntarenas	262	228	668	408	69	3.351
Limón	161	154	122	0	56	679
Total	**1.120**	**1.242**	**1.847**	**1.812**	**208**	**13.413**

% de entrevistados según motivo de viaje

MOTIVO DE VIAJE	**%**
Placer , descanso, vacaciones	61,5
Visita a familiares y/o amigos	8,4
Negocios o trabajo	21,7
Estudio	3,8
Otros motivos	4,6
TOTAL	100,0

% de entrevistados según persona(s) con quien viajó

CON QUIÉN VIAJÓ	%
Solo	39,9
Con la familia	11,3
Con amigos	19,5
Con amigos y familiares	2,3
Con la pareja	21,3
Otro	5,7
TOTAL	100,0

% de entrevistados según frecuencia de visita

FRECUENCIA DE VISITA	%
Visitó Costa Rica por primera vez	58,5
Visitó Costa Rica por segunda vez o más	41,5
TOTAL	100,0

% de vacacionistas 1/ según frecuencia de visita

FRECUENCIA DE VISITA	%
Visitó Costa Rica por primera vez	68,0
Visitó Costa Rica por segunda vez o más	32,0
TOTAL	100,0

1/ El término vacacionista se refiere en este caso a los entrevistados que visitaron Costa Rica por motivo placer, descanso, ocio.

% de vacacionistas 1/ según lugar donde pernoctaron (durmieron) al menos una noche

LUGAR DONDE PERNOCTO (DURMIO)	%
Valle Central	80,6
Guanacaste Norte	24,2
Guanacaste Sur	11,6
Puntarenas, Golfo de Nicoya	20,9
Pacífico Medio	39,2
Península de Osa	9,1
Caribe Norte	11,4
Caribe Sur	16,1
Arenal , La Fortuna, San Carlos	29,6
Monteverde	16,2

% de vacacionistas 1/ según ESTADIA
en el lugar donde pernoctaron

LUGAR DONDE PERNOCTO	ESTADIA PROMEDIO (noches)
Valle Central	5,8
Guanacaste Norte	7,6
Guanacaste Sur	8,4
Puntarenas e Islas del Golfo de Nicoya	6,9
Pacífico Medio	6,4
Península de Osa	5,4
Caribe Sur	4,9
Caribe Norte	2,4
Arenal, La Fortuna, San Carlos	2,4
Monteverde	2,9

Sleeping locations times the lenght of stay in that particular region

548,6	467,48
143,64	183,92
76,5	97,44
107,87	144,21
190,96	250,88
37,1	49,14
62,23	55,86
20,4	38,64
57,98	71,04
35,38	46,98

% de entrevistados según grupos de edad

GRUPO DE EDAD (en años)	%
De 15 a menos de 30	26,0
de 30 a menos de 45	40,8
de 45 a menos de 60	24,4
de 60 y más años	8,8
TOTAL	100,0

% de entrevistados según estado civil

ESTADO CIVIL	%
Casado (a)	50,1
Soltero (a)	42,1
Otro estado civil	7,8
TOTAL	100,0

% de entrevistados según nivel educativo

Nivel Educativo	**%**
Primaria	0,8
Secundaria	16,2
Universitario	55,6
Posgrado	22,6
Otro	4,8
TOTAL	100,0

Estimation of the occupation percentage in 23 hotels in the Central Valley

	No. of Stars														
Month	One			Two			Three			Four			Five		
	1998	1999	1 star	1998	1999	2 stars	1998	1999	3 stars	1998	1999	4 stars	1998	1999	5 stars
Jan	54,5	57,2	55,8	71,7	62,0	66,9	47,5	58,9	53,2	61,0	66,1	63,5	52,1	64,7	58,4
Feb	51,6	58,6	55,1	67,3	65,2	66,2	57,0	66,4	61,7	72,8	74,5	73,7	69,4	74,9	72,2
Ma	66,3	57,0	61,7	56,4	55,3	55,9	68,7	64,0	66,4	64,4	67,8	66,1	73,7	71,6	72,7
Apr	50,2	42,1	46,1	45,9	44,7	45,3	53,8	53,9	53,9	46,5	59,8	53,2	51,7	63,2	57,5
May	47,8	44,3	46,1	38,7	38,9	38,8	45,4	50,7	48,1	38,0	48,3	43,2	45,7	55,0	50,3
June	37,5	40,0	38,7	33,7	33,5	33,6	47,4	55,0	51,2	51,7	47,7	49,7	38,9	49,2	44,0
July	53,2	51,9	52,5	59,8	49,3	54,5	45,4	59,1	52,3	54,8	64,4	59,6	44,3	56,1	50,2
Aug	48,3	51,4	49,8	52,4	44,5	48,4	43,4	52,8	48,1	49,7	55,6	52,7	44,7	53,9	49,3
Sept	38,9	41,1	40,0	42,8	33,6	38,2	40,1	42,6	41,4	43,3	42,1	42,7	44,2	49,2	46,7
Oct	45,5	42,3	43,9	48,6	36,9	42,7	39,9	46,7	43,3	48,4	37,1	42,7	44,5	47,5	46,0
Nov	51,2	56,0	53,6	54,5	47,1	50,8	54,3	62,4	58,4	57,7	60,5	59,1	55,4	64,7	60,1
Dec	53,6	61,9	57,7	45,5	42,3	43,9	45,5	52,6	49,0	51,4	40,5	46,0	50,5	43,6	47,0
Av	**49,9**	**50,3**	**50,1**	**51,4**	**46,1**	**48,8**	**49,0**	**55,4**	**52,2**	**53,3**	**55,4**	**54,3**	**51,3**	**57,8**	**54,5**

Appendix VII Coopelesca Electricity Prices

COOPERATIVA DE ELECTRIFICACION RURAL DE SAN CARLOS R.L. (COOPELESCA)

Tarifa 1 (T-1): Residencial

a. Aplicación: Para consumos en casas de habitación o apartamentos que sirven exclusivamente de alojamiento. No incluye hoteles, hospitales, hospicios, servicios combinados casa-pulpería, ni edificios de apartamentos servidos por un solo medidor.

Si se modificaren las características del servicio, el abonado será reclasificado a la tarifa que corresponda, si el abonado así lo solicitare o de oficio por la Cooperativa. Se tomarán en cuenta las características del servicio para definir si la reclasificación corresponde.

b. Servicio: Servicio monofásico o trifilar 120/240 voltios.

c. Precios mensuales:

Por los primeros 40 KWh o menos..... ¢ 375
Siguientes 160 KWh..... ¢ 1 2,50/KWh
Siguientes 100 KWh..... ¢ 20,00KWh
Por cada KWh adicional..... ¢ 31,00

d. Medidor: De KWh monofásico bifilar o monofásico trifilar.

e. Disponible: En todos aquellos lugares en donde está tendida la red de distribución al voltaje correspondiente.

Tarifa 2 (T-2): General

a. Aplicación: Para consumos no residenciales ni industriales.

b. Servicio: Monofásico o trifilar 120/240 voltios, trifásico 240 voltios.

c. Precios mensuales:

Para consumos menores o iguales a 3.000 KWh
Por los primeros 30 KWh o menos..... ¢ 995
Por cada KWh adicional..... ¢ 33,17

Para consumos mayores de 3.000 KWh
Cargo por demanda
Primeros 15 KW o menos..... ¢ 45 808
Por cada KW adicional..... ¢ 3 054

Cargo por energía
Primeros 3.000 KWh o menos..... ¢ 61 236
Para cada KWh adicional..... ¢ 20,41

Tarifa 3 (T-3): Industrial

a. Aplicación: Esta tarifa se aplicará a los servicios eléctricos utilizados en instalaciones dedicadas a la producción de bienes, por medio de la explotación o transformación de materias primas.

b. Servicio: Se suministra a alta o baja tensión según disponibilidad de la red y las características de la carga. Servicio monofásico o trifásico 14.400/24.940 voltios.

c. Precios mensuales:

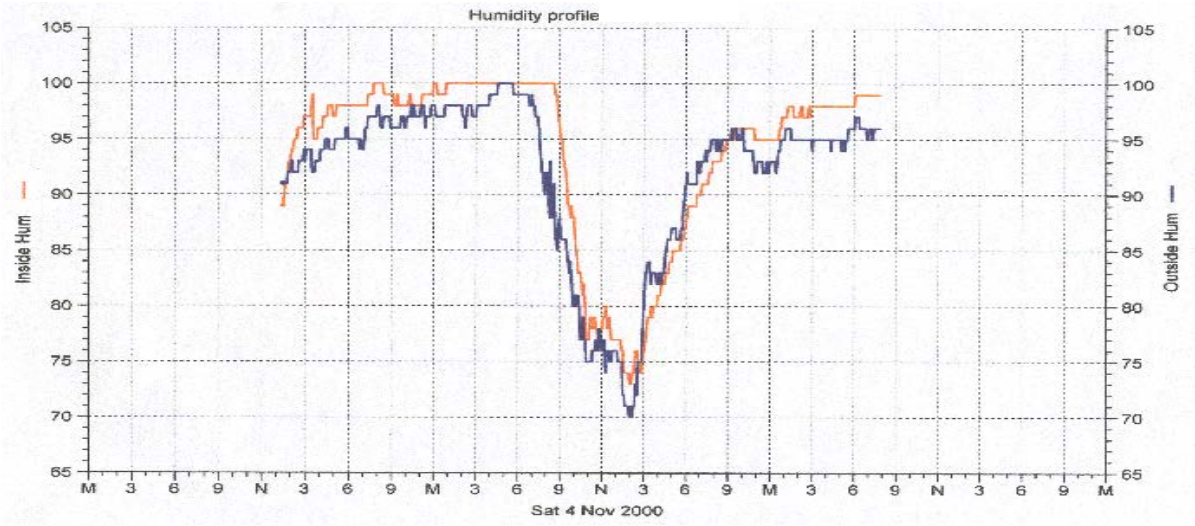
Para consumos menores o iguales a 3.000 KWh
Para los primeros 30 KWh o menos..... ¢ 859
Por cada KWh adicional..... ¢ 28,63

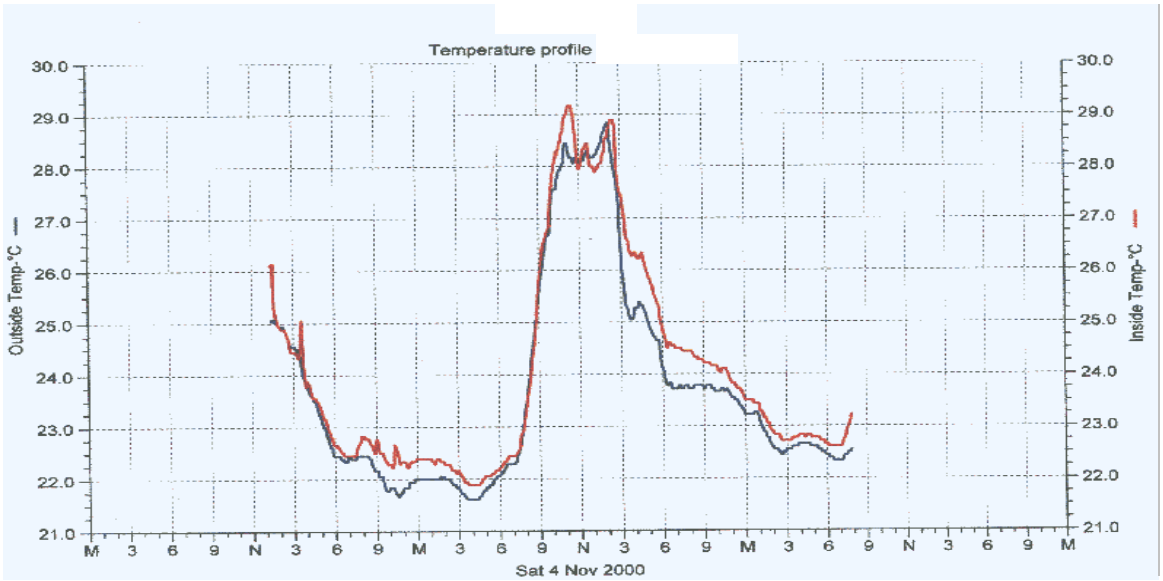
Para consumos mayores de 3.000 KWh
Cargo por demanda
Primeros 15 KW o menos..... ¢ 39 044
Por cada KW adicional..... ¢ 2 603

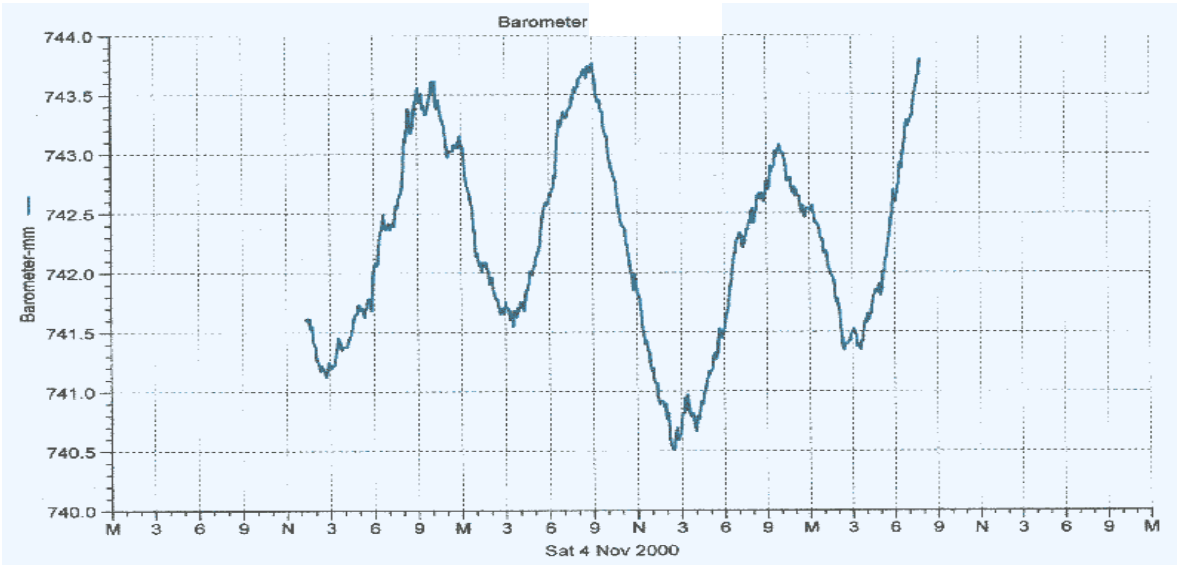
Cargo por energía
Primeros 3.000 KWh o menos..... ¢ 52 731
Por cada KWh adicional..... ¢ 17,58

Appendix VIII Climatic Measurements at the Hotels

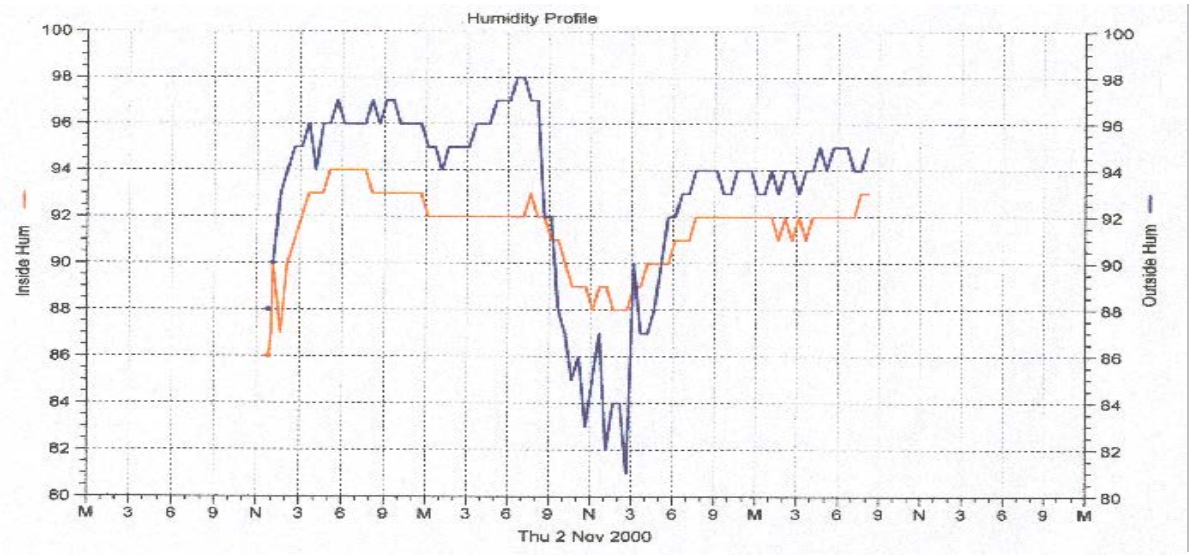
Hotel No2 LC

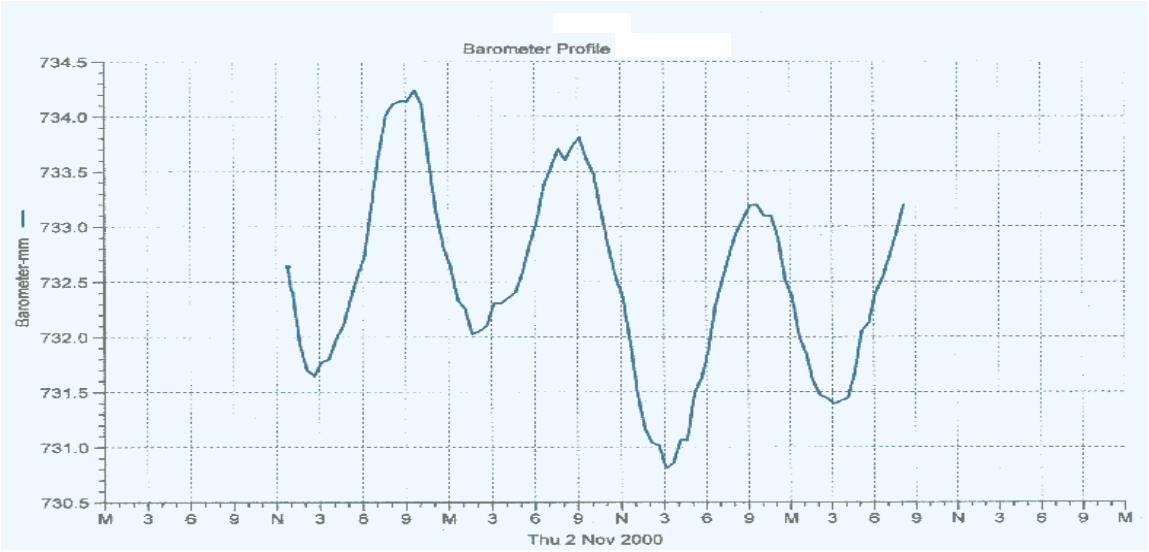


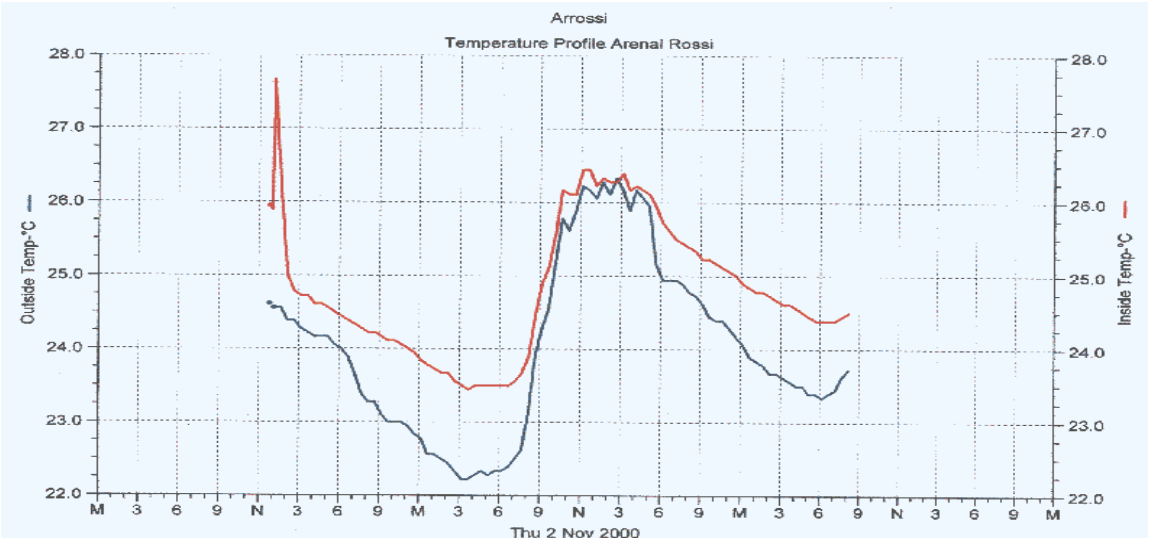




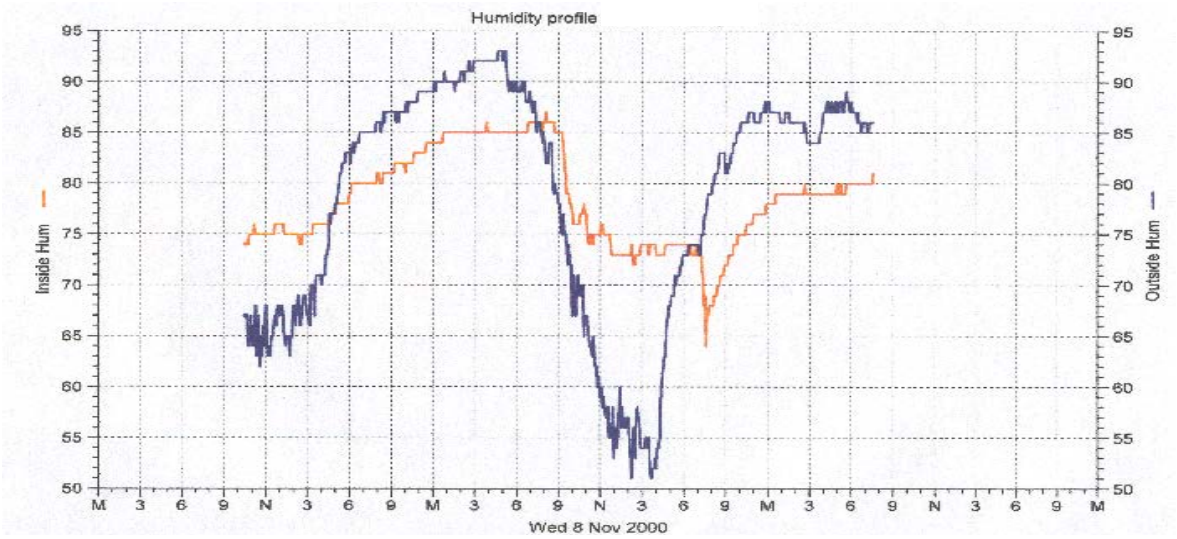
Hotel No3 AR

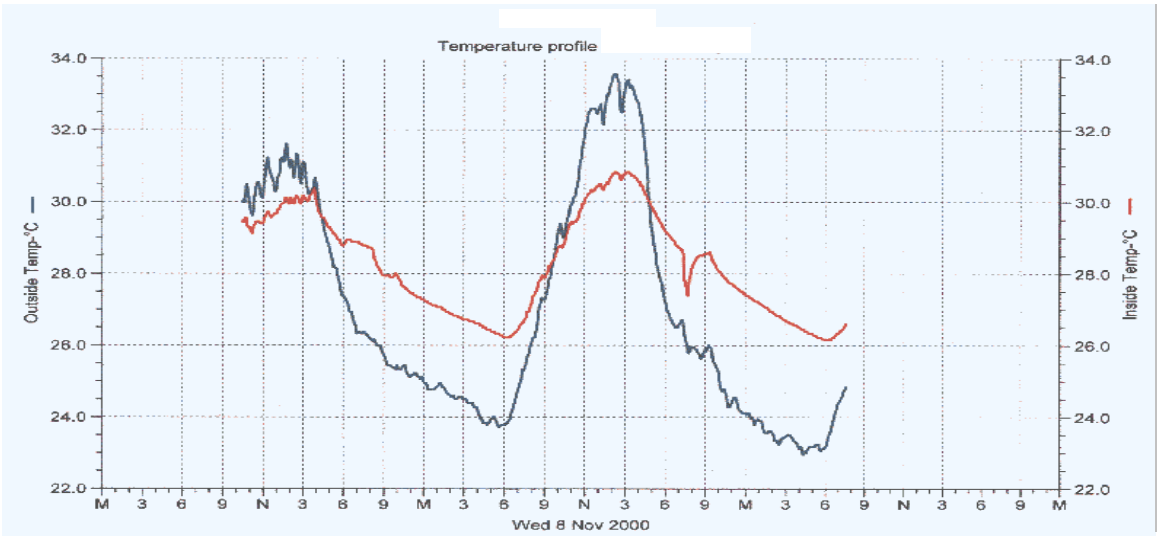

Humidity Profile
Inside Hum
Outside Hum
100
98
96
94
92
90
88
86
84
82
80
M 3 6 9 N 3 6 9 M 3 6 9 N 3 6 9 M 3 6 9 N 3 6 9 M
Thu 2 Nov 2000

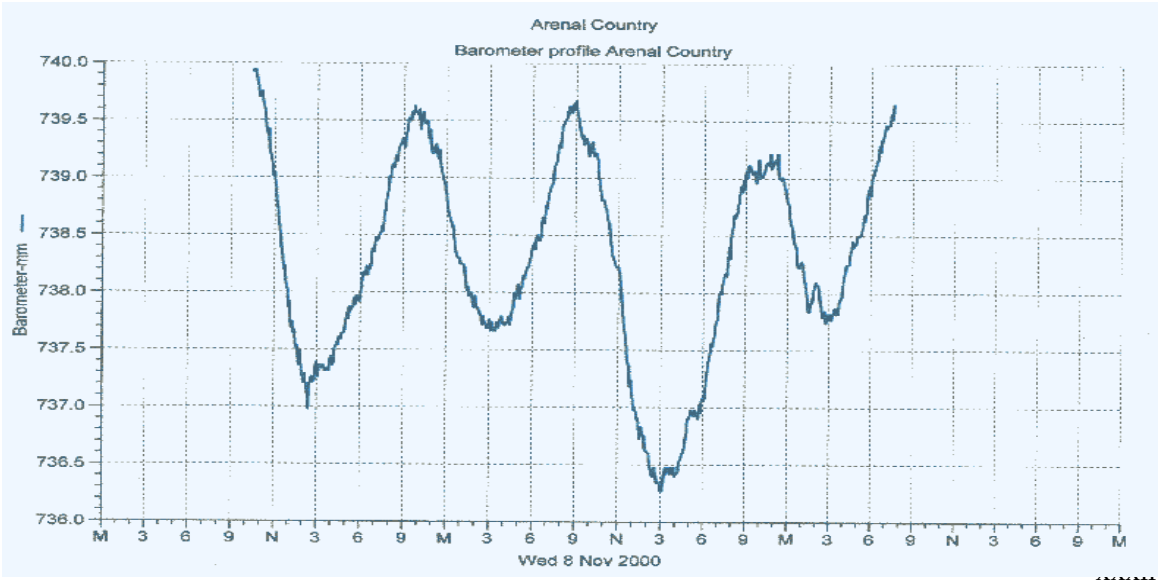

Barometer Profile
Barometer-mm
734.5
734.0
733.5
733.0
732.5
732.0
731.5
731.0
730.5
M 3 6 9 N 3 6 9 M 3 6 9 N 3 6 9 M 3 6 9 N 3 6 9 M
Thu 2 Nov 2000


Arrossi
Temperature Profile Arenal Rossi
Outside Temp-°C
Inside Temp-°C
28.0
27.0
26.0
25.0
24.0
23.0
22.0
M 3 6 9 N 3 6 9 M 3 6 9 N 3 6 9 M 3 6 9 N 3 6 9 M
Thu 2 Nov 2000

Hotel No4 AC


Humidity profile
Inside Hum
Outside Hum
95
90
85
80
75
70
65
60
55
50
M 3 6 9 N 3 6 9 M 3 6 9 N 3 6 9 M 3 6 9 N 3 6 9 M
Wed 8 Nov 2000


Temperature profile
Outside Temp-°C
Inside Temp-°C
34.0
32.0
30.0
28.0
26.0
24.0
22.0
M 3 6 9 N 3 6 9 M 3 6 9 N 3 6 9 M 3 6 9 N 3 6 9 M
Wed 8 Nov 2000


Arenal Country
Barometer profile Arenal Country
Barometer-mm
740.0
739.5
739.0
738.5
738.0
737.5
737.0
736.5
736.0
M 3 6 9 N 3 6 9 M 3 6 9 N 3 6 9 M 3 6 9 N 3 6 9 M
Wed 8 Nov 2000

Appendix IX Process Technologies: Humanware, Infoware and Orgaware

Hotel No1 SB

The Humanware

There are 12 people working at the hotel. The manager/owner of this hotel received primary education. From the other personnel two of them received secondary education and the others primary. The experience the employees have mainly comes from on the job training and the general knowledge they got from the education. There is a certain degree of family involvement since 3 of the employees have a family relation with the manager.

The Orgaware

The owner of the hotel is also the manager. He is responsible for the administration together with one of the employees. There are two people responsible for maintenance in the hotel, but the owner also works on maintenance himself. Maintenance not only consists out of maintenance of equipment but also out of gardening. A lot of the work done in the hotel is done under guidance of the owner[61].

When looking at the maintenance more specifically there are two types of maintenance performed: corrective and preventive. According to the owner the corrective performance is performed within a week from discovery of the malfunctioning.

The Infoware

As already mentioned most of the people working at the hotel received primary education. Information about equipment they get from on the job training. Most of the equipment installed is delivered with manuals. These manuals are the main information source for the use and installation of the equipment. Most of the manuals are not available in the hotel anymore.

There is no registration of the maintenance that is performed. This means that there is no overview of the state of the different equipment.

Hotel No2 CR

The Humanware

At this hotel there are 24 employees. There is a variety of education levels, but most of them have primary education. Four have secondary education and another four received tertiary education (bachelor level). These four people with a bachelor degree are responsible for the administration and the management.

Most of the employees followed courses directed at their job requirements. The receptionists followed an English course and the personnel responsible for the maintenance got a specialised training related to gardening.

The Orgaware

The hotel has a more stratified organisation structure as the first hotel. The people responsible for the management and administration are not working on maintenance or in the kitchen or the other way around. Maintenance is performed on two levels: corrective and preventive. The preventive maintenance is performed once a month.

The Infoware

Regular information about the equipment that is consuming energy is gathered through manuals. The manager of this hotel is also participating in a program related to sustainable energy consumption. From that program he received information about several possibilities related to energy efficiency.

There is no registration about the maintenance that is performed in the hotel

[61] E.g. the construction of extra capacity was also supervised by the owner himself.

Hotel No3 AR

The Humanware

At this hotel there are 9 employees including the manager. The people get their experience mostly from working at the hotel. The manager/owner of this hotel received secondary education. From the other personnel non of them received tertiary education and around half of the people got secondary education.

The Orgaware

The hotels is owned by a family of which three people are working at the hotel itself. There is a lot of overflow of the

In relation to the maintenance only corrective and preventive maintenance are performed. The preventive maintenance is done once a month.

The Infoware

At this hotel the manuals are kept after the installation of the equipment.

There is no registration system of the maintenance that is performed. All is passed through by mouth to mouth information.

Hotel No4 AC

The Humanware

There are 10 people working at this hotel. The management and administration of this hotel is run by people with a bachelors degree. The receptionist has secondary education and the personnel responsible for maintenance and gardening has primary schooling.

The Orgaware

The hotel is run by a family. There is one owner and one manager. There is one head of maintenance and. Tasks are divided clearly between the different employees.

The Infoware

Information related to energy efficiency is hardly used. There was little information about the features of the air conditioning for example and there was no written information about the equipment at the hotel.

There is no registration on maintenance performance, but they said this was mainly because the hotel just started operating and therefor no maintenance had to be performed until know.

Education level at the different hotels

Hotel No1 SB	**No. of people**	**Education level**
Receptionists	2	Secondary
Cleaning personnel	4	Primary
Maintenance and Gardening	2	Primary
Guards	2	Primary
Administrative and management	2	Primary

Hotel No2 CR	**No. of people**	**Education level**
Receptionists	3	Secondary and English course
Cleaning personnel	4	Primary
Maintenance and Gardening	4	Primary and courses
Tourist guide	1	Secondary and English course
Kitchen personnel	5	Primary and courses
Bellboys	3	Primary and courses
Administrative and management	4	Tertiary bachelor

Hotel No3 AR	**No. of people**	**Education level**
Receptionists	2	Secondary
Cleaning personnel	1	Primary
Maintenance and Gardening	1	Primary
Kitchen personnel	3	Primary
Bellboys	1	Secondary
Administrative and management	1	Secondary

Hotel No4 AC	**No. of people**	**Education level**
Receptionists	2	Secondary
Cleaning personnel	2	Primary
Maintenance and Gardening	3	Primary
Administrative and management	3	Tertiary bachelor