Energy efficient low cost housing in South Africa : exploration of the low cost housing practice in some South African townships : recommendations for improved design and development of energy efficient low cost housing

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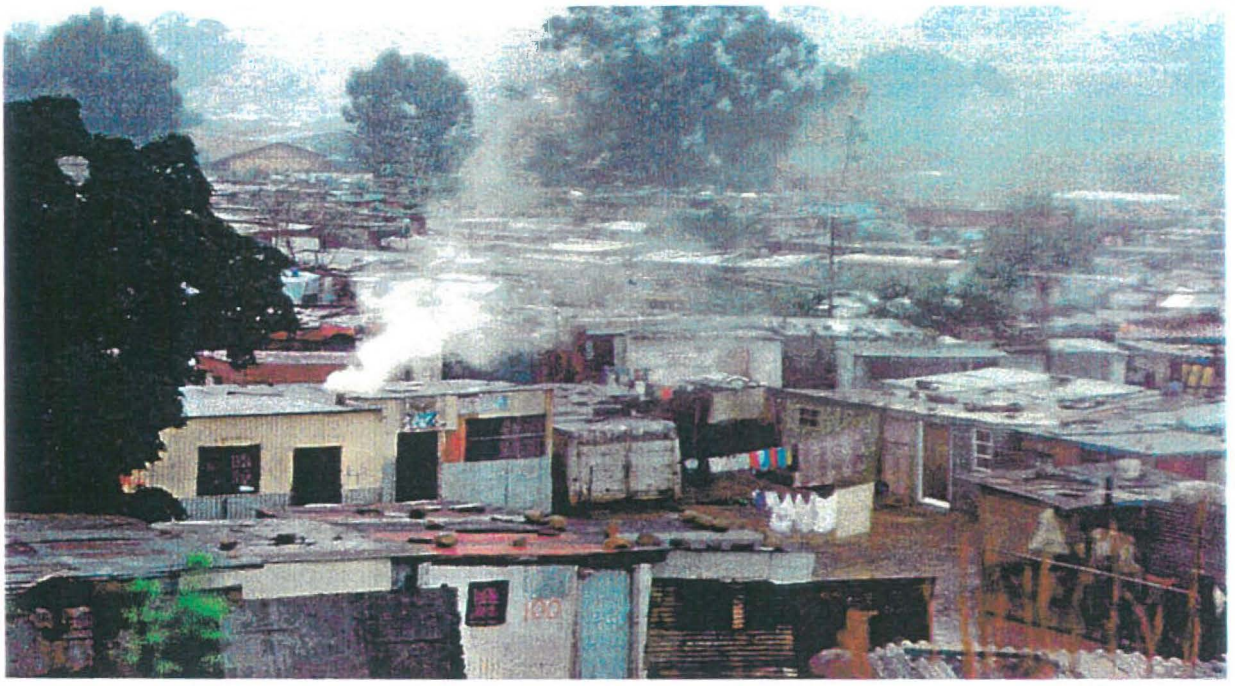

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Exploration of low cost housing practice in some townships; Recommendations for improved design and development of energy efficient low cost housing.

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June 2001

A report on behalf of the Netherlands Energy Research Foundation (ECN), Department of Solar and Wind Energy, Divisions of Implementation of Renewable Energy and Renewable Energy in the Built Environment, Petten, the Netherlands;

An M.Sc. thesis written for the Eindhoven University of Technology (TUE), Faculty of Technology Management, School of Technology and Development Studies (TDS), Eindhoven, the Netherlands.

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Picture front page: *Pollution in Soweto*, photograph reproduced with permission of IIEC-Africa.

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LIST OF ACRONYMS AND ABBREVIATIONS

AAGV = All African Games Village
AIJ = Activities Implemented Jointly programme
ALSA = Affordable Living Solutions Africa
BNC = Bi-National Commission
CBO = Community Based Organisation
CENT = Centre for Experimental and Numerical Thermoflow
CSIR = Council for Scientific and Industrial Research
DGIS = Generale Directorate of International Co-operation
DH = Department of Housing
ECN = Netherlands Energy Research Foundation
EDRC = Energy Development and Research Centre
GHG = Green house gas
IIEC = International Institute for Energy Conservation
IRE = Implementation of Renewable Energy (ECN, Department of -)
KCIHT = Kutlwanong Civic Integrated Housing Trust
LA = Local Authorities
LPG = Liquid petrol gas
MANTAG = Minimum Agreement Norms and Technical Advisory Guide
NBR = National Building Regulations
NBRI = National Building Research Institute
NGO = Non Governmental Organisation
NHF = National Housing Forum
NWR = Nederlandse Woning Raad
OHS = October Household Survey
PHB = Provincial Housing Board
PV = Photo Voltaic
$PV_{affordable\ house}$ = Present Value affordable house
RDP = Reconstruction and Development Programme
RSA = Republic of South Africa
SA = South Africa
SABS = South African Building Standards
SAWB = South African Weather Bureau
SAC = Save Alexandra Campaign
SADC = Southern African Developing Countries
SEED = Sustainable Energy, Environment, and Development
SHN = Sustainable Homes Network
SHI = Sustainable Homes Initiative
TDS = Technology and Development Studies (School of -)
TUE = Eindhoven University of Technology
UP = University of Pretoria
UCT = University of Cape Town

Unspecified: AMV, IES, PEER, ... which are acronymic names of organisations that are elaborated on in the report.

PREFACE

The author of this report worked in South Africa from April 1999 to March 2000 for the completion of his M.Sc. thesis. This thesis is done for the School of Technology and Development Studies (TDS) of the Eindhoven University of Technology (TUE) and the Netherlands Energy Research Foundation (ECN). The aim was to find information on how present low cost houses in South Africa meet the needs of low income households, from the perspective of energy efficient dwelling. This was to provide the South African housing-sector with suggestions for the design and development of future low cost houses, in order to improve living circumstances.

Meanwhile, the author was requested to assess the opportunities of the ECN to contribute to this market, which is said to be the fastest growing housing market in the world (ECN *et al.* 1997:9). The request has been formulated into the following mission:

The exploration of the energy efficient low cost housing market in South Africa, with particular reference to stakeholders and market structure.

The exploration aims at mapping the potentials of ECN-IDE/DEGO in this market. For this reason, the identification of opportunities for the ECN to contribute to this market are of major interest for the ECN, and therefore determine the structure of this report. Meanwhile, the author personally was particularly interested in the interaction between the design and development of the house on one hand, and the living patterns of its dwellers on the other. This interest fits within the mission as defined by the ECN, and matches with the philosophy of the School of ITDS that studies amongst others the relation between technology and its user in developing context. In summary, the scope of study in this report has become rather broad, hence the title: *Energy Efficient Low Cost Housing in South Africa.*

Despite the wide scope of study, senior field workers positively commented the report as being comprehensive. The comprehensiveness is achieved through focusing on a few cases, rather than to cover the total South African low cost housing market. Also, all topics considered have been selected if and only if they affect the interaction between living patterns and energy efficiency of low cost housing. Hence the subtitle of this report: *Exploration of the low cost housing practice in some South African townships, in the perspective of energy efficient dwelling.*

The outcomes presented in this M.Sc. thesis are embedded in, sustained through, and an elaboration on various findings from literature. The outcomes of literature research are presented in a separate volume that comes with this report, and are referred to wherever needed.

Benoit Chamuleau,
Eindhoven, August 2000.

ACKNOWLEDGEMENTS

This report has been the result of a lengthy but fascinating field research, which went not without problems in the initially alien but always adventurous context of South Africa. Based on my reports, sometimes concerns raised in the Netherlands, where life is comparatively quite and secure. Unmistakably, people in the Netherlands did get then the wrong picture as stories transmitted from far and alien places usually reflect only part of reality. Indeed, I also did also make mistakes, and retrieved invaluable lessons of work and life from these errors subsequently.

Petra Lasschuit never ceased having confidence in my work however, structurally criticised and supported it, mediated between me and ECN, and helped me to keep on track when I felt lost. I am grateful to her for having been there.

I thank Chris Westra, head of ECN-IRE, who gave me the freedom to set up the work as it is done, and who showed his confidence by allowing me to extend the internship after six months and finishing the work. His feedback has eventually contributed to invaluable lessons of how to act professionally while following your heart.

Of the extensive staff of supervisors I was gifted with, I also wish to thank Mr Bakker, my technical advisor whose extensive comments on my work throughout the process inspired me to go on; Mrs van Egmond, and Jan Cloin.

Habitat for Humanity is acknowledged for introducing me to the townships of Alexandra and Orange Farm. Also thanks to the students of the Witwatersrand University who assisted me in carrying out the survey in the townships. They were invaluable to me with their sensibly approach to communities, which had to be addressed in various languages.

For their efforts, I thank the fascinating and exemplary community of Kutlwanong. I am also grateful to Douglas Guy of PEER Africa whose constructive criticism on my approach to low income communities has been appreciated.

Finally, I am grateful to all others who have kindly assisted me in my work by responding on many questions, such as the IIEC, Sharon Lewis of the SA department of Housing, Stefan Köhler of AMV in Durban, the staff of Witwatersrand University, and all the others who I am unable to specify here.

The stay in South Africa and Swaziland would not have been as enjoyable as it were without the many friends I encountered in the various cities. Now, the lessons from one year living in South Africa, may be summarised by a quote I accidentally found in a workshop paper written by the community of Kutlwanong:

Go to the people
Live with the people
Learn from them, love them.

Start with what they know
Build with what they have
(...).

When their work is done
The task is accomplished
The people will say
We have done it ourselves.

[Lao Tsu, China 700 B.C.]

EXECUTIVE SUMMARY

1 Objective and methodology

Through this report together with the appendix (separate volume) an attempt is made to provide a comprehensive picture of the South African low cost housing market, with particular reference to energy efficiency. This is to identify factors that may contribute to sustainable energy efficient low cost housing and, more specific, to provide ECN a tool in identifying its opportunities in this market. Particular attention is paid to the mutual impact of energy efficiency in house design and socio-economic and cultural living patterns of the inhabiting household. Also is attention paid to the structure of the market, regulations and funding possibilities, as well as which stakeholders are involved.

The report is a synthesis of literature research, field surveys amongst townships in Johannesburg, Kimberley, Cape Town, and Durban, and interviews with various stakeholders, such as building contractors, NGOs, communities, and the government. The core business contains the study of informal, semi formal and formal low cost houses in the surveyed townships. The dwellings and the inhabiting low income households are selected in such way that a sensible picture is obtained of housing design and processes, socio-economic and cultural living patterns, energy consumption practices in the perspective of space heating, cooking, lighting and 'miscellaneous' (e.g. fridge and radio). Through the study of these aspects recommendations are made for sustainable house designs and housing processes in future.

2 Problem setting

2.1 Housing need en relevance of energy efficiency

Presently a housing backlog of ca 2 million houses exists, while ca 60% of the people lives in houses with insufficient standards or no houses at all. To redress the inequalities, annually 300,000 houses have to be built in the coming twenty years. When energy efficiency is included in the design, great positive repercussions regarding health, comfort, economy and environment are expected both on the household, regional, national, and international level.

Households with income levels of up to 800 Rand per month spend up to 35% of their income on energy. Around 50% is needed for space heating, 15% for cooking, 15% for lighting, and a remaining 20% for other needs. The large amount of energy consumed in low income households results from, apart the need, particularly from poor thermal housing design, inefficient appliances and consumer unawareness. The figures demonstrate that space heating requires the greatest share in energy consumption, while this share can be reduced to virtually zero through thermal efficient house design. The fuels used for space heating depends on area and income level, amongst other factors, but are dominated by electricity (70% of energy consumption) and paraffin (17%).

2.2 Space heating

The suggested space heating system for a dwelling depends on region, household income level and thermal efficiency of the house. While the prime function of a heating system is to produce heat, thermal comfort is an important secondary function. Though the winters can be classified as mild, the subsequent heating requirements are excessive for those who have hardly the financial means, due to inefficient and inadequate appliances and thermal poorly performing houses. The prime concern, here, is thus how to reduce the financial excesses. Heat and thermal comfort and thus financial requirements are significantly reduced through thermal efficient housing design and an appropriate space heating system.

Cooling, as is required in some areas in South Africa, can merely be obtained through passive measures in housing design such as appropriate insulation and ventilation. Mechanical

cooling is far beyond the financial means of low income households. Cooling need is however a minor concern, which is reduced to virtually zero through appropriate thermal design.

2.3 Passive solar energy efficiency housing measures

The table below presents a summary of technical solutions for passive solar energy efficiency housing measures.

Category	Measure	Physical effect	Benefits (Other than energy/ financial savings)
1) Urban	• Distance between buildings	Optimising solar penetration	Thermal comfort
	• Orientation buildings	Optimising air flow	
	• Topography	Optimising solar penetration + Optimising air flow	Energy saving, thermal comfort.
2) Vegetation	• Trees	Filtering summer light, blocks wind	Less overheating (thermal comfort), less glare, less excessive cooling
	• Shrubs		
	• Grass	Absorption reflecting sunlight	
3) Orientation	• Main axis plan East-West	Optimising solar benefits	Thermal comfort, less glare
4) Layout	• Living room north	Optimising solar heat and lighting patterns	Light and warmth during day with reduced glare
	• Kitchen west		Light in evening
	• Bedroom East		Light and warmth in morning
	• Toilet south		No heat, improving hygiene
5) Building form	• Reduced surface/volume ratio	Less thermal losses	Thermal comfort
	• Double storey		
	• (semi-) terrace housing		
6) Window orientation + sizing	• Proper sizing and orientation	Solar heat and light penetration maximised	Thermal comfort, natural lighting
7) Ceiling	• Initial insulation	Preservation warmth/coolness	Thermal comfort, stops dust, fire proofing, etc
8) Insulation	• Insulated ceiling	Preservation warmth/coolness	Thermal comfort
	• Insulated walls		
9) Thermal mass	• Dense and heavy materials	Slowing down/killing temperature shocks	Thermal comfort
10) Ventilation	• Sloped ceiling	Increased airflow	Fresh air, lower smoke and humidity levels evt. Leading to better comfort and health, and less moulding of materials
	• Air bricks	(Semi-) controlled airflow	
	• Openable windows		
	• Mech. vent shafts		
	• Chimneys	Drain smoke	
11) Overhang	• Overhang over open (window) areas where otherwise summer sun enters	Prevention penetration summer sun	Less glare, less overheating (thermal comfort)
12) Colours	• Roof light coloured	Reflection sunlight	Less overheating (thermal comfort)
	• External walls dark	Absorption sunlight	
	• Ceiling light	Reflection and diffusing daylight into room	Better natural lighting
	• Internal walls light		
	• Floor		
13) Weather sealing + stripping	• Plastic under floor	Stops penetration humidity	Better thermal qualities building materials; no moulding; no schimmel
	• sealing joints	Stops uncontrolled airflow	Comfort (less draft), energy saving (less loss)

2.4 Socio-economic and cultural aspects

The perceived housing need of (urban) poor is constrained by income level, the people's perception of 'good housing', and their living patterns. These factors determine for an important part whether a housing project will be successful. Key aspects to keep in mind in (energy efficient) low cost housing is to consult the people throughout the process, while awareness building is the ultimate tool to change most of hindering perceptions. When a perception can not be altered in favour of a more energy efficient appropriate low cost house, the design should accommodate for this perception in such way that the negative impact on the energy efficiency of the house is reduced, while the wishes of the inhabitants are respected.

Also, sufficiently high quality materials and techniques should be strive for, as inferior materials are unacceptable, despite the people's low budget. While, culturally, low cost house design may not differ much from higher income house design, distinct differences do occur due to limited household budgets (e.g. families growing from 2 to 10 people) and neighbourhood concerned (social security, tenureship, space, and so on).

However, housing priorities should focus on (thermal) quality of the skin, space, and flexibility. Small households with a limited budget should be offered modest but flexible houses, as to enable the household to modify the house when needed and affordable. People should be involved in the process to reduce costs, while good cost management offers many opportunities for better and bigger houses.

3 Stakeholders and their relationships

The relationships between stakeholders in a RDP housing project are defined by a series of agreements, which have in South Africa as main objective to involve beneficiaries more in the design and building processes, hence the People's Housing Process. The agreements and suggested relationships are defined by the South African Department of Housing.

An average low income household of 4.4 people has a monthly income of up to 3,500 Rand. The subsistence income level for a household is estimated to be around 1,300 Rand. Typically, the share of expenditures on housing in total household expenditures remains closely around 15%, regardless income level. The average expenditure on fuel ranges from above 5 to less than 2% amongst the low income households. Both housing and energy are basic needs.

Only 30% of the commercial builders take energy efficiency into account. All other factors being equal, energy efficiency is likely to be incorporated only if they would lead to direct raises in profits. Government is working on incentives however, which may stimulate the increased application of energy efficient house design.

The government itself is on most levels involved in the design of strategies stimulating energy efficiency in house design. Indeed, since mass quality housing has a top priority in the national campaign, there are various reasons to include energy efficiency which increases both quality and affordable housing.

Mortgage lenders are ideological in the possibilities of loans regarding housing finance, but are reluctant when it comes to practice. At the end of the day, the government takes the responsibility for the risks.

Consultancies and research institutes in the South African energy efficient low cost housing sector make a small world with consensus on the energy efficiency and sustainable housing ideologies. There is much discussion and co-operation between these rather few organisations, which contrasts the otherwise great difficulties that is faced to disseminate knowledge on energy efficient housing in South African context.

4 Institutional framework

Housing regulations
The housing regulations change dramatically to accommodate for a quick and effective recovery of the housing backlog. While rules are increasingly being standardised and universally applicable, the approach has changed from being of mainly imposing nature to rather end user oriented, as to accommodate for the great variety of socio-economic living standards of the people. Thermal efficiency has been increasingly part of the policy.

The South African climate is ideal for thermal conscious design, yet the elaborate knowledge regarding the matter has troubles to get diffused in the housing sector, while regulations are still rather marginal. Though not having a legal status yet, the government is working on the inclusion of thermal performance in the regulations, and incentives favouring energy efficient design are put in place already.

Both the National Building Regulations (NBR) and Code of Practice are performance orientated, allowing for innovative design, and facilitating the introduction of foreign companies in the South African housing market.

The NBR applies to all local authorities unless 'designated areas' are regarded where the concept of self-help, core housing, roof schemes or shell housing apply. These areas can apply for the Minimum Agreement Norms and Technical Advisory Guide (MANTAG) in which other standards, more appropriate to the conditions of need and affordability, are applied to the building of innovative low-cost, single-story, detached housing.

In the urban context, as soon as a household takes steps to build a permanent structure by either laying a foundation or concrete floor, the structure has to comply to building regulations, by either the 'deemed to satisfy' rules of SABS 0400 or, if the area has been designated, by meeting the MANTAG requirements.

There are, in fact, several methods of persuading the Municipality that a particular design complies with the requirements of the NBR. See section 4.2.3 for details.

Networks
With the increasing concern for energy efficiency in low income housing some facilitating networks have been initiated. Durability of such networks is improved by the preference policies of the RDP schemes that prioritise housing projects that include thermal efficiency measures in their projects. In this report the *Sustainable Homes Network* and *SEED* have been highlighted.

5-9 Case studies
The cases are selected to study the impact of different circumstances, and a differentiated response of the communities:

- Alexandra demonstrates the effects of a high density crime ridden area, where people tend to act slightly contradictory due to mixed up interests. Meanwhile, the shape of a living environment typical for an area with little space for privacy and extensions emerges.
- Orange Farm shows also some apparent contradictions. While the complaints about the inconvenient location relative to economic opportunities is frequently heard, the people like to stay in this otherwise comparatively calm area. Here, typology of gradual extended houses are easily followed and show characteristic patterns.
- Kutlwanong is physically similar to Orange Farm, but differs because of a different climate, people, and history. The people, here show much dedication to organising

themselves in order to manage things for a better life. Various housing projects are ongoing here, which provides scope for fairly good comparison.

- Khayelitsha, in Mitchell's Plane, Durban, has been only briefly viewed because of an energy efficient low cost housing project. The main issues at stake, here, are the provisions for extensions and the place that ventilation has in the campaign.
- Waterloo, a location nearby Durban, finally, is taken into consideration because of the experiment with the introduction of improved earth structures, a so-called 'inferior' technique. That project shows how the people's perception on materials can be altered through appropriate tools.

10-11 Discussion/conclusions

The case studies reveal various aspects, but do have some common findings:

- The end users should be involved in the design and building process to ensure the success of the project. This leads to various positive repercussions besides a good (and thermal efficient) house: first, the housing process is likely to be sustainable, given the project is comprehensive: the people's pride is conserved or re-established, employment is generated through self help, awareness for good practice (e.g. regarding household energy regime) raised, good houses for low prices, and a greater range of alternatives offered. In contrast to what commercial developers tend to say, such projects are commercial viable, the only additional investment being creativity in pricing, design, and co-operation between different stakeholders, while benefits should be seen on the long term, rather than on project basis.
- The people's perception has to be respected, but the origins of thoughts have to be appreciated. Only then the potential for failure of success of projects and new technologies can be anticipated on.
- Awareness raising campaigns are critical but, till present, not comprehensive. Much can be achieved this way to change perceptions, but also many opportunities are still missed. For instance, while ventilation is commonly believed to be a critical component of healthy housing, its application is still rather poorly developed.

While much of the findings from the case studies are highlighted, the integrative nature of the discussion provides scope for some more outcomes, particularly regarding design:

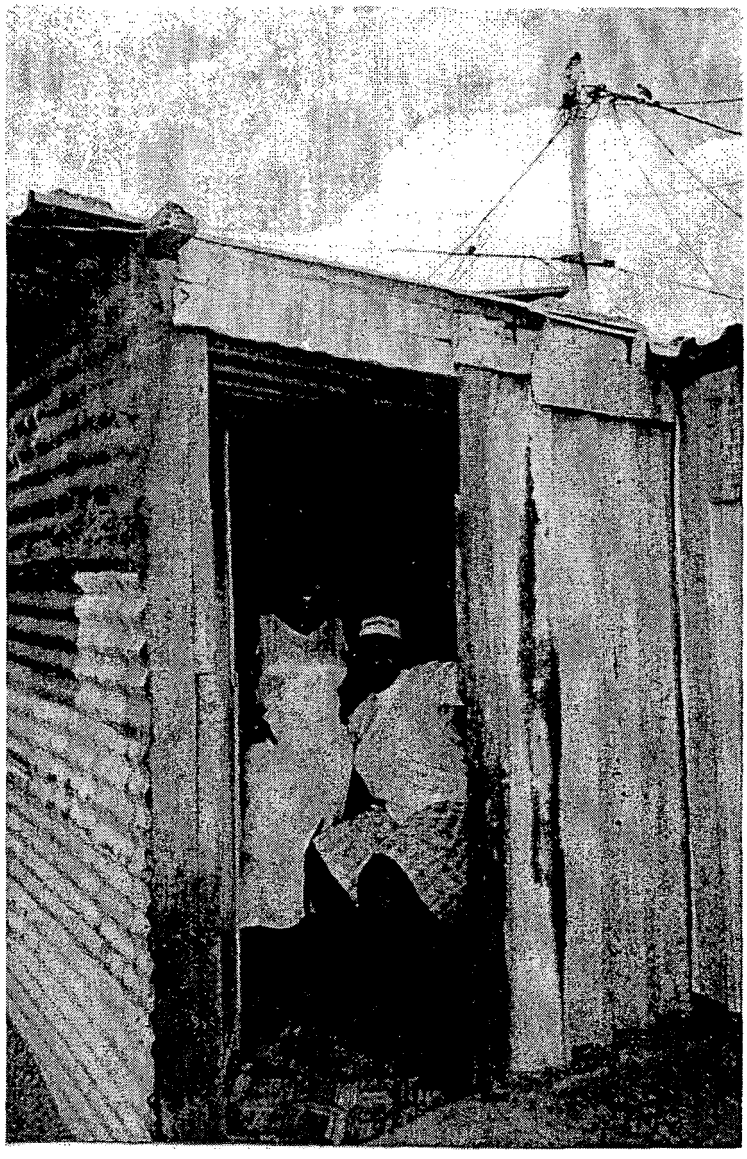
- Ventilation, indeed, is a critical component of healthy housing, but its poor application and use in reality shows the need for more attention in design and awareness raising campaigns.
- Internal doors in low cost houses have low priority. External doors should be sheltered from weather and social control. If a second door is applied, then this should be far from the first door and preferably on the side of future extensions, so that it serves as a gateway.
- Internal walls have a higher priority. Particular attention should be paid to the separation of kitchen space from living room space, for functional division and smoke generation.
- Living rooms should be comparatively large.
- The bathroom space should be well discussed on beforehand: will people really need/want it and if so, can they afford it?
- The core concept of a house should allow for canalised and least cost incremental extension possibilities.

Some recommendations for research are:

- A study to effective *awareness raising* campaigns. Special attention should be paid to the issue of the meaning of awareness when it comes to extensions, a few years after the initial energy efficient house has been built. Also of potential interest is the training of South African schoolchildren on the issue of (low cost) housing. This will help to break through the apathetic attitude that has grown through Apartheid history, and which still

lives amongst the elder Africans. It also will counter commercial exploitation as the grown up children will have more understanding of what they want and what is viable.

- After a period of ca 10 years filled with simulation programmes, the South African low cost housing market seems ready to start large scale *monitoring* of the thermal performance of low cost housing projects, as to see how close the simulations come to reality, and to conclude the effectiveness of the various energy efficiency measures. There is little in place however, and seems to offer great opportunities for organisations with the facilities to do such work.
- A study to general *diffusion* of (technical) knowledge (on energy) in the South African society seems useful: despite great advances in the South African scientific world, hardly any knowledge (compared to the scale of housing market) is actually applied.
- The need for a study to the possibilities of *Green Financing* in the low cost housing sector has been frequently expressed. While technically and socio-economically all possibilities are identified, it is believed that, today, Green Financing is the great gap to be studied, with particular reference to international experiences, to make climate sensitive housing viable.



PART I: INTRODUCTION TO ENERGY EFFICIENT LOW COST HOUSING IN SOUTH AFRICA.

1 INTRODUCTION

Here, an introduction is given to the focus of this report, and how the research has been executed. It acknowledges that 60% of South Africans lives in houses with insufficient standards, with negative repercussions on comfort, health and environment. To enhance the understanding of the energy efficient low cost housing market in South Africa, the introduction gives an outline of how this report investigates through surveys amongst low income households, interviews of various stakeholders, and literature research.

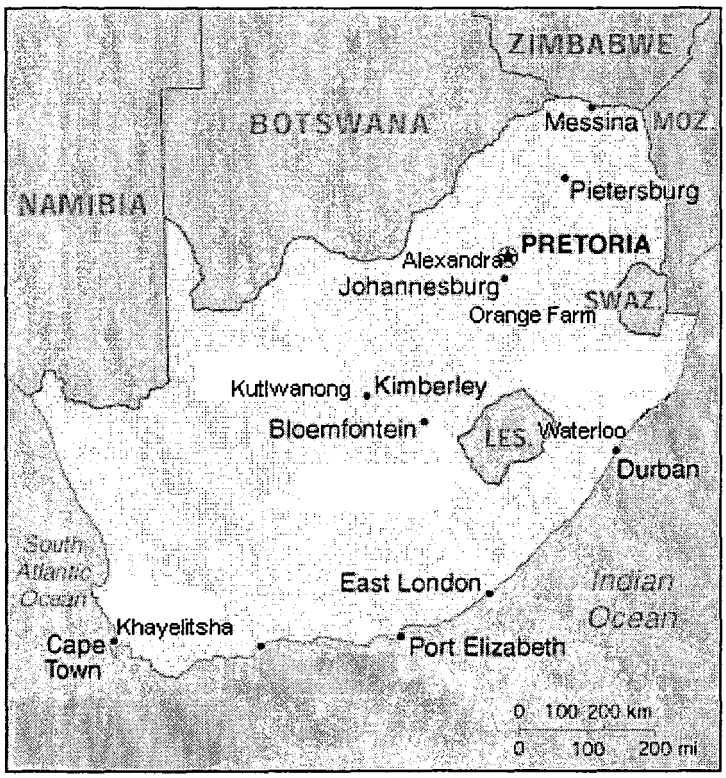


Figure 1.1: ***South African map with case study sites***

1.1 The South African energy efficient low cost housing market

Six years after the abolishment of Apartheid, South Africa still faces a huge housing backlog for low income households. 60% of the South Africans today live in houses of insufficient standards or do not have any shelter at all. To recover from this backlog, 250,000 houses have to be constructed annually in the coming fifteen years. A factor of main concern is that low income households spend up to 40% of their income on space heating. The poor thermal performance of these houses is not only a drain on limited financial resources but has also repercussions on thermal comfort, health, and the environment.

If at the same time the present housing backlog has to be reduced and the quality of houses have to be improved, structural changes in the South African institutional framework and housing delivery processes have to be enforced. The urgency of the present low cost housing situation, however, makes that the process tends to be focused on quantity, rather than quality in general, and energy efficiency in particular. Fortunately, some positive changes can be observed already. These relate particularly to the attitude towards thermal performance of low cost houses, as well as to appropriate housing delivery processes. The government is increasingly stimulating thermal efficiency, while the housing processes are more end-user oriented than before.

The South African low cost housing market is huge and incensed by the pressing needs of the poor. Yet, its development progresses slowly. This includes the slow integration of energy efficiency measures, despite the growing international concerns regarding environment and energy.

It is in this complex and changing field that ECN intends to get involved, as to contribute to the development of energy efficient low cost housing. For this mission, however, it needs to get a detailed picture of how the South African housing market works. It is the objective of this report to provide the ECN with this information, by summarising the present state of the art of this housing sector, while also is attempted to get a picture of the market mechanisms to find out where the opportunities for the ECN are.

1.2 Methodology and outline report[1]

The problems highlighted in the previous section will be first quantified in more detail in chapter 2. Also an overview is presented of a selection of energy efficiency measures, together with indications of their assumed benefits.

In chapter 3 and 4, a general study on the construction practice framework is presented as to illustrate within which regulatory constraints projects tend to be carried out. These constraints are indispensable in the perspective of mass scale projects, when a fluent design and development process with little hinder, or even (financial) assistance from government or other bodies is needed.

For the case studies, typical low cost housing projects in townships are selected for this study: Alexandra and Orange Farm, respectively in and nearby Johannesburg; and Kutlwanong in Kimberley (see figure 1.1). These sites are selected since the ECN would possibly start in these areas, and are discussed in the respective chapters 5 to 7. Additionally, the cases of the All African Games Village, also in Alexandra, Khayelitsha in Cape Town, and Waterloo nearby Durban, are selected as reference projects, and are presented in appendix C.4. These are mainly described on basis of interviews with project developers and literature.

The case studies are based on information obtained through literature and interviews with home owners. An attempt is made to follow a uniform pattern for all cases. Each case starts with an introduction to the location, including the considered housing types. Then, the local demographics are described which explain much of the people's attitude of the house. Next, the various houses are discussed in terms of design and, wherever possible, in terms of their energy performance. Suggestions are given of how the houses can be thermally improved. Each case, at the end, is concluded with a discussion on issues specific for that case, while the more generally applying issues are presented in chapter 8.

In each township, both formal and informal and, in the case of Orange Farm, also semi-formal houses, have been studied. The total sample of 161 interviews includes 6% PEER Africa ECO Homes, which are here called the 'first grade' low cost housing, 35% 'second grade' low cost housing (e.g. Grinaker), which includes all mass scale and little housing designs, as well as 59% of 'third grade' ultra low cost housing, i.e. shanties (see table 1.1). The households are interviewed, and sketches of their houses are made, in order to address the following issues:

- household characteristics;
- energy consumption patterns and problems;
- housing practices and preferences; and
- housing financing.

Table 1.1: *Houses surveyed for this report*

Housing type	*Alexandra*	*Orange Farm*	*Kutlwanong*	*Total*
PEER	-	-	10	10
EE Standard	-	-	11	11
Habitat	11	12	-	23
Grinaker	-	-	10	10
Semi formal	-	12	-	12
Shanties	32	43	20	95
Total	***43***	***67***	***51***	***161***

Shanties have been studied wherever a case has been tackled. Though far from perfect, this type of shelter still gives a picture how people would like to live from socio-economic and cultural point of view. By lining out a typology of the incremental growth of a shanty in chapter 8, it becomes clear what poor people prioritise as a function of household size and income, if no developer is involved.[2] This information provides the developer a useful tool to optimise commercially developed houses that may be technically better than shanties, but which show frequently deficiencies when it comes to functional design. Functional design, which should follow from the socio-economic and cultural living patterns, is a grossly underestimated factor in sustainable low cost housing, and this report is an attempt to make a change on that point.

Apart from case studies, information is acquired through project documents, and by interviews with involved stakeholders. Reports on the characteristics of each area, the stakeholders involved, and on what went actually well and wrong, are referred to. These studies show how energy efficient low cost housing actually works out in reality under the varying circumstances in South Africa. After all, South Africa is characterised by distinctly differing geography, climate, culture, and the subsequent varying socio-economic and cultural household living patterns. In chapter 2 factors that determine the South African setting are briefly discussed. Far more elaborate discussions are presented in the referenced appendixes. The variety demands housing approaches specific for each region and target group. These approaches are discussed to highlight where they have been successful, and where changes in strategy should be considered.

Chapter 8 starts with an overall comparison of the house designs and related housing processes of the case studies. This comparison forms the backbone of the subsequent discussion. The findings on energy efficient low cost housing in South Africa are critically assessed by means of synthesising the opinions of the various stakeholders and authorities and critics from newspapers and the like. This review forms the basis for conclusions and recommendation on the South African housing market, as presented in chapter 9, and gives some insight in the opportunities for ECN's involvement.

2 PROBLEM SETTING

In the problem setting the South African state of art of low cost housing is given. To redress the housing backlog 5.7 million houses have to be built in the coming 20 years. As the lowest income households spend up to 35% of their incomes on energy, various environmental, health, comfort and economic benefits accrue on household, regional, national and global level when energy efficient low cost houses are built. A complicating factor is that energy consumption and economics within the lowest income brackets vary by region, income level, and application. Income level and space heating are perhaps the prevailing factors determining energy consumption patterns. The chapter reviews relevant literature revealing a richness on energy efficient design options in low cost housing, while it is found that socio-economic and cultural aspects seem to be sparsely investigated, while it appears to be a critical factor in successful housing.

2.1 Introduction

Since housing need in South Africa is pressing, the focus tends to be on housing quantity, rather than quality. As for housing quality, this report focuses on the thermal performance and energy efficiency of low cost houses, which determine household energy consumption patterns. Household energy consumption, in turn, is the main factor affecting thermal comfort, health, environment, and economics, which are of main concern.

There are various technical housing design options to come to energy efficiency. In South Africa the associated problems with poor housing have been acknowledged only since the late 1980s, but literature reveals that in a short time a wealth of information on the matter has been accumulated. The problem, however, appears to be the diffusion of this information amongst relevant stakeholders in the housing process.

A grossly under appreciated factor in the housing process is the low income household. Still, it is a commonly accepted fact that the stakeholders' unfamiliarity with the characteristics of low income households is the cause of many failures. It seems that the priority of commercial enterprises is to make directly profits, which is possibly the main cause of neglecting the household. Namely, a decent understanding and involvement of households in terms of housing requires much time and effort, while the revenues are only marginal and generated on the long term. Although this may be true in most cases, good project planning and an appropriate structure has already proved in some cases to lead to 'win-win' situations, where both the households and the commercial stakeholders have interesting gains.

This chapter evaluates the South African state of art regarding energy efficiency in housing, energy consumption patterns, their repercussions, housing design solutions, and socio-economic and cultural factors. An insight in these factors allows to put needs and impacts in the perspective of the household, and the national, and international setting.

2.2 Housing need

The present population of South Africa (ca 40 million people, 9 million households) has presently a housing backlog of up to two million houses. To cover this backlog, and anticipating that during the coming 20 years 5.7 million houses have to be built, i.e. ca 300,000 houses annually (South African government 1994a).[1]

As a first step to redress housing inequalities, the South African government has pledged to provide one million new housing opportunities by the end of 1999, but seems unrealistic. Even if the government managed to sustain the intended building rate of houses, still 60% of the people would live in shacks by the year 2020 (Holm 1997). Nevertheless, it is "an impetus to jump-start the low cost housing market in South Africa" (ECN *et al.* 1997:i).

2.3 The urge of energy efficiency

Considerable benefits accrue from the construction of energy efficient / passive solar low-cost housing. These benefits include:[2]

- Reduction in household greenhouse gas emissions - estimates of 20 to 30 tonnes of CO_2 per household per decade;
- Improvement in local and indoor air quality - through the reduction of the combustion of solid fuels for space heating. This would lead to a reduction in respiratory disease and other illnesses, particularly among women and children; black South African children under 5 years old are 270 times as likely to die from a respiratory infection as children in Western Europe (von Schirnding *et al.* 1991);
- Improvement in overall quality and comfort of the dwelling;
- A reduction in energy related accidents (e.g. burns, fires and poisonings) - over 15,000 children are hospitalised from paraffin poisonings each year, and burns are one of the top four killers of children under 14 (Ebenhard and van Horen 1995). Household surveys in various parts of South Africa suggest that between 1% and 6% of poor urban households have experienced incidents of poisoning in recent past (van Horen 1996).
- Less time spent gathering or purchasing fuel;
- A reduction in household expenditure on fuel for space heating - the poorest households spend up to 40% of their income on subsistence energy needs; savings of 50 to 90% on winter space heating fuel can be achieved;
- Reduced household / government expenditure on health care – Nationally, treating the victims of respiratory disease (who are able and willing to afford to access a hospital) cost South Africa R307 million annually (van Horen 1996). Direct and indirect health savings would, according to Basson (1996), amount to approximately R500 million per annum; and
- A reduction in peak load electricity consumption - Eskom's highest annual consumption level coincides with the coldest night of the year (Surtees 1993).

2.4 Household energy consumption

Energy consumption in South Africa is high. The fact that energy is relatively cheap can however hardly be a valid argument for the population that lives below or around subsistence level. Estimates suggest that the lowest income households spend between 5 (StatsSA) to 35% (Thorne 1995) of their income on energy, which is required for cooking (7-18% of the previous estimates), space heating (38-52%), lighting (1-16%), and other facilities (0-5%) (Simmonds and Mammon 1996). Additionally, water heating constitutes 30-50% of the total household energy load (Beute 1993). For these purposes a multitude of resources are used, such as electricity, coal, paraffin, wood, candles, gas, animal dung, and waste.

Consumption figures in the established low income electrified homes are substantially larger than those of typical Dutch households. One of the reasons for these figures is the high electrical consumption associated with stoves and ovens (found in 75% of households), space heaters (48%) and irons (76%) in these households (Hoets and Golding 1992). Also the average household size in South Africa is with 4.4 people substantially larger than in the Netherlands, where the average household size is 2.3 (although this may affect marginally the energy consumed for cooking and space heating due to scale effects of the large family). The impact of families using electric heaters is significant bearing in mind recent studies showing that South Africans on average start heating their homes when outside air temperatures fall somewhere below 19°C (Annegarn & Kneen 1995) and 16°C (Surtees 1992, Wentzel 1982).[3]

The energy resources used vary considerably by region (determining climate, geography, and socio-economic and cultural patterns), income level, urban context (rural or urban), culture (black, coloured, Indian, white),[4] application (cooking, heating, lighting, warm water,

appliances), housing type (formal or informal), gender (male or female headed households) and on whether households are electrified.[5]

The secondary household energy consumption data below illustrate this.

- **Energy use by application and race**[6]

Figures 2.1 to 2.3 allow for a comparison of energy use between the main racial groups in South Africa. Typically, the white community is almost entirely electrified, while only half of the Africans are. The Africans who do not cook or heat with electricity get their energy primarily from wood and paraffin, while gas and coal follow on a distance. The African household obtains its lighting primarily from electricity, with candles as a second option, while paraffin follows on a distance.[7]

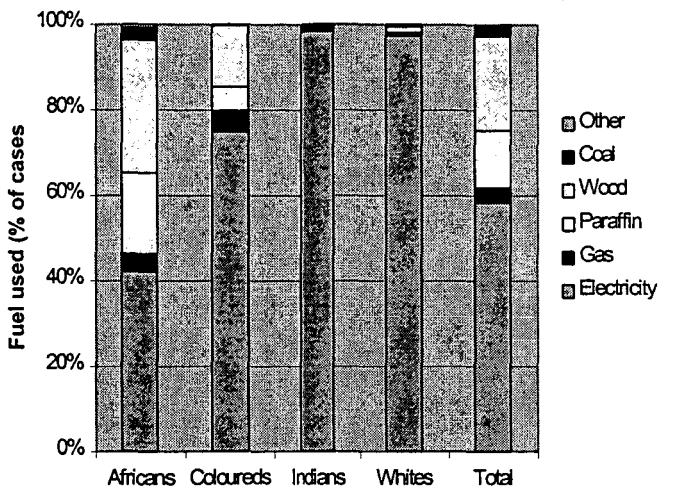


Figure 2.1: ***Main energy sources for cooking in South African households (OHS 1995).***

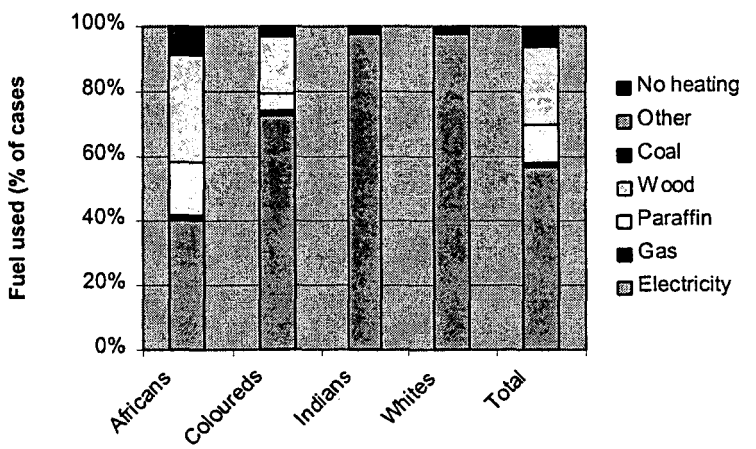


Figure 2.2: ***Main energy sources for space heating in South African households (OHS 1995).***

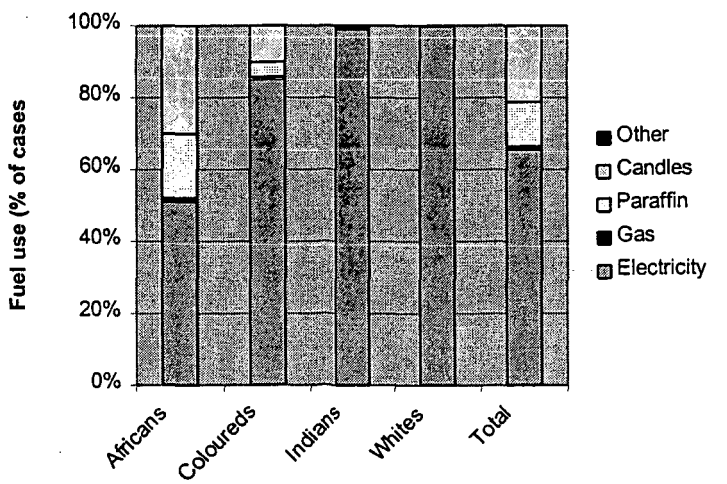


Figure 2.3: ***Main energy sources for lighting in South African households*** **(OHS 1995).**

- **Energy use by Africans; by application and by urban context**

The *October Household Survey 1995,* further differentiates the previous data on energy consumption by Africans in urban and non-urban contexts:[8]

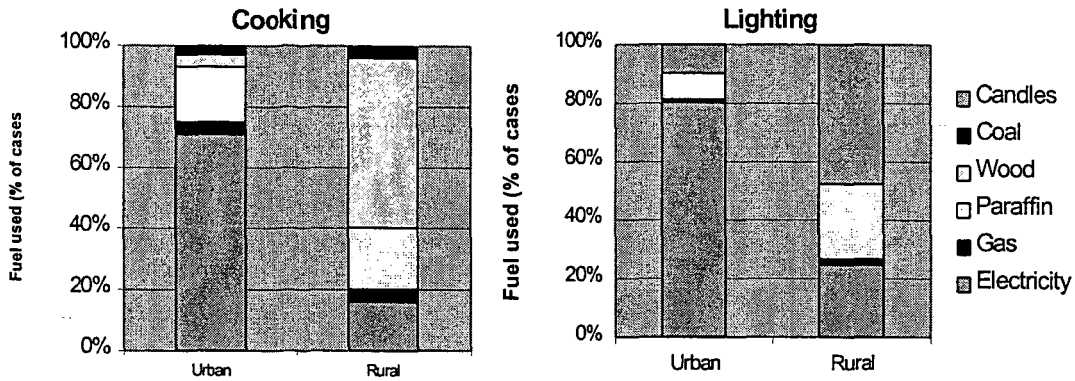
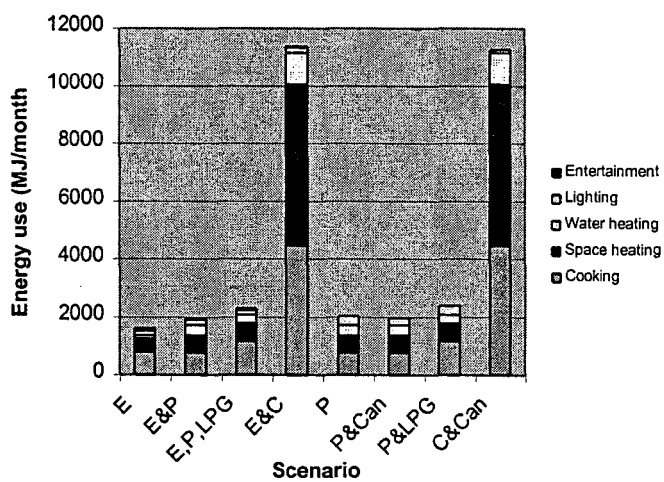


Figure 2.4a and b: ***Main energy sources for urban and non urban Africans*** **(OHS 1995).**

The poor electrification of the Africans mostly hits the rural population (see figure 2.4). When only the urban blacks are considered, electrification increases by 50% relative to the total picture of the previous figures. As a consequence, African candle use for lighting in the urban areas drops to a share of 10%, closely followed by paraffin. Rural households have the biggest share in the high wood consumption for cooking. Only 4% of the urban households use wood. Instead, paraffin is with 18% after electricity the main cooking fuel for the urban households.[9]

Figure 2.5: ***Energy scenarios for urban low cost housing (energy use in MJ/month). Notes: E – Electricity; P - paraffin; C – Coal; LPG – LPG; Can – Candles (Simmonds and Mammon 1996).*** [10]



Assuming that cooking and heating patterns are proxies of each other (see figures 2.1 to 2.3), it is likely that the urban Africans use mainly electricity (ca 70%) and paraffin (ca 17%) for space heating, while wood consumption is used by only 4% of the urban households.

Figure 2.5 presents the main fuel combinations for the urban low income households, as well as the amounts of energy involved.

- **Energy use by region**

Table 2.1 shows which consumption patterns can be observed when only coal, gas, paraffin, and electricity are selected for investigation. Due to its heavy and bulky nature, the price of coal is influenced by transport and handling costs. The greater the distance from a coal mine, the higher the price. As a result, coal's most widespread domestic use occurs in the vicinity of the coal mines. Thus, 69% of the households in Gauteng and the Free State, which are near to the coal fields, use coal, compared with only 4% of households in the Western Cape and 1% in the Eastern Cape, which are far from the coal fields (Ebergard & van Horen 1996).

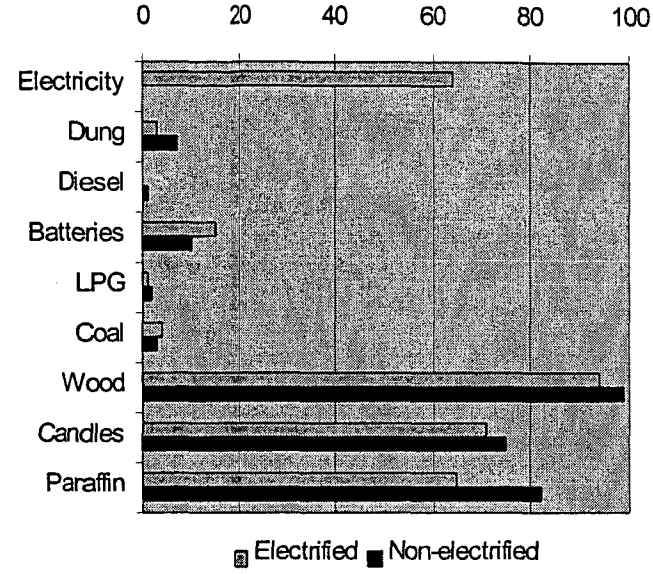
Fuel:	Cape Town:	Port Elizabeth:	Durban:	Gauteng region:
Coal	4 %	1 %	22 %	69 %
LP gas	24 %	14 %	30 %	17 %
Paraffin	60 %	90 %	87 %	47 %
Electricity	41 %	13 %	6 %	39 %

Table 2.1: ***Urban low income households using selected fuel carriers (Trollip 1993).***

- **Energy use by electrification**

Though it is not as distinguished as the other classifications, there are visible shifts in fuel uses, when electrified households are compared with the non-electrified households. Figure 2.6 shows how many of each category in rural areas actually uses the mentioned fuels.

Figure 2.6: ***Percentage of low income rural households using different energy carriers (David and Ward 1995).***[11]



According to Kutlwanong *et al* (1997:9) does liquid petrol gas (LPG) have a small market share because there is no established distribution chain and due to a price control mechanism, is not competitively priced. Under the current Energy Policy, LPG is regarded as a liquid fuel and is linked to the fixed price of petrol. If LPG were priced at world market levels, it could be one of the cheapest household energy options per unit of useful heat delivered. LPG has other environmental benefits, including the fact that it is a clean, no-smoke fuel and has a lower carbon content per MJ output than coal"

2.5 Space heating in low cost houses

In many low-income households resources that do not primarily serve to heat the space do actually contribute to it (e.g. wood fire for cooking). This makes that space-heating utilities in terms of efficiency and impact are difficult to distinguish from other end-uses and appliances (Gowen and Leach 1983:83). A typical example that illustrates the complexity of heating in low-income houses is given by Holm and van Aswegen (1992:5), who report on the case of Mabopane, an informal settlement north of Pretoria. Here, people use coal for thermal energy services in winter, while in summer they move outside to cook or switch to paraffin. A student from the rural areas described a similar seasonal pattern in Willowvale, a settlement in the Transkei, where people cook on paraffin in their house in summer, while they switch to wood fire in a separate hut in winter.[12]

Heating systems vary considerably by region (Simmonds and Mammon 1996), the characteristics of which are determined by climatic, geographic and socio-economic and cultural factors. For instance, in the Gauteng coal is largely available and comparatively cheap, thus being the main fuel. In Villiers, the belief in contact with the ancestors through open fires prevails, leading to a very difficult introduction of the electric heater, despite its affordability and much more healthy (van Niekerk 1998). The main fuels for heating the black South African low cost houses are electricity (40%), wood (33%), coal (5%), gas (2%), and others (e.g. animal dung and waste, a substantial remaining group of 20%).[13] However,

entirely in line with Gowen and Leach, as referred to above, and Mills and Armstrong's (1993) remark "multi-functionality is a hallmark of poverty", resources such as paraffin, candles, and cooking gas, that originally serve other functions (e.g. lighting or cooking) also contribute to space heating. More specific, in the case of lighting every unit energy that is not used for lighting contributes directly to space heating.

Typically, despite the coldness during South African winters even in higher income housing hardly any sophisticated heating system (e.g. central heating) can be found; here too, improvised solutions such as gas and electric heaters are rather common. This may be explained by the possibility that winters are still not considered as cold or long lasting enough (indeed these were reasons for some white residents in Kimberley), while the cold can be overcome by using blankets, open fires, or by sitting in the sun.[14] A fieldworker argued, however, that when people do use blankets, and when they do try to fetch the heat from cooking fires, their behaviour expresses a distinct need for heating, while they may not be able to financially afford it.

This suggests that energy consumption for space heating may be low, and seems to contradict with previous reports stating that energy expenses in low-income households are excessive. Yet, a distinction has to be made between sophisticated systems, which are useful when much heating is required; and less sophisticated heating devises, which are still sufficient when lower levels of heating are required. In the latter case however, the costs may be 'excessive' for the lowest income groups without financial means, partly due to the use of inefficient appliances or houses. So while space heating requirements may be met by simple heating systems, the systems usually lead to excessive costs for the poor. Sophisticated heating systems accommodating for more severe coldness are beyond their reach, and seem actually not required considering their absence amongst even the higher income groups.

Thermal comfort is assumed to be highly relevant. Yet, thermal comfort requirements hardly affect the diffusion of appropriate heating systems and thermally optimised housing designs. Here, the reason may be that thermally comfortably designed houses reduce the absolute need for more improvements in comfort and efficiency till such extent that needs shift to other priorities. This research sustains this explanation: while shanties almost unanimously apply space heating, almost half of the so-called energy efficient houses, even when efficiency seemed marginal, did not have space heating at all. It suggests that, provided that a house is thermally well-designed, the need for additional facilities, such as heating appliances, is reduced significantly. There are even examples where there is virtually no need for such systems at all.

In South Africa there are also climatic regions where cooling is periodically needed. Usually natural ventilation and cooling systems (e.g. semi-permeable water cans providing evaporative cooling) would do. Problems occurring in situations where mechanical intervention is required, however, are unlikely to be solved. Mechanical cooling is beyond the financial possibilities of low income households. In this research fans, as a means of convective cooling, have been observed incidentally only, when it comes to low cost housing.

In summary, winters are cold in many parts of South Africa, but seem for the time being mild enough to not require sophisticated heating systems. The suggested heating system depends on region, household income level and thermal efficiency of the house. While the prime function of a heating system is to produce heat, producing thermal comfort is an important secondary function. Though the winters can be classified as mild, the subsequent heating requirements are excessive for those who have hardly the financial means, due to inefficient and inadequate appliances and thermal poorly performing houses. The prime concern, here, is thus how to reduce financial excesses. Heat and thermal comfort – and thus financial requirements are significantly reduced through thermal efficient housing design, while the

selection of proper heating systems do the rest to significantly reduce heating, and thus financial, requirements.

Cooling, as is required in some areas in South Africa, can merely be obtained through passive measures in housing design. Mechanical cooling is far beyond the financial means of low income households.

2.6 Design options[15]

The opportunities for energy efficient low cost housing in South Africa are significant. An unidentified author illustrated this in 1997 to the Dutch DGIS:

> "Estimates of incremental cost of building a low-cost home in South Africa that has a good thermal design performance range from 0% (Holm 1996) to 5% (Thorne 1995) of dwelling construction costs. Holm maintains that changes improving thermal performance can be made at no additional costs due to resizing the windows and re-siting the structure on the plot to save connection fees (Scholand 1997). On the other hand, if incremental cost were 5%, comparing this cost with the long-term operating costs would still easily come out in favour of thermal efficiency. Taking the standard entry-level home which has a price tag of R15,000 [i.e. cost of a house for the RDP scheme], the measures would cost between 0 and R750 per home. These measures would save approximately 80% of dwelling space heating requirements (Thorne 1995)."

Holm and van Aswegen (1992) also predict that a shielded window on the north side of the building and a 50 mm layer of glass wool insulation over the exterior shell could reduce typical heating/cooling requirements by as much as 80%. This applies to new housing and to a large extent to existing housing. The focus is on passive solar systems as, according to NEC-NER, they require no moving parts, repair or maintenance, and there are no transmission losses on distribution systems. Little can go wrong: no brownouts, blackouts, and so on. Furthermore, as such systems are integrated in housing technology, little additional costs, compared to the high costs of active systems (e.g. PV systems), are involved. Research has shown that various significant energy savings are available at hardly any cost. For instance, insulating the roof of a house with card board ceilings (without additional insulation materials) leads to at least 14% saving (NEC-NER:1).

Below a review is presented of findings on energy efficiency measures for South African low cost housing from a multitude of literature. Figures 2.7 to 2.9 visualise the possible energy efficiency measures.[16]

- Site

Not just any site is freely available, thus one has often just to accept the local circumstances, i.e. the micro-climate, surrounding objects and limiting dimensions. If there is any choice, however, then a flat or north facing slope should be selected in South Africa while some other buildings or mountains may be around, as long as they do not produce shading between 9.00 a.m. and 3.00 p.m.. Furthermore, the major dimensions of sites should not deviate by more than ca. 15 degrees from true north-south or east-west orientation to facilitate good building orientation (Holm and Viljoen 1996:10).[17] When scale of housing and size of site are sufficiently large, they will allow for an integrated urban and housing plan, thus increasing the energy benefits on urban scale. For instance, a sensible configuration of houses (anticipating on prevailing wind directions, types of turbulence, and interaction with the other climatic elements) may generate a certain external airflow that provides cooling in summer, and which is slowed down in winter, while draught is avoided.[18]

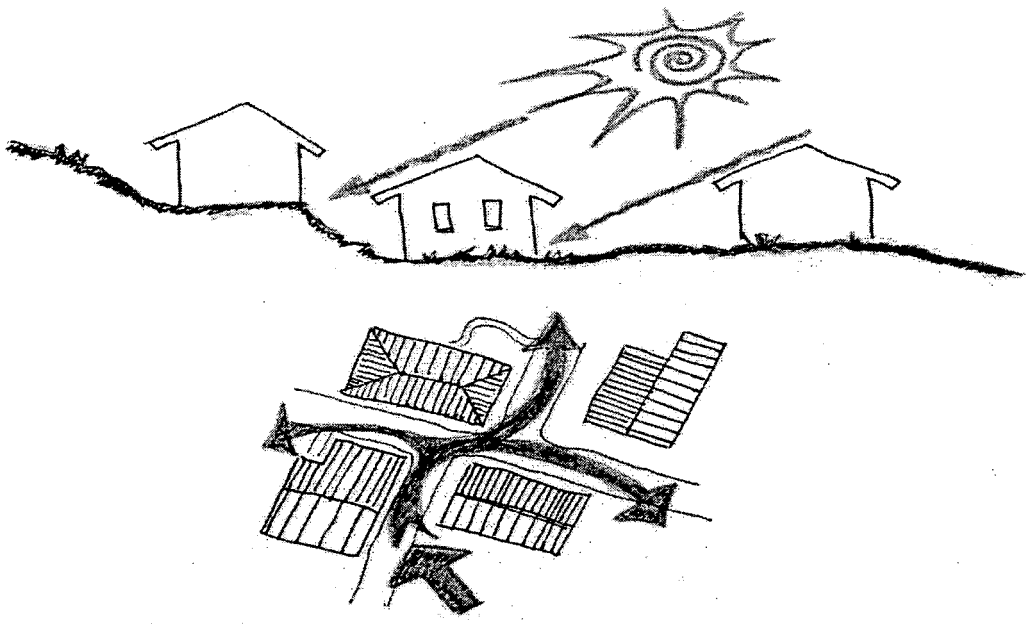


Figure 2.7: ***Passive energy efficiency measures in low cost housing (1): 1: Allowance for solar access through urban layout; 2: Airflow sensible orientation through urban layout.***

The impact of correct building orientation should not be relied on too optimistic however. The greatest energy saving that can be obtained amongst 'ultra-low-income houses' (the average shack made of corrugated iron sheets) is merely 2% (Mathews *et al* 1995), while the advantage slowly increases to ca 10% for low income houses (Mathews and van Wyk 1995) to 14% for middle-income houses (Mathews *et al* 1997).

Various sources indicate that vegetation, such as trees and pergolas with deciduous creeper helps to kill wind speed, which otherwise may lead to accelerated cooling of the dwelling.

Meanwhile, trees may block the worst sunlight radiation in summer, while trees that lost their leaves allow for maximising solar access in winter. It is also suggested that grass around the house absorbs heat by which the house stays cool. This in contrast to houses that are exposed to heat infiltrating the house after being reflected by paving or sand. It is rather common that people experience more overheating and blinding sunshine in townships, compared to better-off areas nearby: the dust roads, pavements, and abundance of corrugated iron sheets lead to extreme reflection.

- **Functional plan**

The main axis is preferably oriented east-west, so that the largest wall faces north, where the sun reaches its zenith. The benefits further increase when the largest windows are on this side. This goes together with positioning the areas on this side where people live most of the time (e.g. living room and kitchen). Other areas, such as bathrooms and storage are suggested to be designed on the far west or east side, as then hindering radiation of low sunshine can be reduced, while bedrooms are preferably on the eastern side as to benefit from the morning light and warmth (figure 2.8).[19]

The dwelling should be designed as compact as possible, i.e. having an as large volume-surface ratio as possible, to reduce heat losses. This also includes the construction of dwellings alongside each other, a presently quite uncommon practice in South Africa, where houses historically are stand-alone. This alternative may be frustrated by cultural barriers (see section 2.7).

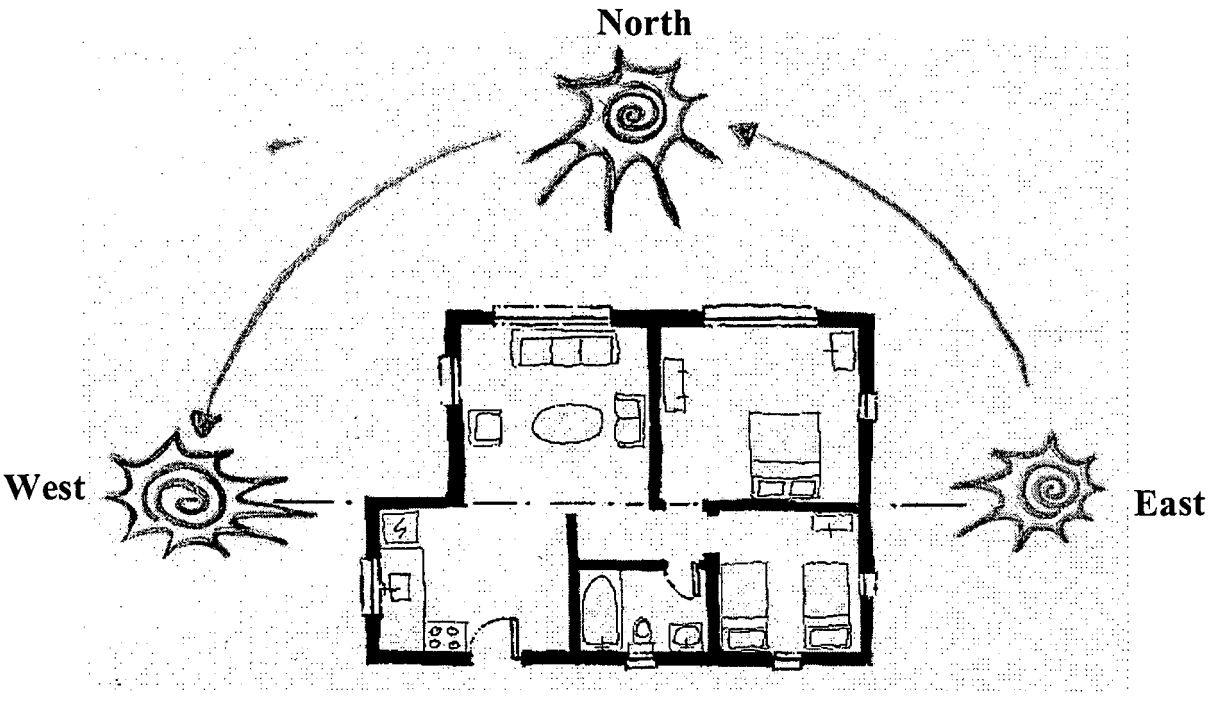


Figure 2.8: ***Passive energy efficiency measures in low cost housing (2) 3: Main axis East-West; 4: Proper window sizing and orientation (see also figure 2.9); 5: Compact building envelope; 6: Appropriate functional layout.***

- **Geometry**

Other measures to prevent glare and overheating in summer are overhangs. These should be designed in such fashion that they prevent the worst summer radiation from entering through the window, while they allow for solar access in winter (figure 2.9).

In areas where energy resources are used that produce poisonous smoke (e.g. Kimberley, where the use of coal dominates), chimneys, shafts or other measures are suggested to channel it. The design may be a sensitive matter though, considering the cultural implications as discussed in the following section.

Windows should be predominantly on the northern side, and in the areas where people live most. Optimal size in South Africa, according to standards of architectural and passive solar design, is a ratio of around 1:5 window to floor surface (i.e. 20%), depending on climatic region.[20] According to Holm (1996:11) this leads to optimised solar penetration, where solar gain efficiencies would be between 50 and 70%, which is good for heating and natural lighting. Mathews *et al* (1997) are less optimistic and calculate that heating requirements of properly sized windows in middle income houses are only 10% less.

Window surfaces in other areas should be reduced to minimise heat losses.[21] The final choice of window size should be the result of careful balance between thermal losses on the one hand and natural space lighting on the other. When windows become too small, not only thermal gains may be lost, also energy costs for interior lighting will otherwise increase, thus negating the energy savings in interior heating (Holm 1996, Mathews *et al* 1997).

In order to enable the household to ventilate the house, which is particularly necessary in case of the toxic emissions when fuels are combusted, openable windows should be considered. The issue of ventilation is rather young, so the debate still focuses on how and in which extend ventilation should be applied in low cost housing. More on the issue in chapter 8 and appendix C.4.

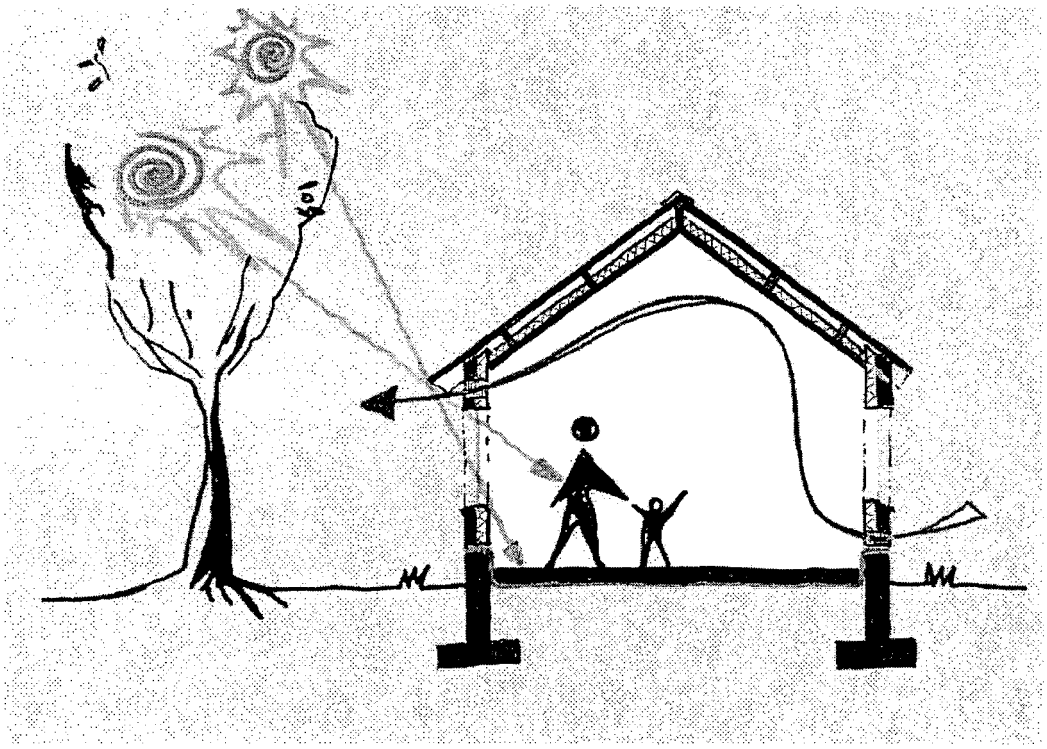


Figure 2.9: ***Passive energy efficiency measures in low cost housing (2). 7: Vegetation; 8: Natural ventilation; 9: Insulation; 10: Thermal mass; 11: Sealing and stripping; 12: Overhang; 13: Ceiling; 14: Appropriate colour selection.***

- **Materials / physical aspects**

Appropriate thermal insulation is a prime requisite in energy saving design, as it regulates temperature changes and it leads to energy saving. (Passive) heat systems may contribute to reduction of energy consumption for heating.[22] Choice of material, in terms of surface treatment and colour, further contributes to the amount of absorbed cq. stored or reflected heat.[23] For instance, the tough reflecting surface of plain concrete floors would enhance natural lighting.

Energy savings around 54-84% during the heating season can be achieved when ceilings are applied underneath roofing sheets, a solution that improves further to 83-90% through the application of insulation on top of the ceiling (Mathews and van Wyk 1996; NEC-NER: 4).[24] The average monthly monetary saving that can be made with this measure ranges from R54 for middle and higher income housing to R66 for low cost housing (Mathews *et al* 1997).[25] Mathews *et al* (1997:18-27) breaks the thermal gains and related monthly monetary savings and payback periods further down to the two income groups and climatic regions.

Much of thermal insulation is in vain if no proper sealing and weather stripping is applied. Some ventilation for clean and comfortable indoor air is important, but it should be controllable, as through opening windows or specially designed ventilation channels.

Thermal mass has the capacity to accumulate and transmit heat from convection and radiation when it is cooler than its environment, while it emits the heat when it is warmer. It does so with a certain delay, which is greater when the mass is higher. This is the so-called thermal mass 'phasing' phenomenon. Inherent to this phenomenon is that internal temperature fluctuations follow the outdoor fluctuations with reduced amplitudes, thus decreasing the extend of internal temperature fluctuations. The accumulation and phasing properties can be highly beneficent when the appropriate mass is selected and when the house is well designed. In such case daily heat is stored in the structure delaying its transmission to the internal

environment, thus keeping the internal environment cool when it is hot outside, and warm when it is cold. This way fairly comfortable spaces can be offered at low costs (little heating or cooling is needed) in an otherwise hostile climate.[26]

The roofs are preferably light coloured as to reflect the intensive summer sun, while the external walls are dark coloured as to absorb the solar heat of the lower standing but less intensive winter sun. Energy gains due to application of light colours, compared to energy requirements in dark coloured houses amount are in the order of 36% for the ultra-low-cost houses (Mathews *et al* 1995), 34% for low cost houses (Mathews and van Wyk 1995), and 10% for middle-income houses (Mathews *et al* 1997). Internal walls have preferably light colours to reduce the need for artificial lighting.

- **Technology**

House construction technology is hardly discussed in literature on energy efficiency in low cost housing. Nevertheless, its impact may be significant, as proves the case of Kutlwanong (chapter 7). For instance, mass production, given it is done according to sufficient standards, may lead to enormous gains, relative to conventional housing that is built on small scale. The use of larger elements, possibly prefabricated, may lead to structures which are well sealed by their nature, and where all required facilities are included. Houses constructed by the people themselves may lead to imperfections that are more energy consuming. In addition, mass production may lead to technologies that become feasible (through scale economies) which, on small-scale, would be beyond reach. E.g. corrugated concrete sheets as an alternative of corrugated iron sheets are feasible when applied on large scale.

- **Costs**

The exact financial costs and benefits of passive energy efficiency measures are hard to quantify in the South African context. All assumptions being equal, the climatic variation throughout the country is so great that payback periods for, for example, insulated ceilings vary from 4 to 7 years (in the highveld) to unfeasible periods of over 10 years (the eastern border of SA). The long term viability of the solutions depends thus per climatic region, and need to be specified per dwelling.

2.7 Socio-economic and cultural aspects

It is important for the success and sustainability of any housing project to consider socio-economic and cultural living patterns (hence 'living patterns') of households. This is particularly true for the case of low income households, whose living patterns may deviate significantly from the housing developers' living patterns who usually come from higher income groups. The latter may have a lack of vision of these differences, which may lead to a wrong appreciation of the impact of housing design on the target group.

The consequences may be aggravated due to the limited financial resources of the household. Having a limited resource means that a house has to suit exactly to the needs without spilling money. No margin is viable, such as designing larger spaces, thus limiting design options. Higher income households can permit more spacious houses, which have the capacity to absorb specific living patterns, thus leading to designs that are more likely to be successful.

It is argued that a better appreciation of the people's life also contributes to a better understanding of the thermal performance of a house. After all, man is perhaps the most unreliable factor affecting energy consumption.

In appendix C.1 is elaborated on potential conflicts between energy efficiency measures and the living patterns of low income households. The findings are included in the review below.

- **Ultra-low-cost houses and energy efficiency**

Currently the need for shelter is mainly provided by ultra low cost houses, which are in fact shacks that are mainly constructed of corrugated iron sheets. Mathews *et al* (1995) suggest that where no houses of sufficient standard can be provided, shacks could be retrofitted as to reduce energy requirements. The reductions which, according to Mathews, could lead to 75% of the original energy consumption patterns, lead not only to savings allowing the household to alternative investments, they would also lead to higher comfort and health levels, while environmental benefits are also significant, as less fuels are burned. The savings could be reached by practical and economical feasible solutions such as the application of cardboard insulation, which can be obtained for prices of virtually zero.

Yet, despite that economical gain might be a strong incentive, it is questioned whether the argument holds against social acceptability. Frequently heart is: 'Where does the rich man get the right from, particularly when he is white, to tell the poor African to invest more in his shack, while he himself lives in a comfortable house? And did the government not promise decent houses for all?' Here not only information dissemination is at stake. Of crucial importance is *how* the information should effectively reach the people.

- **Priorities of implementation**

From the findings in Mathews *et al* (1995, 1997) and Mathews and van Wyk (1995) can be concluded that different energy efficiency measures have different levels of impact. Indeed, the impact of applying an insulated roof has with energy savings of up to 90% by far the greatest impact of these measures, while the payback period of 3 to 7 years of this application seems acceptable. In contrast, measures such as placing the building in the right orientation, designing roof overhangs, and so on, seem to have a minor energetical impact, while social impacts of such measure may negate the quality of the house. One may therefore argue to focus on insulating the roof, while less effective energy saving measures are sacrificed by measures that may improve, for instance, social safety, urban habitability, and so on. After all, these aspects also need attention in low income housing when the improvement of living standards is at stake.

Cases such as the *All Africa Games Village* (see appendix C.4) show what happens if all attention is explicitly focused on energy efficiency: what emerges is a rather technocratic location without character, which shows similarities with the previous "sterile urban areas with row after row of matchboxes as designed by the Apartheid planners" (Mills and Armstrong 1993).

A similar dilemma occurs at urban planning level. From energy but also from cost efficiency point of view a particular urban design may be preferred. For instance, when ventilation is required to reduce overheating, the urban plan may be such that houses are lined parallel to the prevailing wind. Such a design, however, is rather technocratic and risks to be a step back to the former Apartheid town planning dogmas, that were based on cost efficiency. Such an imposed design may conflict with social patterns, that otherwise lead to organically growing settlements that lead to higher social safety *per capita* and a more enjoyable environment (Mills and Armstrong 1993). Certainly, both cases represent extremes of the range. The answer lays somewhere in-between. A Space Syntax helps to design with understanding for the urban and housing living patterns method (see appendix C.2).

- **Shape house**

In South Africa the stand-alone house is a cultural entity, from which it is hard to deviate. "People want to be able to walk around their houses", is commonly summarised. Yet, such houses have negative cost, energy, and spatial consequences, to mention but a few drawbacks. Terrace, courtyard, multiple storey housing, and urban villas may alleviate much of these drawbacks but are hindered by socio-economic and culturally based convictions. These include arguments such as lack of privacy through noise transmissions through walls, lack of

extension possibilities, lack of play ground, and so on. One respondent in Alexandra said that attached houses make people associating the neighbours with each other, which is a problem if you have a neighbour you do not want to be associated with.

Multiple storey housing is also often regarded as no good. There are no extension possibilities, while one may suffer from leakage or noise from higher storeys. Typically, in areas such as the All Africa Games Village, where solid flats are built, such complaints are not heart. Here it seems that a good house simply overrules the arguments against such houses as, possibly, people are just too happy to have a decent house. As long as the standards are good, they seem to be able to live with the fact it is attached and multiple storey. It seems that people have to experience what the potentials of such houses are. This highlights the effect of "show me" culture in South Africa (ECN *et al* 1998). This is also why negative attitudes towards multiple stories are found in other areas where poor performances by such houses are demonstrated.

The circular shape of the rondavel, the traditional circular African hut with thatched roof, is about to disappear in the urban landscape. For many it is a symbol of poverty. Even in rural areas the rondavel is increasingly replaced by rectangular houses, even though rectangular shapes involve more complications in construction. Yet, this traditional house implies smart aspects. Apart from that it is easy to construct, the rondavel approaches of all housing types best the ideal energy saving ball, which has a minimised volume-surface ratio, thus allowing a minimum energy loss and reducing space heating requirements. So, if the stand-alone housing culture in South Africa has to be respected, then this shape could be promoted.[27]

- **Spatial configuration / functional plan**

The survey shows that the functional house plan depends on the means of the household, and its income level in particular. At the bottom side of the income range one will find a single multifunctional room, which serves as bedroom, storage, and perhaps cooking and living. Once the house gets an additional room, the bedroom and storage is separated as one space in the private area of the house, while living and cooking are in a single space on the front side. Walls ('room dividers') and doors are made of cupboards and curtains. When a house has a formal structure (built up with construction materials), attention is paid to the skin, including roof and floor. Elements inside have less priority, leading to walls that are still made of curtains and cupboards. When the means is there also kitchen and living room are separated, while the main entrance lays in the kitchen area. This is multifunctional, as the private living area is protected from draught and direct interference in privacy, while the kitchen is better ventilated.

Bath room and toilet are the last functions that come in a house when income increases. Their particular nature (humidity, smells) makes that people prefer to have them singled out as long as the house standards are not sufficiently buffering the inconveniences. Yet, speaking about extending their house, the bath room is, together with extra bed rooms, the first thing people mention.

- **Elements**

It has been theoretically and empirically shown that houses with predominantly north-facing windows contribute significantly to heating these houses. The benefits are reduced significantly, however, when people cover their windows with curtains or the like for privacy or other reasons. When asked about it a young man, who just moved in his house in the All Africa Games Village, replied that the curtains had to protect him: "People don't have to know whether I am in, what I am doing, and what I have." The fact that he lives in an apartment on the first floor did not make any difference. This case illustrates that it makes not always sense to attribute significance to north facing windows, and it may even be wondered if attempts to change such habits will work out.

Some elements, such as ceilings, are subject to a wide range of beliefs, misconceptions, and other arguments determining whether such an element will be applied in a house (e.g. White *et al* 1996; see appendix C.1).

- **Materials**

A classic example of acceptability of proposed solutions are the use of loam ('mud') and straw. Though these materials are thermally far better and much cheaper (to mention but a few advantages) than the more commonly used concrete bricks and iron sheets, the latter materials are socially accepted as symbols of modernity and thus status, while the former materials are often considered as 'a step backwards'; signs of rurality, i.e. a symbol of poverty (e.g. Holm 1997). Yet this cannot be generalised. Prominent representatives point out that in Kutlwanong mud bricks and thatched roof are highly regarded – "even the white people in town have it" – but these materials are expensive and difficult to get.

Successful attempts to re-introduce traditional materials such as loam do exist however. In a Durban township loam houses have been constructed, which people are perfectly happy about. The 'symbols of poverty' have been camouflaged by plastering and painting the walls. Other experiments show the successful replacement of the expensive and thermally highly inconvenient iron sheets by locally produced concrete sheets of a similar shape, but which is cheaper, and with better thermal characteristics.

- **Colours**

Though the choice of appropriate colours for walls, roofs, and so on may have a significant impact, it seems that people do not like dark-coloured houses (Holm Jordaan Holm undated, Holm *et al* 1996). However, it is argued that opinions are often based on individual perceptions, which can be altered by training and awareness building programmes.

- **Energy appliances**

Energy appliances are, together with household living patterns and climatic and geographic factors, directly affecting appropriate housing design. The fuels used and the amount of energy produced may lead to particular material choices (e.g. porous materials for ventilation, absorbing materials to buffer humidity), facilities (e.g. chimneys) included, and even house shape (space for appliances, storage, etc).

The introduction of energy efficient, cheaper, and safer energy appliances in housing frequently encounters problems with socio-economic and cultural origin, however. The type of problems can be differentiated by the urban contexts: rural areas, township settlements, that are dominated by transitional or migrant cultures, and settled urban areas.

For instance, the replacement of an open fire by a cooking stove with plates, may be problematic, as it cannot replace, and actually eliminates, the functions of the traditional open fire. The open fire not only serves to cook, but also contributes to space-heating, social gathering and to maintain contact with ancestral spirits (van Niekerk 1998). While cooking can be taken over by the cooking stove, the space heating function gets lost through efficient cooking, while excess heat (and smoke) are channelled away. Social gathering around the fire is not possible anymore, and so aren't the contacts with ancestral spirits.

For these reasons, cooking stoves are difficult to be introduced in rural areas, where people are poorly educated and where there is lack of communication with the wider world. In townships, it is often a matter of generations. The first generation, often coming from the rural areas, might have difficulties to accept the new technology, but the children who grow up in the urban context, see what the alternative possibilities are through education and examples 'next door', they lose traditional beliefs, and are likely to eventually accept it. So, as a matter of fact, not only the urban contexts matters, but also the people involved: are they young or old, and by which urban context are they influenced?

Literature reveals that much of the discussed conflicts can be overcome by involving the communities in the housing development right from the design stage (e.g. White *et al.* 1996). This means that an end-user oriented approach, rather than imposed design, is suggested. This 'professional team' approach may take a longer preparation time, and it may reduce the direct profits of the commercial stakeholders, but it increases significantly long term benefits for all. Awareness building programs and experimental demonstration projects are also important agents to break through faulty beliefs that limit (energy efficiency) design options.

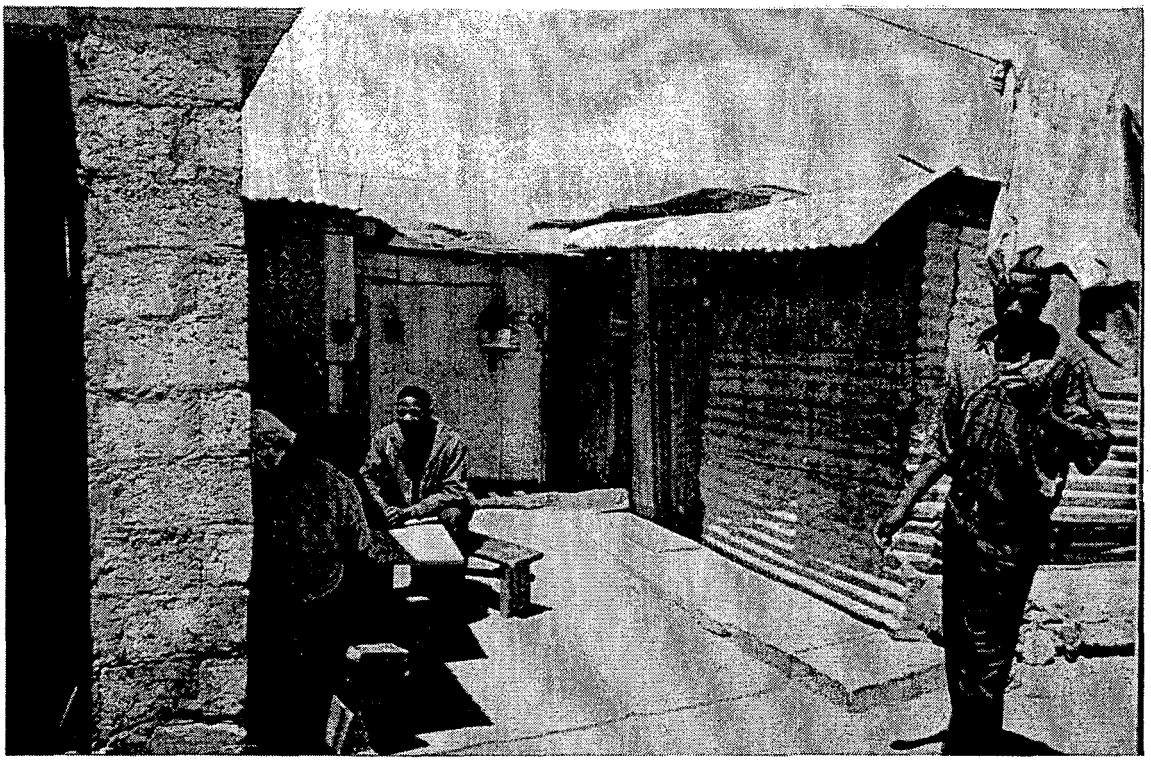
- **General design considerations**

"Issues which are not directly obvious to the designers have been raised by the community" (Kutlwanong *et al* 1997). In fact, African urban house design does not seem to differ much from 'white' house design. The main differences are determined by budget. Substantially differing wishes regarding spatial configuration have not been observed; Eland (1999) remarks explicitly that "no direct obvious issues' were that the poor do not accept inferior materials just because they are poor: if they get the opportunity, the will demand decent materials, and no things such as "cheap board materials".

- **Conclusion**

In South Africa, multiple factors contribute to a successful introduction of an energy efficiency measure. First, the background of the target group has to be respected. Its background (education level, where do the people come from, what are their intentions, etc) gives an indication of how easy it might be to introduce a new measure. Second, the "Show me" culture influences heavily the successful introduction of a new measure. This means also that if there is a bad example, the people will be much harder to convince in future to accept a similar measure, even though it has improved. Meanwhile, there are socio-economic and cultural patterns which can hardly be changed. Energy efficiency measures which do work out theoretically should be considered in this perspective, as to prevent too optimistic predictions in energy saving.

Perhaps the most important point one should realise is that people's perception of what is good and what is desirable is very much subject to what the people actually know and what they experienced. A person may dislike a certain measure initially, but may change his thoughts and perceptions if time is taken to demonstrate what the real drawbacks and advantages are. As a consequence, a survey on what people aspire or what they find desirable may give an impression indeed, but once a suitable program is designed much of the original attitudes can be changed. The 'good' news is that the poor have basically many desires similar to the richer people's desires, thus making many poor man's solutions disputable.



PART II:
LOW COST HOUSING FRAMEWORK.

3 STAKEHOLDERS AND THEIR RELATIONSHIPS

This chapter highlights the structure of RDP housing projects, which include most low cost housing in South Africa. The chapter starts with the discussion of the relationships within a typical housing process. Next, various stakeholders such as building contractors, the household, community trust, government and NGOs are reviewed on their objectives, their visions, and recent achievements.

3.1 introduction

The model RDP subsidy project as discussed in *Housing Project Programming Guide* (DH 1997: 4-6) is a starting point in the discussion on stakeholders and their relationships in low-income housing projects. It is the prevailing low cost housing project type in South Africa as it involves major amounts of governmental subsidies.

Basically, there are four types of RDP subsidy programmes (DH 1995). First, the project subsidy program, or 'project linked programmes', are estimated to constitute roughly 80% of total government subsidies. It is the traditional commercial project where developers play a key role. Second, programmes stimulating individual initiatives to construct homes, the 'individual subsidy programmes', run usually with the incorporation of banks. These subsidies incorporate ca 4% of total subsidy funding today. Third, the 'institutional subsidy programme', addresses mass housing projects initiated by companies who want to house their employees, and social housing schemes. It constitutes an estimated 8% of total subsidies.[1] The last programme is the 'People's Housing Process', which is community driven, and their trusts play key roles in these projects.[2] These schemes absorb presently the last 8% of total RDP subsidy. The structure of these programmes are very much comparable with the project subsidy programmes. It is the definition of the social compact (as discussed below) however that determines that not the developer, but the trust plays a central role.

Success of projects in the last two categories leads to a growing demand for them. Additionally, political pressure further stimulates intensified efforts to make such projects run. There is a growing belief that the involvement of future dwellers in the design and construction process leads to results that meet better the people's need. The growth is slow however, as less money can be made by commercial stakeholders, due to their reduced influence.

This chapter starts with the discussion of how relationships in housing processes tend to be, regardless the type of RDP scheme followed. Next, some key stakeholders are highlighted. These stakeholders can be excellent connection points for foreign companies to tie in the South African low cost housing market. Often they have a portfolio of projects to offer for which they still seek for capacity in terms of skilled manpower or financial input (see appendix D.1).

3.2 Stakeholder relationships

The relationships between stakeholders in a housing project are defined by a series of agreements. Figure 3.1 shows how the stakeholders relate to one another in housing programming projects, and the agreements that govern these relationships.

The developer sits at the centre of a project, directing its progress and managing the relationships between the parties. The way in which the developer undertakes this management is set out in the 'Social Compact' agreement (1) between the developer and the community based partner. Social compacts are required for most subsidy projects, and they allow the relevant stakeholders in a project to agree on the manner in which the development will occur. Some provinces do not require a social compact. Developers should make sure they know the Provincial Housing Board's specific requirements.

Once the project has been conceptualised and the social compact agreement signed the developer enters into a 'Land Availability Agreement', or a 'Purchase Disposal Agreement' (2) with the landowner.

The Land Availability Agreement gives the developer power of attorney on behalf of the landowner, earmarking the land for the proposed development. On the basis of this agreement, the landowner will not enter into a sale agreement with another buyer, and the developer can proceed with the development. At this stage, it is not yet necessary for payment or transfer to take place, though the payment price and date of occupation are agreed. The agreement also includes clauses regarding the roles and responsibilities of the parties to the agreement, possible cancellations of the agreement, dispute resolution, and breach of contract. On the basis of the Land Availability Agreement, the developer acts on an agency basis on behalf of the owner.

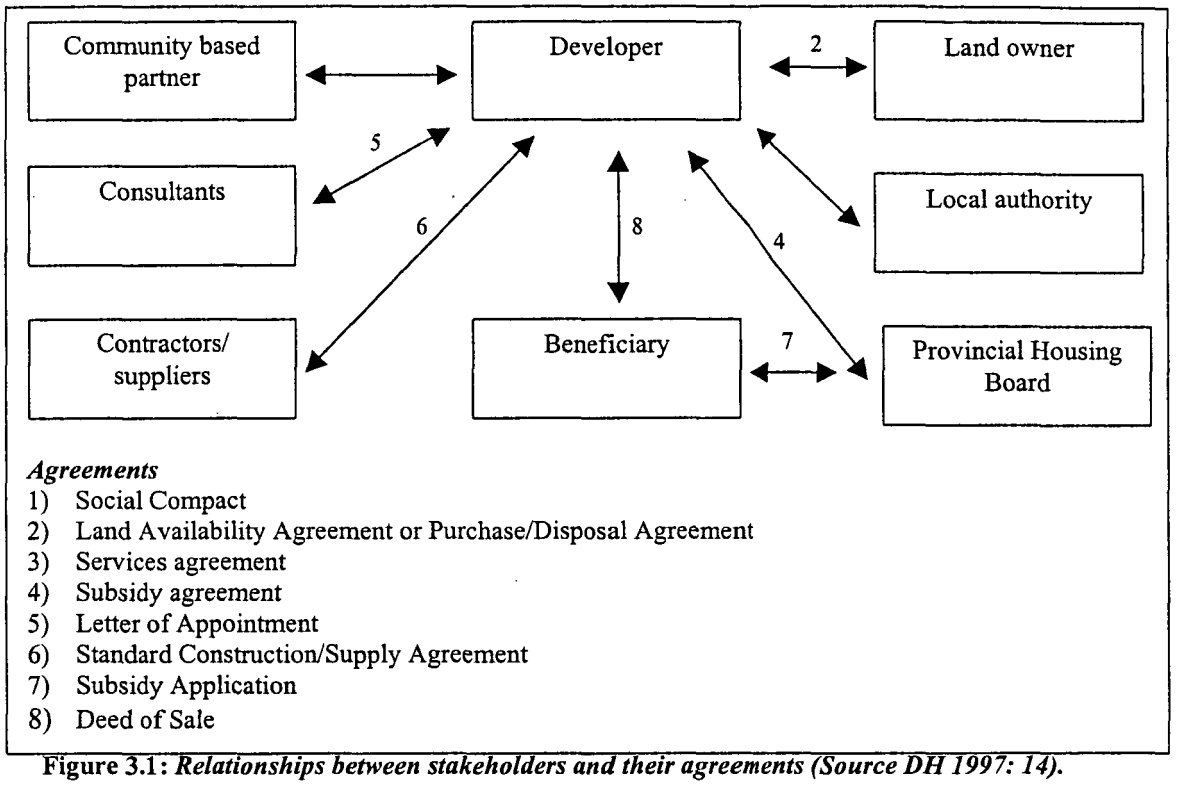


Figure 3.1: ***Relationships between stakeholders and their agreements (Source DH 1997: 14).***

Alternatively, the developer may enter into a Purchase or Disposal Agreement with the landowner, In this case the developer purchases and takes transfer of the land, acquiring individual title. This alternative route is not often followed, as it requires an additional transfer step (from developer to beneficiary) with correspondingly increased conveyancing fees.

After the land has been secured, the developer approaches the local authority to make the necessary servicing arrangements. The housing subsidy covers the costs of services within the development (i.e. standpipes, ablution facilities, internal roads, etc.). It is the responsibility of the local authority to ensure that adequate bulk and connector services exist to connect the development to the broader infrastructure grid. The 'Services Agreement' (3) specifies the responsibilities of the developer and the local authority in respect of servicing the land for the proposes development, as well as servicing standards to be maintained by each party.

With in-principle agreements for the social compact, land availability and services in hand, the developer submits the project application to the Provincial Housing Board (PHB). After evaluating the application on the basis of criteria included in the *Housing Subsidy*

Implementation Manual (DH 1995), the PHB drafts a 'Subsidy Agreement' (4) which sets out the terms and conditions of the project, how it will be undertaken, when subsidy progress payments will be made, and the responsibilities of the developer and the PHB. The subsidies paid to the developer over the course of the development in five separate draw downs which are each attached to the achievement of a specific milestone:

- P1 = engineering design
- P2 = town planning and land surveying
- P3 = Servicing and land costs
- P4 = registration of transfer
- P5 = end of project

The developer will need to negotiate the timing and Rand amount of these progress payments (based on the number of beneficiaries in the project and their subsidy eligibility) with the PHB. The subsidy agreement also includes deadlines and suspensive conditions (such as the formalisation of the social compact, land availability and services agreements) for the developer. If these deadlines and conditions are not met, the project may be terminated by PHB. The subsidy agreement, which confirms the PHB's intention to fund the proposed development, also acts as an encouragement to the various parties to formalise the social compact, land availability and services agreements.

It is here that the ECN comes in the picture. Namely, the developer may also appoint consultants to undertake certain aspects of the project. For instance, a 'social consultant' may be appointed to liase between the beneficiary community and the developer to ensure that all parties are satisfied with both the process and over progress of the development. Other consultants could include an engineer, land surveyor, town planner, conveyancer, and project manager. To bind the consultants to the particular job which each is to undertake in respect of the project, the developer and each of the consultants sign a 'Letter of Appointment' (5). Letters of appointment with core consultants who are involved throughout the project, such as ECN in the AIJ project, are normally signed in the project preparation phase.[3] Specialist consultants called in to deal with particular aspects of the project are appointed with a Letter of Appointment when needed.

Finally, the developer enters into an agreement with a building contractor and/or materials supplier. The 'Standard Construction/Supply Agreement' (6) sets out the terms and conditions of the construction or supply arrangements, including the nature of the contract, the type and volume of materials to be purchased, the supply arrangements, what happens in the event of damage to or theft of property etc. These agreements feature both in the land servicing and in the building process.

Even though the developer has entered into an agreement with the PHB, individual beneficiaries involved in the housing project must complete a 'Subsidy Application' (7). This is necessary because subsidies are allocated on the basis of individual household circumstances and cannot be repeated. Developers are required to facilitate these individual applications, thereby easing the considerable administrative burden arising from the operation of such a scheme.[4]

Finally, once the development has been completed, plots are sold to beneficiaries who have had their applications successfully reviewed by the PHB. The 'Deed of Sale' (8) is between the developer and the beneficiary, with the developer acting on an agency basis for the landowner. Once both parties have signed the deed of sale, it is submitted by the conveyancer to the Registrar of Deeds who issues a title deed in the name of the beneficiary.

In the following sections some of the stakeholders as operating in the South Africa are discussed. Who are they, what are their objectives, and what are their strategies are the

leading questions. At the end of each section, their strengths and weaknesses are discussed, as well as what might be beneficial to the ECN.

3.3 The beneficiaries

- Low income households

The urban poor, that is the target group that is investigated in this report, are in South Africa still synonymous to the poor urban blacks. Ironically, the urban black low income household, at the end of the day the beneficiary of the considered housing efforts, is a grossly underestimated stakeholder in housing processes. The lack of understanding of the consequences of the needs and wishes associated with low incomes, and lack of communication throughout the process between developer and community have led to many failures in the past.

As criterion for a low income household is chosen for a monthly income of virtually zero to 3,500 Rand. If a household earns above 3,500 Rand per month, it is assumed to be able to finance a house with sufficient standards itself without subsidy. The subsistence household income level is estimated at 1,300 Rand per month. This means that almost 50% of the South Africans live below subsistence level. The 'average' household size is nowhere mentioned, but can be estimated to be around 4.4 people.[5]

The expenditure patterns of South African low income households may be regarded as a reflection of household needs, expressed in money terms. Regardless the level of income, the share of household expenditures on housing is closely around 15%. The share on energy ranges between 2 and 5%.[6]

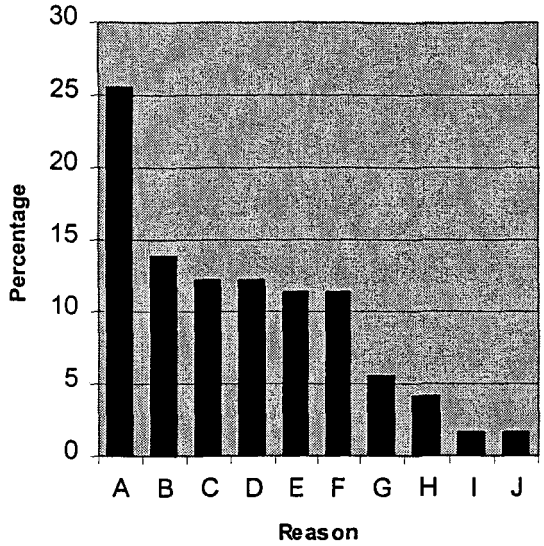
- KCIHT[7]

The Kutlwanong Civic Integrated Housing Trust (KCIHT) is a CBO, run by an elected committee of the community of Kutlwanong. To manage the housing initiative in Kutlwanong, the community established a *Housing Subcommittee* within the framework of the KCIHT. It was formed to work directly with external advisors to develop a community-oriented, self-build construction technology. The two main goals of the Subcommittee are to provide homes to the community and to participate directly in the management and development of the project for the community.

3.4 The building contractors

Commercial builders do not easily change their practices (Vine *et al.* 1991). Thorne (1995:51) comments that if commercial builders were building houses that were to be labelled for durability and thermal performance in accordance with a recognised standard, builders may find the incentives sufficient to alter their practice to construct houses with improved thermal performance. For this reason, government incentives as discussed in chapter 4 have been designed, and are likely to work out. Thorne further states that if energy efficiency of dwellings becomes a desirable feature of housing, this could contribute to the dwelling's saleability. It is thus clear that South African building contractors are pretty conservative, which is not different from the attitude to be found amongst contractors in the Netherlands. Generally speaking, contractors want to see direct benefits and, if no direct benefits are involved, are only prepared to change their practice if regulation and standards, and explicit home owner's wishes, force them to do so.

In 1993, around 70% from a poll of 121 builders and building contractors appeared seldom or never to take into account energy efficiency measures (Lewis 1993:11).[8] The figure below gives an impression of various reasons "why builders choose not to include energy efficient in the designs of dwellings in a climate well suited to passive thermal design" (Thorne 1995:51).



Key

A	Not cost effective
B	Applying efficient design all the time or often
C	SA's climate good enough
D	Public lack of interest/not in demand
E	Needs more research
F	Designers do not use it
G	Not applicable to housing
H	Other things more important
I	Energy is cheap
J	Lack of experience

Figure 3.2: ***Builders' reasons for 'seldom' or 'never' using energy efficient design*** **(source: Lewis 1993)**

3.5 South African government

Since the early 1990s the government structure has been subject to radical structural change. As a consequence, still many inefficiencies do occur due to lack of transparency, confusion of task distributions, and errors. Yet, the basic principle is that local municipalities have extended powers in choosing, selecting and implementing projects. The provincial authorities have distributing powers, while the national government concentrates on general policy making.

Some fieldworkers argued that where delays in process were not the result of inefficiencies in building processes, they were so because of mistakes following contradicting actions between the different government levels, as well as incompetence and power games of individual officials.

Matters become complex when projects are multidisciplinary, thus involving more than one department. For instance, in the AIJ, apart from the housing department, the department of Minerals and Energy, and Department of Environmental Affairs and Tourism are also involved.[9]

The government does acknowledge the need of energy efficiency in housing, and is increasingly stimulating energy efficient practices, as will be clear in chapter 4.

3.6 Mortgage lenders

To evaluate the quality of housing, and to assess the security of their loans and investments respectively mortgage lenders have established the Housing Consumers Protection Trust (Thorne 1995:50).

De Blanche (1993: 9-10) optimistically reported that mortgage lenders believe that the provision of adequate, affordable housing is of paramount importance to the future welfare and stability of [the South African] nation, and is committed to provide such finance on a much larger scale than present, should the situation be normalised. All players with an interest in low cost housing need to focus on ways and means of putting people into the types of shelter or housing they can afford. The mortgage lenders enter into 20 to 30 years relationships with borrowers during which borrowers are required to pay back loans. If the

borrower is using less of his or her resources on keeping the house warm, this may imply that the borrower is able to afford larger loans in the first place and is in a better position to honour repayment obligations. The mortgage lenders may agree to be partners in thermal performance upgrades of dwellings in a market worth R7.5 billion per annum, which is an estimate of the financial resources required to build 330,000 units a year to make up the low income housing backlog (de Blanche 1993:5-10).

Only two years later Thorne (1995:50) reports that negotiations between the Department of Housing and mortgage lenders have recently concluded a government guarantee for loans made to low income households. Therefore the responsibility for repayments have been transferred back to government. So, the lenders philosophy as characterised by a seeming goodwill towards the South African nation and its poorer citizens seems to be merely 'sweet talk': it is rather a façade to camouflage their practical and conservative approach. Namely, according to Thorne (1995:50), the mortgage lenders have through negotiation minimised their risks by leaving the responsibility for repayments to the government.

3.7 Consultancies

- IIEC-Africa[10]

The International Institute for Energy Conservation (IIEC) is an international NGO, with US origins, operating throughout the world on technical energy related issues. IIEC-Africa, based in Johannesburg, is a young and dynamic office, with apparent competence.[11]

IIEC's theme for the South African low cost housing sector is "Housing for a Sustainable South Africa". Under this heading, the IIEC is presently involved in a few important programmes. The *Eco-home Advisors programme* seeks to improve the quality of housing delivered to the historically disadvantaged communities of South Africa. In this programme energy experts in housing delivery groups across South Africa are identified, trained, and placed (IIEC undated).

Another project is the *Eco-Star Homes project*, in which IIEC-Africa seeks to create a voluntary programme using marketing and incentive-based techniques to influence builders and developer actions in delivery of low-cost energy efficient housing (e.g. IIEC 1997). The programme is based upon successful international examples such as Energy Star Homes in de US and the R-2000 programme in Canada.

The *Sustainable Homes Network* and *Sustainable Homes Initiative* (e.g. Eskom *et al.* 1997) are framework projects, and are discussed in the next chapter.

Within these programmes the IIEC contributes directly to project co-ordination and development. Examples are the Kutlwanong project (ECN *et al* 1998), and the recently started AIJ project (see ECN *et al* 1998). Thus, no matter whether the IIEC operates beyond or within the programmes, its main function is co-ordination, monitoring, scheduling trainings, organising (free) consults with green architects, and the like. The main technical work is left to third parties, preferably local actors with historically disadvantaged background, as to allow them to grow into the market.

- PEER Africa[12]

PEER Africa is a civil and environmental engineering and science consulting firm. Working with the historically disadvantaged communities of South Africa, PEER Africa is concentrating on the creation and development of sustainable, environmentally sound communities. These communities are assumed to promote healthier living through the use of energy efficient housing, cleaner fuels, appropriate and adequate public health and sanitation facilities.

The co-operation between the PEER Africa and IIEC, who share the same office, seems close. PEER-Africa has a limited number of staff: "PEER Africa is a small business", Kutlwanong *et al* (1997:40) states.[13]

Kutlwanong *et al* (1997) maintains that PEER Africa's major obstacle to scaling up is an inability to obtain necessary financing to hire staff who could respond to the business demand. This inability is due primarily to the banking system's reticence to lend to a relatively new, small business. PEER recognises that the traditional method of hiring is an impediment to its ability to deliver. Business plans have been developed and submitted to major funding/lending organisations for company growth and development. PEER Africa has been able to secure some bridge financing loans and community facilitation grants from a South African NGO that is backed by an international financier. This, however, took over three years, despite the fact that the company has substantial housing funds and other contractual funds on account in several South African banks. As in many small businesses, capitalisation continued to be problematic, even when the business is proven.

- **Habitat International**[14]

Habitat is an American Christian NGO that is based in 56 countries and with about 2000 volunteers, who are committed on three year contracts, and who are recompensed for food and housing. Habitat's headquarters is in Georgia, US, while every country has a national board respectively office co-ordinating the activities nationally. Under these national boards are regional committees, which supervise the so-called "affiliates". Affiliates are directly related to the separate project sites. These are teams of 8 to 15 committee members who are people from the communities.

In South Africa, there are three regional boards (in Kwazulu-Natal, Gauteng, and Cape Province) co-ordinating projects. Also there are three project sites, which are Alexandra and Orange Farm, squatter camps respectively in and nearby Johannesburg, Inanda and Amanzimatoti, respectively in and nearby Durban, and Khayalitsha in Cape Town. Nationally, Habitat realised in three years time 253 houses, with 161 houses in the last year, while from now on a construction rate of over 200 houses per year is achieved.

- **ALSA**

Affordable Living Solutions Africa (ALSA) is an association incorporated under section 21, that operates within the organisation of Stocks & Stocks, one of South Africa's biggest construction companies aiming for high standard products.[15] ALSA promotes and facilitates projects that have an holistic approach, amongst which housing and energy efficiency, employment generation are main issues, while high standards are maintained (see figure 3.2). It contains a healthy commercial approach combined with socio-economic and cultural respect to the target group.[16]

ALSA is still in an initiating stage. While it is young, it has already big projects in the pocket, of which some are in the preparation stage, while others wait for stakeholders. Some Dutch companies have already contacted ALSA, but in most cases they seem not to fit the profile of the partner that ALSA is looking for. First, ALSA is not looking for entreprises that attempt implementing single products, regardless the needs of the target group, which is totally contradictory to the holistic approach of ALSA. Second, the idea exists amongst Dutch parties that low income communities are only able to afford low standard products, and thus that they are willing to accept such. This is not ALSA's vision, which has, for instance, consequently serious doubts about the 'total house concept' of the Texolite product as developed by Prinsen Engineering, which is cheap, but also seems to be of marginal quality.[17]

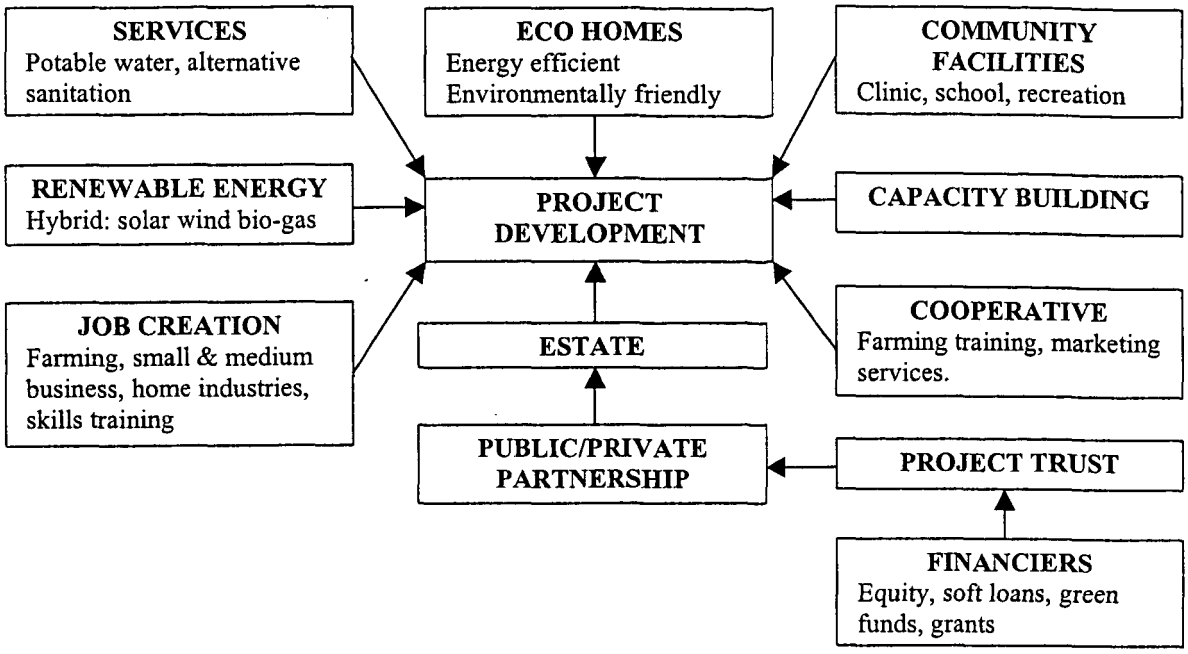


Fig.3.3: ***Example for an ALSA development model (source: ALSA)***

- **AMV**[18]

AMV Project Managers cc (hence AMV) is a project management firm that specialises in the co-ordination and management of large community driven development projects. It offers a professional and efficient service and deals with a wide variety of projects from large site-and-service schemes to in-situ upgrading projects. The project management team is experienced and combines a variety of disciplines such as engineering, architecture, town planning, engineering geology, and law which has proved effective in dealing with the complexities of large development projects. The key to its success seems the ability to work closely with the communities involved, who are brought into projects from the outset. Not only can AMV efficiently manage a project using modern computer programmes and project management techniques, it also ensures that the community is provided with a product that meets their needs. AMV is capable of delivering large scale, multimillion Rand, development projects within time, within budget, and to the appropriate standard. The training and upliftment of communities together with the creation of better environments are some of its primary objectives. One of AMV's main projects is discussed in chapter 9, the case of Waterloo, nearby Durban.

3.8 Research institutes

There is major work carried out regarding energy efficient low cost housing in South Africa. This varies from socio-economic and cultural studies to physical assessments, the development of relevant software, to energy impact studies.[19]

- **CENT**

The *Centre for Experimental and Numerical Thermoflow* (CENT), is a reputed research institute within the Department of Mechanical and Aeronautical Engineering of the University of Pretoria. CENT work has been focused on energy analysis in South African ultra-low, low, and middle-income housing (e.g. Mathews *et al* 1995, 1997, and Mathews and van Wyk 1995), and on the development of the relevant software QUICK. QUICK is a highly user friendly and powerful program addressing passive thermal housing design, which has become soon the main software tool in the international thermal low cost housing design.[20]

Despite its authoritative work CENT has been criticised as being mainly focusing on technical and theoretical research, without displaying genuine interest for the end-users. As a consequence, it is said, a gap exists between CENT's research and real world applications.[21]

Yet, CENT does consider the socio-economic issues.[22] Still the socio-economic considerations seem to have a paternalistic nature: CENT decides what is important and focuses on this. Obviously, when the end-users are asked about the utility they will respond positively. But what if is asked, what they feel what is most important in their life? This is the issue that sometimes is referred to as the wrong "conceptual framework".[23]

- **EDRC**[24]

The Energy and Development Research Centre at the University of Cape Town seeks to be a leading-edge African energy policy research, consultancy and capacity building institution. In achieving this vision, EDRC is committed to:

- undertaking research to deepen knowledge and understanding of the energy needs, problems and challenges in South Africa, and the rest of Africa, and innovative ways of responding to these;
- contributing to transformation and improved social equity, economic efficiency and environmental sustainability in the energy sector through public-interest advocacy and through communicating knowledge and understanding as a resource for better policy-making and implementation; and
- educating, training and developing human resources in the energy field.

EDRC is committed to undertaking work that can affect society, economy and environment. The Centre's work is intrinsically cross-disciplinary, reflecting a sectoral and problem-solving orientation, with staff having qualifications in engineering, natural and environmental sciences, urban and regional planning, economics, politics, law, sociology and anthropology. EDRC undertakes mainly policy-related research supported by empirical investigations. Broadly, its policy research is oriented towards investigating means to improve social equity, economic efficiency/competitiveness and environmental sustainability in the energy sector. These areas are captured in four research programmes:

- Energy, Efficiency and Environment; a programme in which policy issues are researched in the energy efficiency and energy-environment areas at household, national, regional and global levels.
- Energy Markets and Governance; a programme in which policy in the electricity and gas sectors are researched in the area of governance, regulation, restructuring, pricing and financing.
- Energy Poverty and Development; that aims to understand the energy related problems of poor urban and rural areas and ways to address these through integrated energy policies, including electrification strategies, paraffin and gas supply and the sustainable use of biomass fuels.
- Co-operative Assistance for Rural Energy and Development in Africa; that connects knowledge generation in energy and sustainable development with support activities for rural development.

EDRC is committed to ensuring that the research that is done contributes to transformation, and recognises the importance of using the research and knowledge it generates to develop lobbying and advocacy strategies which target key players in energy policy and implementation. EDRC's expertise and knowledge is made available to various constituencies to improve their capacity to provide or to negotiate for better energy services. For example, participatory and action research can build the capacity of the poor to negotiate for better services. Research support is provided to parliamentarians, government, civil society and energy providers. Knowledge and understanding is also communicated through conferences, workshops, meetings, training, reports, papers, and other publications.

- **CSIR**[25]

The CSIR is the leading research institute of South Africa. It has a similar range of research fields as the Dutch TNO, while it operates as a market-oriented contract and consortium research partner to its clients and stakeholders, which is comparable to ECN's approach.

The CSIR is a uniquely South African organisation, committed to innovation. It provides technology solutions and information to support sustainable development and economic growth in the context of national priorities. In essence the CSIR delivers scientific and technological services, many at a sophisticated level, in areas where industry, parastatals or government clients require support as well as innovative leadership in the development of new technologies which can be further developed and exploited by the private sector. The CSIR provides:

- Research, development and implementation services;
- Global science and technology links and perspectives;
- Specialised technical and information consulting services;
- Venture establishment, technology transfer and technology assessment;
- Prototyping and pilot scale manufacturing;
- Software development and products;
- Education and training; and
- Policy and strategic decision support.

The CSIR works in South Africa at national, provincial and local level (prime core business focus) SADC countries (strategic regional focus), Africa and internationally (based on CSIR's strengths, or market demands).

The CSIR has nine major operating Divisions, of which the Building and Construction Technology ("Boutek") is one. "In addition, in increasingly striving towards being a boundaryless organisation, there are many cross-cutting and integrating initiatives which draw on skills from across the organisation" (CSIR 1998c: 12). Boutek "serves the building and construction industry, and government at national, provincial and local level. ... The technological areas are development planning and monitoring, ... housing management systems and services; research and development in the field of municipal engineering and affordable housing, compilation of guideline documents, development and implementation of strategic support systems for strategic facilities planning and management, including research, planning, briefing, design and specialist consulting services; construction technologies which aim to enhance competitiveness, performance of materials and structures, ... and energy efficient buildings" (CSIR 1998c: 13-4).

Regarding (energy efficient) low cost housing CSIR presents two recent achievements under the heading 'Housing the nation'. CSIR (1998b:13) reports on its contribution (through appointment by the department of Housing) to a major revision of the 'well-known Red Book', which provides planning and engineering guidelines for human settlements. The revised Red Book has as its central concern the needs of people in residential areas, maximising opportunities for self-actualisation, and awareness of impacts on the natural environment. Under 'Caring for the environment can save money' CSIR (1998b:20) reports its partnership with the Green Buildings for Africa Programme, in which property owners are assisted to improve the environmental performance of their buildings within the bounds of good business sense.

3.9 Eskom[26]

Due to recent changes in the regime, parastatals have been put under political pressure. Eskom was given the choice between either to comply with the new policies, including the nation wide electrification campaign, or to change the whole management structure. Eskom chooses for the former, although that generated technical problems in its efforts to

simultaneously grow, become environmentally sensible, and to contribute to the alleviation of social inequalities (through the nation-wide electrification campaign).

Eskom is South Africa's leading electricity firm. Its electricity production is enormous, and grows annually due to the increasing national economic output and growing number of electrified households. Whereas it is in Eskom's interest to have an increased electricity demand, it also raises problems:

- Increased demand leads to the necessity to increase the electricity production capacity, which requires huge investments for new and extended plants, sacrificing profits on the short term;
- These costs increase even further through the increasing pressure to implement new environmental sensible technologies; and
- Due to the increased share of households in the total energy load, the peak-off-peak (POP) ratio grows.

To reduce the POP-ratio, Eskom has two options:

- Reduction of space-heating, cooking, and lighting requirements that mainly happen in the morning and evening when demand peaks.[27] Solutions may be facilitating energy-efficient housing, energy efficient lighting, water efficient showers and so on.
- Increasing the off-peak demand through the nation wide electrification campaign, allowing people, to do electric ironing (Thorne 1995: 102), listening to radio, electric cooking for lunch, and so on, during day time when demand is low. Much potential for reducing the POP-ratio lays in warm water facilities. It is a service which can easily be controlled because the use of hot water does not need to coincide with the heating of it (Beute 1993: 73). An example is the (solar) boiler. Also much potential lays in the photo-voltaic (PV) systems that allow for electricity generation and accumulation (in batteries) during the day, which can be used during night.

As for housing, Eskom seems to focus on the construction of as many energy efficient houses as possible, preferably without too much involvement of the communities.[28]

3.10 Conclusions

The government runs multiple programmes under the RDP housing scheme, of which the 'People's Housing Process' seems most promising from the perspective of sustainable mass (energy efficient) low cost housing. Although is contains a marginal percentage of total investments in the RDP scheme, successes within that programme makes it increasingly popular.

Although the scheme is a structural facility and a long term commitment of the South African government, its capacity is so small it can by no means cope with the huge demand. As a consequence, various projects are waiting for alternative ways of funding. Besides, various enterprises also develop projects without the help of RDP subsidy schemes, the problem there being that there is a lack of skilled manpower.

It seems that all fields within the low cost housing sector are covered by the companies, where it not that the demand for expertise overruns the supply. So, while new companies wishing to contribute to this market will have difficulties to find a niche in terms of expertise, they should be able to find a way by exploiting the lack of present supply.

4 REGULATORY FRAMEWORK

In this chapter the complex institutional framework of the South African low cost housing sector is highlighted. Particular attention is given to the rapidly changing national regulations in which thermal performance becomes increasingly important; to the expanding networks aiming at information diffusion on energy efficient housing, and to other programs to promote thermal improvement of South African low cost housing. The situation is diffuse, but the fast developments in the field are encouraging.

4.1 Introduction

Acknowledging the need for thermal efficient design in low cost housing various facilities are available to effectively implement measures. Though there is still a long way to go, the government works on a legislation that increasingly accommodates, facilitates and stimulates energy efficient design, which is part of a much larger scale program involving the restructure of South African housing regulations. Various stimulation and supportive programmes involving the international community are set up, and supporting networks to stimulate the diffusion of relevant knowledge in the housing sector. It is the latter effort that is critical but problematic: while much research has been done, and much information is readily available on energy efficient housing, few facilities are available for actual implementation. Marketing and diffusion of information is a big problem in South Africa, particularly in the housing sector.

The next section discusses the transformation and associated problems of the legal framework since the late 1980s. It concludes with what the state of the art today is: still rather messy, but a great improvement compared to ten years ago, particularly as far as regulations regarding thermal performance are concerned. Section 4.3 discusses the growing and effective NGO initiated networks that are laid out nation wide, and which aim at diffusing awareness and knowledge on energy efficiency. The last section discusses briefly the financial factors determining the scale and quality of (energy efficient) low cost houses.

4.2 Legal framework

4.2.1 Introduction

The housing policy in South Africa still requires much development. Presently, it is full of flaws and mismatching regulations. In the apartheid era, different housing standards coexisted for the white and black communities. In fact, there was hardly any regulation for the black people, as they were expected to sort out their own problems in the former homelands. With the abolishment of the apartheid regime, an attempt has been made to transform the regulations to the same standards for all. However, this appeared to be a problem, as the standards for the richer people were not affordable by the poor. Eventually, the poor could grasp back to the few formerly existing regulations, as these were more socio-economically more appropriate.[1]

Given the housing shortage, it is acknowledged that the regulatory problems such as non-transparency, discrimination by income and race, incompatibility, contradictions, and flaws, hinder an effective and appropriate recovery. Therefore, various commissions have been put on the case since the late 1980s to improve the legal framework. The changes were also supposed to include a more performance oriented approach, while incentives would be included for more end-user oriented approaches: "With the ending of apartheid legislation there is an attempt to move from development by imposition to more end-used informed practices such as the NHF's proposed social compacts" (Thorne 1995: 31). It was hoped that this trend would lead to houses that better meet the needs of low income households.

At the same time an attempt was made to reduce the variety of regulations, norms and advises, to a few uniformly applying standards. Ramsay (1992) comments that such "standards are often imposed or imported from elsewhere and are therefore seldom in line with local conditions, culture or building traditions. These standards also fail to recognise that upgrading of squatter housing is an incremental process and not a one-off exercise of building complete houses" (cf. Thorne 1995:28). Thorne elaborates that standards are seldom based on consensus and often result in unaffordable housing for end-users. "Standards do no often reflect peoples' priorities; they may for example favour the quality of construction above the quantity of space, whereas space is what most people want in the first place" (Ramsay 1992).

Also when the development of thermal efficient low cost housing in particular is regarded, problems are identified in former and recent approaches. According to Thorne (1995: 31), problems of dissemination of information in a climate of limited resources for the intended beneficiaries (the urban and rural poor) are widely acknowledged as being reasons for the failure of thermal efficient housing technologies. He suggests that the result has been to build low-(first)-cost housing which maximises floor space in proportion to the available funds. A spokesperson for the Build Environment Support Group suggested that the strategy in the early 1990s in most hot-humid areas is to maximise the space under conditions of affordability and cost-effectiveness of these structures. Thus the affordability of housing is still considered from a supply perspective (comparable to the former Apartheid practices) and not from an end-use perspective. The low-cost buildings where therefore of low-(first)-cost to suppliers and buyers, but have high life-cycle costs for the end-users which outweigh the low-(first)-cost benefits.[2]

Thorne concludes nevertheless that with the ending of apartheid legislation there is an attempt to move away from development by imposition to more end-user informed practices such as the NHF's proposed compacts. Methods for including end-users of housing and services in the delivery of this infrastructure include the professional team approach which contains labour based practices in the provision of services. "With increasing use of the labour intensive paths and negotiations that include end-user concerns, the future again looks good for low-(life-cycle)-cost housing through self-help building practices" (Thorne 1995: 32).

4.2.2 Thermal performance

Thorne (1995: 22-31) examines briefly South Africa's National Building Regulations and some policy recommendations. He concludes:

> "South Africa has an ideal climate for passive regulation of comfort within the dwelling. However, there is *no* policy in place to achieve this, and few building contractors show interest in this aspect of housing. In addressing the housing needs of the poor, the conventional response has been the low-(first)-cost housing which has become equivalent to high-(life-cycle)-cost housing" (Thorne 1995: iv).

With the relevance of optimisation of thermal performance being acknowledged, recent positive movements can be detected. Much research on energy efficiency and thermal design has been ongoing. Leading institutes such as the NBRI, EDRC, Eskom, CSIR, the Universities of Pretoria and Cape Town, run extensive programmes on the issue, as is also noticed by Thorne (1995: 31).

According to an employee of the CSIR, however, it is the lack of structural policy to thermal efficiency in housing that the science remains in a rather experimental stage. The most potential stakeholders are not interested in a following up, thus hindering a sustainable development in the discipline.

However, there is evidence that things are crystallising. While old regulations such as the NBR and MANTAG still apply, on the 19th of December 1997 a new *Housing Act* has been

published in the *Government Gazette,* summarising regulations regarding building specifications, stakeholder relationships, and financing.[3]

4.2.3 The National Building Regulations[4]

The National Building Regulations (NBR) were promulgated in 1987, and the Code of Practice for the application of these regulations, SABS 0400, was published in 1988. This signified a move away from a prescriptive to a performance based set of criteria towards 'deemed to satisfy' regulations.[5]

The SABS 0400 rules are comparable with the Dutch Code of Practice: the SABS 0400 contains no regulations, nor does its have the force of law of the NBR (Lewis undated). These rules are rather provided to assist designers to meet the performance requirements set out in the NBR regulations, while dealing with conventional structures.

Such standards allow for innovative developments in terms of materials and technologies. This allowance is particularly relevant to low income communities that have to improvise with limited resources, while minimum standards are still targeted. Instead of forcing poor communities to build with prescribed but unaffordable materials and technologies to achieve these standards, they are free to find their own ways.

The NBR applies to all local authorities (LAs) unless they decide to waive them on the grounds of first-cost affordability. Such areas are called 'designated areas'. These are areas "where the concept of self-help, core housing, roof schemes or shell housing apply and which are designated as such by building authorities under whose jurisdiction such areas fall" (Agrément Board 1985: 1).

Designated areas can apply for a second tier of certification called MANTAG (Minimum Agreement Norms and Technical Advisory Guide) in which other standards, more appropriate to the conditions of need and affordability, are applied to the building of innovative low-cost, single-story, detached housing:

> "MANTAGs are based on acceptable safety and health criteria for houses and related out buildings, non-residential schools and primary health care centres in areas where the local authority is of the opinion that the type of construction is appropriate, given that in these areas it is of paramount importance that the buildings be erected at the lowest possible cost" (Lewis undated).

The Agrément Board that supervises MANTAG certification, is an advisory body only. These certificates are not binding on the LAs and who have the right to either accept or reject this advice. The Agrément Board also advised building societies and banks.

MANTAG certificates are granted after a technical evaluation of durability, habitability, maintenance, practicability, and safety of the certified structure or product. The evaluation includes: a general description, materials specifications, details of manufacturing processes, erection or installation details and performance test results. Positive evaluations serve to increase the range of options that may be acceptable under SABS 0400 (Agrément Board 1976: 1-5).

Amongst the Agrément Board's suggested minimum performance norms used for MANTAGs is thermal performance (MANTAG 1985: 6): "The CR-method[6] will be used to predict indoor conditions in dwellings of standard layout and fenestration with floor areas of 30, 53, and 77 m^2 situated in the various climatic zones of South Africa." Indoor temperatures (without artificial heating or cooling) calculated in this manner, should not be lower than the minimum winter outdoor temperature at the coldest time of the day, or higher than 40°C

Standard Effective Temperature (SET) at the hottest time of the day in the summer (NBRI undated).

The technical advisory guide stipulates that "the calculated maximum and minimum indoor temperatures will be related to thermal comfort in terms of a thermal comfort scale presently used in Agrément certificates. Thermal performance diagrams will be used for this purpose."

In achieving natural lighting, the Agrément Board suggests that the minimum window area (light area) be greater than 5% of the floor area (MANTAG 1985: 9). The Board also pays attention to the durability of the structures, which affects the energy embodies in the structure.

Unplanned informal housing, and most rural structures are outside the scope of the regulations. In the urban context, as soon as a household takes steps to build a permanent structure by either laying a foundation or concrete floor, the structure has to comply to building regulations, by either the 'deemed to satisfy' rules of SABS 0400 or, if the area has been designated, by meeting the Agrément certification requirements.

MANTAG certification appears to be a useful mechanism for the acceptance of materials and designs that are unknown in South Africa. The certification allows a degree of flexibility in what is acceptable housing while maintaining standards, This may result in housing presently designated as informal gaining formal status, and thus access to financing.

Lewis (undated) summarises that there are, in fact, several methods of persuading the Municipality that a particular design complies with the requirements of the NBR, namely that the building will be constructed in accordance with:

- A design that conforms in all respects with the Deemed-to-satisfy rules set out in SABS0400;
- A certificate issued by the Board of Agrément SA, that is,
  - An Agrément Certificate; or
  - A MANTAG Certificate; or
- A rational design prepared by a competent person.

4.2.4 Space

Space is a critical issue in good low cost housing, which ought to be a balance of price, space, quality, and speed (quantity). The *National Norms and Standards in Respect of Permanent Residential Structures* (Lewis, undated) prescribes a minimum standard size for a subsidised house of 30 m^2.[7]

The actual size of subsidised houses vary from place to place. Peoples Housing Projects where there are no labour costs have produced 40 m^2+ units. Other projects where land is very expensive or where the topography or soil conditions make building very expensive complain that it is impossible to build even a 30 m^2 house with the subsidy amount.

4.3 Networks

With the growing concern for energy efficiency in low cost housing some facilitating networks have been initiated. Durability of such networks is improved by the preference policies of the RDP schemes that prioritise housing projects that include thermal efficiency measures (Napier and Meiklejohn 1997).

4.3.1 Sustainable Homes Network[8]

The *Sustainable Homes Network* (SHN) is a project initiated by the IIEC that took off mid 1999. In this programme the IIEC tries to create a network of professionals, NGOs, communities, and housing interest groups to focus on building capacity around healthier, more environmentally sound low-cost housing. It aims to establish linkages between key

housing practices, and work directly with housing delivery groups to provide information, technical assistance and support.[9] A first glance on this concept would lead to the suspicion that this Network in itself would not be sustainable. Services are offered for free and members can join (and thus abort) without effort. However, though involvement on voluntary basis is required, the great pro is that it allows very well for good networking, information exchange. The only condition is that the involved parties are willing to keep their business progressing and evolving by actively interact with third parties outside their ongoing projects.

The *Sustainable Homes Initiative*, which took off mid 1999, is a three-year programme incorporating a range of support, training, outreach and networking functions to bring about a change in the building, finance, and materials sectors servicing the historically disadvantaged communities of South Africa. It is closely related to the SHN in that it provides effectively what is obtained through the SHN. Trading off the pioneering work of groups like the Kutlwanong Civic Integrated Housing Trust, the Nova Foundation, the Thlolego Learning Centre, PEER Africa, and Holm Jordaan and Partners, this project promotes healthy and environmentally sound low cost housing.

The Initiative is documenting existing 'best practice' in South Africa to show that Eco housing – through the People's Housing Process (see section 3.1) and through commercial building – is a sensible and practical approach for South Africans. Specifically, the objectives of the programme are to:

- Network all Eco housing projects – Create a forum to share knowledge on Sustainable Homes between builders, developers, housing delivery organisations, and other key housing stakeholders;
- Influence new housing projects – Offer technical assistance to low-income communities wishing to build energy-efficient homes;
- Achieve a 'greening' of existing builder training courses – Develop training curriculum, tools and information to expand the knowledge base of Sustainable Home construction and technology among existing and emerging developers, as well as key decision makers;
- Have commercial builders adopt the Eco-Home model – Provide information, training and support to large commercial housing developers and thereby promote the replication of Sustainable Home projects; and
- Impact policy and support government initiatives – Work with the Department of Housing, the Parliamentary Portfolio Committee on Housing and other key stakeholders to establish a low-cost national programme to recognise energy efficient homes and influence mass-housing delivery industry.

The SHI intends to bridge the delivery gaps that occur when housing beneficiaries understand and start to request eco homes. The first gap is at the decision making level: local housing and building authorities, town planners and engineers must be properly informed. The second gap is the lack of skills of emerging contractors who do the actual construction: they must be offered an opportunity to learn about building in an environmentally sound way. Addressing these barriers to the delivery of eco homes, the initiative provides the capacity building at both the decision maker and contractor levels.

Another feature of the Initiative is to develop a commercial building industry standard that creates a better public relations profile for builders who incorporate sustainable home principles into their large-scale mass delivery projects. The principles being promoted by the SHI are not a trade-off with floor space, many are no cost when done at the time of construction. IIEC-Africa is also working with the Department of Housing to explore special finance schemes that could be made available to commercial builders who adopt Eco-home construction practices. This financing programme will be modelled after 'green finance' incentive programmes in the UK and other countries.

Finally, the Initiative offers free technical assistance to low-income communities who wish to have Eco homes built. Called the *Green Professionals Scheme*, project resources have been set aside to cover the consulting fees of experts to spend a limited amount of time working on a project to ensure that their housing project incorporates at least the no-cost Eco home measures.

4.3.2 SEED

SEED (Sustainable Energy, Environment, and Development) promotes sustainable energy and environment practices in rural and urban development projects in South Africa. It aims to build the capacity of NGOs, CBOs, local authorities and other implementing agencies to plan and carry out development projects, integrating sustainable energy options. In addition, the programme contributes to national and regional information dissemination, awareness building and policy development (SEED undated). SEED operates an interactive web site to be an information hub for sustainable energy and development in Southern Africa.[10] To enhance communication and networking, the web site is also offering space to other South African and regional actors in the sustainable energy field, interested in sharing experience. The site is updated weekly and contains information on news and events, contact lists, articles and documents, interactive email conferences etc. The organisation is young, however, and the web site has still to be fuelled. To reach out to actors with limited access to the Web, SEED distributes a quarterly newsletter in print, mainly based on the information available on the web site (e.g. SEED 1999).

4.4 Financing

4.4.1 Housing costs

It has been suggested that the RDP is destructive to South Africa. Since the RDP is the fulfilment of the promise to provide the people with entirely free to partly subsidised houses, so the argument goes, the people get 'lazy': "Why investing time and effort if the government provides me with a house?" is a hopeful – often in vain – expression frequently heard. The RDP might help the least privileged with houses at no or little costs, it does not help the economy working: people feel no incentive to do long term planning or investment for a better future. This system, it is argued, kills the market mechanism in the South African low-income housing sector. Initiatives from NGOs that promote sustainable development seem to be dead-borne, as they require efforts from the communities. Others argue that a scheme such as the RDP has a donor-nature, thus not being commercially sustainable. Yet, these arguments seem a bit farfetched as there are multiple examples, such as the case of Kutlwanong (chapter 7), that use the RDP as a jump-start mechanism for the development of a programme that goes far beyond housing alone, namely such programmes may incorporate also employment generation, urban upgrading, and so on.

Regarding the costs, there is debate on where the attention should be focused: on quality of the house, including proper servicing, or spacing. Generally the people tend to choose for space (e.g. Napier and Meiklejohn 1997), but it is advisable to consult each community on what people wishes. Often, there is actually no choice as budget is limited, and these days it seems to be often too small to build adequate houses. The RDP subsidy is a fixed and limited amount, which does not keep pace with inflation and rising prices. Additionally, corruption and non-transparent building practices reduce funding available.

Table 4.1: *Household income levels and related RDP subsidies.*[11]

Monthly Income (Rand)	Subsidy	Number of Households (milj.)	Total % of Households
0 - 800	R 15,000	3.30	39.7
801 – 1,500	R 12,500	2.41	29.0
1,501 – 2,500	R 9,500	0.98	11.8
2,501 – 3,500	R 5,000	0.46	5.6
> 3,500	no subsidy	1.15	13.9
TOTAL		8.3	100

The former Minister of Housing, the late Joe Slovo, embraced an incremental approach to the housing problem. He argued strongly for the provision of starter homes which could subsequently be improved by the occupants' own "sweat equity", using government-supported building centres and self-help measures.

Because there was not enough money, this approach has translated into the provision of serviced sites with rudimentary (one-room) structures as a starting point. Serviced sites typically cost around R7,500, rising to R11,250 in places with difficult topography (Financial Mail 1996; Kutlwanong *et al* 1997: 27).

According to *Financial Mail* (1996) builders say that, for R15,000 after varying site servicing costs, they can provide only a single-room house using conventional methods:

- Murray & Roberts says its unit would be up to 10 m^2 in size;
- Grinaker provides three options – a 40 m^2 roof structure with an enclosed toilet, a 20 m^2 room with an outside toilet, or a 20 m^2 room with an enclosed toilet on the newer schemes.
- Stocks & Stocks offers a range of three units from 20 m^2 to 25 m^2 and 30 m^2 single-room houses – all providing a WC cubicle in a corner of the room and a sink.
- Newco, like Murray & Roberts, can offer only serviced sites in some places, a 17 m^2 one-and-half-room structure in others or an enclosed toilet in a larger roof/slab structure.
- The SA Housing Trust says it can produce one-room products in the region of 19 m^2 – 25 m^2; and LTA, though not producing for the 15,000 market now, says it could produce a 40 m^2 roof with an enclosed 4 m^2 – 12 m^2 shower/toilet cubicle.

Compare these alternatives with the NE 51/9, the famous "matchbox house", which was the standard response to the housing crisis in South Africa over the past 40 years. These structures are mass produced and not designed for expansion and are laid out in a way which would not encourage a cohesive society (Thorne 1995:48), as it was designed according to the "sterile apartheid town planning" model (Mills and Armstrong 1993). Initially designed for 8 people, these structures with a surface of 53.7 m^2 on average accommodate 13 people, and construction costs were around R11,000 (Ramsay 1993).

The case of Kutlwanong shows that there is a greater range of possibilities if only time, effort, and creativity is invested: Servicing costs can be reduced to a third and, if the developers' vertical monopoly is pierced through, significant savings through quantum discounts in building materials are possible.

4.4.2 A preliminary calculation[12]

Basically, 5 main variables determine the affordability of the house (see variable 1 to 5 in figure 4.1). First, there is the household income level (1), which determines the subsidy a household can apply for (6). The household determines which share it uses for housing (7). Generally, this varies between 15 and 25% of household income level. In South Africa it

seems to be rather close to 15%. Second, the repayment period (2) is generally up to 15 years, but South African low cost housing experience teaches that one should not go for liabilities longer than 10 years.[13] Next, the annual inflation (3) depends on the country concerned. In South Africa, since the abolishment of Apartheid, inflation rate has decreased from around 15% to around 5%, but shows a capricious tendency. It seems safe to assume 10%. This variable is obviously subject to economics, rather than to the wish of the calculator. The interest rate (4) is determined by what the companies involved charge. The inflation and interest rates determine the total commercial discount rate and, together with the repayment period, the annuity factor (8). Finally, a household may have made savings in time, which it can use as an initial investment for the construction of a house (5).

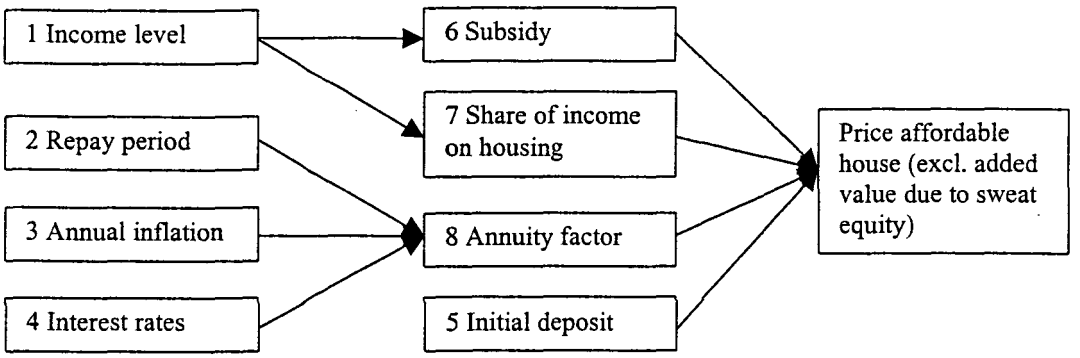


Figure 4.1: ***Factors determining the price of an affordable house.***

The following assumptions are based on the circumstances as can be found most likely in the South African low cost housing practice. Based on these assumptions an estimate of the costs of affordable low cost housing in South Africa is made:

- Household spends 15% of its income on housing
- Repayment period 10 years
- Given an annual inflation of 10% and an interest rate of 15% of the bank, the real annual interest is 115/110 *100% = 4.55%.
- Stakeholders charge 5% to cover costs.
- The total interest to be calculated is thus 4.55 + 5 = 9.55%, say 10%.
- The 10 year repayment period and 10% discount rate combine to a present worth annuity factor of 6.145 (e.g. Dix 1983:129).

An affordable house costs thus (in present value terms): 10% * Monthly income level * 12 months * 6.145 + applied subsidy or, expressed in general terms:

$$PV_{affordable\ house} = ((100 + i_{bank})/(100 + i_{inflation}) + i_{charge\ stakeholders}) * annual\ income\ level * annuity\ factor + subsidy$$

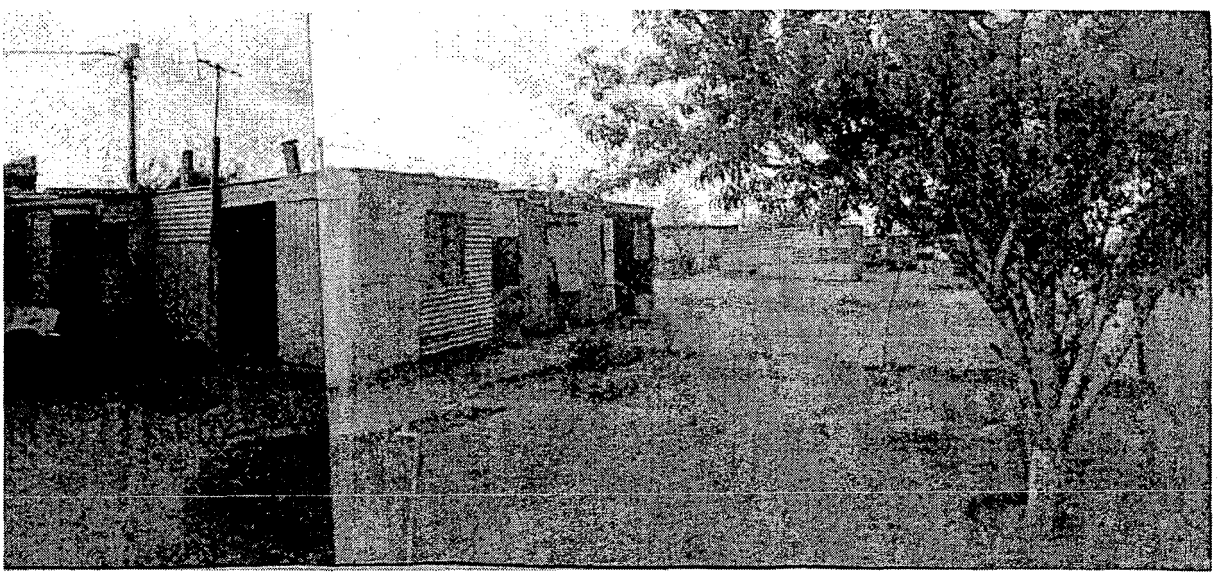
The formulae completed with the assumptions produces table 4.2. The table indicates the following points:

- Commercial developers are likely to be primarily interested in the higher income groups of this otherwise poorest segment of South African society, as profits are increasing from 0 Rand per house for the lowest (no) income group to roughly 2,000 Rand per house for higher income groups.[14]

Table 4.2: *Cost estimates affordable low cost housing in South Africa.*

Monthly income level (R)	15% of monthly income level (R)	Present value total household expenses on housing over 10 yrs (R)	Applied subsidy (R)	Present value affordable house (R)[15]	Present value stakeholder profit/house (R)
0	0	0	15,000	15,000	0
800	120	8,849	15,000	23,849	442
801	120	8,860	12,500	21,360	443
2,500	375	27,653	12,500	40,153	1,383
2,501	375	27,664	9,500	37,164	1,383
3,500	525	38,714	9,500	48,214	1,936
3,501	525	38,725	0	38,725	1,936

- To generate a socio-economic sustainable development, housing projects should include profitable elements, to build in a margin for less profitable elements such as the lowest cost houses that hardly yield profit.
- The table also suggests that a surprisingly large range of viable construction prices exists. If low cost houses are viable in the range from 15,000 to 50,000 Rand, then much greater variety in design, materials and techniques should be possible as is presently the case. A greater variety leads through a greater range of design options, thus more opportunities for the home owner to distinguish his house from other houses, and thus eventually to an increased self esteem of the owner. Meanwhile, the built environment becomes visually more pleasant.



PART III: CASE STUDIES IN TOWNSHIPS.

5 CASE: ALEXANDRA

Alexandra is one of the historically and socio-politically most reputed townships in South Africa, and is of major interest in terms of housing as it demonstrates the social consequences of overpopulation of a poor urban area with minimum level of ownership. In response to the high density, Habitat did an experiment of double storey housing, while the All Africa Games Village (discussed in appendix C.4) has been an experiment on different types of dwellings. The population responded differently on the two projects, hence a major issue is: why did they?

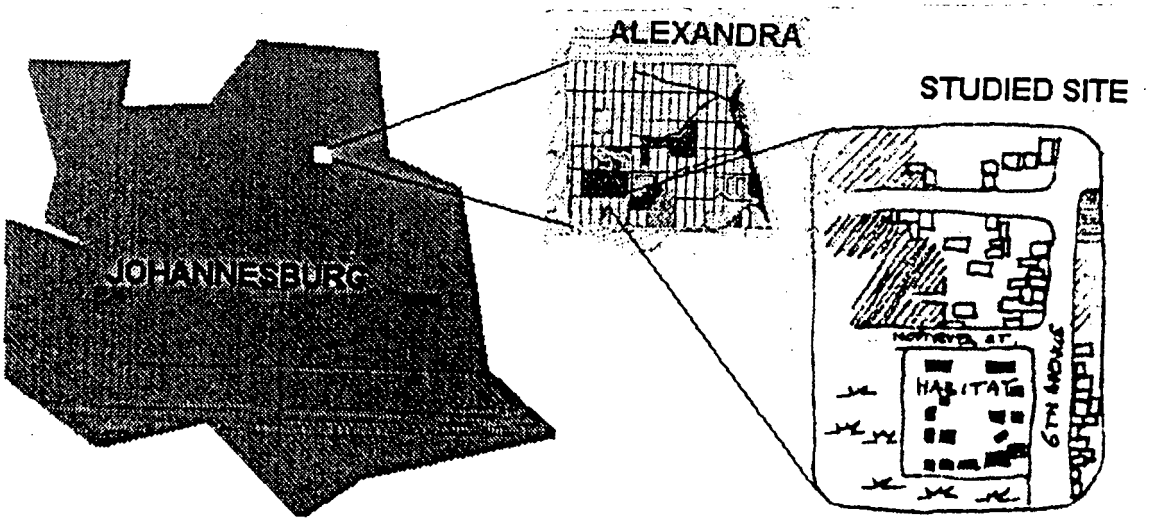


Figure 5.1: ***Location Alexandra and observed site.***

5.1 Introduction[1]

Alexandra is one of the oldest townships of Johannesburg, with a politically and socio-economically turbulent history. A basic knowledge of its history, as presented in appendix E.2, helps to understand Alexandra's present social system. Today many interventions go on there in various fields, ranging from housing to education, while many problems emerge due to lack of understanding of Alex's historical character.

The population of Alexandra grows extremely fast: the annual growth rate over the past 20 years has been between 9 and 14%. In 1979 an estimated 50,000 people were recorded, while today's population is estimated to be between 400,000 (Lucas 1995) and 500,000.

In its relatively short history, the township has been soon proclaimed to be a high-density area, given the high number of people living on a surface of 358 ha. This means that around 100,000 people live per km^2, allowing less than 10 m^2 per person.[2] Housing projects seem to have come to a standstill today, as no land is available anymore. It is not surprising that crime rates are horribly high in this socially unstable area.

Yet, despite the miserable circumstances, characterised by lack of space, facilities, hygiene, and so on, the high density has forced the people to develop an extensive social system, in which many are prepared to stay. Previous surveys suggested that 49% of the people did

already live here for years, while 51% intended to stay here permanently for reasons of family and job opportunities (Ratcliff 1981, Pillay 1984).[3]

In this chapter, the survey carried out on houses built by Habitat for Humanity International and a sample of the surrounding shanties is presented. This survey was carried out in October 1999 (spring). The selected area lays in the Southwest corner of the Alexandra township. Table 5.1 presents the types and numbers of houses observed.

Table 5.1: ***Details survey Alexandra***

House type	Sample size
Habitat double storey	9
Habitat single storey	2
Shanties	32
Total	43

The two types of houses that have been developed by Habitat are selected for this survey as they allow for a comparison of single storey houses with double storey house. A double storey house is an opportunity for energy and space efficient construction.

It should be noted that Alexandra is by no means a homogeneous area.. Alexandra has clearly internal cultural differences between the different sections within the relatively small area. For instance, cultural differences are created by immigrants sticking together by nationality (evidence of which are the sections that emerged in Alex, such as 'Lusaka' and 'Mozambique', names that relate to the immigrants' backgrounds). The biggest cultural differences, however, exist between formal and informal households (Lucas 1995), as well as between various sorts of semi-formal households (e.g. Ratcliffe 1981, Raymer 1989).

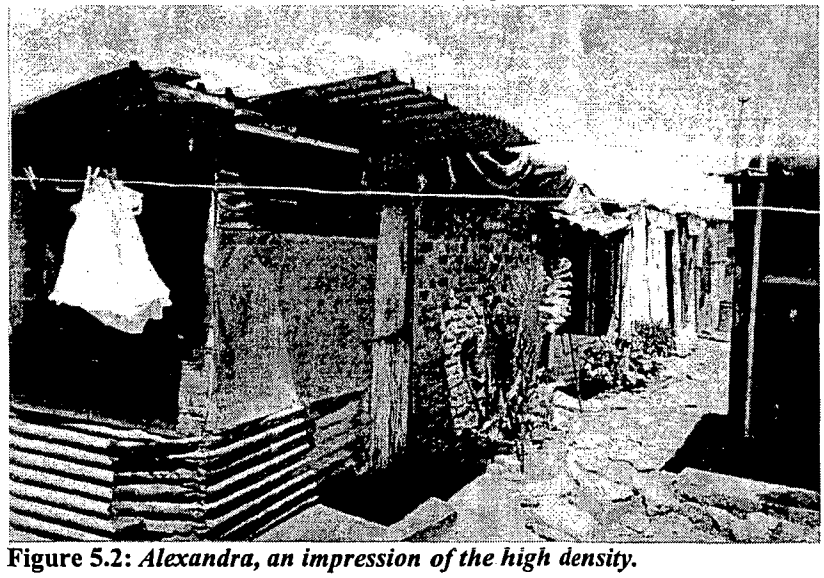


Figure 5.2: ***Alexandra, an impression of the high density.***

The lack of space in Alexandra made NGOs, such as Habitat, moving to other sites. On the eastern side of Alexandra the *All Africa Games Village* has been developed for ca 1,800 low cost houses, in order to release some pressure from Alexandra. It was a prestigious project that initially would be used to house the athletes of the All African Games. This project is discussed in appendix C.4. That project is relevant for this study as it is a large scale commercial project full of energy efficiency measures. While the developers claim it is a success, the controversial project has become subject of heated debates.

5.2 Demographics

- Gender and age distribution

Overall, the genders are fairly evenly distributed, which agrees with the findings of Pillay (1984). Only amongst the Habitat houses women account for the majority in all age categories, adding to a total of two third (67%) share in the survey sample of all Habitat houses.

The median of the total sample is 24 and the average age is estimated to be below 30. This again agrees with Pillay (1984) and further sustains the assumption that the demographic structure of Alexandra has been virtually unchanged from 1984.[4]

The distribution shows however a pattern that deviates from the classic prototypes typical for the developing and developed societies. While the youth up to age 10 is group is fairly well represented, their share reduces significantly till age 18. The economic group 19-36 years constitutes almost 50% of the sample.

- Household size

The household size distribution differs significantly between the Habitat and shanty households. Whereas the size of shanty households is distributed relatively even (90% of the households had between 1-4 members), the Habitat household size ranges from 1 to 9 members.

Table 5.2: ***Household characteristics of sample from Alexandra***

	Hab 2 st.	Hab 1 st.	Shanty	Total
# hh	9	2	32	43
# people	47	5	92	144
Av. hh. size	5.2	2.5	2.9	3.3
Adults	3.9	2.5	2.2	2.5
Children (≤16 yr)	1.3	0	0.7	0.8

The average dependency ratio ranges from 1.5 for the double storey Habitat household to 2.3 for the shanty households. The higher end of the range seems to contradict with the relatively few children that have been observed in the shanty households, but it highlights why these households chose to live in this area: people come looking for a job but fail, and rely on the few income generating members of the household. On the other hand, the dependency ratios amongst shanty households are high when they are related to household size: 79% of the household relies on the remaining 21% that generates income.[5]

- Motives to stay in Alexandra

Work and family are the most common reasons why people come and stay in the crime ridden and socially unstable Alexandra. Those who grew up in Alex and tried their luck elsewhere usually seem to return to the 'ugly mother' out of love for their background hidden in the alleyways of this township.[6]

The high density (no space for extensions), lack of services (none of the sampled shacks was connected to the grid, hundreds of shacks share bathroom and washing facilities), and high crime rate makes that many people prepare for a temporary stay.[7] Yet, despite their initial complaints, new residents eventually seem to find their way and stay in Alex for a long while. Pillay (1984) found that the average time a household stays in Alex is 11.3 year. Of course, as figure 5.3 suggests, lack of alternative opportunities is perhaps the most common reason for people to stay.

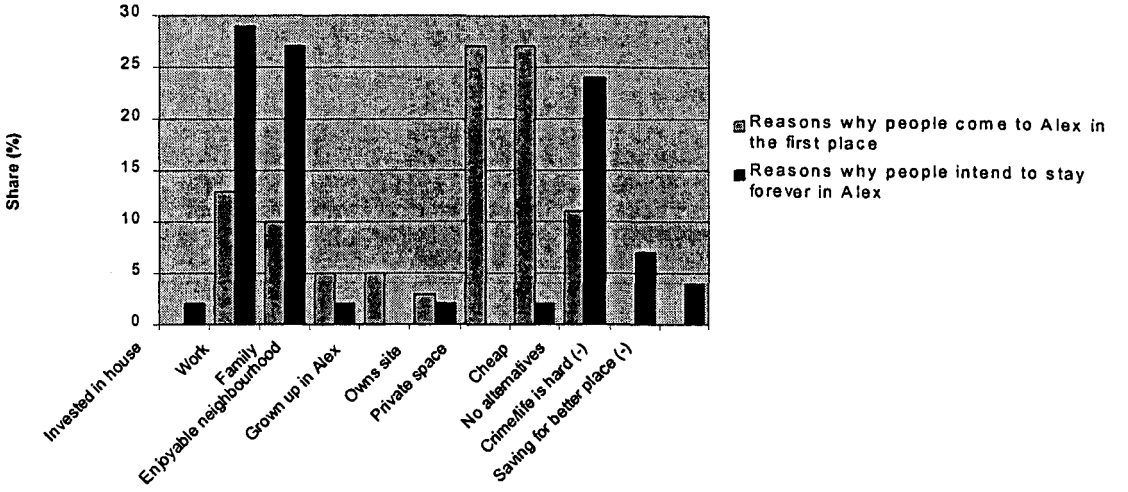


Figure 5.3: ***Reasons to live in Alexandra***

Given their initial intentions, the new residents are actually migrants, accepting having to live in tiny shanties packed between the others. While in the past these shanties were mainly built at the time of arrival, today the settlers buy them for a price of around 800 Rand, or rent a shack for around 40 Rand a month. Once they realise that they are going to stay in Alex and the household is growing, they start looking for a larger place in the area. As a consequence, the shanty area remains the same, having a migratory nature where new immigrants settle when the older generation moves to a larger place that happens to come free (which is usually not much of an improvement).

Now it may be deduced from the above findings that for the feasibility of a housing project a repayment period of 10 years seems realistic: for projects, then, households should be selected that already reside for a while in Alexandra, to assure that they know that they want to stay longer and, thus, to invest in their houses.

- **Education, employment, and income**

The unemployment level amongst the Habitat households is between 0% to 10%, while a significant share of the males are unemployed. Typically, the main income generating force here is constituted by women. These low unemployment rates contrast with the high unemployment rates of the shanties, thus illustrating the selection procedure of the Habitat households.

Table 5.3: ***Alexandra unemployment rates***

	Male		*Female*		*Total*	
House type	*Force*	*Unemployed*	*Force*	*Unemployed*	*Force*	*Unemployed*
Hab. 2 st.	8	38%	23	4%	31	10%
Hab. 1 st.	3	0%	2	0%	5	0%
Shanties	36	35%	33	52%	69	43%
Total	47	33%	58	31%	105	31%

The Habitat households earn with an average monthly income level of ca 1600 Rand per month (median 1500) more than double the income of the average shanty household has to satisfy with (700 Rand, median 800).

5.3 Shanties

The functional differentiation of shanty design is small compared to shanty housing in other surveyed areas. This is the evident consequence of lack of space. The households tend to be small, containing up to 4 people max, still disproportional compared to the size of the shanty,

which may be as small as less than 10 m^2, while serving a whole household. Typically, when the household size was five or larger a second room was found. This means that, when the cases are aggregated, the surface size is rather uniform amongst shacks housing households up to four people (ca 10 m^2), while the surface size jumps to ca 20 m^2 when a household reaches size five. This pattern is possibly the consequence of lack of available space and finance; only when the need reaches a certain limit the extension will be realised through the taking over of another shanty.

Figure 5.4: ***Two cousins sharing a 7 m^2 shanty.***

The functional design is rather uniform: The space, closely varying around 4 by 2.5 meters, usually contains a curtain as room divider, separating the bed and private belongings (on the backside of the shanty) from the area next to the door, where cooking utensils and some improvised seats and stands are found. Only when the shack is separated from its neighbours one or two windows may be found, otherwise walls are just blind.

No bath room is found in the shanties. Instead, the people resort to communal taps and toilet facilities. The people are unsatisfied about these facilities because they are filthy and badly maintained. It was said this was because nobody felt responsible.

Most shanties were erected with corrugated iron sheets, although there were some brick houses as well. Though the brick houses were by no means larger, the owner's response on the question whether they would stay permanently inclined to be more positive that the corrugated iron shanty owners.

5.4 Habitat houses

The project that included in total 16 units has been developed within the marked boundaries of the Habitat site. In contrast to the surrounding area where shanties are packed and stacked, the houses are all stand alone and have their own access and gardens.

The first generation houses are double storey (stand alone) and consist of two times 35 m^2; 70 m^2 in total. The ground floor consists of a combined kitchen and living area, a bedroom, and a bathroom. The first floor is accessible by a small staircase in the corner of the house that leads to a small hallway. This hall gives access to two bedrooms.

The double storey houses are erected on concrete foundations. The ground floor is concrete as well, while the first floor is made of wooden beams covered with wooden sheeting. External walls erected by plastered hollow concrete blocks that are made on the site. Internal walls consist of a wood frame covered by card board. In some cases a gypsum ceiling is applied on the owner's initiative. Roofing is asbestos.

The second generation houses are single storey (stand alone). Only two of this type have been constructed on this site. More has been constructed in Orange Farm and are discussed in chapter 6.

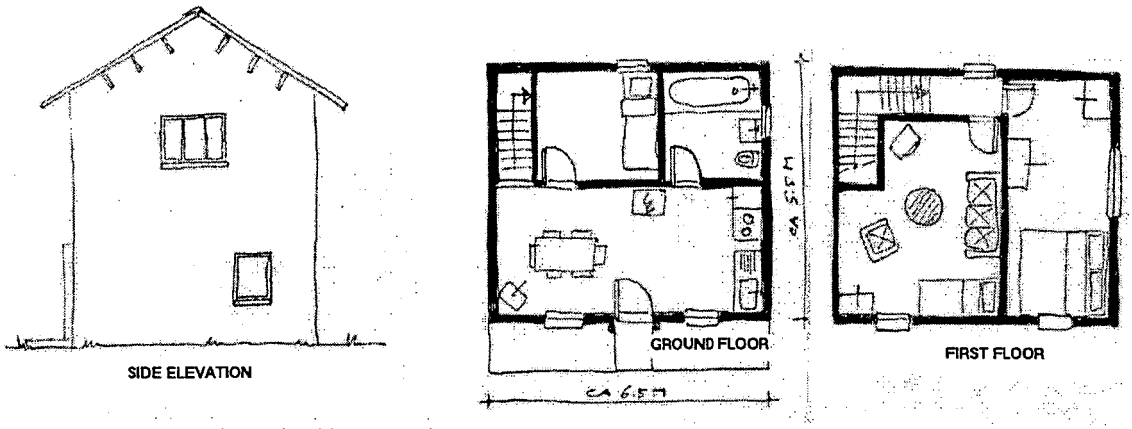


Figure 5.5: ***The Habitat double storey house.***

- **Housing process**

The construction has not always been smooth. Jealous reactions were sometimes heart, some expressing the suspicion that the project was politically motivated. This accusation is not uncommon in the high density areas of South Africa where people tend to be politicised while living under miserable circumstances, and who have been promised better housing. Housing processes that can only accommodate a limited number of people then become the target of disputes. These can lead to excesses such as shootouts and have to be anticipated on when developing a project.

Habitat's target group consists of households of the 800 to 1,500 Rand/month income group. Habitat assists these communities in building their houses, which are worth 15,000 to 25,000 Rand. The cost of the houses is expressed in equivalents of cement bags, which makes it easier to appreciate for the future owner what he has to pay, while changing price levels (e.g. through inflation) are easily incorporated on annual basis (the number of cement bags does not change). So the cost of a house may expressed in 700 cement bags, rather than in 15,000 Rand, and the repayment can be about 4 bags per month. The people do hardly pay for labour, as most work done through 'sweat equity'. Habitat does not make profits, but gets its funding from sponsors.[8]

Habitat applies a repayment scheme stretching over a period of 7 to 15 years, while the instalments and repayment periods are based on 25% of the household's income. To force a household to make its payments, Habitat makes sure that the houses built remain its possession, until these have been paid for in full. When people get too much behind on the repayment scheme, Habitat enforces the right to take off gradually elements such as doors, facilities and so on, until the house has been torn off, or until the household catches up with its repayments. Habitat believes this is a reasonable measure of force, as is assumed that nobody wants to lose his house or, more generally speaking, his hard earned acquired wealth.[9]

This procedure is assumed to contribute thus to a development that goes beyond mere housing. Habitat's part in the whole process is the initiation of the projects, giving training and workshops, and managing the processes, while also quality is checked and the house design remains subject to improvements. Habitat claims to contribute to sustainable development of communities through provision of houses, but also through skill development (building houses, manufacturing building materials), and employment generation.

- **Lessons from the design**

Various problems have been detected in the two storey house design, as is also acknowledged by Habitat that improved the design in later versions. In this survey the identified problems were:

- The functional design was poor insofar that no living room was provided, while staircases are difficult to climb, particularly for the elder people. As a consequence, the people are forced to use either the kitchen or a bedroom as a living.
- The technical design was poor, viz. contact noise and air noise coming through the floor from first floor to ground floor. Also unhappiness has been expressed about poor ventilation.
- The finishing is found to be extremely poor, viz. unfinished walls on first floor so that the rooms were linked through open air at the level where a ceiling was supposed to be. Also crumbling asbestos roofs were observed.

The unfortunate consequence of the failure of the double storey house is that people see how housing should not be, while they ascribe the failures to the type of house that the regarded house belongs to: the perception developed that double storey housing and trouble are synonymous. Hence the demonstration effect of a poor example. In the area it will be very hard to convince people to live in double storey housing, even if the proposed house is just fine, and even if the need is there. Nevertheless, some exceptions on the rule seem to appear, such as the case of the All African Games Village, which is discussed in appendix C.4.

5.5 Energy performance

Lack of connection of electricity has become an earmarking feature amongst the shanties in the surveyed area of Alexandra. The few grid connections amongst the shanties characterise illegal squatter camps and informal settlements like Alexandra where hardly has been anticipated on population growth. Virtually all households resort to the paraffin stove for cooking. In some cases paraffin is also used for lighting, but for that purpose candles are much more common. Though heating is claimed to be not applied in most of the cases, it is assumed that the heat generated through cooking (and lighting) benefit the internal temperature during cold winter nights.

By lack of electricity, which is said to be unavailable or unaffordable, households resort to dry cells and car batteries for the use of radios, tvs, sometimes lighting, and to other electric appliances. For ironing and cooking water, open wood or coal fire is also incidentally used.

The Habitat houses are all electrified, and the appliances have been almost uniformly adjusted to it. It is perhaps because of the easy access to electricity that all basic needs to run a house (heating, cooking, lighting) are used. Most energy is generated through electricity while in some instances, the 'fuels of the poor' (e.g. paraffin) are used in case of power rupture or lack of units.[10]

5.6 Conclusions

Alex's main attraction is that it offers affordable housing nearby jobs. Because of its strategic position, as well as its historical background, it has been overpopulated in time, having subsequently adopted a tense atmosphere with appalling crime rates that people arrive with the intention to leave the stage as soon as they have earned enough. The socio-economic circumstances are so bad however that the migrants eventually stay much longer than foreseen. The evolving poverty, crime, migratory nature and overpopulation does not offer much scope for gradual house improvements or extensions. Therefore, single roomed houses, either made of corrugated iron or bricks, are dominating the location.

Double storey housing has been experimentally built, where the Habitat houses appeared to be perceived as greatly disappointing because of technical failures, while social functions were

not adequately included. The people living in and around these houses tend to associate the double storey housing with the technical failures and built in time an aversive attitude towards this type of housing. This in contrast to the double storey houses in the All African Games Village, where the houses are technically of high standard and where, for the time being, people respond positively. This conclusion has to be considered with care however, as the site is delivered only recently, and failures may still emerge. The All African Games Village was not perfect either, and appeared to face many problems when it came to the organisation of the mass scale low cost housing process where, amongst others, the design has been classically imposed, rather than that the beneficiaries have been consulted.

6 CASE: ORANGE FARM

The case of Orange Farm elaborates further on the Habitat International for Humanity programme, which aims at building houses without subsidies. It also shows where a project may fail when it tends to be too small.

6.1 Introduction

Orange Farm is a township 30 minutes drive to the Southwest of Johannesburg. It has been established in the late 1980s and is a typical township insofar that it is inconveniently located, while services are poor. Many of the people arrived there as they did not have any alternative. People spend up to a third of their income on transport to get to their jobs. As transport is in quite some instances unaffordable, people are forced to wake up at three in the morning to arrive on their job in time by foot while returning late at night. As a consequence, many children hardly see their parents, while adults hardly can enjoy their spare time.

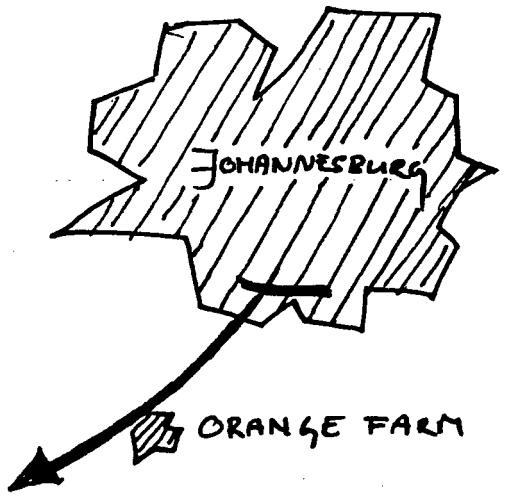


Figure 6.1: ***Location Orange Farm***

Nevertheless, the people seem to be fairly happy in this otherwise spacious and comparatively safe township. The plots have fairly well defined boundaries, increasing the sense of security and ownership. The plots are spacious allowing those, who can afford it, to build formal houses.

The households as investigated in Orange Farm inhabit basically three types of housing, the shanties, the Habitat houses, and the other formal structures:

Table 6.1: ***Details survey Orange Farm***

House type	Sample size
Habitat (single storey)	12
Other formal and semi formal houses	12
Shanties	43
Total	67

The Habitat houses as observed here are more recent than the Habitat houses in Alexandra. Habitat has learned from the Alex experience, and has stuck to single storey housing only. Also Habitat tried a single pitched roof as an economic version of the gable roof.

The 'other formal houses' are called formal as they are erected with formal building materials, which meet the building standards. Yet, these houses remain often 'informal' as they usually have not been constructed by a formal contractor, while combinations with informal materials also occur. Hence, occasionally these dwellings are also called 'semi-formal'.

The third category are the shanties, which prove to be much more diverse here than in Alexandra. They are diverse insofar space allows the households to build more rooms, but the materials are still dominated by corrugated iron sheets for walls and roofs, and concrete, if any material is used at all for the floor.

6.2 Demographics

- Gender and age distribution

The gender distribution of the sample happens to be normal. The average age is 25, while half of the sampled people is younger than 20 (median). There are three distinctive groups visible in the age distribution: The great majority (more than 50%) of the people are equally distributed between 0 and 24 years old, and seem to be the descendants that originally settled in Orange Farm in the late 80s early 90s. These settlers constitute ca 40% of the population and show an even distribution in the age groups from 25 to 50. A remaining 10% is found amongst the elderly from age 50 onwards.

- Household size

The household size distribution of the sample in Orange Farm displays a smooth normal distribution that slightly skews to the left, and with the peak on size 5 that constitutes a quarter of the total sample. The Habitat households show a narrow distribution around size five, while the shanty households are represented by all sizes.

Table 6.2: ***Household characteristics of sample from Orange Farm***

	Shanties	Semi formal	Habitat	Total
# hh	43	12	12	67
# people	197	62	52	311
Av. hh. Size	4.6	5.2	4.3	4.6
Adults	2.9	3.1	1.2	2.9
Children (≤16 yr)	1.7	2.1	3.1	1.7

The table above reveals that the shanty households represent well the average household of the total sample. It sustains the assumption that the shanty household forms the backbone of a township in terms of demographic development. Not so much because it is overwhelmingly represented in townships, but rather because the shanty is the starting point of virtually every household that tries to raise its living standard, amongst others through the construction of (semi) formal houses in time.

The dependency ratio is 2.0 for the Habitat households, 2.7 for the semi formal households and 2.8 for the shanty households, giving an overall dependency ratio of 2.2 for the total sample.

- Motives to stay

A quarter of the people that settled in Orange Farm did so because of the promise of having their own plot. Indeed, the location is spacious, while the plots are well defined. Many also said they came to Orange Farm as it would be close to job opportunities. This seems contradictory to the distance of Orange Farm to the epicentre of work, i.e. Johannesburg, that lays at more than 30 minutes drive over main roads away. Possibly transport (mainly mini bus taxis and trains) is well arranged, allowing the people to commute quick and efficiently between home and work. The fact that transport costs absorbs up to a third of their income seems to be a minor concern. Other important reasons for arrival in Orange Farm were reunion with family that already stayed there and the fact that many did actually not have a choice to go anywhere else.

While there may have been some confusion amongst the respondents on the difference in the question on why they came to Alexandra in the first place, and whether or not they intend to stay there forever, some differentiation has been found. Virtually nobody had the intention to move away from Orange Farm, in a third of the cases the enjoyable neighbourhood was mentioned as main reason. Property, family, and work were the obvious other arguments.

- **Education, employment, income**

The unemployment rate amongst the shanty households in Orange Farm is similar to the one in Alexandra, which suggest that almost half of the shanty workforce is unemployed.

Although the data are not comprehensive, there seems to be a correlation between housing typology and highest education level obtained in the households. The Habitat and formal households have generally more or less completed the matric, while amongst the shanty households various grades below matric are obtained as highest form of education.

Table 6.3: ***Orange Farm unemployment rates***

	Male		*Female*		*Total*	
House type	*Force*	*Unemployed*	*Force*	*Unemployed*	*Force*	*Unemployed*
Shanties	61	34%	64	53%	125	44%
Semi formal	20	20%	17	29%	37	24%
Habitat	14	14%	23	39%	37	30%
Total	95	28%	104	46%	199	38%

Despite the explicit question whether there were home based income generating activities, nobody responded positively. Such activities did emerge, however, based on answers to income related questions. The activities included the sales of liquor, raw meat, ice creams, and all kind of relish that is stocked in refrigerators. One out of three household performs such an activity, which shows, first, that income level may be higher than originally estimated and, second, the much more frequently availability of refrigerators in houses, than would be observed in the question on electric appliances.

Overall, the sample of 67 households in Orange Farm shows an average income level of 1300 Rand per household per month, while the median clings on subsistence level of 1200. The Habitat households, as a sub group, show most similarities, while the shanties show the greatest range, with incomes up to 5600 R/hh.month. Paradoxically, the median is with 800 lowest in this group. The formal households are on average best off with both median and average above 1400 R/hh.month.

6.3 Shanties

The shanties show much more diversification than in Alexandra, and this can be attributed to the available space. Despite the apparent diversification, the functional design of the various shanties can be simplified to a few basic concepts. These concepts, including the gradual growth with household size and income level, show similarities all over the country. Therefore, in chapter 8 the shanty will be discussed in more depth.

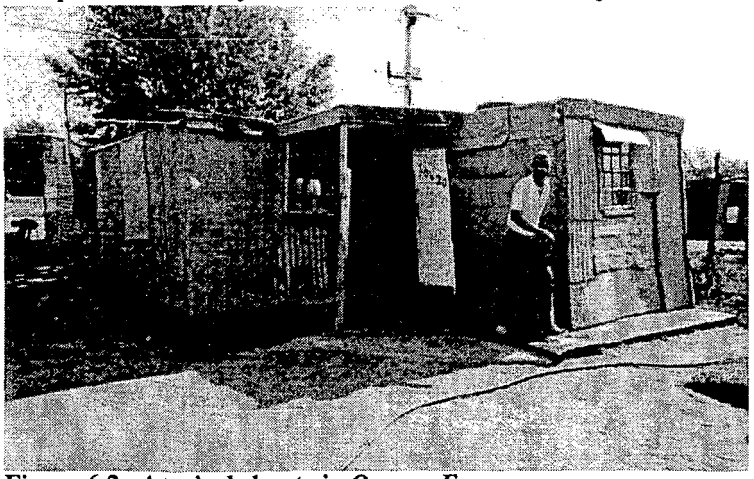


Figure 6.2: ***A typical shanty in Orange Farm***

6.4 Semi formal houses

The semi formal houses refer to the fact that these houses are built with materials that have the potential to meet building standards. Often these houses are built by the owners themselves, or are the works deployed by them to some hired forces which they know through their social network. Usually, there is no quality control so while the potential to meet the standards is there, it may be the case that the structure is poorly constructed.

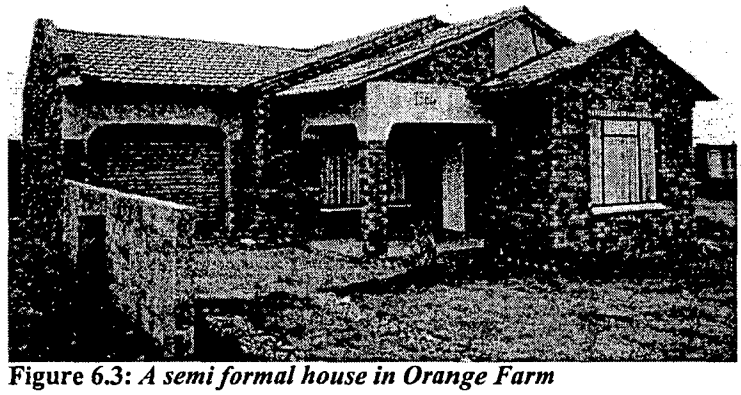


Figure 6.3: ***A semi formal house in Orange Farm***

The semi-formal show some typical characteristics which distinguish them from any other housing types:

- Fancy and expensive details are included, which seem to be copied from formal house designs which the owner aspired, but which he may not have been able to afford.
- The houses seem to be never finished, always showing one or another part being under construction.
- As the construction tend to continue in time in response to the evolution in household and income, the houses often look like patchwork.
- There is a tendency to the forming of many 'box rooms' in such houses, with for each room a separate function.
- A house that looks like an extracted accordion is frequently found. Such shape makes the house look big and is a pretentious way to show off the social status of the household.

6.5 Habitat houses

The basic single storey Habitat house design is functionally similar to the Eco houses of PEER Africa as built in Kutlwanong (chapter 7). It also has two bedrooms, a bathroom, and a combined kitchen and living room, while the spatial layout is similar. The house is smaller however, and the design does not include distinct energy saving measures. The house design underwent some changes in time. The experiment with two storeys was a failure, as it requires higher technical standards than is normal for a single storey house. Without these standards associated problems become disturbingly apparent: noise transmission, leaks, and small surfaces were the dominating complaints in Alexandra.

The floor is concrete, the walls are built up with hollow concrete blocks, while roofs are made of asbestos or iron sheeting.[1] In Orange Farm, Habitat has experimented with the single pitched roof which was more economical that the conventional pitched roof. Indeed, savings were made in labour time and skills, while less cement blocks were required to fill the smaller wall surface underneath the roof. The experiment was at the time of survey too fresh to obtain a matured opinion from the people. Yet, evidence from Swaziland suggest that economics stimulate the people to favour this roof type while, if the concept of modern housing is considered, people may still prefer the conventional pitched roof.[2]

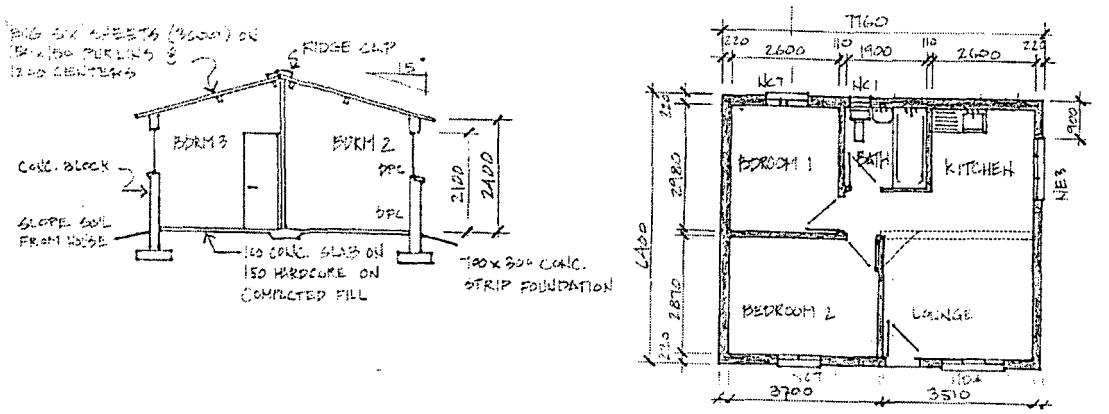


Figure 6.4: ***Prototype single storey Habitat house (source: Kurt Firnhaber, Habitat).***

Most of the construction is done by the future owners to save money, while the practice leads to new skills, a philosophy similar to the case of Kutlwanong.

Habitat operates without RDP funding. Instead, it receives fees through donations of American companies who can deduce their charity donations from the tax bill.

6.6 Energy performance

Electricity and paraffin are the main cooking fuels, constituting 75% (Habitat) to 90% (Semi formal) of the samples, where electricity is the main fuel for the semi formal households and paraffin the main fuel for the Habitat households. The shanty households show a more dispersed range of preference for cooking fuels.

Lighting is mainly provided by electricity, often combined with candles in case of power rupture. All housing types show that any combination of the two fuels constitute 90% of the cases.

Half of the Habitat households say they do not use space heating, against 40% of the semi formal households and 22% of the shanty households. There is no clear preference for any of the fuels available.

Although half of the Habitat households does not use space heating, energy requirements can be more reduced by the addition of low and no cost energy efficiency measures. The main measures that could be taken are:

1) Installing a ceiling or, if affordable, an insulated ceiling;
2) Appropriate orientation of the house;
3) Appropriate sizing of the windows;
4) Appropriate hangovers;
5) Application of proper colours on roof and walls; and
6) Insulating the walls.

Indeed, most of the measures are easy and low to no cost. While a proper orientation would have been a problem in Alexandra by lack of space, the plots in Orange Farm are spacious enough to allow for this measure at virtually no additional costs.[3] The application of the proper colours is also no additional cost, considering the fact that the walls are plastered anyhow.

The ceiling is suggested to be the major measure that may require an adjusted payment scheme, but its payback period of less than 7 years due to the subsequent energy savings makes the additional effort justifiable.

6.7 Discussion

The sustainability of the process, despite Habitat's claims, is disputed: Habitat survives on funding from external charities (the so-called 'trickle down effect' from the rich to the poor, as to establish welfare redistribution), while economic sustainability is supposed to rely on self sufficiency. This is rather contradictory, although Habitat's vision is understandable: the basic idea is to have a starting capital from outside the project (charity funding from US companies) to start the local economy and as to ensure that it will operate independently afterwards. Yet, the second stage hardly ever takes off the ground. For this an economic network is required that is sufficiently large in terms of both scale, and number of economic activities. None of the two conditions are met at present. For instance, economic centres such as cement block factories are built, while there is no client other than Habitat habitants who can afford the product. The chance that such small industries sustain is thus small.

Also a structural problem seems to exist on an organisational level within Habitat, regarding the system of volunteers who work for a low salary on temporary basis. Often these volunteers are from various disciplines and must be trained on the job to carry out their tasks properly. Unfortunately, they usually serve a three year contract only, after which they leave the organisation. Though training on the job leads to a highly specialised and thus potentially effective labour force, the duration of the contract is unlikely to give much scope for strategic long-term vision on sustainability. This system requires much effort from the employees who first have to be trained intensively, and then, due to understaffing, are being overloaded with work. Ultimately, the employees tend to suffocate, leading to cases in which they do not aspire to look broader than their defined work field. This phenomenon is likely to allow little for organisational and strategic progression.

The expression of costs of houses in equivalents of cement bags seems to be a good means of payment: the people face a fixed amount of bags that have to be repaid, while changes in prices only avail in the price per bag. Habitat's repayment scheme, that is based on 25% of households' incomes, agrees with international literature that suggests that throughout the world low income households spend between 15 and 25% of their income on housing. Yet, this may not be the right choice for the case of South Africa. Stats SA data suggest that regardless household income level the household spend closely around 15% of its income on housing (appendix B.1). This discrepancy between what seems the practice and what is applied may explain the problems Habitat faces with the significant amount of bad-payers in South Africa. Additionally, Habitat acknowledges that a repayment period of 10 to 15 years might be unrealistically long.[4] A total repayment of 10 years maximum is suggested.

In this payment scheme, the margin of 15% to 25% of household's income, the length of repayment period, the total cost of the house, and the income related RDP subsidy, are four variables. These variables allow for flexibility in quality of housing and its terms of payment. This issue is discussed in section 4.4.2.

"Habitat builds while the RDP destructs South Africa", maintained a Habitat employee: while RDP provides the people with entirely free to partly subsidised houses, Habitat requires from the people to actively participate, and to take responsibility. The people tend to wait that the houses are built for them, rather than to actively getting involved. Unfortunately, the people who prefer to wait for the RDP housing do so for many years and often in vain. Additionally, RDP houses without people's involvement appeared frequently to be high dissatisfactory, as also appeared from the case of Kutlwanong. The latter, however, also shows how RDP scheme can effectively contribute to build the country, rather than to destroy it. See next section.

6.8 Conclusions

After the case of Alexandra, Orange Farm seems to complicate further the logic behind township structures and living patterns. While it is located most inconveniently, constraining

the people by huge impacts on their budget for transport to job and the purchase of basic needs, the people seem happy in Orange Farm because of the relative peacefulness and spaciousness.

While the Habitat houses, in terms of design, seem successful here, the housing process itself seems to be rather problematic because of its small scale. Energy efficiency measures would be easily incorporated in the present design and would lead to improvements of the thermal performance of the Habitat houses.

7 CASE: KUTLWANONG AND BOIKHUTSONG

This major case study addresses one of the most reputed energy efficient low cost housing projects in South Africa. The community-based Kutlwanong Civic Integrated Housing Trust is famous for its assertiveness and creativity, which has lead to the high quality and spacious houses, built today. While their own reports go into quantitative detail on energy consumption, here the issue is rather qualitatively addressed, and is the attention focused on the design of the houses. Also the impact of secure tenureship on housing in general becomes apparent.

7.1 Introduction[1]

Kutlwanong is a typical township on all levels and in all fields, many characteristics of which are comparable with other South African townships. Yet, it distinguishes itself from other places through the unique mission the people have accomplished there, and which justifies this case study. Kutlwanong ("let's understand each other") is a community that is united in its efforts to transform a post-apartheid 'township' settlement into a sustainable community, spurred on by grass-roots development. The community is governed by the *Kutlwanong Civic Executive Committee* (hence KCIHT),[2] an elected council of eight people. It works closely with its community to ensure that they have support in their initiatives. They have been successful in various projects, such as electrification and securing a post office. The KCIHT main efforts lay in the provision of housing, embedded in a more broad sustainable development programme.

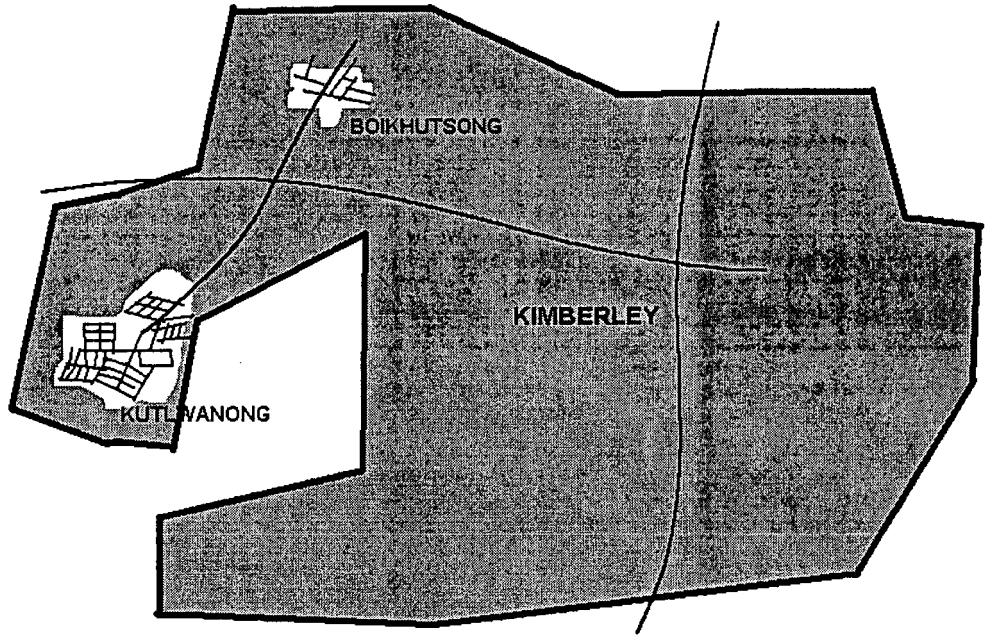


Figure 7.1: ***Map of location Kutlwanong and Boikhutsong in Kimberley.***

Kutlwanong is located eight kilometres to the west from the city centre of Kimberley in the Northern Cape Province of South Africa. Over 8,000 residents constituting approximately 2,300 families reside on an area of roughly 129 ha (average family size 4-6 (Guy 2000); density 6,202 people/km^2). Kutlwanong is a relatively young township founded in 1994 through an effort of a local civic organisation putting pressure on the municipality to establish a recognised community from the growing settlement.

Following national trends with respect to informal settlement planning, Kutlwanong is not conveniently located. Potential places of employment and shopping are far away, and transportation is a luxury. Unemployment is high, ranging from 60 to 75% (Kutlwanong *et al* 1997), and the isolation from mainstream economic activity tends to perpetuate this situation. Differences in employment opportunities between the genders are significant.

The community has presently little opportunity to reverse its negative economic situation. Further complicating matters, about 10% of the community is situated adjacent to a large municipal storm-water runoff holding pond (Guy 2000, Kutlwanong *et al* 1997) . Land plots in the area are frequently water-soaked, and are not suitable for building. Additionally the holding pond creates problems with mosquitoes, rats, snakes and other vermin.

Yet, Kutlwanong does have adequate infrastructure: paved and wide streets, electricity, wired and cellular telephone service, drainage and individually serviced (water and sewerage) plots. However, there are problems with the existing drainage and sewage systems, which result from the installation of inferior/inadequate design and poor construction techniques. These systems were installed by the Kimberley municipality prior to the housing initiatives conducted by KCIHT and PEER Africa (PTY) Ltd.[3]

The provision of formal housing and job creation are the main priorities for the community. Prior to 1995, the majority of the community lives in 20 to 30 m^2 shacks constructed of corrugated iron sheets. These shacks have no ceilings and curtains are often used as room dividers. The shacks are draughty, and cardboard is sometimes being used as a wall cover for cracks and to provide a modest insulation benefit. Like anywhere in South Africa, the dwellings have been found to be colder inside than outside in the winter, and hotter inside than outside in summer. During winter months it is common to see people sitting outside on the east side of their shacks in the mornings to get warmth from the sun.

This case study presents the results of the survey that was carried out in Kutlwanong and surrounding areas during the first two weeks of December 1999 (summer). The four types of housing that are addressed are presented below:

Table 7.1: ***Details survey Kutlwanong and Boikhutsong***

House type	**Sample size**	**Incl. sketch**
Shanty	20	18
PEER Africa ECO Home	10	9
Grinaker standard house	10	9
e.e. standard house in Boikhutsong	11	6
Total	51	42

The shanty dominates by large the South African townships, and given their quantity and poor standards, they are taken as a reference point in improving the housing circumstances. In this study too, they are studied on their socio-economic desirability and technical characteristics.

The second category is the Kutlwanong Housing Project, which is the focus of this study. This project is the result of the United States – Republic of South Africa Gore-Mbeki Binational Commission (BNC) Energy Conference held in Kimberley in 1995, and is part of the BNC's Integrated Housing Programme.[4] Following from this, the Kutlwanong community decided to use PEER Africa to help and rebuild the 'township' into a holistic, sustainable, and economically viable community. The intention was to incorporate environmental and energy efficiency awareness, economic upliftment and capacity building into the planning, development, and implementation process.

The project was conceived to provide homes, jobs, and improved quality of life, and other social benefits to a historically disadvantaged community of South Africa. A benefit to the global society of this project is the anticipated reduction in greenhouse gas emissions.[5]

The third type of house considered is the Grinaker standard house, which has been constructed all over South Africa with RDP funding, while it is mushrooming all over Kutlwanong.[6] Despite the convenience of the speed in which the units are being constructed, allowing the people to move quickly from their shanty, this type of house has been severely criticised by some residents for its poor performance. This house is said to be a marginal improvement compared to shanties, and parallels are frequently drawn with the imposed matchbox houses from the apartheid era. On the other hand, so PEER Africa (2000) observes, many residents are happy to be out of shanties and thankful that the government followed up on its promise to deliver houses.

The standard houses in Boikhutsong[7] which are claimed to be energy efficient are included to assess satisfaction level of the households in terms of design and energy efficiency.

7.2 Demographics

- Gender and age distribution

Literature suggests that the age of a household tends to correlate positively with the success of a housing project. Where younger people may tend to move and save for later, the elder are seeking to settle shortly as they have accumulated savings throughout the years, and stable employment. Indeed, payment problems in recent projects tended to be mainly amongst the younger households, who realised only when houses were erected not to be willing or able to invest yet.

Apart from some deviations, the overall pyramid-shaped age distribution of Kutlwanong is typical for a developing society. The average age is ca 24, while ca 50% is younger than 20 year (median).

The age distribution of the shanties shows that the 30ers account for a relatively high share. As they constitute the main labour force, it may suggest that households are mainly settled in Kutlwanong for employment opportunities. However, this did not reveal from the survey, in which the majority of the respondents said they like to stay in Kutlwanong because of an enjoyable neighbourhood and family.

The ECO Home population sample visualises there may be a tendency towards development, considering the onion-shaped age distribution that seems to develop. If true, this pattern may sustain the argument that people are planning their lives, while benefiting from energy savings through investment in other priorities. This may mean that the project achieves the objective to stimulate a rise in living standard of the PEER Africa ECO Home households.[8]

While the original survey accommodated for the identification of gender related deviations from standard functional designs, these did not become apparent in the fieldwork.[9] There was, for instance, neither visible gender related bed room distribution, nor other facilities have been observed that accommodate for segregated living of men and women. However, gender does seem to affect the quality of the environment.[10] Where women staid home, houses tended to be more tidy and kitchens better equipped. This in contrast to houses where men had to take care for the house.[11] Generally speaking, the distribution of decision power and responsibilities between sexes has an impact on how a house may be perceived, and how its quality eventually will be perceived as well.

The gender distribution is uneven, the woman representing 57% of the total sample (with extreme representation of 63% amongst shanty households). They outnumber men

particularly in the age categories from 13 to 24 years. This may be the result of traditional role patterns in which men go to school, while women stay home to take care for children and home. It may also suggest that men are working elsewhere in the country, which is quite possible considering the few employment opportunities in Kimberley. As a consequence, men are not a direct part of these households, while they do contribute by sending remittances or the like. Indeed, the survey revealed that quite a few households receive remittances. Women also dominate amongst children up to 6 years. This is harder to explain, and might be just coincidence. Typically, the comparatively heavily represented age groups from 25 to 36 show the most balanced gender distribution. It supports the suggestion that men may be away for study or work at younger age, while coming back home to settle at later age.

- **Household size**

The average household size of the surveyed households in Kutlwanong is 4.3, which fits between previous estimates of 3.5 and 4.6 (Kutlwanong et al 1997: 18).[12] 77% of the households have 2 to 5 members. 20% of the households have 6 to 10 members. This shows that the household distribution is large, with serious potential for incremental housing to accommodate for growing households. Unfortunately, so PEER Africa (2000) observed, the provision for a South Africa subsidy does not take household size into account. Also, housing subsidies are randomly selected, and no mass developer would take the time to evaluate the needs of individual families.[13]

The sample from the Grinaker homes displays a fairly uniform distribution of households of up to 5 people.[14]

Table 7.2: ***Household characteristics of sample from Kutlwanong and Boikhutsong***

	PEER	Boikh.	Grin.	Shanty	Total
# hh	10	11	10	20	51
# people	42	59	34	86	221
Av. hh. size	4.2	5.4	3.4	4.3	4.3
Adults	1.8	2.7	2.2	2.3	2.4
Children (≤16 yr)	1.4	2.7	1.2	2	1.9

It was expected that once formal houses are constructed for which people are held responsible for regular payments, the average size of the household would reduce, as members extending the family and consuming what the earners bring in, would no longer be appreciated. This study shows however that loyalty, in terms of providing relatives shelter, seems unaffected when the owner moves into the new house. In contrast it sustains the argument that household size is rather income related.[15]

Notwithstanding the former arguments, a household can not afford a formal house if too many people are dependent on a single income. On the other hand, it may be argued, more adults in a household might increase the chance of having some sort of income, as compared to a single bread earner. Given the random selection procedure of households for PEER Africa ECO Homes, a clear explanation, here, is not found for the observed low dependency ratios amongst the lower dependency ratios in formal houses as compared to the shanties.

More than half of the households (55%) have a dependency ratio of up to 4 people per earner. A fifth of the households have a dependency ratio from 4 to 9. A quarter of the households have no income at all. The overall unemployment rate is 44% with the shanties households having the highest dependency ratios.[16]

- **Motives to stay in Kutlwanong**

On the question "How long do you intend to stay in Kutlwanong?", the people replied unanimously that they intended to stay permanently. Generally speaking, almost two third of

the surveyed people said this was because of the enjoyable neighbourhood, while work was the second main reason (40%). Typically, the responses from Grinaker and Boikhutsong show similar patterns. The households in these two categories arrived in 1998 and 1999 in the locations, and constitute therefore the most recent arrivals. It may indicate that 98-99 was a stimulating year in terms of employment in Kimberley.

Table 7.3: ***Reasons to stay in Kutlwanong***

	PEER Africa ECO Home (N=10)	Boikhuts. (N=11)	Grinaker (N=10)	Shanties (N=20)	Weighted Total (N=51)
Already invested in house	30%	0	0	0	6%
Work	0	55%	50%	0	22%
Family	0	0	0	10%	4%
Enjoyable neighbourhood	50%	0	0	40%	25%
Family + enjoyable neighbourhood	0	9%	10%	35%	18%
Family + enjoyable neighbourhood + work	0	36%	40%	5%	18%
No alternative plans yet	20%	0	0	10%	8%

Guy (2000) remarks that the fact that 30% of the ECO-Home owners noted that "investment in house" as a reason to stay and none of the others indicated this, is a significant piece of information. The current study did not investigate the reason for this response. It is PEER Africa's view that the fact that residents participated in the construction of the homes gave them a sense of ownership and pride that was not necessarily noted during the survey from others. The second reason, according to Guy, may very well be tied to the fact that the ECO-Homes are more expensive and better quality.

Kutlwanong is relatively well-off compared to an average informal shanty settlement. People are tenants of their own plots, which are spacious enough for future expansion, infrastructure is fairly developed, with each house its own tap, toilet, and sewage system, and each house is connected to the electrical grid. Crime rate is the highest in the province yet relatively low compared to similar communities with high unemployment rates in other parts of the country, and the general community atmosphere is relaxed. Job opportunities are very low in Kimberley, so that cannot be the main reason to stay.

In the case of shanty households, employment has seldom been mentioned as an argument to stay in Kutlwanong. Perhaps this is partly a result from the Kimberley town plan policy in the early 1990s. The main objective at that time, it was said, was to design a location for the unemployed and pensioners. This corresponds with the dependency ratio of the shanties.

- **Education, employment, and income**

The table below reveals that the overall unemployment rate amongst the sampled households is about 50%, while there is a higher unemployment rate in the female workforce than in the male workforce. There seems to be no correlation between education level and unemployment. Considering the comparatively low level of education (only 2% has been following a tertiary education), this would be unlikely anyway, as real specialisation has not yet occurred.

The household income levels are fairly uniformly spread within a small range from virtually zero to 1600 Rand per month.[17] The average household income level is 1034 Rand, which is comparable to average household income level of about 1100 Rand in Galeshewe.[18,19] The lowest average is found amongst the ECO Home households (790 R/hh.month), followed by the houses in Boikhutsong (890 R/hh.month) and shanties (1090 R/hh.month), respectively. The Grinaker households, on average, earn most (1334 R/hh.month).

Table 7.4: *Kutlwanong and Boikhutsong unemployment rates*

	Male		*Female*		*Total*	
House type	*Force*	*Unemployed*	*Force*	*Unemployed*	*Force*	*Unemployed*
PEER Africa ECO Home	15	40%	15	60%	30	50%
Grinaker	10	40%	12	33%	22	36%
Boikhutsong	17	24%	14	36%	31	29%
Shanties[20]	18	44%	20	70%	38	58%
Total excl. Boikh.	43	42%	47	57%	90	50%
Total incl. Boikh.	60	37%	61	52%	121	44%

Ca 50% of the sampled households have an income of 900 Rand per month (median) or less, and ca 70% lives under or around subsistence level of 1200 Rand/hh.month.

Despite small variations amongst the four housing type categories, this overall picture reflects the global characteristics of the community, which appears to be extremely poor.[21] Only 2% earns sufficiently to not qualify for a RDP housing subsidy.

7.3 Shanties

Shanty housing shows similar patterns throughout the country, and a typical incremental housing pattern is therefore discussed in chapter 10. The main differences that occur are, apart from socio-economic circumstances, mainly from local climate, space, and resources available.

In Kutlwanong most shanties are built on spacious legally owned plots, with clear market borders, thus increasing the general feeling of secure tenureship. An exception was the case of a tenant, who thought he was the legal owner of his plot, but when he handed a building plan at the council, it appeared that the land was ascribed to somebody else, whom nobody could trace back.

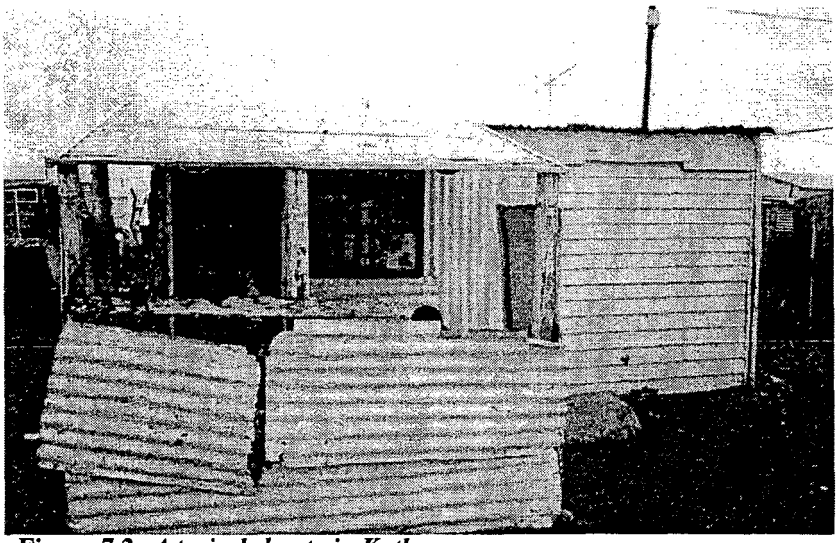


Figure 7.2: ***A typical shanty in Kutlwanong.***

Because of space and security of tenureship, the shanties are spacious and generally fairly well equipped. Usually they are built in the back of the plot in anticipation of a future formal structure that has to be built in the middle of the yard with a representative front garden and a private back garden.

The materials used are mainly corrugated iron sheets. The floors are made of rammed earth, rammed earth covered with plastic sheeting, or concrete. Usually one door and one or two windows can be found. Usually there is no ceiling and curtains are often used as room

dividers. The shacks are draughty, and cardboard are used as wall cover for cracks and to provide a modest insulation benefit.

As mentioned in the introduction of this chapter, the shanties have been found to be colder inside than out in the winter, and hotter inside than out in summer. During winter months it is common to see people sitting outside on the north side of their shacks to get warmth from the sun. Because of the glaring summer sun, a cover or shield of corrugated iron sheets is often built as protection.

7.4 PEER Africa ECO Homes[22]

The ECO Home design process is based on an iterative and consultative process between the community, its leaders, PEER Africa, the structural engineer, suppliers, finance organisations, local city council, local builders, provincial housing board, municipal inspector, the conveyancing lawyer and the architect. The objective was to first understand the resident's acceptable living standards (e.g. number of rooms, surface required, materials, etc) and to develop those standards into a basic house plan (see figure 7.4). Residents raised issues concerning their lifestyles, which were not initially obvious to the engineers and architects. Work shops, visits to other locations, and matching with available budgets, further contributed to consensus about the first prototype final design in 1995.

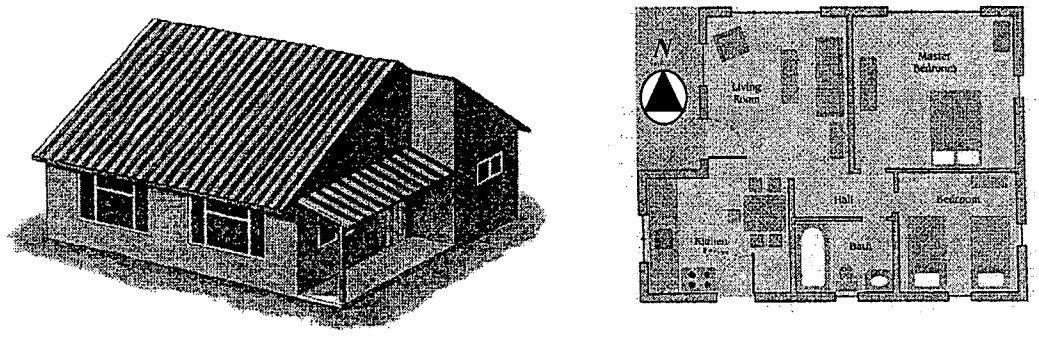


Figure 7.3: ***Prototype PEER ECO Home (source: PEER Africa).***

Issues were, for instance, the perception of quality of materials. The community of Kutlwanong demonstrated not to accept inferior materials, even though these might be cheaper. During the 1995 community needs assessments workshops conducted by PEER Africa the participants indicated their concerns over existing RDP units that did not have privacy. They requested PEER Africa to design a structure that has bedrooms which separates at least the parents from children for reasons of privacy. The overwhelming issue with room function was oriented around the location of the house relative to the street. In some cases residents wanted the kitchen and living room linked, which is different from the Johannesburg area, where people desired merely a living room as big as possible, thus reducing the size of both kitchen and bed rooms. Extension/modification possibilities of the house are said to be available in the design, as it is easy to extend the house at the back and front side, while leaving the facades with the main windows alone.[23]

The first houses are based on an insulated cavity wall system using a steel frame as the basic structure, and polystyrene as the primary insulating material. The homes are north facing and window systems are designed to maximise solar gain during the cold months and maximum ventilation and air flow. Roof overhangs are used to shade window systems during summer. The outer skin of the home is a single layer of brick, while the inner walls are made of gypsum board. The inner walls are finished and painted by the community teams before the dwelling is turned over to the homeowners. All the homes have insulated ceilings and are made from products that are easily obtainable in South Africa.

As houses have been built and inhabited, experience grew while new technologies emerged on the market. Consequently, changes have been made in the plans and the housing management concept. In time the range of products and product systems in the Kutlwanong houses have changed. While gypsum board and steel frames were the cheapest option for internal walls, their delivery time appeared often long and unreliable. Therefore, the more expensive but easily accessible bricks were used as alternative material for internal walls.

Evolving knowledge on energy saving measures and the like have been equally incorporated. Flat ceilings have been changed into sloping ceilings that follow the line of the roof, thus enabling a better internal airflow, improving comfort and health standards. Where possible, houses face north. As open fires hardly occur in the Kutlwanong houses a window and open door was assumed to be sufficient for ventilation. For coal stoves it was said to be easy to install a ventilation shaft through the roof. It seems to me, however, that ventilation of the kitchen area can be improved, as an open door is not always practical (e.g. in the way) or desirable (e.g. stormy weather). Furthermore, one extra door to close the hall seems advisable, as to isolate the bedroom from the noisy living room. Obviously, it would include extra costs.

7.5 Grinaker houses

The Grinaker houses also conform to the RDP scheme. The contractor however does hardly consult with the future owner, who is only left to say what he wants to build himself.

The Kutlwanong Grinaker house has a surface of ca 35 m2, and includes two bedrooms and a living room, all linked by door openings without doors (usually, curtains serve as door). The living room has one front door facing the street, and one back door facing the backside of the plot. The bedrooms have a window each, and the living has one window of similar side on both the front and backside. The concrete block walls are erected from a concrete foundation and floor, and bear a corrugated iron roof.

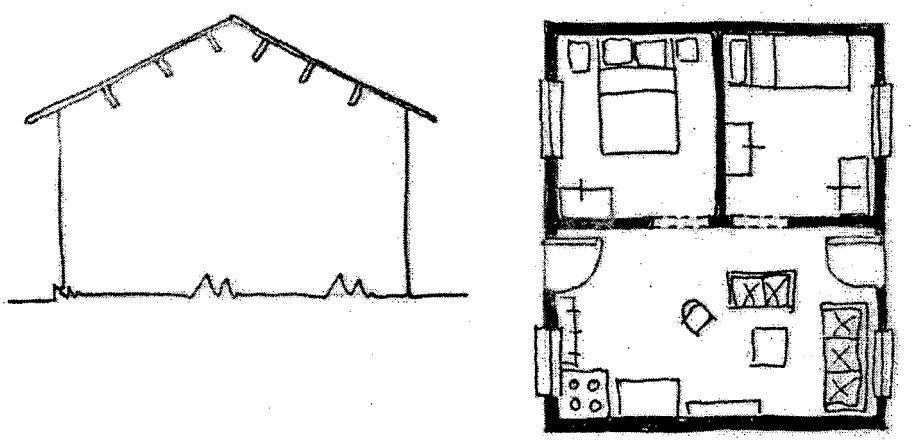


Figure 7.4: ***Prototype Grinaker house.***

A major issue that generates a conflict between the Grinaker and PEER ECO Home projects, is that there is an overlap in the responsibilities of the local municipality of Kimberley and the provincial authorities. While the provincial authority has promised land for the KCIHT to build more ECO Homes, the municipality appeared to have already made some arrangements with Grinaker for the same plots.

A process is now ongoing to find a diplomatic compromise, but the inhabitants have expressed clearly their opinion: they do not like the design and constriction of the Grinaker houses, which does not allow for much involvement, while the quality is miserable. In

contrast, the people feel, the PEER ECO Homes proves its standard. Nevertheless, Grinaker can go on constructing as contracts were made already. Sadly, it is clear that the commercial interest is given priority above the wish of the end user, who even have explicitly expressed the willingness to wait a few years longer to get a quality home.

Mass and quality housing proves, here, to go far beyond technical issues, awareness campaigns and organisation: it is also about politics and that proves to be time and over again a problem throughout re-organising post apartheid South Africa. It is said that procedures go so slow that frequently the people involved are disappeared from the stage before a stage has been finished, leaving the other parties with another person who still has to get into the issue, while he may have his own ideas – differing from what his predecessor had, and differing from what the people had achieved so far.

7.6 Boikhutsong houses[24]

Slightly more creatively designed than the Grinaker houses, the standard houses in Boikhutsong are claimed to be energy efficient.[25]

The energy efficiency seems to be obtained through the use of prefabricated cavity walls with a thick layer of plaster on the outside, while the lower side of the roof is insulated with alu-foly. The insulating walls that reduce temperature shocks, in contrast to iron sheets in shanties, may also contribute significantly to the increase of comfort, hence the reduction of space heating. These factors together may be the cause of the assumed energy efficiency of these houses, where about half of the households interviewed indicated they did not use space heating in the winter months.[26]

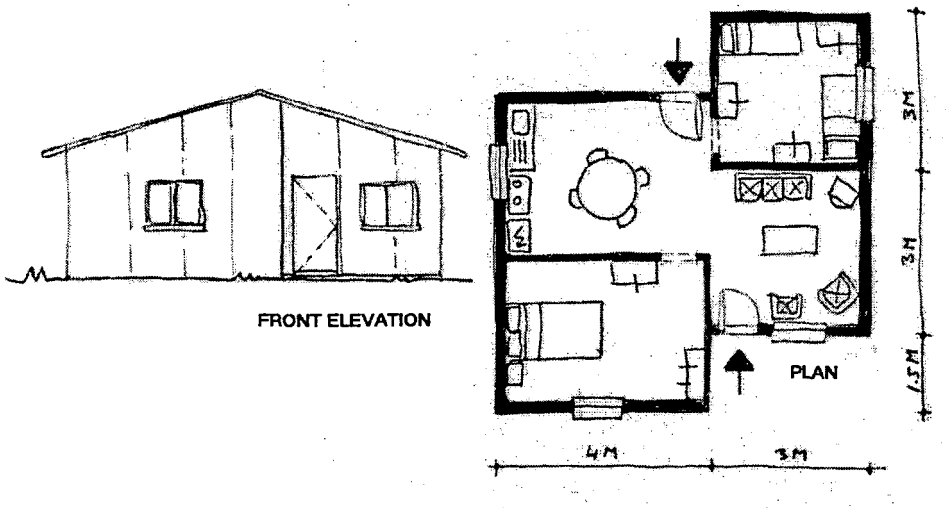


Figure 7.5: ***Prototype standard 'eco' house in Boikhutsong.***

On the other hand, the survey sample, here, was very small indeed (N= 11, see section 7.1), while possibly some households have not lived a full winter in these houses yet. This gives scope for interpretation of informal interviews as PEER carried out amongst residents in north facing units in this community: they even observed the case in which one resident indicated that she was told the houses were warm in winter but she was really comparing it to her shanty. She was not aware that there was a house that was actually warm enough during winter so as not to require any space heating.

Possibly, more 'costly' fancy design elements were viable due to the construction with prefabricated elements, saving money through economies of scale.

People tend to be generally happy about their houses, which is likely to be partly attributed to their recent move: the houses have been delivered one year ago at most. Yet, complaints are made about the quality, such as crumbling roofs and windows that cannot be opened. PEER Africa interviewed several of the residents of this community and found that they were most happy about the size of the units.

7.7 Energy performance

Households use fuels such as low-grade coal, wood, and paraffin, for cooking and heating the shacks in winter. Use of these fuels inside the home creates considerable indoor air quality problems, as well as contribution to the degradation of local air quality. PEER Africa and the US Department of Energy conducted a preliminary survey in the Kutlwanong informal settlement found that in 50% of the sample shanties using paraffin for cooking and heating, and in 10% of the sample shanties using informal coal heaters, there were dangerously high levels of carbon monoxide indoors (Freeman *et al.* 1997). The people's exposure to hazardous air pollutants, especially particulate matter, exceeds WHO health guidelines by a factor two to three in summer and seven in winter when households use an increased amount of coal to meet their space heating requirements (van Horen 1996). In winter, one can see from a distance a cloud of smoke over the community in the morning and evening resulting from the use of these fuels for heating and cooking.

Fuel type	% of household	Average used per month	Average used Per year	CO_2 per year
Paraffin	99%	26 litre	312 litre	825.4 kg
Coal	5%	59 kg	708 kg	1940.8 kg
Wood	9%	16 kg	192 kg	316.6 kg
Gas	<5%	n/a	n/a	n/a
Candles	68%	28	336	n/a

Table 7.5: ***Galeshewe demographics 1992, comparable with Kutlwanong (Sources: Golding and Hoets 1992; Energy Research Institute 1995; OECD 1991)***

Fuel use data were obtained from the 1992 Galeshewe demographic survey. The findings regarding the energy portion are also said to be comparable to those in Kutlwanong. The data from this survey are presented in table 7.7 along with the annual CO_2 emissions that would result from the consumption of that energy.

The survey brought forward in this report specifies the use of fuel types by space heating, cooking, and lighting, as is believed that these are the main energy services that relate to the thermal performance of a house (see figure 7.6). It shows that with increasing poverty and less facilities available, the range of fuels used increases and that these fuels are more multi-functionally used (compare shanty households with PEER Africa Home dwellers). This may have consequences on the thermal performance of the house.

The table shows that the ECO Homes prove their thermal capacity: virtually no heating requirements are recorded. In 45% of the surveyed standard houses in Boikhutsong that were claimed to be energy efficient, no heating was required, while most of the remaining households use paraffin or wood to heat their houses (fire outside, of which the coals are brought inside). Typically, no electricity seems to be used for space heating in Boikhutsong. The Grinaker houses seem to be a marginal improvement relative to the shanties in terms of space heating.[27] Though the heating requirements are not quantified, the range of fuels used for space heating indicate the need.

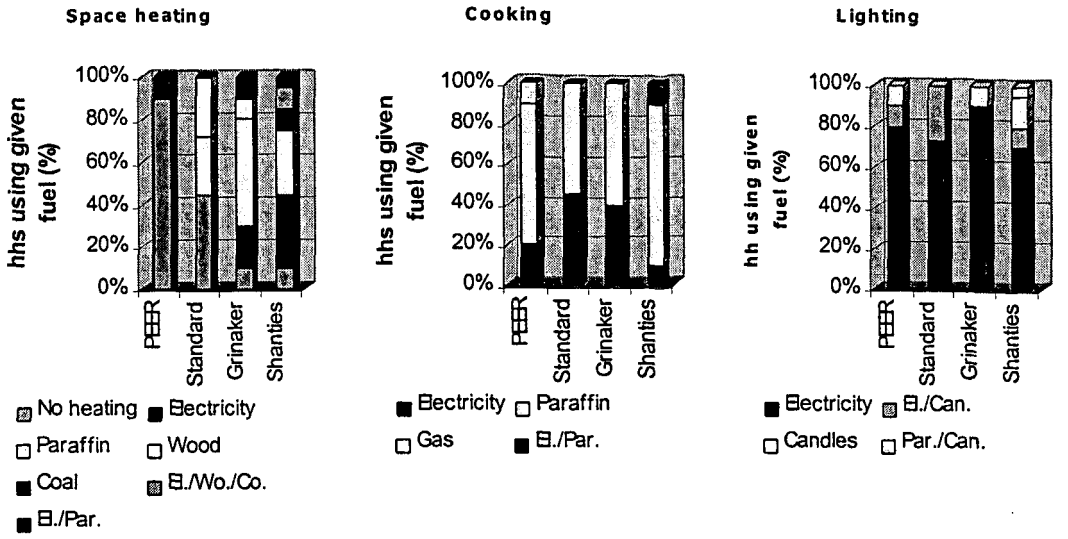


Figure 7.6: ***Fuels used for space heating, cooking, and lighting.***

Paraffin is the predominant fuel for cooking. This includes the case of the ECO Homes, where high paraffin consumption by faulty cooking and heating devices reduces one of the beneficent effects of ECO-House design. In these houses the use of renewable energy resources for all heating and cooking purposes was aimed at to achieve a healthier, safer, and less costly indoor environment.[28] This was hoped to be achieved by not only reducing fossil fuel requirements for space heating, but also by orchestrating the choice of cooking fuels through energy efficiency and environmental awareness building campaigns. It seems that the main effect so far has been the reduction of the fuel range applied, i.e. that the use is limited to mainly electricity and paraffin.

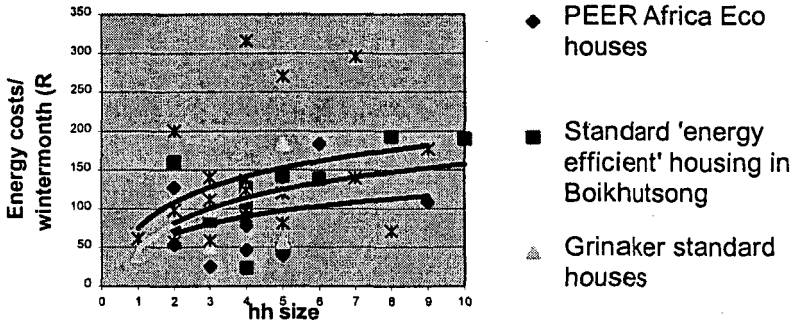


Figure 7.7: ***Typical energy costs vs. household size.***

The consequence is, however, that electricity is now used for space heating and lighting only, while paraffin is used specifically for cooking. The specialisation implies an intensified use of the selected fuels. In the case of paraffin this leads to emission levels for cooking that may approach the levels of its multifunctional use in other housing types, where burning paraffin may serve simultaneously to cooking and space heating. In other words, when the tasks cooking, heating and lighting are considered individually, emissions seem to be reduced (less heating requirements, and better maintained appliances), but they do also shift (changed vision of the user). In sum, the combined change in consumption of resources and subsequent emission patterns lead, at least for the time being, to a poorly reduced aggregated emission level.

Without exception, electricity is the predominant source for lighting in these electrified households, with candles and paraffin being used as a back up in the event of a power cut or when a household runs out of units. It is concluded that there is no important contribution from artificial lighting to space heating in these cases: relative to cooking or space heating, heat emitted through (electric) lighting is marginal.

Energy costs are, per location, and apart from house type, consumers behaviour, and fuel efficiency, primarily related to household size, household income level, and the building envelope. While potential bias are borne in mind because of the limited sample, the following observations are made:

- While shanties tend to gradually grow from ca 15 m^2 to ca 40 m^2 depending on household size, ECO-Homes have various sizes ranging from the smallest 35 m^2 units to a large surface of ca 50 m^2.[29]
- Despite the large surface the findings show that the ECO-Houses have by far the lowest energy requirements, while the shanties have the highest energy costs of all houses observed. Even the difference between shanties and the Grinaker houses are considerable, which seems to weaken the argument that the standard RDP houses are a marginal improvement compared to shanties. At least this seems not true in terms of energy consumption patterns.
- Typically, the data suggest that the houses of Boikhutsong have, in terms of quantity, energy requirements similar to Grinaker houses. This seems striking (only half of the surveyed Boikhutsong houses indicated space heating is actually applied during winter months, in contrast to Grinaker houses which are almost all heated), but in fact these houses have been delivered recently only, by which space heating regimes have not matured yet.

The evidence that thermal performance of the Boikutsong houses is hardly an improvement compared to the Grinaker houses seems to validate Guy's argument that there is nothing significant about the construction of the Boikhutsong units that makes them much different than Grinaker units other than size. The 'eco' modifications made to the building envelope of the structures in Boikhutsong are slight and seem not to have that significant impact unless other factors are at work here.

7.8 The people's perception of their houses

As observed on the Habitat sites in Orange Farm, in Kutlwanong too there are households that keep their shanty after construction of their new home. In the new stage of their life the household keeps the shanty for rental to other households (income generation), it uses it as extra space complementary to the new house (e.g. for sleeping) if the new house is still too small; as a storage; or the household reserves the shanty for later times, when family grows and the house becomes too small, so that the extended family can re-occupy the shanty.

To observe the PEER ECO Housing process in reality served to put into perspective the rather optimistic elaborations in Kutlwanong *et al*'s (1997) report, including the pictured plan of the house that demonstrates the 'ideal' situation. There were some striking observations:

- First, in the small sample of ECO-Homes visited frequently the kitchen was not used for cooking at all. In these cases, the cooking activity has been moved to the bathroom. The people visited usually operate paraffin stoves that generate smoke. This is not only smelly and irritating to the eyes, but also affects the ceiling, which is said why the people moved the cooking utensils to the bathroom. In the bathroom, these utensils were usually placed on the ground, and not on a table. Possibly, again, to avoid deterioration of the ceiling by the smoke. It seems valid to conclude that the bathroom was preferred as cooking area, as in this way people in the living room were less exposed to smoke, while deterioration of the bathroom ceiling would be less visible. In some cases the household just wanted to isolate cooking activities from living.[30]

- Most ECO Home base units were constructed without internal doors as these were, apparently, too expensive. Some homeowners funded individually the internal doors. Most people however used curtains to create a greater sense of privacy. This issue has been hardly mentioned by the households, whereas the wish to add a wall between kitchen and living room has been frequently expressed. When this is set in the light of housing typology relative to income level, one may conclude that dividing walls between functions have priority above doors. First priority are walls between bedrooms and other spaces. Second priority are walls between bedrooms. Third priority are walls dividing living room and kitchen. Only when these needs are satisfied, the insertion of doors may be considered.
- Third, there was no single surveyed house where the bathroom is used in the originally intended manner. The toilet was missing, as were sink and shower. Inquiries revealed that these facilities are considered too expensive by the households, who thus resort to the toilet and tap in the back garden.[31] One respondent said that she did not like to have the toilet inside the house at all because of smell and potential sanitary problems. Bathing (in a tube) was sometimes done in the bathroom, but most of the time it was used as storage room or, as suggested before, as kitchen. Typically, the people in the so-called 'standard' (RDP) houses that were not equipped with a bathroom, complained about this omission.
- The PEER ECO Home design includes two external doors. Though probably not on purpose, it suggests that the door in the living space is the main entrance. The second door was partly designed to be used for ventilation during cooking. In reality, however, there was hardly a case where the assumed main entrance was used as such. Instead, only the kitchen door has been used – usually open standing. This may be explained by four reasons. First, a door that gives direct access to the heart of the living area is quite a rough solution, where people may feel interfered in their privacy, while the visitor may feel uncomfortable. Second, draught and practical inconvenience (opening door in the middle of living room) may be a problem. The third explanation might be that people wish to keep the entrance out of sight from the street, possibly for reasons of security and privacy. Finally, wind and rain may enter freely from the street depending on the prevailing winds.
- Typically, there were various instances where the garden was very well maintained: beautiful trees in green and well-cut grass, while flowers mark the border of the plot.

It is interesting to think about what the people really want, especially when the ECO-Homes are regarded. They seem to want quality of the 'external skin' and space. All the other aspects, such as internal privacy, water facilities, and toilet inside, are a secondary consideration, and become only interesting when the budget allows for it: priority is shifting towards these aspects with rising income. Ironically, one seems to invest in the garden from a low income level on, even though the theoretician might think that the garden is a third grade consideration. Typically, regardless income level, the people generally do grow food crops. These crops usually cover only a small area of a plot (up to a few m^2s), which indicates the crops are perhaps not so much a necessity, but rather a tradition.[32]

A respondent living in a shanty replied on the question what she likes about formal houses that the construction is solid. And that is all what she wishes, a strong structure that provides comfort.

The people got their ECO-Houses after being qualified for a government subsidy and being fortunate enough to be a part of the pilot study group. The self help program conducted by KCIHT provided an opportunity for them to earn a living while they 'contributed' by sweat equity, and following work shops. This pilot construction process allowed for housing the poorest members of the community in quality housing units. It is a strange perception to see how relatively high standard houses intended for the poor are effectively used by them: they cannot afford to further appropriate the house, even though the material facilities and technical assistance is available. Extension of the house is also limited. Instead, people rely on

shanties as mentioned before. Apart from lack of financial means, this practice also suggests that the impact of awareness building campaigns regarding energy efficiency is less than was hoped.

It seems that the highly secured tenure of households in Kutlwanong (the plots are owned, spacious, and well-fenced) and the relatively good servicing of the area (electricity, water, and toilet drains) encourage the people to invest in their gardens, regardless whether they live in a shanty or formal house. Indeed, not only the formal (PEER ECO-) houses have nice gardens, there were also shanties nicely hidden away behind a prosperous tree or a pergola with deciduous creeper, while crops were cultivated.

Typically, the maintained gardens in Kutlwanong, as the gardens in Alexandra and Orange Farm, contain (rammed) red coloured earth with slaps of sharply edged green grass, in which vegetables and the like are grown.

The furniture in houses typically contain couches, and simple kitchen or garden chairs, and the walls are covered with verses addressing love, god, or the ideal household or hospitality; of which so many are sold in the street and in shops.

People are rather concerned about safety and security. Burglar bars have high priority, and food gardening (e.g. grapes) is preferably out of street sight, said to be because of fear children stealing fruits from the garden.

Almost all shanties in Kutlwanong are built in the far backside of the garden, which does not seem to rhyme with the frequently expressed wish to have a protected garden.[33] The plot regarded however is well defined as the people's property, as the various marking fencing systems suggest. This secure tenureship seems to encourage the people to think on the long term: the shanties are built in the backside, so was commonly said, to anticipate on the construction of a decent (formal) house in future, which would be much more in the front of the plot.

Asked specifically about why people like the PEER ECO Homes so much, particularly as compared to the standard RDP (Grinaker) houses, they mention that for the same price the house has a much higher quality, because of:[34]

- Energy efficiency, thus saving money, and being healthy and comfortable;
- Larger surface;
- Better internal layout; and
- The materials and techniques applied are better.

Yet, the standard RDP houses show leakage, damp walls in the rainy period, poor craftsmanship, while the houses deteriorate visibly within 5 years. The roofs are not insulated thus still allow for thermal shocks, rain noise, and other inconveniences. The surface is smaller, while the number of rooms is also less. The layout is not creatively designed. From the living room people can look straight into the bedrooms, while the PEER ECO Home prototype structures includes a sort of hallway, combined with slightly shifting rooms, thus making it more difficult to look straight into private areas. The additional advantage is that noise transfer may be slightly reduced due to the corners.

On the other hand, also the follow-up of the PEER ECO Housing project shows its shares of problems. Here, one of the first houses that has been constructed by a private contractor, instead of by the community, is considered. The contractor seems to have made it himself easy by rushing the construction, leaving the house with many faults. Windows that can not be put at a fixed position due to missing rails, doors that cannot be closed, poor masonry with as a result that people can look through the joints from one room to the other, broken walls

due to initially faulty positioning, with as consequence that the new walls are not structurally fixed to external walls, cracks in structural parts of the wall such as lintels above doors. This experience shows the necessity of continuous quality control. During the normal KCIHT maintenance and follow-up program the issues described above were corrected by the contractor.[35]

Indeed, craftsmanship and quality of materials applied by private commercial contractors is often poor and the people generally also consider these as such. As a matter of fact, the materials can be taken as an offence to the people's dignity, who are often assumed to accept the imposed technology without criticism, as is thought that they should be happy that at least their circumstances have improved (regardless the marginality of improvement).

Though the complaints regarding the standard (Grinaker) houses are justifiable, it is likely that they tend to be partly aggravated by the people who compare them with the PEER ECO Houses that are built next door. Marginally better standard houses have been built two locations (say four kilometres) further, where people do not know about the PEER ECO Houses, and they tend to be relatively happy. However, these houses are finished just last year, which means that the people there are likely to be still excited about the recent move from a shanty into a 'real' house.

A positive aspect that can be learnt from the Grinaker houses is that they have a backdoor that gives straight access to the shanty and garden on the backside of the house. Observing the effects of outside doors (as discussed earlier on), it is suggested to change the door policy by applying one door on the side of the house (for visitors, while privacy is preserved and the weather cannot freely interfere; and ventilation of kitchen is still possible); and one door on the backside for having straight and private access to the 'back regions' of the house, including the back garden, shanty, toilet, and crops.

7.9 Conclusions

The fact that plots are owned and well defined improves the perception of security. It leads to higher satisfaction level amongst the people regarding their life. The satisfaction is expressed through the time and money people invest for the maintenance of their houses and gardens.

The owner's satisfaction level increases significantly when he has been involved in the design process, where he is able to ventilate his wishes, and to understand why certain aspects are possible or impossible.

Some design issues such as positioning and function of doors, windows, extendibility, and ventilation have been addressed. In chapter 9 these aspects are considered in the perspective of all case studies together, as to propose some recommendations for future design.

The enthusiasm with which 'progressive' projects (addressing community empowerment) usually start is often tempered by the frustrating effect of politics, lack of finance and lack of skilled forces. Indeed, a housing project such as Kutlwanong can be a success, but requires exceptional amounts of persuasion, (individual) sacrifice, inventivity, and vision. The Kutlwanong project provides us with valuable lessons of how things should be done, and how strategies should be designed to increase the chance that 'replications' and scaling-up programmes will be a success.[36] Chapter 8 will elaborate further on these issues that apply for the South African (energy efficient) low cost housing market in general.

The required qualities as mentioned above lead to houses that for the same price can have a higher quality (more comfortable, healthy, spacious, energy saving, durable, suiting to living patterns). The table below summarises the comparison of the studied houses in Kutlwanong and Boikhutsong.

In terms of energy efficiency, the PEER ECO Homes demonstrate to be far more thermally efficient than any other house in the area: no single case of actual space heating has been recorded. It must still be demonstrated however, what happens when it comes to extensions: application of energy efficiency measures in such cases will be the ultimate evidence of the value of awareness raising programmes and the demonstration effects of the present ECO Homes.

It may be questioned whether the range of fuels used is limited and, meanwhile, restricted to alternatives with higher energy efficiency is the function of awareness raising campaigns: perhaps the thermal performance of the PEER ECO Homes is so much better than the other housing alternatives, that just less fuels are needed.

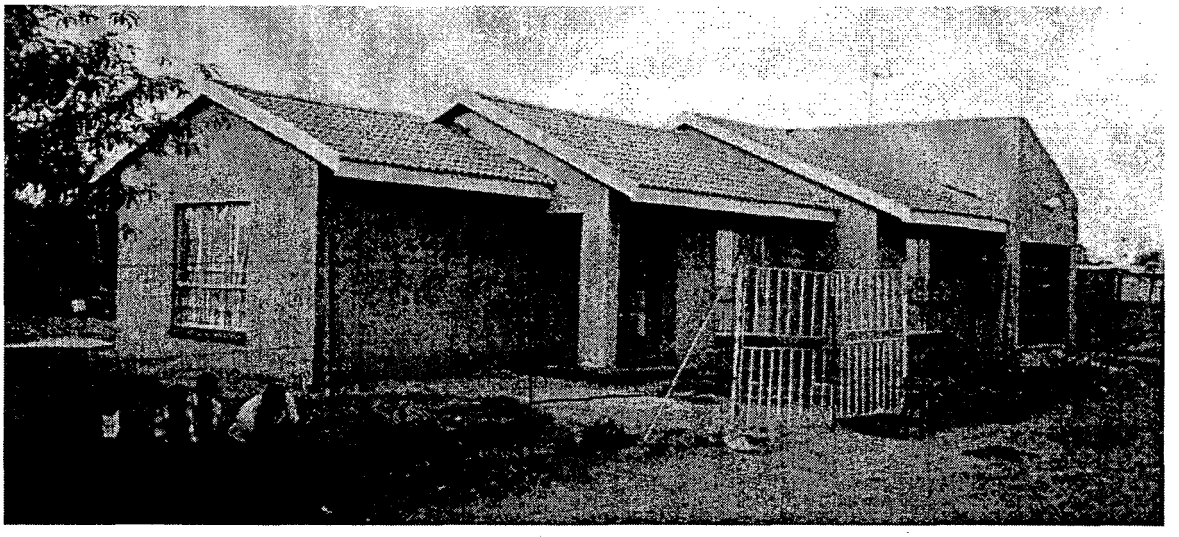
The owners of the PEER ECO Homes seem happy with the functional design, which allows for privacy. The only complaints recorded refer to the position of the doors, the link between kitchen and living area, and the corner for cooking.

As for the materials, some of the people living in the first ECO Homes were rather unhappy about the gypsum board material used for the internal walls, as these showed to be very vulnerable.[37]

The Boikhutsong houses have been reasonably well appreciated by their habitants. Their energy efficiency seems to be higher than the average RDP house as only half of the households seem to use space heating. The Boikhutsong design is also slightly more creative, due to a plan in which spaces are shifted, and allowing for a little more privacy than usual for RDP housing. People do also like the materials, apart from the aluminium folio that serves as an insulating ceiling, but which looks improvisational.

The Grinaker RDP houses represent the type of house, which is being built by thousands through South Africa, but which are considered to be a marginal improvement a compared with the shanty. The space offered is limited, and non creative, allowing for little privacy. The people complain about the poor materials and techniques applied which lead to a degradation of the structure within five years. Walls are soaking and moulding, while the roof is not insulated and thus allowing for thermal fluctuations and rain noise. Though the complaints may be aggravated as the people can compare with the ECO-Houses next door, the failures cannot be underestimated.[38]

The shanty houses, which served as a point of reference in this study, are obviously the poorest standard that can be found. Nevertheless some of the people interviewed seem to be fairly patient with what they have as, at least, they are shaped the way the people thought was best with the means available. Some shanty dwellers would rather wait and live a few years longer in their shanty to get a PEER ECO Home, than to move quickly in a Grinaker standard house.[39] For that reason it is sad that Grinaker is allowed to continue to construct with a permission based on a contract and political reason, rather than that the people's wish is respected. After all, it is their life what the housing is about.



PART IV: ENERGY EFFICIENT LOW COST HOUSING – DISCUSSION AND RECOMMENDATIONS.

8 DISCUSSION

This chapter presents a synthesis of the various aspects discussed in the previous chapters, and aims at giving a picture of the present state of the art of the South African energy efficient low cost housing market, including the prevailing discussions today and suggestions for improvement.

8.1 Introduction

The previous chapters focused mainly on stakeholders, their relationships and, most important of all, energy efficient low cost housing practices. In this chapter the various findings are synthesised in an attempt to distillate the critical factors that should contribute to sustainable energy efficient low cost housing. So far a surprising uniformity of critical factors availed, yet this seems not so apparent to the various stakeholders in the field. Besides, projects differ greatly in nature because of the always varying circumstances from case to case, and the continuous institutional development in the field of low cost housing.

In the next section the case studies are compared on house design and housing process. The subsequent sections discuss various energy related issues that emerged throughout the case studies.[1]

8.2 A qualitative comparison of the case studies

Table 8.1 presents an indicative comparison of the house types studied in terms of general house design, from the perspective of socio-economic and energy point of view. The aspects considered are 'very good' when the overall score for socio-economic and energy considerations is favourable, while they become 'very poor', when at least one of the two factors considered is not appropriate at all. The PEER ECO Homes are on top of all ratings, while the Boikhutsong 'eco' homes, as a 'free rider' copy of the ECO Homes, are not bad either. The Habitat single storey houses perform also pretty well. The plan and materials have been fairly well considered.

Table 8.1: ***Indicative comparison house designs***

	PEER ECO Home	Boikhutsong Stand. 'eco'	Grinaker standard	Habitat 2 storeys	Habitat 1 storey	Semiformal	Shanties Alexandra	Shanties Orange Farm	Shanties Kutwanong
Functionality									
• Functional segregation	+	--	+	+	++	++	--	-	-
• Configuration	++	--	--	++	++	+	--	--	+
• Utilities	0	--	--	0	0	0	--	--	-
• Flexibility	-	+	+	-	-	+	--	+	+
Dimensions									
• Area	+	+	-	+	+	+	--	-	--
Building materials									
• Appropriateness materials	++	-	--	+	0	+	-	-	-
• Appropriateness colours	++	--	--	+	+	+	-	+	-
Physical performance									
• Thermal	++	+	-	-	-	-	--	--	--
• Comfort	++	+	0	+	+	+	--	--	--
• Health	++	+	--	+	0	0	--	--	--
Costs									
• Affordability	+	0	0	+	+	+	+	0	+
Construction technology									
• Quality	++	+	--	0	0	+	--	--	--
• Price/quality	++	0	--	+	+	+	--	-	-

Note: *- - = Very poor; - = Poor; 0; + = Good; ++ = Very good*

The Habitat houses seem to fail when it comes to considerations on the higher level: they do not contribute to the envisaged sustainable development including employment generation.

Much changes for the better, as soon as inhabitants had the freedom in choice of materials, design, involvement, etc.

This becomes apparent when the factors affecting the housing process are considered. See table 8.2. Here, we see that although Habitat aims at a economical sustainable housing process, they will have difficulties to do so, as the projects (per location) are small scale. This fact seems sustained by the other projects that show the mutual dependency of the factors studied. For instance, complex technology does not have to be inappropriate, as long as there are local skills available that can tackle these technologies. Where these are not available, these can be produced through technology transfers.

Table 8.2: ***Indicative comparison housing processes***

	PEER ECO Home	Boikhutsong Stand. 'eco'	Grinaker standard	Habitat 2 storeys	Habitat 1 storey	Semiformal	Shanties
Technology							
• Complexity	++	++	0	+	0	+	--
• Local availability	+/-	-	+	+	+	0/+	++
Human resources							
• Visiting professionals	+	++	+	+	+	+	--
• Local craftsmen	++	--	0	+	+	+	--
• Future owners	+	--	0	+	+	+	++
Information							
• Directly available knowledge	+	--	+	+	+	+	--
• Training in skills	++	--	--	+	+	0	--
• Awareness programmes	++	--	--	--	--	--	--
Organisation							
• Management in local hands	++	--	--	0/+	0/+	++	++
• Technology transfer	++	--	--	+	+	--	--
• Scale of project	++	0	++	0/+	0/+	--	--

-- = Not at all; - = A little; 0 = Indifferent; + = Much; ++ = Very much

The PEER ECO Home project offers a range of buildings technologies such as brick work, carpentry and steel construction work. This project suggests that technology complexity does not have to be a problem for the sustainability of the project, provided that there are sufficient skills, or that skills are developed through solid training programmes.

Through scale and range of materials, the local availability seems to become a less constraining factor. The presence of sufficient alternatives allows for ordering for materials that are temporarily out of stock. A limited scale, in contrast, impedes the sustainability. In such cases (e.g. Habitat) there is neither the finance (working capital) to keep businesses running when demand is low, nor is it likely that the demand will grow through limited awareness programmes amongst the target group.

The Grinaker and Boikhutsong houses are examples of commercial development with virtually no involvement of the target group. These projects may sustain as long as RDP funding lasts, but it is seriously questioned whether the satisfaction level of the target group remains high.

While certain technologies may be basically simple, they become complex when they lead to multiple storey housing. Higher stability and strength requirements demand for higher quality work and products, which are achieved through more expert quality control and craftsmen during production and processing of the materials. This mainly leads to increased project costs. When it comes to social acceptability, the success depends on (previous) demonstration units and awareness raising programmes.

8.3 Housing processes

Community empowerment is seen as a critical factor in the sustainable development context. Yet, despite many experiments, it does not settle easily between the commercial stakeholders who perceive it as a waste of time, while (direct) profits are marginalised. Some argue that the democratisation process in this post apartheid society is going too fast and that the people's spirit is not yet sufficiently matured to capably participate in the decision making process. The aversive attitude towards community development is demonstrated by the small share of 8% of houses that are built up to today through the People's Housing Process.[2] The issue of community participation is a debate that rules all over the world, and it is unlikely it will come to an end soon.[3] In developing South Africa however, where the developer's and poor household's perception of a good house differ greatly, community participation seems so very important, that it may be the ultimate way to obtain affordable and acceptable houses. Success stories as presented in this report have a positive influence on the attitude to the relatively new phenomenon in South Africa, thus making annually grow the share of RDP subsidies used for People's Housing Processes.

Throughout South Africa, KCIHT *et al* (1997) reports, builders are not creative in the approach to building homes in the formerly marginalised communities. They tend to build the cheapest structures that offer high profits. Many of the developers also have a vertical monopoly on the structures they build, either manufacturing all the necessary materials themselves or purchasing them from partner companies. Developers also do seldom enter into consultation with the communities to develop specific housing guidelines and criteria that contain the community vision. In contrast to the typical developer, PEER Africa provided several housing concepts to local engineering firms for development. These designs were then presented to the community and modified by them. The Kutlwanong home was then registered with the municipality and approved by the community. This example is now called the Kutlwanong model and is one of the home designs that has already been accepted and requested by several other historically disadvantaged communities in the Western and Eastern Cape.

Some comment that the success story of Kutlwanong is difficult to replicate. Indeed, when the case of Kutlwanong is studied in detail, it shows why such processes are so difficult to implement: they require a large sense of creativity, effort, and time from each individual. Commercial stakeholders who tend to focus on short term profits are not likely to make these investments, if long term benefits are not secured.

The difficulties that emerge in achieving long term effects of community development is demonstrated by the Habitat projects. For instance, in Orange Farm township, a concrete brick factory has been started, that produces the bricks required for Habitat houses to be built in the township. It was hoped it would create employment and qualitatively better houses. However, the main customers so far are Habitat project participants only. The bricks are paid by Habitat, while the future homeowners pay their units later. What happens if Habitat leaves the stage? Orange Farm is a township far from the epicentre of employment. The unemployment is said to be high (although this survey suggested otherwise), while there are no signs that in time more employment, and thus income, will be generated, as to sustain the housing project and factory business.

Habitat is faced with yet another problem. It builds while "the RDP destructs South Africa", as a Habitat employee said: while RDP provides the people with entirely free to partly subsidised houses, Habitat requires from the people to actively participate, and to take responsibility. It is said that with the prospect (often a dream in vain) of having a free RDP house from the government without the slightest effort, the people are reluctant to become active in self help programmes.

However, RDP is not likely to be abolished soon. The need for adequate housing for the poor is still massive. Moreover, Waterloo and Kutlwanong give evidence that the RDP provides the economy with income generating boasts through sustained job creation in various fields. The latter communities demonstrate that sustainable community empowerment is very possible indeed. Kutlwanong goes even further: the community has taken the initiative and profiles itself as the main stakeholder throughout the design and construction process. It demonstrates that, by electing a commission of competent people, it can generate an innovative process where even commercial stakeholders can generate profits.

One of the main thrusts of People's Housing Processes is the initiation of Housing Support Centres (as the one in the Waterloo project, see appendix C.4). The functions of these centres include technical and general advice and support in planning and funding new housing developments; help and advice in accessing building materials; training in building skills; administration of subsidies and other community services. Start-up funds for such centres are provided by the Department of Housing through the Provincial Housing Boards. Moreover, People's Housing Processes, with their emphasis on a broad spectrum of housing support and community involvement and initiative, tend to produce more spacious houses.

The conclusion is that community participation is essential for acceptability of houses and therefore sustainability of the housing process. This is however a time consuming process, which is considered by the commercial stakeholders to be too costly. It is suggested that the government plays a facilitating and stimulating role to change the views of these stakeholders, and to provide room to develop effective People's Housing Processes that is mutually beneficent for the home owners and the commercial stakeholders.

8.4 Energy and environmental consciousness

While the South African society consumes relatively large amounts of energy, which lead to depletion of resources and generating hazardous emissions, the climate allows for enormous savings. In time the South African research institutes have gained large amounts of knowledge on energy efficiency and environmental conservation in housing. Yet, this knowledge seems to be extremely hard to diffuse amongst the professionals and households.[4] This is curious as the measures in fact combine to a simple checklist for implementation in conventional house design without the requirement of radical technological changes. The measures are covered by 13 basic principles that are easy to materialise through conscious application of conventional technological solutions. While the measures are simple and costing virtually nothing, the long term financial savings are significant and have positive repercussions on health, comfort, economics, and the environment.

Text box 1: Sticking to traditions

A woman was making a fire in her garden, and when it burned well she took the burning wood inside her ECO Home. This she did as to prevent having too much smoke of the starting fire in the house, although the well-burning branches still produced a significant amount of smoke.

The community representatives who promoted and implement energy efficient ECO Homes passed by and wondered why she was doing this: "You know that you can kill yourself with this amount of smoke inside the house?!"

"It's our tradition" the woman replied, "it makes gathering the men." Once inside, the house appeared to converted into a small shebeen (informal bar). Indeed, the men gathered all around the Mbolla (traditional open fire), having their bogala balekhotla (traditional beer). For the woman the Mbolla served as tool to attract her clients, while for the men it was an enjoyable way to gather and socialise.

Awareness building programmes addressing energy efficiency, and subsequent economic, health and comfort implications, are widely acclaimed as the ultimate means to make people aware of the benefits. Also, it is assumed that where cheaper alternatives are offered which, in addition, have positive repercussions on health and comfort, people will step off the traditional tools.[5]

Yet, reality seems slightly more complicated. While the above assumptions certainly are valid till some extent, there are important exceptions, illustrating the value of the people's cultural values, and the rather limited impact of awareness building campaigns. The example in text box 1of the woman that makes a wood fire that she carries in her ECO Home illustrates how a cultural value may persists in a fully electrified community, where people have been submitted to awareness building programmes.

It is a fact that people have difficulties to understand the rather abstract concept of energy efficiency. Often the term does not even exist in the local language, the first tongue that most of the people speak. Awareness raising programmes preceding progressive energy efficient low cost housing projects usually include the meaning of thermal efficiency, and how consumer behaviour should be modified in order to achieve an energy conscious living pattern. The example in text box 2 shows that the meaning is not always grasped. The anecdote exemplifies how unaware people may be about the effects of energy patterns. It also shows that measures which may seem counter-productive, or which reduce the intended effect of other measures, are often merely resulting from unconscious consumer behaviour. The beneficent effects of an energy efficient house are thus very much dependent on consumer behaviour and awareness.

Text box 2: A bewitched house

It was in the middle of the winter. Temperatures dropped very low in Kimberley. A homeowner who just got his energy efficient ECO house that summer came to the project manager:

"I have to move out. My house burns at day", he said, "and at night it is unbearable hot". The manager wondered what was going on.

"Somebody has bewitched it. Somebody must have put something on the house by which it is always hot. I *got* to move!" The manager suggested to have a look. This man appeared to have a typical open wood fire cornered by stones. When he kills the fire before sleeping, the stones remain hot for a long time. And since the ECO house is thermally well-insulated, the heat accumulates in the house, which partly explained the relentless heat inside. So the man was suggested to air his house by a window, or to reduce the fire.

"Oookay, said the man in the typical black South African fashion, "aaalll right...". The manager also noticed that the curtains on the northern facing windows were most of the time open, allowing the low winter sun to have full access to the house, thus heating this up for a great deal.

"If you control solar infiltration by closing the curtains, much of excessive heating can be avoided" the manager explained to the man.
"Oookay" the man said again. And the problem was solved. The house was not bewitched.

At least it seemed that the man understood why his house performed so inappropriate and that its poor performance was the product of natural and human causes, rather than of witchcraft. One may wonder whether the man really did understand this.

When energy efficiency survives these pitfalls, it is rather usual that it strands when, after some years, extensions are built: despite the training people grasp back to the to them familiar construction methods which may be cheap in construction, but which provoke excessive heating regimes during use.

The examples show the complexity of the issue. The possibility whether people accept certain measures depends on a range of socio-economic, cultural and other factors, which should be accepted till certain extend,[6] or respected when overcome. Meanwhile, the effectiveness of implementation depends on the comprehensiveness of the awareness programmes. It seems that training programmes contain omissions leading to instances as described in the text boxes.

Surprising results are achieved by programmes developed at primary schools where children have designed their own houses. These programmes facilitate the childrens' knowledge on housing. Examples are given of children designed their own house and built models of it (Marschall 1998) or even constructed a house on real scale (Thorne 2000). Tests a few years later on demonstrated that little of the knowledge was lost. It is believed that these programmes contribute to the self empowerment of communities who know what they want, and who understand the required quality. This may be particularly relevant for the SA context where the African people have learnt to live with imposed projects which they simply had to swallow without comments.

In summary, three main issues are identified in the process of energy efficiency awareness building programmes. First, cultural factors should be respected. If these cannot be overcome, facilities to accommodate these factors should be built in the design as to reduce their negative effects from energy, health and comfort point of view.

Second, the programme should be comprehensive, including all factors that may contribute to energy efficient housing and behaviour, in order to increase the chance for a successful transfer. These factors include choice of fuels, the effects of fuels, and the control of indoor climate (heating, lighting, ventilation) through the diverse means available (e.g. heat control through ventilation, reducing the heat source, controlling solar penetration; ventilation through mechanic vents, opening windows). House design principles seem technical and irrelevant, but is also important to make people understand the benefits of investments in certain materials and measures while a basis be built in the people's mind for energy conscious house design when the stage of extensions is reached.

Third, the success of both affordable quality housing through self-empowerment and energy consciousness, seems to be enhanced when programmes are developed for schoolchildren, who become conscious and competent clients in future.

8.5 House design

Energy efficiency measures have been reviewed and discussed in the second chapter. Here, more general housing design as observed in practice are discussed, with particular reference to energy efficiency.

8.5.1 Speed, quality, and space

There is a debate on what the end user prioritises in terms of housing: is this space, quality, or urgency? Obviously, the ideal situation would be a combination, but reality shows that this is difficult to achieve.

Eskom seems to focus on the construction of as many energy efficient houses as possible, preferably without too much involvement of the communities. Eskom's housing consultant believes it is more important to build as many (energy efficient) houses as possible while compromising a little on quality, rather than to construct less houses of higher standards, while leaving more people without appropriate shelter. He argues that the process democratisation in South Africa only delays construction processes, because too many incapable people get involved.[7] When asked about it, the target group itself responds in different ways: in Kutlwanong the people rather wait a few more years for a high quality house, than moving into a standard RDP house tomorrow. In Johannesburg, people wait until the houses are built for them, rather than getting involved in the actual building process. This discussion shows that the housing process goes beyond mere housing, and affects sustainable development as a whole.

At a the household level, the process tends to be equally difficult. Awareness building programmes such as the one in Kutlwanong demonstrate however that people tend to prefer to wait 'a few years' longer to get a better and larger house (from PEER Africa), rather than to move in the poor quality and small Grinaker houses that seem to crumble down in a few years time.

Literature suggests that when only quality and space are considered (speed and awareness building not being issues), people tend to go for space, while quality should be restricted to the skin of the house. When the need and money is available in time, they prefer to extend or consolidate the house themselves, rather than to have to live initially in a small and overcrowded place.

Mathews demonstrates in his articles the impacts of various energy efficiency measures, where the installation of (possibly insulated) ceilings have by far the greatest impact. Therefore, it maybe sensible to concentrate on this measure only, while saving on the other measures. This way, the quality of the house can be improved on other issues, which are equally important to obtain an enjoyable and comfortable house. These issues include social security and urban comfort, aspects which have been so much neglected in the Apartheid area, and where township planning have been dominated by imposed designs that were motivated by economics, social destability, and police control.

It can be concluded that through focusing on quantity the enormous backlog in the South African housing market may be reduced faster than when focusing on quality. This policy is generally supported by the people who are willing to wait a little longer once the merits of the affordable quality houses are demonstrated. The quality consists not so much of energy efficiency only, but is a sensible mix of design choices that contribute to the overall quality of the house and urban environment. Where no awareness building programmes have been developed, people rather chose for spacious houses of which only the skin is high quality, while they can arrange the interior to their wishes in time.

8.5.2 Incremental housing

- **Typical incremental shanty housing**

Though there seems to be a great variety amongst the shanties, a closer look reveals that there are many similarities, eventually leading to only a few basic concepts. The 'typical shanty' as described below is therefore likely to cover the majority of shanties found in Kutlwanong and, probably, in the Gauteng.

The smallest shanties consist of a rectangular single room of up to about 15 m^2, with one door and one window in the otherwise entirely corrugated iron sheeting cover. Inside, the floor consists of rammed earth or concrete, while the room is divided by a curtain (hence the "room divider"), to create a sleeping and storage place on the far end from the door, and a cooking and living space on the door side. Since the house is tiny, most activities happen outside, and do people only move in when the weather forces them to do so. Inside it feels damp and dusty, while the smell of paraffin prevails.

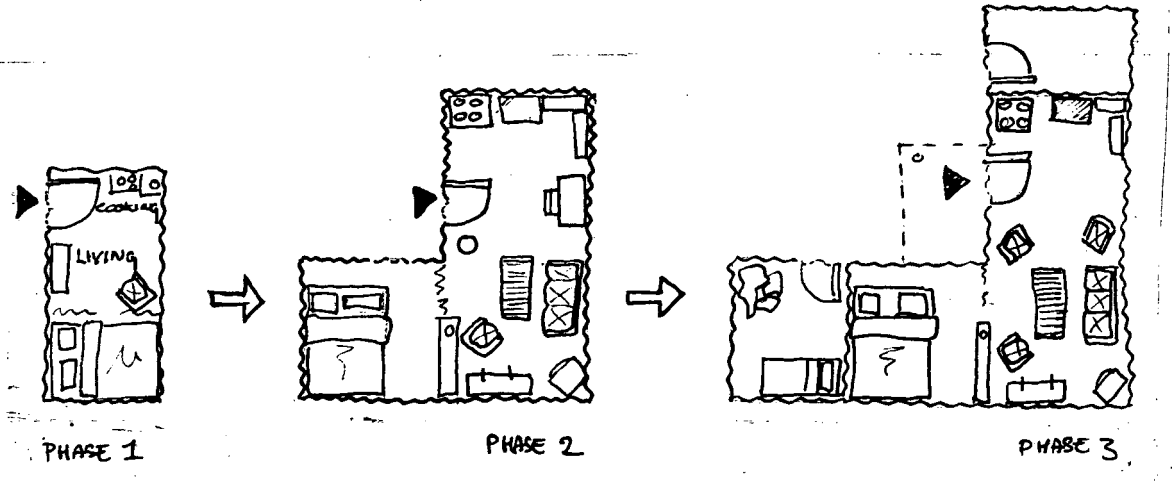


Figure 8.1: ***Incremental growth of a typical shanty.***

The gardens in Kutlwanong are poor but usually well maintained. The plot consists mainly of plain red coloured earth, with bits of well maintained grass. Some shrubs and trees are usually

found, as well as some crops for food. In the back of the garden rubble and a drum or the like to burn waste. In the back is also a lose toilet cabin, while a tap is found on the street side.

Social life is intensive insofar that people communicate all over, from street to house and vice versa. It is therefore typical that the main entrance of the houses are not found on the street side, but nearly always out of sight. Asked about it, a respondent replied that it would otherwise rain into his house. Though a plausible argument – the only place where wind can blow freely into the house is from the street through the empty front garden – another reason may be privacy. Looking at the housing designs by both PEER and Grinaker neither of the two has taken this issue into account as most of the houses have front doors facing the street.

In time the shanty gets overcrowded due to the growing household and the growing amount of furniture. Usually, when money or the materials are available, the shanty will then be extended, eventually leading to a 20-30 m^2 L-shaped shanty, where the front door moves to the extension, the kitchen area closely behind the door. The living area moves also to the extension, while the old shanty will serve as bedroom/storage alone. At this stage, also furniture, mainly cupboards and the like serve as room dividers apart from the curtains. Walls are partly to entirely covered with curtains or cardboard, for reasons of comfort or aesthetics.

There is a fairly close relationship between household size and floor area of the shanties amongst the surveyed shanties. On average, floor surface increases with 3 m^2 per added person, which is very marginal indeed. Assuming that the minimum standard for space per person is ca 10 m^2 in a house starting with a minimum surface of 30 m^2 (cf. Lewis, undated) for up to three people,[8] this means that over-crowdedness in the Kutlwanong shanties already occurs from two people in a shanty. The situation quickly deteriorates with each added person, as the shanties do by no means grow in the same pace as the households. The worst case observed was the 9 people household that lives in a 36 m^2 shanty, which means that there are 2.5 times more people living in that shanty, than would be reasonable from space point of view.[9]

Though people may know the benefits of insulating their shanties, they hardly do so. The argument in Kutlwanong is that it costs money, while they expect to move soon in a real house anyway (regardless the likelihood that that house will be built).[10]

8.5.3 Functional design

- **Hallways**

A smart feature of the PEER Eco Home design that is not apparent on the first sight, is the 'hallway' that links the different rooms. The configuration of the spaces surrounding this hallway is such that privacy is maximised: it is impossible to look from living room straight in any other room, and vice versa. Additionally, though marginally perhaps, noise is slightly absorbed before it reaches from one room the other. Massive walls and absorbing ceilings contribute to a silent atmosphere. The recent Habitat house shows similar features. This is quite a contrast with the Grinaker and Boikhutsong houses observed, where privacy is minimised in favour of seemingly lower construction costs, allowing people to look in every possible corner of the house, while discussions can be also followed from wherever one is in the house.

- **Double storey**

The case of the first generation Habitat houses in Alexandra show the devastating demonstration effect of poor (double storey) housing. All people were unhappy with their functionally poorly designed double storey houses (small rooms, unpractical staircases), while technically things were wrong as well (leaking floor, noise, unfinished top floor walls, etc). Neighbouring residents who saw these houses unanimously responded negatively on the question whether they would like to live in such a house. In contrast, the *All Africa Games*

Village includes some double storey terrace houses, which are technically good quality, and the people seem to be all happy.

People who were not confronted at all with double storey housing seldom seemed to aspire such housing. Arguments ranged from staircases being dangerous to children and unpractical for elder people, lack of extension possibilities; to the idea that double storey houses could provide only small spaces. A very few did aspire such houses, and used opposite arguments: the extension possibility in the height, more room, and so on. Apparently, most of these respondents did not really know what they were talking about.

In conclusion, it seems that much sympathy can be gained for double storey housing by good demonstration projects which work out well from both technical and functional (social) point of view.

- **Living room and kitchen**

The direct link between the living room and kitchen in the ECO Homes have frequently been commented as undesirable. It was often felt as undesirable that visitors can observe the activities in the kitchen area, while smoke disturbs the people relaxing in the living room. Technically, however, the smoke problem can be reduced through the use of smoke barriers, ventilation shafts nearby the sources, or the use of smokeless sources.

Also, it has been felt that the kitchen is relatively too large. People expressed the wish to reduce its surface in favour of a larger surface in the living room. Indeed, in a private design project in Mpumalanga similar complaints were expressed, and when the kitchen was reduced in favour of a larger living room, with a foldable double-door linking the kitchen and living room, the client was happy.

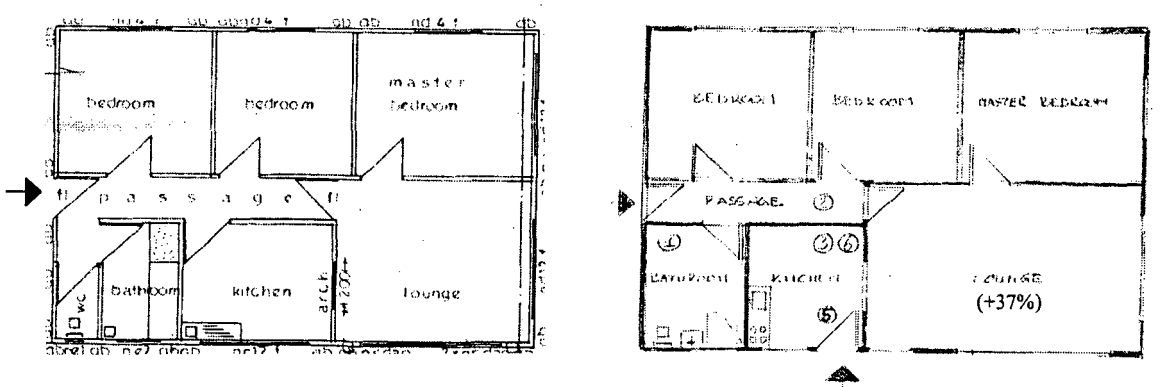


Figure 8.2: ***Design house Mpumalanga (original and altered version).***[11]

- **Extensions**

As suggested before, the effects of awareness building campaigns have been marginal insofar that it has been observed that energy efficiency measures were never part of extensions. People usually rely on the traditional shanty. It proves that despite training in construction cost implications and long term beneficent effects, people do not risk the investment, or, have no facilities. This may indicate that an awareness campaign on itself may not work, but should rather be complemented with facilities such as technical advice and the availability of appropriate materials and skills for affordable prices.

In house design also some facilities accommodating for energy efficient extensions may be included. For instance, like the case of Khayelitsha shows, foundation slabs may be laid out, which indicate the place of future walls. Such 'construction canalising facilities' may stimulate to have a better organised construction process, not only leading to savings of labour and materials, but also to the choice of energy saving materials. After all, when the construction process is planned, people may make more conscious choices in terms of

materials, and then bricks may become a more evident option than, for instance, the rather improvisory iron sheets that are often used when there is no clear plan.

While walls should be structurally strong, parts of it may include joints with weak mortar. For instance, when walls should be broken for future extensions, these walls may have a lintel carrying over a selected part of the wall with weak mortar that can easily be removed – and reused.

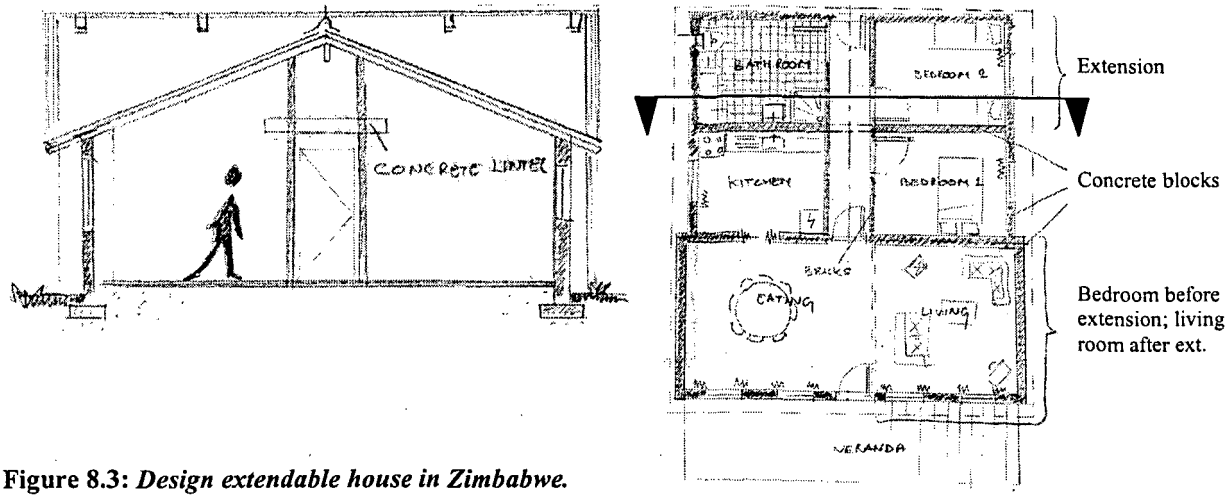


Figure 8.3: ***Design extendable house in Zimbabwe.***

In conclusion, while energy efficiency and health awareness building campaigns may be effective to make people accepting the shifts in housing expenditures, the sense for such issues seem to vanish as soon as extensions are constructed. It is suggested that provisions are devised to canalise future extensions. These provisions may range from elements in the house structure, to public facilities where people can obtain the appropriate materials. If such facilities are available, the owner is more likely to follow the patterns of energy efficiency.

- **Doors**

The survey demonstrated that internal doors have a very low priority indeed. It may be argued that the small size of the houses contribute to the incidental application of internal doors, which are unpractical and space consuming. To create a sense of privacy, people usually use curtains as door.

External doors, however, are evidently important. Their significance is highlighted by the way how people actually use the external doors in formal houses, as compared the way they were intended to. The formal houses of PEER Africa, Grinaker, and the houses in Boikhutsong have two external doors, while most Habitat houses have a single door. The front door is often on street side and gives straight access to the living room (Grinaker and PEER). The back door is on the opposite side (Grinaker), or in the side of the house (PEER Eco houses) accessing the kitchen. It was said that the side door in Eco houses served partly as ventilation.

It the case studies four main factors have been identified that contribute to the way how doors are appreciated and used:

- Exposure to outdoor climate (wind, rain). A door that is not sheltered from rain or wind, which is often the case when it faces the street (usually an open plain), generates draught and allows rain to be blown in. For that reason people prefer the use of doors that are deeper in the wall, or side doors that are protected from wind and rain through shelter offered by shrubs and adjacent buildings.
- Privacy/security relative to street life. Doors on street side allow strangers to peer straight into the living room, which is the heart of the house. Apart from reduced privacy, the people feel that they subsequently become easier victims of burglary: thieves can see

what can be collected, whether somebody is in, and can run easily from the street in the house. For that reason people prefer side or back doors.
- Privacy within house. Where doors give straight access to living rooms people feel interfered in their privacy, while the visitor may feel uncomfortable. Therefore, is was frequently observed that the main access door was any door but the one that gives access to the living room.
- Access to extensions. It has been observed that in some cases the back door is used as the gateway between the house and extension.

Obviously the use of external doors in practice follows from a mix of the above considerations, while house design and orientation also contributes to the eventual household behaviour. It was clear, however, that the front door that gives straight access to the living room is a waste of money and living comfort. The only argument for its existence might be its function as emergency exit for the case of fires. Yet, as the two doors were so close to each other in the case of the PEER houses, this seems useless. Curiously, it was said that the design choice to put an external door in the kitchen of the PEER Eco houses was to enable the people to ventilate excess smoke from cooking. This seemed to contradict with a modest and controlled ventilation regime that should conserve energy while air is sufficiently refreshed.

Properly designed doors lead to reduced waste of money, more living comfort, and even energy efficiency. Following the living patterns, which make every sense, the following is recommended regarding the positioning of external doors:
- Front doors are preferably out of direct sight to enhance privacy and safety
- Doors are preferably sheltered through hangovers, adjacent objects, or positioning deeply in wall, to protect indoor climate from the weather.
- Doors should not give direct access to the living room, as this makes both visitor and inhabiting household feel uncomfortable. Rather, a hallway should be considered, or a space where privacy seems less important (e.g. kitchen).
- A second door on the back side seems highly recommendable as it allows for an easy link with extensions, without breaking away elements of the original house.

- **Windows and curtains**

Windows are an important point on the energy efficiency checklist, as they have a high heat transmission factor, while the need for artificial lighting is reduced (also a point in terms of comfort). The way how windows are used, however, seem to be counter productive: the inhabitants tend to close curtains twenty-four hours a day, even in the living room. Asked why a respondent summarised the general motives as "People don't have to know whether I am in, what I am doing, or what I have". Curtains are thus mainly used for privacy and security reasons, which seems particularly true for the crime stricken Johannesburg area.

A properly used curtain serves however multiple purposes. Closed curtains at night time help to conserve the heat at cold winter nights, while glare is reduced during (winter) days when the sun is low, and overheating of the house is reduced at hot days.

The problem is that curtains lead to a rather dichromatic use: either it is closed, or it is open, and seldom can be benefited from all the functions a curtain should serve. In Kimberley the use of jalousies, which is semitransparent, is more common, and seems to be a good compromise between energy efficiency, natural lighting, and social safety. The use of jalousies may therefore be considered as part of the awareness building programme, where also attention should be paid on the use of it.

- **Ventilation**

Ventilation is critical in energy efficient housing, as it is heavily interconnected with energy efficiency, health and comfort aspects. Yet, it seems that this aspect does not receive sufficient attention in the field of energy efficient low cost housing. No ventilation means a

poor indoor climate as hazardous emissions from fossil fuel combustion cannot escape, while waste air cannot be exchanged for fresh air, both ultimately leading to respiratory diseases. Additionally, no ventilation provokes high humidity levels, ultimately leading to deterioration (moulding) of housing structures, lower thermal efficiencies, and to humidity related diseases (e.g. rheumatics). Still, ventilation measures are cheap, simple and highly effective; but as the people are not familiar with them these measures are seldom integrated in the house design.

Says a DAG SEED Adviser: "Energy efficient housing may lead to reduction of energy requirements, but many problems remain when ventilation is omitted." Part of the issue seems to be the people's misperception of the negative repercussions of ventilation through means such as air bricks.[12] These are sometimes believed to allow for incoming rain, noise, dust, and cold air in winter. As a consequence it is frequently observed that such bricks are stuffed with waste paper or other materials. Yet, through improved house design and product technology ventilation bricks hardly allow anymore for most of these inconveniences today, and are they limited to the most necessary ventilation. On the other hand, dwellers open windows only when they come home and then only when it is hot. As a consequence, houses are generally insufficiently ventilated.

This is not to say that dwellers are completely ignorant about ventilation. Despite the available knowledge on ventilation conscious house design, many low cost houses have been criticised by the dwellers on poor ventilation performance. This concern has been registered in most standard formal low cost houses that do not have a facility for gradual ventilation that in the same time allows for protection against burglary.

It is therefore a point to not only put ventilation regimes within households on a central place in awareness building campaigns, but it should also be a point of concern for the developers, including the architects. The SEED adviser believes that the required additional effort of the conscious household living in a well-ventilated house does not lead to "a feeling of being fed up with all these adjustments in daily activities for a healthier life". Rather, once the people are accustomed to the change in their life style as promoted by awareness building campaigns, they would not even think about adjustments as such anymore.

Windows than can be opened may be useful when vast quantities of air changes are required (e.g. during cooking when vapour and smoke is generated, after a bath, or when a space is overcrowded), but safety in such cases has to be preserved through burglar bars, which are often absent. Though all the time a certain minimum ventilation is required for refreshing air and removing used air, smoke, and moist, much less is needed for the other spaces (such as living rooms, storage, and normally occupied bed rooms) that also benefit from air changes in other rooms if 'ventilation routes' are well designed.[13,14] Save, cheap, and discrete measures that are sufficient for such rooms are ventilation bricks (or 'air bricks') that, if well designed, do not allow for noise, rain, humidity, rats and insects, while ventilation is preserved.

More advanced ventilation grills allow for manual regulation of air change capacity, while safety and comfort is entirely secured, but which require the user's awareness how and why to handle such vent, while it may be more expensive.

It is therefore suggested for low cost houses that each room has both openable windows and air bricks, so that the window can remain closed when the user desires, while a continuous minimum ventilation is preserved through air bricks.

- **Roofs**

The most common roof types vary from double pitched, through mono pitched to flat roofs. The eventual choice depends on taste, finance, and the consideration of energy aspects. While a flat roof is cheapest, it hardly stimulates a dynamic internal air circulation, and is not much aspired because of its simplicity. A double pitched roof, in contrast, does stimulate a dynamic

airflow, but the pitched structure may require a supporting framework, while additional costs are made through the extra brickwork required to fill the gap under the triangle of the roof. A sufficient middle way is the single pitched roof, but the eventual choice has to be made from case to case.

8.5.4 Materials and techniques

A sensible choices of materials and techniques is a prerequisite throughout any construction project, regardless the economic background of the users: people tend to waste their capitalised assets if it does not suit their needs or aspirations. This is a human reaction regardless the socio-economic status, but the impact is more dramatic when it comes to low income households. In addition, because of lack of understanding of the developer for the poor man's needs and aspirations on the one hand and, on the other hand, the lack of appreciation by the poor of long term effects and possibilities, wrong choices are easily made in low cost housing processes. It is therefore critical that both developer and future owner are consulting each other on the possibilities and desirability of materials and techniques.[15]

The choice of materials follows from price, imago, physical performance, delivery time, and ethics. Below an outline is given of some relevant points of consideration when it comes to the appropriate choice of materials, typically important for low cost housing.[16]

- **Price**

The price of materials is hardly fixed, as it follows from a range of factors, such as negotiation skills, scale of project, delivery distance and speed. A serious option of consideration is the fabrication of materials on site, i.e. by the people themselves, as to save labour and transport costs. Concrete products (e.g. hollow concrete blocks – Habitat) seem particular popular for this option.

Besides material cost, the labour cost to integrate the material in the building varies as well. Time and skill required are the predominant factors determining labour price. It is often observed that where specialisation is low, the people take over the job themselves as to save on the labour costs. A common example is the installation of insulated ceilings (e.g. Kutlwanong).

Inventive design also can reduce costs. For instance, prices of the present houses can still be improved when concrete slabs in the design would be replaced by concrete beams. The foundation would remain fairly effective. In worst case, only minor cracks might occur in the structure which are easily repaired and which, once the foundation has set, do not occur again. People may complain about poor structures referring to such minor failures, as was the case in Kutlwanong, but it should be remembered that people will always tend to complain. As far as complaints are concerned, there will never exist a perfect house.

- **Delivery time**

Some materials may have unreliable or long delivery times. In such cases the delivery may be anticipated through adjusting the stock on a worst case scenario. If even this becomes an unrealistic option (e.g. cost of stock raising to much), alternative materials may have to be resorted to. The case of Kutlwanong showed that despite the popularity of the brick, some internal walls have been raised with an iron framework. Such a structure was there more expensive but the delivery was fast and reliable.

- **Physical performance**

Physical characteristics imply amongst others thermo and hydro characteristics which in turn determine thermal capacity, waterproofing, health and comfort.

Iron sheeting is in the energy efficient housing sector for the obvious reasons considered as the utmost inappropriate material to be used for roofs and external walls. Yet, in many areas

people insist on corrugated iron sheeting which they see as a symbol of modernity for an affordable price. Where workshops and demonstrations failed to bring the people on other thoughts, solutions have been designed that provide a compromise of what the people aspire and what is thermally recommended. For instance, in energy efficient low cost houses roofs of iron sheeting have been applied with insulated ceilings underneath.

- **Structural performance**

When structures are so cheap as is the case in low cost housing, structural performance (strength, flexibility, durability) becomes a critical issue as safety and durability is at stake. Structural brick walls have been observed to have joints that were so weak that the mortar could be scratched out (Orange Farm – Habitat). Besides price, also ignorance may be critical to proper housing. Strong winds that occur in South Africa in general, and in the Cape in particular, has blown away the roofs of houses where the roof structure was not anchored to the main structure. By simple wiring the beams to the walls the incidents would have been avoided.

Also the gradual extension and modification of houses can seriously affect the structural performance. People may break open a wall which has a structural function (e.g. carrying the roof), thus putting their safety at risk. For that reason not only a flexible design is required, but also materials that further facilitate such extensions. Lintels built in walls are helpful to make safe breakthroughs in future. Weak joints (high sand cement ratio) on the regarded places may be another solution, that meanwhile allows for reutilization of the old materials.

- **Aesthetics**

Aesthetics are mainly determined by imago and status. Materials can be highly popular in one area, while being rejected in others. The ultimate example is perhaps thatch roofing. In Alexandra and Orange Farm, thatch roof was regarded as a symbol of rural poverty, which is considered similar to backwardness. In Kutlwanong, however, it seems to be highly respected, but is it either unaffordable, or nobody masters the skill of thatching, or the reed does not grow. In other words, the imago of the selected materials have to be assessed. If such material is initially rejected, but does it have beneficent qualities (e.g. thermal efficiency, cost, etc), then an attempt should be made to make it acceptable through workshops, demonstration houses, etc.

- **Ethics**

Asbestos has proved to be harmful to human beings to the extent that its particles cause lung cancer. Most of these asbestos particles are released when mining the raw material, when the sheets are being cut to the right format without precautions, and when untreated products crumbles with age.

Despite this knowledge cases have been recorded in this research where the sheeting has been applied because its is cheaper and thermally better than iron sheeting, while its image is similar. This ethical wrongdoing is sometimes countered by the argument that presently people die from Aids before they can suffer from cancer.[17,18]

Clearly, this argument is disputable as this generalisation does reduce the chance for a healthier life for those who do not suffer from Aids. Not to speak about the miner's health. Possible developments in the fight against Aids are not considered either.

If the use of Asbestos is insisted on, then at least he following precautions should be considered in the housing sector:

- Paint the sheeting with a coating that protects Asbestos from age and climate related deterioration.
- Design the sheeting in such manner that it is kept beyond reach of children who may try to break it.

9 CONCLUSIONS AND RECOMMENDATIONS

This chapter resumes the findings in this report, ultimately leading to recommendations focusing around issues that simultaneously affect energy efficiency and socio-economic and cultural appropriateness of low cost house design and low cost housing processes. These findings are however only a selection of a literature research and field work that go beyond the defined scope of energy efficient low cost housing. The reader is suggested to scan through the appendixes in the separate volume to get a much more comprehensive image of the South African low cost housing practice.

9.1 Introduction

The findings presented here tend to be diverse, but are focused on those issues, which are either the result of field work, or based on data that have not been explicitly highlighted comprehensively in literature before. The issues relate to optimisation of energy efficient low cost housing and housing processes, while simultaneously the socio-economically and cultural appropriateness is considered. Some findings may seem obvious but when it comes to reality, the suggestions appear to be rarely applied, resulting into various kinds of problems in the low cost housing scene.[1]

9.2 Energy efficiency measures

Literature research reveals that passive energy efficiency measures for ultra-low to middle income housing are covered by 13 basic principles of passive energy efficiency measures (see table 9.1). The exact specifications and impact of these measures depend on the regarded climate, house type (quality, size, shape), materials used and consumer's behaviour, and should be calculated through simulation or actual monitoring programmes.

Table 9.1: ***Overview passive energy efficiency measures for low cost housing***

Category	Measure	Physical effect	Benefits (Other than energy/ financial savings)
1) Urban	• Distance between buildings	Optimising solar penetration	Thermal comfort
	• Orientation buildings	Optimising air flow	
	• Topography	Optimising solar penetration + optimising air flow	Energy saving, thermal comfort.
2) Vegetation	• Trees	Filtering summer light, blocks wind	Less overheating (thermal comfort), less glare, less excessive cooling
	• Shrubs		
	• Grass	Absorption reflecting sunlight	
3) Orientation	• Main axis plan East-West	Optimising solar benefits	Thermal comfort, less glare
4) Layout	• Living room north	Optimising solar heat and lighting patterns	Light and warmth during day with reduced glare
	• Kitchen west		Light in evening
	• Bedroom East		Light and warmth in morning
	• Toilet south		No heat, improving hygiene
5) Building form	• Reduced surface/volume ratio	Less thermal losses	Thermal comfort

	• Double storey • (semi-) terrace housing		
6) Window orientation + sizing	• Proper sizing and orientation	Solar heat and light penetration maximised	Thermal comfort, natural lighting
7) Ceiling	• Initial insulation	Preservation warmth/coolness	Thermal comfort, stops dust, fire proofing, etc
8) Insulation	• Insulated ceiling • Insulated walls	Preservation warmth/coolness	Thermal comfort
9) Thermal mass	• Dense and heavy materials	Slowing down/killing temperature shocks	Thermal comfort
10) Ventilation	• Sloped ceiling	Increased airflow	Fresh air, lower smoke and humidity levels evt. Leading to better comfort and health, and less moulding of materials
	• Air bricks • Openable windows • Mech. vent shafts	(Semi-) controlled airflow	
	• Chimneys	Drain smoke	
11) Overhang	• Overhang over open (window) areas where otherwise summer sun enters	Prevention penetration summer sun	Less glare, less overheating (thermal comfort)
12) Colours	• Roof light coloured	Reflection sunlight	Less overheating (thermal comfort)
	• External walls dark	Absorption sunlight	
	• Ceiling light • Internal walls light • Floor	Reflection and diffusing daylight into room	Better natural lighting
13) Weather sealing + stripping	• Plastic under floor	Stops penetration humidity	Better thermal qualities building materials; no moulding; no schimmel
	• sealing joints	Stops uncontrolled airflow	Comfort (less draft), energy saving (less loss)

Presently, quantitative data on saving capacities of these measures (both in terms of percentages and in terms of financial savings) is sparse and contradictory. The impact of energy efficiency measures are interrelated and differ with housing typology and climate. By far the greatest energy savings are however made with ceilings, which can lead to ca 75% to 90% savings amongst ultra low cost houses. The payback period for such investments are estimated to be 7 years on average in regions where cold nights occur.

9.3 Design principles

- General house design

Houses should be designed in co-operation with the future owners. Houses are preferably designed in 'modules', allowing for incremental housing, so that people can mutate their houses whenever need, money and time is there. Facilitating design features may include foundations canalising future extensions, and 'flexible' joints to break out walls to create space.

A generally suitable basic design for a functional house includes:

- Two bedrooms
- One living room (spacious)
- One kitchen (preferably separated)
- One bathroom or storage

The minimum acceptable house is around 30 m^2 for up to three people, after which a house is recommended to grow in pace with 10 m^2 per added person.

- **Doors and walls**

Factors affecting the choice whether a door is needed, and where it should be placed are privacy, security, space, and climate. Internal doors have low priority and are often omitted, particularly when spaces are small. The main reason for their use is privacy, and the need for them can be reduced by designing smart hallways that reduce the possibility of straight view lines from one room to the other.

There is a tendency to split a house into function specific spaces, ultimately leading to houses having multiple rooms.

External doors are preferably sheltered from climate (wind, rain), and out of direct sight from the street. If two doors are applied (which is a good option for fire escape procedures), the second door is preferably far from the first door (e.g. on backside), so that it may function as future gateway to extensions and to serve as a fire escape.

- **Roofs**

Major factors determining the shape of the roof in low cost housing are: finance, ease of construction, ventilation, and aesthetics. A flat roof is economic in terms of materials and easy to construct, but does not enhance internal airflow, and it is often felt to be aesthetically unattractive. A pitched roof, on the contrary, is usually considered fancy, while it enhances internal airflow, but it requires more skill and time to construct, as well as more material (both for walls and roof surface). When a pitched roof is tilted in the right angle and direction, it may also serve as basis for solar panels.

- **Ventilation**

Although the importance of ventilation is generally acknowledged to be critical for a healthy and energy efficient dwelling, ventilation techniques in low cost housing are not widely used yet, which is partly the consequence of the people's poor understanding of the merits, and partly because of the lack of attention that ventilation receives from developers. Improvements on this matter are:

- Making the ventilation issue part of awareness building programmes for both dwellers and developers (architects).
- Introducing multiple ventilation solutions, such as sloped ceilings, air bricks, and windows that can be opened.

- **Selection of materials**

The selection of materials depend on a multitude of factors. Particular relevant for low cost housing are the following factors:

- Price
- Delivery time
- Physical and structural performance
- Aesthetics/people's perception
- Ethics

Earth technology and thatching are two very appropriate materials because of the low costs involved, the comfort that can be achieved with them, and potential for employment generation. They are, however, professionally underdeveloped while the (urban) mass in South Africa tend to have a negative perception of these otherwise highly potential construction alternatives. Research on the possibilities of development of these technologies in South African context is recommended.

9.4 Suggestions for a project strategy

There are various very clear suggestions developers should follow in order to increase the sustainability of a low cost housing project.

The *target group* and the associated constraints should be known: household income distribution, age distribution, household sizes, types and levels of employment, as well as the back ground of the people (rural/urban, etc). The characteristics of the target group defines the needs, perceptions, wishes, and associated constraints/potentials that may be faced during a low cost housing project.

The *objective* of the project should be well defined. In the context of this research the objective is: sustainable low cost housing. This includes aspects as affordability, environmentally soundness, employment generation, a continuing housing process, appropriate house design (in terms of functional use and selected materials). The objective implies that potential materials that otherwise are unusual in the South African low cost housing sector may be introduced. It offers foreign companies the opportunity to introduce their products on the South African market.

Demonstration units prove time and over again to be critical to convince dwellers about the merits of a certain housing type and materials used. Often these are found to serve as office building or a public function, to allow as many people in and around the building as possible. These units should be well designed and built however, as any failure may lead to total rejection of the regarded type of product by the target group.

Community participation, or rather *community empowerment*, is critical to stimulate an active attitude from the participants, to make certain solutions acceptable (e.g. choice of materials, design), and to create a basis for process continuation after the developer's departure.

Awareness building programmes are very important to demonstrate the sense of certain choices, and to change life styles. These programmes can be combined with demonstration units, which are often an integral part of the campaigns. Here, it must be noted though that few awareness programmes are comprehensive yet (e.g. adequate explanation of ventilation is usually lacking, as well as the benefits of budget saving and planning), resulting into a marginal effect. More research and development of this issue is therefore recommended.

Anticipation on *incremental house design* is not yet as usual in progressive housing projects as may be expected. It is critical though to design an appropriate house for the household at the time the project is going on, and which allows the house to adjust smoothly, and at lowest cost possible, to changes that occur in household structure in time.

Options offered as opposed to imposed design have a tremendously beneficent effect on the success of a project. Do people want to build their houses themselves to save money, or do they have no time to do the job themselves? What is the range of materials the people can choose from, and do the alternatives meet the wishes of the people?

Newcomers on the (South African) low cost housing market are often unaware of the fact that the target group may be poor, but that its wishes and aspirations are, basically, not much different from the newcomer, who usually has a western and 'rich' background. Therefore, it is important to realise the following throughout the process:

- 'The poor are not different': they want to be involved in the design and construction process, they want to have the feeling they can make their own choices, which is after all the basis for pride and self-consciousness. However, denial of this fact has a more dramatic impact on the poor man's life. While the rich live in a comfortable margin of making the choice between 'good' and 'better' housing, do the poor because of severely limited financial means, quickly changing households, and developers that seldom appreciate their needs and wishes, have to chose from a very limited range of options within a small range of housing. Hence, a faulty alternative can lead to comparatively large constraints on a good living. In conclusion, it is perhaps more important to co-

operate with customers in housing processes when it concerns poor communities, then when it comes to richer communities.

- On the other hand, listening to the people's wishes, and appreciating their needs requires some skills as well: people always tend to complain, regardless the quality of the product. The complaints may increase through means of comparison, particularly the demonstration of alternatives which are perceived to be better. Here, it is of utmost importance to demystify the origins of the people's complaints, and often the people's attitude towards products can be altered into a more favourable one through awareness raising and demonstrations.
- While some products do seem to match the discussed requirements to achieve appropriate and sustainable housing, they still risk to be rejected. This happens, for instance, when it comes to industrially developed products that are cheap, but that are insulting to the people, as these products seem to be rejected by the rich. So, the dwellers argue, why would the poor get it if it is not good enough to the rich? Such products may be presented by the developer in a way that can be interpreted as imposing.

9.5 Awareness building programmes

Three main issues are identified in the process of energy efficiency awareness building programmes. First, social and cultural factors should be respected if these have to be overcome. These factors include, for instance, the meaning of fire, or the reason why curtains are closed 24 hours a day. If such factors cannot be overcome, facilities accommodating these factors should be built in the design as to reduce their negative effects on energy consumption, health and comfort.

Second, the programme should be comprehensive, including all factors that may contribute to energy efficient housing and behaviour. These factors include choice of fuels, the effects of fuels, and the control of indoor climate (heating, lighting, ventilation) through the diverse means available (e.g. heat control through ventilation, reducing the heat source, benefit from thermal accumulation effects, or controlling solar penetration; ventilation through mechanic vents or opening windows). House design principles seem technical and irrelevant, but is also important to make people understanding the benefits of investments in certain materials and measures, while a basis be built in the people's mind for energy conscious house design when the stage of extensions is reached.

Third, the success of both affordable quality housing through self-empowerment and energy consciousness, seems to be enhanced when programmes are developed for schoolchildren, who become conscious and competent clients in future.

For a proper understanding of the constraining factors, and to develop an effective awareness building campaign, the issues should be put into perspective of the people's background (vz. culture, education level, rural, urban, migratory people, etc). Development and implementation of programmes addressing the above issues is critical in the contribution to sustainable development of energy efficient low cost housing.

When it comes to energy efficient low cost housing design, developers should be informed as well. Surprising few professionals are familiar with the basic and rather simple energy efficiency design measures. Therefore, it is suggested to design a diffusion programme as to inform the developers on the potentials of energy efficient low cost housing.

9.6 Housing processes

When the objective is to achieve *sustainable mass low cost housing*, the People's Housing Process seems to be by far most fruitful. The starting procedure may be slow, and the initial output small, but when the process is on its way it offers scope for mass delivery on the long term, with all kind of positive repercussions, such as employment generation, environmental

conservation, as well as economic savings, and ultimately leading to general upliftment of the people's living standard and economic growth.

Critical issues in such housing processes are:
- Involvement of the people in decision making and execution
- Appreciation for what they can do themselves and what they can be trained in to do themselves
- Affordable solutions and payment schemes

Low prices can be achieved through:
- Purchasing materials in bulk and making long term commitments
- Negotiation on fixed prices (e.g. clearing and servicing site by municipality) of materials and transport
- Delegating jobs to the homeowners.

9.7 Opportunities for newcomers[2]

Though energy efficiency is part of the national policy, and while it is getting more attention every day, there is still much work to do. Evidence are the many requests for details from organisations who either never thought about the possibilities, and those who are willing to include energy efficiency, but who do not know how to do so. Moreover, organisations exist that never thought of the opportunity to apply energy efficient measures. The demand for energy efficient housing overwhelms the building supply capacity. The enormous gap in the market thus created invites organisations specialised in energy efficiency to try their luck. Their chances for success seem to be reasonable, as national policy stimulates prioritising energy efficiency in housing project selection procedures (e.g. in application procedures for RDP subsidies). While the demand for housing is far greater than supply, the present traditional stakeholders do not seem to respond as desired since, due to under-capacity, they do have a sort of a monopoly. This position does also not allow for much information diffusion on energy efficiency.

The research on the relationship between socio-economic and cultural aspects and energy efficiency measures in the South African low income housing market may be a start of the exploration of a field that so far has received little attention. A multidisciplinary approach to technical projects may be extended by more focus on the socio-economic and cultural aspects of energy consumption in the developing context, thus creating the actor a unique position on the market. He may anticipate on designs that are likely to fail due to deficiencies on socio-economic and cultural aspects, by involving the people right from the investigation and design stage. This 'bottom-up' approach seems to have great support amongst the fieldworkers who feel that the people are a key factor in the effective reduction of energy efficiency and increasing the satisfaction level of related houses.

The huge low cost housing market may appear to be a false potential, as low cost housing requires expertise on how to implement affordable technology at minimal costs, thus allowing little benefit on the short term for commercial companies.

Though national policy may be neatly lined out, the governmental practice still suffers from deficiencies such as corruption and power games, by which delays occur before approvals are signed, thus risking funding vanishing away, eventually margining initially beneficent projects. In addition, regarding the thermal performance of energy efficient housing, much legislation has yet to be enforced. Till that time, the energy efficient (low cost) housing market remains in a rather experimental stage, which reduces the chance for a sustainable follow up.

Heavy competition from other research institutes that are ways ahead regarding research on energy efficiency in South African housing may also be a serious threat to newcomers on the market to contribute to energy research in South Africa. Also, NGOs and other organisations providing key service, thus draining potential off the competitors. As said, however, the demand exceeds the supply.

In summary, major opportunities for newcomer research and development organisations are:

- Monitoring programmes, mapping the thermal performance of the various types of houses, including GHG emissions;
- Design, develop and implement awareness building programmes, both on actual sites and amongst children on schools, as well as amongst developers;
- Consultancy on energy efficiency measures in various (self-help) housing projects;
- The introduction of new building materials and technologies; and
- Research on green financing schemes.

Severe competition may be expected on the most obvious key programmes but, again, much of it is mitigated by the demand that exceeds the building supply capacity. The opportunities for the ECN in specific are elaborated on in appendix D.2.

ENDNOTES

CHAPTER 1

1. A detailed research proposal is presented in Appendix A.
2. In Appendix H an overview is presented of the possible limitations of interpretation of these data.

CHAPTER 2

1. Discrependencies in data are the consequence of shifting attention in various researches that address the housing backlog in South Africa. Some statistics distinguish formal from informal housing, others high-income housing from low-income housing (e.g. Scholand 1997), others again exclude the former homeland areas (e.g. De Vos 1989) and, also, sometimes distinction is made between adequate and non-adequate shelter (e.g. UF 1990). In addition time spans vary per study. Furthermore, data in this section includes the dynamic stock of houses required in time due to population growth and continuing poverty, which accounts for half of the annually required houses (Scholand 1997, Thorne 1995).
2. See, amongst others, ECN *et al.* (1998).
3. These are but a few factors contributing to the relatively high South African electricity consumption, compared to the Dutch households: other factors affecting the pattern are, amongst others, energy efficiency appliances, thermal efficiency housing, energy awareness, life style, fuel resources used, and so on.
4. It may be questioned whether the energy patterns which differ distinctively per race, are really be a function of race. It may be argued that these differences are purely socio-economic, but that the former South African policy did not allow the 'non-whites' to achieve similar standards, thus leading to a possible misleading perception that the choice of resources are race dependent. While from practical point of view it was correct to reason like this till 1994, racial segregation in terms of energy resources opted for are clearly blurring since that historical year.
5. Aggregated data as provided by, for instance, Hoffmeyer (1994), Moller (1985) and Uken and Sinclair (1991) (see also Thorne 1995: 60) are therefore useless for analysis on household level.
6. Like the figure headings already suggest, 'main' source does not automatically mean 'the only' source. In contrary, often sources are multifunctional (Leach and Gowen 1987), i.e. they may mainly serve a particular purpose (cooking, heating or lighting), but may also contribute to other purposes.
7. Candles and paraffin in electrified households are mainly used as substitute when there is a power cut.
8. Unfortunately, the web site where the data are obtained from did not contain such data on space heating.
9. From the two series of tables can be calculated that just over half of the total black South African population (53%) still lives in rural areas, while 47% lives in urban areas.
10. Electricity usage is not as efficient as it seems here since, from a life cycle perspective, electricity production involves roughly 70% loss of primary energy (Scholand 1997).
11. Note that the bars demonstrate how many households of the electrified and non-electrified categories actually use the various fuels. The graph does not illustrate quantities consumed.
12. This is a dynamic seasonal process which cannot be observed in the fieldwork of this research, as households are only visited one day. The only way to find out is to directly enquire the household about changes in patterns during the year.
13. As is previously demonstrated, however, clear shifts in resource use occur when the data are segregated to income level, region, etc.
14. In Bulawayo, Zimbabwe, is observed that the first thing people in locasi (Zimbabwean townships) do when they wake up, is sitting in the sun to recover from the night's cold. Kutlwanong et al (1997) report similar patterns in Kutlwanong.
15. Based on: DEAT et al (1998), IIEC (1997), Eskom et al (1997), Holm and Viljoen, Thorne (1995:44-7), unless stated otherwise.
16. Unfortunately, literature is full of contradictions, as is highlighted in Appendix H B.1.
17. The economic use of land should not be lost out of sight. Mills and Armstrong (1993) give a calculation of that when all low cost housing projects are built with houses absorbing only 10% of the plot, eventually an area of 15 times the surface of Soweto, the largest township of South Africa, would be needed.
18. In the Netherlands norms are presently being developed that include the urban environment in suggestions of energy efficient house design. So, eventually, a environmentally sensitive

integration of house and urban design in order to achieve maximum energy savings will become normal practice.

19. On the Southern hemisphere the sun rises in the east, reaches its zenith in the north, and sets in the west.
20. For exact ratios per climatic region, see Holm (1996).
21. However, "Measures such as double-glazing lie far outside the scope of this [AIJ] project" (Unidentified author 1997).
22. E.g. the passive solar system 'Trombe wall'. This system may be too expensive or sophisticated for low cost housing though.
23. A distinction has to be made between short wave radiation (i.e. solar radiation) and long wave radiation (e.g. radiation from the direct environment). Surface and colour usually do not matter for long wave radiation, but they do matter for short wave radiation. In addition, mass is particularly relevant in summer, while in winter it is not really useful (Bakker, or. emph.).
24. Roofs are especially subject to energy transfers, as they are directly intermediating with the sky: at daytime sun in shining on it, turning the house into an oven, while at night the sky draws all energy out of the house through the roof.
25. While the absolute monetary difference between these savings may be small, proportionate to related income levels the difference is big. The saving of R66 for a R800 income group is as much as 8.3% of the (limited) income, thus bringing down the share of heating requirements on total expenditures from 14.5% to 6.2%. A R54 saving for a R3,500 income group reduces the share of expenditures on energy requirements with a mere 1.5%, from 1.8% down to 0.3%.
26. Obviously, comfort is determined not determined by just temperature, but is the result of a combination of air and radiation temperature, air flow, and humidity, amongst others.
27. Indeed, the shape is designed to reduce heat losses. It is however by far from optimal to capturing solar radiation heat. The gross effect of heat gain should thus be studied when the circular shape is considered.

CHAPTER 3

1. The NWR is involved is this kind of projects. Inform for their publication that provides an overview.
2. The *People's Housing Process* is a definition by the South African Government, and is an attempt to address the lowest income groups. It refers to home construction projects where communities are involved to take the initiative to organise, design, and build their own homes. See also Napier and Meikljohn (1997: 22).
3. Even though letters of appointment may be signed on the project preparation phase, these should still be specific enough to tie the individual consultant to the particular body of work that he or she is being employed to do. This is to protect the developer from having to pay the consultant if, for any reason, the project is cancelled or changed in such a way that the services of the consultant are no longer required.
4. Typically, households can only apply for RDP if they are organised through a trust, a co-operation, or the like. When a group of households apply for the RDP, the construction process might lead to economies of scale, thus saving the state some financing, while houses are likely to be of higher quality.
5. The attribution of subsidy to incomes of up to 3500 Rand per month is according to the RDP, the prevailing governmental financing scheme in South Africa. Depending on what household aspect is regarded, different income scales have been applied. Appendix C.8 presents an overview of various scales applied by different organisations. The assumed household subsistence level varies from 750 Rand per month (Viljoen 1994) to 1,500 Rand per month (de Vreede 1999). Based on data from the OHS (1995) and IES (1995), including an annual inflation rate of 10% the present household subsistence income level can be estimated to be somewhere in the margin of the two referred data. The average household size in South Africa is determined by dividing the population of 40 million people by the estimated 9 million households. It should be remembered that the average household size of 4.4 people is a rough estimate; the lower the income of a household, the larger the household size tends to be. A *per capita* subsistence income of less than 300 Rand per month is therefore likely to be an optimistic estimate.
6. See Appendix C for a more elaborate discussion on household expenditure patterns.
7. Based on Kutlwanong *et al* (1997).
8. This poll suggests that with 95% certainty can be said that between 22 and 38% of South Africa's builders and building contractors *did* take into account energy efficiency (author's calculation).

9. It has been widely acknowledged that the more stakeholders are involved the more complicated a project becomes, and the greater the risk it ends up in a dull and little challenging end-product. Yet, the funding that tend to equally grow with project scale is such an attraction that stakeholders are eager to overlook the problems they will face, in favour of the cash they eventually hope to gain.
10. Based on interviews and flyers: IIEC (-), Eskom and IIEC (-), PEER Africa, IIEC, MEETI (-)
11. Multiple employees (e.g. Bob Price, Lloyd Wright, Michael Scholand) are known through their publications, with particular reference to the (South) African context.
12. Mainly based on Kutlwanong *et al* (1997).
13. The same report suggests that if PEER wishes to scale-up its present activities for replication, it must first increase its resources and financial basis. It is suggested that identifying, securing, and managing the necessary resources are well within the skills of PEER, but it cannot possibly keep-up with all of the requests because of its present size.
14. Based on interviews with Habitat employees David Brownstein jr and Kurt Farnhaber. See also Fuller, Millard (1994), *The theology of the Hammer*, Macon: Smyth & Helwys Publishing, Inc; - (1995), *A Simple Decent Place to Live*, London: Word Publishing; Fuller, Millard, and Fuller, Linda (1990), *The Excitement is Building*, London: Word Publishing; Fuller, Millard, and Scott, Diane (1980), *Love in the Mortar Joints*, New Win Publishing Ltd; - (1986), *No more shacks!*, London: Word Books; Habitat for Humanity (-), *Building Houses Building Lives*, undated flyer.
15. A section 21 organisation (section 21 refers to a RSA law) are NGOs and CBOs, both profit and non-profit, that are registered with the government as being organisations that are community oriented. Provided they meet some conditions they receive preferential treatment in particular projects.
16. ALSA is founded and presided by Mrs Jo Dunstan, who has many years of field experience with poor communities.
17. In contrast, ALSA seems genuinely interested in the ECN that has a 'tailor made implementation approach', and of which the flyer demonstrates the capacity of implementing a wide range of technologies. Dunstan is preparing a map which shows all projects which are in the pocket, and for which she is still seeking other partners. Check author on information about the Marikana Agri-Village project.
18. Based on documentation on *AMV Project Managers CC*, Durban.
19. Typically, there are only a few people really involved, which makes the discipline a small world. The relevant people can be traced through their published work and the main institutes, although many experts seem to stay relatively shortly with one institute before they move on to the next.
20. For overview publications, see website *http://www.up.ac.za/academic/www.me.up.ac.za/cent/public.html*. For download of demonstration program NEWQUICK, see website http://www.newquick.com
21. Such a case can be observed by reading Mathews' report on ultra low-income housing (Mathews *et al* 1995), which discusses the technical upgrading possibilities of shacks. No question was uttered about the social acceptability of such measures. See also appendix B.
22. The 'Madiba Heat Barrow' is an example. It is a product that responds to the problems associated with water collection in rural areas, where the water source is often distant. It has to ease water collection which is often done by children, while it purifies the water during transport through heating, and fuel wood is saved.
23. Check Appendix D.1 on planned and ongoing CENT projects.
24. From: *http://phantom.eri.uct.ac.za*
25. Based on CSIR (1998a, b, c).
26. See Appendix C.3 for more details on Eskom's policy regarding control and exploitation of the electricity grid.
27. Demand of energy for space heating, cooking, and lighting contribute with 25-50%, 38-52%, 7-18%, and 1-16% respectively to the peak load demand (Simmonds and Mammon 1996). See also section 2.4.
28. An Eskom employee stated: "What is more important, to build as many (energy efficient) houses as possible while compromising a little on quality, or less houses of higher standards, but also leaving more people without any proper shelter at all?" He argues that the democratisation process only delays construction processes, because too many incapable people get involved. See also chapter 9, under *housing processes*.

CHAPTER 4

1. Based on an interview with a professor at the Witwatersrand University, Planning Department of Architectural Faculty.
2. When the end user is asked to chose, he would presumably chose for the low first cost house, rather than for savings on the long term. However, the report assumes that the end user is properly informed on the benefits of the long term savings, hence that the end user would chose for the low long term cost house.
3. The Department of Housing is presently working on a document that incorporates all the deemed to satisfy regulations, which includes also suggestions regarding thermal performance. Though thermal performance has still no legal status, they do affect the building practice. Applications for subsidies are approved on basis of various criteria as set by the Provincial Housing Board, including the standards for thermal performance. Since the demand for subsidy is larger than funding is available, the applications that do not include thermal efficiency are risking to drop out the selection first.
4. This section is based on the brief examination by Thorne (1995: 22-3), and completed with author's own and referenced texts. Thorne's text is, according a representative of the South African Housing Department, still actual.
5. The NBR is comparable with the *Dutch Bouwbesluit*, as is introduced in the Netherlands in the early 1990s. The Dutch regulatory framework for housing aims at maximising design freedom and innovation in the construction sector through imposing performance based requirements, rather than requirements that are based on existing materials, techniques and solutions. It is the result of the acknowledgement that required performances (structural strength, stability, resistance to rainwater penetration, damp proofing, fire protection, lighting and ventilation, drainage, and so on) are not related to a single material of technology.
6. This is a testing method that was designed by Wentzel, Page-Shipp, and Venter (NBRI undated) to predict the thermal performance of housing taking into account variables such as the climatic conditions, materials of construction, window sizes, rates of ventilation, and so on.
7. This means that it could be less than 10 m^2 per person depending on the size of the family, given that the subsidy aims to provide for a starter house which can be extended by the household.
8. Based on Eskom *et al.* (1997), IIEC (1999), and author's observations.
9. Note that ECN, unit Solar and Wind Energy, recently joined into this network, where Petra Lasschuit serves as ECN contact person.
10. See *http://www.seedlinks.org*.
11. Financial data is 1997, quantity of households is 1994. Households with incomes in excess of 3500 Rand are not eligible for the RDP housing subsidy. Sources: Department of Housing, 1995; Simmonds, 1997.
12. Selected data and assumptions are based on findings on economics of the household and the nation, as explored in Appendix B.1.
13. Particularly Aids prevents that repayment periods are viable.
14. Note that these are only indicative data. The actual profits depend on the scale of project, extend of self help, organisation of project, materials and techniques applied, to mention but a few factors.
15. This is including service costs (drains, pipelines, etc).

CHAPTER 5

1. Facts based on Ratcliff (1981), Pillay (1984), and Raymer (1989), unless stated otherwise.
2. In the Netherlands, around 500 people/km^2 do live, by which the Netherlands is considered as one of the highest density countries in the world. In addition, here high rise construction does relief social stress, while in squatter settlements, where on average between 2000 and 4000 people live per km^2, hardly any multiple story buildings can be found.
3. It may be argued that these are no valid evidences to indicate that someone likes it in Alex. However, the fact that for these reasons people say that they want to stay somewhere permanently is illustrative. On the other hand again, the fact that they do say so, might also suggest a fatalistic attitude of not believing in any change.
4. Although the Apartheid regime has been abolished since 1984 with significant impacts on South African society as a whole, socio-economic circumstances in Alexandra seem to have been marginally affected. In its short but turbulent political history it was soon acknowledged as a black settlement area that the authorities preferred to leave alone as long as its presence did not affect (white) life elsewhere.

5. Numerically, this does not differ with the European standards where until recently up to 5 members being dependent on one member (usually the father) was not uncommon. But then the income levels make the difference. Incomes in the investigated households are so low that the household is forced to make more members work if it wants to live above subsistence level. See paragraph on incomes.
6. M.W. Serote (1972) is a poet originally from Alexandra. His work provides an excellent picture of life in Alexandra, and how it is generally perceived.
7. Johannesburg is presently the world's 'crime capital', a status to which Alexandra contributed a great deal.
8. Most funding comes from US companies who can deduct their charity gifts from tax payments.
9. The philosophy is that sweat equity construction and repayment enforcement stimulates the regarded households and communities, of which many people are unskilled and unemployed, to really work and plan to earn their houses.
10. The categorical use of electricity as energy source for all applications is inefficient however. Different fuels are more efficient for different appliances. Generally, electricity is only preferred for lighting and appliances such as tv. The overemphasis on use of electricity leads to excessive costs that could be reduced if proper choices in fuel use were made. In Alexandra most of the alternatives are available for reasonable prices. Awareness campaigns should effectuate shifts in consumption patterns.

CHAPTER 6

1. Asked about how Habitat justifies the use of the potentially hazardous asbestos sheets, the reply was that people die because of other causes (e.g. Aids) before they reach the age at which their exposure to asbestos particles leads to disease and, ultimately, death.
2. Author's experience from an ongoing ECN energy efficient housing project in Swaziland. See also Appendix F.
3. Some cost increase may follow from extended sewage and pipelines.
4. At present, life expectancy tends to decrease due to the appalling growth rate of Aids.

CHAPTER 7

1. Based on Kutlwanong *et al* (1997) and author's field research, unless stated otherwise.
2. KCIHT (Kutlwanong Civic Integrated Housing Trust) was established as a legal not for profit section 21 organisation as a component of the PEER Africa Community Development Framework Model being implemented in Kutlwanong. The purpose of the transformation from community civic to legal entity was one of the strongest steps taken in the province toward empowerment and self determination. The legal entity and the Public-Private Partnership (PPP) between Kutlwanong and PEER Africa provides a development environment that caters to energy and environmental projects, while increasing the potential for real sustainable development (PEER Africa, KCIHT 2000). As such, NGOs such as IIEC were introduced to the community by PEER Africa as a means of creating greater job opportunities, capacity building and development in the community while expanding grass roots environmentally and energy cost optimised program development (source: Guy 2000, PEER-Africa).
3. PEER Africa (PTY) Ltd. is a design build environmental and sanitary engineering firm that specialises in innovative best practice environmentally sound development practices in developing countries (see also section 3.7.2). They have involved with the Kutlwanong community since 1995. PEER Africa's "Framework for the introduction of innovative energy and environmentally friendly projects in developing countries" is the hallmark of the Kutlwanong ECO community development program. PEER also coined the phrase energy or environmentally cost optimised (ECO) development as a practical outcome of its years of work experience with communities throughout southern Africa. The tem ECO, it is suggested, is in stark contrast to Western and European approaches to energy and environmentally housing which are technology focused. The ECO approach is based on "cost optimisation" and a comprehensive effort to integrate local community ideals and cultural bias into the final housing product (Source: Douglas Guy 2000).
4. The BNC is a co-operative working agreement between the US and RSA governments.
5. However, this was never a main component of the programme. Douglas Guy, PEER Africa Operations Director, comments clearly: "PEER Africa was working with the community and the local government officials prior to the BNC meeting in 1995 and used the event to sign a memorandum of understanding (MOU) with the province and the community. During this time the primary objective of the program was to understand the needs of the community and to

develop a model or "Framework" for addressing the needs of the community and to allow for the successful introduction of new and innovative approaches to environmentally sound development. Greenhouse gas emissions reduction was never a component of the original business plan or development plan of the community. Even to this day, it is not a serious consideration or goal of the community residents. In fact, it is one of the most misunderstood components of the KCIHT/PEER Africa program and MOU. The objective is community development and poverty eradication not greenhouse gas emissions reductions. Their approach is more simple than the complexities of GHG reduction. PEER Africa believes that human behaviour will be changed once the level of awareness and benefits are understood and experienced amongst poor families. It did not start with a lecture on GHG reduction or technology, but start with the basic necessity for sustainable development and the eradication of poverty. Greenhouse gas reduction is a by-product of changing human behaviour, it is not and never will be the purpose of a sustainable project in developing countries unless it provides real tangible benefits to the individual family. Global warming is too far away from the reality of not having money and being cold in a shanty at night and needing heat. PEER Africa's interest in GHG reduction or avoidance is based on a curiosity to understand and figure out how to channel more of the money and funding that is being wasted on figuring out how Western and European countries can benefit from GHG projects in developing countries, to real business case and demonstration projects which provide direct benefits to the grass root consumer. It has to be more of a win/win proposition."

6. Grinaker is the largest supplier of low costs housing in southern Africa. They are currently negotiating with PEER Africa regarding a joint venture to incorporate ECO Home features into future projects.
7. Boikhutsong is a location not far from Kutlwanong. It seems reasonable to assume that the demographics of this location are similar.
8. These are households that, according to PEER Africa and KCIHT (2000) were selected at random, based on the national government subsidy process.
9. Literature studies suggested for instance that polygamy is still a vivid practice all over the African continent with various instances were houses were accommodated for a man having multiple wives. Whereas the practice of polygamy has also been observed in the black South African urban context, polygamy seems to have been largely reduced to the 'informal' sphere. This is true insofar that men and women may practice it in secrecy, rather than that it is decreasingly accepted in official social structures. Still a prevailing belief is that tasks are gender related. For instance, women are supposed to cook and take care for the house, while men produce income and relax in their spare time.
10. This is particularly true when the household head is a woman. Lasschuit (1996:24-5) shows that if a woman is not only responsible for cooking, but that if she has also decision power, then appliances that are important to her get a higher priority.
11. Exceptions on the rule have been observed as well, such as the instance of the four male mechanics, aged early 20, who lived together in a shanty that contained a bedroom and a living room, and which was perfectly well maintained and tidy, and with walls nicely plastered with newspapers and wall paper gum.
12. The household size sample shows a normal distribution that tends to skew slightly to the left, while the household size ranges from 1 to 10.
13. Therefore, PEER Africa calls this is a 'mass housing project environment'.
14. The argument, however, that it may indicate that Grinaker has focused on households with more or less stable income (this can be verified through correlating the household income levels with the housing categories), hence which may imply more family planning, is said to be inaccurate for the Kimberley project.
15. Some argue that the extended family may be considered as an inherent characteristic of the black South African culture. Others again, like PEER Africa and KCIHT (2000), reason that the basic reality here goes back to the issue of poverty eradication rather than culture: Once the house is constructed the shanty provides a source of income by, for instance, renting it to third parties or providing shelther to relatives who may contribute to the household income, and not more than that. It is PEER Africa's experience that adults need at least 10 m^2 of space. This is particularly true when the building functions as a residential property. This changes when it becomes a source of income or functions as a dual rental property and residential structure. The proliferation of shanties throughout the country is testimony to the fact that the number of shanties is growing faster than the number of RDP housing. To the residents who already have RDP housing or otherwise, the homeless people are a source of extra income, not costs. Besides the basic need for

more space, income generation is the primary reason for the fact that most RDP residents do not remove their shanties after receiving a house (PEER Africa, KCIHT 2000).

16. Typically, all surveyed shanty households have one breadwinner only.
17. The household income levels as given by the respondents are correlated to the household income levels as estimated from what is reasonable to expect from the income generating activities, the remittances and pensions in a household. Extreme values are omitted as to get a reliable picture. Indeed, the significance increased considerably with the increase of the Kendall correlation factor from 0.389 to 0.741 when three extreme values were omitted from the original sample.
18. Discounted from Golding and Hoets (1992), who calculated 660 Rand/month as the average household income level in Galeshewe.
19. Though the average of Galeshewe is higher, the sample suggests that the Kutlwanong community may be economically slightly better off. Galeshewe shows a distribution that skews towards the lower incomes while, within the given range, the Kutlwanong income levels tend to skew to the right. The small size of this sample requires, however, more research to confirm the suggestion. Together with other differences (e.g. household size), it may be questioned whether it is right to assume that the Galeshewe data are representative for Kutlwanong, as is suggested by Kutlwanong *et al* (1997).
20. Calculation of the estimation errors shows that the spreads around the two rates are large, but also that with 95% certainty can be said that the majority of the female workforce is unemployed, while with almost the same level of certainty can be said that the minority of the male workforce is unemployed. A Fisher-exact-test still has to be performed to test whether the differences between the male and female workforce are significant (cf. Baarda and de Goede 1995: 223).
21. Poverty strikes particularly hard because of the urban context, where little opportunity is left for self-sufficient living as is possible in rural areas.
22. Based on Kutlwanong *et al* (1997) and author's field research, unless stated otherwise.
23. The eventual 'Kutlwanong Style' house has its origins based on acceptability and the presentation of appropriate technology options presented in key no-cost/low cost measures that achieve energy savings features. The business case and project finance did not afford the necessary additional overhead necessary to design GHG modelling and monitoring into the project. Furthermore, the status of AIJ programs were not formalised at that time. GHG emission reductions among PEER Africa ECO Homes are a by product of good planning and environmentally sustainable development practices, not a design criteria (Guy 2000).
24. Amongst the locals the Boikhutsong houses are better known as 'Blumanda' houses.
25. This project can be viewed as a "free rider" project in the terminology of the CDM monitoring and verification community. The Kimberley City Council approved the construction of hundreds of prefabricated "eco" homes after the response from residents throughout the province relative to the KCIHT/PEER Project. The City had a valid issue in that the KCIHT PEER Project was a special research project and not a mass housing project. Demand from residents forced the City council to design a project that met their requirements. The main requirement was the provision that the units must be constructed for the balance of funds after the City extracted its fees for the land and the services. KCIHT and PEER Africa were not consulted on this project and basically the appointed contractor presented his version of the PEER ECO-Home based on a ±R11,000 price for the top structure. The units were marketed to residents as 'eco' homes, which are warm in winter and cool in summer (PEER Africa, KCIHT 2000).
26. Regardless income level – there was no significant correlation found between income level and space heating.
27. Preliminary results from a more comprehensive study of fuel use patterns by EDRC suggest that fuel consumption increased when residents left the shanties and moved in to standard RDP homes.(Guy PEER Africa 2000)
28. The PEER Africa, KCIHT US DOE study found high levels of CO in shanties whose occupants were using faulty cooking and heating appliances. The use of a properly functioning paraffin stove is acceptable and necessary in poor communities in the near future. It is the best option available to poor communities at this time. The fact that residents became more conscious about the hazards of these appliances allowed for more conservation of fuel due do wastage. This had a positive effect on the amount of fuel used. The study contributed to a national standard being developed on low cost paraffin heating devices. (PEER Africa, KCIHT 2000)
29. "The PEER Africa ECO-Home concept is to provide a minimum of 10 m^2 per adult. The current housing subsidy plan makes it difficult to achieve this objective creating an appearance of a fixed price and size regardless household size" (Guy 2000).

30. According to PEER Africa does the 'bathroom' not function as such due to restrictions on connecting indoor plumbing to the municipal sewerage system. The system was undersized by the municipality and frequently backs up due to a number of reasons including blockages caused by children. As such, the toilets are kept outside. This essentially allows the 'bathroom' to be used for other purposes by the family. It happens to be the smallest room in the house and typically should not be on the north side of the unit in any case. PEER maintains that the presence of smoke is more a function of a faulty appliance or the fact that residents choose not to open kitchen windows while cooking. Low cost chimneys could also be a solution to this problem but were somewhat problematic to install within the budget constraints and after the solicitation of professional opinion from indoor air quality experts (PEER Africa 2000).
31. See previous footnote discussing the regarding municipality restrictions. The price is also an issue and the perspective of some residents is correctly stated here (PEER Africa , KCIHT 2000).
32. Common crops are for instance mielies and vegetables. 'Mielies' is South African for maize. 'Vegetables' – as a particular food crop is called by Africans - are comparable with spinach.
33. See previous discussion on why shanties and housing units are positioned as they are.
34. The idea that the PEER Africa ECO Homes are better for the same price is, according to Guy and Abron (2000), a perception: most residents never know how much a subsidy house really costs. In 1995 PEER Africa was able to leverage the subsidy to produce the 'standard steel frame" ECO House. However, this required a special arrangement with the municipality to allow R15,000 of the R17,250 subsidy to be used for the top structure. This is no longer the case as the subsidy will not cover the costs of a 50 m^2 ECO Home using local materials. This opens the opportunity for foreign products and technologies which could increase or maintain the current thermal performance yet reduce the cost of construction (Abron, Guy 2000).
35. Yet, it is important to point out that Grinaker and the KCIHT contractors face the same overall problem of working within very small budgets for houses. The net result is often a lack of funds to cover the cost of seasoned builders and contractors. This points to the need to have an aggressive quality control program. Quality control is also critical to energy efficiency and therefore is a vital component of the KCIHT program (KCIHT 2000).
36. For this purpose Kutlwanong *et al.* (1997) presents some recommendations which are useful, but which will not be recited in this report, as they either follow from the case study as described, or discuss matters which are beyond the scope of this report. Yet, the interested reader is advised to read the report *Housing as if People Mattered – The Story of Kutlwanong* (Kutlwanong *et al.* 1997) in detail to acquire all the information.
37. These comments, KCIHT claims, became more prevalent after the double skin brick units were introduced. Prior to that, most residents accept the fact that they would be receiving a new wall system. In fact, they approved the wall system after local residents constructed it and after seeing in the show house for 9 months before their houses were constructed. The first four houses were used for the initial training and more than 100 local residents were trained using these methods (KCIHT 2000).
38. The complaints have to be set in a large perspective, however. Douglas Guy (2000): "It is PEER Africa's view that Grinaker Housing Corporation did not set out to build inferior products. The fact of the matter that many of the problems outlined here led to great cost to the firm. The real breakdown and problem was the lack of quality control and assurance in the system. Why did residents have to complain before the quality issues were uncovered? We are also aware that a significant amount theft and corruption may have also undermined their ability to professionally control the situation where residents themselves turned a blind eye during the construction process. Many of these same residents lead the complaints about Grinaker housing stock quality."
39. This is a tragedy in that PEER Africa encourages families to move into formal housing as soon as possible for a number of reasons. Also, PEER Africa ECO Housing delivery is controlled by the provincial housing board, not KCIHT or PEER Africa. If new units are not approved, there will be no houses. Grinaker builds acceptable homes and residents should be encouraged to move into the safest best house available. (PEER Africa, KCIHT 2000)

CHAPTER 8

1. Although this report focuses on the socio-economic and energy related issues, is housing more than these issues alone. Sustainable housing is a complex of various disciplines and factors on different levels. For instance, various hazards in South Africa, including flooding and fire, may particularly inflict low cost housing. Hazard mitigating design measures are therefore critical for durable and safe low cost housing design, but may not affect the energy efficiency. In such cases, the reader is referred to the related appendixes. For instance, appendix C.6 presents an overview

of the most common hazards that may inflict South African low cost housing. Similarly, in appendix C.7 some materials and techniques are the discussed that may improve the sustainability of low cost housing from the perspective of financial viability and social acceptance.

2. Estimate given by SA Housing Department official.
3. Even in the industrialised countries such processes are still in minority. Such processes generally do work out there, but have the advantage that most people are sufficiently educated to allow for a smooth co-operation between home owners and other stakeholders.
4. Some argue that the marketing culture in South Africa causes the poor diffusion of this important knowledge. As for the poor, they are often insufficiently educated and subsequently unaware of the consequences of their energy inefficient houses.
5. For instance, the practice of indoor wood fire is expected to vanish as soon as the house is electrified. Lower costs and less effort to generate heat with electricity while suffering from smoke would be past; thus making electricity popular. However, the point needs to be made that heat generation with electricity is not efficient when it comes to space heating. Electricity should therefore be restricted to lighting and, if it needs to be, cooking.
6. Aspects affecting the acceptability and comprehension of proposed e.e. measures are the type of people (rural, migratory, urban people; traditional, transitional, modern people, education, etc.
7. This represents, according to Marschall (1998: 120), the opinion of those stakeholders, "who focus on the 'waste' of time and financial resources implicit in an extended process of community involvement [and who] perceive community participation strictly as a step on the way to obtain a particular building – not as a means for community empowerment in connection with a building".
8. Calculation based on minimal functional space requirements for household sizes from 1 to 10 people.
9. It was expected that the survey would show a shift upwards in the space-people ration at a certain household size. This seemed likely to occur as there may be a point that people feel that the limit of over-crowdedness is reached and decide to expand the house. The results do not show this pattern however, which may be an indication that the financial means are severely limited indeed. Instead, the people seem to prefer to expand their shanties gradually and modestly, rather than to wait for one moment to make one big expansion.
10. Besides, it may be hard to convince people to do upgrade their shanty when they know that the promoter himself does not live under similar circumstances.
11. First sketch shows the original design as drawn by unknown official. The second sketch shows the same house, but with spatial design appropriated (by author) to the wishes of the low income household.
12. 'Air bricks' are ceramic products with ventilation openings. These bricks are an integral part of masonry, and allow for air exchange between the spaces in the dwelling and the external environment.
13. This determines the 'flushability' of a house, which is subjected to standards.
14. The lack of attention for ventilation is surprising considering the abundance of literature on passive ventilation measures. Such measures range from urban planning, geometry and orientation of the house, positioning and sizing of vent shafts, to room configurations.
15. This is a relatively new phenomenon in South Africa, where many people have to get used to the idea of discussing on equal basis, rather than imposing a project as was usual in the time of Apartheid.
16. Appendix C.7: elaborates briefly on some building technologies that have certainly potential in Southern Africa.
17. Life expectancy in South African townships is much lower than in the better off environments, and is expected to go down further due to Aids. In the mean time, people who have been extensively exposed to Asbestos particles during mining or living suffer from cancer at an early age.
18. This highly controversial attitude has been expressed by managers of both an NGO and a commercial builder. Some say that these arguments should not be taken seriously, but when such ideas are living "for pragmatic reasons", should they really be ignored? The argument given here is that developers cannot generalise beyond the people's heads. They would simultaneously abuse their ignorance and socio-economic status, while killing the chances of those people who may get older.

CHAPTER 9

1. This 'main report' reflects only a fraction of the total literature research and fieldwork carried out. In fact, the whole low cost house design and low cost housing practice in South African

urban context has been studied, but most of the work is presented in the Appendix. Hence, the conclusions and recommendations are limited to what is discussed in the main report, while the reader should put them in the perspective of the total picture of South African low cost housing.

2. Tailor made recommendations for the ECN are found in Appendix D.2.

LITERATURE

African National Congress (ANC) (1994), *The Reconstruction and Development Programme: a planning framework,* Johannesburg: Umanyamo Publications.

Agrément Board (1976), Minimum Agrément Norms and Technical Advisory Guide, Agrément Board.

- (1985), Performance criteria and minimum requirements for the assessment of innovative methods of construction, Agrément Board.

Andrews *et al* (eds.) (1989), *Adobe Guidelines – Mud brick building in Victoria*, Victoria (Aus): Ministry of Housing and Construction.

Annegarn, H.J., and Kneen, M.A. (1995), *Source Apportionment of Township Air Pollution*, Household Energy for Development Communities Conference, 18-21 July 1995, South Africa.

Anonymous (8/9/1997), *Housing for a Healtier Future: A Feasibility Study for an Activities Implemented Jointly Project in South Africa*, response to DGIS reviewer's comments.

Baarda, D.B., Goede, M.P.M. de (1995), *Methoden en technieken*, Houten: Stenfert Kroese.

Bakker, F.E. (1998), *Bouwfysica – warmte*, Eindhoven: Eindhoven University of Technology, reader.

Basson, J.A. (1996), *Thermal Housing Design*, Pretoria: Department of Minerals and Energy.

- (1997) *Personal Communication*, draft Energy White Paper, DME.

Bergeijk, A.v. (1999), *An Appropriate School for Tanzania*, Eindhoven: Eindhoven University of Technology, M.Sc. Thesis.

Berrisford, A.J., and Bluff, E. (1991), *Electricity load profiles of developing communities*, Eskom Load Research.

Beute, N. (1993), *Domestic utilisation of electrical grid energy in South Africa,* Potchefstoom University for Christian Higher Education, PhD-thesis.

Blanton (1994), Richard E., *Houses and Households – a comparative study*, New York and London: Plenum Press.

Budlender, Debbie (1999), "The Debate over Household headship", a paper from website: *http://www.statssa.gov.za/*

Central Statistical Service (1992), *Survey of Household Expenditures, 1990,* Pretoria: CSS, No.01-11-01 [1990].

Cubitt, G., and Helfet, A. (1977), *Zuid Afrika.*

CSIR (1998a), *CSIR Annual Report 1998*, Pretoria: CSIR, June.

- (1998b), *CSIR Technology Impact 1998*, Pretoria: CSIR, June.
- (1998c), *Concise CSIR*, Pretoria: CSIR, October.
- (1999), *The State of Human Settlements – South Africa 1994-1998*, Pretoria: CSIR/ Department of Housing, draft version 3.

Davidson, Forbes, and Payne, Geoff (eds.) (1983), *Urban projects manual*, Liverpool: Liverpool University Presss.

Davis, N.E. (1985), *A History of Southern Africa*, Harlow: Longman.

Davis and Ward (1995), *Household energy use patterns in rural areas: the effects of access to electricity*, Cape Town: Energy and Development Research Centre, University of Cape Town.

Demissie, Fassil (1998), "In the Shadow of the Gold Mines: Migrancy amd Mine Housing in South Africa", from: *Housing Studies*, Vol.13, No.4, pp.445-469.

Department of Environmental Affairs and Tourism (DEAT), Department of Housing (DH), Department of Minerals and Energy (DME), Department of Water Affairs and Forestry (DWAF) (October 1998), *Environmentally Sound Low Cost Housing. Draft Guidelines*, South Africa.

Department of Housing (1995a), *Housing White Paper*, Pretoria.

- (1995b), *Implementation Manual – Housing Subsidy Scheme and other Housing Assistance Measures ("Housing Subsidy Implementation Manual")*, Pretoria: Department of Housing.

- (1997), *Housing project programming guide,* Pretoria: Department of Housing.
Department of Water Affairs and Forestry *The A to Z of Water Saving Devices*, South Africa.
Dingley, C. (1992), "Institutional Frameworks for the Electricity Supply Industry", from: Theron, P. (ed.), *Proceedings of the ANC National Meeting on Electrification*, ANC Department of Economic Planning, Cape Town: Centre for Development Studies.
Dullemen, Caroline van (1992), *Zuid Afrika*, Amsterdam: Royal Institute of the Tropics, Landenreeks.
Eberhard and van Horen (1995), *Poverty and power: energy and the South African state*, London: Pluto Press.
ECN, IIEC, AT Consulting Engineers (1998), *Housing for a Healthier Future in South Africa,* project proposal developed for the Environment and Development Department DGIS, Ministry of Foreign Affairs The Netherlands, unpublished paper.
Egmond - de Wilde de Ligny, E.L.C.(1998), *Technology and Technology Transfer*, Eindhoven: Eindhoven University of Technology, reader.
Erkelens, Peter, A. (1985), *De derde wereld onder dak – werkgelegenheid en productiviteit in de informele (woning)bouwsector*, paper for the WUOO-workshop 'Informele bouwsector'.
- (1991), *Self Help Building Productivity – A method for improving housebuilding by low income groups applied to Kenya 1990-2000*, Eindhoven: Eindhoven University of Technology, Faculty of Building Engineering, Bouwstenen-series no. 20.
Eskom (1992), *Annual Report 1991*, Johannesburg: Eskom.
- (1994), *Eskom Statistical Yearbook 1993*, Johannesburg: Eskom.
- (1995a), *Annual Report 1994*, Johannesburg: Eskom.
- (1995b), *Eskom Environmental Report 1994*, Johannesburg: Eskom.
- (1999a), website: *http://duvi.eskom.co.za.*
- (1999b), website: *http://www.eskom.co.za.*
Eskom, IIEC *(-), Sustainable Homes Initiative – Housing for a Sustainable South Africa*, Johannesburg: IIEC-Africa, flyer.
Eskom, IIEC, MDA, PEER (September 1997*), Housing for a Sustainable Africa – The Sustainable Homes Network*, draft proposal.
Fanger, P.O. (1972), *Thermal Comfort.*
Fisher, A.C. (1981), *Resource and Environmental Economics*, Cambridge: Cambridge University Press.
Friedman, Yona (1975), *Toward a Scientific Architecture*, Cambridge: M.I.T. Press.
Gaillard, Herman (1995), *Methodological Issues Related to Cross-Cultural Research: Sample Design – A synopsis of the relevant literature*, Eindhoven University of Technology: Centre for International Co-operation Activities.
- (1996), "Financing of Housing in Tanzania", from: Egmond (ed.), *Report of Baseline Surveys on the National Opportunities for the Application of New Bamboo Construction Technologies in the Housing Sector in Tanzania*, Eindhoven: Eindhoven University of Technology, pp.23-8.
GCIS (1999), website*: http://www.gcis.gov.za/level2/land.htm*
Gibson, B. and van Seventer, D.E. (1995), *The Macroeconomic and Environmental Implications of Green Trade Restrictions on South Africa*, draft paper.
Givoni, B., (1976), *Man Climate and Architecture*, London: Applied Science Publishers Ltd.
Griffiths, J.F. (ed.) (1972), *Climates of Africa*, New York: Elsevier Publishing Company.
Goldemburg, J., Johansson, T.B., Reddy, A.K.N., Williams, R.H. (1987*), Energy for a Sustainable World*, New Delphi: Wiley Eastern Ltd.
Golding and Hoets (1992*), Energy Usage in Urban Black Households in Selected Formal and Informal Townships of South Africa*, Pretoria: Report to the National Energy Council.
Guy, Douglas (2000), PEER Africa Operations Director, *personal communication.*
Helm, D. & Pearce, D. (1990), "The Assessment: Economic Policy Towards the Environment", from: *Oxford Review of Economic Policy*, vol.6, no.1.
Hillier, Bill, and Hanson, Jullienne (1984), *The Social Logic of Space*, Cambridge: Cambridge university Press.

Hohmeyer, O. (1988), *Social Costs of Energy Consumption*, Berlin: Springer Verlag.

Holm, Dieter (1996), *Manual for Energy Conscious Design*, Pretoria: Department Minerals and Energy – Directorate Energy for Development.

- (1997), *Counter-Intuitive Priorities of Owner-Builders in Informal Settlements*, paper submitted to the History of Architecture symposium (18 & 19 July), Durban: University of Natal.

Holm, Dieter, and van Aswegen, J. (1992), *Environmental Conditions and Space Heating/cooling of informal Dwellings in South Africa*, Pretoria: Energy Branch Department of Mineral and Energy Affairs.

Holm, Dieter, and Holm, R.A. (1996), *Passive Solar Housing Demonstration Project*, a report prepared for the Directorate Energy for Development of the Department of Minerals and Energy, Pretoria.

Holm Jordaan Holm (-), *preliminary report on informal and formal low-cost housing in the Highveld region*, Pretoria.

Holm, D., Trieloff, K., Aswegen, D.F. van, Wyk, S.L.van Wyk (1994), *Towards a policy for passive thermal design in low-cost housing*, Pretoria: The Department of Mineral and Energy Affairs.

Holm, Dieter and Viljoen, Reinhold, *Primer for Energy Conscious Design.*

Horschowitz, R., and Orkin, M. (1996), *Living in South Africa. Selected findings of the 1995 October Household Survey*, Pretoria: Central Statistical Service.

Houghton, John (1997), *Global Warming – The complete briefing*, Cambridge University Press

Howell Jones, David (ed.) (1980), *Shelter*, Washington, D.C.: World Bank, Poverty and basic Needs Series/

IIEC (1997), *Eco-Star Homes – Creating Voluntary Incentives for Energy Efficient, Low Cost Homes in South Africa*, proposal.

- (1999), *Sustainable Homes Initiative – Project Workplan*, Johannesburg: IIEC, document prepared for the first meeting of the Southern African Sustainable Homes Network.

- IIEC (-), *Partners for Sustainable Energy Solutions*, Johannesburg: IIEC-Africa, flyer.

Johnson, G.Allan (1996), *The Blackwell Dictionary of Sociology – A user's guide to sociological language*, Oxford: Blackwell.

KCIHT (2000), *personal communication.*

King, H.A. & Rodseth, K.L. (1993), *Gaseos detoxification Technologies*, Johannesburg: Eskom TRI, TRR/P93/083.

Koenigsberger, Ingersoll, Mayhew, Szokolay (1974), *Manual of Tropical Housing and Building – part 1: climatic design*, London New York: Longman.

Kutlwanong (the community of -) , PEER Africa, EDRC, IIEC (1997), *Housing as if People Mattered – the story of Kutlwanong, South Africa*, A No Regrets Case Study Prepared for the United Nations Conference of the Parties III.

Lapperre, P.E.(1996), *Sociologie en Techniek*, Eindhoven: Eindhoven University of Technology, reader.

Lasschuit, P.E. (1996), Rural Electrification in Swaziland, Amsterdam: IVAM, University of Amsterdam.

Leach, Gerald, and Gowen, Marcia (1987), *Household Energy Handbook – An Interim Guide and Reference Manual*, Washington, D.C.: The World Bank, World Bank Technical Paper no.67

Lennon, S.J. & Turner, C.R. (1992), "Air Quality Impacts in South Africa: Addressing Common misconceptions", from: *Journal of Energy Research and Development in Southern Africa*, May.

Lewis, Sharon (undated), *National Norms and Standards in Respect of Permanent Residential Structures*, Pretoria: Department of Housing, unpublished.

- (1999), Department of Housing Pretoria, *personal communication.*

Lewis, L. (1993), *State of the Building Industry*, BMI Building Research Strategy Consulting Unit, Johannesburg: Information Transfer Group.

Linden, A.C. Van der (1988), Bouwfysica, Delft: Waltman.
Lucas, Justine Clare (1995), *Space Society and Culture: Housing and Local Level Politics in a section of Alexandra Township 1991-1992*, Johannesburg: University of Witwatersrand, MA thesis for the anthropological faculty.
MacGregor, Karen (1999), "Survey finds a reversal of attitudes", in: *The Star*, Tuesday April 20: 1,13.
Mandela, Nelson Rolihlahla (1994), *Long Walk to Freedom*, London: Little, Brown and Company.
Markus, T.A., and Morris (1980), *Buildings Climate and Energy*, London: Pitman.
Marschall, Sabine (1998), "Architecture as Empowerment: the participatory approach in contemparory architecture in South Africa", from : *Transformation,* no. 35.
Maslow, A.B. (1954), *Motivation and Personalities*, New York: Harper & Row.
Mathews, E.H., M.Kleingeld, P.B.Taylor (1997) "Estimating the electricity savings effct of ceiling insulation", from*: Building and Environment* 34 (1999): 505-14, Elsevier Science Ltd. (Pergamon).
Mathews, E.H., P.G. Richards, S.L. van Wyk, P.G. Rousseau (1995), "Energy Efficiency of Ultra-Low-Cost Housing", from: *Building and Environment*, Vol. 30, No.3, pp. 427-32, 1995, Elsevier Science Ltd (Pergamon).
Mathews, Eh.H., Taylor, P.B., Gass, I.G. van, Weggelaar, S. (1997), *Insulation:your guide to money savings and improved comfort*, Hatfield: MCI Publishing Divisio.
Mathews, E.H., S.L. van Wyk (1995), Energy efficiency of formal low-cost housing in South Africa's Gauteng region", from: *Energy and Buildings* 24 (1996): 117-23, Elsevier.
- (1996), "Energy Effiecy of Formal Low Cost Housing in South Africa's Gauteng Region", in: *Journal of Energy and Building*, vol. 24, No. 2: 117-23.

McLead, Milana (ed.), *Habitat World*, magazine of Habitat for Humanity International.
Meyer, A. & Cooper, T. (1995), *A Recalculation of the Social Costs of Climate Change*, London: Global Commons Institute.
Midrand Ecocity (undated), *We are the word because we are the future*, Midrand: Midrand ecocity, flyer.
Mills, Glen, and Armstrong, Sue (1993), "Africa tames the town planners", from: *New Scientist*, 1 May 1993, Vol. 138, No. 1871, pp.21-5.
Milne, M. and Givony, B. (1979), "Architectural Design Based on Climate", in: Watson, D. (ed.) *Energy Conservation Through Building Design,* New York: McGraw-Hill.
Murray, Jon, Williams, Jeff, Everist, Richard (1998), *South Africa, Lesotho & Swaziland*, Lonely Planet.
Napier, Mark, and Meiklejohn, Cathy (1997), *Core Housing and Incremental Growth – Is the vision being realised?*, Pretoria: CSIR, division of building technology.
NBRI (National Building Research Institute) (undated), *The Prediction of the Thermal Performance of Buildings by the CR-Method*, Pretoria: NBRI, Council for Scientific and Industrial Research.
NEC-NER, *Passive Thermal Design Housing*, Lynnwood Ridge: the National Energy Council and Energy for Development Division.
Niekerk, Attie C. van (1993), *One Destiny – Our common future in Africa*, Cape: Tafelberg.
- (1996), *Anderkant die reënboog,* Cape: Tafelberg.
- (1998), "A place to feel at home: a social perspective on the family hearth in Africa", in: *Boiling Point*, No. 41: 3-5. See also the more extended draft.

Oak Ridge National Laboratory (ORNL) and Resources for the Future (RFF) (1994a), *Estimating Fuel Cycle Externalities: Analytical Methods and Issues*, Report no. 2, Washington: McGraw-Hill/ Utility Data Institute.
- (1994b) *Estimating Externalities of Coal Fuel Cycles*, report no. 3, Washington: McGraw-Hill/ Utility Data Institute.
- (1995a), *Estimating Externalities of Natural Gas Fuel Cycles*, report no. 4, Washington: McGraw-Hill/ Utility Data Institute.
- (1995b), *Estimating Externalities of Oil Fuel Cycles*, report no. 5, Washington: McGraw-Hill/ Utility Data Institute.

- (1995c), *Estimating Externalities of Hydro Fuel Cycles,* report no. 6, Washington: McGraw-Hill/ Utility Data Institute.
- (1995d), *Estimating Externalities of Biomass Fuel Cycles,* report no. 7, Washington: McGraw-Hill/ Utility Data Institute.
- (1995e), *Estimating Externalities of Nuclear Fuel Cycles* report no. 8, Washington: McGraw-Hill/ Utility Data Institute.

Orkin, F.M. (1997), *Earning and Spending in South Africa – Selected findings of the 1995 Income and Expenditure Survey*, Pretoria: Central Statistics.

- (1998), *The People of South Africa - Population Census, 1996 – Definitions*, Pretoria: Statistics South Africa, website: *http://www.statssa.gov.za.*

Pearce, E.A. and Smith, C.G. (1990), *The World Weather Guide*, London: Hutchinson.

Pearce, D.W. & Turner , R.K. (1990*), Economics of Natural Resources and the natural Environment*, Hemel Hempstead (UK): Harvester Wheatsheaf.

PEER Africa, IIEC, MEETI (-), *Eco-Home Advisors – building a Healthier Future for South Africa – Housing as if People Mattered*, Johannesburg: IIEC-Africa, flyer.

Pigou, A.C. (1920), *The Economics of Welfare*, London: Macmillan.

Pillay (1984), P.N., *Alexandria: an analysis of socio-economic conditions in an urban ghetto,* Cape Town: University of Cape Town, SALDRU, carnegie conference paper no. 19.

Ramsay, G. (1992), *A strategy for the measurement of building performance within the formal building sector*, Cape Town: University of Cape Town, School for Architecture and Planning.

- (1993), *The use of energy in the upgrade of informal housing in the western cape*, Cape Town: University of Cape Town, School of Architecture and Planning.

Ratcliff, Simon Toby (1981), *Alexandra: an alternative redevelopment*, architectural dissertation, Johannesburg: University of Witwatersrand, architectural dept.

Raymer, Peter Brian (1989), *Investigation into urban renewal in Alexandra with specific reference to housing*, architectural dissertation, Johannesburg: University of Witwatersrand, architectural dept.

Roos, G., (1995), *Personal Communications*, Johannesburg: Eskom: TRI.

Rowlands, I.R. (1995), *South Africa and Global Climate Change*, London: London School of Economics, draftpaper.

Ruffini, Antonio (1999), "Africa Games Village showcases energy efficiency", in: *African Energy*, June-July, Vol. 1, No. 3.

SALDRU (South African Labour and Development Research Unit) (1993), *Project for Statistics on Living Standards and Development*, University of Cape Town.

Scholand, M. (1997), *Indoor Air Quality: Heath Effects and Preventative Interventions. A case study of South Africa*, Boston: Tuft University, M.Sc.-Thesis.

SEED (undated), *Sustainable Energy, Environment and Development*, flyer.

- (1999), *SEED update*, Vol.1, Nr.1, 1 July 1999.

Schirnding, Y. von, Yach, D., Klein, M. (1991), "Acute respiratory infections as an important cause of childhood deaths in South Africa", from: *South African medical Journal*, vol.80, 20 July 1991.

Shell (1999) website: *http://www.shell.com*

Spence, Robin, Wells, Jill, and Dudley, Eric (1993), *Jobs from Housing, - Employment, building materials, and enabling strategies for urban development*, London: Intermediate Technology Publications.

Simmonds, Gillian, and Mammon, Nisa (1996), *Energy Services in Low-Income Urban South Africa: A quantitative assessment*, Cape Town: EDRC Report series.

South African Weather Bureau (1997), website: *http://cirrus.sawb.gov.za.*

Sowman, Merle, and Urquhart, Penny, *A Place Called Home: Environmental Issues and Low Cost Housing,*

Stavins, R.N. (1995). "Transaction Costs and Market s for Pollution Control, Resources", from: *Resources for the Future*, no.119.

Stein, R.G. (1977), *Architecture and Energy*, Doubleday & Company, Inc.

Stein, Benjamin, et al. (1986), *Mechanical and Electrical Equipment for Buildings*, 7th ed. – vol. 1, New York: John Wiley & Sons.

Surtees, R.M. (1992), *What our consumers use and when they use it*, Johannesburg: Eskom.

- (1993), *Impacts of Electrification on the South African Load Profile, Technology Research and Investigations*, Johannesburg: Eskom.

Swindells, Steven (1998), "SA struggles to house its poor – Apartheid legacy leaves 3 million without shelter", from: *Financial Gazette*, 3 December 1998.

Thorne, S.J. (1995), *Energy Efficiency and Conservation: policy options for low income households in South Africa*, EDCR, University of Cape Town.

Tol, A. van (red.) (1984), *Jellema Bouwkunde 7a*, Delft: Waltman

- (1986), *Jellema Bouwkunde 7b*, Delft: Waltman

TOOL (1997), *Investering in het buitenland voor de vermindering van het broeikaseffect – Proceedings Joint Implementation Symposium*, Amsterdam: TOOLConsult.

Tyler, H.A. (1980), *Environmental Science - level IV*, New York: Van Nostrand Reinhold Co.

Uken, E.A., and Sinclair, D. (1991), *The effective use of energy in newly urbanised homes*, Pretoria: Department of Mineral and Energy Affairs, Cape Technicon.

United Nations (1971), *Climate and Housing Design – Design of low-cost housing and community facilities*, New York: UN, Department of Economic and Social Affairs.

Van Horen (1996), *Counting the Social Costs – Electricity and externalities in South Africa*, Rondebosch: Elan Press and UCT Press.

- (1995), "Eskom, Its Finances and the National Electrification Programme", from: *Development Southern Africa*, October, in press.

Van Wyk and Mathews 1995, "Energy Efficiency of Ultra Low Cost Housing", in: *Journal of Building and Environment*, vol. 30, no. 3: 427-432.

Viljoen, R.P. (1994), *Rural wood & wood fuel survey – National comparative report*, Pretoria: Department of Minerals and Energy Affairs.

Vreede, Esther de (1998), *Transfer of Manual Pit Emptying Technology (MAPET) to unplanned urban areas in Southern Africa*, Eindhoven: Eindhoven University of Technology, M.Sc. thesis.

Wallén, C.C. (ed.) (1970), *Climates of Northern and Western Europe*, New York: Elsevier Publishing Company.

Walton, James (1956), *African Village*, J.C. Geriche library, University of Stellenbosch.

Wentzel, J.D. (1982), *Acceptable indoor thermal environmental conditions*, Pretoria: CSIR, Quarterly report of Environmental Engineering, NBRI R/Bou 895.

White (1995a), *Social Determinants of Energy Use: national summary report*, draft, Johannesburg: Centre for Policy Studies.

- (1995b), *Social Determinants of Energy Use: Gauteng*, draft, Johannesburg: Centre for Policy Studies.

White, C.F, Crankshaw, O., Mafokoane, T., Meintjes, H. (1996), *Social Determinants of Energy Use in Low-Income Households – Soweto report*, Doornfontein: Centre for Policy Studies.

Wilk, Richard, R. (1990), "The Built Environment and Consumer Decisions", in: Kent, S. (ed.), *Domestic Architecture and the Use of Space*, pp. 34-42, Cambridge: Cambridge University Press.

Wit, M.H. de (1995), *Bouwfysica – warmte en vocht*, Eindhoven: Eindhoven University of Technology, reader.

World Bank (1993), *World Development Report 1992*, Oxford: Oxford University Press.

World Bank (1997), *African Development Indicators 1997*, Washington, D.C.: The World Bank.

World Commission on Environment and Development (1987), *Our Common Future*, New York: Oxford University Press.

Worldwatch 1995, 1996

(-) 19 December 1997, *Government Gazette of the Republic of South Africa*, No. 18521, addressing the Housing Act, Cape Town: Office of the President.

(-) *Financial Mail* (1996), February 09, 1996

WOZA (1997) website: *http://www.woza.co.za*