THE EMERGENCE OF GREEN BUILDING PRACTICES: CASE STUDY OF STELLENBOSCH

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DECLARATION

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ABSTRACT

The aim of the study was to determine the application of green building practices in Stellenbosch. In order to achieve this aim certain objectives had to be met. The first objective was to retrieve national and international literature on green building initiatives. Six main sections were discussed in the literature namely, climate change and the environment, the built environment, the concept of sustainability in cities and buildings, green building designs and practices, green buildings, green building councils and the different green rating systems, with a specific focus on the Green Star SA rating tool. The second objective was to discuss three case scenarios in Stellenbosch that practice green initiatives. The case scenarios selected are Distell Group Limited, Spier wine estate and the new Remgro head office Millenia park. Buildings in Stellenbosch selected by means of probability sampling. A total of 35% of all commercially zoned buildings in the Stellenbosch core were selected to participate in the sample. The land zoning maps from the Stellenbosch municipality was obtained and relevant buildings were sampled. Nine of the sampled buildings were heritage buildings (older than sixty years) and seventeen were buildings from the modernist era (younger than sixty years). Nine architect companies in Stellenbosch were also sampled. The respondents were determined by means of haphazard sampling. The third objective was to design two questionnaires, one for building owners and another for architects. The first questionnaire developed for building owners was divided into two sections. The first section determined what green practices owners are incorporating into their office buildings. These green practices developed in the questionnaire focused on the use of natural light in the buildings, LED lights, indoor ventilation, recycling methods, water saving methods, energy saving methods and whether management plans exist to monitor and evaluate the buildings energy usage. The second section focused on the perception of the building owners. The respondents had to rate the importance of the above mentioned green initiatives on a scale of one 1 (being not at all) to 5 (being very important). The fourth objective was to develop a questionnaire for architects. The questionnaire determined whether green designs are incorporated by architects and if there is a greater demand for green designs by clients. The findings of the study revealed that respondents find natural light and air quality to be the most important aspects in an office. Recycling is applied by 93% of respondents. Less than

10% of respondents have installed solar panels, HAVC systems, rain water harvesting or other water management systems. Architects find that there has been an increase in the demand for green designs, but that there is a lack of knowledge of green initiatives by building practitioners. The main recommendations of the study are that the concept of green development be broadened into other spheres apart from planners. Education and training of green building must be available to all building owners and practitioners. Sustainable materials should be more accessible to building practitioners and these materials should be made available locally. Finally more buildings should be refurbished or renovated rather than be demolished to prevent waste and secure open spaces.

OPSOMMING

Die doel van die studie was om die toepassing van groen initiatiewe in Stellenbosch te bepaal. Ten einde hierdie doel te bereik moes daar aan sekere doelwitte voldoen word. Die eerste doelwit was om nasionale en internasionale literatuur oor groen inisiatiewe te verkry. Ses hoof afdelings is bespreek in die literatuur, naamlik verandering van die klimaat en die omgewing, die Beboude-omgewing, die konsep van volhoubaarheid in stede en geboue, groen gebou ontwerp en praktyke, die rade vir omgewings vriendelike geboue en groen evalueering stelsels. Die tweede doelwit was om drie gevalle studies is Stellenbosch te bespreek wat groen inisiatiewe beoefen. Die gevalle studies wat bespreek word is Distell Eiendoms Beperk, Spier landgoedere en Remgro se nuwe hoof gebou Millenia Park. Waarskynlikheids steekproewe is gebruik om die geboue te identifiseer vir die veld werk, ʼn totaal van 35% van al die kommersiëele gesoneerde geboue in die Stellenbosch-kern is geselekteer om deel te neem in die steekproef. Die landsoneringskaarte van die Stellenbosch-munisipaliteit is verkry en betrokke geboue was geselekteer. Nege van die geselekteerde geboue was historiese geboue (ouer as sestig jaar) en sewentien was geboue van die modernistiese era (jonger as sestig jaar). Nege argiteks maatskappye in Stellenbosch is ook geselekteer vir die studie. Die respondente is deur middel van'n lukrake steekproef bepaal. Die derde doelwit was om twee vraelyste te ontwerp, een vir die eienaars van die geboue en die ander vir argitekte. Die eerste vraelys wat ontwikkel is vir die gebou-eienaars is verdeel in twee afdelings. Die eerste afdeling bepaal watter groen praktyke eienaars implimenteer in hul kantoor geboue. Die groen praktyke in die vraelys fokus op die gebruik van natuurlike lig in die geboue, LED ligte, binnenshuis ventilasie, herwinning, water besparing metodes, energie besparing metodes en bestuur planne wat opgetrek is om die energie verbruik van geboue te monitor en te evalueer. Die tweede afdeling van die vraelys fokus op die persepsie van die gebou-eienaars. Die respondente het die belangrikheid van die bogenoemde groen inisiatiewe gradeer op 'n skaal van een 1 (glad nie) tot 5 (baie belangrik). Die vierde doelwit was om 'n vraelys te ontwikkel vir argitekte. Die vraelys bepaal of groen ontwerp op geneem is deur argitekte en indien daar 'n groter aanvraag na groen ontwerpe deur kliënte is. Die bevindings van die studie het getoon dat die respondente natuurlike lig en die gehalte van binnenshuis lug as die belangrikste aspekte in di kantoor ag. Herwinning is deur 93% van

respondente toegepas. Minder as 10% van die respondente het sonpanele, HAVC stelsels, reën wateropvangsisteme of ander watersparingssisteme geinstaleer. Argitekte vind dat daar 'n toename in die vraag na groen ontwerpe is, maar dat daar 'n gebrek aan kennis oor groen-inisiatiewe is deur prakisynes . Die aanbevelings van die studie is dat die konsep van groen ontwikkeling versprei moet word na ander sfere behalwe beplanners. Inligting en opleiding oor omgewingsvriendelike geboue moet beskikbaar wees aan alle gebou-eienaars en praktisynes. Volhoubare materiale moet meer toeganklik wees vir bou praktisynes en hierdie materiale moet ook plaaslik beskikbaar gestel word. Laastens moet meer geboue opgeknap word eerder as om gesloop te word, om afval te voorkom en oop ruimtes te behou.

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ACRONYMS AND ABBREVIATIONS

BREEAM: British Research Establishment Environmental Assessment Method

BWI: Biodiversity and Wine Initiative

CASBEE: Comprehensive Assessment System for Building Environmental Efficiency

CDC : Centers of Disease Control and Prevention

CFLs: Compact Fluorescent Lights

CHP: Combined Heat and Power

DSM: Demand-Side Management

DWAF: South African Department of Water Affairs and Forestry

ELA: Earth life Africa

ENGOs: Environmental Non- Governmental Organizations

EPA: Environmental Protection Agency

ERVs: Energy Recovery Ventilators

FTTSA: Fair Trade in Tourism South Africa

GBC: Green Building Councils

GBCSA: Green Building Council of South Africa

GIS Geographic Information systems

GRC: Glass Recycling Company

GRI: Global Reporting Initiative's

HCFCs: Hydrochlorfluorocarbons

HVAC: Heating, Ventilating, and Air-Conditioning

HVR: Heat-Recovery Ventilators

IPW: Integrated Production of Wine

LCA Life-cycle assessment

LEED: Leadership in Energy and Environmental Design

PCF: Processed Chlorine Free

RDP :	Reconstruction and Development Programme
RTDs:	Ready-to-drinks
TCF:	Totally chlorine-free
USGBC:	United States Green Building Council
WHO:	World Health Organization
WIETA:	Wine Industry Ethical Trade Association

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CHAPTER 1: INTRODUCTION

In the last decade there has been rapid growth of industrialization in the world, especially in developed countries. (Das Sharma, 2008). It has been estimated that 2030, 60 per cent of the world population will be living in cities (United Nations Human Settlement Program, 2008). From a sustainable development perspective, the harmonious environmental relationship between cities and the urban and rural areas are of great importance to the wellbeing of future generations (United Nations Human Settlement Program, 2008). The rapid growth caused by industrialization has lead to unplanned development of urban areas. The conversion of agricultural land to human habitation and deforestation has made it difficult to maintain ecological balance. A rapid increase in population growth and migration in urban areas, have caused wide spread pollution (Das Sharma, 2008). If cities are not properly planned and managed, the quality of the air, the availability of water, waste processing, recycling systems and all qualities of the urban environment contributing to human wellbeing will be under threat (United Nations Human Settlement Program, 2008).

Ill health, respiratory disease and premature death have been linked to the levels of air pollution in several developing countries. Middle income and countries that have been recently industrialized are experiencing new challenges associated with increases in motorized transport and industrialization, such as increases in air and water pollution. The World Health Organization (WHO) estimated that more than “1 billion people in Asia alone are exposed to outdoor pollutants that exceed the WHO guidelines, leading to the death of half a million people annually” (United Nations Human Settlement Program, 2008: 123). Given that air pollutants cause major health risks, and increase sensitivity in healthy people, improving the air quality in cities will have positive health impacts for all. UN-HABITAT analysis has indicated that indoor air quality is the main cause of respiratory illnesses in women and children living in Africa and Asia slums, as it is probable that they are regularly exposed to poorly ventilated cooking areas. The analysis estimated that indoor air quality is responsible for “between 2.7 and 2.8 million deaths annually” (United Nations Human Settlement Program, 2008: 125). Biomass fuel and coal used for cooking are the main causes of indoor pollution. These fuels produce pollutant particles such as "particulate matter, carbon monoxide, sulphur dioxide, nitrogen dioxide and other organic compound into the atmosphere, causing respiratory illness" (United Nations Human Settlement Program, 2008: 126). Biomass fuels such as animal dung, wood and crop residue produce the highest levels of these pollutants. The burning of wood indoors emits 50 times more indoor pollution than gas from a stove (United Nations Human Settlement Program, 2008). Therefore it is important for developing countries to promote policies that will accelerate the transformation from biomass fuels to liquid fuels or electricity.

Another burden in cities is inadequate waste management. Insufficient collection and disposal of waste is becoming a great concern in urban areas, because of the health risks it poses to the urban population. The inadequate collection and disposal of waste is impacting on the ecosystem of cities and also the urban environment. In Freetown Sierra Leone for example only 35 to 55 per cent of solid waste is collected. (United Nations Human Settlement Program, 2008). The waste that is not collected is illegally dumped in open spaces. The majority of waste that is collected in developing countries consists of organic waste, food, wood, coal etc. Although recycling and reuse methods have become a familiar practice in the developing world, these practices are often implemented by the informal sector in treacherous conditions. Solid waste management practices that have been executed poorly can lead to a "range of excreta and vector-related diseases" (United Nations Human Settlement Program, 2008: 126).

In cities we also find the "heat island effect". The radiation balances in urban areas affect the temperature distribution. Solar radiation is absorbed and transformed into heat. "Pavements, walls and roofs store heat and emit long wave radiation to the sky" (United Nations Human Settlement Program, 2008:127). The city takes much longer to cool off than the surrounding vegetated areas. Vegetated areas take longer to cool because the sun causes water held in soil and leaves to evaporate, and shading of the plants keep the ground cool. The urban areas have higher temperatures than surrounding rural areas. This phenomenon is known as the "heat island" effect (United Nations Human Settlement Program, 2008).

Green building designs is one solution to environmental problems such as pollution and water use (Byrne, 2004), energy consumption and material use (Rees, 1999). Green building is a way to attempt the dilemma of global climate change on a local urban level (Mckinstry, 2004; Codiga, 2008; Irvin *et al.*, 2008). Researchers of energy policy issues indicated that there will be a noteworthy reduction in building energy use if there is a strong focus on sustainable building (Retzlaff, 2009). A study done by Clean Energy Futures found that if the current trend continues, the primary energy usage of buildings will increase by 22 percent in 2020, with extensive policy changes it will reduce by 2% (Koomey *et al*., 2001). Many people are turning towards green building because of their concerns about the public health impacts of conventional development. Green development helps to improves human health through enhanced indoor air quality and reduced energy use (Rees, 1999; Malmqvist, 2008). While considerable changes in all spheres of government and the private sector are needed for these results to materialize, green building policies can be one strategy to help minimize energy consumption and pollution.

1.2 AIM AND OBJECTIVES

The primary aim of the study was to determine the green building practices in the town of Stellenbosch.

In order to achieve this aim certain objective had to be met:

- Identify green building initiatives and ratings through international and national literature
- To present three best case scenarios on green building practices
- Conduct a sample survey among building owners and architects in Stellenbosch to determine which building practices and designs are occurring
- Conduct sample surveys among building owners and architects in Stellenbosch to determine their opinions on green building practice
- To make recommendations on green building practices

1.3 METHODOLOGY

Firstly national and international literature on the concept of green building was consulted. Information was collected through internet sources, books and journals. Secondly the best methods to attain information from building owners and architects during the field work had to be determined. Buildings for the field work were identified by means of non probability sampling. The respondents were identified by means of haphazard sampling. A total of 35% of all commercially zoned buildings in the Stellenbosch core were selected to participate in the sample. The land zoning maps from the Stellenbosch municipality were obtained and relevant buildings were sampled. Nine of the buildings that were sampled were heritage buildings (older than sixty years) and seventeen were buildings from the modernist era (younger than sixty years). Nine architect companies in Stellenbosch were also sampled. Both qualitative and quantitative methods were used in the study. Two questionnaires were designed, one for building owners (see Appendix A) and one for architects (see Appendix b). The first questionnaire that was designed for building owners was divided into two sections. The first section of the questionnaire determined what, if any green practices owners are incorporating into their office buildings. These green practices developed in the questionnaire focused on the use of natural light in the buildings, LED lights, indoor ventilation, paper recycling methods such as using multi functional machines and printing on both sides of the paper, water saving methods such as rainwater harvesting and meter taps and energy saving methods such as solar panels, daylight and movement sensors and whether management plans exist to monitor and evaluate the buildings energy usage. The second section focused on the perception of the building owners. The respondents had to rate on a scale of 1 (being not at all) to 5 (being very important) the importance of each above mentioned green initiative to them personally.

The questionnaire designed for the architects asked architects to provide their understanding of the term green design and whether they have ever been involved in a green building project. The architects had to rate statements on a scale of 1 (fully agree) to 5 (fully disagree). These statements designed in the questionnaire questioned whether architects recommend green initiatives in their designs to their clients and whether there has been a greater interest in green building designs in Stellenbosch. The questionnaires were dropped off and recollected from the respondents. A person in a managerial and knowledgeable position answered the questionnaires. The program SPSS was used to quantify the responses given in the questionnaires. The application of the data frequency tool in SPSS made it possible to develop graphs and tables that provided valid percentiles, standard deviation and the mean of each green initiative that was conducted in the questionnaire. The data was analyzed to establish the application of these green building practices by the respondents. Data produced by SPSS was used to identify to which extent the applications of green practices are occurring in Stellenbosch and to determine the perception of green building by the respondents. Three case studies were selected in Stellenbosch. Distell Group Limited wine producers and manufacturers. The Spier wine estate and the new Millenia Park building, which is the new head office of Remgro. The new Millenia Park building was selected as a case study because it became the first building in Stellenbosch to receive a five star Green Star rating by the Green Building Council of South Africa (GBCSA). Distell Group Limited and Spier were selected as case studies when surveys were conducted with these institutions. During the surveys both institutions provided information and examples of green initiatives that are presently implemented at their institutions.

1.4 STUDY AREA

The study area is the town of Stellenbosch. Stellenbosch is a town in the Western Cape province of South Africa, situated about 50 kilometers east of Cape Town, along the banks of the Eerste River. It is the second oldest European settlement in the Western Province, after Cape Town The town was established in 1679 by the Governor of the Cape Colony Simon van der Stel, who named it after himself Stellenbosch means "(van der) Stel's forest (Fairbridge, 1922).

Figure 1.1. Location of survey participants *Source: Google Earth, 2012*

1.5 RESEARCH DESIGN

A research design diagram (Figure 1.2) is developed to show all the steps followed in the study

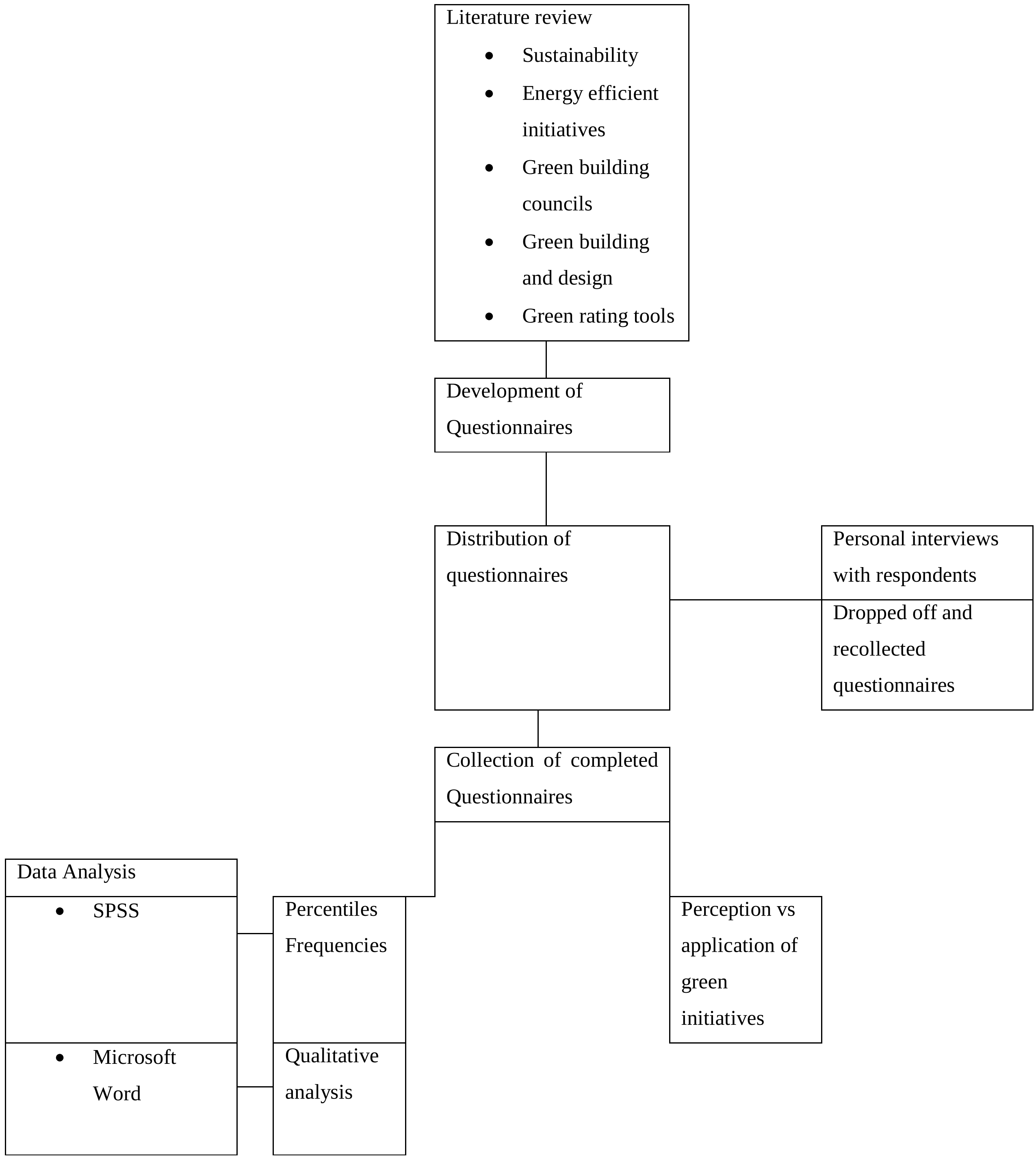

Figure 1.2 Research agenda

1.6 CONCLUSION

To summarize, the introduction explains the aversive effects of climate change and how green building is an option to minimize the impact that climate change has on the environment. Green or sustainable building is constructing structures and using processes that are environmentally responsible and resource-efficient throughout a building's life-cycle. Stellenbosch was chosen as the study area. The Remgro head office, Millenia Park in Stellenbosch was awarded a five star green star rating by the Green building Council of South Africa, and is discussed in a case study. Green practices implemented by Distell winery and Spier wine estate are also discussed in case studies. The methodology has been outlined in order to explain how the research of the town of Stellenbosch was undertaken. The literature review elaborating on the concept of green building, green rating systems, South Africa's Green Star rating tool and green building councils follow in the next chapter.

CHAPTER 2: LITERATURE REVIEW

2.1 INTRODUCTION

This chapter discusses the literature that was researched. Environmental sustainability, sustainability in cities and buildings green practices, green building councils and green rating tools are all explained in this chapter. The literature review will start by explaining the role of the urban environment, the importance of our urban setting, and also the adverse effects that development has on the natural environment. Secondly there is a discussion on the diverse concept of sustainability and sustainability in buildings. Green practices are discussed with a focus on energy efficiency, and methods to minimize energy consumption. There is a focus on green buildings, and Green Building Councils and what they comprise off. Furthermore the concept of a green rating tool is discussed, followed by the different green rating tools and models that are applied globally.

2.2 ENVIRONMENTAL SUSTAINABILITY

Our atmosphere consists of numerous gases. Some of these gases, such as carbon dioxide and water vapor, naturally absorb “long-wave radiation that is emitted from the earth's surface. Short-wave solar radiation enters the earth's atmosphere and is absorbed by the earth's surface. This radiation is then recycled and emitted as long wave terrestrial radiation” (Mower, 1996: 5) Gases such as water vapor and carbon dioxide absorb this radiation, retains it in the atmosphere, and keep the temperature of the earth warmer than it would otherwise be if there wasn't an atmosphere. This is what meteorologists refer to as the “natural greenhouse effect” (Mower, 1996).

Problems could potentially arise, when human activities add additional trace gases into the atmosphere that also absorb out-going long-wave radiation. These additional trace gases include methane, aerosols, ozone, and carbon dioxide. The result is an increase in the amount of long-wave radiation that is being trapped by the atmosphere. It is believed that this could increase the average overall global temperature (Ruhf, 1999). Carbon dioxide "...is considered the trace gas of greatest importance because of the substantial increase in its atmospheric concentration as well as its probable continued rise due to global consumption of fossil fuels" (Rhodes,1997: 116).

The concept of sustainable development, which is closely related to sustainable energy, has become increasingly important. The development paradigms in operation after the Second World War led to major social and environmental problems. During the 1950s and 1960s, most nations were preoccupied with economic growth and energy consumption; this led naturally to a dramatic increase in energy demand. Economic growth was the major concern, with social and environmental issues being ignored in comparison. After the 1950s, the road chosen to restore the devastation of the Second World War incorporated new focus on the social deprivation of the majority of the world's population. By the 1970s development paradigms began to include social considerations. There was a new realization of the social dangers of a world where the richest 20% of the population received 83% of the world's income and the poorest 20% received 1.4%. In the late 1970s and the 1980s there was a growing understanding of the significance of the deterioration in the environment, and a significant number of people began to call for development paradigms that would consider environmental issues alongside economic and social issues. The late 1980's saw further concerns being raised about the global environment, the climate change threat in particular (Ürge-Vorsatz *et al.*, 2003).

At the start of the third Millennium, there have been complicated interactions that are contributing to the degradation of the environment. Examples of these forces are globalization, urbanization, unsustainable consumption patterns, and poverty and population growth. Global climate change, depletions of the ozone layer, deforestation, desertification, loss of earth's biological diversity and hazardous wastes, to name a few, are contributing to the adverse affects on the lives and health of the world's nations and its population (United Nations Development Programme, 1995).

The world is in the midst of a massive urban transition unlike that of any other time in history. Within the next decade, more than half of the world's population, an estimated 3.3 billion, will be living in urban areas – a change with enormous implications both for human well-being and for the environment. As recently as 1975, just over one third of the world's people lived in urban areas. By 2025, the proportion will have risen to almost two thirds (World Resource Institute, 1996). The most rapid change is occurring in the developing world, where urban populations are growing at 3.5 percent per year, as opposed to less than 1 percent in the more developed regions. Cities are also reaching unprecedented sizes – "Tokyo, 27 million; Sao Paulo, Brazil, 16.4 million; Bombay, India, 15 million – placing enormous strains on the institutional and natural resources that support them" (World Resource Institute, 1996: 1). Historically, cities are places of industry that boost economies and social wellbeing. Urbanization is associated with higher incomes, access to information, diversity, health and quality of life (World Resource Institute, 1996).

Though there are obvious advantages of urbanization, there are many environmental disadvantages that occur. Examples of these environmental ills that are taking place are patterns of sprawling land consumption, global warming, pollution, and the loss of our natural environment, environmental trends are increasingly dismal. Cities will play a very important role in addressing these problems (Beatly, 2000). Challenges that developing countries like South Africa also will have to focus on, is to improve the environmental conditions for the urban poor. Because of high population growth and lack of finances, different strategies must be used than that of developed countries. A second, and related, challenge is for cities to reconcile the often-competing demands of economic growth and environmental protection (World Institute of Research, 1996). Cities are for the most part located in key environments – on rivers, at ocean harbors, or near the fall line, where waterfalls provide water power. Therefore, major cities tend to develop at locations essential for biological conservation. Buildings account for one-sixth of the world's fresh water withdrawals, one-quarter of its wood harvest, and two-fifths of its material and energy flows (Roodman and Lenssen, 1995).

Urban areas have distinctive biophysical features in comparison with surrounding rural areas (Bridgman *et al*., 1995). For example, energy exchanges are modified to create an urban heat island, where air temperatures maybe several degrees warmer than in the countryside (Wilby, 2003; Graves *et al*., 2001). The scale of the urban heat island effect varies in time and space as a result of "meteorological, locational and urban characteristics" (Oke, 1987: 12). Hydrological processes are changed in such a manner that there is an increase in the rate and volume of surface runoff of rainwater (Mansell, 2003; Whitford *et al*., 2001). Such biophysical changes are, in part, are sult of the altered surface cover of the urban area (Whitford *et al*., 2001).

Urbanization replaces vegetated surfaces, which provide shading, evaporative cooling, and rainwater interception, storage and infiltration functions, with impermeable built surfaces. However, urban green spaces provide areas within the built environment where such processes can take place (Whitford *et al*., 2001). These ecosystem services (Daily, 1997) provided by urban green space are often over looked and under-valued. For example, trees are felled for the perceived threat they pose near highways and buildings (Biddle, 1998), infill development takes place on former gardens, front gardens are paved over to provide parking spaces for cars, and biodiverse urban 'wasteland' is earmarked for redevelopment (Duckworth, 2005; GLA, 2005; Pauli e*t al*., 2005). In a changing climate the functionality provided by urban green space becomes increasingly important.

Cities provide both challenges and opportunities for environmentally aware developers. There are opportunities to reduce energy demands, and minimise the pressure on the surrounding natural environment. Building design and practice, as well as perception and lifestyle must adopt sustainability thinking (Register, 1987). If we are interested in biological conservation, then we must begin to design urban habitats and environments as well as to legally designate wilderness areas and rural nature preserves (Botkin, 1997). If we are interested in helping people live in better environments, we must focus on urban environments.

2.3 SUSTAINABLE CITIES AND BUILDINGS

The concept or sustainability is so complex that it is difficult to define what is meant by the term. The concept of sustainability has come a long way since its initial introduction by the World

Commission on Environment and Development in its publication *Our Common Future*. The term is used throughout society for many different purposes and meaning each having a different association to the term. However there is a general understanding that sustainability of the environment, society and economics are important. The complexity of sustainability is known but not yet fully understood (Boyle, 2005).

Cities form a very important part of the human condition (Eaton, Hammond and Laurie, 2007). The form of a town or city can affect its sustainability. Relationships exist between the size, shape, density and uses of the city and its sustainability (Williams, Burton and Jenks, 2000). However there is no consensus on what the true nature of this relationship is. The sustainability of high and low urban densities, or centralized and decentralized are still widely disputed. One finds that certain urban forms appear to be more sustainable in some respects than others. Certain urban forms might minimize travel or promote fuel efficient technologies but are harmful in other ways, perhaps having detrimental impacts on the environmental quality or enabling social inequalities. Other forms may be sustainable locally but may not be valuable city wide or regionally (Williams *et. al.*, 2000). If there is any progress to be made in urban sustainability, links have to be made between urban form and a wide variety of elements of towns and cities have to be made on all geographical scales. If an understanding of these relationships can be obtained, than a more sufficient sustainable urban form can be achieved then what is found at present (Willams *et al.,* 2000).

The concept of sustainability in respect to buildings is also not clearly defined. Much of the focus is on the energy consumed in buildings. The energy that is used in a buildings operation overshadows that of the energy consumed during construction. “Up to 90% of energy is consumed in operation over the life span of the building” (Winther and Hestines, 1999: 10). Embodied energy within a building is a key indicator of environmental impact. Embodied energy considers all the energy that is consumed in production of building materials, the construction of the building and also the energy needed for recycling and disposal of materials. Embodied energy is frequently used as a key indicator for the sustainability of buildings (Boyle, 2005).

Concerns have been raised about energy use alone, and that many other factors have not been considered. Buildings contribute significantly to environmental problem. Buildings account for "30% raw materials, 42% of energy, 25% water and 12% land use, 40% of emissions and 25% solid waste" (Uher, 1999: 3). The sustainability of a building therefore requires more than a focus on energy consumption over the life span of a building. An integrated urban management system (Table 2.1) is needed together with local councils striving to define acceptable areas for development such as inner cities, understand the confines of ecosystems, develop urban population strategies to manage the city population, provide infrastructure that can be managed with a focus on maintaining existing systems, provide requirements that meet architectural and urban design standards, consider the use of existing infrastructure in the life cycle of a building and require the use of recycling and re-use of local materials (Boyle, 2005).

Table 2.1 Estimates of potential reductions through changes in building management.

Source: Boyle, 2005

Activity	**Potential reduction**
Planning	
Increasing urban density	50-90% energy and impacts
Development on marginal lands	40-50% improvement in crop production; reduction of erosion
Integrated urban and architectural design	Improvement in building value
Incorporation of green and open space	Improvement in building value; human health
Human-powered transportation	90% energy; improvement in human health
Establishment of mixed-growth managed forest to supply industries	50-80% in energy and impacts
Construction	

Passive solar power	50-90% energy
Local source of materials	50-80% impacts and energy
Use of low energy materials	50-80% energy
Recycling/reusing materials	40% energy; 10-50% impacts and materials
Water tanks, composting toilets	80-90% external water and energy
Operation	
Low energy, low water appliances	20-50% energy and water
Use of human powered transportation	90% energy; improvement in health
Minimising water and energy use	10-20% energy and water
Maintaining and refurbishing building	50-80% over 200 years

Builders, architects and developers have to work together with local councils to determine and identify the limitations of the environment and developing designs that incorporate environmentally friendly practices such as solar heating, water tanks, recycling of local materials, and minimizing the use of materials so as to have the least possible effect on the environment. Owners of buildings must also take part in the system, recognizing when their buildings need to be refurbished or need maintenance instead of rebuilding or construction. They should include low energy and conservation appliances and methods into their buildings, with a focus on the use of local materials and recycled material (Boyle, 2005).

There are limited buildings, green or otherwise that can be deemed sustainable, either in the construction or in the use of materials or their operational lifespan. A truly sustainable building must consider not only the embodied energy of materials that are used in the building but also the measures that are needed during construction and operations of the building, the withdrawal and disposal on the integrity of the environment. Buildings owners and building practitioners have to take into account the sustainability of the building and its operation. Special training and education has to be provided to building owners, clients and those in the industry the tools to construct and manage a building in a sustainable fashion. A program such as GIS (Geographic Information Systems) is a good planning tool to define, map and manage local regions, identifying sensitive areas, land use, soil types, urban densities and infrastructure. GIS can also be used to map future scenarios, and changes in ecosystems and land use. LCA (Life-cycle assessment) is another program that is being used to identify life-cycle impacts of buildings for example identifying which technologies are suitable for a specific design or building. GIS and LCA assist in the system thinking and management. Construction of a sustainable building must include more than just the building itself. "Those involved must recognize it to be a component in a system which must itself be assessed for sustainability" (Boyle, 2005: 47).

Despite the shortcomings in present formulation of sustainable development, the concept still retains much potential. Sustainability should be redefined in a more specific manner. The concept of sustainability should not be viewed as black and white. The idea of sustainability should be broadened. "If a crisis is defined as the inability of a system to reproduce itself, then sustainability is the opposite: the long-term ability of a system to reproduce" (Campbell, 1996: 23). This should not only apply to natural ecosystems, but to economic and political criterion. As governments focus on reproducing their institutions, interests and macro and micro economies, so too should it sustain the ecological system. The goal for planning must be to broaden the agenda and sustain the political, environmental and environmental spheres simultaneously (Campbell, 1996).

Another way of redefining sustainability is to distinguish between specific and general sustainability (or local and global). Sustainability might be obtained easily in a single sector, but to achieve sustainability in all sectors requires such complex restructuring that the only likely way to achieve global sustainability is through a long, "incremental accumulation of local and industry specific advances" (Campbell, 1996: 24). What this approach means is that planners will find it easier to develop their image of a sustainable city after negotiations over land use and economic development policies are concluded. Not as the basis for the beginning of the effort. Planners should develop certain designs to promote the sustainable city, and the most important is land-use and design. The potential balance between economic and environmental wellbeing exists in the design itself, as in a greenbelt community (Elsom, 1986). Land-use planning remains the most important tool to planners. The way to resolve environmental problems through land use planning is to bring together the conflicting territorial logics of human and natural habitats (Campbell, 1996)

2.4 GREEN BUILDING PRACTICES

As previously established the built environment has a vast impact on the natural environment, human health, and the economy. By adopting green building practices, we can maximise both economic and environmental performance. Green practices are goals and mechanisms that are developed to reduce waste and conserve energy in the work place or home. Green construction methods can be integrated into buildings at any stage, from design and construction, to renovation and deconstruction. However, the most significant benefits can be obtained if the design and construction team takes an integrated approach from the earliest stages of a building project (U.S. Environmental Protection Agency, 2012). In this section the different green practices are highlighted and discussed. They include greening of roofs and walls, energy efficiency, combined heat and power generation, LED lighting, evaporative coolers, solar panels, improved insulation, wind energy, water efficiency, waste reduction and air quality

2.4.1 Green rooftops

Cities have millions of square meters of vacant and unattractive roofs that present wasted opportunities to enhance the quality of city life. "Roofs present by far the most significant opportunities for the greening of buildings" (Johnston and Newton, 2004: 45). Green rooftops are surfaces of living vegetation fitted atop buildings, ranging from small garages to large industrial buildings (Metropolitan Council, 1998).

2.4.1.1 Benefits of green rooftops to the environment

Green roofs help manage storm water by imitating a variety of hydrologic processes associated with open space. The plants capture rainwater on their leaves and absorb it in their root zone (Metropolitan Council, 2012). Studies in Berlin have shown that green roofs absorb 75% of participation, so immediate discharge is reduced to 25%of normal levels (Johnston and Newton, 2004). The water that is absorbed stimulates evapo transpiration and prevents much of the storm water to enter the runoff stream. The water that does exit the roof is slowed and kept cool, which is beneficial for downstream water bodies. Green roofs are particularly effective in short-duration storms, and it has been shown that 50% of cumulative annual runoff in temperate climates is reduced (Metropolitan Council, 2012).

2.4.1.2 Technical benefits of green rooftops

Green buildings provide technical advantages to developer, planners, and clients and to those who live and work in city buildings. One technical benefit is the protection given to roofing materials. The layer of soil and plants keeps destructive impacts away from the roof surface. An example of this is the roof garden on the Kensington High Street building in England. The roof was installed in 1938, the roof materials were examined 50 years later and it was found that the roof surface was in excellent condition, on average flat roofs have a life span of 10 to 15 years (Johnston and Newton, 2004). The most significant technical advantage of vegetation on rooftops is the protection against ultra-violet radiation. Uncovered surfaces asphalt will heat up much more than areas that are covered by vegetation. Studies have shown that an area of a black roof can heat up to 80 degrees Celsius, whereas an equivalent area that is covered by vegetation only reaches 27 degrees Celsius. Temperatures between gravel and grass covered areas are less, but nonetheless still noteworthy. On average a gravel roof will be 3 degrees warmer in summer (Kohler and Baier, 1989). A layer of vegetation also protects roofs from physical damage such as punctures and cracks that occur when betumic materials are softened by heat (Johnston and Newton, 2004). Green roofs also increase the insulation value of roofs by as much as 10% (Gotze, 1988). Insulation values of different vegetation types vary. Grass mixtures have been found to be the best insulators during winter months (Kolb, 1986).

2.4.1.3 Intensive and extensive methods

Greening of roofs can be categorized into two groups: intensive and extensive methods. These two methods are used to differentiate the different aims, methods and applications of green roofs. There are various considerations that will determine which method would be the beat to apply (Johnston and Newton, 2004).

2.4.1.4 Intensive method

Intensive roof gardens have need of intensive management. They characteristically have thick growing medium, at least 200mm of soil, an artificial watering system and various plants species, mostly garden varieties. The main objective of intensive roof gardens is to provide open spaces for people. They usually incorporate areas of paving and seating (Johnston and Newton, 2004). Roof gardens can vary. Given sufficient lighting, irrigation and shelter most types of garden can be grown: "formal and informal, exotic and native, vegetable and herbaceous" (Johnston and Newton, 2004: 53). All types of roof gardens will be beneficial to wildlife; certain plants can be selected specifically for this purpose.

2.4.1.5 Extensive method

Extensive green roofs are mostly developed for ecological or aesthetic reasons. Extensive green roofs require little maintenance. They are mostly self-sustaining, they require little water and fertilizer. The growing mediums on extensive roofs are much thinner than that of intensive green roofs, as little as 50mm. Plants for these roofs are chosen for their natural ability to adapt and survive in the particular environment on the roof. They are generally not used for recreation (Johnston and Newton, 2004).

The extensive method is used on large roofs and existing structures because of the light weight demands. It is perfect for inner city areas where there is little scope for development. The method provides less insulation value than that of the thicker growing mediums of the intensive roof; it has the advantage of flexibility, being suitable for roofs that have a slope of up to 30 degrees (Johnston and Newton, 2004).

2.4.2 Green walls

Green walls are another option for greening buildings and cities. Climbing plants can be used on buildings to enhance good design. Green walls are both feasible and desirable. By encouraging plants to grow on and up walls the natural environment is being extended into urban areas.

2.4.2.1 Benefits of green walls

The layer of vegetation protects buildings from radiation and this reduces the thermic tension within the structure. Vegetation on building walls also assist in cooling buildings in the summer and insulate them in the winter (Johnston and Newton, 2004). The leaves of many climbing plants raise their leaves in response to the high angle of the sun, which creates the effect of a ventilation blind. Cool air is drawn inward and upward, and warm air is vented at the top. Evaporation and transpiration also provide cooling (Witter, 1986). Insulation is also provided by evergreen species that trap the layer of air against the façade, minimizing heat loss (Bauman, 1986). Green walls are also beneficial to our health. The plants filter out dust and other pollutants (Johnston and Newton, 2004).

2.4.2.2 Management of green walls

To prevent plant interfering in guttering or growing into the building, pruning is needed on climbers. This happens rarely. Plants such as ivy for example should be pruned every three years.

The amount of irrigation needed depends on the species used. Plants that grow on the south side of the wall will need much more irrigation than plants on the north and west facing walls. For those plants, water supply must be retained by natural sources and the moisture retaining quality of the substrate into which they are growing.

An interest has been shown in using plants as actual structure components and not just as a skin. Plants can be used to stabilize embankments along-side roads or bordering buildings. Steel can be used as a skeleton of support to a wall while plants can be used to protect and bind exposed soil (Johnston and Newton, 2004).

It is not suggested that introducing these initiatives of vegetation on buildings will eliminate all the urban ills, but green building is important as an integrated green approach to cities. Every method helps. Every person who introduces vegetation to the surface of a building will be making a difference in the quality of city life (Johnston and Newton, 2004).

2.4.3 Energy Efficiency

In terms of energy efficiency it means adding value to energy where energy efficiency of an activity, a building or appliance, an industry, or an economy" (World Resource Institute, 1996:1). can be achieved. It is the ability to produce the same or better outcomes for less energy use. "It is the measure of value obtained per unit of energy consumed" (World Resource Institute, 1996: 1). In the last few years, problems related to energy have become a regular headline news item. Turmoil, such as gas supply restrictions from Russia in January 2006, soaring oil prices in the middle of this decade continuously surpassing highest price predictions, latest scientific findings about the impacts of climate change are all increasingly signaling that it is progressively more difficult to fuel economic growth and prospering lifestyles worldwide with the present energy supply systems (Ürge-Vorsatz *et al.*, 2003).

Up to 30 years ago, the global energy system was about 34% efficient, meaning that only a third of the world's energy input was being converted into useful energy. Since then, improvements to the efficiency of the global energy chain have led to this figure increasing to about 39%. Viewed thermodynamically, there is major 'irreversibility'' in the system, which means that the task of further improving the overall efficiency of the global energy system is a daunting one (Nakicenovic *et al*., 1998).

Many environmental and social problems are caused by the way the energy system operates. The combustion, transport and disposal of energy sources, as they go through different conversion processes result in harmful emissions. These emissions result in many global environmental problems, including serious, even fatal, human health hazards (Davidson, 2002). Sustainable energy can be defined as "energy which provides affordable, accessible and reliable energy services that meet economic, social and environmental needs within the overall developmental context of society, while recognizing equitable distribution in meeting those needs (Davidson, 2002: 6). In practice, sustainable energy has meant different things to different people. Some think of it as the energy related to renewable energy and energy efficiency. Some include natural gas under the heading of sustainable energy because of its more favorable environmental quality. Whatever approach is used, sustainable energy always implies a broad context which covers resource endowment, existing energy infrastructure, and development needs. From the perspective of improving energy efficiency, the buildings sector is a very important one: while it is perhaps the one with the highest cost-effective opportunities for reduction, the barriers preventing these opportunities are especially numerous and strong. Therefore markets and policies have achieved only modest results in taking advantage of these large opportunities (Ürge-Vorsatz *et al.,* 2003).

Sustainable resource management is very important when constructing a green building. Energy efficiency should be the main concern, not only because it saves the environment, but that it saves on running costs. According to the Department of Energy, office equipment accounts for 16 percent of an office's energy use. There are many small things that can be done around the office to decrease energy use. The use of computers, printers, copiers and fax machines adds up. Machines can be switched off when you leave the office at night, but simply turning your computer's sleep mode on when you're not using it can save energy. Printers, copiers etc. can be put on sleep mode. Or purchasing a machine that performs multi-function is another energy saver (Rassa, 2007).

2.4.4 Combined heat and power (CHP) generation

An initiative for energy management is cogeneration. It is an on- site power generation approach that uses fuel to produce multiple types of energy. Cogeneration, also known as combined heat and power (CHP). Combined heat and power can significantly reduce your energy consumption and costs, increase power reliability, expand your facility's capacity and reduce carbon dioxide emissions. This system uses fuel such as natural gas to produce heat and electricity simultaneously. The electricity can be used for any household device such as lights and appliances. Concurrently, the heat produced can be used for water heating and/or space heating. About 10% of the fuel used is lost as exhaust, much like high efficiency furnes (National Association of Home Builders, 2010).

Some problems with Combined Heat and Power Generation systems are that fossil-fuel-based CHP cannot be a long-term solution on climate or energy because fossil fuels are still being burned, and therefore still emit bountiful amounts of CO2. Reducing that by 20% or even 50% is not enough (Smith, 2010). Efficiency claims for CHP systems are frequently exaggerated. Heat is lower-quality energy than electricity, and only at high temperatures does it become close to comparable. Efficiency claims for CHP systems that use high-temperature heat are not so far off, but CHP systems that make use of low-temperature waste heat have much lower thermodynamic efficiencies than usually claimed. The exaggerated efficiency claims often lead to assertions that CHP is the "largest" or one of the largest potential solutions. But the numbers of applications that require high-temperature heat where CHP efficiency really is quite high are limited. And the modest efficiency gains with low-temperature waste heat use, which could be much more widely applied, don't lead massive improvement in energy use. The combining of heat and power production in CHP systems can reduce our fossil CO2 emissions by a few percent, but much more than that is needed in coming decades (Smith, 2010).

2.4.5 Efficiency of LED light bulbs

LEDs or light-emitting diodes, are a form of "solid-state lighting that is extremely efficient and long-lasting. While incandescent and fluorescent lights consist of filaments in glass bulbs or bulbs that contain gases, LEDs consist of small capsules or lenses in which tiny chips are placed on heat-conducting material" (Lee, 2012: 1). LEDs measure from 3 to 8 mm long and can be used individually or as part of an array. The diminutive size and low profile of LEDs allow them to be used in spaces that are too small for other light bulbs.

2.45.1 Benefits of LED light bulbs

The traditional incandescent light bulbs produce light by running a current through a filament, heating the filament till it reaches a high enough temperature to emit visible light. The filament is contained within a glass container to avoid oxidation and deterioration. Incandescent bulbs convert 8% of its input power to visible light and the rest is lost to heat. Fluorescent bulbs that are generally used in office buildings contain a "gaseous mixture of mercury and inert materials in a phosphor coated glass tube that is electrically excited to emit light" (Broderick, *et al.*, 2010: 1). These lights covert 21% of their input power to visible light and the rest is lost to heat (Broderick *et al.*, 2010).

LEDs emit light by transferring electrons thorough the connection of two semi-conducting materials. Photons of a specific wavelength are emitted. The light-emitting semi-conductor material is small, making this a point source type of light. One of the noteworthy benefits of LED lights is its efficiency to convert electricity to usable light. LEDs can convert 15-25% up their input light to visible light, technological projections say that it can be up to 50% in the coming years (United States Department of Energy, 2009). Because LEDs give off light in a precise direction, they are more efficient in function than incandescent and fluorescent bulbs, which waste energy by emitting light in different directions. (Lee, 2012).LEDs last longer than traditional incandescent bulbs, approximately 50 times longer and 2.5 times longer than fluorescent bulbs. Because LEDs are resilient they withstand vibrations better that other bulbs, this reduces maintenance costs in certain applications (Broderick *et al.*, 2010). Another benefit of LEDs is their cold temperature efficiency. Incandescent and fluorescent bulbs decline in cool temperatures. LEDs emit no ultra violet light which is beneficial is certain manufacturing, preservation or scientific environments.

2.4.5.2 Challenges associated with LEDs

To produce a white light developers have to combine different colored LEDs (eg. red, green or blue) or coat a blue LED in phosphor to "spread the spectrum and obtain a more white quality" (Broderick *et al.*, 2010: 2). The viewer will interpret the light as warmer or cooler depending if the color of the light is more red or blue. Most viewer prefer the warmer light, similar to that of incandescent lights, but warm LEDs typically have a lower luminous efficiency (Broderick *et al.*, 2010).

LEDs have a higher luminous efficiency than conventional lights, but they are inclined to convert more of the energy to heat at the source, making heat dissipation a problem. About 80% of a LEDs supply power is lost in the heating the device, whereas as only 18% input energy is needed to heat an incandescent bulb and 73% is radiated away as infrared energy. High temperature can degrade the life span of LEDs, needing properly engineers "heat sinks to minimize junction temperatures" (Broderick *et al.*, 2010: 2). The heat sinks need added materials and produce installation problems that other bulbs do not need (Broderick *et al.*, 2010).

2.4.5.3 Energy efficiency of LEDs

Lighting is responsible for 18% of energy usage in commercial buildings. Conventional lights provide 8% of light in commercial buildings and use 32% of the lighting energy (Department of Energy, 2002). In addition to saving on lighting energy, the improved luminous efficiency of fluorescent and LED versus incandescent means less heat is created to produce the equivalent light. An incandescent bulb uses 55 Watt as heat while the equivalent lumen output fluorescents and LEDs use 10Watt (Broderick *et al.*, 2010).

Other factors except LEDs efficiency make them more affordable. The longer life span of LEDs mean that they require replacements less frequently than incandescent bulbs. This results in less maintenance which is one the main long term costs of lighting systems. With fewer labor costs the payback period for commercial buildings will be shortened considerably. Building operators will have to have different mindsets when it comes to lighting. LEDs are a long term investment in building infrastructure similar to an HAVAC system. This is in contrast the mindset of replacing lower cost light bulbs continuously (Broderick *et al.*, 2010). Building owners can incorporate other systems such dimmers and controls that also reduce energy consumption. Examples of these controls are daylight sensors. Daylight sensors are used to turn off the lights when there is sufficient daylight in the area. Daylight sensors can be used to dim or turn-off lighting when there is adequate daylight. There is also night time switching, which can be linked to the daylight sensors, to ensure that the lighting is only turned on when necessary. Movement sensors are also used to turn lights off automatically in spaces that are not used (CSIR, 2011).

Thirty years ago when compact fluorescent lights (CFLs) were introduced to the public, they were met with less than keen reviews, due to people suffering from eye strain, poor color quality and significant variability of price and quality. Only now are consumers beginning to be more accepting of CFLs and more educated on their proper application. LEDs that are Energy Star-qualified should provide unwavering light output over their projected lifetime. The light projected by the LEDs should be of exceptional color, with brightness at least as sufficient as that of a conventional light source and its efficiency should match that of fluorescent bulbs. The LEDs should also light up instantly when turned on, should not flicker when dimmed and should not consume any power when switched off (Lee, 2012). For LEDs to grow in the market industries need to educate their customers and manage their expectations to lead LEDs into suitable application (United States Department of Energy, 2006).

2.4.5.4 ESKOM Demand-Side Management Strategy.

Currently in South Africa Eskom has as part of its Demand-Side Management (DSM) Strategy, developed a strategy that installs CFL's in the country free of charge. Unfortunately LED light bulbs are not used, but CFL's are more energy efficient than incandescent light bulbs. To date Eskom has installed more than 30 million CFL's nationwide since 2007. They distributed the CFL's through a combination of door-to-door, gate-to-gate, and exchange points. This program has to date reduced seven million tons of Co2 emissions, which saves al lot of energy consumption. The project has saved households money on their electricity bills and has also created over 30 000 short-term jobs for South Africans (Eskom, 2010).

Through their Sustainable Program, Eskom plans to distribute between 20 and 40 million CFL"s throughout the country between 2011 and 2013. The first phase of this project will distribute more than 6 million CFL's in the Western Cape, Mpumalanga and the Eastern Cape. A vital part of the program is the development of carbon credits, to cover the cost associated with the purchase of the lamps, supply, disposal, communication and monitoring and evaluation of the procedures. Households that have participated in the program have saved costs on their electricity bills (Eskom, 2012). "A 60 W incandescent exchanged for a 15 W CFL delivers approximately R40 per year in cost savings (based on an electricity price of R0.71/kWh)" (Eskom, 2010: 2). Exchanging six CFL's would, therefore, save R250 peryear, a material saving for low- and middle-income households" (Eskom, 2010).

2.4.5.5 Natural light

The use of natural daylight instead of artificial lighting is still the most sustainable and resourceful way of saving energy in buildings. Skylights and windows can provide sufficient illumination in living and work spaces without using artificial lighting during the day. High performance glazing allows for more windows to be operable. Glass with high light transmittance supports good daylight within buildings, reducing the requirement for artificial lighting (City of Cape Town, 2011).

2.4.6 Evaporative coolers

"In low-humidity areas, evaporating water into the air provides a natural and energy-efficient means of cooling. Evaporative coolers, also called swamp coolers, rely on this principle, cooling outdoor air by passing it over water-saturated pads, causing the water to evaporate into it"(U.S. Department of Energy, 2010:1). The cooler air is then directed into the home, and pushes warmer air out through windows. Evaporative coolers have a low first cost, use a lot less electricity than conventional air conditioners, and do not use refrigerants, such as chlorofluorcarbons (CFCs) and hydrochlorfluorocarbons (HCFCs) that can harm the ozone layer (National Association of Home Builders, 2010).

There are two types of evaporative coolers: direct and indirect (all called two-stage). In a direct evaporative cooler, a fan pushes air through a porous water-soaked pad. As the air passes through the pad, it is filtered, cooled, and humidified. An indirect evaporative cooler has a secondary heat exchanger which prevents humidity from being added to the airstream which enters the home. Evaporative coolers can be used as a cooling system in a home, as an alternative cooling system to a traditional air conditioner, or in combination with a refrigeration system. However, conventional air conditioners should not be operated at the same time as direct evaporative coolers, because air conditioners dehumidify while evaporative coolers humidify, and the two systems will work in opposition (National Association of Home Builders, 2010).

2.4.7 Solar energy

"More energy from the sun strikes Earth in one hour than all the energy consumed by humans in an entire year" (Lewis, 2007: 1). The solar energy resource dwarfs all other renewable and fossil based energy sources combined (Goldemberg and Johansson, 2004). Solar energy is a free, infinite resource, however harnessing it is a fairly new idea. A Swiss scientist Horac de Saussre developed the first thermal solar collector in 1767, which was used to heat and cook food. In 1839 a French physicist, Edmund Bacquerel discovered that the sun's energy can produce a photovoltaic effect. Selenium Photovoltaic cells (PV cells) were developed later in the 1880's that could convert light into energy with a 1-2% efficiency. However the conversion was not well understood. It was Albert Einstein that gave an explanation for the "photoelectric effect" in the early 1900's for which he also won a Nobel Prize. Solar technology advanced to roughly its present form in 1908 when William Baily invented a collector with an insulated box and copper coils. In the 1950's Bell Telephone labs achieved a 4% efficiency and later on 11% with PV cells. Interest grew later in the 60's and 70's but was forgotten when fossil fuels became more available and affordable. Recently there has been renewed interest in PV modules and other solar electricity methods, due to the growing energy demands. Solar electricity or photovoltaic (PV) technology is receiving much attention as a prevalent approach to sustainable energy consumption. Solar panels, also known as photovoltaic modules (or PV modules), convert sunlight into electricity, and they have been the backbone of renewable energy for decades. A solar panel (PV module) is a device that will produce a flow of electricity under sunlight. This electricity can be used to charge batteries and, with the help of an inverter, it can power normal household electrical devices. PV modules can also be used in systems without batteries.

Most solar panels are framed in aluminum, topped with tempered glass, and sealed with a waterproof backing. In between the glass and backing layers there are photo-reactive cells, often made of silicon (Lafayette, 2011). There are many different uses of solar electricity, for example on small scale electronic or music devices can be charged. Solar panels are assembled individually or wired together for a bigger solar range. For providing electrical power to homes or offices, two main types of systems are used, they are stand-alone battery bases systems or grid tied systems (Lafayette, 2011).

To provide an extensive primary energy source, solar energy must be captured, converted and stored in a cost efficient manner. Even a solar energy device that operates at the theoretical limit of 70% will not be provide the technology needed if it were expensive and if there were no cost effective instrument to transmit, store or convert solar energy on demand. In order to attain a complete solar-based energy system, PV manufacturing methods have to be minimised, together with scientific and technological contributions to enable in a convenient, scalable manufacturing form, the gainful capture, conversion and storage of sunlight (Lewis, 2007). Although there is great growth potential in PV in electricity generation, solar energy cannot be a material contributor to primary energy generation without cost-effective methods for storing and distributing vast quantities of electricity (Smalley, 2005).

The sun goes down every night, and the "intermittency imposed by the diurnal cycle must be dealt with to provide a full base-loadable primary energy from the sun" (Lewis, 2007: 3). Due to the lack of cost-effective large scale electrical storage capacity on Earth, an important focus on the development of space-based solar power systems are needed. The cheapest method of large scale electricity storage on Earth is pumped-water storage. Pump-water storage can be very efficient but it does not scale well. Every reservoir would have to be filled every day and emptied every night, which results in a copious amount of water that will be needed to compensate for the diurnal cycle if a great contribution is to be made to the global energy generation through this method.

Batteries are a neutral approach to electricity storage. For the batteries storage to be cost-effective over the 30-year life span of a PV system, an immense quantity of batteries would have to be placed on the grid, and they would have to cost about the same as led-acid batteries while producing the life cycle of lithium-ion batteries (Lewis, 2004). Perhaps the most attractive cost-effective method of large scale storage might be in the forms of chemical bonds (chemical fuels). It is central to photosynthesis and plays a vital role in the recent attention that is given to bio fuels. One approach of storing electrical energy through chemical bonds is through electrolysis where water is split into H_2 and O_2 in an electrolyzer. However this process is also expensive and it is doubtful that it will be scalable to the levels that are required for this process to be influential in global energy production (Ivy, 2004). Efficient and cost effective capture, conversion and storage of sunlight has its challenges and the integration of all of these components into a functioning global scalable system will require much development in science and engineering and technologies if the full potential of solar energy is to be realized.

2.4.8 Improved Insulation

Thermal insulation is a material or combination of materials, that, when properly applied can delay the rate of heat flow by means of conduction, convection and radiation. It delays heat flow into and out of buildings due to the high thermal resistance (ASHRAE, 2001). Insulation is an integrate element in building a more energy efficient space. Insulation materials are rated according to their ability to resist heat flow. The thermal resistance rating is known as an "R-value". The higher the R-value of a material, the better its ability to resist heat flow. When insulation materials are properly installed there are fewer gaps and voids through which unconditioned air can leak into a building. This helps avoid dirt molecules, dust, and other impurities to enter the living space and reduce the in-door air quality. A tight building cover is a critical component to ensure good indoor air quality. Improved insulation also helps to minimise heating and cooling loads, allowing less heating, ventilation, and air-conditioning (HVAC) systems. The cost savings from using smaller HVAC equipment can be used to compensate the additional cost of high efficiency heating and cooling equipment (Miller,2000).

Thermal insulation is the first step to achieving energy efficiency especially in envelope-load dominated buildings that are situated in sites with harsh climates. To achieve the best performance of insulation, insulation materials must be placed close to the point of entry of heat flow (Al-Homoud, 2004). Insulation should be inserted to the inside for climatic regions where winter heating is dominant and to the outside where summer heating is dominant, although it is more practical to insert insulation between wall cavities. There are different forms of insulation loose-fill form, blanket bat or roll form, rigid form, foamed in place or reflective form. The choice of insulation material and method depends on the type of material and application (Al-Homoud, 2004).

2.4.8.1 Benefits of thermal insulation

Using thermal insulation in buildings minimizes the reliance on electrical systems in buildings, saving energy and natural resources. There is little capital expenditure in using thermal insulation, reducing operating costs and minimizing use of HVAC systems. Thermal insulation also provides environmental benefits as resilience upon mechanical means with the emitted pollutants being reduced. Thermal insulation reduces temperature fluctuation in buildings, which helps preserving the integrity of the building structure. If thermal insulation is properly installed and designed vapor condensation on building surfaces will be avoided. Appropriate insulation materials delay flame immigration into the building in case of a fire (Al-Homoud, 2004). The proper uses of insulation in buildings do not only reduce costs in air conditioning systems, but also contributes to saving in energy cost. Thermal insulation provides thermal comfort without the dependence of mechanical systems, especially during inter-season periods. The levels of energy savings will depend on the building type, the climatic conditions where the building is located and also the type of insulation material that is used. Building owners should not focus on the whether or not to use insulation, but rather determine which type of material should be used and how much (Al-Homoud, 2004).

2.4.9 Wind Energy

The terms "wind energy" or "wind power" describe the process by which the wind is used to generate mechanical power or electricity. Wind turbines convert the kinetic energy in the wind into mechanical power. This mechanical power can be used for specific tasks (such as grinding grain or pumping water) or a “generator can convert this mechanical power into electricity to power homes, businesses, schools, and the like” (Wind Energy Development Programmatic EIS, 2011:1).

In 1973 an interest in the development of wind energy grew due to the rise in oil prices and limited fossil fuel resources. From the 1990’s onwards the main appeal to the development of wind turbines was the low levels CO^2 emissions that wind turbines produced during manufacturing, installation, production and de-commissioning, and also the potential of wind energy to ease climate change (Gipe, 1999). With a high rise in oil prices in 2006 and further concerns over energy supplies further interest was given to wind energy. A series of policies in many countries were developed to encourage the use of wind energy. In 2007 the European Union declared that 20% of all energy should be attained through renewable sources by 2020. In some countries an energy supply of 30% to 40% should come from renewable energy, because of the difficulty of using renewable energy for transport or heating purposes. Wind energy is likely to play a major role in achieving this (Gipe, 1999).

Wind energy has been more rapid in some countries than in others. This can be due to several factors including: "financial support mechanisms for wind generated electricity, access to the electrical network" (Gipe, 1999: 3), the process by which local authorities give permission to construct wind farms and the public's perception of wind farms, particularly the visual aspect. Construction of offshore sites, although expensive is in response to these concerns of the environmental impact of wind farms. New technologies like wind energy needs financial support to promote its development and motivate interest from private companies. Such support is provided in many countries and realises the contribution wind energy makes to climate change alleviation and the safety of national supplies. In Germany and Spain Feed-In-Tariffs are offered, where a fixed price is paid per kWh used from renewable sources. Different rates are applied to wind energy, photovoltaic solar energy and other renewable energy sources. This incentive provides the benefit of giving certainty of the revenue stream of a successful project (Gipe, 1999).

2.4.9.1 Modern turbines

Modern wind turbines combined ancient knowledge with our present technology. From Greek sailboats to the wind mills in the Netherlands, people have used wind as an energy source for centuries. Modern wind turbines are 20 stories tall, with blades that are 90 feet long. Generally wind turbines are built in clusters that we call wind farms. Turbines can also be built alone, which will produce enough energy to supply a factory or a small town. There are four core parts to a wind turbine: the base, tower, nacelle and the blades (Bower, 2000). The blades of the turbine capture the wind's energy, spinning a generator in the nacelle. The tower of the turbine (see Figure 2) contains the electrical conduits (a tube protecting insulated electronic wires), supports the nacelle, and provides access to the nacelle for maintenance. The base of the turbine is made of concrete or steel which supports the entire structure. The blades of the turbine are designed like airplane wings. The blades use lift to capture the wind energy. The blades are designed in a specific manner so that the wind creates a pocket of pressure behind the blade. The pressure that is created pulls the blade causing it to rotate. The modern design of the turbine blades are much more efficient than the design of old farm windmills, which use drag, the force of the wind pushing against the blade (Brower, 2000).

The nacelle consists of a generator and a gearbox. The blades of the turbine are connected to the generator through a number of gears. The gears increase the rotational speed of the blades to the generator speed of over 1, 500 RPM. As the generator rotates electricity is produced. Generators consist of either variable or fixed speeds. Variable speed generators produce electricity at a varying frequency, which must be corrected to 60 cycles per minute. Frequency speed generators do not have to be corrected, but are not as capable to take advantage of variation in wind speeds (Brower, 2000). The general design of the towers a white steel cylinder that is between 150 to 200 feet tall and about 10 feet in diameter. Certain turbines use lattice towers, which have ladders running up the inside and a hoist for tools and equipment. The base of the turbine is made from concrete reinforced with steel bars. There are two different designs of the base one is a shallow flat disk about 40 feet in diameter and three feet thick. The other design is a deeper cylinder, which is about 15 feet in diameter and 16 inches thick (Brower, 2000).

The electrical output of a wind turbine will change as the wind speed changes. If an off-grid turbine is used to supply energy to homes or small buildings, batteries will be needed to store power and even out the fluctuations. If the turbine or wind farm is part of a power grid, with many power plants and power-consuming appliances, these fluctuations are not noticeable. The output that wind turbines generate is known as the capacity factor (Brower, 2000). A capacity factor is “ the amount of power produced in a given time period compared to what the generator could produce if it ran at full capacity for that time period” (Brower, 2000: 2). If a generator had to run at its full capacity permanently it would have a capacity factor of 100 percent, but no power plant runs all the time. A wind turbine, if placed in a good location, produces a 33 percent capacity factor on average. This does not mean that turbines are inactive two thirds of the time; it mostly produces lower levels of power. Wind turbines can produce power from winds as slow as 11 km and as high as 72 km. An excellent wind resource is where winds are around 16mph over a period of a year. Wind speeds are categorized into classes. From a low of class 1 to a high of class 7 (Brower, 2000).

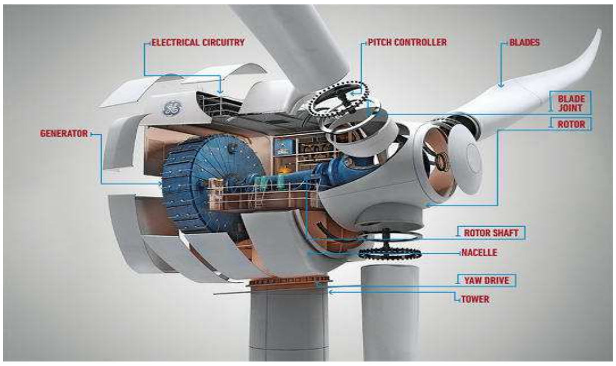

Figure 2.1 Modern wind turbine *Source: Modern wind turbines: Google images, 2012*

Wind speeds that fall into a class of 4 and higher as used for wind power production. Wind power is measured in watt per square meter, and this increases by the cube of the wind speed. For example winds of 24 km are twice a powerful than winds of 19 km, doubling the production of the wind turbine. The density of air also plays a role in the output the turbine produces. If the air is cool and at lower altitudes the turbines produce more power than when the air is warm and at high altitudes. Height too has as influence on the wind speed. Taller turbines that are not obstructed by buildings or trees capture the higher winds speeds and produce more energy than shorter turbines (Brower, 2000).

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The availability, potential, and feasibility of primary renewable energy resources must be analysed early in the planning process as part of a comprehensive energy plan. The plan must justify energy demand and supply and assess the actual costs and benefits to the local, regional, and global environments. Responsible energy use is primary to sustainable development and a sustainable future. Energy management must balance justifiable energy demand with appropriate energy supply. The process couples “energy awareness, energy conservation, and energy efficiency with the use of primary renewable energy resources (Wind Energy Development Programmatic EIS, 2011: 1).

2.4.10 Water efficiency

Water efficiency has traditionally gained little attention when designing or operating a building. Water is used carelessly in building, but with declining water supply and rising costs, building owners have to start implementing more water efficient strategies. Water use in commercial buildings varies with plumbing-fixture type, the type of equipment installed, and the function of the building. For example, buildings that have commercial kitchens and cafeterias will have higher process water consumption levels than those that do not. Similarly, buildings that have hydronic cooling systems also have higher process water consumption levels. These systems consume a fair amount of water but they are not the main users. The systems that consume the most water are plumbing fixtures in bathroom, toilets water closets and urinals. Restroom use up to 60% of the total water use in office buildings, the other 40% is estimated to be used by heating and cooling systems (Glimer and Hughel, 2008). There are a number of fixtures and new technologies that can be initiated in the design phase of a building and retrofits that can be applied to existing installations to make water consumption more efficient (Arab Forum for Environmental Development, 2011).

2.4.10.1 Detecting leaks

The water leakage from plumbing fixtures, toilets and taps can be responsible for between 10 to 30% of water losses (Arab Forum for Environmental Development, 2011). By implementing regular checks and maintenance to leaking fixtures a vast amount of water can be saved. In commercial buildings complex measures such as overnight checks, monitoring and water balances will be needed to determine the extent of leakages. Devices that combine water and air minimise the flow rates of water and increases wetting efficiency. An example is faucet aerators, which saves up to 50% water use during hand washing. Many modern faucets are equipped with integrated aerators and should be favored for new installations (Arab Forum for Environmental Development, 2011). On-demand faucet units are also a method used to reduce water consumption. The on-demand units use infrared sensors to trigger the water flow, which reduces water use in basins significantly. Another system used to reduce the flow of water is an automatic shut off system. The flow of water is stopped once a predetermined amount has been discharged. These systems use infrared or mechanical triggers to control the water flow. These shut off systems need to be combined with water saving aerators (Arab Forum for Environmental Development, 2011).

2.4.10.2 Storage tanks in commercial buildings

In commercial and institutional building water received from the main is often stored in tanks before use. Storage tanks deteriorate over time. In order to detect leakage the water level of the tank should be checked in a time when no water is being extracted. The water storage tank should be designed with two independent cells each carrying a 50% capacity of the total tank volume. This design will allow water from one cell to be transferred to the other cell during maintenance, precluding the need to drain the entire water content of the tank. The cells must also be designed to be emptied independently (Arab Forum for Environmental Development, 2011).

2.4.10.3 Water distribution networks

Another method to achieve water efficiency in commercial buildings in to design internal water distribution levels with independent segments. This should be defined by through the area of the building and also the type of water consumption. Each system should have a meter that measures the water consumption in the sector. Examples of independent water sectors can be one sector per floor, or one sector per common area such as corridors and one sector for the HVAC system (Arab Forum for Environmental Development, 2011).

2.4.10.4 Infrastructures for water re-use

Grey water is produced by certain activities in a building such as basins and laundry rooms. Grey water can be use for the flushing of toilets or irrigation. In order to assist the use of grey water in a commercial building, systems to collect, treat and store the grey water should be initiated in the early stages of the design phase. It is important to initiate this in the design phase because the re-use of grey water in toilets requires the installation of additional pipes, storage units and pumps and it can be expensive to retrofit existing toilets and urinals (Arab Forum for Environmental Development, 2011). Black water (former waste water, or sewage) is also treated to remove solids and certain impurities, and then used in sustainable landscaping irrigation or to recharge ground water aquifers. This is done for sustainability and water conservation, rather than discharging the treated wastewater to surface waters such as rivers and oceans. The cost of reclaimed water exceeds that of potable water in many regions of the world, where a fresh water supply is plentiful. However, reclaimed water is usually sold to citizens at a cheaper rate to encourage its use. As fresh water supplies become limited from distribution costs, increased population demands, or climate change reducing sources, the cost ratios will evolve also. Using reclaimed water for non-potable uses saves potable water for drinking, since less potable water will be used for non-potable uses (Mc Lennen, 2004).

2.4.10.5 Rainwater harvesting

Rainwater collected from roofs or other paved areas can reach vast amount and can be used for cooling and heating, toilet flushing, hygienic purposes, drinking water and general cleaning in buildings (Arab Forum for Environmental Development, 2011). Rainwater harvesting systems (see Figure 2.2) include the following mechanism:

Catchment area: An impervious surface such as roofs or parking lots to capture the rainfall.

Conveyance system: Sufficient drainage and piping is needed to transport the captured rainwater to the treatment and storage tank (Arab Forum for Environmental Development, 2011).

Treatment: The water that is captured needs to be treated according to the characteristics of the catchment area and the intended use of the harvested water. Rain water retrieved from roofs generally has fewer pollutants than rainwater captured in paved areas or parking lots. The first part of the collected run-off is usually not used because of its tendency to have a high level of impurities. The run-off water is then passed through a filtration system to retain organic and other impurities. A coarse filtration that can be achieved with a sand filter might be sufficient for a clean harvest. For finer filtration to attain water of a higher quality a micro filtration may be needed (Arab Forum for Environmental Development, 2011).

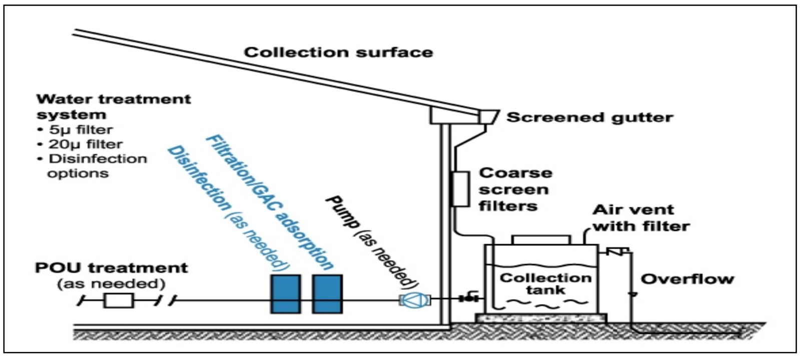

Figure 2.2 Rainwater harvesting system for buildings *Source: Water use efficiency in buildings, 2011*

Storage: After the filtration process, the water must be put in a storage tank. The dimensioning of the tank is important to consider and it requires an estimation of the volume of rainwater that can be harvested. The tanks must also be fitted with an overflow system (Arab Forum for Environmental Development, 2011).

Delivery system: Pipes, pumps and valves will be needed to transfer the water from the tank to the point of use. A pump can be installed within the tank to transfer the water to the point of use. However if the rain water needs to meet advanced hygienic requirements or will be used as potable water, additional filtration systems such as UV disinfection or granulated activated carbon filtration may have to be integrated into the system (Arab Forum for Environmental Development, 2011).

Care needed: The storage tanks of the rainwater harvesting systems have to be cleaned frequently, particularly in warmer climates the storage tanks can become breeding grounds for insects such as mosquitoes. To prevent this from occurring all orifices that are not frequently in use should be appropriately closed and sealed. Orifices that are frequently used such as input and overflow pipes should be covered with mesh (Arab Forum for Environmental Development, 2011).

2.4.11 Waste reduction

In the context of commercial buildings, waste can be described as materials and products that are un-used. Waste is materials and by-products that are consumed during business activities and building management and maintenance (Terry and Moore, 2012). Waste is generated over a buildings life cycle. The waste is generated during the construction, operation, refurbishment and demolition phases. Construction and demolition phases can occur simultaneously at new building and refurbishment stages, but produce different volumes and types of waste. Operational waste also creates other forms of waste, mostly from business activities (Terry and Moore, 2012). During the construction phase waste is mainly due to demolition of existing buildings, design changes, poor onsite materials control, left over surplus materials and cost and delivery pressures that make for working practices that are not contributing to conserving materials and avoiding damage (Dainty and Brook, 2004).

Packaging waste is also common in all building life cycle activities. Construction elements, materials and equipment that need special protection produce a high proportion of packaging waste. In the operational phase consumable products such as cleaning products, paper and lighting have considerable packaging, not only the individual product, but also products that are transported in bulk. Packaging when considered with the product is often not seen a major factor, but packaging must be considered in waste minimization, and dealt with appropriately in all phases of the building's life cycle (Terry and Moore, 2012).

2.4.11.1 Business performance benefits of waste management

Waste reduction and management contributes to the minimizing risk and enhancing social corporate responsibility. It creates good public relations and can also enhance an organization's business continuity by attracting like-minded clients and employees. The cost reduction benefits are a small part of the operational costs, but tracking and controlling waste is part of the overall strategy enhance organizational performance and outcomes (Terry and Moore, 2012).

2.4.11.2 Triple bottom line benefits

Implementing waste reduction methods and management strategies can generate cost savings, and contributes to resource conservation, pollution and emission avoidance and landfill reductions. Initiating waste programs can also raise awareness across industries. This may enhance an individual's understanding of waste implications of purchasing decisions. This in turn will have an effect across the supply chain and further develops behaviors that reduce the waste stream and recycle and re-uses products appropriately (Terry and Moore, 2012).

Sources of major waste production occur at the construction and demolition stages of a building's life cycle. However refurbishment and fit-out activities also produce a large amount of waste over the life cycle of the building. During the design stage of a building waste can be avoided through decisions about processes and material specifications (Dainty et al., 2004). Design that keeps materials clean make it easier to re-use and recycle materials in the long run. UK-based research has found that 25% of waste produced from construction and demolition can be minimized through source reduction and by improving the management of waste on site (Department of the Environment, 2000). Demolition provides the most potential for recycling and re-use of materials. However the methods of demolition must be considered, methods enabling recycling and the re-use of materials may be more labor intensive than the traditional method.

Renovation and refurbishment of buildings generated a high volume of waste, it is important to implement recycling and re-use strategies during refurbishment to minimize waste generation (Miller, Khan et al., 2005). Strategies for reducing new material use include: "accurate condition assessment, designing out waste through use of standard, modular units, specification of durable materials and planning for deconstruction" (Terry and Moore, 2012: 17). Accurate ordering of materials, appropriate storage and controlling and monitoring waste on site are construction strategies that can improve economic and environmental practices.

2.4.12 Air quality

Indoor air quality is very important in securing a healthy and productive working environment. Environmental Protection Agency (EPA) and its Science Advisory Board (2012) report that indoor air pollution is among the top five environmental risks to public health. EPA studies show that levels of some indoor air pollutants can reach more than 100 times that of outdoor air pollutants. Indoor air pollutants such as dust mites, bacteria, and pollen come from almost everything in our homes and offices including cleaning supplies, smoke, dust, molds, paint, carpets, drapes, upholstery, furnaces, gas burners, wood, and other building materials. Volatile organic compound is found in many machines and materials used in offices, it is found in products like paint, treated wood, photo copiers and fax machines. Emission from these products can cause headaches, nausea and skin irritation. Natural ventilations and light minimises exposure. Avoid building and decorating materials (such as paint, varnished wood, carpets, etc). Materials such as natural wood finishes or paints should rather be used. Central air purification systems minimize the amounts of these particulates in indoor air (National Association of Home Builders, 2010).

Damp conditions inside a building cause microbial growth. These damp conditions allow funguses and bacteria to breed, creating an unhealthy environment for those working or living in the building allergies asthma, bronchitis and pneumonia, and Legionnaire's disease, can be contracted from these funguses. Regular cleaning and servicing of air conditioning equipment reduces the risk of damp build-up (City of Cape Town, 2011).

Many companies now manufacture dehumidifying ventilators that provide fresh air induction that is filtered and dehumidified for residential applications. Typically, the equipment operates to provide fresh (outdoor) air when ventilation is needed through ductwork where it is mixed with indoor air drawn from the house and filtered prior to being delivered to the supply plenum of the fresh air duct and some units simply re-circulate and filter indoor air (National Association of Home Builders, 2010:1).

A heat recovery ventilator (HRV) can help make mechanical ventilation more cost effective by reclaiming energy from exhaust airflows. HRVs use heat exchangers to heat or cool incoming fresh air, recapturing 60 to 80 percent of the conditioned temperatures that would otherwise be lost. Models that exchange moisture between the two air streams are referred to as Energy Recovery Ventilators (ERVs). ERVs are especially recommended in climates where cooling loads place strong demands on HVAC systems. When the heat recovery ventilation system is not running properly, the air in your living space is dry, not stabilized, and even contains allergens, and mold build up is also possible (National Association of Home Builders, 2010).

2.4.13 Site selection of buildings

Another focus of green building is the site on which the building is developed. In line with the ethos of green planning practices undeveloped green field sites should be avoided and already disturbed sites known as brown field sites should be chosen. To construct new infrastructure such as roads, sewerage, storm water systems and communication networks, new development will need a substantial investment of energy. Existing sites or brown fields avoids further reductions in the size, and therefore the ability, of the natural environment to absorb carbon dioxide resulting from man's activities (Council of Scientific Industrial Research, 2008). Site layouts should also be developed to avoid affecting a neighboring building's access to sunlight and ventilation. Ideally, site plans should be developed in combination with neighboring sites in order to create an integrated plan that promotes energy efficiency. Examples of areas that could be collaboratively explored include: Shared car parking space and transportation systems Linked pedestrian and cycle routes and " integrated building layout and landscaping that developed beneficial microclimates"(Council of Scientific Industrial Research, 2008: 30). Noise surrounding the site is also important to concentrate on when developing a building. If the site is adjacent to noisy areas such as highways, the site layout should be developed to maximize the distance of buildings to this. Non-occupied buildings such as parking garages and electrical substations provide a solution, by acting as sound buffers(Council of Scientific Industrial Research, 2008).

2.5 GREEN BUILDINGS CONCEPTUALIZED

On this section green buildings, green initiatives, green rating tools and green building councils together with alternatives to the Green Building Councils Models: Government- lead rating schemes, are explained in detail.

Green building is the practice of creating structures and using processes that are environmentally responsible and resource-efficient throughout a building's life-cycle from "design, construction, operation, maintenance, renovation and demolition" (U.S Environmental Protection Agency, 2012: 4). This practice enhances and complements the classical building design concerns of economy, value, resilience, and comfort. A green building is also known as a sustainable or high performance building (U.S Environmental Protection Agency, 2012).

Green buildings are designed to promote human health and minimise the aversive effects on the environment. There are certain green guidelines that are followed, these are: Using natural and manmade resources efficiently; Considering the impact of buildings and development projects on the local, regional and global environment, Reducing building footprint and development size; Allowing ecosystems to function naturally; Conserving and recycling water; treating storm water on-site; Capitalize on the use of local materials; Optimizing energy performance by installing energy efficient equipment and systems; Optimizing climatic conditions through site orientation and design and lastly integrating natural day-lighting and ventilation (Sharma, 2009).

Green is a general term that is used for a whole spectrum of issues. These issues are discussed around three central themes: depletion of natural and scarce resources through bad and excessive production and consumption activities, waste accumulation and emissions because of production processes, the use of hazardous materials, fast replacement consumption patterns, and usage, re-usage and disposal habits. Unhealthy products and side-effects arising from unhealthy environments, materials used, and improper choice and use due to uninformed consumer decisions (Van der Merwe and Oliff, 1990).

Green buildings have an improved environmental performance over standard buildings through all phases of their lifecycle: beginning in design and construction through operations and to the end of life, including deconstruction and demolition. Green buildings also produce methods that make it healthier for its occupants, such as increased daylight and fresh air and non-toxic materials. By reducing the amount of energy and other resources green buildings are less expensive to control, making it more valuable in the market place. A green building can achieve these outcomes by focusing on it from the first stage of the design. These outcomes must be focused on and implemented throughout the construction. Its performance should constantly be monitored and evaluated during its operation (Van der Merwe and Oliff, 1990).

2.5.1 Green building councils and rating tools

This section 2.5.2 an alternative to the green building council model: government-led rating schemes will be discussed as well as how South Africa adopted the green star rating tool.

Green Building Councils (GBC) are non-profit, member-based organizations that look to transform building industries towards sustainability by encouraging the adoption of green building best practices. At present there are numerous green building councils around the world that are in different stages of development, and there are 20 Green Building Councils that are fully recognized. South Africa has the only fully established green council in Africa to date. There are three new GBC's in Morocco, Mauritius and Egypt that are currently in their early stages of development. One of the essential activities of most GBCs is the implementation of green building rating tools (United Nations Habitat, 2010).

A green building rating tool is a voluntary mechanisms used to rate and verify the environmental performance of a building. By rewarding exemplary building performance, rating tools provide a motivation for building owners to go above what is required by government building codes (which define the baseline level of performance to be a legal building). Building owners can use the ratings to display the quality of their buildings to a variety of interested stakeholders, including occupants, investors and the public (United Nations Habitat, 2010).

The British Research Establishment launched the first commercial green building rating tool in 1990, known as BREEAM (British Research Establishment Environmental Assessment Method). This was followed by LEED (Leadership in Energy and Environmental Design) in 2002, in the United States, CASBEE (Comprehensive Assessment System for Building Environmental Efficiency) in Japan, Green Star in Australia and several other country-specific tools in Asia and Europe (United Nations Habitat, 2010).

The LEED rating tool is based on U.S standards. Any building in the world can register for LEED certification using the LEED rating tool. LEED provides building owners and operators with a structure for identifying and implementing practical and measurable green building design, construction and operations that recognize projects that implement strategies for improved environmental and health performance. The LEED rating systems are developed through an open, consensus-based process led by LEED committees, various groups of volunteers representing a cross-section of the building and construction industry (U.S. Green Building Council, 2011).

The USGBC has agreements (legal and financial) with several GBCs to use LEED in their countries. The GBC’s of India and Canada were allowed to make changes in the LEED rating tool to suit their specific market system, because of the early adoption of the tool. However LEED tools now instead have options for ‘regionalization’ where certain initiatives can be rewarded differently according to the location. The USGBC is considering revising its LEED adoption framework in order to allow for other countries to have some right to customize LEED. Wherever LEED is used, the USGBC will be in control of the assessment and certification of the projects (United Nations Habitat, 2010).

The GBC of Australia developed the Green Star system and will not certify a building in another country under Green Star, as it was created specifically for Australia. However, there were legal and financial agreements made by other GBCs allowing them to modify Green Star to be used in their countries (to date, two countries have done so). Once Green Star has been customised for that specific country, the adoptive GBC is responsible for assessment and certifications of the projects under their scheme (United Nations Habitat, 2010).

Several GBCs particularly in Asia and more recently in Germany, have opted to create their own tools for their markets Most of these rating tools view similar aspects. The differences lie in how the impact issues are categorised within the tool, the performance benchmarks for each initiative, the type of documentation required to prove compliance with the rules of the tool, and the methods by which the buildings are assessed under the scheme (United Nations Habitat, 2010).

Most rating systems start out with tools for new buildings, which apply to new construction and major refurbishments (buildings with minor refurbishments could also use the tools but would have significant challenges in meeting the criteria put forth in the tools). Some systems now have rating tools for existing buildings that rate how the building performs in its ongoing operation. Green Building Councils have focused on new building design and construction because up to “85% of a building’s lifecycle costs might already be determined once just 7% of its up-front costs are spent. Also, owners of new buildings have had the most incentive to pursue certification in order to create a market differentiation for their building. As some of the more veteran rating systems have matured, they have created “suites of tools with specific rating tools for each building type; the tools are specific to the function and form of each particular type of building. For example, a given suite may have tools covering offices, schools, shopping centers, homes, etc ” (United Nations Habitat, 2010: 8).

With a number of successful tools in use around the world, each GBC now has the option to either: adopt one of the existing tools that allows its use in other countries with no or minimal changes, adopt one of the existing tools that allows its use in other countries with customization for the local context, or create a new tool customized specifically for its market. There are also some examples internationally of governments developing their own rating schemes, most often with a focus on operational energy usage rather than holistic building performance. These government-led approaches can be easy for building owners/managers to use and can have wide uptake, but require extensive data collection and resources to be implemented effectively (United Nations Habitat, 2010).

2.5.2 An alternative to the green building council model: government-led rating schemes

The rating tools Energy Star in the U.S.A and NABERS in Australia are examples of rating tools that national governments have developed as their own rating schemes in addition to rating tools developed by Green Building Councils. These systems primarily look at the ongoing operational impacts of buildings in terms of energy us. These ratings generally look only at energy use and therefore are not considered holistic green building ratings. However, the green building tools developed by GBCs can take advantage of the market acceptance of these energy ratings and use them within their own tools. For example, Energy Star is an energy performance certification scheme of the US Department of Energy that offers certification for a range of products, from electrical appliances and computer equipment to buildings and industrial plants. The LEED for Existing Buildings Operations & Maintenance tool gives the option for projects to use the Energy Star Portfolio Manager tool to help meet the documentation requirements within certain credits in the LEED Energy category (United Nations Habitat, 2010).

There are many systems worldwide, with many differences. A building evaluated by one system, may fare completely differently when evaluated by another system. According to a rough comparison conducted by the BREEAM Centre, when buildings that score “Platinum” on the USGBC’s LEED system would only score BREEAM’s second-highest score (“Very Good”).

Buildings that rate high marks on a green assessment generally exceed the standard building codes in their home country. So nations in Europe, for instance, which have sterner standard codes than the U.S., will also tend to have more thorough green assessment criteria (Novitski, 2010).

Another major difference between the world's systems is the weight they give to different categories. For instance, Japan's Comprehensive Assessment System for Building Environmental Efficiency (CASBEE) gives land use a 2 to 3 times greater fraction of the total score than systems in Western countries. Another example is Australia's Green Star system, which is built on BREEAM and LEED, but modified for hot climates. Green Star uses a credit system with nine categories, some of which—indoor-air quality, water, materials, land use, transport, and innovation—are similar to LEED categories. Green Star also offers credit explicitly for reducing greenhouse gas emissions and for adopting sustainable development principles from project formation through construction and operation. Like LEED's design and construction rating systems, Green Star calculates the environmental performance of buildings before they are occupied. Green Star doesn't have its own version of LEED's Existing Buildings, Operations &Maintenance (EBOM), but it is complemented by the National Australian Built Environment Rating System (NABERS), which measures actual performance (Novitski, 2010).

The Green Star system has recently been adopted by New Zealand and South Africa. Similarly, The Netherlands and Hong Kong have based their own systems on BREEAM. LEED has been adopted in Brazil, Canada, and Italy. Indeed, LEED is used internationally, by multinational corporations for instance, those have buildings in many countries and want to have a general system for their entire portfolio. Differences in culture, weighting and climate have made it difficult for researchers to calculate the comparisons between various systems (Notvitski, 2010).

The Green Building Council of South Africa (GBCSA) developed Green Star SA, founded on the Green Building Council of Australia's Green Star rating system. The rating tool provides an objective measuring tool for green buildings in the commercial property industry. Green Star SA recognizes and rewards environmental leadership in the property industry. Each Green Star SA rating tool reflects a different market sector or phase in the building life cycle (Green Building Council of South Africa, 2011). The objectives of Green Star SA are to establish a common language and standard of measurement for green buildings. To promote integrated, whole-building design, raise awareness of green building benefits, reward environmental leadership and reduce the environmental impact of development (Green Building Council of SA, 2011). There are nine core categories that the Green Star rating tool assesses, they are:

- Management
- Indoor environment quality,
- Energy
- Transport
- Water
- Materials
- Land use and ecology
- Emissions
- Innovation.

Al nine of these categories are divided into credits, each of these credits addresses initiatives that encourage environmental improvement. Points are then awarded to each credit, if the actions demonstrate the Green Star SA objectives. When the credits in each category are assessed, a percentage score is calculated, and Green Star SA weighting factors are then applied. Weighting factors vary across rating tools, to reflect the different environmental concerns of each of the rating tools. The following Green Star SA certified ratings are available or all projects: Four Star Green Star SA Certified Rating recognizes “Best Practice” and consists of a score between forty five and fifty nine. Five Star Green Star SA Certified Rating recognizes “South African Excellence”, which is a score between sixty and seventy four. Lastly there is a Six Star Green Star SA Certified Rating which recognizes “World Leadership”, which scores between seventy five and a hundred (Green Building Council of South Africa, 2011).

2.6 CONCLUSION

Buildings account for one-sixth of the world's fresh water withdrawals, one-quarter of its wood harvest, and two-fifths of its material and energy flows. When Building green there is an opportunity to use our resources in an efficient manner while creating healthier buildings that enhance human health, build a better environment, and provide cost savings. Energy efficiency is the most important focus of green development. Different rating tools have been developed to rate the performance of buildings. By rewarding exemplary building performance, rating tools provide an incentive for building owners to go above what is required by government building codes and market their business to interested stakeholders. In the next chapter the focus will be on the Stellenbosch as a case study. All three case studies will be reviewed as examples of best green practice.

CHAPTER 3: SETTING THE TREND FOR GREEN BUILDING IN STELLENBOSCH: THREE CASE STUDIES

3.1 INTRODUCTION

Three case studies are discussed in this chapter. The case studies investigate the green practices that Distell Group Limited, Spier wine estate and Remgro (with a focus on Remgro's refurbished head office Millenia Park) have implemented. Distell Group Limited is South Africa's leading producer and marketer of fine wines, spirits, ciders and ready-to-drinks (RTDs). Distell is a partner of the Biodiversity and Wine Initiative (BWI). The BWI is a partnership between South African wine industry and the conservation sector (Distell Briefcase, 2010.) Distell is also situated in the Cape Floral Kingdom and aspires to reduce the depletion of the natural habitation and make the wine production process more sustainable by adopting the biodiversity guidelines that have been developed by the South Africa wine industry. Distell has developed water saving, biogas energy and recycling projects to minimize their ecological footprint. Spier wine estate focuses on being more ecological by promoting waste water treatment, a vermiculture project, and developing their natural wetlands. The third case study focuses on the company Remgro's green initiatives that are implemented within the company, and specifically the new head office in the Millenia Park building that has been refurbished. The refurbished building in Stellenbosch has received a five star green star rating from the Green Building Council of South Africa. Natural light, air quality, waste management measures, energy saving methods, recycling and a biodiversity have all been incorporated in the refurbished building.

3.2 CASE STUDIES 1: DISTELL ENVIRONMENTAL AWARENESS CAMPAIGN

This case study elaborates on Distell's water-saving and recycling efforts to minimise their ecological footprint.

Distell Group Limited is South Africa's leading producer and marketer of fine wines, spirits, ciders and ready-to-drinks (RTDs). The Group is listed on JSE Limited (see Figure 3.1). Distell employs over 4 200 people and has an annual turnover in excess of R7.9 billion (Distell Briefcase, 2010). Through innovation and commitment, Distell has maximised its shareholders' wealth. Distell has high levels of brand awareness, local market leadership, a resilient distribution network, strong trade relationships and a structural capacity to introduce new products across all categories. The company has secured an international footprint in niche markets in Europe, Asia Pacific, North and Latin America and Africa (Distell Profile, 2010).

Figure 3.1 Distell offices in Stellenbosch *Source: Google images, 2012*

Distell's responsibility towards biodiversity includes a partnership with the Biodiversity and Wine Initiative (BWI). BWI is a partnership between the South African wine industry and the conservation sector. Its goals are to minimise the loss of natural habitat and make the wine production process more sustainable by adopting the biodiversity guidelines that have been developed by the South Africa wine industry. Distell's participation in the BWI is towards sustaining the environment and the Cape Floral Kingdom. The Cape wine region is at the heart of the smallest, but richest, plant kingdom in the world. It is one of six plant regions in the world and hosts over ten thousand plant species, of which 70% is found nowhere else on the planet. One of the goals of the BWI is to assure that everyone working in the Cape wine industry is aware of these facts. The BWI also introduced an ecotourism angle for South African wine tourism. Distell is part of the Green Mountain Eco Route, which is the world's first biodiversity wine route.

The Integrated Production of Wine (IPW) is administered by the Wine and Spirit Board of South Africa. The board advises the Department of Agriculture on technical issues relating to the wine industry. IPW practices are vital to assure the long-term sustainability of non-renewable resources. "Adhering to IPW reduces the use of fungicides, herbicides and pesticides, as well as water" (Distell Profile, 2010: 5). These practices promote safety among consumers and workers, and for other grape product. The programme monitors the spraying practices and ensures that residues of agrichemicals are environmentally and consumer friendly. IPW includes strict management of wastewater, water quality and quantity, and the use of irrigation.

3.2.1 Saving water in the cellars

Distell saves water in their cellars. How this is done is discussed further below.

Distell has been promoting measures to reduce water usage and encourage recycling to many wine cellars and bottling plants. Nederburg, for example, has installed water meters at each cellar, monitoring water that is consumed. The meters can identify where water usage is high. Investigations can then be undertaken with the cellar workers to find a solution. Nozzles have been fitted to all hosepipes to ensure that no water flows out of the hosepipe until the nozzle has been opened. Nederburg also recycles fresh water, which cools the filtration machines that separate solids from liquids. This is possible because of the installation of a tank, pump and fixed stainless steel line to a fresh water-holding tank. The water used for cooling is then pumped back into the fresh water system. Cellar manager Dick Murray states that the benefits of recycling solids/liquids in the separator is saving of up to 82 000 litres of water per month. It also allows accurate monitoring of the quantity of water consumed per litre of wine filtered. Separator operators become very aware of the importance of saving water at all times (Distell Profile, 2010).

Distell has a green park bottling plant, which is a plant that uses environmentally friendly methods in their procedures to recycling procedures. There has been a major reduction in water consumption in the bottling plants because of a cooling tower that was installed on the pasteuriser for one of their production lines. The cooling tower is said to reduce the 11 000 litres of water used on average per hour to 1 000 litres per hour. There are also different options being investigated for water recovery from bottle washers. Distell tries to find the best solutions to help save water and minimise water use (Distell Profile, 2010).

3.2.2 Recycling

Distell recycles by turning the effluent produced by the distilling process into biogas and also recycles all packaging and glass containers through a "give back, get back" project. According to Distell's waste management specialist, Jacques Blignaut, Distell now has one of only two anaerobic digestion systems (decomposing of organic matter in the absence of oxygen) used on grains whisky effluent in the world. There will be a considerable decease in Distell's carbon footprint because of the biodegradable effluent from their distilling process being turned into biogas, containing methane. The biogas will be used as an energy source to power a dedicated boiler to create steam for the distilling process. This anaerobic digestion system is also planned for the Adam Tas, Bergkelder and Van Ryn sites. The carbon footprint, as well as the municipal load, will be minimised. Fossil fuel will be replaced with biogas for energy to be used to generate electricity or to fire boilers (Distell Profile, 2010).

3.2.3 Recycling of packaging

All plastic, paper and cardboard glass packaging waste is separated by Distell on site and collected by a recycling company. Every year, recycling companies tender for the purchase of recycling materials from the Bergkelder, J.C. le Roux, Adam Tas and Nederburg sites. The company that wins the tender signs a contract that ensures that the legislation is complied with. In former years all this waste would go to landfills, but now recycling companies are paying excellent prices to recycle waste responsibly. The proceeds of the sale go back into the company to offset production costs and upgrade recycling facilities. The proceeds have escalated from R 243 232 in 2002 to R 803 217 in 2010 (Distell Profile, 2010).

3.2.4 Glass saving project

Distell is further minimising its environmental footprint through the "give back, get back" initiative. The aim of the initiative in to quicken glass bottle returns and to light-weight the company's wine and cider bottles (Davenport, 2012). This campaign will restrict waste, minimise electricity use and limit greenhouse gasses (Davenport, 2010). It encourages involvement by the public and retail traders by paying for every bottle returned, up to four times more than for cullet glass. Cullet glass is the term used to describe recycled container glass derived from broken receptacles that is compressed before being made up into new glass containers (Distell Profile, 2010).

The project spans over all product categories, covering 63 different products and close to 150 bottle sizes. There is a recognisable logo on the eligible bottles, which consists of a bottle encircled by an arrow. The campaign works through a large network of retailers. The trade costumers are paid between 80c and R1.50 per bottle returned to Distell, depending on the size, and the retailers pay their costumers for the bottles they return. The more the retailers pay their costumers, the greater the interest by the public will be. The greater the interest, the more successful the campaign will be. However, retailers can decide if they want to pay all or part of what they receive to the people who return bottles bearing the logo. Once the bottles are delivered to Distell, they are separated and the labels are removed, after which they are thoroughly cleaned numerous times. The bottles then go through a quality test and, if they comply with these standards, they are refilled. The bottles can sometimes be used up to ten times, which helps contain operating costs and price competitiveness in an environment. (Distell Profile, 2010).

In an interview, Carine Gous, the business director of wine at Distell Group Limited, revealed that Distell is equipped to re-use bottles across their product portfolio at three plants: at Wadeville, Green Park in the Western Cape and Port Elizabeth. Between July 2009 and June 2010, Distell was able to re-use 132,3 million bottles, in the process saving a total of 73 268 tons of glass, representing 111 079 tons of CO_2-equivalent emissions had new bottles been produced (Distell Profile, 2010). The programme works together with other beverage industry efforts to recycle glass through the Glass Recycling Company (GRC), of which Distell is a shareholder. Glass bottles are crushed as cullet glass for return to the glass manufacturers. In addition, those of Distell's bottles not considered appropriate for re-use continue to go through the GRC for crushing. Distell provides large funding to the GRC for this job-creation venture, which focuses on improving recycling levels through public awareness, capacity-building initiatives and provision of infrastructure, such as glass banks where glass can be taken for recycling (Distell Profile, 2010). Distell has been involved in glass recycling enterprises for more than 20 years, but the new venture is aimed at increasing the present return ratio of 60% to 65%. Distell is currently involved in a nationwide educational initiative targeting off- and on-consumption trade. The "give back, get back" campaign is being supported by extensive merchandising material (Distell Profile, 2010).

In one year, Distell also saved 333,5 tons of glass by light-weighting 2,9 million wine bottles. This was achieved by reducing the weight of the average 750 ml bottle from 570 grams to 455 grams across the wine range (Distell Profile, 2010)."Distell strive to maintain the highest standards of environmental responsibility, seeking to promote environmental sustainability in all areas, to reduce the impact of production and distribution processes and to prevent pollution by using best practice and technology where appropriate and possible" (Distell Profile, 2010: 13). Distell formally applies the ISO 14001 Environmental Management System at selected production facilities to ensure improvement in their resource-use efficiency, that will focusing on water use, wastewater, waste and recycling, greenhouse gas emissions, energy efficiency and awareness and training, all of which will enhance their environmental performance.

3.3 CASE STUDY 2: SPIER WINE ESTATE

This case study focuses on Spier wine estate's water- and energy-saving initiatives, their wastewater treatment plant, the vermiculture project that has been introduced, and practices that have been developed to save and enhance their natural wetland and biodiversity.

Spier was one of the first wine farms in the Stellenbosch area to be established by the early settlers (Figure 3.2). They chose the site because of its close proximity to the Eerste River, which is beneficial for agriculture (Gass, 2010).The Spier wine farm covers approximately 750 hectares and is located in the Cape Floral Kingdom, one of only six floral kingdoms in the world. Spier is acknowledged as a global biodiversity hotspot (Spier Report, 2012).

Figure 3.2 Spier Wine Estate *Source: Google images, 2012*

Spier is home to many endemic and endangered plant species that occur nowhere else in the world. This highlights the importance of the conservation that Spier has to undertake. The estate takes great care not to harm any of these sensitive environments. According to the Environmental Management Plan completed in 2006, Spier has 273 indigenous plant species, seven Red Data Book species, 66 bird species and 11 mammal species on the estate (Spier Report, 2012).

Ever since the current owners acquired the estate in 1993, sustainability has been very important to Spier's approach to business. It began with a sense of protection of the cultural heritage – the owners felt obliged to restore the historic buildings on the estate – and this ethos soon extended to the environment and communities around the estate. In 2003, Spier appointed a Director of Sustainability, whose task, amongst others, was to develop key indicators that measure performance against financial, environmental and social criteria. At present the operational team takes full responsibility for Spier's triple bottom line performance, and these goals are reviewed on a monthly, quarterly and annual basis (Smith, 2009).

Spier is promoting a sustainable environment by reconstructing the “renosterveld”, re-establishing the natural wetlands, eliminating all invasive alien species, clearing river corridors, and planting indigenous trees, of which 1 000 already have been planted in the past two years. Spier tries to conserve the most biodiverse portions of the land so that is will last forever (Spier Report, 2012). Spier is a member of the Biodiversity and Wine Initiative, which is a partnership between the South Africa wine industry and the conservation sector. The estate also aims to conserve 25% of its land by 2017 (Spier Report, 2012).

3.3.1 Preserving the environment: an environmentally conscious estate

Protecting biodiversity and the natural environment is one of Spier’s core values. Spier protects its environment through an array of initiatives, which includes a water waste recycling system that recycles 100% of the wastewater used at Spier. Emma de Boer, leisure sales manager, explains that Spier has a thriving solid waste recycling programme that is currently in use. The recycling program recycles 85% of Spier’s waste. Spier also has a prosperous vermiculture project. The estate also is rehabilitating its soil using biodynamic farming practices. There is a focus on restoring the biodiversity of the land by eliminating alien plant species. The aim is to have 25% of the land in conservation in the coming years. Land and utilities have also been donated to two wildlife conservation programs (Spier Report, 2012).

Spier has been recognised by many organisations and has been awarded many accolades for its efforts in protecting and preserving the environment (Gass, 2010). Spier was one of the first luxury hotels in South Africa to receive Fair Trade in Tourism (FTTSA) accreditation (Smith, 2009) and, in 2004, the winery was the first in South Africa to receive accreditation from the Wine Industry Ethical Trade Association (WIETA). It received a Condé Nast Traveler World Saver Award in 2007, achieving third place in the overall destination category, and an honourable mention in the HIV/AIDS category. The Spier Hotel received a Gold award in the 'Virgin Holiday Partners in Sustainability Award in 2009' (Spier Report, 2012: 3).

The Spier Hotel implements water and energy conservation projects. Energy savers have been placed in all hotel rooms, and the organic waste from the kitchen is recycled and directed back to the farm's vermiculture project. Worms then produce fertiliser (vermicompost), which is used for growing fruit and vegetables, which are then used in the hotel kitchen. Farmers around the world have started to set up vermiculture projects. India and Cuba currently are the leaders in vermicomposting. Vermicomposting centres are abundant in Cuba and vermicompost has become the largest input used to replace traditional fertiliser, which became difficult to import after the collapse of the Soviet Union. In India, an estimated 200 000 farmers practice vermicomposting, with 10 000 farmers producing over 50 000 metric tons of vermicompost a month (Munroe, 2012). Scientists in the U.S.A., Canada, India, Australia and South Africa have also been documenting the benefits associated with vermicompost (Munroe, 2012).

Over four hundred water-saving devices have been installed on the estate. Devices such as low-flow taps and showerheads, and uni-flush toilet-flushing systems have been installed. These devices are sustainable and do not only save money, but also benefit the environment. Spier's laundry service re-uses the water up to three times before it is pumped away to the wastewater treatment plant. Only white items are washed at the laundry service, which makes it possible to re-use water for several washing loads. This saves up to 1 500 litres of water daily. Geyser settings are also set at an optimum to ensure that as little electricity as possible is being used in the laundry service. Numerous sustainable materials have been introduced to all new buildings and designs. The hotel also buys locally where possible, and procures items from empowerment programmes. Alternative energy systems, such as “card in, card out” light switches help to save electricity in the hotel rooms (Spier Report, 2012).

Guests staying in the hotel are given a chance to stay in an energy-neutral environment. This is part of the Hotel’s on going Green Initiative Programme. The Hotel’s energy offset is calculated at 20.83 kg CO_2 emissions per room per night, and a donation of R5 per room per night offsets this energy consumed. This donation goes to a sustainable-development project, Plan Vivo Foundation, which assists forest communities as a way of successfully balancing these emissions (Spier Report, 2012). “Guests who donate to this initiative receive electronic micro certificates to guarantee that they have successfully offset their carbon energy whilst staying at the Spier Hotel” (Spier Report, 2012: 5).

The Plan Vivo Foundation is an innovative sustainable development project that work with forest communities. Some of the programme’s charitable aims are to relief poverty in developing countries by involving rural communities in sustainable land-use programmes. The programme promotes environmental protection and management, as well as improvement through the protection of ecosystems, and the restoration and conservation of biodiversity. There is also a focus on transferring knowledge and skills to developing countries, improving their education and building local capacity. Spier also subscribes to the SASSI (the Southern African Sustainable Seafood Initiative) guidelines as part of a Sustainable Fisheries Programme that aims to meet objectives in terms of how fish are caught and traded. The SASSI Word Wildlife Fund initiative focuses on retailers, restaurants, chefs and consumers. The main goal of the SASSI list is to increase the consciousness of seafood consumers about different species of fish, to discourage them from selecting illegal species, and to guide them towards more ecologically friendly choices when faced with a selection of different species (Spier Report, 2012).

3.3.2 Wastewater treatment

Spier has had an operational wastewater treatment plant since 2007, in which used water (grey and black water) is recycled and used again for flushing toilets or for irrigation. The water treatment plant has resulted in 100% of Spier's grey and black water being recycled. The recycled water is being used to irrigate the gardens and grounds, creating a cyclic system of cleansing and replenishment on the estate. This wastewater treatment plant was the first in South Africa. It was built and designed to combine the best green engineering, art and healing techniques. The plant processes 1 million litres of water at a time. It would take a river 350 kilometres to purify what the treatment plant can do in one day.

Spier's wastewater is treated onsite. Until 2007, the waste was processed by a number of separate Biolytix filtration systems and septic tanks. Biolytix is an Australian waste management system that converts wastewater into a reusable water resource. In 2006, Spier discovered that the Biolytix systems were not treating the wastewater to the legal requirements for reuse of the South African Department of Water Affairs and Forestry (DWAF). While Biolytix is highly effective in small communities, is not effective enough for Spier's broad spectrum of effluent coming from the estate's varied operations, such as the hotel and the restaurant. The cyclical nature of the estate put pressure on the Biolytix system. The seasonal fluctuations in the hotel's businesses caused an issue in scalability (Spier Report, 2012).

Spier was also trying to develop a way to treat the wine cellar effluent; the wine cellar was not linked to the Biolytix system. The cellar's wastewater was used to irrigate kikuyu grass, which is a common manner to dispose of cellar water. The National Water Act of 1999, which is currently under review, specifies that kikuyu is an acceptable method for reusing water in an ecological manner. After learning this, Spier decided to take it to the next level. After considering various alternatives, it was decided that they would select a centralised system. They chose this option because it "offered the most consistent quality for reuse; centralized winter storage; did not add further load to the municipal system and was scalable and able to meet

Spier's future expansion, and would be the simplest to maintain and report on internally and to the authorities" (Spier Report, 2012: 7).

Apart from the benefits of this system, Spier wanted a solution that suited their culture and philosophy. A closed-loop system was created, in which the wastewater is treated and the used to irrigate the estate. The plant uses an "Archimedean-screw mechanism for screening and an activated-sludge bioreactor. The activated-sludge process is a biological method of wastewater treatment performed by a variable and mixed community of micro-organisms in an aerobic aquatic environment" (Spier Report, 2021: 8). The bioreactor, an open-air tank divided into four sections, accepts water into the first tank, and subsequently forces the water into each of the remaining tanks in an anti-clockwise direction It process up to a million litres of wastewater at any given time (Spier Report, 2012).

The aeration pumps switch off periodically, allowing the bacteria and waste to settle to the bottom. The cleaner water is skimmed from the top and moved through pipes that "irrigate an oval-shaped reed bed" (Spier Report, 2012: 8). The reed bed is a model area for the natural expansion of bacteria and continues the cleansing process. The water passes through the reed bed into a pond where it is forced through a number of 'flowforms' before being transported to the nearby irrigation dam. It is believed that this process calms the water and helps it return to its more harmonious state. Spier has been able to turn the self-reliant, all-natural treatment plant into a resource that is important to business and supports its environmental goals. Treatment plants are usually perceived as vulgar places, kept out of sight from the public, but Spier has made its treatment plant a place of cleansing and healing and more aesthetically pleasing. This will make it easier for the public to engage with the issue of waste, the publics' relationship with the environment and how our impact on it can be reduced. An eco-walk has also been designed around the estate, along which guests are taken to the treatment plant, where they learn about waste and the best way to treat it.

3.3.3 Spier's vermiculture project

In 2007, Spier introduced its vermiculture project, which is where worms are used to convert the food waste into fertiliser to be used on the farmlands. This process is organic and odourless. The redworm that is used on the worm farm excretes amino acids and enzymes, which assist plants to access nutrients in an easier way. The *Eisenia fetida* (commonly known as the red worm or manure worm) is indigenous to most parts of the world and is very adaptable (Munroe, 2012). The worms live in container homes made from recycled pipes, filled with shredded newspaper, brown leaves, straw and food scrapes like apple cores, vegetable peels and coffee grounds. From this the worms produce water-soluble and nutrient-rich compost, which is used to fertilise the plants, vines and vegetables. The worm's excretions contain growth hormones that provide energy for the plants and do not scorch the plants, as some chemical fertilisers do. It is a sustainable solution to organic waste disposal.

The compost that the worms produce is called vermicast. Vermitee is the liquid that runs off from this process, which also makes an excellent liquid fertiliser. The compost is used on the farm's vines, which saves costs in wine production. The process contributes to the alleviation of waste produced by all the tourism and leisure activities in an environmentally sustainable manner. Excess compost and worms are also sold to the public (Spier Report, 2012). Vermicompost seems to be superior to traditional fertiliser and can have other uses on farms, such as high quality animal feed, and has the potential as a source of supplemental income for organic farmers (Munroe, 2012). However, vermiculture is a more complex process than conventional composting. The process is generally quicker, but requires extra labour. The worms also need more space, because they are surface feeders and will not function in material more than a metre in depth. The process is also more susceptible to environmental pressures such as drought or freezing conditions. Most importantly, it requires more resources to start up either financially (in buying the worms) and in time and labour (to grow them) (Munroe, 2012).

Spier is also an active member on the board of the Lynedoch EcoVillage, which is also home to the Sustainability Institute, an international living and learning centre established in 1999. The Lynedoch EcoVilliage is "the first ecologically designed, socially mixed, international community in South Africa" (Swelling and Annecke, 2006). The EcoVilliage combines economic, social and ecological objectives that provide an example of integrated sustainable development. The EcoVilliage consists of a primary and pre school for the local community, residences that were converted from the old "Drie Gewels" hotel, commercial space for offices and crafts people and landscaped areas to be planted with indigenous plants. Lynedoch incorporates new technologies that "span the energy, water, sanitation and building materials fields" (Swilling and Annecke 2006). Lynedoch EcoVilliage is a worthy example of a sustainable development because of the commitment to a long-term vision of economic, social and ecological sustainability (Swilling and Annecke, 2006). The Sustainability Institute was a vital partner in providing knowledge and support to Spier in its journey to become more sustainable. All of the staff members attended the Sustainable Living and Learning programme as an extension of Spier's induction programme. The Institute also plays a significant role in Spier's leadership development and forms part of its Executive Development Programme. Spier also contributed to the establishment of the Sustainability Institute, and has been a long-term partner of both the Institute and the Lynedoch Eco Village through various funding measures. Spier has definitely been a pioneer and driving force of conservation and sustainability. The Spier Estate is a great example of being more sustainable and environmentally aware.

3.4 CASE STUDY 3: REMGRO HEAD OFFICE: MILLENIA PARK

This case study focuses on Remgro's carbon emissions and the energy-saving methods that Remgro has initiated. There is a discussion of the refurbishment of the new head office building, Millenia Park, followed by a look at the challenges faced during the refurbishment as well as the solutions rendered. Also given is Remgro's motivation for striving for a Green Star rating.

Remgro Limited is an investment holding company established with effect from 1 April 2000, after the reorganisation of the former Rembrandt Group Ltd. The group's interests consist of investments in banking and financial services, glass products, medical services, mining, petroleum products, food, wine and spirits, media, technology and various other trade mark products. The company's activities are focused mainly on the management of investments and the establishment of support, rather than being involved in the day-to-day management of business units of investees (Sharenet, 2012).

The 29-year-old Millenia Park building (Figure 3.3) is situated in the outskirts of Stellenbosch. The building was previously occupied by Gilbey Distillers and Vintners, the Peace Parks Foundation and the World Wide Fund for Nature. The building was considered an architectural time-piece, which is why it was decided to refurbish the building rather than demolishing it. Millennia Park thus became the new head office of Remgro (see Figure 3.3). A new and larger office space was needed after Remgro merged with Venfin in 2009. There were approximately 120 staff members, who moved into the building after the refurbishment was completed. Refurbishing an existing building to achieve a Green Star SA rating has many challenges to overcome, as opposed to a new building that can be designed green from the start (SA Commercial Property News, 2012).

Figure. 3.3 Five star green building: Millenia Park. *Source: Google images, 2012*

With a refurbishment project, you have to take what you have got and work with it, for example the orientation of a building cannot be changed. This forces architects to be more creative to overcome inherent challenges (SA Commercial Property News, 2012). Without Green Star SA, it would have been considered to demolish the existing building, dig a basement for parking, and maximise the size and coverage to ensure maximum use of the site to ensure an acceptable yield for the developer. Dealing with all the important Green Star SA initiatives, the idea of refurbishing a building is very different from what normally would be planned. (SA Commercial Property News, 2012).

Remgro upholds a commitment to minimise the impact that it and its subsidiaries has on the environment. The company is guided by an Environmental Management Policy and the criteria of the Global Reporting Initiative's (GRI) reporting indicators. The policy commits Remgro, inclusive of Remgro Management Services Limited (RMS – its service company), Rainbow Chicken, Tsb Sugar and Wispeco, to strive to be a value partner to all stakeholders, including the environment. To this end, and as a minimum oath, Remgro aims to constantly improve its environmental performance against set goals and objectives; comply with all relevant legislation; and educate and train employees in good environmental practice. These values are primarily enacted through a focus on important areas of environmental impact over which Remgro exercises due control (Remgro Limited 2011).

3.4.1 A focus on Remgro's carbon emissions

Man-made processes and global climate change have placed focus on international and local companies' carbon emissions and the carbon dioxide they emit (British Broadcasting Corporation, 2008). Remgro has been tracking its emissions over a four-year period, in accordance with the Green House Gas (GHG) Protocol, and has also formed part of the Carbon Disclosure Project on an annual basis (Remgro Limited, 2011). This initiative was established in South Africa in 2007 in partnership with National Business Initiative, in which all JSE-listed companies are listed (Kausch, 2010).

The GHG Protocol developed a guideline for how emissions can be analysed in terms of the following categories (Figure 3.4):

Scope 1 emissions – direct emissions from equipment owned by Remgro, e.g. factories of Rainbow Chicken, Tsb Sugar and Wispeco

Scope 2 emissions – indirect emissions from the consumption of electricity

Scope 3 emissions – indirect emissions from third-party suppliers (air travel, car rental, hotel accommodation, third-party transport, office paper)

Non-Kyoto Protocol GHG emissions, e.g. freon, which is used in air-conditioning and refrigerant equipment.

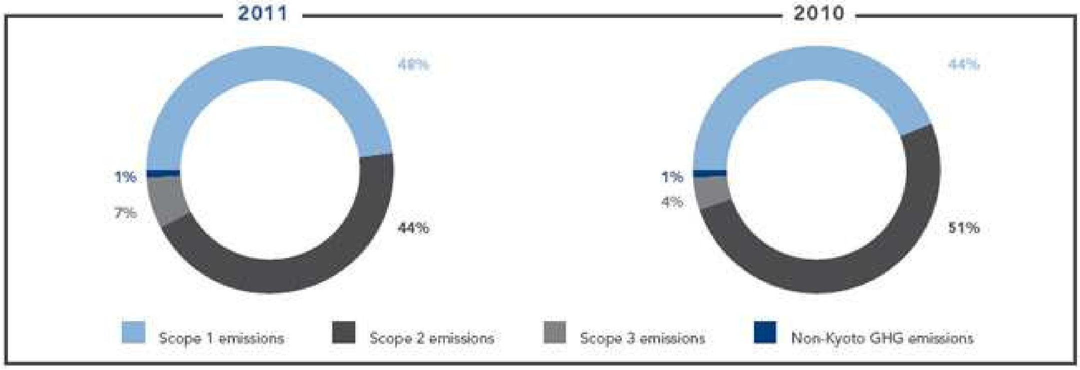

Figure 3.4 Total carbon emissions per subsidiary company in 2011 *Source: Remgro Limited, 2012*

The company's Scope 1 emissions decreased by 4.6% in 2011. A 7.8% decrease in Scope 1 and 2 emissions was found per full-time employee. This occurred because of pronounced environmental initiatives by subsidiaries (Remgro Limited, 2011). One example of a subsidiary that implemented energy efficiency is Rainbow Chicken. Rainbow Chicken set out targets to reduce their electricity consumption by 5%, and reduce coal consumption by 10%. Rainbow Chicken fitted improved insulation in their poultry house design and in their cold storage facilities. Energy-efficient LED lighting has also been installed in the poultry houses, and waste-heat recovery processes have been installed in the refrigeration at their different plants. This reduces the use of coal in the plant boilers. Another subsidiary, Wispeco, has also installed LED lighting in their factories and offices. Energy-saving shower heads have also been fitted in their production lines (Remgro Limited, 2011).

3.4.2 Water-saving methods that are implemented by Remgro

Rainbow Chicken has set out to use 13 litres of potable water per chicken at the processing plant. The quality and quantity of water is crucial to all of Remgro's operations in its plants, and increased costs will also be experienced over time. Remgro has initiated a group-wide water management strategy by making provision for future qualms. Waste minimisation practices are of great importance to the company. The employees are very conscious of resource scarcity.

Waste minimization practices and recycled materials are implemented where possible (Remgro Limited, 2011). Together with its environmental pledge, Remgro undertook to refurbish Millenia Park, an existing building in Stellenbosch, in accordance with the criteria of the Green Building Council of South Africa (GBCSA). Green buildings make use of design, materials and technology to reduce resource consumption, such as energy, water, waste and even commuting. Natural light, efficient air ventilation and energy-efficient air conditioning all reduce electricity consumption by as much as 30%.Non-toxic materials and low-VOC paints are used and recycled materials are maximised. Water interventions include competent plumbing, rainwater harvesting and water recycling, saving as much as 35% to 50% in usage. Waste generation can be reduced by 50% to 90% and carbon dioxide emissions by 35% to 50% in green buildings (Remgro Limited, 2011). The Millennia Park office building has attained a 5-Star Green Star SA Office phase 1 ‘Design’ certification from the Green Building Council of South Africa (GBCSA). The Millenia Park building is the first refurbished building in South Africa to receive this honour (SA Commercial Property News, 2012).

3.4.3 Challenges faced and solutions rendered

The floor ceiling space of the building was limited and 260 mm of ceiling space was left in the redesign. This challenge gave rise to the idea to install a chilled-beam air conditioning system, rather than a conventional air conditioner. A chilled-beam air conditioner is more environmentally efficient. It uses less energy than a conventional air conditioner, is cost-effective, takes up less space, is quieter and much more effective with heating and cooling. Green appliances such as solar water heating and efficient lighting, together with the cooling beams, have reduced the electricity costs of the building by 30% (SA Commercial Property News, 2012).

Because of the building’s architectural significance, the Stellenbosch Municipality stated that the building could not increase its height. A mezzanine floor was incorporated inside the existing ceiling for future use and storage space. This allowed for a three-sided atrium to be designed to permit more natural light to enter the building. The steel structure from the old roof was reused in the undercover parking areas and 70% of the steel used originated from the old building (SA Commercial Property News, 2012).

More than 80% of the waste generated on the site was diverted from landfill, and much of it was used in the refurbishment process. Crushed stone and concrete from the existing building were recycled to elevate the parking area to above the 50-year flood-line. Other materials were donated to the community. For example, the Kikuyu grass from the previous site was donated to the local municipality for sports fields (SA Commercial Property News, 2012).

One of the challenges faced during the project was to retrieve certified green products. Although materials from the project were recycled, certain new products had to be obtained. The South African markets are expected to change in the future as green building becomes more prominent and develops in the industry. Considerable water saving measures were designed for the refurbished building. The building's water savings will be about up 79% in comparison to the old building. This is possible because of grey water recycling, rainwater harvesting and waterless urinals. The new landscaping at the building also minimises water consumption attributable to irrigation, with about 50% runoff from the paved areas being used for irrigation by making use of permeable paving in the parking area. Rainwater can infiltrate into the ground through the gaps between the pavers. Water is also filtered through geo-film and a stone layer under the paving. This initiative also helps to prevent erosion (SA Commercial Property News, 2012).

The greatest feat of the project is the enhancement of the biodiversity on the site. The man-made wetland, which was in a poor condition, was restored, and more indigenous and water-wise plants were introduced to the landscaping. An innovation point under Green Star SA was also awarded to the project for Remgro's on going involvement in the cleaning and improvement of the rivers in the surrounding area. The ecological diversity of the site has been enriched by 420% (SA Commercial Property News, 2012).

3.4.4 Motivation for striving towards green star SA rating

One of the overriding reasons why Remgro decided to strive for a Green Star SA rating was because of the long-term rewards on operating costs. The decline in operating costs will eventually add value to the asset. Another reason was because top management felt that it would be the environmentally correct thing to do. Green building consultant Richard Duckitt, a consultant for Bornman & Associates, notes that Millennia Park is registered for a Green Star SA Office 'As-Built' rating from the Green Building Council of South Africa (GBCSA). The building must work as close to the design as possible, and an As-Built rating will be pursued to prove that it can be done (SA Commercial Property News, 2012).

Green building requires a very different approach and has different practices on the site. The team in control of the project helped to educate contractors, sub-contractors and product suppliers on how to apply green practices, and this will hopefully be passed on in the future. The verification and certification process distinguishes the Millenia Park building from other buildings that might make unsupported green claims. Achieving a rating from the GBCSA, which is an internationally recognised institution, is a "reflection of the extent to which a client and it's team went to create an environmentally responsible product" (SA Commercial Property News, 2012: 2). Everyone involved agreed that targeting a Green Star rating is hard work, including an auditing process needing specific documentation, but that this will improve in time. Green building encourages collaboration, and although coordinating a team may take longer, it is worth it.

The GBCSA mentioned that it was proud to award a Green Star SA rating to a refurbished office building for the first time, and pleased to see that companies are giving new life to existing buildings in South Africa. The GBGSA is encouraged by the results of the Millennia Park project in improving the environment and combating urban sprawl, as well as the insight gained by the professionals involved (SA Commercial Property News, 2012: 2). Remgro has the first and only building in the town of Stellenbosch to receive a five-star rating from the GBCSA, and the company refurbished the Millenia Park building to use as their head office. The building incorporates the principles set out by the GBCSA in the Green Star Rating guidelines. Natural light, air quality, waste management measures, energy-saving methods, recycling and a focus on biodiversity have all been incorporated in the refurbished building. This is a phenomenal achievement.

3.3 CONCLUSION

Three case studies were selected in Stellenbosch. Table 3.1 summarises the main green building achievements of the case studies. All three of these case studies have implemented green practices. Distell developed water saving, biogas energy and recycling projects (such as the “give back, get back” programme) to minimise their ecological footprint. Spier Wine Estate is situated in the Cape Floral Kingdom and is home to many endemic and endangered species. Spier focuses on being more ecological by promoting wastewater treatment, running a vermiculture project that produces fertiliser from food waste, eliminating alien plant species and developing its natural wetlands. Remgro and its subsidiary companies have initiated practices that save water and reduce their carbon emissions. The new Remgro head office, Millenia Park, was refurbished and achieved a Five Star Green Star rating. Remgro is the only building in Stellenbosch to receive this rating. During the construction of this building, there was a strong focus on enhancing natural light in the building, improving the air quality and promoting environmentally friendly waste and water management. All three of the case studies that were discussed have set a good example to other institutions in Stellenbosch by promoting ecological awareness. Table 3.1 shows the different categories of green building and the level of achievement of each category by the three case studies.

Table 3.1 The level of achievement in green building categories by the three case studies.

Green building guidelines	Distell	Spier	Remgro
Management	✓	✓	✓
Indoor environment	x	x	✓

quality			
Energy saving	*	✓	✓
Water management	✓	✓	✓
Materials	*	*	*
Land-use and ecology	✓	✓	✓
Emissions and innovation	✓	✓	✓

✓ achieved

* = partially achieved

x = not achieved

CHAPTER 4: HOW GREEN ARE STELLENBOSCH BUILDINGS?:

This chapter focuses on the data collection for the study. It includes a discussion of the methods that were used to analyse the data and to determine the findings of the survey. The respondents' implementation and perceptions of green building practices are also discussed.

4.1 INTRODUCTION

The findings presented in this chapter aid the objective by establishing to what extent green building practices are being implemented by building owners in Stellenbosch. Their perceptions of green building practices are also presented, and how the respondents' perceptions of green practices might differ from actual application of these practices. A questionnaire was designed that determined what green initiatives the office buildings currently contain, and what the occupants perceived to be the most and least important sustainable factors. Data was analysed by means of the SPSS programme. The various green practices are discussed in this chapter, along with the overall findings on each green category. Surveys were also distributed to nine architectural firms in Stellenbosch. The focus of the survey was to determine whether architects incorporate green initiatives into their designs, and if the demand for green designs has escalated in the past few years. A total of 35% of all commercially zoned buildings in the Stellenbosch core were selected to participate in the sample. The land-zoning maps of the Stellenbosch Municipality were obtained and relevant buildings were sampled. The office buildings were selected from heritage buildings (older than 60 years) and modern buildings (younger than 60 years). Questionnaires were distributed to the owners of these office buildings. If the owner was not available, the survey was conducted with a person in a managerial position. A second survey was designed and distributed to different architectural firms in Stellenbosch, where the majority of the surveys were conducted with the owner of the firm or the chief designer or architect. The building survey (Table 4.1) aimed to find answers on the importance of natural light, LED light bulbs, appliances used in office buildings, solar panels, waste management, water management and indoor air ventilation.

Table 4.1 Green practices incorporated in commercial buildings

	Yes	No
A consciousness of energy saving	20	6
Primarily make use of natural light in the building	14	12
Use compact fluorescent lights	16	10
Lights that are linked to daylight sensors	16	10
Movement sensors for lighting	22	4
The practice of using laptops instead of desktops	17	9
The practice of putting computers on sleep mode when not in use	25	1
The practice of copiers and printers being switched off after hours	19	7
Multi-functional machines (e.g. combined fax and	24	2

printer, etc.)		
Recycled insulation used in the roof and walls	21	5
Heat recovery ventilators	1	25
Solar panels used to create electricity	1	25
Rainwater harvesting	1	25
Meter taps (e.g. taps that reduce water waste)	3	23
Waste reduction methods	11	15
A paper recycling policy	24	2
A policy of making hard copies of documents only when necessary	26	0
A policy of printing on both sides of paper	22	4
Sufficient indoor ventilation (e.g. clean air flowing through the building/office)	22	4
Targets set for energy use	2	24
Management plans that monitor and evaluate the energy usage?	5	21

Table 4.2 compares the response to the importance of the different green practices between heritage and modern building respondents. Their responses are measured on a scale ranging from 1 to 5, where 1 is 'not important at all' and 5 is 'very important'. Apart from the marginal difference in the perception of the respondents in terms of having insulation, having heat recover ventilators, installing solar panels, applying waste-reduction methods and monitoring and evaluating energy usage, there is no real difference in perception.

Table 4.2 The perception of the importance of green practices in commercial buildings

		1 Not important at all	2 Not important	3 Neutral	4 Important	5 Very important
Having natural light entering the building	Heritage	0%	0%	0%	75%	25%
	Modern	0%	0%	0%	29%	71%
Installing light sources that are energy efficient	Heritage	0%	0%	25%	38%	38%
	Modern	0%	0%	0%	47%	53%
Using machinery in an energy-efficient manner	Heritage	0%	0%	25%	37%	37%
	Modern	0%	0%	6%	35%	59%
Having insulation	Heritage	0%	13%	50%	0%	37%
	Modern	0%	0%	35%	29%	35%
Having heat-recovery ventilators	Heritage	13%	25%	50%	12%	0%
	Modern	0%	6%	35%	24%	35%
Using solar panels to create electricity	Heritage	12%	12%	38%	13%	25%
	Modern	0%	6%	24%	24%	47%
Recycling water	Heritage	12%	13%	25%	25%	25%
	Modern	0%	0%	18%	18%	64%
Applying waste-reduction methods	Heritage	0%	12%	13%	25%	50%
	Modern	0%	0%	12%	35%	53%
Recycling paper	Heritage	0%	0%	0%	25%	75%
	Modern				18%	82%
Reusing waste in production processes	Heritage	0%	25%	38%	25%	12%
	Modern	6%	0%	18%	29%	47%
Having sufficient indoor ventilation	Heritage	0%	0%	12%	50%	38%
	Modern			6%	24%	70%

Setting targets for energy use	Heritage Modern	0%	0%	24% 18%	38% 53%	38% 29%
Monitoring and evaluating energy usage	Heritage Modern	0%	12%	13%	25%	50%

4.2 OVERVIEW OF THE BUILDINGS

A total of 35% of commercial buildings in Stellenbosch were sampled. The sampled buildings were divided between heritage buildings (older than 60 years) and modern buildings (younger than 60 years) and plotted on a GIS map (Figures 4.1.a and 4.1.b). The heritage buildings are presented in pink and the modern buildings in yellow. The buildings were sampled from Stellenbosch central and from Tegnopark, an office park in Stellenbosch.

Figure 4.1.a. Location of sampled buildings: Stellenbosch central *Source: ArcView, 2012*

Figure 4.1.b.Location of sampled buildings: Tegnopark *Source: ArcView, 2012*

The table below gives an overview of the buildings that were sampled. The table shows the number of buildings that are heritage building, the number of buildings that are modern buildings, and the functions of the buildings.

Table 4.3 Overview of buildings in the survey

Building name	Heritage building (older than 60 years)	Modern building (younger than 60 years)	Building uses
Eikestad News	✓		Only offices
Dennis Moss	✓		Only offices
Alexander Forbes	✓		Only offices
Stellenbosch Hotel	✓		Hotel
Distell offices		✓	Only offices

Small and Talken Attorneys			Only offices
Kruger Attorneys		✓	Only offices
C.S. Africa		✓	Only offices
Meson Close		✓	Only offices
AVM Audit		✓	Only offices
Tri Alpha		✓	Only offices
Sun Space		✓	Only offices
Geo Med		✓	Only offices
Creo Design		✓	Only offices
Imalivest			Only offices
Greymatter and Finch		✓	Only offices
Le Cocco		✓	Only offices
Capitec Bank		✓	Only offices
Hillebrandt Logistics		✓	Only offices
NPK	✓		Only offices
Independent Securities	✓		Only offices
Van Rooyen Attorneys	✓		Only offices
Remey Group		✓	Only offices
De Leeuw Contractors		✓	Only offices
HVM Accounting		✓	Only offices

Banelpro Finance		✓	Only offices

4.3 THE IMPORTANCE OF NATURAL LIGHT IN OFFICE SPACES

This section focuses on lighting methods that are energy efficient and the importance of natural light in a building.

In commercial buildings lighting typically accounts for 20% to 50% of total energy consumption (Wulfinghoff, 1999). Insistent lighting energy conservation can reduce average lighting energy consumption by a factor of three to ten compared to conventional practices, while still providing good visual quality. In contrast, most modern-day lighting conservation programmes reduce energy consumption by less than half. This shows that there is much room for improvement in current practices (Wulfinghoff, 1999). Light is becoming a very prominent design element in homes and office buildings. Working in a well-lit environment can improve your health, reduce absenteeism and make you happier and more productive (Wulfinghoff, 1999). Having natural lighting in a space has become a global trend. Natural light makes spaces appear larger, minimises strain on eyes and, most important of all, reduces the demands on energy.

Placing workstations within a seven metre radius of a window will help to improve the working environment, while the use of low-level cabinets and shelving will allow natural light into the building to be maximised. Placing workstations on bench-style desks at right angles to external windowed walls will maximise access to natural light for the majority of workers (Gulati, 2008). Simply opening some windows and letting in a breath of fresh air can have the effect of clearing heads and providing a more dynamic workforce. Workers that have an outside view can exercise their eyes and ease eyestrain, an issue that is often complained about, especially by workers who spend long periods of time in front of a computer. Sunlight floods our planet during daylight hours, providing natural lighting, warmth and a clean energy source for things like solar space heating, solar water heating and solar energy (Gulati, 2008). It is important to monitor your personal light-use habits and to try to find methods that produce opportunities to conserve energy expenditure. Therefore, saving energy can begin by focusing on basic facts about lighting, the type of bulb, the type of fixture and the power supply.

There are different methods that can be applied to maximise sunlight in a building. One option is a tubular skylight. This method is fast gaining attention throughout the world. The original skylight was invented in Australia by Solatube International Inc. more than a decade ago. The solatube skylight is a good alternative to the box skylight that was popular in the 1970s and 1980s. The box skylight was associated with leaking, condensation and heat/gain loss. The new tubular skylights give homes and businesses the benefits of natural lighting techniques, without the shortcomings of the box skylights. The tubular daylight device (TDD) is a day lighting system made from the cutting-edge technology, design and materials. "From sun rise to sunset, daylight is captured by the roof top down; redirects low angle sunlight rejects overpowering summer midday sunlight, giving consistent light throughout the day" (Gulati, 2008: 1). The tubular daylight device delivers an abundance of clean white light into interior space. The effect lens allows you to alter the light and gives the option to soften or warm light colours. The TDD light output is phenomenal and produces the same amount of light you would expect from a skylight twice its size. The tubular is cost effective and insulation is fast and easy (Gulati, 2008).

Daylight and movement sensors are other methods to reduce energy consumption. Daylight sensors are used to switch off lights when there is adequate daylight in the area. Daylight sensors can be used to dim or turnoff lighting when there is adequate daylight. There is also night-time switching, which can be linked to the daylight sensors to ensure that the lighting is only turned on when necessary. Movement sensors are used to turn lights off automatically in spaces that are not used (Council of Scientific Industrial Research, 2011). These methods are a few of numerous examples that can be utilised by building owners to increase natural light in a building and so use less electricity and promote energy efficiency. The majority of the respondents in the survey primarily make more use of natural light than artificial light in their office buildings in Stellenbosch (Figure 4.2).

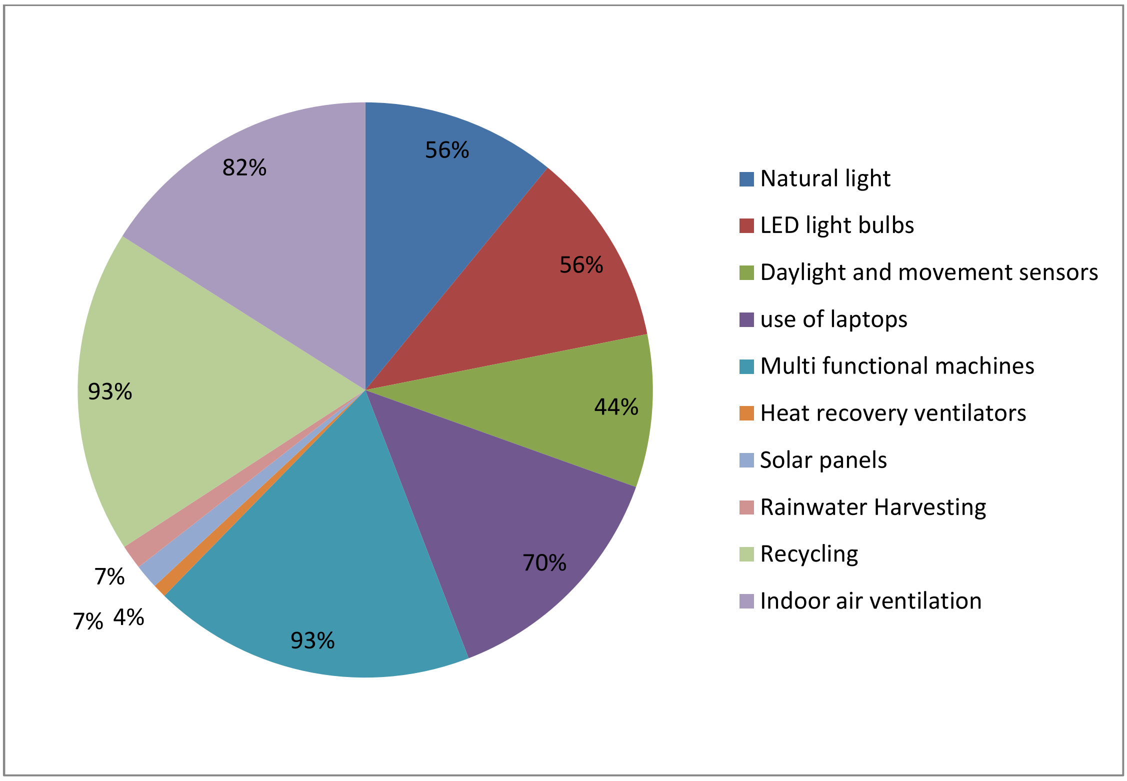

Figure 4.2 Percentages of different green practices. *Source*: Excel, 2012. (Note: multiple responses-will not add up to 100%)

The buildings seem to be designed in a manner that is optimum for natural light to enter. It was found in the survey that buildings that are older than sixty years (such as the offices of Dennis Moss Partnerships, Alexander Forbes, Eikestad News and the Stellenbosch Hotel) are also designed in such a way that promotes natural sunlight to enter the building. This can be due to the fact that quality of the artificial lighting that was used in that period was not as luminous as fluorescent or LED lights are currently, and natural sunlight was needed to attain efficient light. It could be that natural light has been important for decades. Only a quarter of the respondents have implemented daylight and movement sensors in their office buildings. This can be due to the fact that the sensors and their installation are expensive. A majority of the respondents seemed to be very concerned about the costs, but did not realise that they would save money on their electricity costs in the long term and help minimise energy usage. Sensors are also not as well advertised and well known as compact fluorescent lights (CFLs), for example.

4.4 THE ENERGY EFFICIENCY OF LED LIGHT BULBS

This section provides a discussion of compact LED lights and the advantages that they hold in contrast to regular light bulbs. LEDs give off light in a specific direction, and are more efficient in function than incandescent and fluorescent bulbs. The white high-power LED is projected to have a life span of 35 000 to 50 000 hours (Lee, 2012).

Because LEDs have a longer life span, the bulbs do not have to be replaced as often, saving time, labour and money spent on new bulbs. More than 50% of the respondents had CFLs or LED lighting in their offices. It would seem that there is more advertising and information available about energy-saving light bulbs. The respondents had greater knowledge about the bulbs. They did not seem to mind the higher cost of LED bulbs, knowing that the bulbs have an increased lifespan and enhanced luminance.

4.5 APPLIANCES USED IN OFFICE SPACES

In this section the use of laptops is compared to desktop. Also, the environmental advantages of multifunctional machines are discussed.

People are spending more and more time on computers, even when they are not at work. The global domestic use of computers has doubled between 2000 and 2005 and is predicted to escalate by a third by 2020. An average laptop saves up to 85% more energy than a regular desktop computer. Even when a laptop is on “sleepmode” it uses 10 times less energy than a desktop (BBC, 2008). We can generate greater efficiency from our computers if we used them in a more sensible manner. Most people would purchase a laptop instead of a desktop, but this would most likely not be because it is the more sustainable option, but rather because laptops are portable, making them more convenient to use. People can interact and do business from anywhere in the world.

As many as 70% of the respondents in the survey used laptops instead of desktops in their offices. This can be due to the fact mentioned above; however, there is a general consensus that laptops are preferred, which in turn still leads to energy consumption being minimised in offices, thus contributing to the greening of office spaces. Almost (93%) of respondents use multifunctional machines in their offices. Multifunctional machines save companies money because they save on the amount of paper and electricity that is used. One machine combines the functions of various other machines, such as printer, copiers, scanners and fax machines, which would each need ink cartridges and paper.

4.6 SOLAR PANELS

Globally, solar panels are used in numerous commercial properties. Solar panels are believed to be very profitable when used in commercial buildings. Many leading international companies have found solar panels to be greatly beneficial, and that they reduce electricity consumption and cut electricity costs greatly. Solar energy does not only benefit commercial buildings, but is also a great contributor to a cleaner environment. Over the past decade, people have gained more knowledge of the concept of sustainability, sustainable building measures and the overall environmental problems that face the world (Smith, 2009).Leading international companies that have incorporated green initiatives, like solar panels, help to promote the idea of greening globally (Smith, 2009). A well-known American multinational corporation, Walmart, is one of the top companies that are using solar panels to generate electricity for their stores. According to business news reports, “Walmart is covering the rooftops of their stores with solar panels. It is also reported that at present Walmart is producing thirty percent of its electricity through the solar panels” (Solar panel information, 2011).

Less than 10% of the respondents in the Stellenbosch survey had solar panels installed at their commercial building. Although solar panels have become popular in commercial buildings and businesses internationally, South African businesses have not quite latched onto this trend. Most business owners in the survey felt that it was too expensive to set up the panels, irrespective of the fact that they would probably save money in the long term. They feel that it would not save them that much more money on their electricity bills.

4.7 WASTE MANAGEMENT IN OFFICE BUILDINGS

There are certain recycling initiatives that are implemented; these initiatives are mostly set up by the private sector. The National Waste Management Strategy was designed to identify problems relating to waste management and to develop means to combat the problem. Recycling activities are taken on by private companies, especially companies in the packaging industry. Even though there is no legislative framework in place, local authorities have established drop-off facilities and kerbside collection facilities that separate recyclables. There are also educational programmes that promote awareness in schools and in the community. Recycling centres and waste drop-off centres are established in some of the larger cities, where waste divided into different waste sections, such as "glass, paper/cardboard, cans, scrap metal, plastics, garden waste and other waste, may be delivered by members of the public. Separation of this waste is often poor, thus hampering recycling. Collection banks are used on a small scale for glass and paper" (DEAT, 2000: 2). The survey revealed that more than 93% of the respondents recycled in their offices, especially paper. The reason why paper is recycled the most could be that it is easy to do so. Paper is just disposed of and later collected and taken to waste management sites. There is no effort involved and it does not cost any money. There seems to be a consciousness effort to recycle, and this is one mechanism that people find effortless and affordable to reduce their environmental impact.

4.8 SAVING WATER IN OFFICES THROUGH RAINWATER HARVESTING

A report released in early October 2009 by the Water Research Commission of South Africa stated that South Africa has 4% less water than 20 years ago (Desi, 2012). It is predicted that Gauteng will experience problems with water shortage as soon as 2013. Cape Town is not much better off, and it is believed that there will be water shortages by 2016 (Desi, 2012). If we continue to be careless with our water practices, there will not be a sufficient water supply for future generations. South Africans can prevent this by becoming more sustainable in their practices and more aware of and educated on water-saving practices like rainwater harvesting.

Rainwater harvesting is the term used for the “collection, storage and distribution of rainwater. This water can be used anywhere you use tap water” (Desi, 2012:1). Currently, potable water is used to flush our toilets and water our lawns. These practices are wasteful and have to be eliminated, especially with the increasing human population. Rainwater harvesting reduces your environmental footprint and greens your home or office space. Rainwater harvesting is beneficial in numerous ways. It is a free source of water, and the water will always be available, even when the municipality has cut off the water supply. The structure is easy to retrofit to an existing or newly constructed building. The structure is cost-effective and easy to maintain, and it reduces erosion caused by storm water run-off.

In Stellenbosch, fewer than 10% of all the respondents had incorporated this practice at their office spaces. This can be due to the fact that they have the financial means to obtain water from the municipality and at present feel that there is no desperate need for the system as long as the water supply from the municipality is sufficient. Smaller initiatives, like metered taps, have not even been considered or implemented in the majority of the Stellenbosch offices. Less than a quarter of the office buildings have installed these taps or any other form of water-saving instruments. At present it would appear that the respondents are not greatly concerned with water management and how they can reduce their environmental footprint for a better environment for them and Stellenbosch.

4.9 THE IMPORTANCE OF INDOOR AIR QUALITY IN OFFICE BUILDINGS

Air that circulates through the building is known as indoor air ventilation (CDC, 2012). The heating, ventilating and air-conditioning (HVAC) system of a building provides and removes air, either naturally through windows or mechanically to and from an area. Heat recovery ventilation systems (see Figure 4.3) are mechanical systems that use fans to maintain a low-velocity flow of fresh outdoor air into the building (incoming air stream), while exhausting out an equal amount of musty indoor air (exhaust air stream). HVAC mechanically supplies a comfortable temperature and humidity to the occupants of a building. An HVAC system consists of all the tools necessary to heat, cool and ventilate buildings. The system moves air around the building and filters the air.

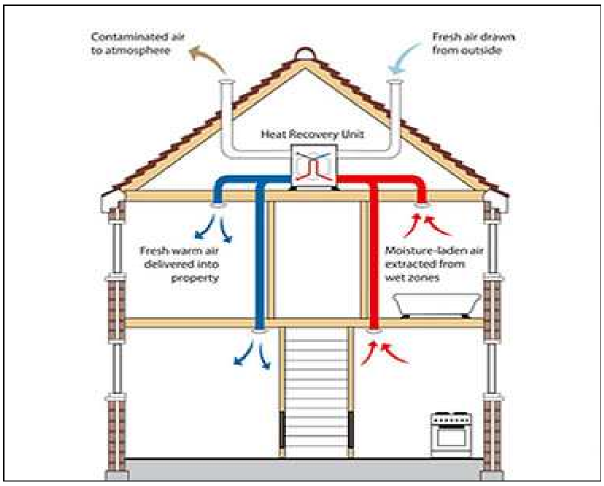

Figure 4.3 Heat recovery ventilator *Source*: Northern Galway, 2012

After a heat recovery ventilation system has been installed, it eliminates the draught coming from vents and walls and minimises the percentage of heat lost in the building. The system can recuperate up to 95% of heat generated by a heating system. These systems regulate how pollutants are dispersed through the building. In order to maintain sufficient indoor air quality in a building, special attention needs to be given to these systems at all times. This includes the layout, design, pollutant source management and filtration. The ventilation in buildings is one of the most important factors affecting the relationship between the airborne transmission of respiratory infections and the health and productivity of office workers (CDC, 2012).Carbon dioxide, detergents, printing and copying machines, pesticides, mould and bacteria are all sources of pollutants that are found in the office. The HVAC system itself can cause pollution if the system is not properly maintained. The filters can become saturated and produce microbial growth and odour concerns (CDC, 2012).

Heat recovery ventilators are an effective, sustainable option to improve the indoor ventilation of a building. Although indoor air quality was rated the category of highest importance by the respondents, fewer than 4% had fitted HRV systems in their buildings. The respondents felt that air entering their buildings naturally through windows and doors was sufficient. It came across that the occupants of office buildings feel that the quantity of air entering the building is more important than the quality of the air. There also was a lack among many of the respondents of wanting to attempt change, especially if they have occupied the building for several years.

4.10 SURVEY RESULTS OF ARCHITECTS IN STELLENBOSCH

This section focuses on the responses from the architects to the survey. The table below illustrates the number of architects interviewed, and their responses to how they have incorporated green building design aspects in their buildings. Their responses are measured on a scale ranging from 1 to 5, with 1 being ‘fully agree’ and 5 ‘fully disagree’.

Table 4.4 Incorporation of green building designs and practices by architects

	1 Fully agree	2 Agree	3 neutral	4 Disagree	5 Fully disagree
I usually recommend to my clients to incorporate green design in their designs	5	4	0	0	0
Recently there has been more interest in green building by my clients	4	5	0	0	0
Information and training about green building is available to all employees	2	4	3	0	0
There is an interest in green building by building practitioners (e.g. town planners, builders, etc.)	0	3	5	1	0
Brown field sites are more often preferred when selecting a building site than a green field site	0	3	4	2	0
I mostly recommend that natural materials are used in the	2	2	3	2	0

walls of buildings					
I mostly recommend that natural materials are used in the flooring	1	4	2	2	0
I mostly recommend that the insulation used in the building is made from recycled materials	4	3	2	0	0
I design my buildings to provide the most natural light practically possible	6	3	0	0	0
Recycled materials are incorporated into my designs	1	4	3	1	0
There are difficulties is retrieving sustainable materials such as recycled insulations and recycled wood	2	4	0	2	1
It is more expensive designing a green building	3	6	0	0	0
When designing and constructing a green building, waste is sorted in as many possible fractions to be recycled		1	6	2	0

The general reply from architects when asked what their understanding of the term green building or design is, was that they felt that as architects it was their responsibility to be sympathetic to the environment and to minimise the environmental footprint by minimising the use of materials and sourcing materials as close to the site as possible. Smuts and De Kock architects, one of the respondents, commented that "Whether energy is being returned or released, it should be done by not having to use artificial methods to retain a good balance" There should be a focus on energy-saving materials such as LED lights, water systems (harvesting systems and recycling systems for grey and black water), and maximising the use of the sun or fire for electrical gain. Minimising the use of resources is done through passive design. The architects agreed that system distribution networks should be maximised and supported by the available technologies.

The majority of the architects questioned have been involved in the design of a green building. Examples of sustainable methods that were introduced in their designs were the use of solar panels to reduce electricity usage; and heat pumps and evaporative coolers were installed to regulate water temperature. Rainwater harvesting and the recycling of grey water (wastewater generated from domestic activities) and black water (water containing human waste) systems are popular methods for saving on water consumption. Wine cellars are also being designed in a more sustainable manner by using concrete as the building material, and letting cool water run through the structure. This system limits the use of air conditioning.

At the Spier Wine Estate the new wine tasting centre was refurbished with natural timber and stone finishes that were recycled from the existing site. The timber and finishes were treated with natural products and non-toxic paint. Only LED lights and solar panels were installed. Other examples of sustainable projects in Stellenbosch are the Prechoros building in Kayamandi, which was built entirely out of old shipping containers. The homes at Lynedoch EcoVillage were built from mud. The new function hall at 401 Rosendal was built with only recycled material. The new Remgro head office is a five star Green Star Building. When asked about what aspects of green building are not aesthetically pleasing, most architects said that solar panels/geysers and water tanks on roofs were the most visually unpleasant. Other examples that the architects mentioned were evaporative cooling units, condenser units and the visual impact of wind turbines on rural and agricultural land. Some felt that these features are more important than the aesthetic value of the features, thus a building should be designed to incorporate these aspects. There are green materials that architects have a demand for, but find difficult to obtain. Many architects struggle to retrieve sustainable timber, bricks and building blocks. Affordable green paint finishes and aesthetics are also problematic to come by. There is a sufficient supply of roofing, flooring, insulation for roofs and walls, aluminium, stone and solar components.

4.11 CONCLUSION

It is evident from the survey of buildings that, considering the array of green building possibilities, Stellenbosch is far behind in green applications. The respondents felt that natural light and indoor air quality were the most important factors to have in an office space. Apart from recycling, no other waste management initiatives are implemented in their entirety by the respondents. In would appear that, although the majority of building owners are aware of green practices, they choose not to implement these initiatives. This can be due to the fact that many of the owners feel that these initiatives will not be much more cost effective than what they have to pay at present. It can also be due to a lack of information about these systems. Many of the building owners have made up their minds about green practices, without really doing any research on the different practices.

The Stellenbosch architects commented that, although there has been an increase in the demand for green designs, the interest is not nearly what it should be. The architects also mentioned that there is a lack of knowledge about green practices among other practitioners, especially in the construction field. Architects have trouble retrieving sustainable timber, bricks and building blocks. Affordable green paint, finishes and aesthetics are also problematic to obtain. There is a sufficient supply of roofing, flooring, insulation for roofs and walls, aluminium, stone and solar equipment. Although there is an interest in green design, it is not nearly enough to say that there is a shift towards environmental design in Stellenbosch. Although there is a consciousness about green building, green design and green initiatives, the initiatives are not actually implemented by the respondents. The respondents talk about the importance of these practices, yet make no real attempt to introduce them into their buildings.

CHAPTER 5: CONCLUSION

5.1 INTRODUCTION

The concluding chapter provides a summary of the objectives of the study, followed by recommendations arising from the study, shortcomings experienced in the study and a few thoughts that can serve as the focus for future research.

5.2 SUMMARY OF RESULTS

The aim of the study was to determine the implementation of green building practices in Stellenbosch. In order to achieve this aim, the following objectives had to be met: the first was to retrieve national and international literature on green building initiatives, which was done in Chapter 2 of the study. Six main sections were discussed in the literature, namely climate change and the environment, the built environment, the concept of sustainability in cities and buildings, green building designs and practices, green buildings, green building councils and green rating tools.

Sustainability is a diverse and difficult concept to define, especially in terms of sustainable buildings. Few buildings can truly be considered sustainable, either in their construction, their use of materials or in their operation. To be sustainable a building should not only focus on the embodied energy of the materials in the building, but also on the services needed during the construction and operation of the building.

Green practices are initiatives that are developed to minimise waste and reduce energy usage in buildings. These green mechanism and construction methods can be integrated into buildings at any stage from design to construction, refurbishment and destruction. Initiatives such as green roofs and walls, combined heat and power generation, LED light bulbs, solar panels, evaporative coolers, wind energy, water efficiency, air quality and waste management are all practices that minimise energy consumption and help achieve green buildings. Green building councils (GBCs) are non-profit organisations that help building industries to be more sustainable by encouraging the adoption of green building practices. South Africa has the only fully established green council in Africa to date.

Three buildings in Stellenbosch were selected as case studies. All three of these buildings implemented green practices. Distell Group Limited is South Africa's leading producer and marketer of wines, spirits, ciders and ready-to-drinks (RTDs). Distell has developed water-saving methods in its cellars, and uses biogas energy and recycling projects (such as the "give back, get back" programme) to minimise its environmental footprint. Spier Wine Estate is home to many endemic and endangered species. Spier is being more ecological by promoting waste water treatment. The estate has developed a vermiculture project, where red worms are used to produce fertiliser (vermicompost) from food waste. Spier is also eliminating alien plant species and developing the natural wetlands on the estate. Remgro and its subsidiary companies have initiated practices that save water and reduce carbon emissions. The new Remgro head office building, Millenia Park, has been refurbished, and achieved a five star Green Star rating from the Green Building Council of South Africa (GBCSA). Remgro is the only building in Stellenbosch to receive this rating. During the construction of the building there was a strong focus on enhancing natural light in the building, improving the air quality and promoting green waste and water management systems. All three of the case studies that were discussed set a good example to other institutions in Stellenbosch by promoting ecological awareness.

A survey of office buildings was conducted to investigate if they practise green building initiatives. A total of 35% of the commercial buildings in Stellenbosch were sampled. Nine buildings were heritage buildings (older than sixty years) and seventeen were buildings from the modern era (younger than sixty years).Nine architectural companies in Stellenbosch were also sampled. The respondents were identified by means of haphazard sampling. Two questionnaires were designed, one for building owners and another for architects. Questionnaires were dropped off and collected from building owners and architects. The survey was conducted with the building owners themselves, or with a person in a managerial position. T he first questionnaire, which was developed for building owners, was divided into two sections. The first section determined what green practices owners are incorporating into their office buildings. These green practices focused on the use of natural light in the buildings, LED lights, indoor ventilation, recycling methods, water-saving methods and energy-saving methods, and whether there are management plans to monitor and evaluate the buildings' energy usage. The second section focused on the perceptions of the building owners. The respondents had to rate their personal views on the importance of the abovementioned green initiatives on a scale of one 1 (being not at all) to 5 (being very important).

The questionnaire designed for the architects determined whether they are incorporating green design into their designs and whether there is a bigger demand for green designs by their clients. It was also determined whether information and training are available to all their employees, if recycled and environmentally friendly materials are included in their designs, whether it is difficult to retrieve these green materials, and if they find it more expensive to design a green building.

The findings of the study revealed that the respondents feel that natural light and indoor air quality are the two key factors to have in an office space. Fewer than 10% of office buildings in Stellenbosch have solar panels, and this can be due to the fact that the majority of the respondents believe that solar panels will not be cost effective and that they cost more than their electricity bills at present. It seems that long-term benefits are not taken into account. Rainwater harvesting is an efficient manner to manage water use, yet only 10% of the respondents in Stellenbosch have rainwater harvesting systems. Fewer than 4% of the respondents have a heat recovery ventilator in their offices; 93% of the respondents recycle paper in their offices. The reason for the high percentage of paper recycling is that it easy to achieve, since paper and other waste is placed in a bin, which is then collected. No real effort has to be made by the office employees. Apart from recycling, no real efforts seem to be made to implement efficient waste management initiatives. In would appear that, although the majority of building owners are aware of green practices, they choose not to pursue these initiatives. This can be due to the fact that many of the owners feel that these initiatives will not be much more cost effective than what they have to pay at present. It can also be due to a lack of education and training about green building practices. Many of the building owners have already drawn their own conclusions about green practices, without really doing any research on the different practices and their long-term benefits.

The Stellenbosch architects commented that, although there has been an increase in the demand for green designs, the interest is not nearly what it should be. The architects mentioned that there is a lack of knowledge about green practices among other practitioners, especially in the construction field. Many architects struggled to retrieve sustainable timber, bricks and building blocks. Affordable green paint, finishes and aesthetics are also problematic to come by. There is a sufficient supply of roofing, flooring, insulation for roofs and walls, aluminium, stone and solar equipment. Although there is an interest in green design, it is not nearly enough to notice any real shift towards environmental design in Stellenbosch. Although there is a consciousness about green building, green design and green initiatives, the initiatives are not really implemented by the respondents. The respondents talk about the importance of these practices, yet make no real attempt to apply them into their office buildings.

5.3 RECOMMENDATIONS

5.3.1 Expansion of the concept of green building

Discussions about green building and design issues should be broadened to other spheres apart from planners. Fields such as economics, architecture, engineering, public policy and the landscape should all be involved in the issues and problem solving of green building.

5.3.2 Education and training

Building practitioners, especially in construction, need to be informed and educated about green building practices. Training and workshops should be available to all practitioners and all employees. Green building initiatives cannot succeed if all employees involved in green building do not have the same understanding of how certain aspects and methods should be applied. Research should be done by building owners and other practitioners to educate them about the initial expenses of green systems, and the long-term financial benefits that are gained.

5.3.3 Sustainable materials

Sustainable materials should be made more accessible to building practitioners so that green buildings can be easier to design and build. Plans should be put in place by suppliers to provide more of these materials that are hard to come by, such as sustainable timber, bricks and building blocks, and affordable green paint, finishes and aesthetics. The possibility of manufacturing these materials locally should also be promoted.

5.3.4 Renovating buildings

Much of the focus of green buildings in practice and research has been on the construction of new buildings, rather than on refurbishing and renovating existing buildings. Buildings near existing communities and infrastructure should be renovated instead of always being demolished, causing waste and occupying valuable green space. Materials from existing buildings should be recycled and re-used in the renovation of the building.

5.4 SHORTCOMINGS OF THE STUDY

- Due to green building and green building initiatives being recent developments in South Africa, there is a lack of comparative studies that could be used as references for my study.

- Because both local and national governments have not passed legislation enforcing green building initiatives, few commercial building owners in Stellenbosch have implemented these initiatives due to a lack of knowledge about green building initiatives.

- Many potential respondents did not want to participate in the survey due to their own time constraints. Also, many respondents did not want to participate because they are still sceptical about the relatively new concept of green building.

5.5 FUTURE RESEARCH

- Local municipalities should take responsibility for developing the necessary legislation and policies that will lead developers and building contractors to adhere to green building initiatives and thus to ensure the least possible effect on the environment.

- Studies must be done on better building materials to be utilised in the construction of green buildings. The most suitable building materials to be used in the design of green buildings must be identified.

- Studies must be done on the cost effectiveness of green buildings to determine whether green buildings are 'cheaper' than conventional buildings, and if greener buildings are a better alternative to conventional buildings.

- Research can be done on more cost-effective, environmental-friendly designs in the building of green buildings.

- Most studies on green building practices are still comparative to other countries and not to South Africa. It is important to develop green building guidelines and techniques that are specifically designed for South Africa. These guidelines should also be based on South African currency so that it is easier to determine whether green building is cost effective and viable in South Africa. Green building design in South Africa should focus on our unique topography, elevation and climate, for example green building in coastal areas or in semi-arid areas such as the Karoo.

- Research must be done on the recycling of building materials to be used in green building construction, i.e. glass, wood, plastics, etc.

- Research can be done on a green tax - the greener the building the less you pay in rates and taxes. Incentives must be offered to communities, municipalities, etc. if they enforce greener building techniques.

- Green building studies and/or a green building curriculum should be incorporated at the tertiary level in colleges/technicons/universities to make students more aware of the concept.

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APPENDICES

A Building owners questionnaire

B Architects questionnaire

APPENDIX A: BUILDING OWNERS QUESTIONNAIRE

UNIVERSITEIT·STELLENBOSCH·UNIVERSITY
jou kennisvennoot · your knowledge partner

What is your understanding of the concept green building?

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____

____

____

____

____

How green do you think your building/office -is on a scale from one to ten

1- Not at all	2	3	4	5	6	7	8	9	10- Completey green

More or less how old is this building? ____________________

When last has your building/office been refurbished or revamped in any way? ______Month/year

5. Is your building going to be revamped any time in the near future? □ Yes □ No □ I don't know

5.1. If your building is to be revamped, are you going to consider using more green practices part of the considered plan? □ Yes □ No □ I don't know

6. Specify the type of green practices you intend introducing

___

___

___

___

7. Your building/office has:

	Yes	No	Explain if necessary
A consciousness of energy saving			
Primarily make use of natural light in the building			
Use compact fluorescent lights			
Lights that are linked to daylights sensors			
Movement sensors for lighting			
The practice of laptops instead of desktops			
The practice of putting computers on sleep mode when not in use			
The practice of copiers and printers, to be switched off after hours			
Multi-functional machines (e.g. combined, fax and printer, etc.)			
Recycled insulation used in the roof and walls			
Heat recovery ventilators			

Solar panels used to create electricity			
Rainwater harvesting			
Meter taps (e.g. taps that reduce water waste)			
Waste reduction methods			
A paper recycling policy			
A policy of making hard copies of documents only when necessary			
A policy of printing on both sides of paper			
Sufficient indoor ventilation (e.g. clean air flowing through the building/office)			
Targets set for energy use			
Management plans that monitor and evaluate the energy usage?			

8. Rate on a scale of 1 to 5 to what degree your company thinks the following issues should be considered important.

1 Represent s "not important at all" and 5 represents "extremely important".

	1 Not important at all	2 Not important	3 Neutral	4 Important	5 Very important
Having natural light entering the building					
Installing light sources that are energy efficient					
Using machinery in a energy efficient manner					
Having insulation					

Having heat recovery ventilators					
Using solar panels to create electricity					
Recycling water					
Applying waste reduction methods					
Recycling paper					
Re-using waste in production processes					
Having sufficient indoor ventilation					
Setting targets for energy use					
Monitoring and evaluating energy usage					

9. If you have any building/office policy/plan related to green practices or sustainable development practices please provide me with a copy.

APPENDIX B: ARCHITECTS QUESTIONNAIRE

UNIVERSITEIT·STELLENBOSCH·UNIVERSITY
jou kennisvennoot · your knowledge partner

1. On a scale of one to ten how familiar are you with the concept ‘*green building and design*’*?*

1-Not familiar at all	2	3	4	5	6	7	8	9	10- Completely familiar

2. What is your understanding of the term green building and green building design? Please indicate the most important aspects of green building design.

3. Has your company ever been involved in a green building project? □ Yes □ No □ I’m not sure

4. If yes please provide some detail of the most recent such type of development

5. Which aspects of a green building will not be aesthetically acceptable?

6. As an architect rate the following statements, on a scale of 1 to 5, according to the best of your knowledge

1 Represents 'I fully agree' and 5 represent 'I fully disagree'

	1 Fully agree	2 Agree	3 neutral	4 Disagree	5 Fully disagree
I usually recommend to my clients to incorporate green design in their designs					
Recently there has been more interest in green building by your clients					
Information and training about green building is available to all employees					
There is an interest in green building by building practitioners (e.g. town planners, builders, etc.)					
Brown field sites are more often preferred when selecting a building site than a green field site					
I mostly recommend that natural materials are used in the walls of buildings					
I mostly recommend that natural materials are used in the flooring					
I mostly recommend that the insulation used in the building is made from recycled materials					
You design your buildings to provide the most natural light practically possible					
Recycled materials are incorporated into my designs					
There are difficulties is retrieving sustainable					

materials such as recycled insulations and recycled wood					
It is more expensive designing a green building					
When designing and constructing a green building waste is sorted in as many possible fractions to be recycled					

7. What are your green performance indicators that are in place during the design phase?

____

____

____

____

____

8. What type of green specialty companies (e.g. green furniture, green materials, etc.) is there a demand for?

____

____

____

__________ and what is there a sufficient supply off?

____

____

____