A comparative analysis of the implications of Green Development versus conventional development imperatives: A case study of Lufhereng

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ABSTRACT

This research study focuses on providing evidence that indicates that, making use of contemporary green building practices within a low cost subsidised housing project have more social, economical as well as environmental benefits than that of a conventional, non-green approach.

Low cost subsidised housing units have become an everyday sight in the light of the global as well as the local economy. The increasing levels of unemployment and subsequent social problems lead to growing needs for this form of housing. As these projects consume a number of resources, steps need be taken to lighten the load – such as the carbon emissions - that is put on the environment.

According to the United Nations, the key areas that are influenced by sustainability are environmental, economical as well as social. In South Africa, a number of government as well as local policies exist that regulates the planning and building practices of the low cost subsidised housing projects. These policies have been used as a foundation for this study. This study focuses on the Lufhereng project as a case study, and technology used in the Kuyasa as well as Cosmo City developments furthermore assisted in the groundwork for the comparison between the different construction approaches. The challenges facing the utilisation of a contemporary green building approach were researched, identified, discussed and recommendations were made.

SAM (social accounting matrix) multiplier analysis on the Gauteng SAM obtained from the DBSA (Development Bank of South Africa), analysis and comparison of existing data as well as a qualitative questionnaire that was sent to industry stakeholders were utilised to obtain relevant information.

The quantitative as well as qualitative data obtained from the primary as well as secondary research indicated that there are a number of aspects which has an influence on method of construction used in subsidised low cost housing units. The findings from literature as well as empirical research were analysed and discussed accordingly.

Recommendations and suggestions regarding strategies that may be followed to increase the use of contemporary green approaches in these projects were made. These

recommendations were based on the findings from literature as well as the research conducted for this study.

The use of contemporary green approaches are vital for the social, economic as well as environmental sustainability of the country, and thus, ultimately of the world as a whole. It is, in this light, imperative that everything in our power should be done to preserve our resources by any means possible.

KEY WORDS

Carbon emissions
Green development
Low cost housing
Multiplier analysis
Poverty
Social accounting matrix
Subsidised housing
Sustainability
Sustainable human settlements
Unemployment

UITTREKSEL

Hierdie navorsingsprojek fokus daarop om positiewe getuienis te lewer dat, indien daar gebruik gemaak word van ‘n moderne, groen benadering in die konstruksie, ontwikkeling en bou van gesubsideerde lae-koste behuisingseenhede, die sosiale, ekonomiese, asook die omgewingsinvloede daarvan baie meer gunstig sal wees as dié van ‘n tradsionele, nie-groen benadering.

Die verskynsel van gesubsideerde lae-koste behuisingsskemas word algemeen gesien in die lig van die verswakkende plaaslike, sowel as globale ekonomiese situasie. Die stygende vlakke van werkloosheid asook die toename van die sosiale probleme wat daarmee gepaardgaan, lei tot ‘n verhoogde aanvraag vir hierdie vorm van behuising. Die ontwerp en konstruksie van hierdie eenhede gebruik egter groot hoeveelhede hulpbronne. Stappe om hierdie lading vanaf die omgewing te verlig, moet geneem word.

Volgens die Verenigde Nasies is die sleutelareas wat geaffekteer word in volhoubaarheid van bogenoemde benadering die omgewing, ekonomie, asook die sosiale aspekte. In Suid Afrika bestaan daar ‘n groot hoeveelheid nasionale, asook plaaslike regulasies om die beplanning en boupraktyke van gesubsideerde laekostebehuisingsprojekte te reguleer. Hierdie regulasies is gebruik as ‘n grondslag vir hierdie studie. Hierdie studie fokus verder op die Lufhereng projek buite Johannesburg as ‘n gevallestudie. Die tegnologie wat gebruik is met die ontwerp en bou van die Kuyasa en Cosmo City- ontwikkelinge het gehelp met die vergelyking wat getref kan word tussen die twee verskillende benaderings. Die uitdagings wat die gebruik van ‘n moderne, groen benadering in die gesig staar is nagevors, geidentifiseer, bespreek en aanbevelings is gemaak.

SAM (Sosiale Rekeninge Matriks) vermenigvuldiger-analise van die Gauteng SAM, verkry vanaf die Ontwikkelingsbank van Suid Afrika, asook die vergelyking van bestaande inligting, opgevolg met ‘n kwalitatiwe vraelys wat uitgestuur is na bedryfrolspelers is gebruik om geldige inligting te bekom.

Kwalitatiewe asook kwantitatiewe inligting verkry deur primêre en sekondere navorsing het aangetoon dat daar heelwat aspekte is wat ‘n invloed het op die metode van konstruksie wat gevolg word in die beplanning en bou van gesubsideerde laekostebehuisingseenhede. Die bevindinge vanaf literatuur, asook empiriese navorsing, is derhalwe geanaliseer en daarvolgens bespreek.

Aanbevelings en voorstelle ten opsigte van moontlike strategieë wat gevolg kan word om die gebruik van groen benaderings in laekostebehuisings projekte te verhoog, is gemaak. Hierdie aanbevelings is gebaseer op die bevindings vanaf literatuur, asook die navorsing wat onderneem is tydens hierdie studie.

Die gebruik van moderne, groen benaderings in die konstruksiebedryf is noodsaaklik vir die sosiale, ekonomiese en omgewingsvolhoubaarheid van die land, en dus ook die wêreld as ‘n geheel. Dit is in hierdie lig dat ons alles in ons vermoeë moet doen om die skaars hulpbronne tot ons beskikking, te beskerm.

SLEUTEL WOORDE

Koolstofvrystellings
Groen ontwikkeling
Laekoste behuising
Vermenigvuldiger analise
Armoede
Sosiale Rekeninge Matriks
Gesubsidieerde behuising
Volhoubaarheid
Volhoubare menslike nedersettings
Werkloosheid

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LIST OF ABBREVIATIONS

BNG	Breaking New Ground
CDM	Clean Development Mechanism
CEF	Central Energy Fund
CFL	Compact Fluorescent Lamps
CO_2	Carbon Dioxide
CoJ	City of Johannesburg Metropolitan Municipality
COP	Conferences of the Parties
CoT	City of Tshwane Metropolitan Municipality
DBSA	Development Bank of South Africa
DGDP	Gross Domestic product
EMM	Ekurhuleni Metropolitan Municipality
GEEF	Green Energy Efficiency Fund
GEGDS	Gauteng Employment Growth and Development Strategy
GHG	Greenhouse Gas
GP	Gauteng province
GSDF	Gauteng Spatial Development Framework
GVA	Gross Value Added
ha	hectares
IDC	Industrial Development Corporation
IDM	Integrated Demand Management
km	kilometre
km^2	square kilometre
LA21	Local Agenda 21
LEDs	Light Emitting Diodes
MTSF	Medium-Term Strategic Framework
NGO	Non-Government Organisation
NGP	New Growth Path
NPC	National Planning Commission
NPO	Non-Profit Organisation
NRCS	National Regulator for Compulsory Specifications
NSSD1	National Strategy for Sustainable Development and Action Plan
PEA	Potential Economically Active
R	Rand

RDP	Reconstruction and Development Programme
SA	South Africa
SANS	South Africa National Standards
SDF	Spatial Development Framework
SDM	Sedibeng District Municipality
SWH	Solar Water Heater
SIC	Standard Industrial Classification
Statistics South Africa	Statistics South Africa
UCLG	United Cities and Local Governments
UNFCCC	United Nations Framework Convention on Climate Change
WRDM	West Rand District Municipality

KEY CONCEPTS AND DEFINITIONS

Green development and conventional development	For the purpose of this study green development refers to greening interventions that can be applied to low-cost housing to increase its environmental sustainability - in this case retrofitting low-cost housing with an insulated ceiling, compact fluorescent lamps (CFL) for lighting and a solar water geyser (SWG). Conventional development refers to the current or typical approach to low-cost housing, which covers the basic elements included in the basic allowance for a subsidised housing unit and excludes the application of greening interventions such as those mentioned earlier.
Sustainable development	Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs. It contains two key concepts: • The concept of "need," in particular the essential needs of the world's poor, to which overriding priority should be given; and • The idea of limitations imposed by the state of technology and social organisation on the environment's ability to meet present and future needs.
Environmental sustainability	The natural renewable as well as non-renewable resources that make up our surroundings and assist us to sustain and improve our livelihood.
Economic sustainability	The system that determines how the limited resources needed to improve peoples' lives are allocated and subsequently distributed.
Socio-political sustainability	The issues that have direct influences on the lives' of

	the people, and that can either have a positive of a negative influence on their daily existence and life quality
Sustainable construction	The creation and responsible maintenance of a healthy built environment, based on resource efficient and ecological principles
Green buildings	Healthy facilities that were designed and built in a resource-efficient manner, which made use of ecologically sound principles throughout the entire process.
Sustainable human settlements	Settlements that are well-managed entities in which economic growth and social development are in balance with the carrying capacity of the natural systems on which they depend for their existence, and result in sustainable development, wealth creation, poverty alleviation and equity
Informal dwelling	A makeshift structure not erected according to approved architectural plans, for example shacks or shanties in informal settlements or in backyards.

SECTION ONE: ORIENTATION AND BACKGROUND OF THE STUDY

1.1. INTRODUCTION

The need for low cost subsided housing projects is increasing around the globe. This, together with a number of factors including heightened levels of globalisation, decentralisation as well as the rapid population growth that is experienced around the world are leading to increased needs for the development of more environmentally friendly and "greener" building practices.

New, contemporary building and construction technologies are developed globally to complement current, conservative building practices. The objectives of creating greener buildings and structures are at the forefront of national and international discussions, with the common objective to reduce the social, economical and environmental strain that conservative construction practices create.

The situation in South Africa is no different. Rapid population growth is increasing the demand for low cost subsided housing across the country. The cost of these projects as the impact that these have on various levels, needs to be addressed.

It is in the light of the above that the researcher decided to investigate the perceived economic, environmental and social benefits that a contemporary, green approach to low cost subsidised housing projects have versus a conventional, non-green building approach, making use of the Lufhereng integrated development as a case study.

For the purpose of this study green development refers to greening interventions that can be applied to low-cost housing to increase its environmental sustainability - in this case retrofitting low-cost housing with an insulated ceiling, compact fluorescent lamps (CFL) for lighting and a solar water geyser (SWG). Conventional development refers to the current or typical approach to low-cost housing, which covers the basic elements included in the basic allowance for a subsidised housing unit (c.f. 4.2.3 and table 4.1) and excludes the application of greening interventions such as those mentioned earlier.

Diagram 1.1 illustrates the outline of this section.

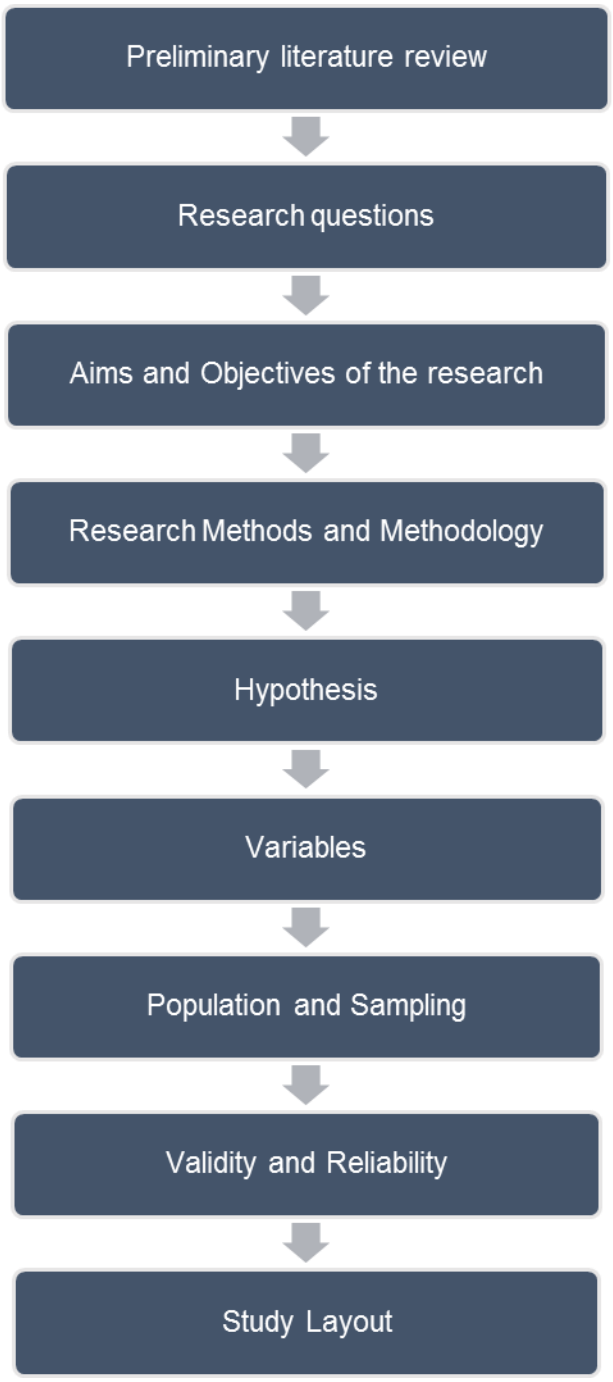


DIAGRAM 1.1 – Outline of the orientation and background section

Source: Own construction

1.2. PRELIMINARY LITERATURE REVIEW

According to a study completed by the US Environmental Protection Agency (2009) the efficient use of water, energy and other resources, as well as the protection of occupant

health, the improvement of the levels of productivity among employees as well as the reduction of the levels of waste, pollution and general environmental degradation are the common objectives that need to be attained by the new and green technologies that are developed in the modern construction environment. The sustainability – defined as the process whereby the needs if the present generations are met without compromising the abilities of future generations to meet their own needs (Allen and Lano, 2008) - of the building projects are at the forefront of global discussions, as this has effects on various levels.

Preliminary research completed by the US General Services Administration concluded that sustainably designed buildings are more economical and cost less to operate than their conventional counterparts. The research conducted also proved that these buildings also have excellent levels of energy performance (GSA Public Buildings Assessing Green Buildings Performance, 2008), and that the classical building design concerns of economy, durability, utility as well as comfort are easily met (US Environmental Protection Agency, 2009), indicating that these designs are an innovative example of the application of trend-setting construction practices.

Ji and Plainiotis (2006) state that green construction practices refers to the processes that are followed which are environmentally responsible and furthermore ensures that the built structures are resource efficient throughout the entire lifespan of the project, from the initial design stages, the construction processes, the maintenance thereof as well as, ultimately, the demolition thereof when it has reached the end of its lifespan. It is these challenges, amongst others, that are forcing developers as well as economists globally to face the paradigm shifts that are taking place on a national as well as international scale and adapt their conventional construction practices into more cost effective, sustainable housing schemes for the ever increasing low-income communities (Gladwin, Kennely and Krause, 1995).

It is in the light of the literature discussed above that the researcher has decided on the implications of Green Development versus Conventional Developments within a pre-determined, set community. Although research around the globe has been conducted regarding low income housing subsidised projects, limited research following this approach has been completed. This study, however, is the first study of its kind within a South African context.

For the purpose of this research study, the focus will be on the sustainability of the low cost subsidised housing project of the Lufhereng integrated development project in Gauteng, South Africa.

1.3. RESEARCH QUESTIONS

Although a number of studies regarding the sustainability of low income subsidised housing projects were consulted - including Hodgson (2002), Bowen, Lincoln and Ross (2010) as well as Badamlzaman, Jazaar and Rasoolimanesh (2011) – limited research on the implications of Green Development versus Conventional Development could be found.

During the course of this research study, the researcher identified specific problem areas that had an impact on the building practices of low cost subsidised housing projects. Subsequently, the problems associated with these building practices gave rise to the research questions:

- ***How do the perceived economic, environmental and social benefits of a green approach to a housing project in Gauteng (the Lufhereng integrated development project) compare with a conventional (non-green) approach?***
- ***Does the analysis of the difference between a contemporary green approach and a conventional non-green approach reveal more intelligent approaches to planning?***

These primary research questions, in turn, led the researcher to ask the following subsidiary questions:

- What are the core differences between a conventional non-green construction approach and a contemporary green construction approach?
- Are there aspects that justify the need to change from the conventional non-green construction approach to the contemporary green approach in the construction of low cost subsidised housing projects?
- Which influences will the change from a conventional approach to a contemporary have on the levels of unemployment within the local community?
- What are the influences of the change from a conventional- to a contemporary approach on poverty stricken and low-income households?
- What are the long term environmental effects of a change in the construction approach?

1.4. AIMS AND OBJECTIVES OF THE RESEARCH

The primary aims of the research were to:

- Determine and compare the different economic, environmental and social implications of the Lufhereng integrated development project following a contemporary green approach and a conventional non-green approach.
- Investigate whether the analysis between a conventional non-green construction approach and a contemporary green approach reveal more intelligent approaches to the planning processes.

The following secondary objectives were pursued in this study:

- The identification of the core differences between a conventional non-green construction approach and a contemporary green construction approach.
- The determination of the aspects that justify the need to change from the conventional non-green construction approach to the contemporary green approach in the construction of low cost subsidised housing projects.
- The explanation of the influences that the changes from a conventional approach to a contemporary have on the levels of unemployment within the local community.
- The empirical investigation of the influences of the change from a conventional- to a contemporary approach on poverty stricken and low-income households.
- The contextualising of the long term environmental effects of a change in the approach.

1.5. PROBLEM STATEMENT

The problem statement for this study can subsequently be expressed as:

Are the economic, environmental and social benefits of a green approach to a low cost housing project in Gauteng (the Lufhereng integrated development project) more significant in comparison with a conventional (non-green) approach?

1.6. HYPOTHESIS

The null hypothesis (H_0) for this study can subsequently be expressed as:
The economic, environmental and social benefits of a green approach to a low cost housing project in Gauteng (the Lufhereng integrated development project) are less significant in comparison with a conventional (non-green) approach.

The alternative hypothesis (H_1) for this study can subsequently be expressed as:
The economic, environmental and social benefits of a green approach to a low cost housing project in Gauteng (the Lufhereng integrated development project) are more significant in comparison with a conventional (non-green) approach.

1.7. RESEARCH METHODS AND METHODOLOGY

For the purpose of this study, the researcher made use of a mixed method approach. Kruger and Welman (2001) stresses that the utilisation of both quantitative as well as qualitative approaches to the acquisition of material enhances the trustworthiness of the data and improves the final outcomes of the study. Maree (2009) also supports this triangulated approach, while Neumann (2000) concurs by explaining that the mixed-method approach provides more weight to the research findings, as it gives both a numerical value to the data which is supported by an in-depth understanding of the opinions of the respondents. It is then in the above context that the researcher also included open-ended questions in the questionnaires.

According to Mason (2002), the use of such a qualitative approach allows the researcher to learn more from the participant's perspectives and personal experiences as it "enlightens" the quantitative findings and can lead to the discovery of the often "hidden" part of the phenomenon (Maree, 2009). For discovering the underlying meanings and patterns of relationships and the determinants that influences the use of a 'green' approach to construction, this qualitative data is deemed appropriate.

1.7.1. Data collection and analysis

A comprehensive literature study was undertaken in which both national as well as international sources were consulted as to provide a solid foundation for the research study.

Diagram 1.2 below illustrates the methods that were utilised by the researcher to obtain and analyse the information that was necessary for the study:

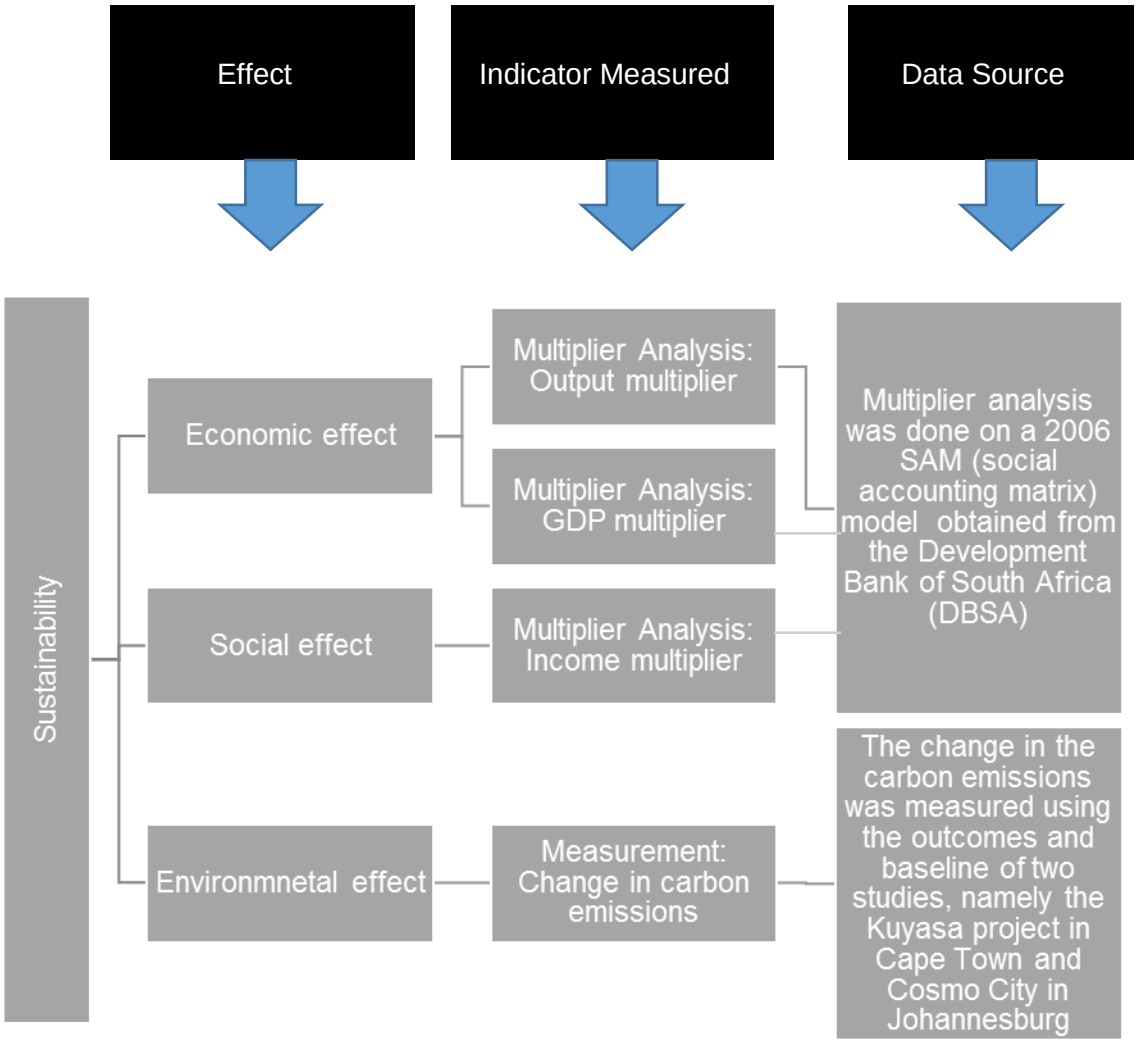


DIAGRAM 1.2 - Methods that were utilised to obtain and analyse empirical information
Source: Own construction

The SAM (social accounting matrix) model obtained from the DBSA (Development Bank of South Africa) was acquired via email correspondence with a coordinator at DBSA (Van Niekerk, 2012).

The information regarding the Kuyasa project in Cape Town was obtained from SouthSouthNorth Non-Profit Organisation (NPO) via email correspondence with Carl Wesselink (Wesselink, 2013) and Blaise Dobson (Dobson, 2013). The information

regarding Cosmo City in Johannesburg was obtained via email correspondence with the City of Johannesburg Environment, Infrastructure Service Department Linda Phalatse (Phalatse, 2013) the Deputy Director of Climate Change & Resilience as well as a Senior Specialist in Climate Change Mitigation, Given Mbara (Mbara, 2013).

In order to render an in-depth understanding of the participants' experiences and opinions, the qualitative data was transcribed and meaningful trends, in terms of the factors influencing the utilisation and implementation of contemporary green building practices in the construction of low-cost subsidised housing projects in South Africa, were identified and discussed.

1.8. VARIABLES

1.8.1. Identification of the variables

Neuman (2000) and Airasian, Gay and Mills (2010) explain that a variable refers to a concept that can take on a number of measures. In other words, a variable can be seen as a "placeholder" that can assume any one of a wide range of values, however, in this particular investigation; the variables were *"social, environmental and economical impacts"* and *"contemporary green building practices versus conventional non-green approaches".*

1.8.1.1. The independent variable

Bless, Higson-Smith and Kagee (2006) state that an independent variable is defined as the "…variable that is manipulated by its relationship to an observed phenomenon, the dependent variable." In terms of McMillan and Schumacher's (2010) view that the independent variable precedes the dependent variable, the independent variable in this study was "*type of building practice employed in the construction process of a low-cost subsidised housing project" (the use of contemporary green building practices versus conventional non-green building practices)*.

1.8.1.2. The dependent variable

A dependent variable can be seen as the variable that can be observed or measured to determine the effect that the independent variable has had on it (Bless, Higson-Smith & Kagee, 2006). As the dependent variable is the variable that needs to be measured by the

research tool and of which the outcome is the result of the independent variables (McMillan and Schumacher, 2010), the dependent variables in this study were "*the economic, environmental and social impacts"* of the building methods (the independent variables) used in low cost subsidised housing projects in the Lufhereng project.

1.9. POPULATION AND SAMPLING

Bless, Higson-Smith and Kagee (2006) explained that a population refers to the "complete set of events, people or things to which the research findings are to be applied." Therefore, it refers to all possible members of a group (Travers & Cooper, 1996, Airasia *et al*., 2010). The population of this study was the low cost subsidised housing projects in South Africa. Purposeful convenient sampling was used as this type of sampling allows the researcher to select participants that will best be able to answer the questions (Lewis, Saunders & Thornhill, 2000). For the purpose of the study, the Lufhereng integrated development in Gauteng was used.

The case study will be based on the abovementioned development project, which sits on 1,800 hectares directly to the west of Soweto, to the north of Glen and to the south of Slovoville, forming a natural western extension of Soweto. The final scope of the Lufhereng project is expected to be between 24,000 and 25,000 housing opportunities, which are to be developed over three principle phases over a period of seven to nine years (Department of Housing, 2008).

1.10. VALIDITY AND RELIABILITY

Reliability and validity are important attributes of a research instrument (Thomas, 1998). McLaughlin and Mertens (2004) stated that validity, as well as reliability, are key to maintaining appropriate standards in research. They continued by stating that research is a scientific method of inquiry and that data obtained should be carefully assessed by testing for validity as well as reliability. This was supported by Leedy and Omrod (2010) who posit that "the validity and reliability of your measuring instruments influence the extent to which you can learn something about the phenomenon that you are studying the probability that you will obtain statistical significance in your data analysis, and the extent to which you can draw meaningful conclusions from your data".

The reliability and validity of the research instrument was discussed in more detail in section three of this study.

1.11. STUDY LAYOUT

Section Two: Previous research as well as relevant literature in the contemporary green building approaches as well as the conventional non green approaches, as well as the background and implications thereof, forms the core of this section.

Section Three: The research design, data collection techniques, sampling of the study as well as the procedures that was used to collect and analyse is dealt with in this section.

Section Four: The collected data is analysed and reported on.

Section Five: This section focuses on an overview of the literature as well as the findings obtained through quantitative and qualitative research.

Section Six: This section deals with the consequent recommendations and the proposed framework that can have an influence on a more intelligent approach to planning for low cost subsidised housing projects by making use of a contemporary green approach to construction.

SECTION TWO: LITERATURE REVIEW

2.1. INTRODUCTION

Global socio-economic changes, such as globalisation, decentralisation as well as the rapid population growth in certain areas (Malkina-Pykh, 2002) have led to the birth of “sustainable development” as a concept (Whitehead, 2003). Research conducted by Gladwin, Kennelly and Krause (1995) and supported by Bowen *et a.l* (2010) indicate that these and other arising challenges are forcing developers, strategists and economists to face the paradigm shifts that are taking place globally as well locally within the field of the development of sustainable housing schemes for the increasing numbers of low-income communities (Gladwin *et al*, 1995).

Climate change, poverty and unemployment are some of the major challenges South Africa faces today. Climate change is already a measurable reality and attention is increasingly given to the “Green Revolution” or “going green”. The National Climate Change Response White Paper of South Africa 2011 presents the South African Government’s vision for a climate change response and for the long-term transition to a climate-resilient and lower-carbon economy and society. Under the United Nations Framework Convention on Climate Change (UNFCCC) and its Kyoto Protocol, South Africa is committed to reduce its GHG emissions by 34% (by 2020) and 42% (by 2025) below its “Business As Usual” emissions growth trajectory. Adapting to climate change and making the transition to a much less carbon-intensive economy will require both massive technological and structural shifts in the South African economy.

Although research regarding the sustainability of low-income housing projects has been conducted around the world by various researchers including Hodgson (2002), Bowen *et al.* (2010) as well as Badamlzaman *et al.* (2011), limited research has been done on the implications of Green development versus Conventional development within a set community. No research to this effect has been completed within a South African framework.

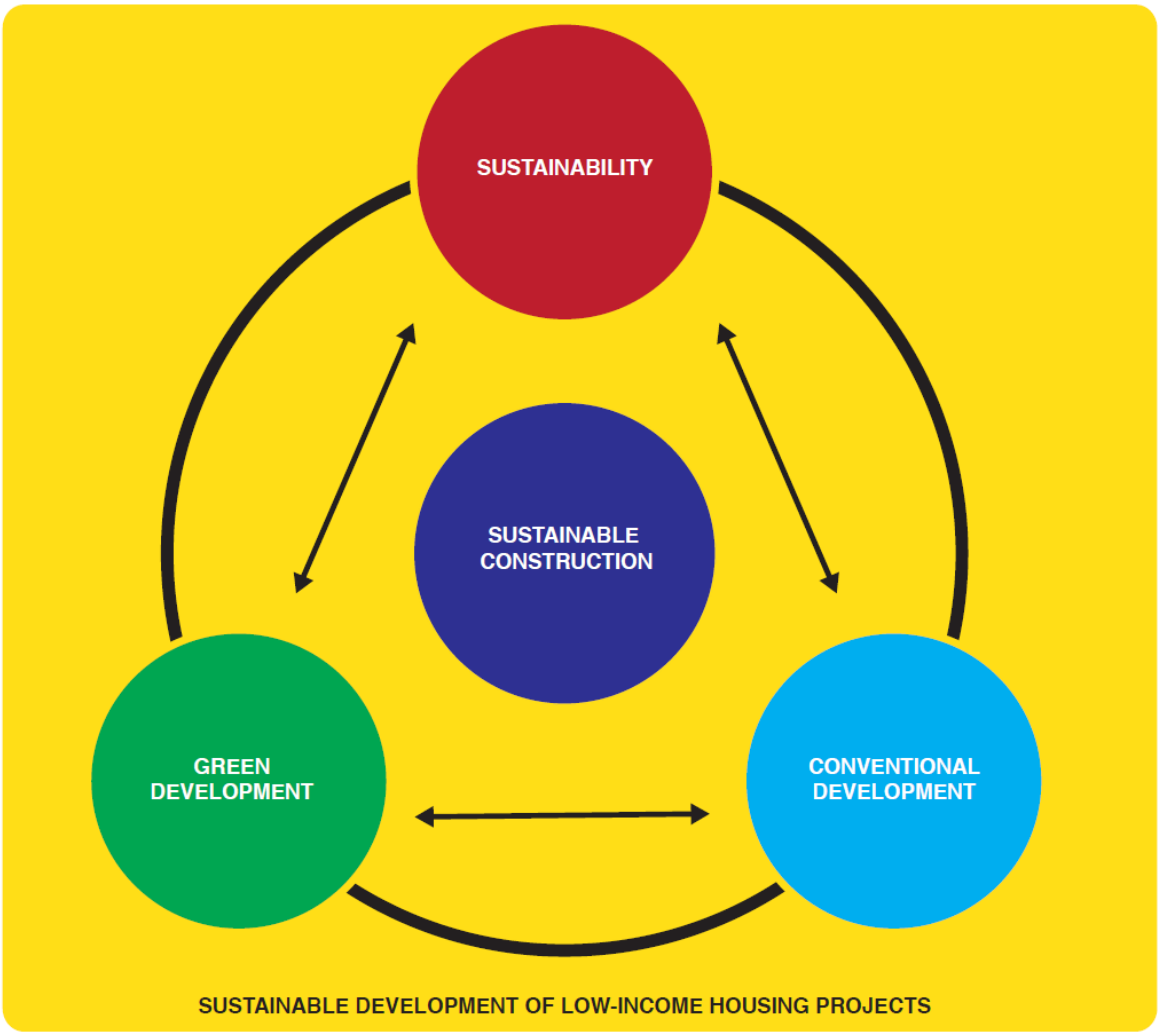


DIAGRAM 2.1 - The determinants of the factors influencing the sustainable development of low income housing projects

Source: Adapted from The World Bank (2002) and Whitehead (2003)

This section will firstly focus on the term "sustainability," the concept of "sustainable development" as well as "green economy and green building practices." The terms will be conceptualised and the main definition and meaning thereof, as well as literature available on the impact and influence that it has on the growth and development within rural housing projects, will be focused on.

The aim of the research conducted in this study is to determine whether a Green development approach is more sustainable than a conventional approach within the low income housing project within the Lufhereng community. As is visible in diagram 2.1, the researcher will deal with literature relevant to sustainability, Green development, Conventional development as well as the economic background and needs within the South African environment.

Diagram 2.2 illustrated the outline of this section:

DIAGRAM 2.2 – Literature section outline

Source: Own construction

2.2. SUSTAINABILITY

This first part of the literature overview deals with the theoretical background related to sustainability. Definitions, theories as well as the determinants influencing the concept as well as the importance thereof within the realm of low income housing are discussed.

2.2.1. Sustainability: Definition and Conceptualisation

The economic concept "sustainability" has been introduced to the world in 1972 during a United Nations conference on the Human Environment hosted in Stockholm (Whitehead, 2003). An idea, however, that was foreign in the 1970's soon became an integral aspect in future international conferences relating to environmental, social as well as economic development. The term was used to explain an economy that was in equilibrium with the basic ecological support systems (Stivers, 1976). Von Moltke (1996) explains that, after the initial introduction of this concept, the Brundtland Commission redefined and moulded the concept, linking it with relevant global and local economic development needs, and gave the term "sustainable development" an acceptable and established definition. Von Moltke (1996) continues by explaining that, even though a definition has been created, it was "crafted masterfully," and that it was a "masterpiece of negotiation." The definition, reads as follows (World Commission on Environment and Development, 1987):

"Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs. It contains two key concepts:

- *The concept of "need," in particular the essential needs of the world's poor, to which overriding priority should be given; and*
- *The idea of limitations imposed by the state of technology and social organisation on the environment's ability to meet present and future needs."*

The United Nations World Summit Outcome Document (2005) states that the "interdependent and mutually reinforcing pillars" of sustainable development are economic development, social development as well as environmental protection.

The United Cities and Local Governments (UCLG), concurs with the above by reasoning that the concept of sustainable development can be divided into three main parts, which are

environmental sustainability, which can be seen as at the natural renewable as well as non-renewable resources that make up our surroundings and assist us to sustain and improve our livelihood; economic sustainability, explained as the system that determines how the limited resources needed to improve peoples' lives are allocated and subsequently distributed, and lastly, socio-political sustainability, defined as the issues that have direct influences on the lives' of the people, and that can either have a positive of a negative influence on their daily existence and life quality. It has also been called for that a more consistent and analytical breakdown of sustainability should include the major areas of cultural, political, ecological as well as economical sustainability (UCLG, 2013).

2.2.2. Agenda 21

In the light of the development and refinement of sustainability as a concept, the UN devised a voluntary implemented action plan with regards to sustainable development (Laporte, 2012). This plan is known as Agenda 21, and is a product of the Sustainable Human Settlement Development meeting which was held at the 1992 United Nations Conference on Environment and Development in Rio de Janero (Whitehead, 2003).

Kaufman and Zernike (2012) explain that the intention of Agenda 21 was to allow for both interaction as well as change from all levels in the world – international, national, regional as well as local. Subsequently, local authorities were encouraged to take active steps in implementing plans and programs relevant to themselves. Programs which were to be implemented locally were widely known as "LA21", or "Local Agenda 21". Whitehead (2003) further states that the Agenda 21 was also employed in 1996 during the Habitat II, to focus on the implementation of LA21 within urban areas.

Nakaguchi (2004), as cited in Tonami and Mori (2007) explains that LA21 is "an agenda that sets tasks and a vision in order to promote sustainable development at the local level and shows the menu of action." The authors also continue by stating that the process of sustainable urban development is the creation of a balance between economic, environmental as well as the social necessities that exists within a community. It is in the light of the above that the LA21 was introduced, and should lead to sustainable developments being liveable, competitive, properly governed as well as bankable entities (The World Bank, 2000 and Spangenberg, Deller and Pfahl, 2002). In other words, the development should employ building practices that will achieve social as well as economic advances without damaging the natural environment that it forms part of.

2.2.3. United Nations Framework Convention on Climate Change (UNFCCC)

A framework convention – a starting point in the process of addressing the problem of climate change – was set in 1992 by the United Nations Framework Convention on Climate Change (UNFCCC). This is an overall framework which encompasses all intergovernmental efforts to address the increasing crisis of global climate change (Department of International Relations and Cooperation, 2011a). This Convention entered into force on 21 March 1994.

According to the Convention, the primary objective is to stabilise the greenhouse gas concentrations at a level that will prevent any form of dangerous human interference with the climate system as a whole. The UNFCCC has near universal membership, as it consists of 194 parties.

The governments that are committed to the convention pledge to:

1. Gather, compile and share relevant and efficient information on greenhouse gas emissions, national policies as well as possible best practices to address the situation;
2. Develop and launch strategies that can address greenhouse gas emissions as well as allow the country to adapt to the expected impacts, which includes the provision of both financial as well as technological support to the developing countries; and
3. To prepare and cooperate with strategies and preparations aimed at the impacts of global climate change.

The different stakeholders have been meeting in the Conferences of the Parties (COP) since the UNFCCC entered into the Force. The COP, which is seen as the 'supreme body' of the Convention, assesses the progress made in the process of dealing with climate change.

2.2.3.1 Kyoto Protocol

In 1997 the UNFCCC met in Kyoto, Japan. During this meeting the "Kyoto Protocol" was developed and was entered into force on 16 February 2005 (Department of International Relations and Cooperation, 2011b).

There are key differences between the Kyoto Protocol and the Convention, of which the most prominent difference is the fact that, while the Convention encourages industrialised countries to stabilise their greenhouse gas (GHG) emissions, the Kyoto Protocol ensures that industrialised countries commits to emission targets.

By committing themselves legally to the protocol and the binding targets that were accepted, the participating industrialised countries are required to reduce their combined greenhouse gas emissions by at least 5% over the 2008 to 2012 period against the levels as measured in 1990. By honouring this commitment, the historical reversal of emissions that started in developed countries at least 150 years ago, is anticipated.

From the 194 committed countries, 192 have, to date, ratified the treaty, while thirty nine of the forty industrial countries have endorsed the Protocol. South Africa is a Non-Annex I, or developing country, within the Climate Convention Change scope, and is also a signatory member of the Kyoto Protocol. Under the UNFCCC and the Protocol, South Africa is committed to reduce its GHG emissions by 34% (by 2020) and 42% (by 2025) below its business as usual emissions growth curve (European Commission, 2013).

Like the Convention, the Protocol's main purpose and function is to assist in the adaptation of developing countries to the hostile effects that exist due to climate change. The protocol facilitates the development, design and ultimate deployment of methods and techniques that can assist and increase the resilience of the counties and the communities within to the harsh impacts that climate change brings about.

In addition to the above, the Protocol also gave rise to the establishment of an Adaptation Fund which finances projects in developing countries that are Parties to the Kyoto Protocol. Clean Development mechanism (CDM) project activities' share of proceeds is mainly used to provide financial backing for the activities of the Protocol.

Countries with an emission-reduction or emission limitation commitment under the Kyoto protocol are given opportunities to implement emission reduction projects in developing countries. These projects can, for example, include rural electrification projects or the installation of more energy efficient geysers for the low cost houses.

The mechanism that is envisioned is aimed at the stimulation of sustainable development practices as well as emission reductions, while, at the same time, allowing industrialised countries some levels of flexibility in the methods that they utilise to meet their limitation- and emission reduction targets.

Governments consolidated the gains of the previous three years' of international climate change negotiations at the 2012 UNCCC that was hosted in Doha, Qatar (COP18/CMP8).

This action led to the opening of a gateway to greater ambition and higher levels of action in all areas. Governments participating in the COP18 launched a new commitment period under the Kyoto Protocol, which ensures that the important legal as well as accounting models remain in place while underlining the key principle that developed countries lead the mandated actions to reduce and cut the greenhouse gas emissions. It was furthermore decided that the Clean Development Mechanism, which falls within the Kyoto Protocol's Market Mechanism, will carry on (UNFCCC, online).

2.3. SUSTAINABLE DEVELOPMENT AND CONSTRUCTION

As stated previously, sustainable development is divided into economic sustainability, socio-political sustainability as well as environmental sustainability. The possible inclusion of construction within the framework of sustainable development was proposed at the September 2002 World Summit of Sustainable Development that was held in Johannesburg. Du Plessis (2005) explains that the Agenda 21 for developing countries was launched as a document for discussion during this summit.

In 1994, Kibert defined sustainable construction as "the creation and responsible maintenance of a healthy built environment, based on resource efficient and ecological principles" (Kibert, 2007). Many authors, including Bowen and Hill (1997), Huovila and Ritcher (1997), Du Plessis (2005) and supported by Shafii (2006), have written about the concept, the aims, goals and objectives of sustainable construction. These researchers posits that the vision that exists regarding sustainable construction remains the same – it is an opportunity for the construction industry to move forward, towards the ultimate achievement of sustainable development, while at the same time, taking into account the current concerns of environmental, socio-economic and cultural origin. Shen, Bakhtlar and Misnah (2008) furthermore concur by explaining that the construction industry as a whole has a significant influence on the environment, and that, subsequently, the concept of 'sustainable development' has drawn the attention of built environment specialists on a global scale.

Van Wyk (2007) is of the opinion that construction activities consume about 50% of the total available global resources, including 70% of all the timber products produced globally, as well as 40% of all the forms of energy that is consumed annually. Both the renewable as well as the non-renewable resources, which include the materials as well as the energy

consumed by these projects, are being over-exploited – mainly by the construction industry - and thus leads to the environment being adversely affected (Kibert, 2007).

According to research conducted by Shafii (2006), the principle issues and the rationales which affects the sustainability within the constructed environment can be grouped together and summarised into six main categories, namely the use of environmentally-friendly construction materials, energy efficiency in buildings, the management of waste produced by both the construction as well as the demolition processes, the health in buildings, the utilisation of sustainable architecture practices as well as, finally, the social impacts which arise from the constructed and built environment. These issues, as well as the rationale that supports them, can be seen in table 2.1.

TABLE 2.1 - Issues and rationale affecting sustainable construction

Issues	Rationale
Environmental-friendly construction materials	The building construction industry consumes as much as 50% of all materials and resources extracted from the earth's crust.
Energy efficiency in buildings	The operations that occur within the construction industry as well as the subsequent demolition of existing facilities account for about 40% of the total amount of energy used. These processes lead to a similar percentage of greenhouse gas emissions.
Construction and demolition waste management	Construction- as well as demolition waste created during the various processes account for 50% of all waste generated prior to the recovery thereof.
Health in buildings	The quality of the internal environment of buildings is an essential element to the overall health of its occupants
Sustainable architecture	Principles and measures within the design processes of these buildings which may lead to the overall, holistic performance of the buildings should be encouraged.

Issues	Rationale
Social impacts arising from construction and the built environment	Sustainable construction practices can improve the living context as well as the intrinsic relationship that exists between citizens and their immediate environment. It may also contribute towards the foreseen increased efficiency that will exist between the social cohesion and the levels of job creation, and the subsequent promotion of cultural and regional economic development.

Source: Adapted from Shafii, 2006

When studied, it became clear that the construction industry can, if managed correctly, significantly reduce the environmental loading that is being placed on all the resources available on the planet. The technological processes and advancements which are adopted in the process as a whole can, in addition, assist in the lightening of the social as well as economical loads that are carried by the target community.

Bowen and Hill (1997) are of the opinion that there are a number of existing methodologies that can play a role in the promotion of the sustainability practices within the built environment (refer to table 2.2). Broadly, these methodologies can be classified as educational, management systems, the green design and building processes, the adoption of green technologies and methods within the construction- as well as the waste management processes.

TABLE 2.2 - Methodologies for the promotion of sustainable development

Method	Description
Education	Ekanayake and Ofori (2000) state that there should be a set curriculum as well training programmes available within the construction industry to improve the knowledge regarding the processes and materials which are utilised in sustainable construction practices. These include practices such as cost saving methods as well as the reduction of construction waste.

Method	Description
	Incentives, reward schemes and funding needs to be made available to provide for the training and education for those who cannot afford to pay for the costs themselves.
Environmental Management Systems (EMS's)	A number of different EMS's have been introduced to address the various influences that development and construction activities have on the environment as a whole. These EMS's normally focuses on the promotion of aspects such as the establishment of waste management plans, the reduction and recycling of waste materials created by the construction as well as demolition processes. The EMS's are furthermore involved in the provision of in-house training for aspects such as legal measures on environmental protection and the concept of environmental management as a whole (Bowen and Hill, 1997).
Green Building	Kibert (2007) defines green buildings as healthy facilities that were designed and built in a resource-efficient manner, which made use of ecologically sound principles throughout the entire process. Research has indicated that these buildings are meant to consume noticeably less energy and materials, and will provide healthy living as well as working environments for the inhabitants thereof. These developments will also greatly enhance the quality of the built environment as a whole. Several methods around the world have been developed to assess the levels of

Method	Description
	'greenness' of buildings and building practices (Cole, 2000; Gibbert, 2005; Ding, 2008 and Kibert, 2007).
Green Design	Green design deals with the identification of suitable methods of construction from the primary tendering processes and design stages (Ekanayake and Ofori, 2000).
Green Procurement	Ekakayake and Ofori (2000) , and supported by research conducted by Rwelamila, Talukhaba and Ngowi (2000), is of the opinion that green procurement systems have been promoted to mitigate construction waste as well as to ultimately achieve better performance.
Green Roof Technologies	A methodology that concerns itself with the assessment of the use of green roofing methods was introduced by Nelms, Russel and Lence (2007)
Lean Construction	Kistan and van Wyk (2007) are of the opinion that engineered-to-order materials can ultimately reduce the total construction time, as well as achieve a number of other performances that can increase the values of the process to both the customer as well as the stakeholders involved whilst, at the same time, reducing the amount of waste that is produced. An example of such a technique includes prefabrication.
Waste Management	Poon (2007), Tam, Shen and Tam (2007) as well as Ekanayake and Ofori (2000) concur that the reduction of waste during the construction process is an important issue within the construction process as a whole. Waste management focuses on the reduction of the amount of waste produced

Method	Description
	during the construction process.
Green Star Rating	The Green Star SA Rating System (Green Building Council, 2013) are agreed standards and benchmarks for green building which allow objective assessment on how "green" a building is. The rating systems provide a menu of green measures that can be used in the design, construction and management of a building to make it more sustainable.

Source: Adapted from Shen *et al*., 2008

Published in 2000 and reprinted in 2005, the Guidelines for Human Settlement Planning and Design document by CSIR (CSIR, 2005) emerged as a result of a collaborative effort by several government departments under the auspices of the Department of Housing. The purpose of this document not being limited to merely assist professionals in producing efficiently serviced "townships", but rather to create sustainable and vibrant human settlements. In this context, a "human settlement" is regarded as any built environment where people live, work and play, with the provision that only residential areas and other developments associated therewith. The document mostly refers to three "green" elements and the designing principals and approaches linked to them. Firstly reference is made to green spaces such as parks and other natural landscapes, secondly to green fields in terms of undeveloped areas and lastly, and indirectly, green development with references to energy conservation, energy efficiency and the use of renewable energy. The document states that global environmental concerns about reducing pollution and greenhouse gas emissions have led to a greater awareness of the benefits of energy conservation and energy efficiency, as well as to a preference for using renewable energy sources where possible rather than fossil fuels which pollute the environment. In response to this statement the document discusses various alternative energy sources (other forms of energy) such as solar- and energy resources.

The energy consumption and expenditure required to maintain a comfortable indoor environment can be very significant, across all classes of housing and commercial building types (CSIR, 2005). The potential for energy savings through improved energy-conscious

building design can be as much as 70% in some cases. The “passive design” or “solar passive design” of buildings refers to construction/design techniques which (CSIR, 2005):

- make better use of natural energy flows (e.g. solar heating in the day, cooling at night);
- use building elements to insulate, capture, store or otherwise control energy flows; and
- reduce the need for “active” energy consumption/management.

Such techniques can be low-cost, long-lasting and offer the following potential benefits (CSIR, 2005):

- lower energy bills for owners/occupants (especially in winter, when the energy bills of poorer households can rise significantly);
- reduced total electricity consumption – winter consumption levels are about 1,600 GWh/month higher than summer;
- reduced electricity peak demand, associated with “cold snaps” (with resultant economic benefits both for electricity generation and the peak national/local distribution capacity required);
- less pollution (and lower health costs); and
- generally, a more pleasant and healthy environment in the home or workplace.

2.4. SUSTAINABLE TECHNOLOGY

DuBose, Pearce and Vanegas (1995) defines sustainable (green) technology as a technology that encourages a change in the behaviour of society as a whole towards the ultimate goals of sustainability, which, in essence, aligns with the goals of sustainable development as a whole. The authors continues by explaining that these technologies’ goals and objectives are to contribute and support, as well as advance sustainable development practices, by making use of strategies that reduces the risks and enhances the cost-effectiveness of the project, while also increasing the efficiency of the processes involved. These researchers further explain that the main goals of these types of technologies are to ultimately create processes, products and/or services that are environmentally as safe as possible while, in the same breath, beneficial to humans in a social as well as economic sense.

It is in this light that the researcher realised that the technologies that are utilised in the construction environment can be used to address the social and economic concerns of the human population while also facilitating the economic empowerment of marginalised sections – such as socio-economic disadvantaged groups for which low-income subsidised housing units are planned. Furthermore, these technologies can also minimise the negative impacts of these projects on the aspects of the environment, economy and social areas that are influenced by these projects. The influence of some of these technologies as relevant to the Lufereng low cost subsidised housing project will be investigated and discussed later in this document.

2.5. POLICY AND REGULATORY FRAMEWORK OVERVIEW

2.5.1. Industry Regulations

Three distinct levels of legislation affecting the land use and the development of the green building industry (directly or indirectly) exist in South Africa under the three spheres of government, namely:

1. Acts, which are introduced in parliament and passed into law by the national government
2. Ordinances and Acts, which are drafted by Provincial Government and affect activities on provincial level
3. Town Planning Schemes and By-Laws, which are operated by Municipalities (local authorities)

Very broadly speaking, land development and building work are governed by a planning and regulatory framework which operates at all three levels of government, namely national, provincial and local government. On one hand, there are the various land, physical planning, development control and environmental protection acts, regulations and measures; on the other hand, the National Building Regulations and standards legislation and enforcement bodies.

On the planning side, control is exerted over the following:

1. The general spatial structure of development (through, e.g. physical planning act, structure plans, town planning schemes, etc.)
2. Land use (through zoning, etc.)

3. Subdivision, consolidation and transfer of land (through acts and land survey and registration systems)
4. The type and nature of development (through zoning and development control measures such as building lines, height and coverage restrictions, etc.).

On the construction side good practice is enforced through standards, building regulations, legislation concerning safety, fair employment practices, training levies, and statutory registration of building professionals, etc. Building regulations have been promulgated nationally, but are applied locally in each area.

Table 2.3 gives an overview of the building regulatory framework within South Africa.

TABLE 2.3 – Regulatory Framework within South Africa

Regulatory framework	Description
National Building Regulations and Buildings Standards Act No. 103 of 1977 (The Presidency, 1977)	The objective of the National Building Regulations is to protect the public interest with respect to health and safety. This Act provides guidelines for building site operations, design and construction. The Act empowers local authorities to permit a deviation or grant an exemption from any applicable building regulation, except for regulations regarding the strength and stability of buildings. Flexibility in the implementation of building regulations is thus largely dependent on local authority interpretations. The South African Government has made use of the act to introduce sustainability into the building sector. In terms of the Act, the National Regulator for Compulsory Specifications (NRCS) has drawn up regulations which are intended to reduce the Green House Gas production in the South African Building Sector. The

Regulatory framework	Description
	resultant amendments to the National Building Regulations are the results of political and administrative processes to introduce sustainable practices to buildings in the South Africa. The amendments to the National Building Regulations for Energy Usage are limited such as to encompass only new buildings and buildings which are changed such as to require an application to Local Authority for Building Planning approval. Thus any extension of, or renovation of a building, or portion of a building, which requires planning approval by the Local Authority in terms of the Act, for the set of nominated building occupancies or building classifications in accordance with Regulation A20 (excluding garage and storages areas contained within these occupancies) shall be designed and constructed so that they are energy efficient, and comply with the regulations for energy usage. The amendments to the National Building Regulations set the following requirements: 1. XA1: Buildings need to use energy efficiently and reduce Green House Gas emissions in accordance with requirements detailed (Functional Regulation) 2. XA2: No more than 50% of the annual volumetric requirement of domestic hot water may be

Regulatory framework	Description
	supplied by means of electrical resistance heating 3. XA3: Provides three means, by which the Functional Regulation (XA1) complies with The Regulations, as published, became legally effective from 10 November 2011, and the Government is bound to promote and defend their implementation. In this regard the Regulator has assisted with the development of foundation training material, and has embarked upon a programme to train Building Control Officers in the implementation of the Regulations. The structure of the amendments to Regulation XA3 is typical of many of the sections of the National Building Regulations in the structure. The similarity is in respect of the Nordic structure and various compliance routes which are made available to satisfy the Functional Regulation XA1. The compliance routes provided in respect of Fire, Structures and Fenestration have a similar array of options, i.e. a Prescriptive route XA3(a) or a Performance route XA3(b) or Reference Building route in XA3 (c). Important wording in the Regulations which should be noted by those implementing the Energy provisions: 1. XA1 excludes the energy impacts of plant and equipment

Regulatory framework	Description
	within buildings, and the performance of the building itself is to be regulated and not the operator or operations conducted within a building. XA1 embraces only a limited number of possible building occupancies, and notably excluded are factories and warehouses. 2. XA2 provides a performance criterion which limits the proportion of resistance heating of hot water allowed to 50%. This amendment is therefore overarching and fundamental to all buildings, irrespective of other energy savings measures which may be introduced. 3. XA3 provides the three compliance routes and stipulates that the 'Performance route' is a Rational Design to be performed by a competent person, and, furthermore, that the Reference Building route will involve the use of Certified Thermal Calculation Software, but does not stipulate that this is performed by a Competent Person, although this is a requirement in SANS10400XA. SANS10400XA (Paragraph 4.2.1) sets out three routes to compliance with

Regulatory framework	Description
	SANS10400XA, all of which are deemed-to-satisfy the Regulations: 1. The Energy Usage and Demand performance requirement method (Paragraph 4.2.1.a) 2. Prescriptive provisions for the building envelope and services (Paragraph 4.2.1.b) 3. A Reference Building route (Paragraph 4.2.1.c) The three methods of compliance are all deemed-to-satisfy the Regulations; however, not all routes are generally available.
South African National Standard SANS 204: Energy Efficiency in Buildings (SABS Standards Division, 2011)	The SANS 204 series of standards have been developed to provide a framework for energy-efficient buildings. Residential houses need to comply with SANS 204-2 which specifies requirements for, amongst others, the following: 1. Orientation requirements 2. Slab-edge insulation 3. Minimum Rand-value for walls 4. Minimum levels of insulation for roof and ceiling construction 5. Requirements on roof lights It is not yet clear whether these requirements for residential housing will be made mandatory for low income housing.
The Electricity Regulation Act (The Presidency, 2006a)	The Electricity Regulations for Compulsory Norms and Standards for Reticulation Services (Regulation No. 773 of 8 August 2008) have been issued in terms of The

Regulatory framework	Description
	Energy Regulation Act (Act No.4 of 2006) introduced by The Presidency. The purpose of these regulations is to maintain good quality of supply to ensure stability of the electricity network, to minimise electricity load shedding and avoid blackouts but it will also impact the energy efficiency of buildings. Amongst others, in terms of these Regulations: 1. Energy-efficient fittings must be used in all buildings except where a specific fitting is required for some purpose and the nature of that purpose does not allow an energy-efficient fitting 2. Street and highway lighting must be energy efficient and the licensee must ensure that it is switched off during the day.

Source: Own construction based on the above mentioned Regulatory frameworks

2.5.2. General Policies

A number of policies at a National (South Africa) as well as a Provincial (Gauteng) level refer directly and indirectly to poverty, unemployment, sustainable human settlements and the Green Economy in South Africa. These policies which include the following:

1. **National Level:**
    a) New Growth Path (NGP), 2010
    b) The Green Economy Accord, 2011
    c) National Development Plan: Vision for 2030, 2011
    d) National Strategy for Sustainable Development and Action Plan (NSSD1), 2011
    e) National Planning Commission (NPC): Diagnostic Overview, 2011
    f) Medium-Term Strategic Framework (MTSF) 2009–2014

g) Ten-Year Innovation Plan (2008 – 2018)
h) The Energy Efficiency Strategy, 2008
i) National Climate Change Response White Paper, 2011
j) The Integrated Resource Plan 2010-2030
k) The National Spatial Development Perspective, 2006

2. Provincial Level:

a) Strategy for a Developmental Green Economy for Gauteng, Preliminary Report, Draft January 2010
b) Green Strategic Programme for Gauteng, Final 2011
c) Gauteng Spatial Development Framework (GSDF), 2011
d) Gauteng Medium Term Strategic Framework (MTSF), 2009-2014
e) Gauteng Employment Growth and Development Strategy (GEGDS), 2010

All the policies mentioned above have an influence on this particular research study. The National policy's implications for this study can be summarised as follow:

TABLE 2.4 – National Policy Review

National Policy	Implications for this Study
New Growth Path (NGP) (Department of Economic Development, 2010)	The NGP states that the extent of joblessness and inequality makes employment creation within South Africa the top priority. The NGP supports employment creation within the infrastructure, the agricultural and mining value chains, the green economy, the manufacturing sector and tourism as well as certain high-level services. The NDP is adamant that the impact of the massive infrastructure programme on job creation across the economy (the "multiplier effect") will be substantial. It further states clearly that there should be a near-doubling of electricity capacity by 2030, with 33% of new generation coming from renewable

National Policy	Implications for this Study
	sources which would play a key part of the plan to improve the overall economic efficiency and to reduce the total amount of emissions. The green economy's potential is emphasised and it targets the creation of 300,000 additional direct jobs by 2020 to the implementation of the green economy practices (80,000 in manufacturing and the rest in construction, operations and maintenance of new environmentally-friendly infrastructure), and to well over an estimated total of 400,000 new employment opportunities by 2030.
The Green Economy Accord (Department of Economic Development, 2011)	The Green Economy Accord (Accord 4) is an outcome of the social dialogue on the NGP Framework. It is a commitment signed by government, organised labour, business, and community constituents. The Green Economy Accord sets the path for the development of the green economy in the country. Various aspects of sustainability are addressed, such as recycling, energy efficiency, innovation and manufacturing, retrofitting of inefficient buildings, and biofuels. It recognises job creation opportunities related to the application of existing technologies. Among those that are related to the green building industry are local manufacturing and installation activities of Solar Water Heaters (SWH) and its components, beneficiation of building rubble into bricks, retrofitting buildings with energy efficient equipment and replacing lights with

National Policy	Implications for this Study
	Compact Fluorescent Lamps (CFL) and next-generation Light Emitting Diodes (LEDs). Accord 4 consists of a series of commitments which are dedicated to the creation of jobs in a way that is also "green." Those that are related to the green building industry are outlined below: 1. Solar Water Heaters (SWH): a) Increase the roll-out of one million solar water heating units with the target of 1 million SWH installed at household level by 2014 b) Improve localisation of solar water heating components c) Secure support from the insurance industry for replaced units 2. Green economy investment: a) Increasing development, incentives and investment in the green economy and green technologies facilitated by the Industrial Development Corporation (IDC), private investors and retirement funds. b) The IDC set aside R22 billion for five years for green project development with a further R3 billion being allocated for manufacturing of green

National Policy	Implications for this Study
	products and components 3. Energy efficiency: a) Transition to the aspirational sectoral energy intensity targets by 2015 with a view to increasing them to, among others, 10% for commercial and public buildings and 15% to residential building 4. Waste recycling, re-use and recovery a) Promote of re-use of waste, including through the finalisation of a Waste Innovation Programme b) Promote measure to separate waste for recycling purposes 5. Retrofitting: a) Regulatory measures are to be put in place to phase out incandescent lighting for domestic and commercial use, including in public buildings through the combination of incentives for energy efficient lighting and increased customs duties on incandescent lighting b) Acknowledgement of the opportunities in introduction of new heating and insulation systems for commercial buildings
National Development Plan: Vision for 2030 (The Presidency, 2011a)	The NDP aims to eliminate poverty and reduce inequality amongst citizens by 2030. In terms of achieving environmental

National Policy	Implications for this Study
	sustainability and resilience, the following key objectives relevant to this specific study are identified in the National Development Plan: 1. The achievement of the peak, plateau and decline trajectory for greenhouse gas emissions, with the peak being reached around 2025. 2. At least 20,000 megawatts of renewable energy should be contracted by 2030. Actions to be taken to achieve these objectives include carbon price, building standards, vehicle emission standards and municipal regulations to achieve scale in stimulating renewable energy, waste recycling and in the process of retrofitting buildings.
National Strategy for Sustainable Development and Action Plan (NSSD1) (Department of Environmental Affairs, 2011)	The reformulated NSSD 1 strategic priority three, four and five is directly linked to this study. These priorities are shortly explained next: **Priority Three: Towards a green economy** A green economy implies the decoupling of resource use and the environmental impacts from economic growth. It is characterised by a substantially increased investment in green sectors, which are supported by enabling policy reforms. It recognises the important shift from current practices towards a resource-efficient, low-carbon and pro-employment growth path.

National Policy	Implications for this Study
	The environmental sector has developed an implementation plan for this particular sector's contribution to a national green economy action. With reference to the implementation plan, the following key focus areas are relevant to this study: 1. Environmental sustainability 2. Green buildings and the built environment 3. Sustainable transport and infrastructure 4. Clean energy and energy efficiency The goals of a transition towards a green economy should include green growth contributions to economic growth and increased employment opportunities, while preventing environmental degradation and pollution, loss of biodiversity and unsustainable natural resource use. **Priority Four: Building sustainable communities** One of the overall specific strategic goals that fall under Priority 4 is the aim to reduce poverty and to provide a decent quality of life for all, which includes the improvement of the quality of housing and other structures to optimise resource efficiency (energy, water, building materials, etc.). **Priority Five: Responding effectively to climate change**

National Policy	Implications for this Study
	The overall specific goals under Priority 5 that relate to the national climate change response and are relevant to this study include: 1. Decrease greenhouse gas emissions to levels required by science/in line with Cabinet-approved targets – with particular emphasis on the energy sector, which accounts for over 70% of South Africa's emissions 2. Reduce the dependency on fossil fuels and enhance the security of electricity supply 3. Build resilience to climate change in communities
National Planning Commission (NPC): Diagnostic Overview (The Presidency, 2011b)	The Vision document by the NPC, while not making Green Economic development an explicit goal, does incorporate a number of principles of Green Economic and sustainable development principles into its long term vision for the country of South Africa. The following principles, which are relevant to Green Economic Growth in South Africa, and thus this study, were mentioned among these visions for the development within South Africa: 1. Renewable Energy: Procuring about 20,000 megawatts of electricity from renewable sources by 2030. A target of 5 million solar water heaters by 2030.

National Policy	Implications for this Study
	2. Transition to a low carbon economy, building standards to measure energy efficiency.
Medium-Term Strategic Framework (MTSF) 2009–2014 (The Presidency, 2009)	Strategic Priority One of the Medium-Term Strategic Framework (which focuses on the speeding up of growth and the transformation of the economy to create decent work opportunities and sustainable livelihoods) indicates that, in order to ensure longer-run growth, government must refine and scale up the implementation of its Industrial Action Plan in order to support broad-based industrialisation, including more advanced manufacturing, as well as encouraging cleaner, lower-energy technologies and green jobs. One of the key programmes under sustainable Resource Management and use (Strategic Priority Nine) are to pursue as well as the further exploration of the concept of Green Jobs, which includes the scaling up of labour intensive natural resources management practices that contribute to decent work and livelihood opportunities.
Ten-Year Innovation Plan (2008 – 2018) (Department of Science and Technology, 2008)	The grand challenge area "in the search of energy security" discusses energy and the economy as well as the process of embracing renewable energy technologies. At present the levels of economic activity and energy supply is insufficient. In order to ensure accelerated and sustainable growth, the energy supply infrastructure must be increased which includes a much greater dependence on nuclear power, natural gas

National Policy	Implications for this Study
	and various renewable forms of energy.
The Energy Efficiency Strategy (Department of Minerals and Energy, 2008)	The Energy Efficiency Strategy is the first governmental document that guides the development and implementation of energy efficiency practices in the country. The Strategy states that the building industry is one of the leading sectors in which energy efficiency can be notably implemented. In the commercial and public building sector, a target of final energy demand reduction of 20% by 2015 is set. In the residential sector, a target final energy demand reduction of 10% by 2015 is set.
National Climate Change Response White l9Paper (The Presidency, 2011c)	According to the National Climate Change Response White Paper, cities and dense urban settlements consume large amounts of energy and therefore face climate challenges. In response to these challenges, South Africa will investigate how to leverage opportunities presented by urban densification by building climate-resilient urban infrastructures and promote behavioural change practices as part of urban planning and growth management. The Paper also states that, in the implementation of low-cost housing, access to affordable lower-carbon public transport systems should be ensured, thermal efficiency should be incorporated into the design processes and that climate-resilient technologies should be utilised.
The Integrated Resource Plan 2010-2030 (Department of Energy, 2010)	The Integrated Resource Plan for electricity generation in South Africa was promulgated on 6 May 2011 and plans for the creation of 8,400 megawatts of new wind power

National Policy	Implications for this Study
	generation, 8,400 megawatts of new Photo-Voltaic generation as well as the creation of 1,000 megawatts of Concentrated Solar Power generation over the period 2010 to 2030. The roll-out of this renewable energy commitment was initiated through the Renewable Energy Independent Power Producer Procurement Programme (REIPPP), initiated in 2011, after the Renewable Energy Feed-In-Tariff was scrapped.
The National Spatial Development Perspective (The Presidency, 2006b)	The NSDP puts forward a set of five normative principles: 1. Rapid economic growth that is sustained and inclusive is a prerequisite for the achievement of other policy objectives, among which poverty alleviation is key. 2. Government has a constitutional obligation to provide basic services to all citizens (e.g. water, energy, health and educational facilities) wherever they reside. 3. Beyond the constitutional obligation identified in Principle 2, government spending on fixed investment should be focused on localities of economic growth and/or economic potential, in order to gear up private-sector investment, stimulate sustainable economic activities and create long-term employment opportunities.

National Policy	Implications for this Study
	4. Efforts to address past and current social inequalities should focus on people, not places 5. In order to overcome the spatial distortions of apartheid, future settlement and economic development opportunities should be channelled into activity corridors and nodes that are adjacent to or that link the main growth centres. Infrastructure investment should primarily support localities that will become major growth nodes to create regional gateways to the global economy

Source: Own construction based on the above mentioned National Policies

The Provincial policy's implications for this study can thus be summarised as follow:

TABLE 2.5 – Provincial Policy Review

Provincial Policy	Implications for this Study
Strategy for a Developmental Green Economy for Gauteng (Department of Economic Development, 2010)	The Strategy for a Developmental Green Economy for Gauteng encourages steps to achieve the greening of the economy, including the principle of energy security. Energy security refers to reducing dependence on oil and coal-based sources of energy by increasing the supply of renewable energy and improving energy efficiency. Two over-arching programmes include firstly sustainable human settlements and secondly efficiency. Sustainable human settlements refer to the building of socially integrated human settlements that are designed to

Provincial Policy	Implications for this Study
	reduce distances between home and work, that generate more energy than they use, that recycle waste, that use less water and are built from the most sustainable building materials. Efficiency is a cross-cutting programme aimed at maximising resource efficiency in all the above resource use areas (water, energy, etc.). The Strategy states that the global economic thinking experienced a paradigm shift at this time from the current capital-focussed resource-intensive development towards what is being called the "Green Economy" (also termed low-carbon economies). Green Economies focuses on the following three initiatives: 1. Initiatives that protect the basic requirements of human beings (food, water, etc.); 2. Technological initiatives that make it possible to do more with less, including reduced energy input per unit of output, reduced carbon emissions and more efficient use of primary resources; 3. Technology initiatives that produce energy from low carbon & renewable energy sources. According to the Strategy for a Developmental Green Economy for Gauteng these green initiatives can achieve significantly increased jobs, and also reduce

Provincial Policy	Implications for this Study
	carbon emissions without any reduction in GDP growth. Additionally, it can be argued that these initiatives protect jobs that may otherwise be lost due to increasing resource constraints and energy costs. The Strategy mentions Policy interventions and their core drivers that will enable a Green Economy. The following core drivers are relevant to the study: 1. Creation of both new skills and jobs in new green-driven industries; 2. Promote innovation in existing processes and new technologies; 3. Improve efficiency in energy and resource consumption; 4. Promote energy security and reduce dependency on crucial imports (e.g. oil); Relevant policies that could be addressed include the prioritisation of eco-efficiency indicators as measurements for benchmarking development progress, public education programs on energy efficiency and renewable energy as well as investment in sustainable green infrastructure.
Green Strategic Programme for Gauteng (Department of Economic Development, 2011b)	The Green Strategic Programme for Gauteng states that the Province needs to understand the opportunities provided by the emerging green economy, both to maximise employment prospects and to achieve global competitive advantage in a fast evolving global industry.

Provincial Policy	Implications for this Study
	Furthermore, in terms of energy, Gauteng needs to switch its sources of energy away from fossil fuels and immediately concentrate on ways to reduce the CO2 and greenhouse gas emissions. The Province needs to radically increase its use of renewable energy sources and scale-up energy efficiency interventions. It recognises that investments, and the associate cluster industries, have the potential to create thousands of jobs. Additionally, Gauteng needs to ensure that its energy supply mix is optimised in terms of economic, social and environmental sustainability, and to foster an enabling environment for this to happen. The Green Strategic Programme for Gauteng states that by refocusing energy strategies towards a renewable and low-carbon future, the Province will gain cost advantages in the face of rising electricity prices, and significant industrial and manufacturing opportunities around renewable energy and energy efficient technologies.
Gauteng Spatial Development Framework (GSDF) (Department of Economic Development, 2011a)	The GSDF defines sustainable human settlements as: "*Settlements that are well-managed entities in which economic growth and social development are in balance with the carrying capacity of the natural systems on which they depend for their existence, and result in sustainable development, wealth creation, poverty alleviation and equity*". From a spatial development point of view, the

Provincial Policy	Implications for this Study
	aim of the GSDF for the Province is to achieve an equitable and sustainable urban system and specifically to structure the urban form that best meets and provides these intentions. The Urban Structure Approach was developed in response to a range of general urban problems that typically characterise the South African urban situation. The urban problems include: 1. Widespread poverty; 2. Continued isolation and marginalisation of township communities from the urban mainstream; 3. Continued struggle of communities to gain access to basic services and social facilities; 4. Unsustainable environmental practices and damaged ecosystems; 5. Continued promotion of urban sprawl and excessive travel distances; 6. A city patterned around the private mobility needs of the few at the expense of the many who rely on public transport but find city-form to be at odds with an efficient system of integrated public transportation; and 7. A shortage of residential living environments The GSDF states that as with all cities, reducing energy consumption is of utmost concern.

Provincial Policy	Implications for this Study
Gauteng Medium Term Strategic Framework (MTSF) (Department of Economic Development, 2009)	The Gauteng Medium Term Strategic Framework outlines the strategic priorities and programmes for the provincial government for the five year term of office ending in 2014. The MTSF states that the Gauteng Provincial Government, in line with its electoral mandate, will make a "commitment to place the creation of decent work and sustainable livelihoods at the centre of its policies and programmes". The first strategic priority of the MTSF is therefore to "create decent work and build a growing, inclusive economy".
Gauteng Employment Growth and Development Strategy (GEGDS) (Department of Economic Development, 2010a)	This Gauteng Employment, Growth and Development Strategy focuses on this first strategic priority in the Gauteng MTSF. It outlines a set of strategic choices and programmes that will build towards a strong and sustainable Gauteng economy in which all can access economic opportunities and enjoy decent work. Even though it focuses on the first priority in the MTSF, this GEGDS does also refer to other strategic priorities to the extent that they also contribute to the overall programme to build a strong and inclusive economy. The GEGDS identifies overarching targets for the Province to achieve: 1. An increased economic growth rate; 2. A decreased unemployment rate; and 3. A decreased poverty rate The GEGDS highlighting the development of

Provincial Policy	Implications for this Study
	the green economy by focusing on alternative energy sources and states that Gauteng needs "*an economy based on green technologies, green jobs, green energy and green production processes that reduce the ever higher input costs stemming from unsustainable resource use*".

Source: Own construction based on the above mentioned Provincial Policies

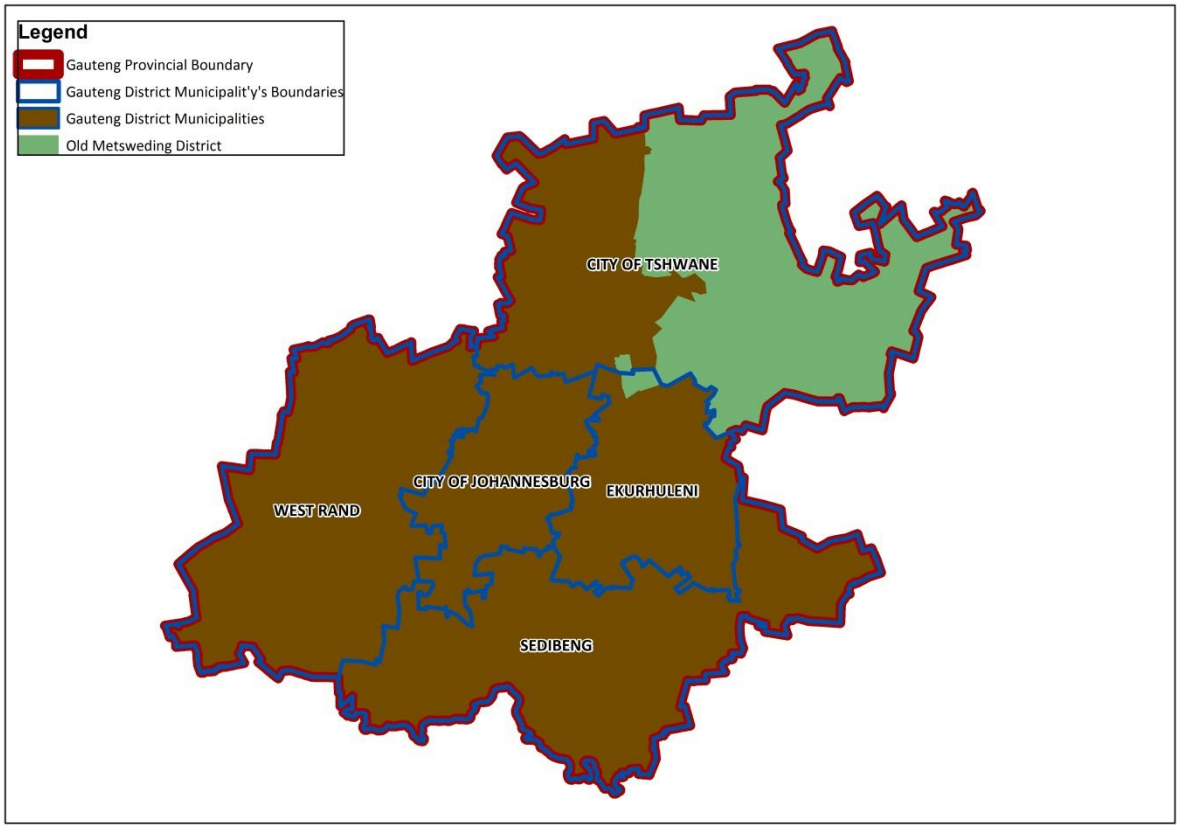
2.6. SOCIO-ECONOMIC OVERVIEW

The purpose of this sub-section is to get a comprehensive and detailed insight into the nature, extent and trends of South Africa, the Gauteng Province and the five District Municipalities located within the Province. The following five District Municipalities are located within the Gauteng Province:

1. Sedibeng District Municipality (SDM)
2. West Rand District Municipality (WRDM)
3. Ekurhuleni Metropolitan Municipality (EMM)
4. City of Johannesburg Metropolitan Municipality (CoJ)
5. City of Tshwane Metropolitan Municipality (CoT)

The study area is located within the City of Johannesburg and therefore a more prominent reference to the City of Johannesburg will be made throughout this section.

Before the 18 May 2011 Local Government Elections the Gauteng Province included at sixth District Municipality, namely Metsweding. As from the election date the Metsweding District Municipality was disestablished and absorbed into the City of Tshwane Metropolitan Municipality (City of Tshwane, 2011), refer to map 2.1. In order to enable comparison between the five districts within Gauteng, all data prior to the elections (that indicate Metsweding as a District Municipality such as census 2001) has automatically been added to the City of Tshwane. Metsweding will thus not be represented as a separate District.



MAP 2.1 – Gauteng Province

Source: Own construction in ArcMap GIS based on Municipal Demarcation Board, 2013

In this section the following aspects will be discussed in relation to South Africa, the Gauteng Province and to each District Municipality:

1. Population and households indicators
2. Age and gender structure
3. Household income
4. Dwelling types
5. Tenure status
6. Household access to services
7. Employment and economic indicators

2.6.1. Population and households indicators

Table 2.6 below shows various population and household indicators for South Africa (SA) and the Gauteng Province (GP):

TABLE 2.6 - National and Provincial Population Household Indicators, 2001 and 2011

Indicator	South Africa	Gauteng
Area (km^2)	1,221,219	16,539
Population 2001	44,819,738	9,178,535
Population 2011	51,770,560	12,272,263
Population Growth from 2001 - 2011	15.5%	33.7%
Population Density 2011 (people per km^2)	42	742
Households 2001	11,778,955	2,889,548
Households 2011	14,450,161	3,909,022
Household Growth from 2001 - 2011	22.7%	35.3%
Household Density 2011 (households per km^2)	12	236
Average Household Size 2011	3.6	3.1

Source: Statistics South Africa, 2001 and Statistics South Africa, 2011

The Gauteng Province covers a geographical area of approximately 16,539km^2 which translates to 1.4% of South Africa's total land surface. In 2011 the Gauteng Province's population was over 12 million, contributing 20.5% to South Africa's total population. Over a 10 year period (2001 to 2011) Gauteng's population experienced a total population growth of 33.7%, which is significantly higher than the South African growth of 15.5%. In terms of population density (people per square kilometre), the Gauteng Province indicates a significantly higher population density of 742 people per square kilometre in comparison with South Africa's 42. In 2011 almost 4 million households were resident in Gauteng (27.1% of South Africa's total) with an average household size of 3.1 individuals, which is lower than South Africa's average of 3.6 individuals per household.

Table 2.7 below shows the population and household indicators for the five Districts within the Gauteng Province.

TABLE 2.7 - District Population and Household Indicators, 2001 and 2011

Indicator	SDM	WRDM	EMM	CoJ	CoT
Area (km^2)	4,208	2,441	1,928	1,646	6,316
Population 2001	796,757	533,674	2,478,627	3,225,305	2,144,172
Population 2011	916,484	820,995	3,178,470	4,434,827	2,921,488
Population Growth from 2001 to 2011	15.0%	53.8%	28.2%	37.5%	36.3%

Indicator	SDM	WRDM	EMM	CoJ	CoT
Population Density 2011 (people per km^2)	218	336	1,649	2,694	463
Households 2001	230,737	183,667	776,447	1,050,224	648,473
Households 2011	279,768	267,397	1,015,465	1,434,856	911,536
Household Growth from 2001 to 2011	21.2%	45.6%	30.8%	36.6%	40.6%
Household Density 2011 (households per km^2)	66	110	527	872	144
Average Household Size 2011	3.3	3.1	3.1	3.1	3.2

Source: Statistics South Africa, 2001 and Statistics South Africa, 2011

In terms of the population distribution within the Gauteng Province, the City of Johannesburg has the highest population within the Province, followed by Ekurhuleni and the City of Tshwane, contributing 36%, 26% and 24% respectively to Gauteng's total population (Refer to figure 2.1). It should be noted that although the most significant portion of Gauteng's population is resident in the City of Johannesburg, it covers the least significant geographical area (square kilometres) of all the five Districts (1,646km or 10% of Gauteng's total). In comparison with the other four Districts, the City of Johannesburg also has the highest population density of 2,694 people per square kilometre. In terms of population growth, the District that showed the most significant growth from 2001 to 2011 was the West Rand (53.8%), followed by the City of Johannesburg (37.5%) and the City of Tshwane (36.3%) all of which was higher than the Provincial and National growth (33.7% and 15.5% respectively). In terms of geographical size, the City of Tshwane covers the largest area within the Gauteng Province, followed by Sedibeng and West Rand, respectively covering 38%, 25% and 15% of Gauteng's total surface area.

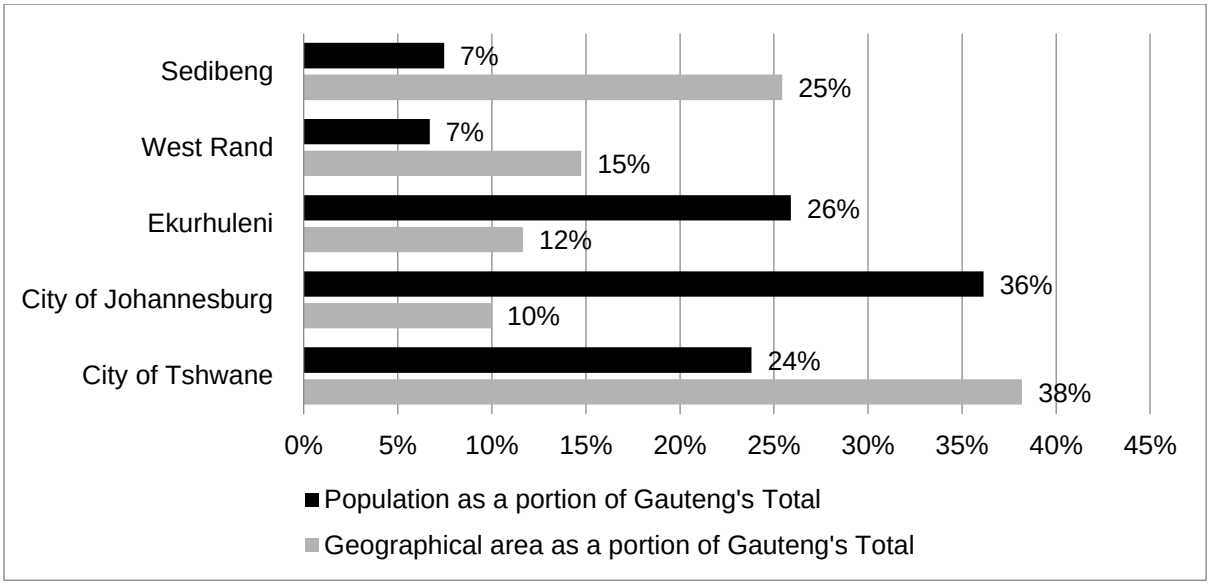


FIGURE 2.1 - Population and Surface Area Distribution, 2011

Source: Statistics South Africa, 2011

2.6.2. Gender distribution

The gender distribution for 2011 of South Africa, the Gauteng Province and the five District Municipalities within the province are shown in figure 2.2.

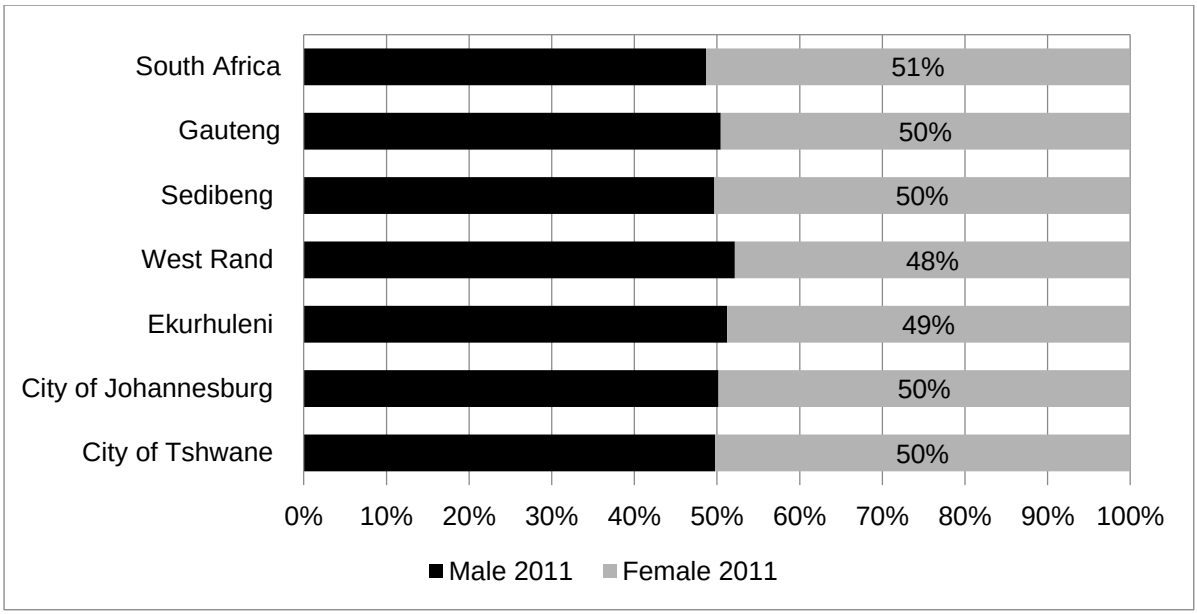


FIGURE 2.2 – Gender Distribution, 2011

Source: Statistics South Africa, 2011

Figure 2.2 indicates that the male/female distribution for the various areas is very similar. In South Africa, there are slightly more females than males where in Gauteng province and the Districts within the province the distribution is either equal (50/50 split) or have slightly more males than females.

2.6.3. Income

The average annual household income for 2011 in South Africa, the Gauteng Province and the five District Municipalities within the province are shown in Table 2.8 below. Households that either have no income or a low-income fall within the low income bracket (R0 to R38,400 per annum); indicating that they experience difficulty in meeting their basic needs. The middle-income bracket is classified as earning R38,401 to R307,200 per annum whereas and a high-income bracket is classified as earning R307,201 or more per annum.

TABLE 2.8 - Annual Household Income, 2011 (Statistics South Africa, 2011)

	SA	GP	SDM	WRDM	EMM	CoJ	CoT
Low Income	63.0%	52.7%	61.2%	56.0%	55.4%	51.6%	48.0%
Middle Income	29.5%	34.7%	32.0%	36.9%	34.5%	33.8%	36.4%
High Income	7.5%	12.6%	6.8%	7.1%	10.1%	14.6%	15.6%
Unspecified	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Weighted Average (R)	120,667	184,199	115,110	120,293	152,712	213,910	211,559

Source: Statistics South Africa, 2011

Table 2.8 indicates that 63% of households in South Africa earn a low income; this translates to over 9.1 million individuals of which 2.2 million earn no income at all. In comparison with the Gauteng Province (and the five District Municipalities within Gauteng) the portion of South Africa's households that fell in the low income bracket is more significant. Within Gauteng, the City of Tshwane has the least significant portion of households within the low income bracket followed by the City of Johannesburg, 48.0% and 51.6% respectively. In terms of high income, the City of Tshwane has the highest portion of households falling within the high income bracket (15.6%) followed by the City of Johannesburg (14.6%). The City of Johannesburg and the City of Tshwane also have the highest weighted average annual income, both higher than the Provincial and National average. Sedibeng has the

lowest weighted average annual income, which is below the Provincial and National average.

2.6.4. Dwelling type

Table 2.9 shows the dwelling type that households are resident in within South Africa and the Gauteng Province.

TABLE 2.9 - Household Dwelling Type, South Africa and Gauteng, 2011

Dwelling Type	South Africa	Gauteng
House or brick/concrete block structure on a separate stand or yard or on a farm	64.9%	59.0%
Traditional dwelling/hut/structure made of traditional materials	7.9%	0.4%
Flat or apartment in a block of flats	5.0%	7.2%
Cluster house in complex	1.0%	2.2%
Townhouse (semi-detached house in a complex)	1.5%	3.5%
Semi-detached house	1.5%	1.2%
House/flat/room in backyard	2.9%	5.6%
Informal dwelling (shack; in backyard)	4.9%	7.8%
Informal dwelling (shack; not in backyard; e.g. in an informal/squatter settlement or on a farm)	8.6%	11.1%
Room/flatlet on a property or larger dwelling/servants quarters/granny flat	0.8%	1.2%
Caravan/tent	0.1%	0.1%
Other	0.8%	0.8%
Total	**100%**	**100%**

Source: Statistics South Africa, 2011

From table 2.9 it is evident that the most significant portion of household's resident in Gauteng lives in a house or a brick/concrete block structure on a separate stand or yard or on a farm (59%), which is 4.9 points lower than South Africa's 64.9%. Approximately 740,000 households residing in Gauteng, (18.9% of the total households) are resident in an informal dwelling. The portion of households in Gauteng resident in informal dwellings is more significant than that the overall portion of South Africa households residing in informal

dwellings (13.6%). Table 2.10 below shows the growth in the number of informal dwellings from 2001 to 2011. According to Statistics South Africa (2010a) an informal dwelling is defined as: "*a makeshift structure not erected according to approved architectural plans, for example shacks or shanties in informal settlements or in backyards*".

TABLE 2.10 – Informal Dwellings, South Africa and Gauteng, 2011 and 2011

	South Africa	Gauteng
Informal dwelling 2001	1,836,230	651,039
Portion of total Households 2001	15.6%	22.5%
Informal dwelling 2011	1,962,733	739,758
Portion of total Households 2011	13.6%	18.9%
Growth in the number of households resident in informal dwellings from 2001 to 2011	6.9%	13.6%

Source: Statistics South Africa, 2001 and Statistics South Africa, 2011

Although the portion of households resident in informal dwellings, on National and provincial level, has decreased, the number of households resident in informal dwellings show an increase. The number of households resident in informal dwellings in South Africa increased 6.9% from 2001 to 2011, while Gauteng shows a 13.6% increase.

Table 2.11 shows the dwelling type that households are resident in within the Districts of the Gauteng Province.

TABLE 2.11 - Household Dwelling Type, Gauteng Districts, 2011

Dwelling Type	SDM	WRDM	EMM	CoJ	CoT
House or brick/concrete block structure on a separate stand or yard or on a farm	75.7%	59.5%	60.6%	53.2%	61.2%
Traditional dwelling/hut/ structure made of traditional materials	0.3%	0.3%	0.2%	0.4%	0.4%
Flat or apartment in a block of flats	2.9%	4.0%	4.2%	10.1%	8.2%

Dwelling Type	SDM	WRDM	EMM	CoJ	CoT
Cluster house in complex	0.5%	1.2%	1.5%	3.2%	2.1%
Townhouse (semi-detached house in a complex)	1.1%	1.3%	2.4%	4.4%	4.8%
Semi-detached house	0.6%	0.5%	0.3%	2.4%	0.6%
House/flat/room in backyard	3.5%	4.9%	7.3%	6.7%	2.9%
Informal dwelling (shack; in backyard)	7.3%	10.9%	7.9%	8.6%	5.7%
Informal dwelling (shack; not in backyard; e.g. in an informal/squatter settlement or on a farm)	6.9%	14.4%	13.6%	8.8%	12.3%
Room/flatlet on a property or larger dwelling/servants quarters/granny flat	0.6%	1.3%	1.2%	1.4%	0.8%
Caravan/tent	0.1%	0.1%	0.1%	0.1%	0.1%
Other	0.5%	1.6%	0.7%	0.7%	0.8%
Total	**100%**	**100%**	**100%**	**100%**	**100%**

Source: Statistics South Africa, 2001 and Statistics South Africa, 2011

The most significant portion of all the Districts households are resident in a house or brick/concrete block structure on a separate stand or yard or on a farm. In comparison with the four other Districts, the City of Johannesburg and the City of Tshwane has the lowest portion of households resident in a house or brick/concrete block structure on a separate stand or yard or on a farm, but show a significant portion of households resident in a flat or apartment in a block of flats (10.1% and 8.2% respectively). The second most significant portion of households are resident in informal dwellings. Table 2.12 below shows the growth in the number of informal dwellings from 2001 to 2011 for the Districts within the Gauteng Province.

TABLE 2.12 - Informal Dwellings, Gauteng Districts, 2001 and 2011

	SDM	WRDM	EMM	CoJ	CoT
Informal dwelling 2001	37,884	47,998	212,560	212,300	140,297
Portion of total Households 2001	16.4%	26.1%	27.4%	20.2%	21.6%
Informal dwelling 2011	39,925	67,737	218,259	249,823	164,014
Portion of total Households 2011	14.3%	25.3%	21.5%	17.4%	18.0%
Growth in the number of households resident in informal dwellings from 2001 to 2011	5.4%	41.1%	2.7%	17.7%	16.9%

Source: Statistics South Africa, 2001 and Statistics South Africa, 2011

In comparison with the other Districts, West Rand followed by Ekurhuleni had the highest portion of households resident in informal dwellings in 2011 (25.3% and 21.5% of their total households respectively). Overall the portion of households resident in informal dwellings (portion of the total households) within the Districts show a decrease, but the total numbers of households resident in informal dwellings indicate an increase. The most significant increase in the number of households resident in informal dwellings from 2001 to 2011 was in the West Rand (41.1%) followed by the City of Johannesburg (17.7%) and the City of Tshwane (16.9%). In 2011 the City of Johannesburg was the District with the most significant number of households resident in informal dwelling, with almost 250,000 households resident in informal dwellings.

Tenure is the arrangement under which a household occupies its home. Table 2.13 illustrates the tenure status for households within South Africa, the Gauteng Province and the five Districts within the Gauteng Province.

TABLE 2.13 – Tenure Status, 2011

	SA	GP	SDM	WRDM	EMM	CoJ	CoT
Rented	25.0%	37.1%	27.9%	41.1%	37.3%	41.2%	32.0%
Owned but not yet paid off	11.8%	16.4%	13.4%	11.7%	16.7%	16.5%	18.3%

	SA	GP	SDM	WRDM	EMM	CoJ	CoT
Occupied rent-free	18.6%	16.0%	20.4%	20.3%	16.2%	15.9%	13.4%
Owned and fully paid off	41.3%	27.9%	35.5%	24.3%	27.3%	23.8%	33.7%
Other	3.4%	2.7%	2.8%	2.7%	2.5%	2.7%	2.7%
Total	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**

Source: Statistics South Africa, 2011

Table 2.13 shows the most significant portion of households in South Africa own their homes and their homes are fully paid of (41.3%), followed by 25% that rent their homes. Within the Gauteng Province, there is a greater trend towards rental, with the majority of households (37.1%) renting their homes. The City of Johannesburg, West Rand and Ekurhuleni follow the same trend as the Province, with the majority of households resident in the respective Districts renting their homes (41.2%, 41.1% and 37.3% respectively). Sedibeng and the City of Tshwane follow the National trend with the majority of households owning their homes (fully paid off).

2.6.5. Access to services

Household's access to services is shown as a portion of the total households (resident in that specific area) for the years 2001 and 2011. Four different service categories are shown, which include:

1. Household access to electricity for lighting
2. Household access to piped (tap) water inside their dwelling or institution, on their yard or less than 200m from their dwelling
3. Household access to a flush or chemical toilet
4. Household access to refuse removal by the local authority or a private company once a week or less often

Figure 2.3 below depicts the National, Provincial and the District household access (as a portion of the total households) to electricity for lighting for the years 2001 and 2011.

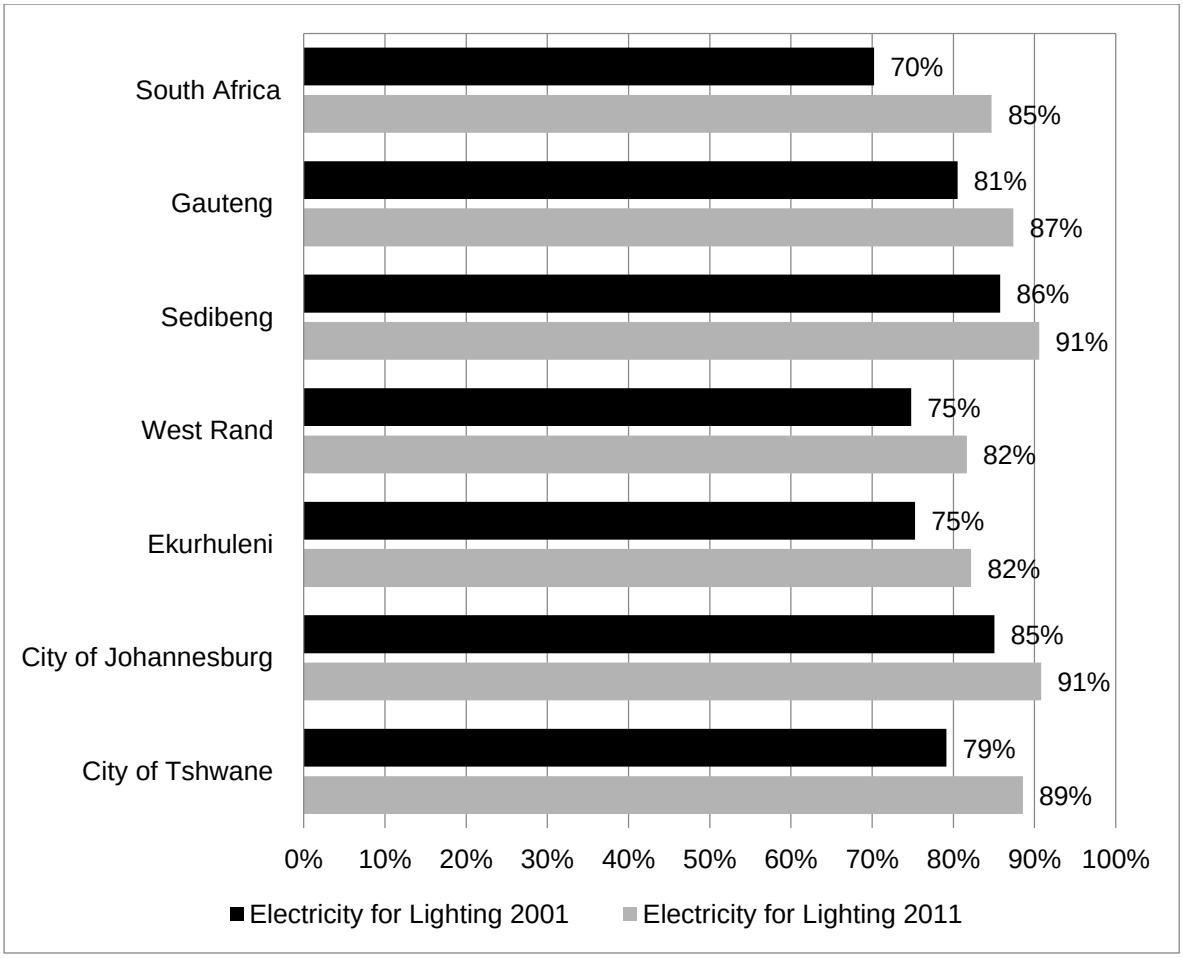


FIGURE 2.3 - Household Access to Electricity for Lighting, 2001 and 2011

Source: Statistics South Africa, 2001 and Statistics South Africa, 2011

Figure 2.3 indicates that the overall portion of households on a National, Provincial and District level, has experienced an increase in access to electricity for lighting. Gauteng and the Districts within Gauteng show a more significant portion of household have access to electricity for lighting (in 2011) in comparison with South Africa. Although 87% of households resident in Gauteng has access to electricity in 2011 another 12%, or almost 475,000 households, used other sources of fuel such as gas, paraffin, solar or candles and almost 9,500 had no access to any source of fuel for lighting. The least significant access to electricity of lighting in 2011 was in Ekurhuleni (82%) and West Rand (82%), while the most significant access was in Sedibeng and the City of Johannesburg, both with 92% of households having access. In the City of Johannesburg, the following alternative fuels for lighting were used in 2011:

1. Candles (6.9% or 98,945 households)
2. Paraffin (1.7% or 23,775 households)
3. Solar (0.2% or 3217 households)

4. Gas (0.2% or 2,710 households)

Figure 2.4 below depicts the National, Provincial and the District household access (as a portion of the total households) to piped (tap) water inside their dwelling or institution, on their yard or less than 200m from their dwelling for the years 2001 and 2011.

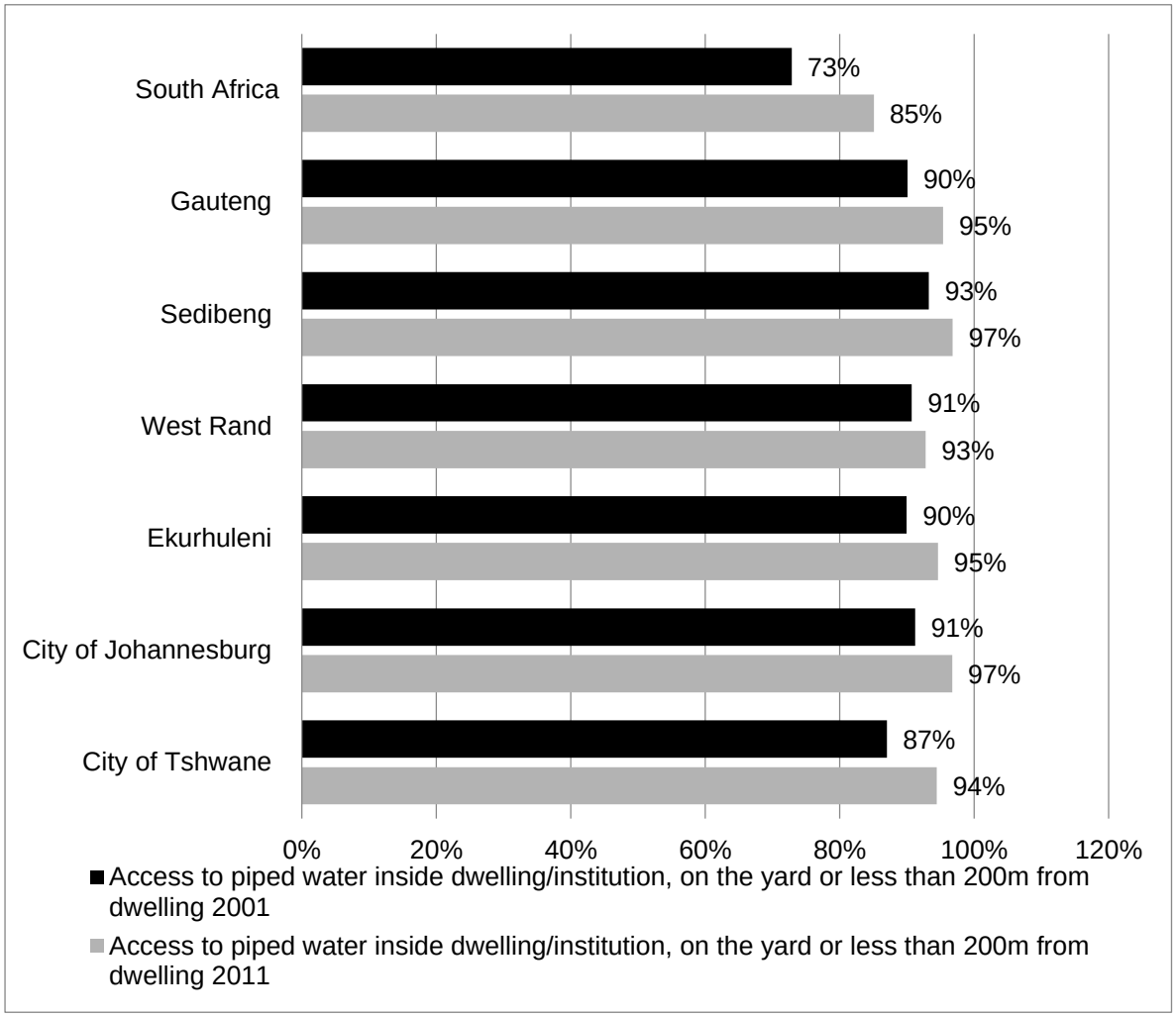


FIGURE 2.4 - Household Access to Piped Water, 2001 and 2011

Source: Statistics South Africa, 2001 and Statistics South Africa, 2011

Figure 2.4 illustrates that the overall portion of households on a National, Provincial and District level, have experienced an increase in access to piped (tap) water inside their dwelling or institution, on their yard or less than 200m from their dwelling. Household access to piped (tap) water inside their dwelling or institution, on their yard or less than 200m in Gauteng increased from 90% in 2001 to 95% in 2011, although this is a five point increase, more than 110,000 households only have access to piped water a greater distance that 200m from their dwelling or institution, while another 70,000 have no access to piped water.

In 2011, Gauteng and the Districts within Gauteng show a more significant portion of households have access to piped water in comparison with South Africa. The least significant access in 2011 was within West Rand followed by the City of Tshwane. The most significant household access was in the City of Johannesburg (97%) and Sedibeng (97%). In the City of Johannesburg in 2011, more than 27,000 households only have access to piped water a greater distance that 200m from their dwelling or institution, while almost 20,000 have no access to piped water.

Figure 2.5 below depicts the National, Provincial and the District household access (as a portion of the total households) to a flush or chemical toilet for the years 2001 and 2011.

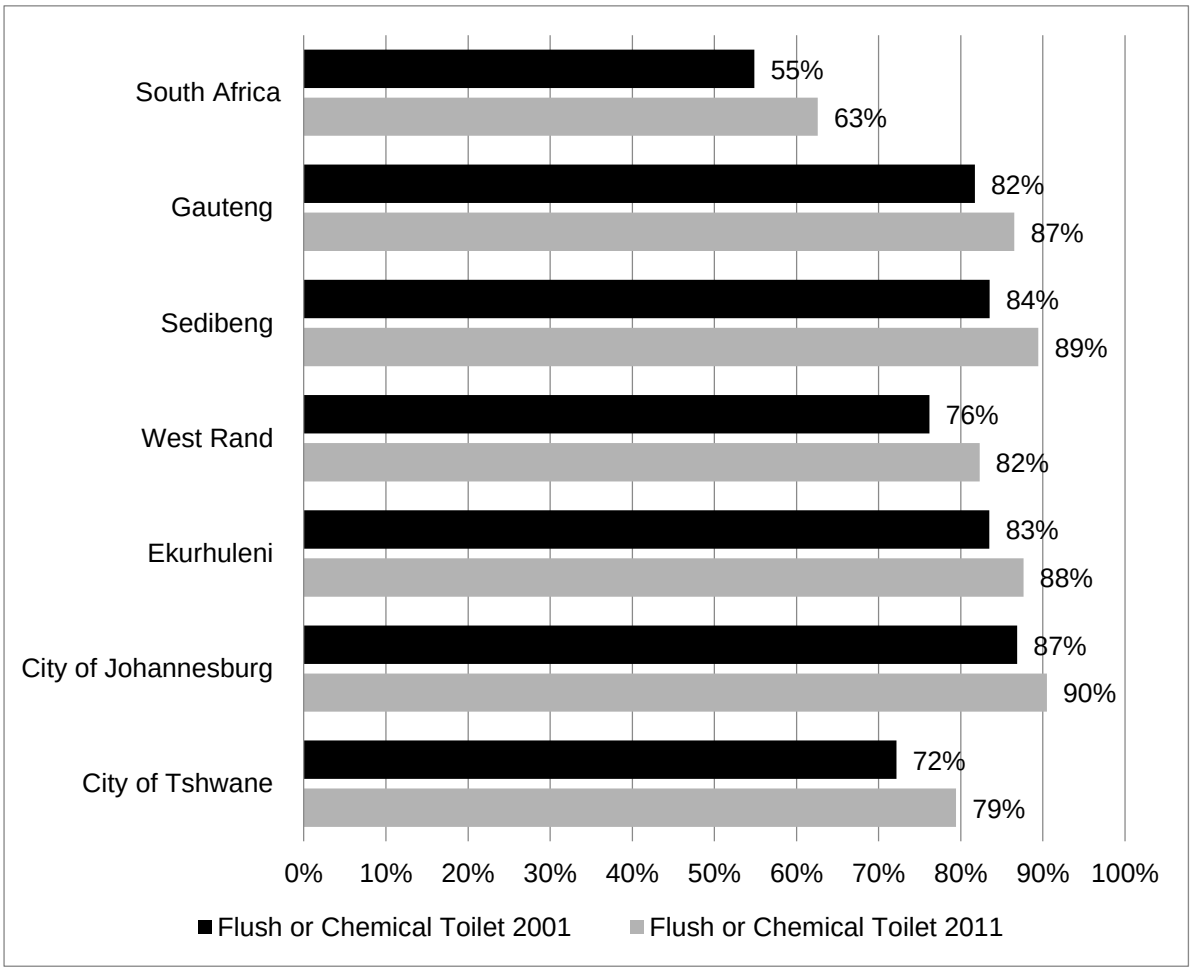


FIGURE 2.5 - Household Access to a flush or chemical toilet, 2001 and 2011
Source: Statistics South Africa, 2001 and Statistics South Africa, 2011

Figure 2.5 shows that the overall portion of households on a National, Provincial and District level, have experienced an increase in household access to appropriate sanitation (a flush or chemical toilet) from 2001 to 2011. In comparison with South Africa, in 2011 Gauteng and

the Districts within Gauteng show a more significant portion of household with access to a chemical or flush toilet. Household access to a chemical or flush toilet in South Africa increased with eight points, but is still low at 63%. Overall access in Gauteng increased from 82% in 2001 to 87% in 2011. This translates to over 480,000 households not having access to a chemical or flush toilet and having to rely on other sanitation facilities such as a pit or bucket toilet. The City of Tshwane showed the least significant household access in 2011, with 79% households having access to a chemical or flush toilet. Although the City of Johannesburg indicated the most significant household access with 90% of households having access to a chemical or flush toilet, almost 125,000 households have to rely on other forms of sanitation such as a pit of bucket toilet.

Figure 2.6 depicts the National, Provincial and the District household access to refuse removal by the local authority or a private company once a week or less often for the years 2001 and 2011.

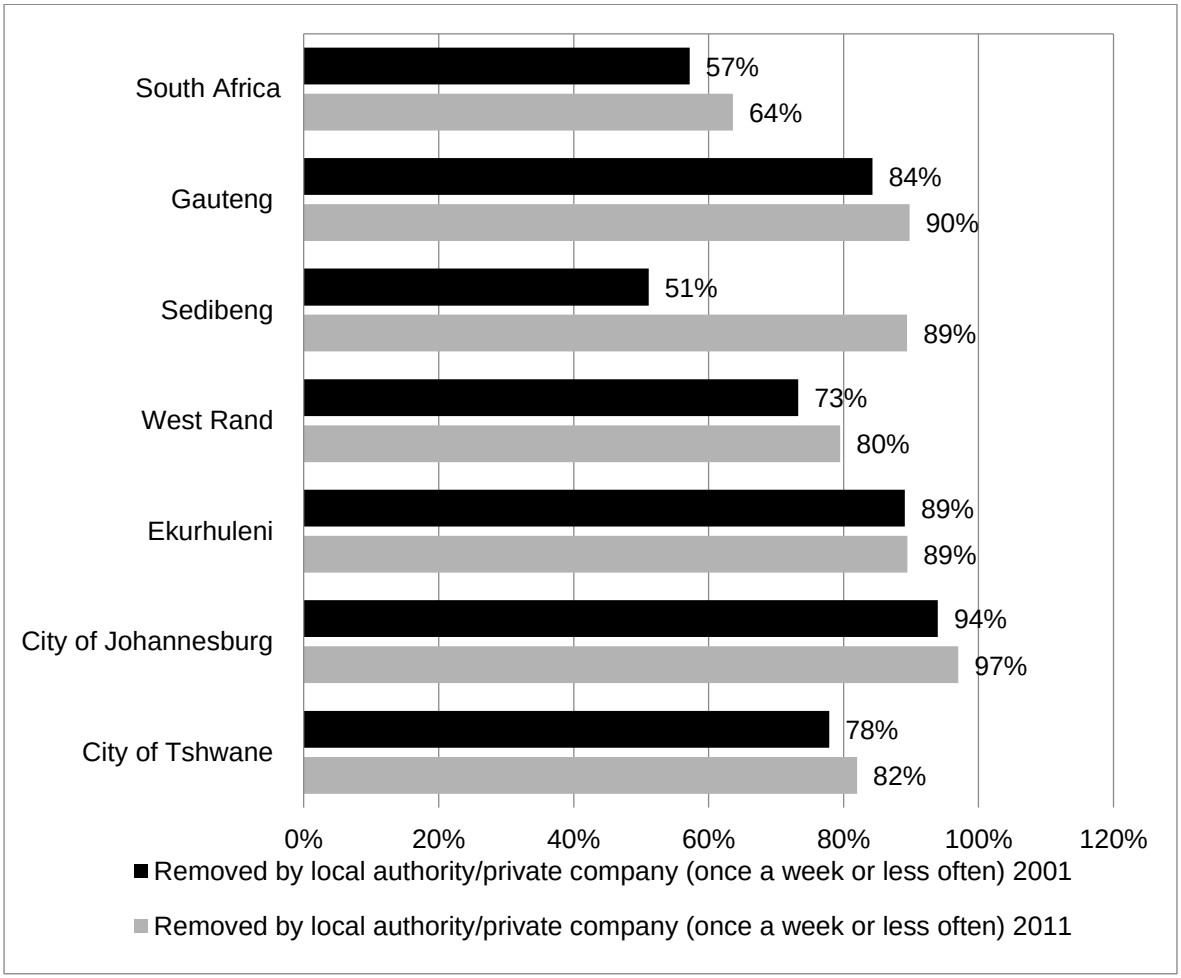


FIGURE 2.6 - Household Access to Refuse Removal, 2001 and 2011

Source: Statistics South Africa, 2001 and Statistics South Africa, 2011

Figure 2.6 shows that the overall portion of households on a National, Provincial and District level, have experienced an increase in household access to refuse removal by the local authority or a private company once a week or less often from 2001 to 2011. In comparison with South Africa, Gauteng and the Districts within Gauteng show a more significant portion of access to refuse removal by local authority or private company in 2011. In 2011, 90% of the households resident in Gauteng had their refused removed by the local authority or a private company once a week or less often, meaning that over 350,000 households have to rely on other methods of refuse disposal. Sedibeng showed a significant increase in access to refuse disposal from 51% in 2001 to 89% in 2011. In comparison with South Africa, Gauteng and the other four districts within Gauteng, the City of Johannesburg had the most significant household access (97%) to refuse removal by the local authority or a private company once a week or less often, which translates to almost 44,000 households having to rely on other forms of refuse disposal.

2.6.6. Economic and employment indicators

Statistics South Africa (2010a) defines gross value added (GVA) as the value of output less the value of intermediate consumption; it is a measure of the contribution to GDP made by an individual producer, industry or sector. The total GVA at current prices for South Africa, the Gauteng Province and the five Districts within Gauteng is depicted in table 2.14 below.

TABLE 2.14 – Total Economic Production - GVA at current prices, 2011

	Total GVA at current prices ('000 000)	Portion of South Africa's Total	Portion of Gauteng's Total
South Africa	R 2,670,423	-	-
Gauteng	R 907,686	34.0%	-
Sedibeng	R 44,017	1.6%	4.8%
West Rand	R 42,406	1.6%	4.7%
Ekurhuleni	R 225,071	8.4%	24.8%
City of Johannesburg	R 351,019	13.1%	38.7%
City of Tshwane	R 245,173	9.2%	27.0%

Source: Quantec Research, 2011

Table 2.14 indicates that the Gauteng Province contributed 34% to South Africa's total GVA in 2011. The Main contributing District to Gauteng's GVA in 2011 was the City of Johannesburg (38.7%), followed by the City of Tshwane (27%) and Ekurhuleni (24.8%).

Table 2.15 shows the GVA average annual growth rate at constant 2005 prices for three periods, including 2010 to 2011, 2006 to 2011 and 2001 to 2006.

TABLE 2.15 - Economic Growth Trends - GVA at constant 2005 prices

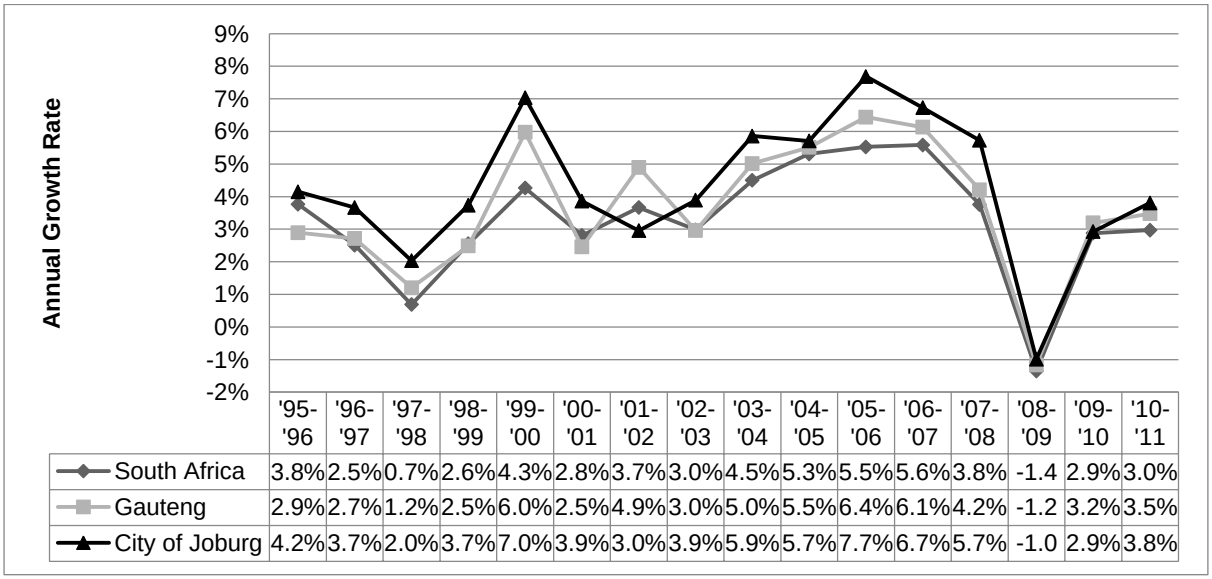
	SA	GP	SDM	WRDM	EMM	CoJ	CoT
GVA Growth Rate 2010 to 2011 (constant 2005 prices)	3.0%	3.5%	2.8%	1.8%	3.8%	3.8%	3.1%
GVA Average Annual Growth Rate (constant 2005 prices) last Five Years, 2006 to 2011	2.8%	3.2%	1.0%	2.1%	2.7%	3.6%	3.6%
GVA Average Annual Growth Rate (constant 2005 prices) Previous Five Year Cycle, 2001 to 2006	4.4%	5.0%	3.3%	3.0%	4.8%	5.2%	5.5%
GVA Average Annual Growth Rate (constant 2005 prices), 1995 to 2011	3.3%	3.6%	1.7%	2.2%	3.7%	4.3%	3.4%

Source: Quantec Research, 2011

Table 2.15 shows that during the period 2010 to 2011, the City of Johannesburg (3.8%) and Ekurhuleni (3.8%) both experienced the most significant growth rate in the Gauteng Province. Their growth rate was more significant than both the Provincial and National growth rate (3.5% and 3.0% respectively). West Rand and Sedibeng experienced the least significant growth rate during the same period (1.8% and 2.8% respectively). The year 2007

saw a global recession in the global economy, which has had an impact on economic growth. This is evident when comparing the 2006 to 2011 average annual growth rate with the 2001 to 2006 average annual growth rate. The City of Johannesburg (3.6%) together with the City of Tshwane (3.6%) experienced the most significant average annual growth rate from 2006 to 2011, both above the National (2.8%) and the Provincial (3.2%) average. During the period 1995 to 2011 the City of Johannesburg experienced the overall most significant growth rate (4.3%) in comparison with the National, provincial and District averages.

Figure 2.7 depicts the annual GVA growth rate for the South Africa, the Gauteng Province and the City of Johannesburg for the period 1995 to 2011.



	'95-'96	'96-'97	'97-'98	'98-'99	'99-'00	'00-'01	'01-'02	'02-'03	'03-'04	'04-'05	'05-'06	'06-'07	'07-'08	'08-'09	'09-'10	'10-'11
South Africa	3.8%	2.5%	0.7%	2.6%	4.3%	2.8%	3.7%	3.0%	4.5%	5.3%	5.5%	5.6%	3.8%	-1.4	2.9%	3.0%
Gauteng	2.9%	2.7%	1.2%	2.5%	6.0%	2.5%	4.9%	3.0%	5.0%	5.5%	6.4%	6.1%	4.2%	-1.2	3.2%	3.5%
City of Joburg	4.2%	3.7%	2.0%	3.7%	7.0%	3.9%	3.0%	3.9%	5.9%	5.7%	7.7%	6.7%	5.7%	-1.0	2.9%	3.8%

FIGURE 2.7 – Annul Economic Growth Trend, 1995 to 2011

Source: Quantec Research, 2011

As indicated within figure 2.7 above it is evident that the impact of the global recession is mainly illustrated by the sharp decline in economic growth for the period 2008 to 2009. It is also important to note that this is the first time that South Africa (-1.4%), Gauteng (-1.2%) and the City of Johannesburg (-1.0%) experienced a negative growth rate during the period 1995 to 2011.

The various industries in an economy can be categorised according to the standard industrial classification of all economic activities (SIC). According to Statistics South Africa (2010c) "*the SIC is a classification of economic activities of industries. An industry consists of establishments engaged in the same or a closely related kind of economic activity based*

mainly on the principal class of goods produced or services rendered. The term "industry" is used in the widest sense to cover all economic activity from the primary industries of agriculture, forestry, fishing and mining to the rendering of social, recreational, cultural and personal services". Table 2.16 below gives an overview of the nine major industry groups of the SIC.

TABLE 2.16 – Standard Industrial Classification

Industry	Definition
Agriculture, forestry and fishing [SIC: 1]	In this industry, establishments which are primarily engaged in farming activities are classified, such as the growing of field crops, the raising of livestock and the production of milk, wool and eggs. Establishments rendering agricultural services such as harvesting, baling, threshing and spraying are also classified under this major division. Also included are establishments engaged in commercial hunting and game propagation and forestry, logging and fishing.
Mining and quarrying [SIC: 2]	Mining and quarrying is used here in a broad sense to include the extracting, dressing and beneficiating of minerals occurring naturally, for example solids such as coal and ores; liquids such as crude petroleum and gases such as natural gas. Mining includes underground and surface mines, quarries and the operation of oil and gas wells and all supplemental activities for dressing and beneficiating ores and other crude materials such as crushing, screening, washing, cleaning, grading, milling, flotation, melting, pelleting, topping and other preparation needed to render the material marketable. Reclamation of minerals from mine dumps and worked out

Industry	Definition
	mines is included.
Manufacturing [SIC: 3]	Manufacturing is defined as the physical or chemical transformation of materials or compounds into new products, whether the work is performed by power-driven machines or by hand, whether it is done in a factory or in the worker's home and whether the products are sold wholesale or retail. The assembly of products from component parts is considered to be manufacturing, except in cases where the activity is appropriately classified under Construction.
Electricity, gas and water [SIC: 4]	This group includes the generation, transmission and distribution of electric energy for sale to households, industrial and commercial users. Electricity may be generated conventionally, hydraulically, thermally, geo-thermally, or by means of solar energy, nuclear energy or tidal energy. Included are electric power plants which, as ancillary divisions of establishments, generate electricity for use by such establishments.
Construction [SIC: 5]	This group includes the demolition or wrecking of buildings and other structures, the preparation of building sites and the sale of materials from demolished structures. Blasting, test drilling, landfill, levelling, earth-moving, excavating, land drainage and other land preparation. Also included are tunnelling, overburden removal and other development and preparation of mineral properties and sites, except oil and gas sites.

Industry	Definition
Wholesale and retail trade, catering and accommodation [SIC: 6]	The Wholesale and retail trade division can be classified into the following sub-divisions: 1. Wholesale trade and commission trade 2. Retail trade, repair of personal and household goods 3. Sale, maintenance and repair of motor vehicles and motor cycles as well as retail trade in automotive fuel 4. Hotels and restaurants
Transport, storage and communication [SIC: 7]	This industry include activities related to providing passenger or freight transport, whether scheduled or not, by rail, road, water or air and auxiliary activities such as terminal and parking facilities, cargo handling and storage. It includes postal activities and telecommunications. In particular the renting of transport equipment with a driver or operator for the different transport modes is considered to be a transport activity and is therefore included in this division.
Finance, insurance, real estate and business services [SIC: 8]	The finance and business services division can be classified into the following sub-divisions: 1. Financial intermediation 2. Insurance and pension funding, except compulsory social security 3. Activities auxiliary to financial intermediation 4. Real estate activities 5. Renting of machinery and

Industry	Definition
	equipment, without operator, and of personal and household goods 6. Computer and related activities 7. Research and development 8. Other business activities (includes consultancy)
General government [SIC: 91, 94] and community, social and personal services [SIC: 92, 95-6, 99, 0]	The Community, social and personal services division can be classified into the following sub-divisions: 1. Public administration and defence activities 2. Education 3. Health and social work 4. Other community, social and personal service activities such as sewage and refuse disposal, sanitation and similar activities 5. Activities of membership organisations 6. Recreational, cultural and sporting activities 7. Other service activities such as washing and (dry-) cleaning of textiles and fur products, hairdressing and other beauty treatments as well as funeral and related activities. Also included is activities related to physical well-being and comfort, such as those carried out by Turkish baths, sauna and steam baths, solariums, spas, reducing and slimming salons, massage salons, restrooms, etc.

Industry	Definition
	Astrological and spiritualist activities. Social activities such as escort services, dating services, services of marriage bureaux, genealogical organisations, shoppers, shoe shiners, porters, etc.

Source: Adapted from Statistics South Africa, 2010c

Table 2.17 show the various industry contributions to their respective economy's total economic production (GVA at current prices).

TABLE 2.17 - Industry Contribution to Total Economic Production, GVA at Current prices, 2011

Industry	SA	GP	SDM	WRDM	EMM	CoJ	CoT
Agriculture, forestry and fishing [SIC: 1]	2.4%	0.4%	0.4%	0.5%	0.3%	0.4%	0.4%
Mining and quarrying [SIC: 2]	9.8%	3.5%	5.5%	19.0%	3.6%	2.7%	1.5%
Manufacturing [SIC: 3]	13.4%	15.6%	24.1%	13.9%	22.5%	12.9%	11.7%
Electricity, gas and water [SIC: 4]	2.9%	3.1%	4.8%	2.8%	3.1%	3.0%	2.9%
Construction [SIC: 5]	4.5%	5.7%	6.2%	5.4%	5.3%	5.7%	6.1%
Wholesale and retail trade, catering and accommodation [SIC: 6]	14.5%	15.6%	15.2%	13.6%	16.0%	17.0%	13.7%
Transport, storage and communication [SIC: 7]	8.2%	7.3%	4.8%	5.8%	8.9%	7.3%	6.6%
Finance, insurance, real estate and business services [SIC: 8]	21.2%	24.7%	15.6%	16.7%	20.1%	30.7%	23.4%
Community, social and personal services [SIC: 92, 95-6, 99, 0]	6.9%	4.9%	4.0%	4.2%	4.7%	5.2%	4.8%
General government [SIC: 91, 94]	16.3%	19.3%	19.5%	18.1%	15.4%	15.2%	29.0%
Total	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

Source: Quantec Research, 2011

From table 2.17 it is evident that the five main contributing industries to South Africa's economy in 2011 were:

1. Finance, insurance, real estate and business services [SIC: 8]
2. General government [SIC: 91, 94]
3. Wholesale and retail trade, catering and accommodation [SIC: 6]
4. Manufacturing [SIC: 3]
5. Mining and quarrying [SIC: 2]

The five main contributing industries to Gauteng's economy in 2011 were:

1. Finance, insurance, real estate and business services [SIC: 8]
2. General government [SIC: 91, 94]
3. Wholesale and retail trade, catering and accommodation [SIC: 6]
4. Manufacturing [SIC: 3]
5. Transport, storage and communication [SIC: 7]

The five main contributing industries to the City of Johannesburg's economy in 2011 were:

1. Finance, insurance, real estate and business services [SIC: 8]
2. Wholesale and retail trade, catering and accommodation [SIC: 6]
3. General government [SIC: 91, 94]
4. Manufacturing [SIC: 3]
5. Transport, storage and communication [SIC: 7]

2.6.7. Employment indicators

According to Statistics South Africa (2010) an economically active person is a person of working age (aged between 15 and 64) who is available for work, and is either employed, or is unemployed but has taken active steps to find work in the reference period. Statistics South Africa (2010a) defines a not economically active person as: "*A person who is not available for work, such as full-time scholars and students, fulltime homemakers, those who are retired and those who are unable or unwilling to work*". The labour market (or potentially economically active population) is defined as (Statistics South Africa, 2010a): "*all persons aged 15–64 years who are employed, unemployed and not economically active (inactive)".* It does not mean that this entire portion of the population is prepared, willing or able to be employed, i.e. some prefer to stay at home as housekeepers, others are disabled and some are full-time students, or have given up looking for work. They do however form part of the

potential labour pool. The age distribution for 2011 of South Africa, the Gauteng Province and the five District Municipalities within the Province are shown in table 2.18 below.

TABLE 2.18 – Age Distribution, 2011 (Statistics South Africa, 2011)

	SA	GP	SDM	WRDM	EMM	CoJ	CoT
Child/ Youth Population Ages 00 - 14	29.2%	23.7%	25.4%	24.1%	24.3%	23.2%	23.2%
Labour Market Ages 15 - 64	65.5%	72.0%	69.5%	71.9%	71.7%	72.7%	71.9%
Aged/Retired Population Ages 65+	5.3%	4.3%	5.1%	4.0%	4.0%	4.1%	4.9%
Total	100%	100%	100%	100%	100%	100%	100%

Source: Statistics South Africa, 2011

From table 2.8 above it is evident that South Africa had a higher portion of child population and aged population in comparison with the Gauteng Province in 2011. Within the Gauteng Province, the age distribution of the five districts is similar in 2011 with the City of Johannesburg showing the highest portion of its population falling into the labour market category (72.7%) followed by the City of Tshwane (71.9%) and West Rand (71.95). In comparison with the other four Districts, Sedibeng had the highest portion of child population (25.4%) as well as aged/retired population (5.1%) within Gauteng.

Employment indicator's definitions (Statistics South Africa, 2010a):

1. Employed "*Those who performed work for pay, profit or family gain for at least one hour in the seven days prior to the interview or who were absent from work during these seven days, but did have some form of paid work to return to."*
2. Official and expanded definition of unemployment: "*The unemployed are those people within the economically active population who: (a) did not work during the seven days prior to the interview, (b) want to work and are available to start work within two weeks of the interview, and (c) have taken active steps to look for work or start some form of self-employment in the four weeks prior to the interview. The expanded definition of unemployment excludes criterion (c)."*
3. Labour Force: "*All employed and unemployed persons of working age"*.

4. Unemployment rate: "*The percentage of the economically active population that is unemployed*."

Table 2.19 below show the employment indicators for South Africa and the Gauteng Province for the years 2001 and 2011.

TABLE 2.19 - Employment Indicators, South Africa and Gauteng, 2001 and 2011

	South Africa	Gauteng
Employed 2001	9,630,830	2,941,184
Unemployed 2001	6,800,685	1,737,793
Labour Force 2001	16,431,515	4,678,977
Unemployment Rate 2001	41.4%	37.1%
Employed 2011	13,180,077	4,467,370
Unemployed 2011	5,594,055	1,598,044
Labour Force 2011	18,774,132	6,065,414
Unemployment Rate 2011	29.8%	26.3%

Source: Statistics South Africa, 2001 and Stats SA, 2011

Table 2.19 shows that the unemployment rate of South Africa decreased with 11.6 points from 2001 to 2011, while Gauteng experienced a 10.8 points decrease. This translates to almost 5.6 million people in South Africa and almost 4.5 million people in Gauteng being unemployed. In 2011, Gauteng's unemployment rate was 4.2 points less than South Africa's.

Table 2.20 below show the employment indicators for the Districts within the Gauteng Province for the years 2001 and 2011.

TABLE 2.20 - Employment Indicators, Gauteng Districts, 2001 and 2011

	SDM	WRDM	EMM	CoJ	CoT
Employed 2001	199,409	182,899	762,068	1,085,885	710,924
Unemployed 2001	155,695	93,526	515,091	646,644	326,837
Labour Force 2001	355,104	276,425	1,277,159	1,732,529	1,037,761
Unemployment Rate 2001	43.8%	33.8%	40.3%	37.3%	31.5%
Employed 2011	271,398	293,335	1,126,844	1,696,520	1,079,273
Unemployed 2011	127,217	104,894	455,608	564,970	345,356
Labour Force 2011	398,615	398,229	1,582,452	2,261,490	1,424,629

	SDM	WRDM	EMM	CoJ	CoT
Unemployment Rate 2011	31.9%	26.3%	28.8%	25.0%	24.2%

Source: Statistics South Africa, 2001 and Stats SA, 2011

From table 2.20 it is evident that there is an overall decreasing trend in the unemployment rate within the Gauteng Province from 2001 to 2011. In 2011, Sedibeng had the highest unemployment rate of the five Districts within Gauteng (31.9%). The City of Tshwane followed by the City of Johannesburg has the least significant unemployment rate in comparison with the other Districts in the Province (24.2% and 25% respectively). The unemployment rate of the City of Johannesburg experienced the most significant decrease from 2001 to 2011, dropping 12.3 points from 37.3% to 25%. In 2011 more than 560,000 individuals were unemployed in the City of Johannesburg. Employment per industry is shown in table 2.20.

TABLE 2.21 - Industry Contribution to Total Employment, 2011 (Quantec Research, 2013)

Industry	SA	GP	SDM	WRDM	EMM	CoJ	CoT
Agriculture, forestry and fishing [SIC: 1]	5.9%	1.1%	1.3%	1.8%	1.0%	1.0%	1.1%
Mining and quarrying [SIC: 2]	5.9%	1.4%	1.5%	9.4%	1.4%	0.9%	0.5%
Manufacturing [SIC: 3]	11.5%	13.7%	18.1%	12.7%	19.4%	11.4%	10.9%
Electricity, gas and water [SIC: 4]	0.6%	0.8%	1.3%	0.8%	0.8%	0.7%	0.7%
Construction [SIC: 5]	4.1%	4.1%	4.1%	3.9%	3.9%	3.8%	4.8%
Wholesale and retail trade, catering and accommodation [SIC: 6]	16.0%	17.5%	18.1%	16.6%	17.4%	18.6%	16.0%
Transport, storage and communication [SIC: 7]	3.5%	4.6%	3.2%	3.8%	5.6%	4.7%	4.0%
Finance, insurance, real estate and business services [SIC: 8]	18.2%	25.8%	19.7%	20.6%	23.2%	29.9%	24.6%
Community, social and personal services [SIC: 92, 95-6, 99, 0]	15.1%	14.6%	15.6%	14.9%	14.0%	15.3%	13.9%
General government [SIC: 91, 94]	19.0%	16.3%	17.1%	15.5%	13.4%	13.5%	23.4%
Total	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

Source: Quentec Research, 2011

From table 2.21 it is evident that the five most significant employing industries in South Africa's economy in 2011 were:

1. General government [SIC: 91, 94]
2. Finance, insurance, real estate and business services [SIC: 8]
3. Wholesale and retail trade, catering and accommodation [SIC: 6]
4. Community, social and personal services [SIC: 92, 95-6, 99, 0]
5. Manufacturing [SIC: 3]

The five most significant employing industries in Gauteng's economy in 2011 were:

1. Finance, insurance, real estate and business services [SIC: 8]
2. Wholesale and retail trade, catering and accommodation [SIC: 6]
3. General government [SIC: 91, 94]
4. Community, social and personal services [SIC: 92, 95-6, 99, 0]
5. Manufacturing [SIC: 3]

The five most significant employing industries in the City of Johannesburg's economy in 2011 were:

1. Finance, insurance, real estate and business services [SIC: 8]
2. Wholesale and retail trade, catering and accommodation [SIC: 6]
3. Community, social and personal services [SIC: 92, 95-6, 99, 0]
4. General government [SIC: 91, 94]
5. Manufacturing [SIC: 3]

2.7. SUBSIDY HOUSING IN SOUTH AFRICA

In 1994 South Africa's housing subsidy programme was launched. Beneficiaries who satisfied the various criteria together with a household income of less than R 3,500 per month were invited to apply for the subsidy. The subsidy comprised mainly the provision of a free standing housing unit provided free of charge on an ownership basis.

Approximately six subsidy mechanisms were available through the housing subsidy programme namely Project Linked, Individual, Consolidation, Institutional, Relocation Assistance and the People's Housing Process. The Project Linked subsidy was made available primarily directly to Developers who undertook approved projects and then on a later stage to Provinces or Municipalities who appointed Developers to undertake projects.

The houses developed through the project were then allocated to the approved beneficiaries. The main principle in respect of this subsidy mechanism was to provide free standing houses within dedicated suburbs on an ownership basis whereby the property was registered in the name of the beneficiary who received the title deed. The house provided was seen as a 'starter' house which the beneficiary could expand over time (Shisaka Development Management Services, 2011).

With respect to the policy trends impacting on the national subsidy programme since 1994, five broad periods are identified. Table 2.22 below provides an overview of the five broad periods as well as the key policy initiatives that occurred within each of the five periods identified.

TABLE 2.22 - Time line periods of policy trends and key policy initiatives impacting on the national subsidy programme

Period	Overview
1992 to 1994: Policy formulation	This period starts with the National Housing Forum and ends with the launch of the National Subsidy Programme in 1994. The key focus of this period is the formulation of South Africa's housing policy.
1995 to 2001: Private sector developer driven delivery	This period starts in 1995 with the implementation of the National Subsidy Programme and ends with the termination of the use of conveyancers to pay out subsidies. The period is characterised by the delivery of subsidised housing through private sector developers who identified land and structured and implemented projects drawing down the subsidy through a process managed by conveyancers. At the outset developers identified the beneficiaries themselves, towards the end of the period beneficiaries were allocated to the project from a waiting list managed by Provinces and/or Municipalities.
2001 to 2004: Public sector	This period starts with the termination of the

Period	Overview
driven delivery	use of conveyancers to pay out subsidies and ends with the publishing of the Comprehensive Plan (Breaking New Ground). The period is characterised by the delivery of subsidised housing through Provinces and Municipalities who structured projects and appointed private sector developers and contractors to implement them. More and more, small scale builders were appointed to implement projects.
2004 to 2009: Delivering human settlements	This period starts with the publishing of the Comprehensive Plan (BNG) and ends with the adoption of the Revised Housing Code. This period is characterised by a focus on sustainable human settlements. This came to be interpreted as the implementation of "Mega-projects" of which subsidy housing was one component. The issue of the need to upgrade informal settlements was identified during this period.
2010+: Informal settlement upgrading	This period starts with the adoption of the Revised Housing Code. Government policy begins to focus on upgrading of informal settlements as the key mechanism to address the housing backlog

Source: Adapted from Shisaka Development Management Services, 2011b

2.7.1. Registered Subsidy Properties

Registered subsidy properties comprise just less than one quarter (24%) of all registered residential properties in South Africa (Shisaka Development Management Services, 2011a). Between 1994 and 2009 a total of 2,94 million subsidy houses were reported as being completed or under construction by the Department of Human Settlements. Of these 2,95 million, 1,44 million (51%) were registered in the Deeds registry. Assuming that the 2,94 million houses reported by the Department of Human Settlements have been developed, this

implies that more than one million subsidy beneficiaries have received a subsidy property without the registration of formal title.

Table 2.23 below shows the number of houses reported completed/under construction vs. total registrations 1994 to 2009 for South Africa and the Gauteng Province:

TABLE 2.23 - Number of houses reported completed/under construction vs. total registrations, 1994 to 2009

	South Africa	Gauteng	Gauteng as % of SA Total
No of houses reported completed/under construction 1994 to 2009	2,941,290	752,960	26%
Total Subsidy Property Registrations 1994 to 2009	1,446,887	395,765	27%

Source: Adapted from Shisaka Development Management Services, 2011a

Table 2.23 indicates that the Department of Human Settlements reported that between 1994 and 2009 a total of 2,941,290 subsidy houses were completed or under construction in South Africa. Within Gauteng, 26% of South Africa's total (752,960), were reported as being completed or under construction. Of these 752,960 only 395,765 (or 53%) were registered in the Deeds registry.

2.7.2. Housing Backlogs

In 2011 South Africa had a backlog of some 2,1 million subsidised houses (Engineering News, 2011). This 2,1 million subsidised houses excludes the previously built units that had to be demolished as a result of quality issues.

According to IOL property (2010), there were over 60,000 people on Gauteng's waiting list for houses. Issues effecting housing delivery include budget constraints, unavailability of land, town planning processes and people flocking into Gauteng in search of employment opportunities.

2.8. ENERGY EFFICIENCY AND RENEWABLE ENERGY INTERVENTIONS IN LOW-COST HOUSING IN SOUTH AFRICA

2.8.1. Kuyasa, Khayelitsha, City of Cape Town (Western Cape)

2.8.1.1. Overview

The Kuyasa Project is a Clean Development Mechanism (CDM) demonstration project (Project 0079), which is aimed at the promotion of energy efficiency within low cost housing structures. AGAMA Energy designed and project managed the installation of three energy efficient interventions comprising the scope of the project, namely hot water on tap supplied by solar water heaters (SWHs), enhanced indoor comfort levels by means of thermal insulation (insulated ceilings) and more energy efficient lighting using compact fluorescent light bulbs (CFLs).

Figure 2.8 – Kuyasa Project
Source: Agama Energy, 2010b

The installation of insulated ceilings in the houses will result in the reduction of temperature amplitude extremes (daily and seasonal), making the houses more comfortable all year round. The reduced demand in energy consumptions will in turn lead to lower electricity consumption in future and/or less dependence on other fuel sources for space heating purposes at present. All of this will carry significant economic and environmental health benefits.

The installation of solar water heaters, if fitted with timers, could also result in reduced peak demand as heating loads peak in the evening in winter even if the systems are backed up using an electrical heating element. Warm water on demand technologies are not installed

as a component of low cost housing delivery in South Africa. Water heating in most low cost houses is mostly achieved through batch heating of water in pots using various fuel sources such as electricity or kerosene. However, for this baseline scenario, the suppressed demand argument is that the technology that would have been used in absence of the project activity is an electric hot water storage geyser, rather than kerosene stoves.

Energy efficient lighting projects do not contribute significantly to the reduction of carbon emissions. Nevertheless, when packaged as part of a bigger project, they can make a significant contribution to the reduction of CO_2 emissions and result in cost savings to the household and reduction in peak demand with all the related electricity infrastructure savings.

According to Cousins and Mahote (2003) the results indicated that the three interventions that were made had a significant impact on the livelihoods of the ten households. Ceilings reduced the amount of energy required to heat the houses, which resulted in savings that had been spent on other essentials such as food, education, health, and clothing. The SWHs radically reduced the total amount of energy spent on heating water for cooking, bathing, and clothes washing. The efficient light bulbs outlasted conventional bulbs and provided more hours of light for less money. The study noted that the interventions had significant impacts beyond household budgets and energy consumption. The warmer houses in winter attracted neighbours and visitors so that they became sites of important social processes. They also improved indoor air quality which in turn improved the health of the occupants. The ceilings also kept blown sand out of the houses, which is a major problem in Khayelitsha. The net effect of the savings generated by these interventions is reduced strain on household budgets and social networks. It enabled these ten households to make a range of choices that were not previously possible. Certain households were able to spend more on energy thus relieving some of the pressure of suppressed demand while others were able to buy essential foodstuffs; others could invest in appliances that aided their livelihood strategy, such as a fridge that kept meat fresh for resale.

Technology used (Moosa, Wesselink & Wesselink, 2010):

1. Insulated ceilings - IsoBoard with a thickness of 25mm and thermal insulation of 0.024 K/w°C. (refer to figure 2.9 and figure 2.11)
2. Solar water heaters - Initially the SWH installed were Genergy SWH and these were later replaced by XStream (a locally manufactured SWH) when it became available (refer to figure 2.10)

3. Energy efficiency lighting - In all instances a minimum of 2, 14 Watt CFLs were provided to the households by Eskom (refer to figure 2.11)

Figure 2.9 illustrates the insulated ceiling in the Kuyasa houses.

Figure 2.9 - Insulated ceiling

Source: Agama Energy, 2004

Figure 2.10 - Three different SWHs

Source: Agama Energy, 2004

Figure 2.10 shows three different solar water heaters. From left, the integral 100-litre system (Solar Beam), the close-coupled 100-litre system (Atlantic Solar) and the close-coupled 100-litre system (Solar Dome). Figure 2.11 shows the insulated ceiling and a compact fluorescent light in a Kuyasa house.

Figure 2.11 - Insulated ceiling and compact fluorescent light
Source: Agama Energy, 2004

2.8.1.2. Emission Reduction

It is firstly important to understand the concept of suppressed demand. According to Winkler and Thorne (2002) the pre-intervention emissions, due to energy consumption, are likely to be due to a “suppressed demand”. This is the consumption of a household which is caused by financial and service constraints. In other words it is a consumption that may not result in,

for example, thermal comfort because the heating energy may have been limited by lack of financial ability to purchase the necessary amounts of energy. In the same way hot water use may be limited by financial constraints and lack of service (no hot water on tap). Furthermore, “unsuppressed demand” (or satisfied demand) is that level of household consumption that would take place to reach an accepted thermal comfort and satisfactory hot water supply, with the necessary spending on energy to deliver this level of energy service. Since households will strive towards the satisfied demand, and may well achieve that with increased income, it is this level of energy use that should be considered for the pre-intervention and efficient emissions. The difference can then be called the unsuppressed carbon emission reduction.

Table 2.25 indicates the following for each intervention (Agama Energy, 2010b):

1. Baseline energy (kWh) per household per annum (unsuppressed demand) before intervention
2. Baseline CO_2 emissions per household per annum (unsuppressed demand) before intervention
3. Annual CO_2 emissions per household per annum after intervention
4. Annual total reduction in CO_2 emissions per household after intervention equals (baseline CO_2 emissions per household per annum (unsuppressed demand) before intervention minus annual CO_2 emissions per household per annum after intervention)

TABLE 2.24 – Kuyasa Project Carbon Emission Reduction

	Energy use baseline (kWh/ household/ annum)	Emissions baseline (kg CO_2/ household/ annum)	Project emission (kg CO_2/ household/ annum)	Emission reduction (kg CO_2/ household/ annum)
Insulated ceilings	7,710	6,860	5,530	1,330
SWH	1,447	1,228	0	1,228
CFLs	331	294	66	228
Total	**9,488**	**8,390**	**2,790**	**2,790**

Source: Agama Energy, 2010b

The results show the overall reduction in carbon emissions due to the interventions (ceiling, SWH and CFLs) for a typical Kuyasa house in Khyelitsha is 2,790 kg CO_2 per annum. This reduction is made up of 1,330 kg CO_2 per annum and for the ceiling intervention, 1,228 kg CO_2 per annum for the SWH intervention and 228 kg CO_2 per annum for the compact fluorescent light bulbs (CFLs).

2.8.1.3. Costing

The costing for the green interventions of the Kuyasa project is depicted below in table 2.26. The costing is based on 2011 figures.

TABLE 2.25 - Kuyasa Project Greening Intervention Costing, 2011

Green Intervention	Cost per 40m^2 Subsidised Unit 2011
Roof insulation (ceiling +160mm isotherm)	R 3,973
SWH	R 6,000
Roof reinforcement for SWH	R 600
Total	**R 10,573**

Source: Wesselink, 2013

2.8.2. Cosmo City, City of Johannesburg (Gauteng)

2.8.2.1. Overview

The City of Johannesburg embarked on a number of energy efficiency and renewable energy interventions in about 600 low-income houses at Cosmo City (Agama Energy, 2010a). The City of Johannesburg's aim being a reduction in energy consumption and thus lessening the climate change contribution by fossil fuel electricity generation and uplifting the Cosmo City community by reducing service costs as well as improving comfort through the supply of hot water and better thermal efficiency. The retrofit interventions on the subsidy houses in Cosmo City included the installation of solar water heaters and insulated ceilings. These are aimed at reducing the energy required to service those houses.

Figure 2.12 - Cosmo City

Source: Mbara, 2013 and Phalatse, 2013

The overall aim of the project was to determine what the carbon savings are by establishing a pre-intervention carbon emission for a standard specification house and then comparing that to the carbon emissions of the energy efficient (post-intervention) house, the difference being the carbon reduction.

Five similar houses with different orientations, room layout and use pattern were chosen by the City of Johannesburg to be monitored. These are 36m^2 electrified houses with cold water supply. The roofs are corrugated cement fibre roof with no ceiling or insulation and the walls have no plaster.

2.8.2.2. Emission Reduction

The application of the water heating methodology produced results for the equivalent energy required by an electric geyser to supply the households' unsuppressed demand for water heating (86 kWh per month). The carbon emissions associated with the water heating is 115 kg CO_2 per month.

The application of the space heating methodology produced results for the equivalent energy required to heat the lounge up to 21°C from 6am and 8am, and 5pm to 9pm. Averaging the monthly space heating energy requirements, and summing over the winter months, resulted in 665 kWh for a typical Cosmo City house without an Isoboard ceiling, and 417 kWh for a

house with an Isoboard ceiling. The carbon emissions associated with these space heating requirements is calculated as 430 kg CO_2 over winter with an Isoboard ceiling, and 685 kg CO_2 over winter without an Isoboard ceiling.

Table 2.27 shows the annual total reduction in CO_2 emissions per household in Cosmo City after intervention.

TABLE 2.26 – Cosmo City Carbon Emission Reduction

Green Intervention	Emission reduction (kg CO_2/ household/annum)
Insulated ceilings	255
SWH	1,380
Total	**1,635**

Source: Agama Energy, 2010a

The results show the overall reduction in carbon emissions due to the interventions (ceiling and SWH) for a typical Cosmos City house is 1,635 kg CO_2 per annum, made up of 1,380 kg CO_2 per annum for the SWH intervention and 255 kgCO_2 per annum for the ceiling intervention. This compares with estimates from the Kuyasa, CDM project, of 1,288 kg CO_2 per annum for the SWH intervention and 1,330 kgCO_2 per annum for the ceiling intervention. The water heating values compare well between Cosmo City and Kuyasa, while values for the ceiling intervention are much lower for Cosmo City. These results are partly due to the different climatic conditions experienced, and partly due to the fact that the Kuyasa space heating considered the heated space to be the whole house, while in Cosmo City only the lounge was considered.

2.8.2.3. Costing

The costing for the green interventions of the Cosmo City project is depicted below in table 2.28. The costing is based on 2010 figures.

TABLE 2.27 - Cosmo City Greening Intervention Costing, 2010

Green Intervention	Cost per 40m^2 Subsidised Unit 2010
Ceiling and CFL retrofit	R 4,673
SWH	R 4,328
Total	**R 9,001**

Source: Mbara, 2013 and Phalatse, 2013

As seen in table 2.28, the estimated cost of the retrofitting of a ceiling, CFL and a SWH totals to R 9,001 per subsidised unit in 2010.

2.9. GREEN FUNDING OPTIONS AND SUPPORT

Table 2.29 outlines potential green funding and support programmes that can be accessed:

TABLE 2.28 – Green funding and support programmes

Fund	Description
South Africa Green Fund (SA Green Fund, 2013)	This is a fund that seeks to support green initiatives to assist South Africa's transition to a low carbon, resource efficient and climate resilient development path delivering high impact economic, environmental and social benefits.
Green Energy Efficiency Fund (Industrial Development Corporation, 2013)	The Green Energy Efficiency Fund (GEEF) supports the introduction of energy efficiency and self-use renewable energy technologies and will ultimately continue contributing to global climate protection while supporting South Africa's economic development and growth
Clean Development Mechanism (UNFCCC, 2013)	The Clean Development Mechanism (CDM) allows industrialised countries with emission reduction commitments to meet part of their commitments by investing in projects that reduce emissions in developing countries.
Central Energy Fund (CEF Group, 2013)	The Central Energy Fund (CEF) includes financing for appropriate energy solutions to meet the future energy needs of South Africa.
Eskom Integrated Demand Management Funding (Eskom, 2010)	Eskom's Integrated Demand Management (IDM) programme makes funds available to its clients in support of reduced energy

Fund	Description
	demand or consumption. The funding models are: 1. Rebate model 2. Standard Product 3. Standard Offer 4. ESCo funding 5. Performance Contracting 6. Customer Model

Source: Own construction

2.10. CONCLUSION

This section firstly focused on the term “sustainability,” the concept of “sustainable development” as well as “green economy and green building practices.” The terms were conceptualised and the main definition and meaning thereof, as well as literature available on the impact and influence that it has on the growth and development within rural housing projects, was focused on.

The section also looked at the National and Provincial policies that refer directly and indirectly to poverty, unemployment and the Green Economy in South Africa. A socio-economic overview was given to get a more comprehensive insight into the nature, extent and trends of South Africa, the Gauteng Province and the five District Municipalities located within the Province. The socio-economic overview included population and household indicators, age and gender distribution, household income, dwelling type, household access to services as well as economic and employment indicators. Because the study area is located within the City of Johannesburg, the socio-economic overview made a more prominent reference to the area.

Subsidy housing was discussed in terms of the policy trends and key policy initiatives impacting on the national subsidy programme, the total registered properties in South Africa as well as the existing housing backlogs.

The location, project phasing and the costing information of the Lufhereng project necessary for the empirical study was discussed as well as two case studies of energy efficiency and renewable energy interventions in low-cost subsidised housing in South Africa, namely the

Kuyasa project and the Cosmo City project. The greening interventions introduced in these two case studies will be utilised in the empirical section.

It is clear from the secondary research that has been conducted that the key issues as identified in the research questions – namely the levels of unemployment as well as the environmental impacts - be addressed in a positive and constructive sense with the implementation of a green construction approach. A green approach will create more employment opportunities within the community itself, alleviating a certain level of poverty, as well as limit, to some degree, the environmental influences that are products of the conventional building practices.

The next section will focus on the framework for the empirical investigations that will be conducted in this research study.

SECTION THREE: RESEARCH METHODOLOGY

3.1. INTRODUCTION

The objective of this section is to provide a framework for the empirical investigations that have been conducted in this research study in view of exploring how the use of contemporary green building practices instead of conventional non-green approaches will have social, economic as well as environmental advantages in the Lufhereng development. In order to achieve the set objectives, quantitative as well as qualitative research methods were utilised.

Research, according to the Oxford Dictionary (2013), is the "*the systematic investigation into and study of materials and sources in order to establish facts and reach new conclusions*." Vermeulen (1998a) supported by Leedy and Omrod (2000) as well as Cooper and Schindler (2006) explained research as a systematic endeavour which seeks to provide answers to questions, implying a dynamic process that builds on previous research and opens opportunities for new research. Salkind (2003) regards research is an activity that generates new questions and that the process resembles a cyclical pattern, primarily undertaken for the betterment of society or, as in this case, the institution.

Henning, Van Rensburg and Smit (2004) state that the research methodology of a study can be described as the philosophical framework which guides the research activity and also serves as the tradition or paradigm within which the research problem is framed. It furthermore guides the selection of the research participants as well as the subsequent data-gathering and data analysis techniques. The research methodology encapsulates people's general orientation to life, their sense of being and even the way they view knowledge, which ultimately informs the choice of source or method of inquiry in a study (Salkind, 2003).

For the purpose of this study a **mixed-method approach** has been used. Diagram 3.1 illustrates the outline of this section.

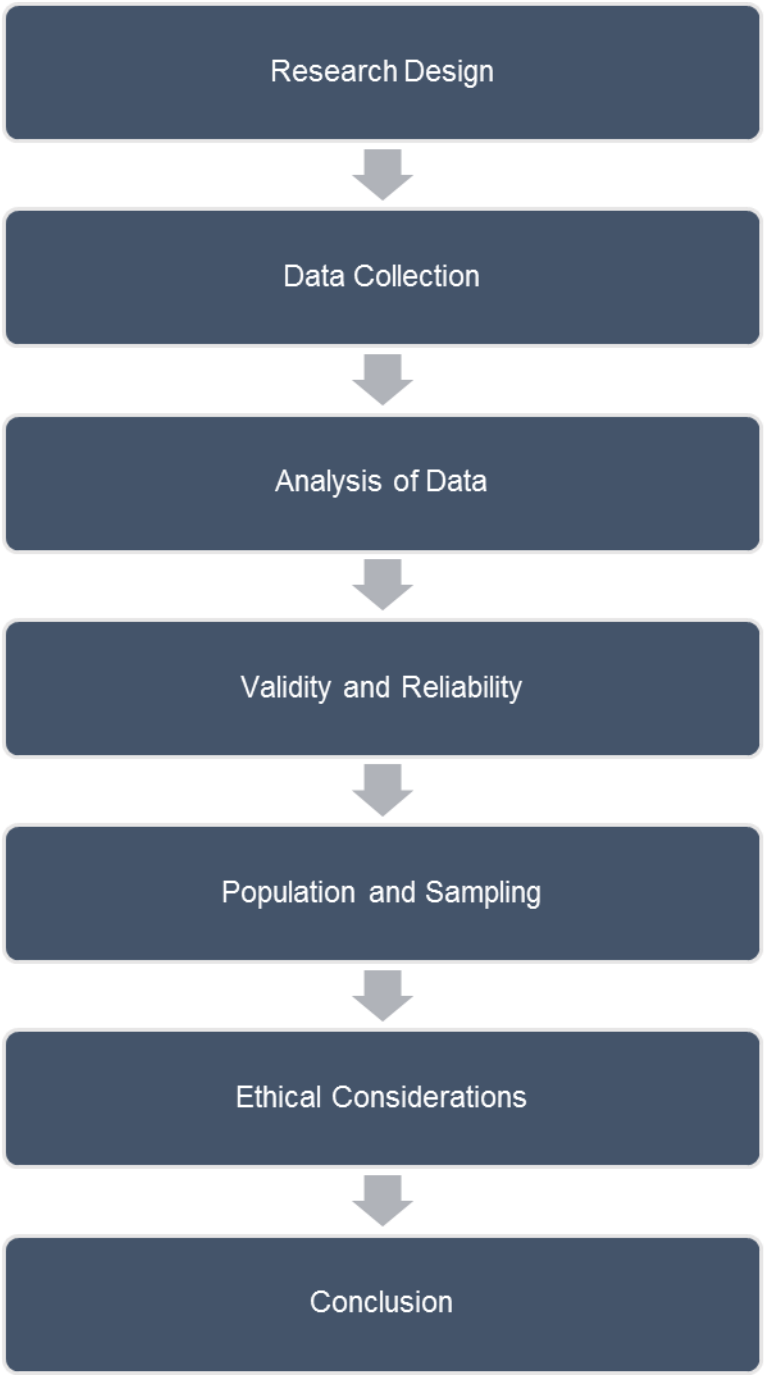


DIAGRAM 3.1 – Outline of the Methodology Section

Source: Own construction

3.2. RESEARCH DESIGN

The mixed methods empirical investigation that has been conducted included both quantitative as well as qualitative methods of research. This will hence be discussed in more detail.

3.2.1 Research methods and methodology

For the purpose of this study, a mixed method research design has been chosen. Both qualitative as well as quantitative research methods as well as data analysis techniques were utilised. According to Fraenkel and Wallen (2010) quantitative and qualitative methods may be combined in any way that is suitable for conducting a research study, even though these approaches differ on a number of levels. Quantitative research, on the other hand, is predominantly embedded in positivism which holds that reality is objective and observable. Qualitative research is rooted in the belief that reality is socially constructed and as such aims at uncovering what lies beneath the surface of the phenomenon that is investigated, while seeking to understand certain perceptions of the stakeholders involved (Airasian *et al.,* 2010).

In the same context, Vermeulen (1998b) states that a quantitative approach relies on numerical data which are highly formalized and explicitly controlled, while a qualitative approach is not strictly formalized and adopts a more philosophical mode of operation.

3.2.1.1 Quantitative research

Airasian *et al.* (2010) explain that quantitative research consists of the collection as well as the analysis of data in numerical form to describe, explain, predict or control phenomena that is of interest. As a positivistic paradigm quantitative methods can be seen as the focus of attention on precise measurements in a standardised and systematic research procedure (Cooper and Schindler, 2006). Leedy and Omrod (2010) explain that quantitative research usually involves the consideration of one or more variables of interest. These authors continue by explaining that this type of research also includes the isolation of the variables that must be tested in the research process, as well as the control of those variables by employing statistical methods to analyse and draw conclusions from the data.

Unlike with qualitative research, quantitative research is not subject to the researcher's subjective perspective, but rather aims at an objective analysis to ensure that the information gleaned from the participants is reflected correctly. This approach is framed within the positivist paradigm, but follows a realist stance by which the data will eventually be viewed and interpreted together with the qualitative data. This will enable the researcher to provide comprehensive evidence to explain the phenomenon as set out in the problem statement.

For the purpose of this study, relevant statistics were obtained from the stakeholders, and interpreted by the researcher.

The statistics utilised are as follow:

1. Statistics South Africa Census 2001 and 2011 provided statistics on the socio-economic environment.
2. The City of Johannesburg provided statistics on the construction costs of the Lufhereng project.
3. The City of Johannesburg as well as SouthSouthNorth, an independent company, provided statistics on green retrofitting costs.
4. The Development Bank of South Africa (DBSA) provided the Socio-Accounting Matrix.
5. The City of Johannesburg also provided statistics on environmental issues.
6. Standardised Regional Data was obtained from Quantec Research.

3.2.1.2 Qualitative research

Best and Kahn (2003) describe the qualitative research approach as a gathering of information whereby participants provide information from their own perspectives. Woods (1999) refers to the meaning that participants attach to their behaviour as well as their interpretation and perspectives on certain situations. Leedy and Ormrod (2001) further maintain the intimate acquaintances that this research approach has with the different feelings, motivations and qualities of people, it tends to uncover situations as they are experienced and understood by the participants.

Qualitative research is a naturalistic enquiry which utilizes non-interfering data as well as collection strategies to uncover the natural flow of events. De Vos (2000) emphasises the multi-perspective dimension of social interaction that qualitative research has on sense-making as well as reconstructing human interaction in terms of the value and meaning that the participants attach to it. Salkind (2003) explains that qualitative research is done to examine human behaviour and the social, cultural, as well as the political context in which it occurs, and that the time frame of this type of research can be current or past, yielding findings in the form of non-numeric data.

Wilson (1997) states that qualitative research employs data collecting strategies that are non-manipulative to uncover the natural flow of events and processes such as semi structured or structured interviews, observations, diaries and/or questionnaires containing

open-ended questions. For the purpose of this study the researcher sent a questionnaire with open ended questions to 200 professionals in the “Green Building” industry (Green Star SA Accredited Professional contact details obtained from the Green Building Council – South Africa). This allowed the respondents to reflect on some of their feelings and opinions regarding the aspects within their environments that may influence their job satisfaction.

Professionals were asked the following:

1. In your opinion, do you think green building can be applied, as a viable option, to low cost (RDP) housing in South Africa? Individuals were asked to motivate their opinion.
2. What green building interventions do you think can be applied to low cost (RDP) housing in South Africa?

3.3. DATA COLLECTION

For the purpose of this research study three data collection approaches were utilised as to allow for triangulation between the findings. Semi-structured interviews, open-ended questionnaires as well as existing statistics were used to collect data.

According to Airasian *et al.* (2010) questionnaires are instruments which attempt to obtain comparable data from all members partaking in the sample given that the same questions have to be answered by all participants. By including open-ended questionnaires for determining how people feel about certain issues, or, alternatively, to establish the effect that troubling issues have on the behaviour of people (White, 2005) could be rather valuable for this study, because, the specific problems and issues that may influence green building practices can only be expressed by the qualitative expression of the views and opinions of the participants.

3.4. ANALYSIS OF DATA

Sarantakos (1998) explains that data analysis can be viewed as the process which involves the selection and focus of data as well as the discarding of irrelevant data. Research means that the collected data is analysed and interpreted by the researcher with the purpose of bringing structure as well as order to the available information.

In view of the fact that this study makes use of quantitative as well qualitative research analysis, both is discussed next.

3.4.1. Quantitative analysis

The quantitative statistics that were obtained from the various stakeholders were interpreted by the researcher and applied in the development of the new model.

Social accounting matrices and multiplier analysis, which are discussed in the next section, were used to interpret and analyse the data.

3.4.2. Qualitative analysis

Cresswell (2003), supported by McMillan and Schumacher (2010) defines qualitative research analysis as an inquiry process of understanding, based on methodological traditions of inquiry that exposes a human or a social problem. During the study the researcher built a complex, holistic picture, and reported detailed views of participants

Themes that emerged from the information obtained, helped the researcher to gain a better understanding of the phenomenon at hand.

3.4.3 Interpretation of data

The quantitative data obtained from the case studies was analysed by means of the relevant matrixes and reported by means of descriptive statistics. In order to render an in-depth understanding of the participants' experiences, the qualitative data was transcribed and meaningful themes were identified and discussed. The findings were summarised according to the influencing factors, the relevant literature as well as the findings from research in Section 5 (c.f. Table 5.1).

3.5. VALIDITY AND RELIABILITY

Thomas (1998) reasons that reliability and validity are important attributes of a research instrument. McLaughlin and Mertens (2004) state that validity, as well as reliability, is key to maintaining appropriate standards in research. They continue by saying that research is a

scientific method of inquiry, and that information should be carefully assessed by testing for validity as well as reliability. Salkind (2003) is of the opinion that “reliability (or consistency) and validity (or the does-what-it-should-do qualities)” of a measurement instrument is essential, as the absence of these qualities or attributes explains why a researcher acts incorrectly when accepting or rejecting a research hypothesis.

3.5.1. Reliability

Gray (2004) believes that reliability is a central concept associated with measurement, and that it essentially means consistency. Consistence, in this instance, means that the scores obtained by an instrument can be confirmed by using alternative data sources. The obtained data can also be interpreted by other researchers to establish whether they reach the same conclusion as the primary researcher. Salkind (2003) explains that reliability is when a test measures the same thing more than once, with the same outcomes. The author continues to explain that reliability is often reflected in the value of the correlation coefficient.

Neuman (1997) explains that reliability means that information provided by certain indicators does not change as a result of the characteristics of the indicators, the research instruments or the measurement device used in the study. This explanation is very significant as it minimizes errors made in the study. This is supported by McLauglin and Mertens (2004) who explain validity as the stability of observed changes over time within a positivist paradigm.

3.5.2. Validity

Seale (1998) views validity as the degree to which findings of a research study presents a true and accurate picture of what is claimed or described in the research. Neuman (1997) explains validity as the appropriateness of a statement including its importance in determining which research information is valid, thus implying that no matter which type of questionnaire or research instrument is used, it should measure what it is set out to measure. The author continues to explain that measurement validity refers to how well the conceptual as well as operational definitions match. Salkind (2003) explains that validity means that the test or instrument that is used by the researcher should actually measure what the researcher set out to measure.

Welman and Kruger (2001) are of the opinion that validity refers to the appropriateness of a statement and moreover, that it is important to determine whether data is valid and are used for its intended purposes. Construct validity refers to the instrument used to measure the variable at hand, controlling that it measures what it is supposed to. These authors continue by saying that the instrument that is used in the study should remain constant over the duration of the study.

In order to ensure the validity of the qualitative aspect of the data, the researcher guarded against bias, and the data obtained from the qualitative portion of the questionnaires were continuously compared until no new affirmative or information that contrasted the existing information, was found, a process which, according to Niemann, Niemann, Brazelle, Van Staden, Heyns and De Wet (2000) can be seen as a manner in which the validity of the findings can be measured. For the purpose of this study, a summative table (c.f. Table 5.1) has been constructed to validate the influencing factors, supporting literature and subsequent findings from research.

3.6. POPULATION AND SAMPLING

The population of a research study refers to the “complete set of events, people of things to which the research findings are to be applied,” (Bless, Higson-Smith and Kagee, 2006), while the sample refers to the specific members within the population that will be used to obtain data from (Travers and Cooper, 2006).

The population and sample utilised for this research study, is discussed next.

3.6.1. Population

Mouton (1998), Maree (2009) together McMillan and Schumacher (2010) define population as a group of elements or cases - be it individuals, objects or events - that conform to specific criteria. Airasian and Gay (2003) as well as Gray (2004), describe the population as a group of elements which interests the researcher, and to which the results of the study will be generalised. Gorard (2001) defines the population as the group that you use for your research study.

The population for this research study consisted out of the low cost subsidy housing projects in South Africa.

3.6.2. Sample

To Vermeulen (1998b), supported by Welman and Kruger (2001) and Corbetta (2003), sampling means taking a portion of the available population and considering it to be a representation of the population. This is confirmed by Arasian, Gay and Mills (2009), who explain that a sample in research refers to the selection of a number of individuals from the greater population of the study in such a fashion that these individuals represent the larger group from which they were chosen.

For the purpose of this study, purposeful sampling was used in the form of a case study approach, focussing on the Lufhereng development. This development is discussed later in this section.

As this research study is based on a single low cost subsidy housing project, the concept of "case studies" will be discussed next.

3.6.3. Case studies

Case studies, according to Breakwell, Fife-Schaw and Hammond (2000), can be defined as "retrospectively written reports of observations or opinions made by individuals, which may raise questions that can initiate research." According to Simon (1987) "a case study is a metaphor that appealed to those who were looking for a way of integrating the comprehensive data requirements that emerged from various critical reviews of the evaluation tradition." Saslow (1982) explains that case studies are narrative descriptions of an individual or organisation's history, symptoms, behaviour, and response to treatment.

Different disciplines also have different interpretations of what a case study is. According to Burton (2000) case studies can be seen as a detailed examination of an event or events which the researcher believes to exhibit the operation of some identified theoretical principal. The author continues by explaining that, from an organisational point of view, case studies can be seen as "empirical enquiries that investigate a contemporary phenomenon in context, and when the boundaries between the phenomenon and the context are not clear, multiple sources of evidence is used" (adapted from Yin, 1994). Ragin (1992) explains that a case study can also comprise an event such as organisational change, or even aspects that may hamper the functionality of an institution.

Shaw (1999) states that case studies are flexible and multi-purpose, and that they may be descriptive, exploring and providing portraits of little known entities, which may be persons, situations or institutions. The author continues by stating that case studies may also be selective, consequently pursuing more richly detailed accounts of different processes at work also showing how these processes influence one another. Case studies may also be designed to produce a kind of experimental isolation of selected social factors within an authentic life context.

Stake (1994) is of the opinion that a case is something to be studied, such as a student, a classroom, a committee or an organisation. The author adds that the case to be studied probably has problems or relationships, and the report of the case is likely to have a theme, but that the case is a unique entity. Yin (1989) comments that case studies allow investigations which may accommodate holistic and meaningful characteristics of real-life events such as individual life cycles, international relations, managerial processes, neighbourhood change, including events such as the maturation and change of organisations.

Schostak and Schostak (2008) explain that case studies are important, because by performing them the "dynamics of the synchronic and diachronic can be elaborated, covering and describing the in-depth interactions of the dramatis personae, mapping the multi-dimensional spaces of their intentional networks, their beliefs, interests, values, practices as well as events that take place, which influence themselves as well as the environment surrounding them."

For the purpose of this study the Kuyasa project in Khayelitsha, Western Cape, as well as Cosmo City, a City of Johannesburg initiative, two low cost housing projects that have implemented green building practices, was used as a baseline again which the Lufereng case study project was measured. Existing information obtained from these existing low cost housing projects, together with empirical primary research as well as secondary research obtained from an extensive literature review, was utilised in the construction of the approach and subsequent findings of this research project.

3.7. Ethical considerations

It is of utmost importance that the researcher at all times protects the identities of the respondents who participate in a study. For this reason it is important for the researcher to apply research ethics, which can be described as the norms and standards of the behaviour that guides the choices and behaviours of a researcher towards the respondents of a study (Cooper & Shindler, 2006). In order for the researcher to adhere to ethical standards, it is important to refrain from any form of bias in the research design, data analysis as well as interpretation of the data.

For the purpose of this study, any confidential information that may lead to the identification of the respondent was omitted by the researcher.

All data, results and methods used by the researcher were honestly used and interpreted by the researcher. Prior consent was obtained from the organisations as well as the respondents who voluntarily participated in the study.

3.8. CONCLUSION

This section initially identified the research methods that will be used as well as the rationale for making use of these methodologies. Quantitative as well as qualitative data analysis was discussed and an explanation was provided on how to validate information obtained from the questionnaires. The data capturing instrument was put forward and clarified after which the population and sample for this study were identified and explained. In the following section the data analysis will be reported and discussed.

SECTION FOUR: EMPERICAL STUDY

4.1. INTRODUCTION

The purpose of this section is to determine the difference between conventional building and contemporary green building practices in low cost housing (subsidised houses) in terms of sustainability (economic, social and environmental effects). In order to make the two approaches measurable for comparison the two different approaches were applied to an actual housing project located in the City of Johannesburg, Gauteng Province, South Africa namely Lufhereng.

With the injection of capital into the economy during the construction phase there will be different economic and social effects. The economic effects will be determined in terms of direct and indirect change in gross output of all production activities (output multiplier) as well as total change in value-added (GDP multiplier). The social effects will be determined in terms of the change in household incomes (income multiplier) caused by the injection of capital during construction. After the construction phase, the greening interventions applied to the subsidised housing units will take effect causing a change in carbon emissions. This change in carbon emissions due to the greening interventions will be used to determine the environmental effects. Diagram 4.1 illustrates the outline of this section.

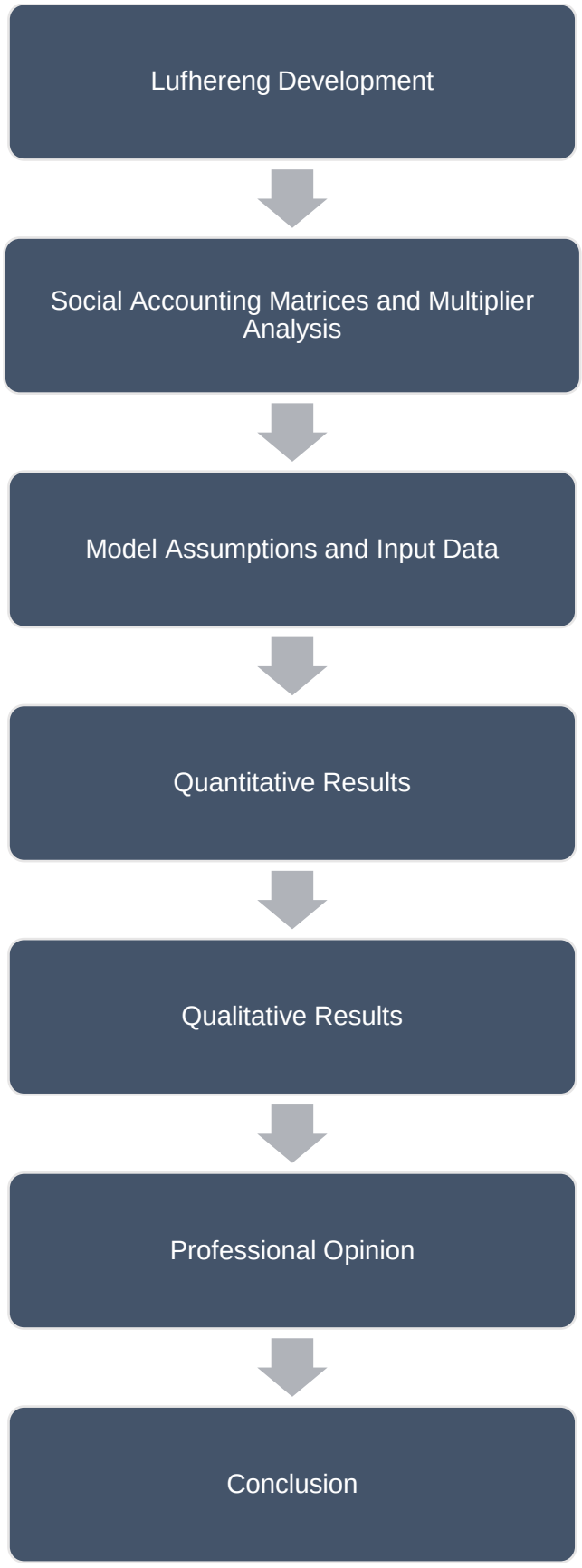


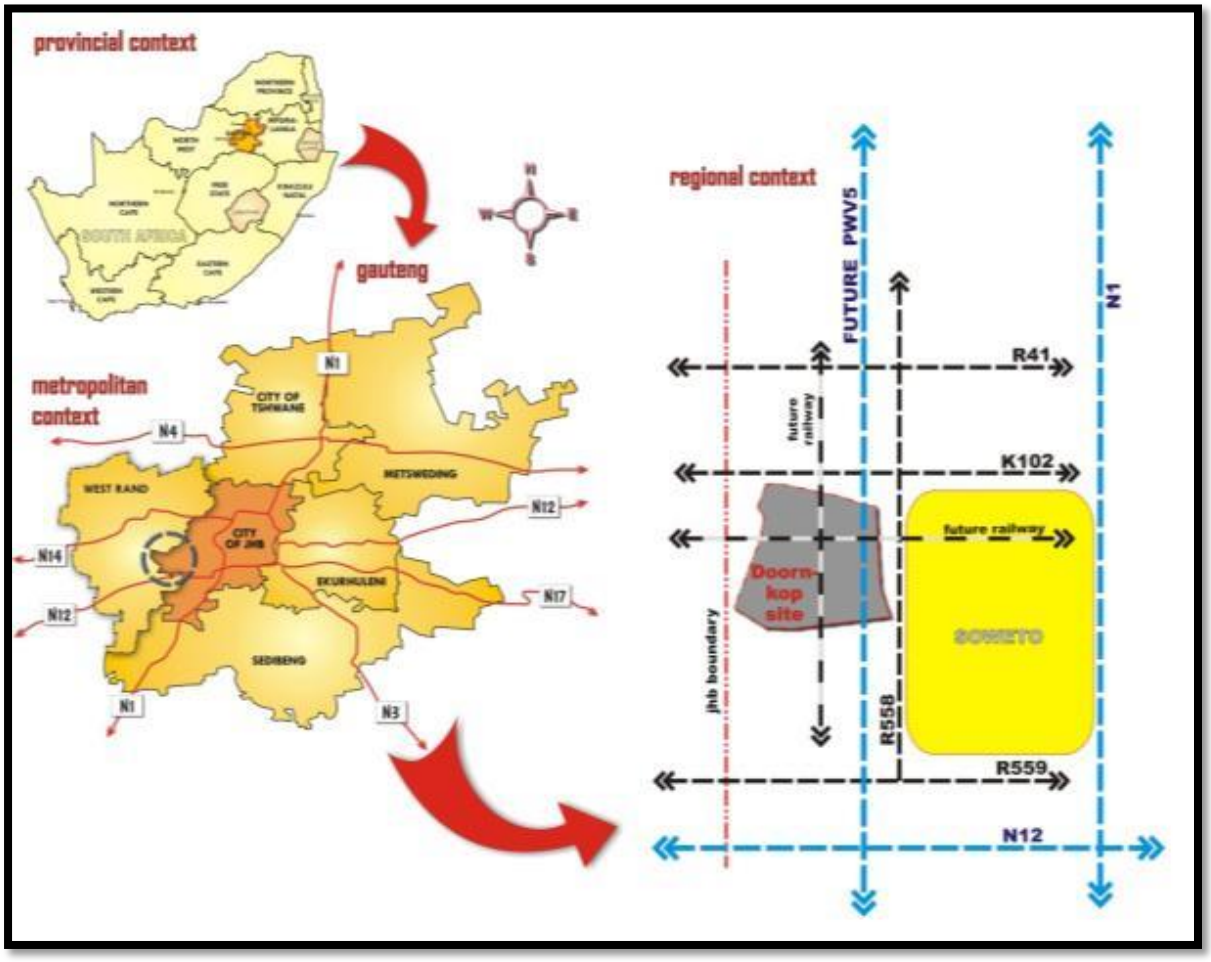
DIAGRAM 4.1 - Outline of the Empirical Study Section

Source: Own construction

4.2. LUFHERENG DEVELOPMENT

4.2.1. Location

On a regional scale (refer to map 4.1 below), Lufhereng is located in the central portion of Gauteng Province, to the west of Soweto in the general vicinity of the Roodepoort and Lenasia nodes. Lufhereng is located on the western side of Soweto, between Slovoville/Tshepisong in the north, and Protea Glen/Lenasia in the south. Two farms are the subject of the Lufhereng development; they are the Farm Doornkop 239 IQ and Farm Zuurbult 240 IQ. The project is located to the west of Soweto and is seen as one of limited sites to accommodate a large portion of the housing backlog in Soweto and surrounds.



MAP 4.1 - Location of the Lufhereng Development on a Regional Scale

Source: Urban Dynamics, 2008

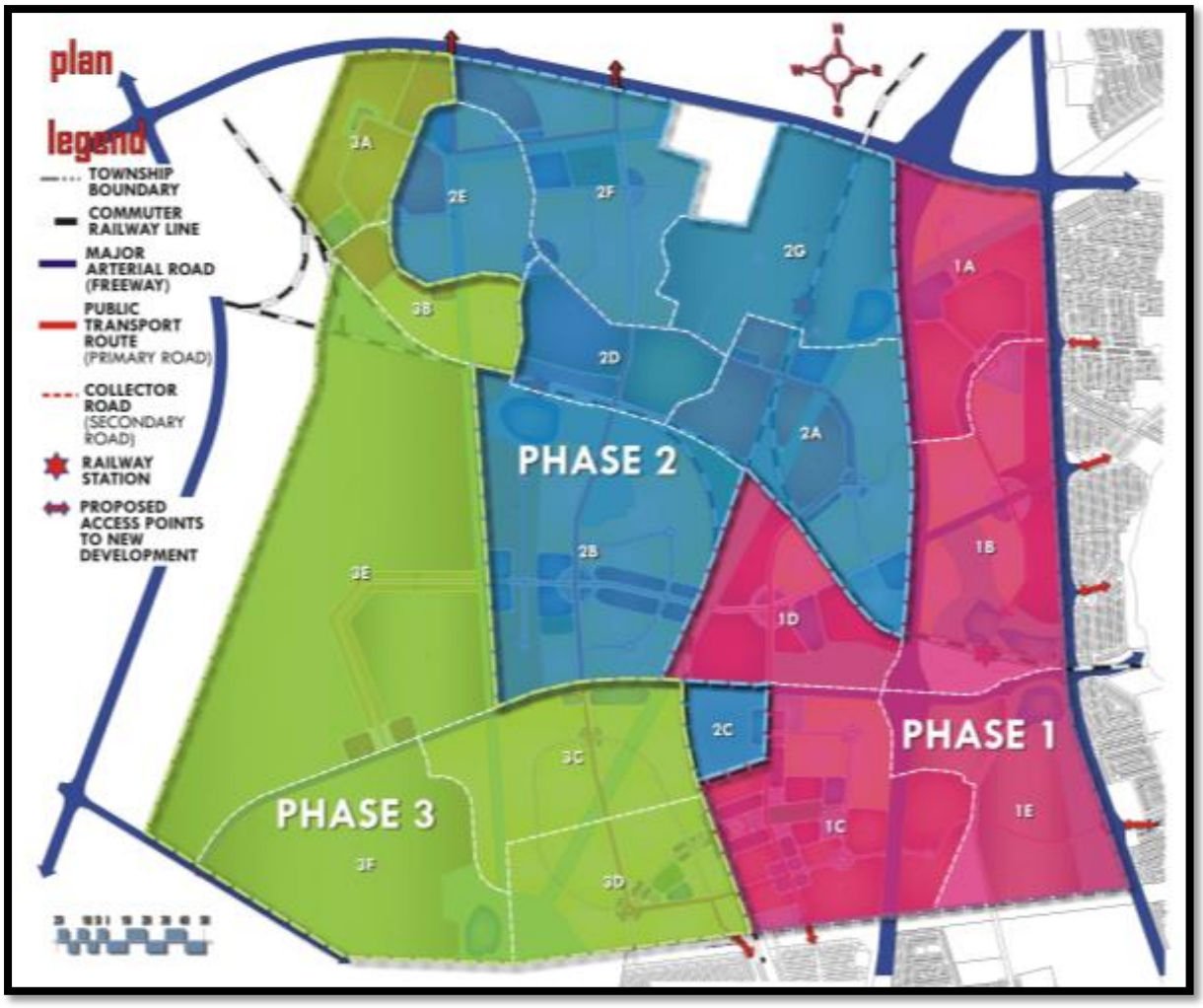
4.2.2. Project Phases

According to the Lufhereng Business Plan (Department of Housing, 2008), the Lufhereng Mixed Housing Development project is divided into 3 Phases and 17 sub Phases (Precincts):

- Phases 1A to D
- Phase 2A to G
- Phase 3A to F

The total number of residential units provided for the Lufhereng Mixed Housing Development is estimated at 24,145 top structure units. The total number single residential stands provided are 15,493 erven of which 7,619 are subsidised erven and another 7,874 are bonded erven. The total number of walk-up (institutional) units provided is 8,652, of which 4,326 units are subsidy/low- rental (institutional) and 4,326 units are rental (institutional).

Map 4.2 below shows the development phasing:



MAP 4. 2 - Lufhereng Development Phasing

Source: Urban Dynamics, 2008

4.2.3. Costing

The overarching business plan provides for cross-subsidised top structures for the subsidised housing units which means the subsidised housing consist of two funding elements, firstly the housing subsidy amount and secondly the cross subsidisation amount. The cross subsidisation amount will be will be generated from the profits generated on the release of serviced stands and the proportional profits on the top structure of all bonded housing (7,874 erven in total). The cross-subsidisation amount in the overarching business plan for 2008/2009 is R15,000 per subsidised stand, plus R2,000 for a boundary fence or wall.

The approved 2008/2009 housing subsidy for a 40m^2 top structure is R 43,506 per housing unit. Alternative sources of funding should be utilised for covering the costs of installing

municipal and link services. Where such alternative funding sources is not available, an amount of R 17,847 per stand will be made available from the housing fund for the installation of the municipal and link services. This totals the overall housing subsidy (top structure and installation of municipal and link services) amount to R 61,353 per subsidised housing unit.

A maximum geotechnical allowance of 15% of the basic subsidy is available for sites with inherent geotechnical difficulties. In view of the base geology which adds substantially to the cost of engineering and top structures, it is expected that the maximum allowance will be available for the development. The additional 15% allowance on the $40m^2$ top structure amounts to R 67,526 per housing unit.

Breaking New Ground (BNG) projects attract more service on top structures costs due to their integrated nature. Service and top structure standards that detract from adjacent bonded units will impair the bonded unit market and repel commercial investment; both key objectives of the BNG integrated development strategy. Inherently, subsidised units that discourage private sector investment work against the primary objectives of the BNG policy, in particular trading in the low cost housing market.

The principle stakeholders in the Lufhereng project have agreed that Lufhereng should be a flagship project demonstrating the effective working of the BNG principals and supporting its objectives. With this in mind, the Lufhereng Project Steering Committee (PSC) recommended a project specific subsidy top-up of R5,000 per fully subsidised residential housing unit for the Lufhereng project.

Table 4.1 indicates the total allowance for fully subsidised top structures in the Lufhereng development.

TABLE 4.1 - Total allowance for a fully subsidised top structure

Item	Amount
Basic housing subsidy ($40m^2$ top structure)	R 43,506
Geotechnical allowance	R6,526
Cross-subsidisation on top structures (from bonded/commercial stands in market)	R 15,000
Cross-subsidisation for a boundary fence or wall (from bonded/commercial stands in market)	R 2,000

Item	Amount
Flagship BNG project special grant	R 5,000
Total (excluding VAT)	**R 72,032**

Source: Davis, 2013

The total number of residential units that form part of the Lufhereng development is estimated at 24,145 top structure units of which 7,619 will be subsidised erven (40m^2 subsidised houses). For the purpose of this study, the focus will fall on the 7,619 subsidised erven.

4.3. SOCIAL ACCOUNTING MATRICES AND MULTIPLIER ANALYSIS

One way of portraying the economy is the circular flow diagram shown in diagram 4.2, which captures all transfers and real transactions between industries and organisations (Breisinger, Thomas & Thurlow, 2009). Productive activities purchase land, labour, and capital inputs from the factor markets, and intermediate inputs from commodity markets, and use these to produce goods and services. These are supplemented by imports (M) and then sold through commodity markets to households (C), the government (G), investors (I), and foreigners (E). In the circular flow diagram, each organisation's expenditure becomes another organisation's income.

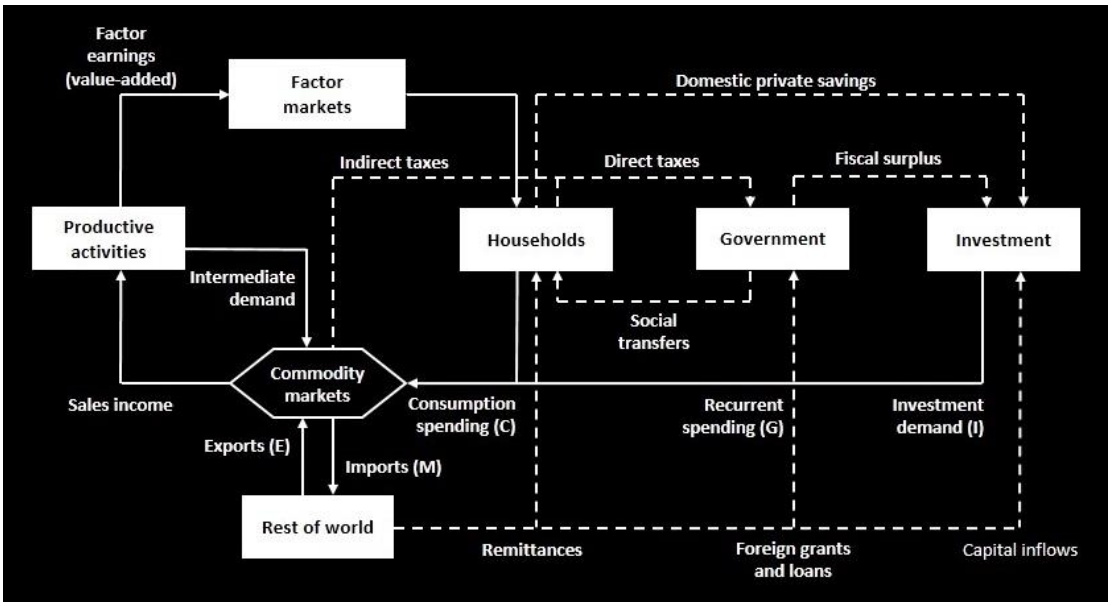


DIAGRAM 4.2 - Circular flow of the economy

Source: Adapted from Breisinger *et al*., 2009

For instance, household and government purchases of commodities provide the incomes producers need to continue the production process. Extra inter-institutional transfers, including taxes and savings, ensure that the circular flow of incomes is closed. In other words, all income and expenditure flows are accounted for, and there are no leakages from the system.

A Social Accounting Matrix (SAM) is also a representation of the economy. According to Löfgren *et al.* (2001) a SAM can be described as a "comprehensive, economy-wide data framework" presented in the form of a square matrix. It has two standard objectives: firstly, to organise information about the economic and social structure of an economy (e.g. a country of a specific region) in a specific period (usually one calendar year), and secondly, to provide the statistical basis for the creation of credible economic models (King, 1985).

More specifically, a SAM is an accounting framework that assigns numbers to the incomes and expenditures in the circular flow diagram. A SAM is laid out as a square matrix in which each row and column is called an "account." Table 4.2 shows the SAM that corresponds to the circular flow diagram in diagram 4.2. Each of the boxes in the diagram is an account in the SAM. Each cell in the matrix represents, by convention, a flow of funds from a column account to a row account. The fundamental principle of double-entry accounting requires that, for each account in the SAM, total revenue equals total expenditure. This means that an account's row and column totals must be equal. The equality of inputs and outputs in a transaction table is considered an accounting identity (O'Connor and Henry, 1975).

TABLE 4.2 - Basic Structure of a Social Accounting Matrix

		Expenditure columns							
		Activities C1	Commodities C2	Factors C3	Households C4	Government C5	Investment C6	Rest of world C7	Total
Income rows	Activities R1		Domestic supply						Activity income
	Commodities R2	Intermediate demand			Consumption spending (C)	Recurrent spending (G)	Investment demand (I)	Export earnings (E)	Total demand
	Factors R3	Value-added							Total factor income
	Households R4			Factor payments to households		Social transfers		Foreign remittances	Total household income
	Government R5		Sales taxes and import tariffs		Direct taxes			Foreign grants and loans	Government income
	Savings R6				Private savings	Fiscal surplus		Current account balance	Total savings
	Rest of world R7		Import payments (M)						Foreign exchange outflow
	Total	Gross output	Total supply	Total factor spending	Total household spending	Government expenditure	Total investment spending	Foreign exchange inflow	

Source: Adapted from Breisinger *et al*., 2009

The SAM distinguishes between “activities” and “commodities.” Activities are the entities that produce goods and services, and commodities are those goods and services produced by activities. They are separated for the reason that sometimes an activity produces more than one kind of commodity (by-products). Likewise, commodities can be produced by more than one kind of activity.

Activities produce goods and services by combining the factors of production with intermediate inputs. This is shown in the activity column of the SAM, where activities pay factors the wages, rents, and profits they generate during the production process (that is, value-added). This is a payment from activities to factors, and so the value-added entry in the SAM appears in the activity column and the factor row (R3-C1). Also, intermediate demand is a payment from activities to commodities (R2-C1). Gross output is derived from adding value-added and intermediate demand together. The information on production technologies contained in the activity column is the input part of a typical “input–output table,” or factor and intermediate inputs per unit of output.

Commodities are either supplied domestically (R1-C2) or imported (R7-C2). Indirect sales taxes and import tariffs are paid on these commodities (R5-C2). This means that the values in the commodity accounts are measured at market prices. A number of economic entities purchase commodities.

As mentioned earlier, activities purchase commodities to be used as intermediate inputs for production (R2-C1). Final demand for commodities comprises of household consumption spending (R2-C4), government consumption, or recurrent expenditure (R2-C5), gross capital formation or investment (R2-C6), and export demand (R2-C7). All of these sources of demand make up the commodity row (payments by different entities for commodities). On their own, the commodity row and column accounts are sometimes referred to as a “Supply–Use Table,” or the total supply of commodities and their different kinds of uses or demands.

The SAM in table 4.1 shows only single activity and commodity rows and columns. Yet, a SAM generally contains a number of different activities and commodities.

A SAM is different from an input–output matrix due to the fact that it not only traces the income and expenditure flows of activities and commodities, but it also contains complete information on different institutional accounts, such as households and the government. Households are usually the final owners of the factors of production, and so they receive the incomes earned by factors during the production process (R4-C3), they also receive transfer

payments from the government (R4-C5) and from the rest of the world (R4-C7). Households then pay taxes directly to the government (R5-C4) and purchase commodities (R2-C4). The remaining income is then saved, or dis-saved if expenditures exceed incomes (R6-C4).

The government receives transfer payments from the rest of the world (R5-C7). This is added to all of the different tax incomes to determine total government revenues. The government uses these revenues to pay for recurrent consumption spending (R2-C5) and transfers to households (R4-C5). The difference between total revenues and expenditures is the fiscal surplus (or deficit, if expenditures exceed revenues) (R6-C5).

4.3.1. Economic Linkages and Multiplier Effects

When referring to “exogenous demand-side shocks” to an economy, one is referring to changes in export demand, government spending, or investment demand. The impacts of these shocks have both direct and indirect effects (refer to Diagram 4.3). Direct effects are those pertaining to the industry that is directly affected by the shock. An exogenous increase in demand for a specific industry’s exports has a direct impact on that industry. But, it may also have indirect effects originating from that industry’s linkages to other industries and parts of the economy. These indirect linkages can, in turn, can be separated into production and consumption linkages. When all the direct and indirect linkages are added up, one arrives at a measure of the shock’s multiplier effect, or how much a direct effect is amplified or multiplied by indirect linkage effects.

Production linkages are determined by industry’ production technologies, which are contained in the input-output part of SAM. They are differentiated into backward and forward linkages.

1. Backward production linkages are the demand for extra inputs used by producers to supply additional goods or services.
2. Forward production linkages account for the increased supply of inputs to upstream industries.

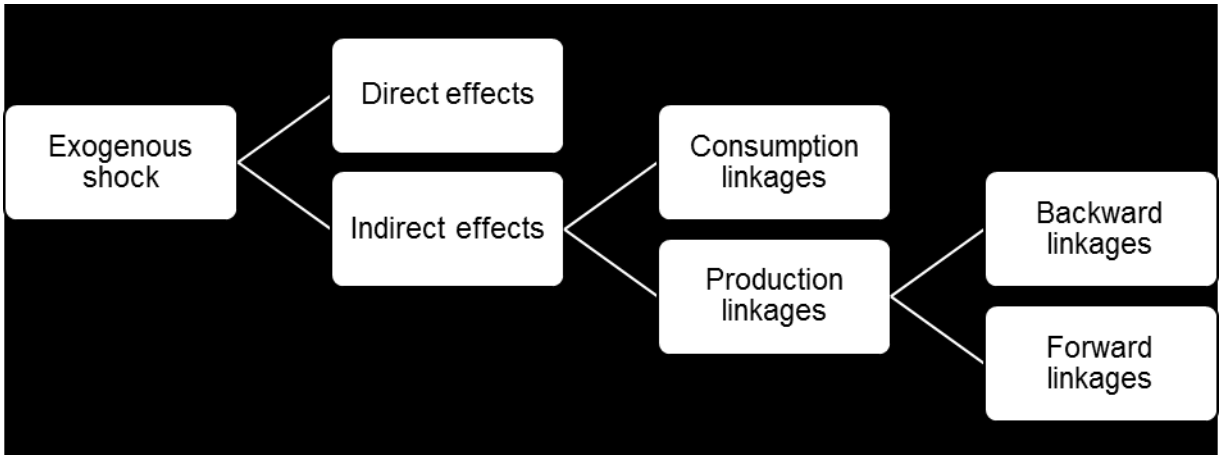


DIAGRAM 4.3 - Direct and indirect linkages

Source: Adapted from Breisinger *et al*., 2009

The stronger forward and backward production linkages are, the larger the multipliers. Originally, input-output multipliers measure the effects of production linkages only. They do not reflect consumption linkages, which arise when an expansion of production generates additional incomes for factors and households, which are then used to purchase goods and services.

Depending on the share of tradable and non-tradable goods in households' consumption baskets, domestic producers benefit from greater demand for their products. The size of consumption linkages depends on various factors, including the share of factor income distributed to households; the composition of the consumption basket; and the share of domestically supplied goods in consumer demand.

Economic linkages are fairly static and are determined by the structural characteristics of an economy. Multiplier effects, on the other hand, capture the combined effects of economic linkages over a period of time. SAM multipliers measure the value of all production and consumption linkage effects. They capture direct and indirect effects in the first and all subsequent rounds of the circular income flow. More accurately, multipliers translate initial changes in exogenous demand into total production and income changes of endogenous accounts.

There can be distinguished between three types of multipliers (refer to diagram 4.4). First, an *output multiplier,* which combines all direct and indirect (consumption and production) effects across multiple rounds and reports the final increase in gross output of all production activities (A on diagram 4.4). Second, a *GDP multiplier* which measures the total change in

value-added or factor incomes caused by direct and indirect effects (B on diagram 4.3). Lastly, the *income multiplier,* which measures the total change in household incomes (C on diagram 4.4).

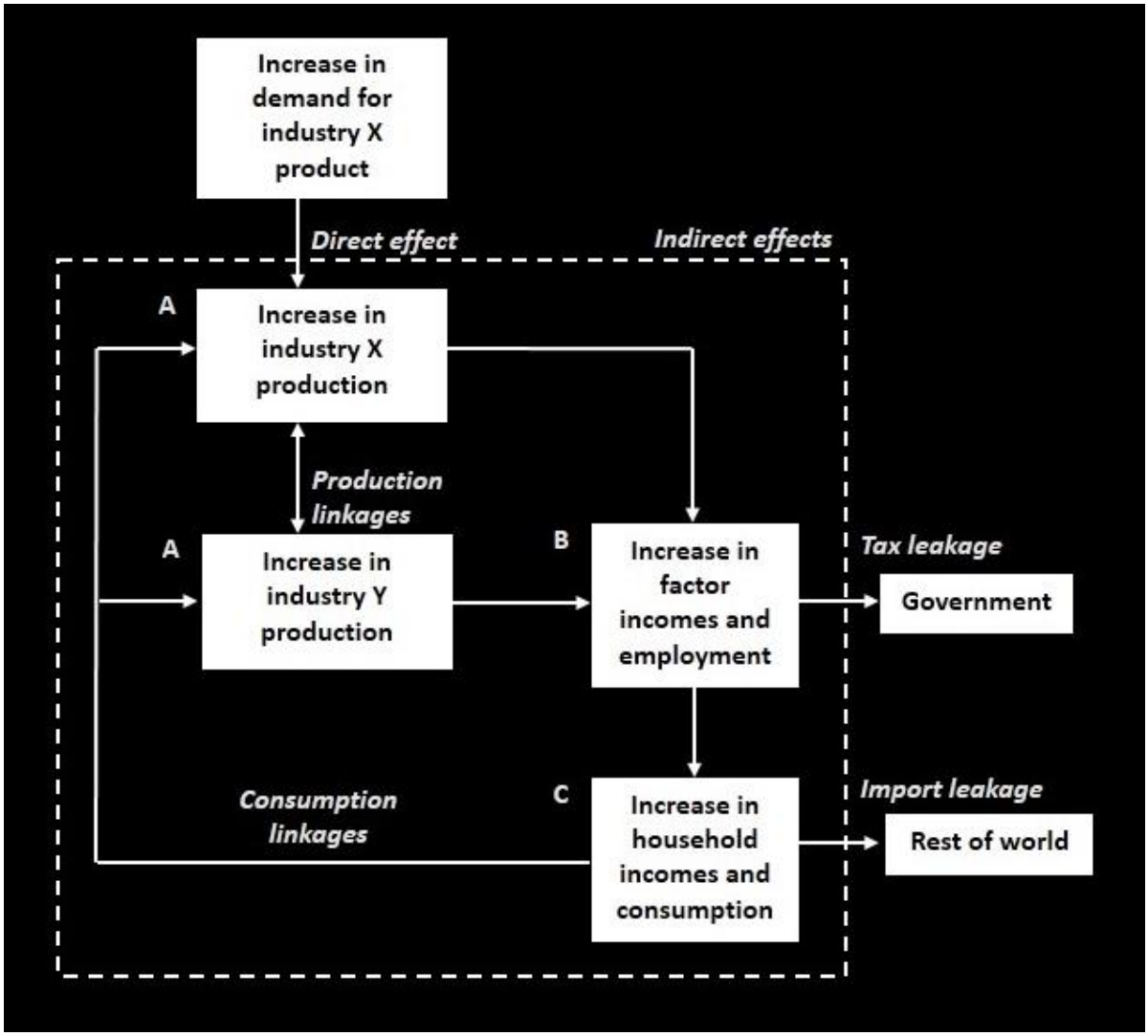


DIAGRAM 4.4 - Circular flow of income in the multiplier process

Source: Adapted from Breisinger *et al*., 2009

4.3.2. Unconstrained Multiplier Formula

SAM multipliers are an extension of the classic Leontief input-output model. Although the Leontief model concentrates on inter-industry production linkages, SAM-based models also include consumption linkages. Consumption linkages are included by making institutions like households and the government “endogenous.” The SAM multiplier method consequently makes use of information on household factor endowments and income distribution. SAM

multiplier models have been utilised for various issues from trade policies and macroeconomic shocks (Pyatt and Round, 1985; Reinert and Roland-Holst, 1997).

The SAM multiplier framework can be utilised to estimate the impacts of changes in any of the exogenous demand accounts in the model. Since households are treated as endogenous in the model, it leaves three possible sources of demand stimulus: export demand, government spending, and investment demand. Exogenous changes in demand for these accounts are then transmitted to endogenous accounts, including producing sectors and households.

Unconstrained multiplier models assume that prices are fixed and that any changes in demand will lead to changes in physical output rather than prices. This in turn requires an additional assumption that the economy's factor resources are unlimited or unconstrained, so that any increase in demand can be matched by an increase in supply. Lastly, the multiplier model assumes that all structural relationships between sectors and households in the economy are unaffected by exogenous changes in demand. This means that the input coefficients of producers and the consumption patterns of households remain unchanged.

Matrix algebra is used to derive the unconstrained multiplier formula. Actual numbers in the SAM is replaced by the following symbols (refer to table 4.3):

- X Gross output of each activity (i.e., X_1 and X_2)
- Z Total demand for each commodity (i.e., Z_1 and Z_2)
- V Total factor income (equal to household income)
- Y Total household income (equal to total factor income)
- E Exogenous components of demand (i.e., government, investment, and exports)

TABLE 4.3 - SAM entries expressed as letters or symbols

	Activities		Commodities		Factors	House-holds	Exogenous demand	Total
	A1	A2	C1	C2	F	H	E	
A1			X_1					X_1
A2				X_2				X_2
C1	Z_{11}	Z_{12}				C_1	E_1	Z_1
C2	Z_{21}	Z_{22}				C_2	E_2	Z_2
F	V_1	V_2						V
H					$V_1 + V_2$			Y
E			L_1	L_2		S		E
Total	X_1	X_2	Z_1	Z_2	V	Y	E	

Source: Adapted from Breisinger *et al*., 2009

The columns are then divided by their total to derive the coefficients matrix (M-matrix), shown in table 4.4.

TABLE 4.4 - Coefficient matrix (M-matrix)

	Activities		Commodities		Factors	House-holds	Exogenous demand	Total
	A1	A2	C1	C2	F	H	E	
A1			$b_1 = X_1/Z_1$					X_1
A2				$b_2 = X_2/Z_2$				X_2
C1	$a_{11}=Z_{11}/X_1$	$a_{12}=Z_{12}/X_2$				$c_1 = C_1/Y$	E_1	Z_1
C2	$a_{21}=Z_{21}/X_1$	$a_{22}=Z_{22}/X_2$				$c_2 = C_2/Y$	E_2	Z_2
F	$v_1=V_1/X_1$	$v_2=V_2/X_2$						V
H					1			Y
E			$l_1 = L_1/Z_1$	$l_2 = L_2/Z_2$		s = S/Y		E
Total	1	1	1	1	1	1	E	

Source: Adapted from Breisinger *et al*., 2009

Where:

a	Technical coefficients (i.e., input or intermediate shares in production)
b	Share of domestic output in total demand
v	Share of value-added or factor income in gross output
l	Share of the value of total demand from imports or commodity taxes
c	Household consumption expenditure shares
s	Household savings rate (i.e., savings as a share of household income)

Using the symbols in the SAM, total demand Z in each sector is the sum of intermediate input demand, household consumption demand, and other exogenous sources of demand E, such as public consumption and investment.

$$Z_1 = a_{11}X_1 + a_{12}X_2 + c_1Y + E_1$$
$$Z_2 = a_{21}X_1 + a_{22}X_2 + c_2Y + E_2 \quad \text{(A1)}$$

Total demand = intermediate demand + household demand + exogenous demand

Gross output X is only part of total demand Z, as shown in Equation A1

$$(1 - a_{11}b_1 - c_1v_1b_1)Z_1 + (-a_{12}b_2 - c_1v_2b_2)Z_2 = E_1$$
$$(-a_{21}b_1 - c_2v_1b_1)Z_1 + (1 - a_{22}b_2 - c_2v_2b_2)Z_2 = E_2$$

Domestic production X is only part of total demand Z.

$$X_1 = b_1Z_1 \quad \text{and} \quad X_2 = b_2Z_2$$

Household income Y depends on the share each factor earns in each sector.

$$Y = v_1X_1 + v_2X_2 \quad \text{or} \quad Y = v_1b_1Z_1 + v_2b_2Z_2$$

The Xs and Vs are replaced in Equation A1.

$$Z_1 = a_{11}b_1Z_1 + a_{12}b_2Z_2 + c_1(v_1b_1Z_1 + v_2b_2Z_2) + E_1$$
$$Z_2 = a_{21}b_1Z_1 + a_{22}b_2Z_2 + c_2(v_1b_1Z_1 + v_2b_2Z_2) + E_2$$

Everything except for E is moved onto the left-hand side.

$$Z_1 - a_{11}b_1Z_1 - c_1v_1b_1Z_1 - a_{12}b_2Z_2 - c_1v_2b_2Z_2 = E_1$$
$$-a_{21}b_1Z_1 - c_2v_1b_1Z_1 + Z_2 - a_{22}b_2Z_2 - c_2v_2b_2Z_2 = E_2$$

The Zs are grouped together.

$$(1 - a_{11}b_1 - c_1v_1b_1)Z_1 + (-a_{12}b_2 - c_1v_2b_2)Z_2 = E_1$$
$$(-a_{21}b_1 - c_2v_1b_1)Z_1 + (1 - a_{22}b_2 - c_2v_2b_2)Z_2 = E_2 \quad \text{(A2)}$$

Equation A2 is expressed in matrix format.

$$\begin{pmatrix} 1 - a_{11}b_1 - c_1v_1b_1 & -a_{12}b_2 - c_1v_2b_2 \\ -a_{21}b_1 - c_2v_1b_1 & 1 - a_{22}b_2 - c_2v_2b_2 \end{pmatrix}\begin{pmatrix} Z_1 \\ Z_2 \end{pmatrix} = \begin{pmatrix} E_1 \\ E_2 \end{pmatrix} \quad \text{(A3)}$$

The first term in Equation A3 is the identity matrix (I) minus the coefficient matrix (M).

$$\begin{pmatrix} 1 - a_{11}b_1 - c_1v_1b_1 & -a_{12}b_2 - c_1v_2b_2 \\ -a_{21}b_1 - c_2v_1b_1 & 1 - a_{22}b_2 - c_2v_2b_2 \end{pmatrix} = I - M$$

By renaming the other two vectors Z and E Equation A3 can be expressed as Equation 4.

$$(I - M)Z = E \quad \text{(A4)}$$

By rearranging, one arrives at the multiplier formula in Equation A5.

$$Z = (I - M)^{-1}E \quad \text{(A5)}$$

Total demand = multiplier matrix × exogenous demand

This indicates that when exogenous demand [E] increases, after taking all the direct and indirect multiplier effects into account [$(I\text{-}M)^{-1}$], one will end up with a final increase in total demand equal to Z. The information on linkage effects from the SAM is incorporated into the multiplier model through the coefficient matrix M. With this formula one can calculate the size of multiplier effects.

4.4. MODEL ASSUMPTIONS AND INPUT DATA

The multiplier analysis (output multiplier, GDP multiplier and income multiplier) will include two models. Model one will be a “non-green” development approach of subsidised housing units. This model will include the basic top structure-cost of the 7,619 subsidised housing units excluding all the extra funding indicated in table 4.1 (the cross-subsidisation, geotechnical allowance and the flagship BNG project special grant). The rational for this is to make this model applicable to other subsidised housing projects all over South Africa. The second model will be the modelling of only the green interventions for 7,619 subsidised housing units and will not include the top structure. Model two can therefore be seen as the additional add-on effect if greening interventions are applied to model one.

The following assumptions pertain to the modelling:

1. 7,619 subsidised housing units will be modelled.
2. The overall construction period is assumed to be 10 years from 2010 to 2020.

3. It is assumed that the same number of subsidised houses will be built each year over the ten year period, thus 761.9 houses per annum.
4. All prices will be based on 2010 estimates and extrapolated assuming an average CPI of 6% per annum.
5. Only the costing of a basic housing subsidy for a $40m^2$ top structure, thus R 43,506 per subsidised housing unit for 2010, will be modelled.
6. The top-structure housing subsidy amount obtained from the Department of Human Settlements is for the 2008/2009 financial year. Indications are however that this amount is not adjusted annually and was thus used as the baseline amount for 2010 where after it was extrapolated assuming an average CPI of 6% per annum.
7. The greening interventions applied to the subsidised houses include an insulated ceiling, a solar water heater as well as energy efficiency lighting (CFLs).
8. In order to be able to compare a non-green approach to a green approach, it is necessary to have the costing of both these scenarios. Due to a lack of information regarding greening interventions in Lufhereng, the cost estimations of green interventions to two other low-cost housing projects namely Kuyasa and Cosmo City (c.f. 2.8) were utilised. In terms of the green-interventions, the Kuyasa project cost estimations were based on 2011 figures and was thus taken back to 2010 for a baseline. On the other hand the Cosmo City project figures were already based on 2010 figures. Due to the fact that there are some gaps in the costing information (the cost of retrofitting the CFLs in the Kuyasa project), the average of the overall Kuyasa project intervention costs and the Cosmo City intervention costs were used (refer to Table 4.5 below).
9. It is assumed that the same number of subsidised houses will be retrofitted with green interventions each year over the ten year period, thus 761.9 houses per annum.

TABLE 4.5 - Green Intervention Baseline for 2010

Project	Costing per Unit
Cosmo City Greening Intervention Costing (2010)	R 9,001
Kuyasa Greening Intervention Costing (2011)	R 10,573
Kuyasa Greening Intervention Costing (2010)	R 9,939
Average Cosmo City and Kuyasa (2010)	**R 9,470**

Source: Own Construction based on Tables 2.25 and 2.27

Table 4.6 shows how the overall total cost for the tops structures and greening interventions of 7,619 subsidise was calculated based on the assumptions above.

Table 4.6 - Overall Cost Calculations, 2010 to 2020

Year	Units per Annum	Cost One Subsidised Housing Unit Top Structure	Cost 761.9 Subsidised Housing Units Top Structures	Cost One Subsidised Housing Unit Green Interventions	Cost 761.9 Subsidised Housing Units Greening Interventions
2010 - 2011	761.9	43,506	33,147,221	9470	7,215,048
2011 - 2012	761.9	46,116	35,136,055	10,038	7,647,951
2012 - 2013	761.9	48,883	37,244,218	10,640	8,106,828
2013 - 2014	761.9	51,816	39,478,871	11,279	8,593,238
2014 - 2015	761.9	54,925	41,847,603	11,955	9,108,832
2015 - 2016	761.9	58,221	44,358,460	12,673	9,655,362
2016 - 2017	761.9	61,714	47,019,967	13,433	10,234,684
2017 - 2018	761.9	65,417	49,841,165	14,239	10,848,765
2018 - 2019	761.9	69,342	52,831,635	15,093	11,499,691
2019 - 2020	761.9	73,502	56,001,533	15,999	12,189,672
Total	**7,619**	**na**	**436,906,728**	**na**	**95,100,071**

Source: Own Construction based on tables 4.1 and 4.5

Table 4.7 summarised the overall cost of the two models, model one, the top-structure subsidised housing component and model two, the greening intervention component.

TABLE 4.7 - Model Input Data

	Overall Cost (7,619 units) 2010 to 2020
Model One	R 436,906,728
Model Two	R 95,100,071

Source: Own Construction based on Table 4.2

The multiplier effect as well as the environmental impact for each of the two scenarios identified above is discussed below:

4.5. QUANTITATIVE RESULTS

4.5.1. OUTPUT MULTIPLIER

The output multiplier combines all direct and indirect effects of the construction of the development and reports the final increase in gross output of all production activities (caused by an increase in consumption and production). The increase of construction activities will have not only a direct effect on the construction industry but also indirect effects on other industries in the economy. The construction of the housing units will require various inputs which include but are not limited to bricks, concrete, building sand, doors, windows, electrical wiring etc. which has to be sourced from other industries. In order for these industries to supply the required input materials to the construction industry they in return might have to source inputs from other industries.

Each industry has various value-chains, which represents a model of how industries receive raw materials as input, add value to the raw materials through various processes, and sell finished products to customers. It is important to understand the multiplier effects through its linkages with other sectors in the economy in terms of the buying of materials, the paying of salaries and wages and the resulting expenditure on consumer goods. A simple example would be doors, for the sake of this example let's say the doors are made of wood. The trees, which grow in a forest (the agricultural, fishing and forestry industry), are cut down by lumberman and supplied to wood mills to be cut into more precise and manageable pieces (manufacturing industry). A door manufacturer (manufacturing industry) then purchases the wood pieces and manufactures the doors which they then supply to wholesale and retail outlets such as hardware stores (wholesale and retail trade industry). The construction industry then buys the doors from the wholesale and retail outlet. This simplified example shows that the door that was needed as part of the construction process involved a minimum of three industries, other than the construction industry. This (simplified) value-chain will be applicable, although very different in terms of the different industries involved, for each of the components required for the construction of the subsidised house. The industries that will show the most significant change in consumption and production will be the industries that have the highest multipliers linked to the building and construction industry. According to the Gauteng SAM (DBSA, 2012), the industries that will be influenced the most include:

1. Buildings and Other Construction
2. Real Estate
3. Trade

4. Communications
5. Chemicals and Chemical Products
6. Business Activities
7. Transport
8. Meat, Fish, Fruit, Vegetables, Oils and Fat Products
9. Non-Metallic Mineral Products
10. Insurance
11. Basic Metal Products
12. Community, Social and Personal Services
13. Structural Metal Products
14. Water
15. Electrical Machinery and Apparatus
16. Machinery and Equipment
17. Accommodations
18. Manufacturing of Transport Equipment
19. Other Mining
20. Electricity
21. Paper and Paper Products
22. Wood and Wood Products
23. Grain Mill, Bakery and Animal Feed Products
24. Publishing and Printing
25. Petroleum
26. Agriculture
27. Beverages and Tobacco Products
28. Other Fabricated Metal Products
29. Furniture
30. Textiles, Clothing, Leather Products and Footwear
31. Dairy Products
32. Other Manufacturing and Recycling
33. Communication, Medical and Other Electrical Equipment
34. Other Food Products
35. Rubber Products
36. Gold Mining

The total change in consumption and production (direct and indirect effects) caused by the capital injection into the economy for the two different models are depicted below in table

4.8. Please note that the value covers the whole extent of the construction period, thus ten years and not per annum.

TABLE 4.8 - Total change in consumption and production

	Model One	Model Two
Total change in consumption and production	R 1,097,000,000	R 239,000,000

Source: Own construction based on the Gauteng SAM output multiplier

Table 4.8 shows that the construction of 7,619 subsidised housing units (model one) over ten years from 2010 to 2020 will result in a total change in consumption and production of R 1,1 billion. Model two shows that if the 7,619 subsidised housing units from model one were to be retrofitted with greening interventions there would be an additional total change in consumption and production of R 239 million, totalling a total change in consumption and production of R 1,3 billion.

4.5.2. GDP MULTIPLIER

The GDP or value added multiplier measures the total change value-added or factor incomes caused by direct and indirect effects. The Gauteng SAM (DBSA, 2012), differentiates between two groups of factor incomes namely labour and capital. Labour is categorised according to occupation and include:

1. Legislators, senior officials & managers
2. Professionals
3. Technical & associate professionals
4. Clerks
5. Service workers, shop & market sales workers
6. Skilled agriculture & fishery workers
7. Craft & related traders workers
8. Plant & machine operators & assemblers
9. Elementary occupations
10. Domestic workers
11. Occupation unspecified

Capital is categorised according to enterprises and include:

1. Public enterprises
2. Private business enterprise
3. Combi-taxi enterprise
4. Informal enterprise

The total change in terms of value-added or factor incomes caused by direct and indirect effects of the two different models are depicted below in table 4.9. Please note that the value is an injection covering the whole extent of the construction period, thus ten years and not per annum.

TABLE 4.9 - Total Change in Value Added or Factor Incomes

	Model One	Model Two
Total change in value added or factor incomes	R 364,000,000	R 79,000,000

Source: Own construction based on the Gauteng SAM GDP multiplier

It is evident from Table 4.9 that the construction of 7,619 subsidised housing units (model one) over ten years from 2010 to 2020 will result in a total change in value-added or factor incomes of R 364 million. An additional change in value-added or factor income of R79 million would occur if the 7,619 subsidised housing units from model one were to be retrofitted with greening interventions (model two). Thus, if model one and model two were to be combined the total change in value-added or factor income would be R 443 million.

In order to get a more detailed representation of the influence the different models will have on individuals in terms of labour, a GDP multiplier analysis was modelled. A GDP multiplier analysis was done for the year 2010 (construction of 761,9 subsidised housing units) and the results was compared with the labour market dynamics in South Africa in terms of the median earnings by occupation (Statistics South Africa, 2010b). The monthly and annual median earnings by occupation for South Africa's labour market in 2010 is shown in table 4.10:

TABLE 4.10 - Monthly and annual median earnings by occupation for South Africa's labour market, 2010

Occupation	Median Monthly	Median Annual
All Occupations	R 2,900	R 34,800
Legislators, senior officials	R 11,000	R 132,000

Occupation	Median Monthly	Median Annual
& managers		
Professionals	R 10,600	R 127,200
Technical & associate professionals	R 7,800	R 93,600
Clerks	R 4,500	R 54,000
Service workers, shop & market sales workers	R 2,500	R 30,000
Skilled agriculture & fishery workers	R 1,900	R 22,800
Craft & related traders workers	R 3,000	R 36,000
Plant & machine operators & assemblers	R 3,000	R 36,000
Elementary occupations	R 1,516	R 18,192
Domestic workers	R 1,000	R 12,000

Source: StasSA, 2010b

Table 4.11 below depicts the following:

1. The total change of value-added or factor incomes in terms of labour (by occupation) caused by direct and indirect effects of the two different models for 2010
2. The median annual income by occupation for 2010
3. The total change in labour income by occupation divided by the median annual income by occupation. This indicates the number of individuals employed by occupation as a result of each of the two models.

TABLE 4.11 - Total change of value-added or factor incomes in terms of labour by occupation, 2010

	Labour Model One 2010	Labour Model Two 2010	Median Annual Income by Occupation	Model One Labour/ Occupation	Model Two 2010 Labour/ Occupation
Legislators, senior officials & managers	R 2,890,130	R 629,085	R 132,000	22	5
Professionals	R 2,840,938	R 618,378	R 127,200	22	5

	Labour Model One 2010	Labour Model Two 2010	Median Annual Income by Occupation	Model One Labour/ Occupation	Model Two 2010 Labour/ Occupation
Technical & associate professionals	R 1,249,356	R 271,943	R 93,600	13	3
Clerks	R 865,506	R 188,392	R 54,000	16	3
Service workers, shop & market sales workers	R 811,590	R 176,656	R 30,000	27	6
Skilled agriculture & fishery workers	R 78,302	R 17,044	R 22,800	3	1
Craft & related traders workers	R 1,061,828	R 231,125	R 36,000	29	6
Plant & machine operators & assemblers	R 464,602	R 101,128	R 36,000	13	3
Elementary occupations	R 855,089	R 186,124	R 18,192	47	10
Domestic workers	R 1,682,773	R 366,284	R 12,000	140	31
Total	**R 12,800,113**	**R 2,786,159**	**na**	**334**	**73**

Source: Own construction based on Tables 4.5 and 4.6

Table 4.11 shows that the construction of 761.9 subsidised housing units (model one) in 2010 will result in 334 employment opportunities in various occupations being created. If greening interventions had to be applied to the 761.9 subsidised housing units an additional 73 employment opportunities in various occupations will be created, thus resulting in an overall 406 employment opportunities. The total employment opportunities created by both scenarios reflects only 2010, this does not mean that the employment opportunities will last

only for one year but it can be assumed that these employment opportunities (resulting from the construction of the 761.9 subsidised housing units) will be sustained for the duration of the construction period due to the fact that it is assumed that the same number of subsidised housing units will be built each year for nine more years after 2010 which will result in the same number of employment opportunities.

These employment opportunities can be grouped into three skill levels namely skilled, semi-skilled and low skilled. A classification of skills categories was drawn from Bhorat and Oosthuizen (2008). Skilled occupations classification comprises managers, professionals and technicians. Semi-skilled occupations classification comprises clerks, sales and services, skilled agriculture, crafts and related trade, plant and machine operators. Low-skilled occupations classification comprises elementary work. Domestic workers are classified separately.

The various labour occupations created by the two models (indicated in table 4.10 above) can be translated into the various skill levels (table 4.12 below). For the purpose of this study, domestic workers were classified under low-skilled occupations.

TABLE 4.12 – Total change of value-added or factor incomes in terms of labour by skill level, 2010

	Model One 2010	Model Two 2010
Skilled occupations	58	13
Semi-skilled occupations	89	19
Low-skilled occupations	187	41
Total	**334**	**73**

Source: Own construction based on Tables 4.6 and 4.7

Table 4.12 shows that the most significant portion of the employment opportunities that was created with both model one and model two are low skilled occupations.

4.5.3. INCOME MULTIPLIER

The income multiplier measures the total change in household incomes. Households supply labour services to industries for production (refer to the output multiplier) and receive monetary compensation in the form of salary and/or wages and in return purchase goods and services. With an increase in the construction sector's production and consumption [and

as a result other industries part of the value-chain (refer to the output multiplier), an increased demand for labour (more employment opportunities) will develop as labour has to produce the goods and services required/demanded. As a result, the increase in labour will result in an increase in household income.

The changes in household incomes due to the capital injection into the economy of the two different models are depicted in table 4.13. Please note that the value is an injection covering the whole extent of the construction period, thus ten years and not per annum.

TABLE 4.13 - Total change in household income

	Model One	Model Two
Total Change in Household Income	R 200,000,000	R 44,000,000

Source: Own construction based on the Gauteng SAM income multiplier

The construction of 7,619 subsidised housing units (model one) over ten years from 2010 to 2020 will result in a total positive change in household income of R 200 million. An additional change in household income of R44 million would occur if the 7,619 subsidised housing units from model one were to be retrofitted with greening interventions (model two). Therefore, if model one and model two were to be combined the change in household income would total R 244 million.

By combining households into meaningful categories, such as a range of income levels, the impact on these households' welfare of a changing economic environment is made possible by the SAM. The Gauteng SAM (DBSA, 2012), differentiates between the different household income categories. The following household income categories are represented in terms of annual household income:

1. No income
2. R 1 - R 4,800
3. R 4,801 - R 9,600
4. R 9,601 - R 19,600
5. R 19,601 - R 38,200
6. R 38 201 - R 76 400
7. R 76,401 - R 153,800
8. R 153,801 - R 307,600

9. R 307,601 - R 614,400
10. R 614,001 - R 1,228,800
11. R 1,228,801 - R 2,457,600
12. R 2,457,601 or more

The different household income categories enable the differentiation of the impact on the various income brackets (low, middle and high). Households that have either no income or a low-income fall within the low income bracket (R0 to R38,200 per annum); indicating that they experience difficulty in meeting their basic needs. The change in household incomes for households that fall within the low income bracket due to the capital injection into the economy of the two different models are depicted below in table 4.14, as such highlighting the extent the development contributes to poverty alleviation throughout the economy. Please note that the value is an injection covering the whole extent of the construction period, thus ten years and not per annum.

TABLE 4.14 - Total change in low income household's income

	Model One	Model Two
Total Change in Low-Income Household's Income (Households earning between R0 to R38,200 per annum)	R 9,900,000	R 2,200,000

Source: Own construction based on Table 4.9

The construction of 7,619 subsidised housing units (model one) over ten years from 2010 to 2020 will result in a total positive change in household income of R 9.9 million for households that fall within the low income bracket. Furthermore, an additional change in household income for low income households of R 2.2 million would occur if the 7,619 subsidised housing units from model one were to be retrofitted with greening interventions (model two). Consequently, if model one and model two were to be combined the change in household income would total R 12.1 million for low income households.

4.6. QUANTITATIVE RESULTS

4.6.1. ENVIRONMENTAL IMPACT

The environmental impacts will be expressed in terms of the total carbon emissions (CO_2) reduced if interventions were applied to the development. The total carbon emissions reduced will be expressed as kilograms or tonnes of CO_2 reduced per annum per $40m^2$ subsidised housing unit as well as for the overall project.

As discussed earlier, the impacts of the multiplier analysis covers the whole extent of the construction period, thus ten years and not per annum. The impact therefore indicated in the multiplier analysis will start when the construction process starts and will cease when the construction process is complete. The environmental impacts will however be annual and will start when the greening interventions are fully installed and operational and will only cease if the greening interventions are removed or aren't operational for whatever reason.

As stated earlier, both the costing as well as the environmental impacts (reduction of carbon emissions) of the Kuyasa project and the Cosmo City project was used as a baseline for this study. The overall reduction in carbon emissions due to the green interventions for both the Cosmo City and the Kuyasa project (refer to 2.8) is depicted below in table 4.12:

TABLE 4.15 - Overall reduction in carbon emissions, Cosmo City and Kuyasa

	Cosmo City: Emission reduction (kg CO_2/ household/annum)	Kuyasa: Emission reduction (kg CO_2/ household/annum)
Insulated ceilings	1,330	255
SWH	1,228	1,380
CFLs	228	-
Total	**2,790**	**1,635**

Source: Own construction based on the Tables 2.25 and 2.27

Table 4.15 shows the overall reduction in carbon emissions due to the interventions (ceiling and SWH) for a typical Cosmos City house is 1,635 kg CO_2 per annum, made up of 1,380 kg CO_2 per annum for the SWH intervention and 255 kg CO_2 per annum for the ceiling intervention. This compares with estimates from the Kuyasa, CDM project, of 1,288 kg CO_2 per annum for the SWH intervention and 1,330 kg CO_2 per annum for the ceiling

intervention. The water heating values compare well between Cosmo City and Kuyasa, while values for the ceiling intervention are much lower for Cosmo City. These results differ partly due to the different climatic conditions experienced, and partly due to the fact that the Kuyasa space heating considered the heated space to be the whole house, while in Cosmo City only the lounge was considered.

As discussed in the multiplier analysis assumptions, the greening interventions applied to this study include insulated ceilings, solar water heaters and energy efficiency lighting (CFLs).

The following assumptions pertain to the modelling:

1. 7,619 subsidised units will be modelled
2. Although the values for the insulated ceiling intervention are much lower for Cosmo City, the Kuyasa space heating considered the heated space to be the whole house, while Cosmo City considered only the lounge. There are however different climatic conditions between the two areas (Cape Town and Johannesburg), thus the total emission reduction due to insulated ceilings per household for this project was calculated using the average the Kuyasa project (1,330 kg CO_2 per annum) and the Cosmo City project (255 kg CO_2 per annum). This results in a 793 kg CO_2 per annum reduction per household due to the insulated ceiling intervention.
3. The water heating values of the Cosmo City project and the Kuyasa project are very alike. Similarly to the calculation of the total emission reduction per household for the insulated ceiling intervention above, the total emission reduction due to solar water heater intervention for this project was calculated using the average the Kuyasa project (1,228kg CO_2 per annum) and the Cosmo City project (1,380 kg CO_2 per annum). This results in a 1,304 kg CO_2 per annum reduction per household due to the solar water heater intervention.
4. The total emission reduction due to CFL intervention for the Kuyasa project are not available, thus the annual reduction of emissions for the Cosmo City project was used for this project. The result is that there is an annual 228 kg CO_2 reduction per household due to energy efficiency lighting (CFLs).

Table 4.16 summarises the reduction of emissions per annum of a single subsidised housing unit as well as for the overall project (7,619 subsidised housing units):

TABLE 4.16 – Emission reduction

	Emission reduction (kg CO_2/ annum) for one 40m^2 subsidised housing unit	Emission reduction (kg CO_2/annum) for 7,619 subsidised housing units
Insulated ceilings	793	6,038,058
SWH	1,304	9,935,176
CFLs	228	1,737,132
Total	**2,325**	**17,710,366**

Source: Own construction based on Table 4.11

By applying greening interventions in the form of an insulated ceiling, solar water heaters and compact florescent lighting, a single 40m^2 subsidised housing unit will decrease its carbon emissions with 2,325 kg CO_2 per annum. The overall emission reduction of 7,619 subsidised housing units would total 17,710 metric tonnes of CO_2 per annum. Figure 4.1 indicates the total carbon emissions saved per greening intervention.

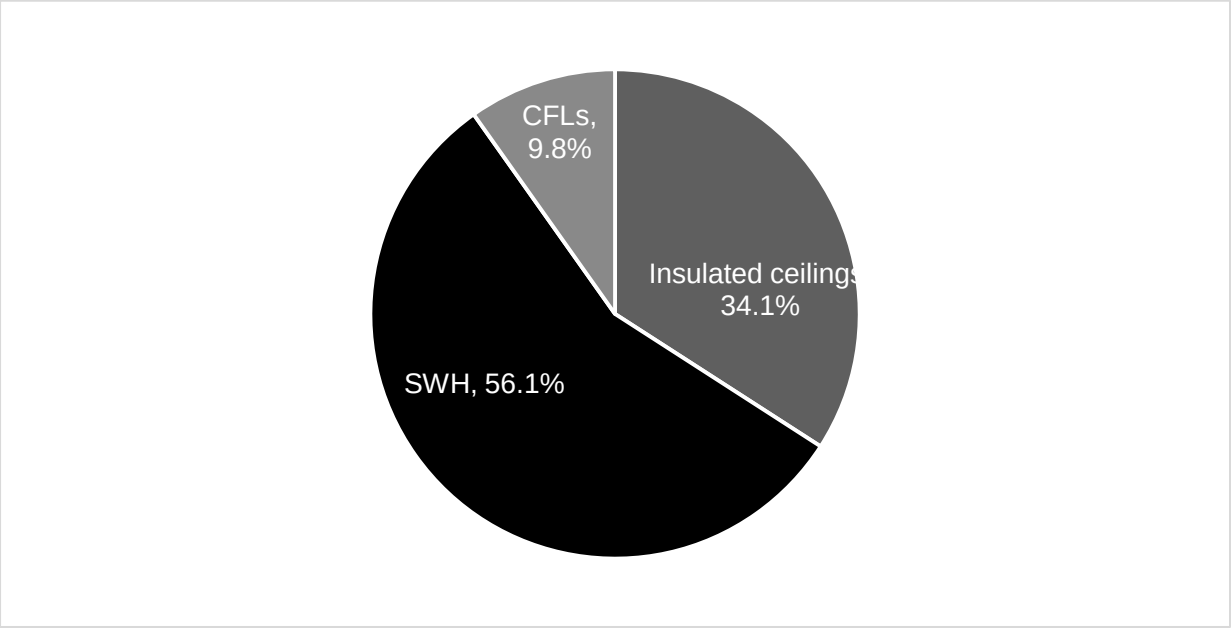


FIGURE 4.1 - Emissions Saved per Greening Intervention

Source: Own construction based on Table 4.12

From figure 4.1 it is evident that solar water geysers contribute the most significant portion (56.1%) of the emissions saved, followed by insulated ceilings (34.1%) and lastly compact florescent lighting (9.8%).

4.7. PROFESSIONAL OPINION

A questionnaire was sent to 200 professionals in the “Green Building” industry (Green Star SA Accredited Professional contact details obtained from the Green Building Counsel – South Africa). The 200 professionals in the “Green Building” industry included a mixture of the following occupations (in alphabetical order):

1. Building services engineer
2. Consulting engineer
3. Contractor/Builder
4. Developer
5. Energy consultant
6. Engineer
7. Green building consultant
8. Project manager
9. Quantity surveyor
10. Town planner

Professional stakeholders were asked the following (please refer to Annexure A):

1. In your opinion, do you think green building can be applied, as a viable option, to low cost subsidised housing in South Africa? Individuals were asked to motivate their opinion.
2. What green building interventions do you think can be applied to low cost subsidised housing in South Africa?

The questionnaire had a 10% response rate (of the 200 questionnaires, 19 were thus completed and returned).

In terms of whether professional stakeholders thought green building can be applied, as a viable option, to low cost subsidised housing in South Africa (refer to figure 4.2), 84% were of the opinion that green building can be applied as a viable option to low cost housing while 16% stated that green building is not a viable option for low cost housing.

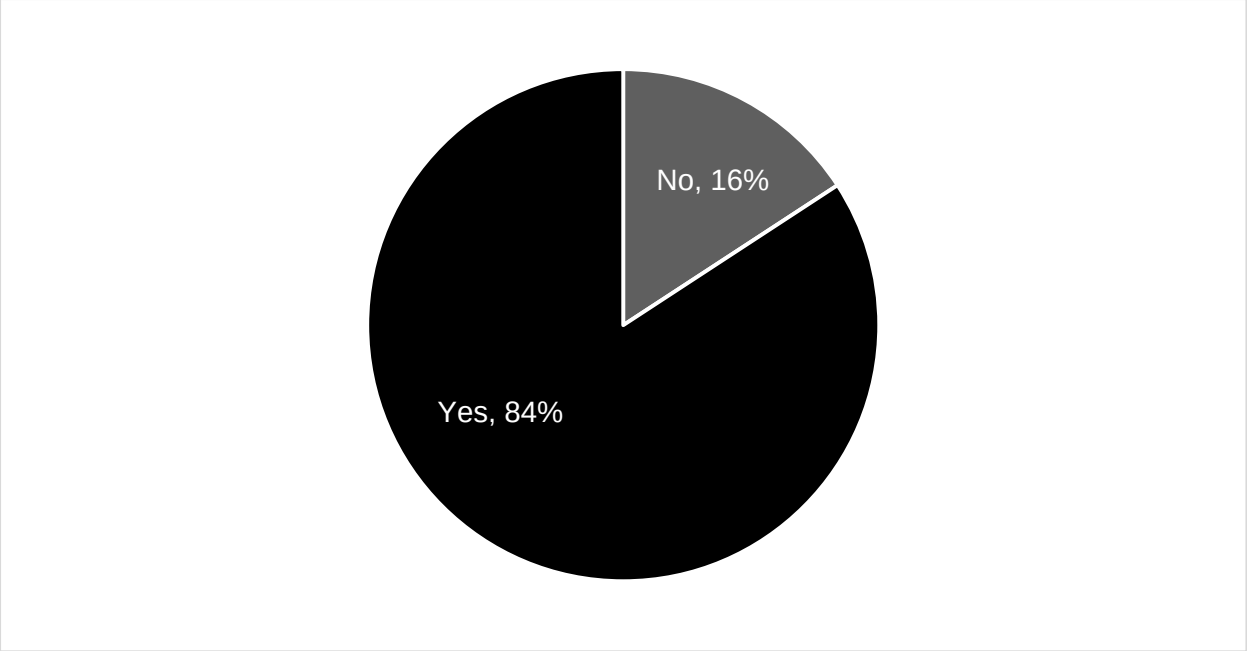


FIGURE 4.2 – Professional opinion on the viability of green building in low-cost housing in South Africa

Source: Own construction based on the professional stakeholders survey

The following reasons were listed as to why green building is not a viable option for low cost housing:

1. "Green building options require an investment over traditional options, which are much less costly. It wouldn't make sense for the government with a fixed budget to build fewer RDP houses with green building options, as opposed to providing more houses to families who don't have. Additionally, where some green building options are designed to lower the running costs of houses that use electricity for heating, this is not usually applicable in RDP developments."
2. "The market is not mature enough to provide efficient energy and water wise solutions for low cost housing that would be feasible in terms of costs."

The questionnaire showed that the following green building interventions can be considered for low cost subsidised housing in South Africa (ranked from most to least significant):

1. Solar water heating (SWH)
2. Insulation (ceiling and walls)
3. Compact florescent lighting (CFLs)
4. Rainwater harvesting
5. Building orientation

6. Local materials & labour
7. Passive design, such as appropriate site selection (to allow walking or cycling to facilities which reduces the need for motorised transport to access basic facilities) and building orientation and master planning between buildings.
8. Recycling interventions
9. Medium – high density

The green building interventions to be applicable to low cost subsidised housing in South Africa according to the questionnaire are shown in figure 4.3 below.

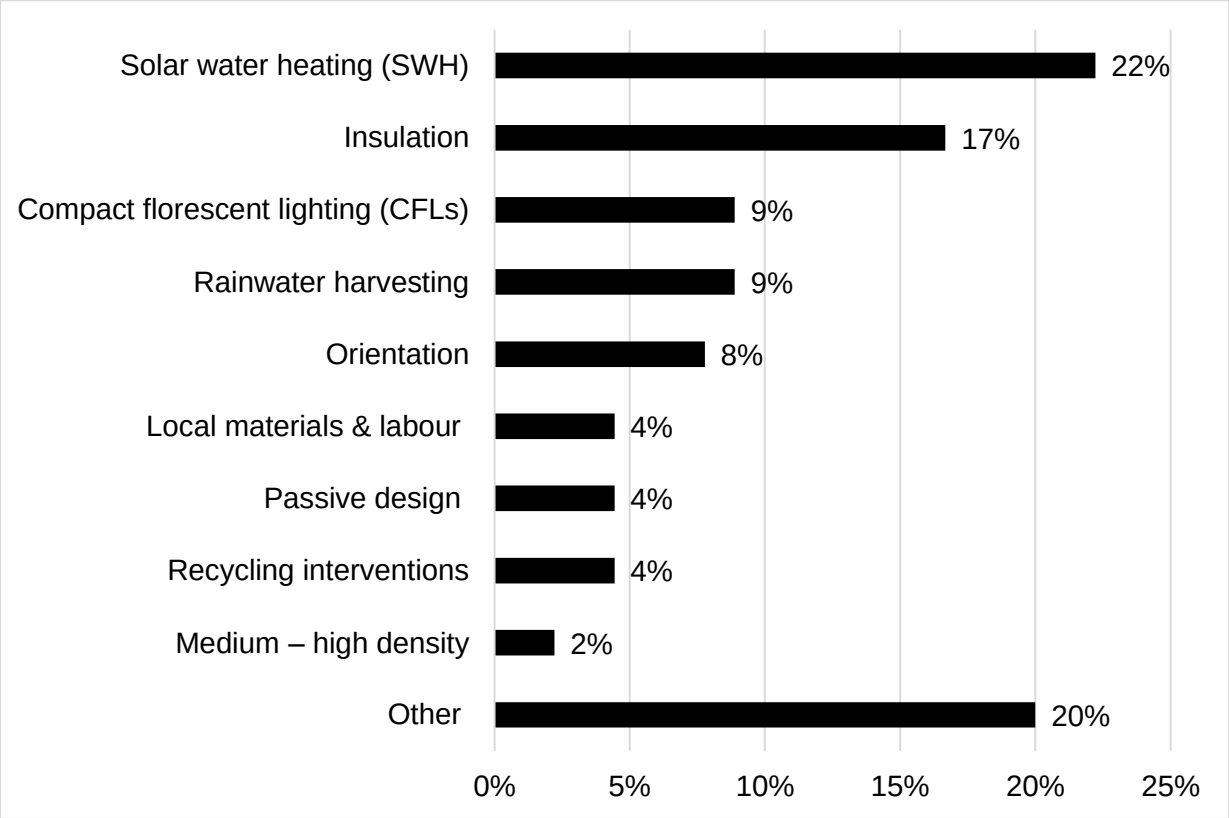


FIGURE 4.3 – Professional opinion regarding green building interventions applicable to low cost housing in South Africa

Source: Own construction based on the professional stakeholders survey analysis

4.8. CONCLUSION

This section showed that the following results if greening interventions were applied to the 7,619 subsidised housing units part of the Lufhereng development:

1. An additional total change in consumption and production of R 239 million (over a ten year period).
2. An additional change in value-added or factor income of R 79 million (over a ten year period).
3. A total of 73 additional employment opportunities in various occupations will be created (annually). Of the 73 additional employment opportunities, 13 will be skilled occupations, 19 semi-skilled occupations and 41 low skilled occupations.
4. An additional change in household income of R 44 million (over a ten year period) - with low income households befitting R 2.2 million of the R 44 million.
5. A single 40m^2 subsidised housing unit's carbon emissions decreases with 2,325 kg CO_2 per annum, totalling 17,710 metric tonnes of CO_2 per annum for the total development (7,619 subsidised houses).

SECTION FIVE: OVERVIEW OF THE STUDY AND SYNTHESIS OF FINDINGS

5.1. INTRODUCTION

Climate change, poverty and unemployment are some of the major challenges South Africa faces today. Climate change is already a measurable reality and increased attention is given to the “Green Revolution” or “going green” (c.f. 2.1). The National Climate Change Response White Paper of South Africa (2011) presents the South African Government’s vision for a climate change response and for the long-term transition to a climate-resilient and lower-carbon economy and society (c.f. 2.5). Under the UNFCCC (c.f. 2.2.3) and its Kyoto Protocol (c.f. 2.2.3.1), South Africa is committed to reduce its GHG emissions by 34% (by 2020) and 42% (by 2025) below its business as usual emissions growth curve. Adapting to climate change and making the conversion to a much less carbon-intensive economy will require both substantial technological and structural shifts within the South African economy.

The three pillars of sustainable development include environmental sustainability, economic sustainability as well as socio-political sustainability (c.f. 2.2.1). The purpose of the study was to determine the difference between conventional building and contemporary green building practices in low cost housing (subsidised houses) in terms of sustainability, thus referring to the differences in economic, social and environmental effects (c.f. 1.4 and 4.1) within the Lufhereng integrated development project.

This section will focus on an overview of the literature, the findings obtained through quantitative and qualitative research to ultimately enable the formulation of appropriate recommendations in the final section. Diagram 5.1 illustrates the outline of this section.

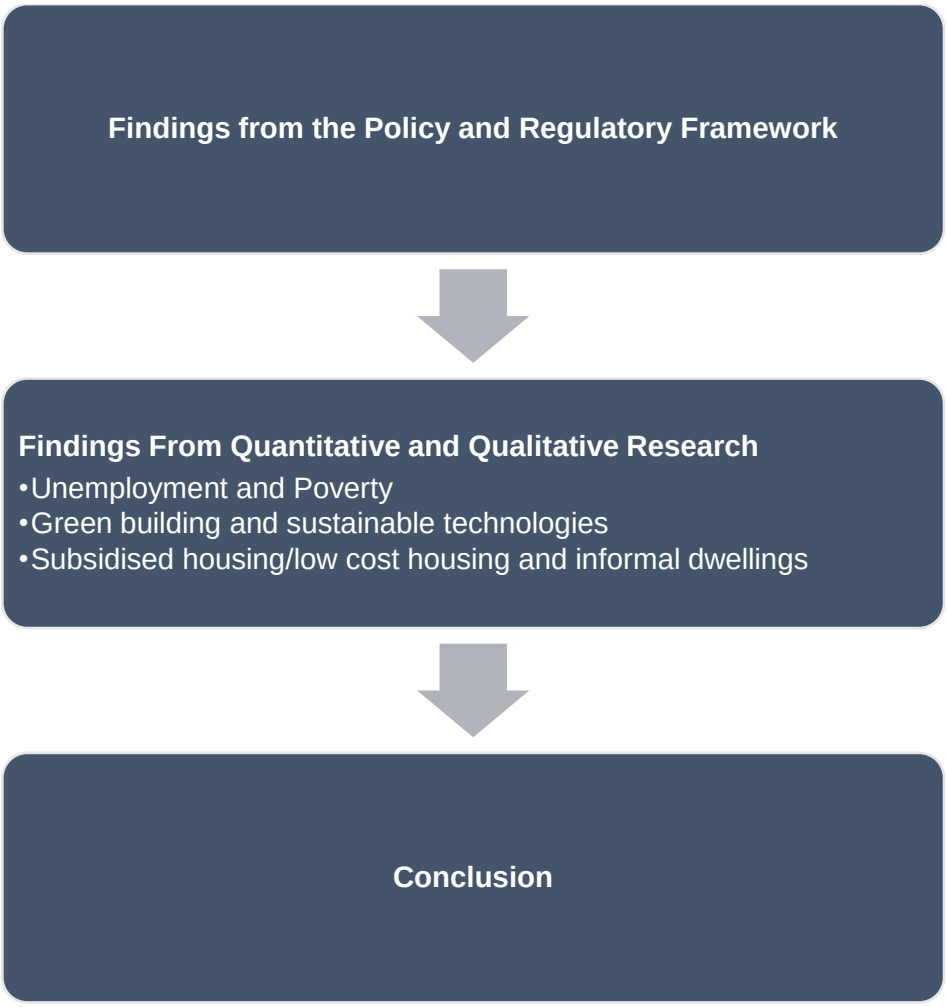


DIAGRAM 5. 1 – Outline of Section Five

Source: Own construction

5.2. FINDINGS FROM THE POLICY AND REGULATORY FRAMEWORK

Three distinct levels of legislation affecting the land use and the development of the green building industry (directly or indirectly) exist in South Africa under the three spheres of government, namely Acts, Ordinances and Acts and Town Planning Schemes and By-Laws (c.f. 2.5.1).

Land development and building work are governed by a planning and regulatory framework which operates at all three levels of government, namely national, provincial and local government. On one hand, there are the various land, physical planning, development control and environmental protection acts, regulations and measures; on the other hand, the National Building Regulations and standards legislation and enforcement bodies (c.f. 2.5.1).

On the construction side good practice is enforced through standards, building regulations, legislation concerning safety, fair employment practices, training levies, and statutory registration of building professionals, etc. Building regulations have been promulgated nationally, but are applied locally in each area (c.f. 2.5.1).

The South African Government has made use of the National Building Regulations Act to introduce sustainability into the building sector (c.f. table 2.3). In terms of the act, the National Regulator for Compulsory Specifications (NRCS) has drawn up regulations which are intended to reduce the Green House Gas production in the South African Building Sector. The SANS 204 series of standards have been developed to provide a framework for energy-efficient buildings. It is not yet clear whether these requirements for residential housing will be made mandatory for low income housing. The Electricity Regulation Act states the use of Energy-efficient fittings must be used in all buildings.

A number of policies at a National (South African) and Provincial (Gauteng) level refer directly as well as indirectly to poverty, unemployment and the Green Economy in the country (c.f. 2.5.2):

- The New Growth Path (NGP) states that the extent of joblessness and inequality makes employment creation the top priority. The NGP supports job creation in infrastructure projects as well as the green industry. It recognised that renewable sources would play a key part of the plan to improve economic efficiency and to reduce emissions.
- The National Development Plans' (NDP) aim is to eliminate poverty and reduce inequality by 2030. In order to achieve environmental sustainability and resilience, the NDP aims to reduce greenhouse gas emissions and to utilise renewable energy sources which include retrofitting buildings.
- The Green Economic Accord addresses various aspects of sustainability, such as recycling, energy efficiency, innovation and manufacturing, retrofitting of inefficient buildings, and biofuels.
- The National Strategy for Sustainable Development and Action Plan (NSSD1) recognises the important shift towards a resource-efficient, low-carbon and pro-employment growth path. It states that the goals of a transition towards a green economy should include green growth contributions to economic growth and employment, while preventing environmental degradation and pollution, loss of biodiversity and unsustainable natural resource use. Furthermore, the Strategy aims

to reduce poverty and provide a decent quality of life for all including improving the quality of housing and other structures to optimise resource efficiency.

- National Planning Commission (NPC): Diagnostic Overview makes direct reference to the utilisation of renewable energy and the transition to a low carbon economy.
- One of the Medium-Term Strategic Framework's (MTSF) 2009–2014 strategic priorities includes speeding up growth and transforming the economy to create decent work and sustainable livelihoods through encouraging cleaner, lower-energy technologies and green jobs.
- The Ten-Year Innovation Plan embraces renewable energy technologies.
- The National Energy Efficiency Strategy guides the development and implementation of energy efficiency practices in South Africa. The Strategy sets target for the residential sector to reduce its final energy demand by 10% in 2015.
- The National Climate Change Response White Paper states that in the implementation of low-cost housing, access to affordable lower-carbon public transport systems should be ensured, thermal efficiency should be incorporated into designs and climate-resilient technologies should be used.
- The Integrated Resource Plan encourages the roll-out of renewable energy.
- Principals of the National Spatial Development Perspective include poverty alleviation, stimulating sustainable economic activities, creating long-term employment opportunities and addressing past and current social inequalities.
- The Strategy for a Developmental Green Economy for Gauteng encourages steps to building sustainable human settlements and to maximise resource efficiency which includes the reduction of greenhouse gases through utilising renewable energy.
- The Green Strategic Programme for Gauteng states that the Province needs to switch their sources of energy away from fossil fuels and immediately concentrate on ways to reduce the CO_2 and greenhouse gas emissions though renewable energy.
- The Gauteng Spatial Development Framework (GSDF) identifies some of the urban problems as widespread poverty and unsustainable environmental practices. The GSDF states that as with all cities, reducing energy consumption is of utmost concern.
- The Gauteng Medium Term Strategic Framework (MTSF) places the creation of decent work and sustainable livelihoods at the centre of its policies and programmes.
- The Gauteng Employment Growth and Development Strategy (GEGDS) identifies an increased economic growth rate, a decreased unemployment rate and a decreased poverty rate as overarching target for the Province to achieve.

It is evident when studying these policies that the broad themes poverty eradication, employment creation, the creation of sustainable human settlements and utilisation of renewable energy are all supported and promoted by National and Provincial Government.

5.3. FINDINGS FROM QUANTITATIVE AND QUALITATIVE RESEARCH

Two models were used to determine the difference between the conventional non-green building approach and contemporary green building. Model one was a “non-green” development approach of subsidised housing units. This model included the basic top structure-cost of the 7,619 subsidised housing units [c.f. 4.2.3 according to the Department of Human Settlements - excluding all the extra funding indicated in table 4.1 (the cross-subsidisation, geotechnical allowance and the flagship BNG project special grant)]. The rational for this was to make this model applicable to other subsidised housing projects all over South Africa.

The second model included only the green interventions for 7,619 subsidised housing units and did not include the top structure. Model two can therefore be seen as the additional add-on effect if greening interventions were applied to model one. Model one plus model two equals the total effect of subsidised housing project with greening interventions.

The economic effects were determined in terms of direct and indirect change in gross output of all production activities (output multiplier) as well as total change in value-added (GDP multiplier), (c.f. 4.4 and 4.5). The social effects were determined in terms of the change in household incomes (income multiplier), (c.f. 4.6). The environmental effects were determined by the change in carbon emissions due to the applied greening interventions (c.f. 4.7).

The study has shown that, through the various methods discussed above, the green development approach with subsidised housing units has the following implications in comparison with a non-green development approach:

1. Increase total change in consumption and production
2. Increase in value-added or factor income
3. Increase in household income
4. Reduced carbon emissions

Table 5.1 below offers a summary of the influencing factors, the literature as well as the findings from research. The findings, in relation to table 5.1, are discussed thereafter.

TABLE 5.1 - Influenced factors, literature and research findings

Factor	Literature	Empirical	Green Development versus conventional development imperatives to subsidised/low-cost housing
Sustainability	The three pillars of sustainable development include (c.f. 2.2.1): 1. environmental sustainability, 2. economic sustainability, and 3. socio-political sustainability.	The purpose of the study was to determine the difference between conventional building and contemporary green building practices in low cost housing (subsidised houses) in terms of sustainability (economic, social and environmental effects), (c.f. 1.4 and 4.1).	The economic effects were determined in terms of: 1. Direct and indirect change in gross output of all production activities (output multiplier). 2. Total change in value-added (GDP multiplier). The social effects were determined in terms of: 1. Total change in household income (income multiplier). The environmental effects were determined in terms of: 1. Total change in carbon emissions due to the applied greening

Factor	Literature	Empirical	Green Development versus conventional development imperatives to subsidised/low-cost housing
			interventions.
Subsidised housing/Low cost housing and informal dwellings	• Registered subsidy properties comprise just less than one quarter (24%) of all registered residential properties in South Africa. (C.f. 2.7.1) • Between 1994 and 2009 a total of 2.94 million subsidy houses were reported as being completed or under construction in South Africa by the Department of Human Settlements. • Of this 2.94 million of subsidised houses, 26%, or 752,960, were in Gauteng.	The empirical study was conducted to determine the difference between the conventional non-green building approach and contemporary green building practices in low cost housing (subsidised houses) in terms of sustainability (economic, social and environmental effects) (c.f. 1.4, 2.2.1 and 4.1). In order to make the two approaches measurable for comparison the two different approaches were applied to an actual housing project located in the City of Johannesburg, Gauteng Province, South Africa namely Lufhereng (c.f.4.2). The	Registered subsidy properties comprise just less than one quarter (24%) of all registered residential properties in South Africa, implying that the performance of these properties has the potential to impact on the total market.

Factor	Literature	Empirical	Green Development versus conventional development imperatives to subsidised/low-cost housing
	• South Africa had a backlog of some 2.1 million subsidised houses in 2011 (c.f. 2.7.2). • In 2010, over 60,000 people were on Gauteng's waiting list for houses. • In 2011, the total number of households resident in informal dwellings in South Africa was 1.96 million, showing a 6.9% increase from 200 (c.f. 2.6.4) • In 2011, 18.9% of Gauteng's total households were resident in informal dwellings. • From 2001 to 2011 the	total number of residential units that form part of the Lufhereng development is estimated at 24,145 top structure units of which 7,619 will be subsidised erven (40m^2 subsidised houses). For the purpose of this study, the focus will fall on the 7,619 subsidised erven.	

Factor	Literature	Empirical	Green Development versus conventional development imperatives to subsidised/low-cost housing
	number of households in Gauteng resident in informal dwellings increased with 13.6% from 651,039 in 2001 to 739,758 in 2011 (c.f. 2.6.4) • In 2011, 17.4% of the City of Johannesburg's total households were resident in informal dwellings (c.f. 2.6.4) • From 2001 to 2011 the number of households in the City of Johannesburg resident in informal dwellings increased with %, from 212,300 in 2001 to 249, 823 in 2011 (c.f.		

Factor	Literature	Empirical	Green Development versus conventional development imperatives to subsidised/low-cost housing
	2.6.4).		
Unemployment	• South Africa has an unemployment rate of 30% (5.6million people are unemployed) • Gauteng has an unemployment rate of 26% (1.6 million people are unemployed) • The City of Johannesburg has an unemployment rate of 25% (564,970 individuals are unemployed) (c.f. 2.7.6).	The results from the GDP multiplier (c.f. 4.4) were further broken down to differentiate between two groups of factor incomes namely labour and capital. Labour was subsequently categorised according to occupations which gave a better understanding of the South Africa's labour market dynamics in terms of median monthly earnings (table 4.6). The different occupations were divided into three skill levels namely (c.f. 4.8): 1. skilled, 2. semi-skilled, and 3. low skilled.	The Lufhereng case study of 7,619 subsidised housing units over a ten year period (2010 - 2020) indicated that if a green approach was to be followed instead of the conventional approach, 73 additional employment opportunities in various occupations will be created (over one year).

Factor	Literature	Empirical	Green Development versus conventional development imperatives to subsidised/low-cost housing
Poverty	• Approximately 63% (or 9.1 million) of South Africa's households earn a low income (c.f. 2.6.3). • Of the 9.1 million households that earn a low income, 2.2 million earn no income at all. • Approximately 53% (or 2,1 million) of the households in Gauteng earn a low income. • The number of households in the City of Johannesburg that earn low incomes total 740,984 or 52% of its total households.	The result from the income multiplier was further subdivided into the different income levels used by Statistics South Africa (c.f. 2.6.3). This enabled the differentiation of the impact on the various income brackets (low, middle and high) (c.f. 4.6).	The Lufhereng case study of 7,619 subsidised housing units over a ten year period (2010 to 2020) indicated that if a green approach was to be followed instead of the conventional approach an additional change in household income of R 44 million (over ten years) would occur. Of the R 44 million, low income households befitted R 2.2 million (c.f. 4.6).

Factor	Literature	Empirical	Green Development versus conventional development imperatives to subsidised/low-cost housing
Green building and sustainable technologies	Research has indicated that green buildings are meant to consume noticeably less energy and materials, and will provide healthy living environments (c.f. 2.3). The main goals of sustainable technologies are to ultimately create processes, products and/or services that are environmentally as safe as possible while, in the same breath, beneficial to humans. The technologies that are utilised in the construction environment can be used to address the social and economic concerns of the human population while also facilitating the	The green interventions applied to subsidised housing units included an insulated ceiling, a solar water heater (SWH) and energy efficiency lighting (CFLs). This correlates with professional's opinion of the three top interventions that could be considered for low cost subsidised housing in South Africa (c.f. 4.8). Two case studies that made use of greening interventions, namely the Kuyasa project (c.f. 2.8.1) and the Cosmo City project (c.f. 2.8.2) were used as a baseline to determine the reduction of carbon emissions due to the greening	If a green approach was to be followed instead of the conventional approach in the Lufhereng case study of 7,619 subsidised housing units, a single 40m^2 subsidised housing unit's carbon emissions decreases with 2,325 kg CO_2 per annum, totalling 17,710 metric tonnes of CO_2 per annum for the total development (7,619 subsidised houses) (c.f. 4.7).

Factor	Literature	Empirical	Green Development versus conventional development imperatives to subsidised/low-cost housing
	economic empowerment of marginalised sections (c.f. 2.4).	interventions (c.f. 4.7).	
Sustainable human settlements	The Gauteng Spatial Development Framework (GSDF) defines sustainable human settlements as (c.f. 2.5): "*Settlements that are well-managed entities in which economic growth and social development are in balance with the carrying capacity of the natural systems on which they depend for their existence, and result in sustainable development, wealth creation, poverty alleviation and equity*".	This study has shown that the benefits of a green development approach to subsidised housing outweighs those of the conventional non-green approach in terms of: 1. job creation (c.f. 4.5), 2. poverty alleviation (c.f. 4.6), and 3. environmentally friendly referring to the reduction of carbon emissions (c.f. 4.7).	As a result it can be concluded that the green development approach of the subsidised housing units are more sustainable than the conventional non-green development approach. The green development approach therefore results in a superior approach to achieving sustainable human settlements.

5.3.1. Unemployment and poverty

Approximately 63% of households in South Africa earn a low income; this translates to over 9.1 million individuals of which 2.2 million earn no income at all. In Gauteng 53% of the households earn a low income, which totals to 2.1 million households. The number of households in the City of Johannesburg that earn a low income total 740,984 or 52% of its total households (c.f. 2.6.3).

The Lufhereng case study of 7,619 subsidised housing units over a ten year period (2010 to 2020) indicated that if a green approach was to be followed instead of the conventional approach an additional change in household income of R 44 million (over a ten year period) would occur. Of the R 44 million, low income households befitted R 2.2 million. (c.f. 4.6)

South Africa, Gauteng and the City of Johannesburg's unemployment rate are 30%, 26% and 25% respectively. This translates to approximately 5.6 million people being unemployed in South Africa, 1.6 million in Gauteng and 564,970 in the City of Johannesburg (c.f. 2.6.7)

The Lufhereng case study of 7,619 subsidised housing units indicated that if a green approach was to be followed instead of the conventional approach, 73 additional employment opportunities in various occupations will be created annually. Of the 73 employment opportunities, 13 are skilled occupations, 19 are semi-skilled occupations and 41 are low skilled occupations (c.f. 4.5).

5.3.2. Green building and sustainable technologies

Primary as well as secondary research has indicated that green buildings are meant to consume noticeably less energy and materials, and will provide healthy living environments (c.f. 2.3). The main goals of sustainable technologies are to ultimately create processes, products and/or services that are environmentally as safe as possible while, in the same breath, beneficial to humans. The technologies that are utilised in the construction environment can be used to address the social and economic concerns of the human population while also facilitating the economic empowerment of marginalised sections (c.f. 2.4).

If a green approach was to be followed (insulated ceiling, a solar water heater (SWH) and energy efficiency lighting (CFLs) -which correlates with professionals opinion of the three top

interventions that could be considered for low cost subsidised housing in South Africa (c.f. 4.8) - instead of the conventional approach in the Lufhereng case study of 7,619 subsidised, a single 40m2 subsidised housing unit's carbon emissions decreases with 2,325 kg CO_2 per annum, totalling 17,710 metric tonnes of CO_2 per annum for the total development (7,619 subsidised houses) (c.f. 4.7).

5.3.3. Subsidised housing/low cost housing and informal dwellings

Registered subsidy properties comprise of just less than one quarter (24%) of all registered residential properties in South Africa. In South Africa between 1994 and 2009 a total of 2,94 million subsidy houses were reported as being completed or under construction by the Department of Human Settlements. Of this 2.94 million of subsidised houses, 26%, or 752,960, were in Gauteng (c.f. 2.7.1.). In 2011 South Africa had a backlog of some 2.1 million subsidised houses. There were over 60,000 people on Gauteng's waiting list for houses in 2010 (c.f. 2.7.2.).

According to Statistics South Africa Census 2011 the total number of households resident in informal dwellings in South Africa was 1.96 million (c.f.2.6.4). The number of households resident in informal dwellings in Gauteng totalled 651,039 in 2001 (23% of Gauteng's total households), this number increased with 6.9% to 739,758 (19% of Gauteng's total households) in 2011. From 2001 to 2011 the number of households in the City of Johannesburg resident in informal dwellings increased with 17.7% from 212,300 in 2001 to 249,823 in 2011 (17% of the City of Johannesburg's total households).

The significant housing backlogs and the quantity of existing informal dwellings (increasing annually) gives an indication of just how much potential subsidised/low cost housing has to impact on the total market.

5.4. CONCLUSION

Table 5.2 below depicts the overall non-green vs. green development approach effects per subsidised housing unit in the Lufhereng case study (this was calculated by taking the overall effect of the project over ten years and dividing it by the total number of housing units).

TABLE 5.2 – Non-Green vs. Green Development Approach to Subsidised Housing

	Non-Green Approach	Green Approach
Total change in consumption and production	R 143,961	R 175, 296
Total employment opportunities	0.44	0.53
Total addition household income: All households	R 26,303	R 32,028
Total addition household income: Low-income households	R 1,303	R 1, 587
Total carbon reduction	0	2,325 CO_2/annum

Source: Own consltruction

The main aim of the study was to research the following problem statement (c.f. 1.5):
Are the economic, environmental and social benefits of a green approach to a low cost housing project in Gauteng (the Lufhereng integrated development project) more significant in comparison with a conventional (non-green) approach?

This study set to evaluate the null hypnosis (c.f. 1.6): The economic, environmental and social benefits of a green approach to a low cost housing project in Gauteng (the Lufhereng integrated development project) are less significant in comparison with a conventional (non-green) approach.

This study has shown that the benefits of a green development approach to subsidised housing outweigh those of the conventional non-green approach (c.f. Table 5.2). As a result it can be concluded that the green development approach of the subsidised housing units is more sustainable than that of the conventional non-green development approach. The null hypothesis is thus rejected and it is concluded that the alternative hipothesis is probably true.

Furthermore, the Gauteng Spatial Development Framework (GSDF) defines sustainable human settlements as (c.f. 2.5): "*Settlements that are well-managed entities in which economic growth and social development are in balance with the carrying capacity of the natural systems on which they depend for their existence, and result in sustainable development, wealth creation, poverty alleviation and equity*". By comparing the different outcomes if the two approaches, green versus non-green, it can be concluded the green development approach results in a superior approach to achieving sustainable human settlements.

It is worth mentioning that one of the ripple-effects of retrofitting low-cost housing with solar water geysers is that this would increase the demand for solar water geysers. In order to respond to this increase in demand, solar water geyser manufacturers will have to increase their production and an increase in production will require more labour. The ripple effect will f retrofitting low-cost housing with solar water geysers will thus include the creation of sustainable green jobs.

With subsidised/low cost housing's significant potential to impact on the total market it can further more be concluded that, by following a green development approach instead of the conventional non-green approach, some of South Africa's major challenges namely climate change, poverty and unemployment can be addressed more effectively.

SECTION SIX: RECOMMENDATIONS

6.1. INTRODUCTION

The main purpose of this section is to discuss the recommendations formulated through the evaluation the literature and the findings obtained through the quantitative and qualitative research relevant to the aims and objectives of this study (c.f. 1.4).

6.2. RECOMMENDATIONS

6.2.1. Assessment Matrix

In order to determine the overall sustainability of a project or to compare two different development approaches, an assessment matrix can be constructed based on the three main criteria, namely:

1. Economic sustainability
2. Social sustainability
3. Environmental sustainability

The assessment matrix allocates a weight to each of the three criteria in column one based on the importance of each criterion that adds to 100 (column two). Under each of the three criteria a number variables (column three) can be identified and also weighted. The variables as well as the number of variables can be adjusted to complement a specific project or development as needed. The variables under each criteria adds to 100 (column four). Points or scores can then be allocated to each variable based on their impact or contribution to sustainability (column five). The scoring can be allocated on a scale from 0 to 100 where 0 is none or negative and 100 very significant. Table 5.3 below depicts a simplified example of an assessment matrix.

TABLE 6.1 - Assessment Matrix Example

Criteria	Overall Weight	Variable	Variable weight	Score Allocated
1. Economic sustainability	30	1.1. Change in gross output	20	
		1.2. Change in value added	20	
		1.3. Employment creation	60	
Sub-Total			**100**	
2. Social Sustainability	30	2.1. Change in household income	20	
		2.2. Change in low-income household's income (poverty reduction)	80	
Sub-Total			**100**	
3. Environmental sustainability	40	3.1. Reduction of carbon emissions	50	
		3.2. Utilisation of renewable energy sources	30	
		3.3. Utilisation of new technologies	20	
Sub-Total			**100**	
Total	**100**			

Source: Adapted from Moed, 2005

The higher the rating from the assessment matrix, the higher the "sustainability" of the project or development. The assessment matrix can either be utilised by developers to determine the sustainability of a development, or to compare two developments or by state departments when evaluating proposals during the tender process. The assessment can be a valuable tool in green development decision making for both the public and private sector.

6.2.2. Institutional Environment

Green building principles is a matter of beginning with the end in mind, and having a project team and developer who are willing to consider approaches which may be outside of their "tried and tested" conventional approaches. This team needs to be competent enough to be able to come up with good and proper solutions. Essentially, since many green building concepts, designs and technologies are relatively simple to implement and have low

associated costs with long-term benefits, they can most definitely be incorporated into RDP housing. Some of the more advanced technologies however would require a cost-benefit analysis to determine their viability.

The question can be asked – why is South Africa still following a conventional, non-green approach if the benefits of making use of a contemporary, green approach in a subsidised housing project clearly outweigh those of the former? The answer is simple - funding. The Department of Human Settlements subsidises and subsequently allocates a predetermined, fixed per-unit amount to the contractors, who need to complete the entire unit within this budget (c.f. 2.8.3). It is evident from the study that a green development approach will have considerable more benefits (economically, socially and environmentally) in comparison with the non-green approach (c.f. 4.8), but it will require more funding. In the Kuyasa case study (c.f. 2.9.1) funding for the green interventions was obtained from the UNFCCC Kyoto Protocol (c.f. 2.2.3) CDM fund (c.f. 2.10). The Lufhereng case study followed a different approach, namely cross subsidisation. The Lufhereng project is a mix housing development project (c.f. 2.8.2), which means that it incorporates both subsidised housing units as well as bonded housing units. The idea behind the cross subsidisation approach is that the cross subsidisation amount will be generated from the profits generated on the release of serviced stands and the proportional profits on the top structure of all bonded housing (c.f. 2.8.3). The overall amount generated by the cross subsidisation approach for each subsidise housing united totalled R 15,000 which is sufficient funding for greening interventions (c.f. 2.9.1.3 and 2.9.2.3). Although only two options to obtain green development funding are mentioned here, other funding options and incentives do exist (c.f. 2.10).

Since low-cost housing is a government initiative and the State has a vested interest in lowering construction, social and environmental costs, the benefits of rated green buildings (according to international standards) in light of their long-term health, social and environmental costs would need to be factored into any green building equation. Sadly, indications are that South Africa has not yet grasped the long term benefit of green initiatives and are too focused on current cost. The current housing subsidy doesn't even cover the cost of conventional construction; therefore green initiatives are unlikely to be considered.

Additional reasons why South Africa still mostly follows non-green development approaches to subsidised housing projects are policy and legislation. Although various policies (c.f. 2.5) on different levels (both National and Provincial) refer directly and indirectly to poverty, unemployment, sustainable human settlements and the Green Economy, and propose

various interventions to make the important shift from current practices towards a resource-efficient, and low-carbon path, there are no policy or legislation forcing developers to follow a green development approach. With the green development approach being more costly in a financial sense and no policy or legislation enforcing green development, most developers don't go the extra mile to obtain additional funding for the green development approach and simply fall back on the old conventional ways.

Often, the pressure on housing developers is to deliver the maximum number of units possible, with minimum capital cost. In the absence of prescriptive legislation in South Africa to enforce construction methods that are more thermally efficient, this tends to result in householders and energy utilities being left with the long-term burden of high energy costs, and uncomfortable living environments. The development of social agreements between prospective homeowners, Non-Government Organisations (NGOs), planners and developers (and possibly with international funders) is an important element of building community-wide strategies to rationalise longer-term energy consumption.

New sustainable building regulations were released by the South African government in 2011 (c.f.2.5.1). However, the enforcement of these regulations in the low cost sector is unclear and remains to be seen. It is important to note that notes that energy sources and applications involve economic and behavioural choices by individual consumers or households. Without developers taking initiative to go-green and doing their part to transform South Africa into a low-carbon economy, the State will have no choice but to start enforcing these interventions.

6.2.3. Recommended Further Research

It is evident that funding options and incentives for green development approaches to subsidised housing within South Africa exist. It is therefore recommended that that further research should be conducted to determine firstly the awareness and secondly the accessibility/user-friendliness of green development funding options and green incentives among private and public sector entities. This will cast more light on whether the implementations of greening interventions – or the lack thereof – can be attributed to ignorance and unawareness, unfriendly and lengthy procedures to attain funding and unlock incentives or whether people just don't care about the environment as a whole.

By determining why greening interventions are not being implemented on as large a scale as one would hope, a suitable approach to address and mitigate these issues can be developed and implemented. However, national or regional strategies can be effective only in as much as they are taken on board by communities and individuals. It is therefore important to engage in debate and education programmes, and generally raise awareness around green development

Furthermore, the State should lead by example - “going green” should start with Government Departments and projects. Detailed information regarding green funding and green incentives should be included in the terms of reference in every housing project tender and should not be considered an added bonus but a non-negotiable element. During the tender process, higher points should be awarded to parties who include green interventions in their proposal. If unfriendly and lengthy procedures are holding the implementation of greening interventions back, government and other funding organisations should properly access and address the issues and concerns identified. Finally, if research show that people just don’t care about the environment as a whole, taking in consideration the social, economical and environmental benefits that such an approach will bring about, it may be time for South Africa’s policy and legislation to start enforcing these principles. As the Native American saying goes: *“We do not inherit the earth from our ancestors, but borrow it from our children…”*

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ANNEXURE A

Professional Stakeholders Survey

2 January 2013

Dear Sir/Madam

I am currently completing my PhD in Town and Regional Planning at the North West University under the supervision of Professor Carel Schoeman. The topic of my thesis is: "A Comparative Analysis of the Implications of Green Development versus Conventional Development Imperatives". The objective of the study is to determine and compare the different economic, environmental and social implications of low cost housing in South Africa following contemporary green approach versus a traditional non-green approach.

As a Green Star SA Accredited Professional your input will be much appreciated. Contents will not be linked to individuals and will be regarded as strictly confidential. Please complete the questionnaire before or on 22 February 2013 and it return to:

Mari Strydom

Email: mari.strydom@ymail.com

Please do not hesitate to contact me with any enquiries. I would like to thank you in advance for participating in my research – without your valuable input; this study will not be possible.

1. In your opinion, do you think green building can be applied, as a viable option, to low cost (RDP) housing in South Africa? (please mark with an X)	
Yes	
No	

2. Please motivate your answer:

3. What green building interventions do you think can be applied to low cost (RDP) housing in South Africa? (please rank from most to least significant)
1.
2.
3.
4.
5.

4. Comments:

Thank you for your participation!!