

**Monitoring Kutlwanong energy cost
optimised homes:
A preliminary assessment**

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Executive summary

Introduction

This work is one of the activities in the NORAD-funded project 'Monitoring, capacity building and decision-making support for government on flexible mechanisms under the UNFCCC'. The monitoring was done in co-operation with the Kutlwanong Civic Integrated Housing Trust (KCIHT) and PEER Africa (Pty) Ltd (PEER Africa).

This report discusses the findings of preliminary monitoring of PEER Africa designed energy cost optimised homes (hereafter referred to as eco-homes) in Kutlwanong, Kimberley in December 1999-January 2000, and the lessons learned.

The key objective of this particular project was to provide a preliminary understanding of the socio-economic and fuel use monitoring issues as a basis for making recommendations for monitoring projects under the flexible mechanisms.¹ The project aimed to establish the processes that should be adopted in socio-economic and fuel use monitoring of community projects, barriers that might be countered and possibly measures that could be used to overcome these barriers. In addition the project aimed to determine whether eco-homes result in greenhouse gas (GHG) emission reductions, and to establish community residents' perceptions of eco-homes and RDP houses on space-heating energy savings, quality and other house attributes.

Monitoring methods

A survey using a pre-structured questionnaire and a focus group workshop was used to gather information on housing from the Kutlwanong community. The questionnaire was administered through one-to-one interviews. The interviewees were community members recruited by KCIHT and trained by EDRC, and focused on residents in eco-homes and RDP houses. PEER Africa offered their supervision services and review of documents at no monetary charge. Due to lack of resources, the focus group workshop was organised by KCIHT and facilitated by EDRC. These methods aimed to gather data on energy use patterns, particularly for space-heating, and residents perceptions on houses.

The findings from the surveys are reported in this report and the key issues from the workshop are presented here, while the full report on the workshop is provided in Appendix A.

Monitoring project limitations

Originally the monitoring was planned for the winter season since this is when most space-heating occurs. Unfortunately, the project schedule and time commitments did not allow enough time for negotiations between the existing KCIHT/PEER Africa project management team and EDRC. This meant that the schedule went beyond the winter and the work had to be conducted in summer. As a result, we had to rely on recall methods to gather information on energy use patterns in winter, and this meant it was often difficult to get absolute values. In addition, the participants in the workshop who lived in an eco-home had not been through a complete winter. Thus, the findings presented in this report reveal general rather than specific trends.

Due to insufficient time and resources available the degree of preparation for undertaking the field work was limited. In retrospect, more time and effort training the community enumerators would have been beneficial and would have speeded the research process. In addition, greater EDRC presence in the community during the survey period would have provided more support for troubleshooting and modifying questionnaires.

¹ Flexible mechanisms are approaches under the Kyoto Protocol to enable developed countries (Annex I Parties) to reduce emissions or meet their commitments under the UNFCCC through investing in projects in developing countries. The mechanisms are Clean Development Mechanism, Emissions Trading, and Activities Implemented Jointly.

Participation at the focus group workshop was rather limited and not well balanced in terms of the proportion of people owning the different types of houses. The workshop suffered from lack of time and budget to allow adequate consultations with the community and other relevant parties prior to its occurrence; it was impossible that the appropriate community general body meetings be called in order to explain the purpose and objectives of the workshop and the work.

Project findings

The findings from this work are preliminary, though useful – especially as a basis for future related work. The key findings from this work are that::

- Eco-homes contribute to reduction in consumption of space-heating fuels – although it was not possible to establish the actual change.
- Eco-homes are preferred to RDP houses mainly due to the larger size, physical attractiveness and higher quality of the houses.
- The majority of the respondents in the survey do not associate thermal energy savings with eco-homes; the energy savings aspect of an eco-home is obviously not an important attraction to the householders, which may be due to lack of awareness of this aspect of the house.
- RDP houses are disliked for their small size, poor quality and ugliness.
- The move from shacks to RDP or eco-homes appears to trigger fuel-switching.
- Respondents seem to lack information on their rights to a good quality house, and on the relative cost of eco-homes and RDP houses.
- The Kutlwanong eco-home project trained some community members on how to construct houses. It seems that imparting construction skills to community members improves their possibility for getting employment. However, this is not done in RDP projects.

Lessons learned

This project has been an important learning experience on issues relating to working with communities, monitoring of potential CDM projects and particularly eco-homes in low-income areas. The following is a summary of the lessons learned:

- Monitoring should be done for extended time periods and across all seasons.
- Community members or 'residents'² should be used but need to be well trained and supervised.
- Project developers should identify community leadership structures and appropriate community leaders to liaise with, and should allow for time to consult with the community.
- Monitoring methods should take into account the dynamics of multiple fuel-use.

² Residents in this case refers to people working in the premises or project being monitored.

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Everyone has the right to have access to adequate housing.

(South African Constitution, 1996)

1. Introduction

Concerns about climate change are pushing the world towards rethinking development along a less environmentally damaging path than in the past. The establishment of the UN Framework for Climate Change Convention (FCCC) in 1992 is evidence of the need and commitment to reduce greenhouse gas (GHG) emissions, which have been identified as contributing to global climate change. This commitment was further cemented by adoption of the Kyoto Protocol in 1997, under which industrialised countries will reduce their emissions by at least 5.2% compared to 1990 levels in the period 2008-2012. Kyoto mechanisms – including Emissions Trading, Joint Implementation and the Clean Development Mechanism (CDM) – were established to assist Parties in contributing to the objectives of the Convention. Under the CDM, which is the most attractive for developing countries, Developed Country Parties can invest in emission-reducing projects in developing countries and use the certified emission reduction units towards meeting their commitments. CDM projects should also foster sustainable development in the developing countries. Such projects need to be monitored to ensure that these goals are met. Though the modalities and guidelines for CDM are yet to be set, it is important to understand the implications of such undertakings for developing countries and hence bargain effectively at the international negotiations.

This work aimed to understand issues relating to socio-economic and fuel use monitoring and evaluating emissions reduction in energy efficient houses. The Kutlwanong Civic Integrated Housing Trust (KCIHT)/PEER Africa (Pty) Ltd Energy Cost Optimised (eco) housing project was chosen because, although it is not designed as a project under any of the flexible mechanisms, it was designed with the aim of saving thermal energy while reducing emissions. More importantly, it was the basis of an approved AIJ Guguletu PEER Africa eco-home project. Kutlwanong is a settlement about ten kilometres from Kimberley, in the Northern Cape province.

While modalities, rules and guidelines for CDM are still in the development stages and have yet to be agreed upon, it is important for stakeholders to be informed of the implications of monitoring in order to contribute effectively to the debate and development of realistic monitoring guidelines.

Monitoring of the Kutlwanong housing project was done as part of the NORAD-funded project 'Monitoring, capacity building and decision-making support for government on flexible mechanisms under the UNFCCC'. The overall goal of this project is to build government's capacity to develop policy and positions around flexible mechanisms, which complement national and local development priorities. The monitoring aspect was thus intended as an illustration in capacity building on monitoring of CDM projects. The monitoring of Kutlwanong housing project was undertaken in collaboration with KCIHT and PEER Africa.

1.1 Objectives

The overall objective of the preliminary monitoring of the Kutlwanong housing project was to understand the monitoring process and document the lessons learned, for use by stakeholders wishing to conduct or track monitoring. The key objective of this particular project was to provide an understanding of the monitoring issues as a basis for making recommendations for monitoring of projects under the flexible mechanisms.³ The project aimed to establish the

³ Flexible mechanisms are approaches under the Kyoto Protocol to enable developed countries (Annex I Parties) to reduce emissions or meet their commitments under the UNFCCC through investing in projects in developing countries. The mechanisms are Clean Development Mechanism, Emissions Trading, and Activities Implemented Jointly.

processes that should be adopted in monitoring of community projects, barriers that might be encountered and strategies to overcome these barriers. In addition the project aimed to determine whether eco-homes result in GHG emission reductions, and to establish community residents' perceptions of eco-homes and RDP-houses on space-heating energy savings, quality and other house attributes.

1.2 Monitoring project design

This project was conducted in partnership with the Kutlwanong community. The Kutlwanong Civic Integrated Housing Trust (KCIHT) and PEER Africa developed the matrix of the housing characteristics which was used in sampling, selected the enumerators, participated in training these enumerators and in the focus group workshop, and commented constructively on the survey questionnaires.

Two distinct methods were used for gathering information: a survey using pre-structured questionnaires and a focus group workshop. The survey was conducted first and the workshop was done two months after completion of the survey.

Survey questionnaires were administered by the enumerators in the eco-homes and standard RDP houses. All the eco-homes included in the survey were of the same size, 50m², while the RDP houses included both 50m² and 35m² houses. Most RDP houses tend to be from 25-35m², but to enable comparison between eco-homes and RDP houses it was deemed necessary to survey the 50m² versions – these are a special case built by the Kimberley municipality and marketed to community residents as subsidy-based 'eco-homes'. These units were constructed after the KCIHT project team provided the Phase 2 ECO-Housing report to the City Council. The City 'eco-housing' project mirrors the PEER Africa eco-homes found in Kutlwanong in basic floor plan and size. The municipality-built homes do not have all the energy saving aspects of the proposed PEER Africa eco-home. This project could be termed a 'free rider' on the Kutlwanong project (PEER Africa, 1999).

The questionnaires aimed to obtain information on various issues including general energy consumption patterns, use of energy for space-heating and -cooling, people's perceptions of the eco-homes and RDP houses and other benefits of eco-homes. The City 'eco-homes' are considered in this report as RDP houses.

The focus group workshop was used to establish community benefits and perception of eco-homes and RDP houses. The workshop aimed to address three key questions:

- a) What makes an ideal house?
- b) To what extent do eco-homes or RDP houses meet expectations?
- c) How to improve communication and build capacity?

The findings from this workshop are discussed in the text but also presented in full in Appendix A.

1.3 Monitoring project limitations

Initially EDRC had envisioned launching a comprehensive technical monitoring programme involving technical equipment for end-use metering over an extended time period, but there was no funding available for this. EDRC therefore decided to conduct some preliminary monitoring and use this to inform parties who might be involved in monitoring later on, as well as a basis for capacity building. Negotiations between the existing community eco-housing project team (which included KCIHT and PEER Africa) and EDRC raised issues around the general approach of the project and limited upfront community team involvement in the program design (because this had been completed as part of an overall project planning process for DEAT in 1997-1998). The necessary discussions between the local project team and EDRC on monitoring modalities delayed commencement of the project to summer rather than

starting during winter as had been planned. As such, we relied on recall to get information relating to energy use in winter. The recall method has specific limitations in that people tend to forget details after a few months. Thus, the information obtained should be used to provide a general overview of energy-use patterns between summer and winter, but with less attention on absolute energy consumption and expenditure. It is noted that the time planned for preparation of the field work was underestimated, and inadequate time and resources were spent by EDRC on interacting directly with the community.

EDRC received the completed questionnaires from KCIHT. However, KCHIT had not received adequate training from EDRC, mainly due to lack of resources and misunderstanding by EDRC of KCIHT capabilities, and were hence not in a position to effect quality control. EDRC had planned for a relatively short period for training the enumerators. The manner in which the questionnaires were completed was, however, evidence that a longer training period should have been considered.

Limitations of the workshop

Although useful information was gleaned in the workshop, it is also important to note some constraints which have a direct bearing on the *quality* of the workshop input. While the actual number of participants should not have a bearing on the quality of the input, it is, however, important to have a balanced cross-section of participants: an ideal workshop should consist of a few participants but should in *qualitative* terms be representative of the focus area. In this case, there was neither a quantitative nor qualitative balance of groups. Only four participants (of which three were KCHIT members) owned eco-homes. The majority of the attendees were living in neither eco-homes nor RDP houses. The implications that this composition has on the workshop was that the focus had to be slightly changed in order to accommodate the 'majority'. In addition, those living in eco-homes had not lived in them through a full winter, so it was difficult for them to report the actual impact of the housing design on winter space-heating.

The second limitation of the workshop, which should have some implications on the findings, was the presence of KCHIT members as participants in the group discussions. Although they were a minority (in terms of numbers), they tended to be more vocal since they had expansive knowledge of housing issues in Kutlwanong, especially regarding RDP and eco-homes.

EDRC was not able spend sufficient time to directly consult with the community on the arrangements for the workshop. This lack of direct contact also contributed to the poor participation at the workshop. The KCIHT support team was also not effective in their efforts to get the target audience to attend the workshop. This points to the need for greater planning and incentives for community participants.

Despite the above limitations, the results of the workshop are useful, especially if they can be compared with, or complemented by, a survey study. They are useful in the sense that questions asked and explored are more qualitative in nature and answers can be trusted. The facilitators were aware of the above constraints and they ensured that the results are not biased towards one group.

1.4 Background of the housing programme in South Africa

On its coming to power in 1994, the new government's domestic policy was centred on the Reconstruction and Development Programme (RDP). One of the RDP goals was to provide housing for the homeless, targeting construction of 200 000 new houses per year in an attempt to address a backlog of three million houses and meet new demand (RDP 1994). However, at the rate at which demand for housing was rising, construction of 200 000 units would only address the need for new houses and not the backlog.

In recognition of the fact that the majority of the low-income population lacked financing for housing, the government established a subsidy scheme to facilitate access to housing. By the

end of March 1999, 1 035 161 subsidies had been approved, but only 745 717 houses had been constructed (CSIR 1999).

The subsidies⁴ depend on the level of household income. Households within the monthly income bracket between zero and R1500 (including a large share of South African households) get the full subsidy – R16000. The minimum subsidy amount is R5500, as indicated in Table 1. The housing subsidy is provided towards the cost of land acquisition, services and the top structure. The subsidy does not cover the housing cost, but the goal is to assist many rather than provide more assistance to a few. In addition, municipalities normally deduct their infrastructure costs from this subsidy, leaving barely enough for a decent house. The cost of the serviced sites can be as much as 60% of the total subsidy (Simmonds 1997). However, the normal subsidy amount may increase by an amount not exceeding 15%, at the sole discretion of the Provincial Housing Board, in order to compensate for abnormal development costs arising from location, geo-technical and topographical conditions.

Table 1: Subsidy levels per income group

<i>Scheme up to 31 March 1999</i>			<i>Scheme since 1 April 1999</i>	
<i>Monthly Income (rands)</i>	<i>Subsidy in 1995</i>	<i>Number of households in SA in 1995</i>	<i>Monthly Income (rands)</i>	<i>Subsidy since 1 April 1999</i>
0-800	15000	3.30m	0-1500	16000
801-1500	12000	2.41m	1501-2500	10000
1501-2500	9500	0.98m	2501-3500	5500
2501-3500	5000	0.46m		

Source: CSIR (1999); DOH (1999)

By December 1998, a total amount of R9,3 billion had been spent on the housing delivery programme since 1994, while a total of 959 415 subsidies had been approved. The Ministry of Housing was allocated some R3,6 billion for the 1998/99 financial year. Of this amount, R2,8 billion was set aside to finance the capital subsidy programmes in the provinces (DoH 1999). About 2% of this was allocated to the Northern Cape province.

The Department of Housing recently announced that it will be providing additional subsidies for the disabled. In view of this, PEER Africa has designed a prototype accessible eco-home and KCIHT contracted local small builders to construct the demonstration unit for the 'differently abled' community.

Recognising the need for better housing in rural South Africa, the department has also committed to providing targeted rural housing subsidies. A Rural Housing Loan Fund (RHLF) was established to provide wholesale loans for rural areas. By December 1998, R105 million had been disbursed through RHLF (CSIR draft 1999).

A Peoples Housing Process, aimed at facilitating construction of houses by people who wish to build their own houses, was launched by the Department of Housing (DOH) in April 1998. Under this scheme, owners commit their own resources, skills and energies to housing themselves and thus reduce labour costs.

In recognition of the fact that some contractors were constructing sub-standard structures, the Ministry of Housing introduced national norms and standards with effect from 1 April 1999. These stipulate the type of engineering services that may be financed with the housing subsidy, as well as the maximum amount that may be spent on the provision of these services. The norms also prescribe the minimum size of a top structure, as well as its engineering specifications, which are to be provided from housing funding. Section 4 of the Housing Act

⁴ The subsidy level was increased by R1000 in April 1999 in response to the rising prices of building materials.

refers to a housing code which would include procedural guidelines in respect of the effective implementation and application of the national housing policy and strategy. These guidelines are, however, not mandatory.

1.5 Background to the Kutlwanong PEER Africa ECO-Community Development Project

The Kutlwanong settlement is located near Kimberley in the Northern Cape province. This community of approximately 2300 households was established in 1994. The people of Kutlwanong came to settle there from backyard dwellings and shacks in various communities.

In line with government's goal of providing housing to low-income households in South Africa, the community sought to gain access to formal housing. PEER Africa (Pty) Ltd, a civil and environmental engineering firm, signed a MoU with the Provincial Housing MEC and the Kutlwanong Civic as result of a bilateral agreement between the USA and South Africa. The KCIHT and PEER Africa established a partnership in 1995 to design, develop and pilot a community-driven approach to self-help integrated housing, capacity building and job creation in the energy and housing sector. The term 'integrated' refers to the integration of energy efficiency and acceptable self-built housing development methodologies. A major element in this approach to housing development, versus the standard approach at that time, was the aggressive effort to expose historically disadvantaged communities, contractors, suppliers, NGOs and underemployed community residents to energy efficiency concepts via self-help demonstrations, and thus empower them. PEER Africa introduced the concept of eco-homes to the community through workshops and discussions. For those who wanted eco-homes, a participatory approach was adopted in the design and construction of the houses. Technical inputs to design were provided by PEER Africa in consultation with the US Department of Energy and the South African Department of Minerals and Energy (DME). A housing subcommittee was formed, with PEER Africa and the community as members, with the aim of developing a community-oriented, self-build construction strategy.

PEER Africa project goals were capacity building and demonstration of self-help energy-efficient building methodologies in a disadvantaged community. One objective in 1995 was to define a methodology by which a PEER Africa eco-home could be constructed using the National subsidy while not compromising PEER Africa's environmentally sustainable housing criteria. PEER Africa was able to develop a comprehensive programme in 1995, which afforded the construction of eco-homes for the subsidy using the steel frame and gypsum board models.⁵ To enable construction of the eco-homes in Kutlwanong, within the housing subsidy, the community negotiated for a reduction in the cost of infrastructure by the municipality. Fortunately, the municipality agreed to waive full upfront infrastructural costs⁶ and this enabled construction of the top structure of eco-homes within the subsidy.

A total of 230 eco-homes have been built or are currently under construction. The assumption was that eco-homes would result in income-related benefits through 60-80% savings in the household space-heating bill, while reducing emissions. Other benefits would include better health through minimising indoor air pollution emanating from space-heating fuels, and increased safety by reducing the risk of fires. Temporary employment opportunities were created during the construction of the homes, where a few community members participated in the construction.

⁵ The price of steel increased substantially since 1995 making it difficult to build within the subsidy.

⁶ Residents are required, however, to pay back over time the difference between the upfront portion taken by the municipality and the selling price (PEER Africa 1999)

1.6 Characteristics of households in sample

A total of 189 households were included in the study: 140 eco-homes and 49 standard homes. Sixty eight percent of all households are male-headed. The share of female-headed households is lower among the eco-homes (23%) than standard houses (37%). The average household size is four persons, although it ranges from one to twelve – the number is the same in both ECO and standard homes. Except for 2% of the households, who received R12000 subsidy, all the households received the full housing subsidy, which indicates that their reported income was less than R800 per month at the time their subsidy was approved.

2. The homes of Kutlwanong

2.1 What is an ideal home? The community perspective

This question was initially asked by PEER Africa during similar studies in 1995. It was the results of such studies that helped to shape the design and approach of the PEER Africa eco-home models that exist today.

As one would expect, an ideal house is unattainable except to a small minority. The focus group workshop participants in Kutlwanong were asked to define their idea of an ideal home during the workshop. The workshop participants organised into two groups while responding. According to them, the key attributes of an ideal home include: a large house with adequate rooms, located in a highly infrastructurally developed area, designed in collaboration with the occupants, of good quality, and preferably constructed by local contractors. Detailed responses are presented in Appendix A. The current eco-home in Kutlwanong may have influenced people's definition of an ideal home.

2.2 The RDP houses

The DoH decreed a minimum floor area of 30m² in 1998 for all the houses built with government subsidy. According to Minister of Housing Mthembu-Mahanyele this size, which was decided upon on the basis of average occupancy of 4,5 persons per family (CSIR 1999), is reasonable. However, the floor sizes of RDP houses vary widely across provinces, ranging from averages of 24m² to 45m². The national average is 33-35m² (CSIR 1999). The standard RDP houses have an average of three rooms, compared to eco-homes which have up to five. RDP houses are made of concrete block walls and roofed with aluminium sheeting and are normally without ceilings.

2.3 The eco-homes

2.3.1 An ideal eco-home: PEER Africa's perceptions

What would be an ideal eco-home in Kutlwanong? This was the question posed to PEER Africa as the developer of eco-homes in Kutlwanong. An ideal eco-home in Kutlwanong would be what PEER Africa refers to as a 'Kutlwanong-style' home. This is a home designed in participatory approach (a 'process and not product' approach) to incorporate the community's perceptions of an ideal house. The house should be built by the community and/or local builders and be constructed after discussion with the home owner on issues such as indoor air quality and energy consumption. The Kutlwanong-style house should take advantage of all passive/no-cost and low-cost measures that contribute to energy savings and GHG emission reductions. There are a number of climatic and economic factors that have to be taken into account. Guidelines are provided as a general rule; they include:

- northward orientation of the house; the structure should provide a room layout and function that allows occupants to obtain the most benefits from the sun;

- proper placement of windows on the north side to maximise thermal benefits in winter when the sun is low;
- high thermal mass in walls and floor so that the storage of daytime heat can be used during cool nights;
- roof overhangs to shade windows during summer;
- an insulated ceiling;
- polystyrene is also used as a moisture barrier and wall insulation⁷ to help prevent heat loss in winter and gain in summer;
- building with locally available material;
- water saving devices, energy efficient lighting, solar water heaters and energy efficient appliances are encouraged.

PEER Africa recommends floor size of at least 10m² per adult and units that are at least 35 m².

2.3.2 The eco-homes

While everyone may have wanted the ideal eco-home, not all features could be used in all the homes. However, in some cases the features can be incorporated at any stage in the lifetime of the house without significant cost. In reality there are a variety of prototype eco-homes in Kutlwanong. The 'eco levels', or rather the thermal measures, differ across the homes, mainly in terms of orientation and building material. Some do not face north; some have a steel frame as the second skin and frame partitions with insulation and ceiling, while others are similar to these except they have brick partitioning instead. Table 2 provides an overview of the number of houses with specific characteristics.

Table 2: Characteristics of eco-homes

<i>Building type / passive solar test variable</i>	<i>Total</i>	<i>Proper sun orientation</i>	<i>Improper sun orientation</i>
Low mass*	67	44	23
Mixed**	98	61	37
Mass based***	51	22	29
Total	216	127	89

*Low mass: The second skin and partitions are steel framed.

**Mixed mass: The second skin steel frame and partitions are brick.

***Mass based: The second skin and partitions are brick.

Most of the eco-homes have a floor area of 50m². There are two bedrooms, a kitchen, bathroom and toilet. However, due to technical problems with the municipality-installed water pipes in the community, the toilets are not operating and the community uses external latrines. The sewer system was installed by the Kimberley municipality before the housing programme was started.

⁷ Wall insulation has been found to be less effective in cavity brick walls however PEER Africa is currently testing a proprietary wall design that incorporates wall insulation in a cavity wall configuration. This is one of several wall types that are used in PEER Africa eco-home models. (PEER Africa 1999)

3. GHG emissions reductions through eco-homes

3.1 Fuel-use patterns in eco-homes and standard homes

This section discusses the energy sources used for various energy services. Cooking, lighting and space-heating are the main focus, although space-cooling, entertainment and refrigeration are also discussed.

3.1.1 Fuels used for major energy services

Cooking

Over 60% of all the households rely on paraffin as the principal cooking fuel, with electricity the second most important (see Table 3). Some 44% of the households do not have an alternative cooking fuel, rather relying on only the main fuel. 80% of these households use paraffin, 16% use electricity and the balance use gas.

Table 3: Percentages of households using various cooking fuels

Fuel	All households *Std.: 0.56 Var: 0.31		Eco-homes Std.: 0.58 Var: 0.34		Standard homes Std.: 0.25 Var: 0.006	
	Main N=184	Secondary N=105	Main N=137	Secondary N=104	Main N=47	Secondary N=1
Paraffin	62	70	51	60	94	0
Electricity	35	28	45	38	6	100
Gas	3	2	4	2	0	0

* Std refers to standard deviation and var to variance. These are provided only for the main fuel.

Paraffin and electricity are the main fuels among eco-homes while paraffin dominates among the standard homes. Since the income structure is similar between eco-homes and standard homes, the differences in cooking fuel patterns cannot be attributed to income. It is unclear if the acquisition of eco-homes is related to people's social standing within the community, a factor that may influence energy-use patterns as well. It may be telling that the proportion of female headed households is lower in eco-homes than in the standard houses, although housing delivery process in the community has made special efforts to involve women.

One additional issue that was raised in the workshop by one eco-home owner was using their paraffin stove in an outside shack because of a build-up of fumes within the house. While the poor combustion of many inexpensive stoves is responsible for generating fumes, residents must manage their environment more effectively in a well-built home because, in order to improve thermal efficiency, eco-homes are constructed to reduce infiltration, particularly compared to typical drafty informal homes. They do have a window or outside door in every room to provide adequate ventilation, to remove solar heat gain and allow for ventilation of cooking fumes, as well as vaulted ceilings, but residents must know how to manage this environment. While residents have been warned of the dangers of using stoves without adequate ventilation in the home, this comment may point to the need for additional information dissemination and awareness among residents. The same would presumably apply to many residents of standard RPD homes as well.

Lighting

Electricity is the principal lighting energy source among all the households (see Table 4). Candles tend to be a common alternative fuel. Surprisingly, a few of the eco-homes use candles as the main fuel, unlike the standard homes where all the households rely on electricity. The reasons for this were not explored. Most standard houses use only one fuel.

Table 4: Lighting fuel use patterns

Fuel	All households Std.: 0.36 Var: 0.13		Eco-homes Std.: 0.42 Var: 0.17		Standard homes Std.: 0.0 Var: 0.00	
	Main N=185	Secondary N=112	Main N=138	Secondary N=105	Main N=47	Secondary N=7
Electricity	96	0	95	0	100	0
Paraffin	1	3	1	3	0	0
Candles	3	96	4	96	0	100
Coal		1	0	1	0	0

Space-heating

Only 39% of the households reported using space-heating fuels. Among these households wood was the most common fuel (see Table 5), with electricity and paraffin more prevalent than coal and gas. Most of the eco-homes that noted use of space-heating fuels (24%) rely mainly on paraffin and electricity. The share of standard homes using space-heating fuels is considerably higher (85%) than in the eco-homes. This indicates the higher degree of comfort among eco-homes and hence less need for space-heating.

Table 5: Percentage of households using various space-heating fuels

Fuel	All households *Std.: 1.7 Var: 2.9		Eco-homes Std.: 1.12 Var: 1.28		Standard homes Std.: 1.5 Var: 2.6	
	Main N=74	Secondary N=26	Main N=33	Secondary N=26	Main N=41	Secondary N=0
Wood	35	0	6	0	59	
Electricity	24	35	42	35	10	
Paraffin	28	58	43	58	17	
Coal	11	4	6	4	15	
Gas	2	3	3	3	0	

Nearly 71% of the eco-home residents used a space-heating fuel in their previous homes, while, currently, only 24% of the eco-homes reported space-heating. This indicates the reduced need for space-heating associated with thermally efficient eco-homes. 79% of standard homes were using space-heating fuels before moving to the RDP houses. The share seems to have slightly increased upon moving to the standard homes. These RDP homes, however, are considerably larger than most shanties, and so would likely require more fuel to heat even if they were more thermally efficient.

Though the objective of the eco-home may not be to encourage fuel switching, an analysis of the fuels used before moving to the eco-homes and standard homes is done to determine whether there is a fuel shift compared to shacks. Moving from shanty houses seems to have interesting implications for fuel-switching. The proportion of households using wood and coal decreases when they move from shanties to eco-homes. It would appear that moving to eco-homes does trigger a shift away from wood and coal. The use of electricity increases as the people move from shanties to eco-homes. This seems to be the same in the RDP houses through to a lesser extent. The notable change in the RDP houses is the increase in fuelwood usage. Table 7 presents percentage of households using various fuels among eco-homes and RDP households.

Table 7: Space-heating fuel prior to moving

Fuel	Eco-home (% households)		Std homes (% households)	
	Before (N=136)	After (N=139)	Before (N=47)	After (N=48)
Wood	18	1	38	50
Paraffin	21	10	21	15
Electricity	4	10	4	8
Coal	27	2	16	13
Gas	2	1	0	2
None	27	76	21	13

Half of the eco-home households stated that they had noted a difference in the total amount they spend on energy consumption (not just space-heating) in winter since moving to the eco-home. For 50% of these their expenditure has risen, while it has fallen among the other half. However, the majority of those spending less noted that the decrease has either been small or moderate. All those spending more are of the opinion that the increase is significant.

This is difficult to correlate with the fact that 24% of eco-home residents report using space-heating, while 71% of that group reported using space-heating in their previous home. This could be due to the difficulty of respondents recalling their expenditure a year ago or to the 'take back' effect, in which money saved on one energy source because of greater efficiency is partly offset by greater purchases for another service to provide higher levels of energy services to the consumer.

Unfortunately, data on the specific amounts of energy used was not available. It is noted that the differences between the sizes of eco-homes or RDP houses and the shanties could have also contributed to the change in energy consumption. In general the shacks tend to be small two-roomed constructions.

Space-cooling

Only 8% of the households use energy for space-cooling and all of them rely on electricity. 73% of these households are eco-homes. Overall, a total of 6% and 8% eco-homes and standard homes respectively space-cool. Thus, space-cooling does not seem to be an important energy service.

Entertainment

Electricity is the main energy source for operating TVs and radios (see Table 6). Some households use dry cell batteries for the radios.

Table 6: Entertainment fuel-use patterns

	All households	Eco-homes	Standard homes
TV	N=103 Std.: 0.29 Var: 0.008	N=77 Std.: 0.34 Var: 0.12	N=26 Std.: 0 Var: 0
Lead-acid	1	1	0
Electricity	99	99	100
Radio	N=112 Std.: 0.61 Var: 0.37	N=87 std: 0.59 var:0.35	N=25 Std.: 0.29 Var: 0.008
Lead-acid	1	1	0
Dry-cell	8	7	12
Electricity	91	92	88

Other energy services

About 61% of households use irons, of which 89% operate the iron with electricity, 10% use paraffin and the balance use gas. All the standard homes with irons (65%) use electricity. The share of eco-homes with irons is 60% and 85% of them use electricity, and 14% use paraffin.

Forty three percent of households have a refrigerator and 98% of these run on electricity. The bulk of the refrigerator owners (79%) are in eco-homes.

3.2 Do eco-homes reduce greenhouse gas emissions?

One of the principal objectives of monitoring was to establish whether having an eco-home had any emission reduction benefits compared to standard houses. The emission reductions were expected to emanate from reduction in fuel consumption for space-heating. However, since the monitoring was done in summer rather than in winter, it was difficult to obtain reliable estimates of the fuel consumption during winter. Hence, the discussion in this section is not necessarily based on absolute amounts of fuel used but mainly on perceptions and aggregate values. PEER Africa and KCIHT have informed EDRC that they are in the process of finalising their project implementation plan for a two-year comprehensive study of fuel-use and thermal performance of the various type of eco-homes built.

The fact that only a small share of the eco-homes use space-heating fuels compared to standard homes indicates a reduction in fuel consumption upon moving to eco-homes and hence reduced emissions. It was not possible to establish whether the quantities consumed in the two types of households differ, due to lack of reliable data.

Comparisons of the amount of fuel used on space-heating across eco-homes and standard homes was difficult since households were unable to estimate the proportion of fuel used for this service where the respective fuel was used for multiple purposes. Use of fuel for multiple services was common practice. The majority of households found it difficult to remember the expenditure on fuel in the last winter.

Eco-homes that use electricity for space-heating (42% of those using space-heating), spend on average R26 per month more on electricity in winter compared to summer. Standard homes relying on electricity for space-heating (10% of those using space-heating) spend R123 more in winter than in summer. Overall, the average expenditure on electricity in winter in these eco-homes is lower by R67 than in the standard houses. Thus, though some eco-homes may be space-heating, the extent to which they do so is lower compared to standard houses.

The information gathered makes it difficult to confidently attribute differences in electricity expenditure between eco-homes and standard homes in winter to space-heating. For instance, the difference could be due to acquisition of new appliances, diversification of energy services derived from electricity or extended use of same services. However, householders were of the opinion that space-heating was the principal service influencing expenditure in winter. Thus, although the costs of other types of fuels used for space-heating were not provided, it can be assumed that they would most likely follow the same pattern as electricity. Thus, eco-homes use less energy for space-heating than standard homes resulting in reduction in emissions.

3.3 Non-GHG benefits of eco-homes and standard houses

Nineteen percent of the eco-home occupants participated in the construction of the houses and 80% of them were trained by the developer. Those who were trained have been employing their skills in building houses in the neighbourhood and are of the opinion that the training will continue to be useful in generating income. Only 1% of the RDP households participated in the RDP construction – the developers did all the construction, which effectively increases the labour costs. Community participation in construction of their own houses has been noted as one of the means of making eco-housing affordable (Simmonds 1997) and the Ministry of Housing is increasing its efforts to provide a conducive environment to facilitate this involvement.

The Minister of Housing, Ms Mthembu-Mahanyele, acknowledges the potential role construction of low-income houses could play in employment creation. In her briefing in February 1999, the Minister stated that for every RDP house built, one permanent and three temporary jobs have been created. She notes that, since the commencement of the housing programme, 681 203 permanent and two million temporary jobs have been created (Briefing, Feb. 1999). This, however, does not seem to have been the effect in Kutlwanong RDP house construction, at least not from the community's perspective. However, this study did not investigate the effects of Kutlwanong RDP housing construction on employment creation among developers, rather focusing on evaluating job creation at the community level mainly because we assume the differences in job creation or other benefits would not be attributable to type of housing but rather to the personalities and values.

Sixty percent of the households know someone who has been trained through the eco-home project and nearly all the persons trained are using the skills acquired in income-generating employment. Over 70% of the trainees are constructing eco-homes, and the rest are building both standard and eco-homes.

Nationally, the RDP housing programme has contributed to empowerment of women through increasing their involvement in housing development by providing them with loans via the National Urban Reconstruction and Housing Agency (NURCHA). About 5% of the new contractors receiving bridging finance from NURCHA are women.

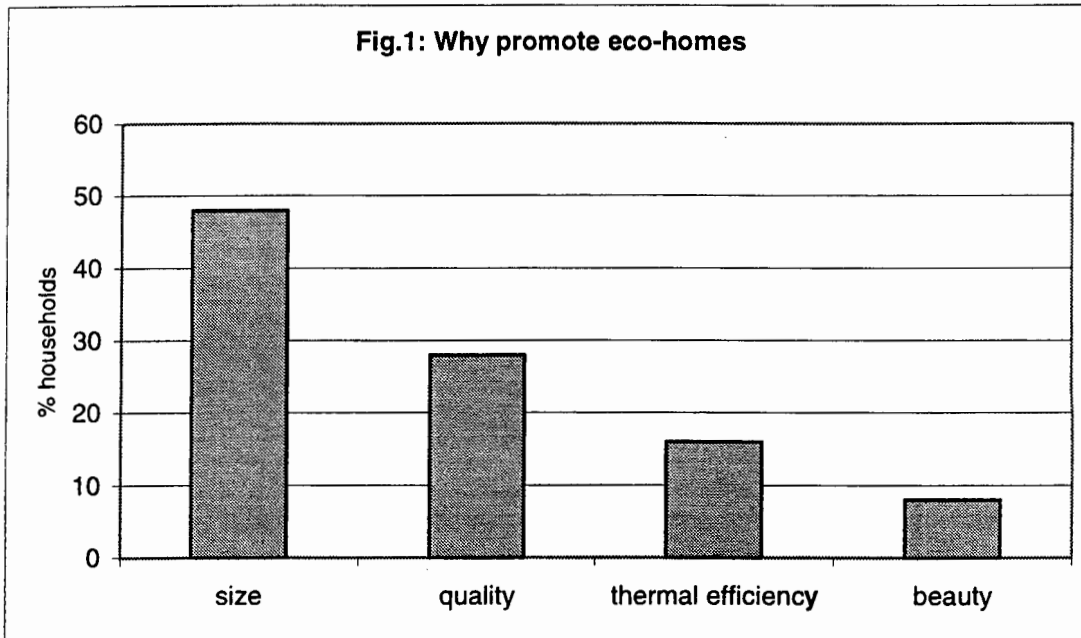
4. Perceptions of ECO and standard homes

All the eco-home occupiers noted that they like the eco-homes, and for all of them they are better than the standard house: size and quality were the main aspects indicated. Only 10% noted energy savings as the characteristic they like most about the eco-home, although an additional 23% stated they like the fact that the house faces north. Some 19% of the eco-home owners noted that they dislike the building material, though it is unclear why.

When asked to compare standard houses with eco-homes, households noted that they prefer eco-homes. For 52% of the respondents, households size was the principal reason for preferring eco-homes. Quality of the eco-home was the reason given by 28%. While the balance cited the fact that the house faced north (as well as its attractiveness), it is unclear if they realise that this is a passive energy-saving measure.

The high quality building material is the main characteristic people associate with eco-homes. Comfort during winter was also an important attribute.

Willingness to promote eco-homes can be an indicator of satisfaction with these homes. Households were asked about the type of house they would advise others to build. Sixty-nine percent of the interviewees responded to this question, and 96% of these would advise people to build eco-homes while the remainder chose RDP houses (no reasons were provided). The size of the eco-home is the most common reason for promoting eco-homes. High quality of the house was the reason cited by 28% the respondents while 16% quoted thermal efficiency (see Figure 1).



Workshop participants did, however, mention thermal efficiency as a positive aspect of the eco-home. This may be attributed to the presence of KCIHT members⁸ in the workshop groups. Box 2 #? presents opinions of workshop participants on the three types of low-income houses in Kutlwanong; shanty, RDP and eco-homes. The first two rows (negative aspects and positive aspects) reflect participants talking about *their own* housing type. Some of their comments reflect a lack of awareness as to what one could realistically expect of an eco-home. For example, they mention the lack of such features as low flush toilets, efficient lighting and solar water heaters, where in fact there are no low flush toilets or solar water heaters anywhere in the Kutlwanong community in any housing type. While these features contribute to energy conservation, they do not necessarily contribute to thermal efficiency. This may then reflect in interest in acquiring these features for their homes, rather than a criticism of the eco-home model *per se*.

Box 2#?: Perceptions and housing types

Shacks	RDP houses	Eco-homes
<p>Positive aspects</p> <ul style="list-style-type: none"> ◆ 'Free' and affordable, although one needs to buy building materials. ◆ Nothing positive about living in a shack. It is just 'to have a roof over head'. 	<p>Positive aspects</p> <ul style="list-style-type: none"> ◆ Better than living in a shack. ◆ At least you have a 'permanent' home. 	<p>Positive aspects</p> <ul style="list-style-type: none"> ◆ Affordable depending on the size. One can build a 50m² Eco-house using the R15000 subsidy money. ◆ Thermal efficiency.
<p>Negative aspects</p> <ul style="list-style-type: none"> ◆ Poverty is the main reason that people continue to live in the shacks. ◆ Shacks are too small, have inadequate windows and there is lack of privacy. ◆ Shacks are not safe. 	<p>Negative aspects</p> <ul style="list-style-type: none"> ◆ 'They appear as if they were not properly planned'. ◆ People are made to choose the design of houses without prior information/knowledge 	<p>Negative aspects⁹</p> <ul style="list-style-type: none"> ◆ Usually bigger houses' costs are double the government subsidy money = R30000. ◆ No low flush toilets.¹ ◆ No energy efficient lights. ◆ No solar water heaters.¹

⁸ KCHIT participants live in eco-homes but have not experienced any winter and their houses did not have ceilings at the time of the workshop (PEER Africa 1999).

⁹ These are peoples' perceptions of what an ideal eco-home should be and not necessarily what is offered.

	<p>about the pros and cons.</p> <ul style="list-style-type: none"> ◆ Small and unattractive. ◆ Cannot withstand bad weather conditions; roofs leak, doors are unstable, windows cannot close and open properly, poor building materials, etc. ◆ Not comfortable and usually stuffy as there is no ventilation. 	<ul style="list-style-type: none"> ◆ Use of wick stoves not desirable, paraffin fumes 'fill the house' forcing people to build out-rooms where paraffin appliances are used.² ◆ Limited choice of using fuels (cannot use paraffin stoves in the eco-home kitchens due to accumulation of fumes).²
<p>On RDP houses</p> <ul style="list-style-type: none"> ◆ Many are not yet complete ◆ Small and built of cheap materials. ◆ Rooms are not separated. ◆ People just take them because 'they want a house'. ◆ When it rains, the houses leak and mould is formed after rains (no ventilation). 	<p>On eco-homes</p> <ul style="list-style-type: none"> ◆ eco-homes are attractive and have more space than RDP houses. 	<p>On RDP houses</p> <ul style="list-style-type: none"> ◆ Low quality materials ◆ Small and too cold/hot in winter and summer, because there is little insulation and roofs do not have overhangs (to provide coolness when hot).

Notes:

1. See note in text.
2. See discussion in Section 3.1.1 under 'cooking' about the issue of fumes and ventilation.

5. Lessons

5.1 Thermally efficient housing has the potential for mitigating climate change and supporting development

Eco-homes do contribute to a reduction in the need for space-heating compared to standard houses and therefore to emissions reduction attributed to space-heating. However, the extent to which thermally efficient housing contributes to climate change mitigation depends on the baseline adopted. If shanty houses are the baseline, the reduction in emissions is considerably higher than where RDP houses are the baseline. PEER Africa argues that shanty houses should be the baseline since the beneficiaries would not have been able to access even the RDP houses without their assistance, mainly due to institutional barriers. In addition, PEER Africa notes that the bulk of the low-income urban houses built today are shanties. On the other hand, government is committed to delivery of better housing so far manifested in an RDP house. While the delivery rate of RDP houses was rather slow in the initial stages, it has picked up significantly and government is committed to developing strategies to remove the institutional barriers.

The choice of a baseline will depend on the local circumstances. Whatever baseline is adopted, it will require justification by the project developer. Shanties may be used as a baseline for some, but not all, thermally efficient housing projects. In this case the argument might be that the community would not have accessed the subsidy without the assistance of the developer. Shanties may also be used as the baseline as a political decision or where a sectoral baseline or benchmarking is used to establish the baseline. Another baseline could be the RDP house, which is quite credible especially as the rates of delivery increase indicate that beneficiaries of eco-homes would have otherwise accessed an RDP house. In this case emission reduction might be lower compared to where the shanty is used as a baseline, mainly due to changes in energy-use patterns associated with movement from shanty houses. People tend to use more

energy services compared to when they are in shanty houses, hence influencing emission reduction levels.

Government is committed to a development process driven from within communities. Through its policies and strategies it will encourage and support initiatives emerging from communities or broader local social compacts aimed at equipping and empowering people to drive their own economic empowerment, the development of their physical environment and the satisfaction of their basic needs. Policies must recognise and give effect to this approach (White Paper on Housing 1995). The ideas that individual households can be given choices of product and location at a project level have largely been overlooked (CSIR draft 1999). It is obvious from this study that people would prefer to be consulted on these issues and more involved in the construction. Eco-home developers have so far shown commitment to facilitate community participation in construction. This is not as evident in conventional RDP construction where the developer normally does all the work. Imparting construction skills to communities empowers them, as it improves their employability. The eco-home development model could serve as a model for other projects.

The quality of RDP houses has been suspect, culminating in the establishment of guidelines to protect consumers against shoddy building (DoH 1999). The high quality of the eco-homes – perceived by the community as ‘strong’, ‘well constructed and firm’ – is a key attribute for preferring eco-homes over RDP houses. The eco-homes of Kutlwanong provide a ‘home’ and not just a ‘house’, in that they take into account the physical appearance and the environment by encouraging owners to green their surroundings with trees and grass. According to community members, eco-homes are ‘comfortable and spacious’, and ‘big for a family’. On the other hand, RDP houses tend to be small and bland grey concrete structures with hardly any vegetation cover around them.

5.2 Implications for monitoring climate change projects

Climate change projects such as CDM projects have to reduce emissions and foster sustainable development. Thus it is essential that their impacts be monitored. Monitoring of thermally efficient houses is necessary for validating the objectives of emission reduction and contribution to development. The experience gained from this project has been useful as a basis for recommending socio-economic and fuel-use monitoring procedures.

Monitoring should be done at the *appropriate time*. Householders often do not keep records on energy-use patterns. The data on thermal efficiency should therefore be gathered in winter and preferably over extended time periods per households. This is mainly because thermal savings are evident in winter when households demand space-heating. Seasonal variation in energy use should be captured by also monitoring in summer.

Various methods can be used to gather information. It is recommended that *multiple methods* be used for quality control and also in order to be able to take into account the dynamics of multiple fuel use. Obviously, most monitoring methods will require the co-operation of the householders. End-use metering should be used whenever possible – such as for electricity consumption. Where households are using fuels such as coal and paraffin for more than one service, more innovative methods need to be designed to establish the share spent on each service – such as space-heating. One such method could be the provision of service-specific containers for paraffin: that is, each container would be used for only one service. The same could be done for coal. Use of coal and wood could be tracked through regular weighing and recording of quantities used. Since weighing may be tedious for the householders, standard containers could be supplied to the households and this would be used whenever fuel is added to an appliance. However, the stoves may be providing more than one service at a time (such as space-heating and cooking) which makes it difficult to establish the energy spent on space-heating alone. Such a decision can be informed by the household practices regarding the stove after completing the cooking task as well as the general use patterns for the stove as a space-heating appliance.

Monitoring of energy use over appropriate time periods is likely to involve some degree of invasion of privacy of householders. Thus, as far as possible, *self-monitoring* should be encouraged. In this case householders are responsible for monitoring their own consumption patterns. However, this method may not be easy to implement and requires some social commitments. Householders would have to be trained on how to monitor themselves and record energy use patterns in log sheets. In addition, measures need to be taken to ensure quality control.

Monitoring of community projects should be done in *collaboration with the communities*. Participation and collaboration of the communities should be sought well in advance – it is important to actively consult with the community from project inception phase and throughout the project. Where possible, they should be involved in the project planning. Ample time and resources should be allocated for these consultations. Discussions with Kutlwanong community representatives started in June 1999, but it was only in November that the monitoring really happened, so the monitoring was not conducted during the appropriate season. Communities often lack the skills necessary to conduct monitoring, however, and require training. Project developers should take this into account when planning and allow adequate time for recruiting and training community members.

5.3 Housing must reflect what people want

It is recognised that in order to address housing shortages in South Africa for low-income people, cost-effective means (implying the erection of numerous, small and 'simple' units) need to be devised. There is also an underlying (and perhaps uninformed) assumption that low-income people prefer any brick structure erected for them: any brick structure, this assumption implies, is better than a shack. This study has shown that the poor have taste, and 'dreams' of owning better houses than the present standard RDP units built for them. While recognising the limited financial resources and space to build houses, attempts should be made to strike the balance between available resources and people's interests or preferences.

House owners would prefer to choose location of their dwellings and the proximity of the houses to each other. There is concern that locating houses too close to each other increases the danger of fire spreading.

5.4 Need for awareness

Although inclusivity was attempted by the KCIHT, there is still room for improvement. People need to be presented with alternatives so they can make informed choices about what types of dwellings they can get. Many people are unaware of the advantages of a thermally efficient dwelling besides the physical appearance and size. The notion of energy efficiency is, however, foreign to most.

5.5 Transcending the gender divide

For development to be broader and inclusive, it is important that it transcends the gender divide. The workshop clearly illustrated that women are still viewed as inferior in development matters, even by community members themselves. Though women dominated the workshop in numbers, when it came to 'hard' issues (construction materials, designs, etc), it was felt that this is beyond the realm of women's capabilities. In the words of a male participant, 'there is no demand for women constructors'. To a large extent, this is the reflection of the patriarchal society we live in, which associates 'soft' issues (such as running and managing the households) with women, while men are associated with production (such as building houses). This view needs to be transformed, as women are also capable of dealing with the so-called 'hard' issues. Although the Department of Housing is facilitating the participation of women as entrepreneurs in the construction industry, it is important to consider ways of involving women at all levels.

It is interesting to note, in this light, that the eco-home project targeted 40% female construction workers, and took steps to engage women in the actual building of the homes. Even one of the unit managers in the community is female. However, over time many of the women found it difficult to cover the cost of childcare with their wages, given the training days involved. They also in many cases found it difficult to keep up with men with experience in construction and manual labour. This, combined with strong pressure to build homes as quickly as possible, meant that women's participation dropped over time (Peer Africa 1999).

5.6 Transfer of skills should be priority

Lastly, to realise sustainable development, transfer of skills should be integral. Although training on construction has been part of the eco-homes project, it appears that it has not been as inclusive as possible. To paraphrase a male participant, 'training [a large number of] people in the project could compromise the project in that targets (pre-determined number of units) could not be reached'. This shows that reaching targets is still considered as the main output of development projects, especially low-income housing projects. The danger of focusing on reaching targeted number of units is that skills would not be transferred and little capacity would be built. In the quest of building as many houses as possible, some 'powerless' groups' participation (such as women) could fall by wayside. This would increase stereotypes such as that the 'physical demands of construction are beyond what women can endure'. It is recommended that more attention be given to transfer of skills to communities during construction, as this has long-term benefits. This self-help approach might mean that housing projects take longer than where established developers implement the housing projects without community involvement. However, communities need to be provided with this alternative.

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Appendix B: Questionnaire for eco-home survey

Date:	Name of interviewer
Household location	Household number
Name of interviewee:	Gender of interviewee:
Relationship of interviewee to household head:	
a) household head <input type="checkbox"/> b) spouse (i.e. wife or husband to household head) <input type="checkbox"/> c) son <input type="checkbox"/> d) daughter <input type="checkbox"/> e) relative <input type="checkbox"/>	

Household Information	
1. Household head-name:	2. Gender of household head: male <input type="checkbox"/> female <input type="checkbox"/>
3. Is the household head married, single or deceased? Married <input type="checkbox"/> co-habiting <input type="checkbox"/> Single <input type="checkbox"/> widowed <input type="checkbox"/>	4. Total Number of persons living in household:
5. number of male children less than 10 years:	7. number of women adults (older than 10 years):

6. number of female children less than 10 years:	8. number of men adults (older than 10 years):
9. House type: (a) eco-home <input type="checkbox"/> (b) standard <input type="checkbox"/>	10. Household subsidy level: a) full subsidy <input type="checkbox"/> (15000) b) medium subsidy <input type="checkbox"/> (12500) c) small subsidy <input type="checkbox"/> (5000)
11. Floor area: a) 50 m ² <input type="checkbox"/> (b) 35m ² <input type="checkbox"/>	12. Number of rooms
14: building type (A) walls with mass <input type="checkbox"/> (B) walls with no mass <input type="checkbox"/>	15: house orientation: facing (A) North <input type="checkbox"/> (B) South <input type="checkbox"/> (C) East <input type="checkbox"/> (D) West <input type="checkbox"/>
16: house eco-Level: (A) no ceiling <input type="checkbox"/> (B) with Ceiling <input type="checkbox"/> (C) eco-windows <input type="checkbox"/> (D) standard windows <input type="checkbox"/>	

Household general fuel use patterns		
17. Which fuels do households mainly (most commonly used) use for cooking, lighting, space-heating, TV, Radio, ironing? Which is the secondary fuel used for these purposes?		
Energy service	Fuel mainly used	Secondary fuel

<p>Cooking</p>	<p>Wood <input type="checkbox"/></p> <p>Coal <input type="checkbox"/></p> <p>Gas <input type="checkbox"/></p> <p>Electricity <input type="checkbox"/></p> <p>Paraffin <input type="checkbox"/></p> <p>Other Specify <input type="checkbox"/></p>	<p>Wood <input type="checkbox"/></p> <p>Coal <input type="checkbox"/></p> <p>Gas <input type="checkbox"/></p> <p>Electricity <input type="checkbox"/></p> <p>Paraffin <input type="checkbox"/></p> <p>Other Specify <input type="checkbox"/></p>
<p>Lighting</p>	<p>Wood <input type="checkbox"/></p> <p>Coal <input type="checkbox"/></p> <p>Gas <input type="checkbox"/></p> <p>Electricity <input type="checkbox"/></p> <p>Paraffin <input type="checkbox"/></p> <p>Candles <input type="checkbox"/></p> <p>Other Specify <input type="checkbox"/></p>	<p>Wood <input type="checkbox"/></p> <p>Coal <input type="checkbox"/></p> <p>Gas <input type="checkbox"/></p> <p>Electricity <input type="checkbox"/></p> <p>Paraffin <input type="checkbox"/></p> <p>Candles <input type="checkbox"/></p> <p>Other Specify <input type="checkbox"/></p>
<p>Space-heating</p>	<p>Wood <input type="checkbox"/></p> <p>Coal <input type="checkbox"/></p> <p>Gas <input type="checkbox"/></p> <p>Electricity <input type="checkbox"/></p> <p>Paraffin <input type="checkbox"/></p> <p>Other Specify <input type="checkbox"/></p>	<p>Wood <input type="checkbox"/></p> <p>Coal <input type="checkbox"/></p> <p>Gas <input type="checkbox"/></p> <p>Electricity <input type="checkbox"/></p> <p>Paraffin <input type="checkbox"/></p> <p>Other Specify <input type="checkbox"/></p>

Space cooling	Wood <input type="checkbox"/> Coal <input type="checkbox"/> Gas <input type="checkbox"/> Electricity <input type="checkbox"/> Paraffin <input type="checkbox"/> Other Specify <input type="checkbox"/>	Wood <input type="checkbox"/> Coal <input type="checkbox"/> Gas <input type="checkbox"/> Electricity <input type="checkbox"/> Paraffin <input type="checkbox"/> Other Specify <input type="checkbox"/>
TV	Lead-acid battery (car battery) <input type="checkbox"/> Coal <input type="checkbox"/> Gas <input type="checkbox"/> Electricity <input type="checkbox"/> Other Specify <input type="checkbox"/>	Lead-acid battery (car battery) <input type="checkbox"/> Coal <input type="checkbox"/> Gas <input type="checkbox"/> Electricity <input type="checkbox"/> Other Specify <input type="checkbox"/>
Radio	Lead-acid battery (car battery) <input type="checkbox"/> Dry-cell battery <input type="checkbox"/> Gas <input type="checkbox"/> Electricity <input type="checkbox"/> Other Specify <input type="checkbox"/>	Lead-acid battery (car battery) <input type="checkbox"/> Dry-cell battery <input type="checkbox"/> Gas <input type="checkbox"/> Electricity <input type="checkbox"/> Other Specify <input type="checkbox"/>

Ironing	Wood <input type="checkbox"/> Coal <input type="checkbox"/> Gas <input type="checkbox"/> Electricity <input type="checkbox"/> Paraffin <input type="checkbox"/> Other Specify <input type="checkbox"/>	Wood <input type="checkbox"/> Coal <input type="checkbox"/> Gas <input type="checkbox"/> Electricity <input type="checkbox"/> Paraffin <input type="checkbox"/> Other Specify <input type="checkbox"/>
Refrigeration	Wood <input type="checkbox"/> Coal <input type="checkbox"/> Gas <input type="checkbox"/> Electricity <input type="checkbox"/> Paraffin <input type="checkbox"/> Other Specify <input type="checkbox"/>	Wood <input type="checkbox"/> Coal <input type="checkbox"/> Gas <input type="checkbox"/> Electricity <input type="checkbox"/> Paraffin <input type="checkbox"/> Other Specify <input type="checkbox"/>

Household Space Heating fuel Use- ASK ABOUT WINTER OR COLD MONTHS

18. Type of fuels used for **space-heating** and the heater types, do you use **the stove** for space-heating (**ask if they are using the stove for space-heating and include it as a heater type**) used when using each fuel (**indicate if more than one type of heater is used for each fuel type**). Rank them, Starting with the most frequently used and ending with the least used. What other energy services are these fuels used for? What proportion of the total fuel bought is used for space-heating?

Fuels used For space-heating	heater type	Stove type	Other uses for this fuel	% fuel used for space-heating
a) gas				

b) electricity				
c) paraffin				
d) coal				
c) wood				

19: if the household uses the stove for **space-heating**: Why do you use the stove for **space-heating**?

- (A) no alternative heater
- (B) like the way the stove heats the room compared to a heater
- (C) the stove use less fuel than a heater
- (D) like the look of the fire from the stove
- (E) easy to use
- (F) other-**please specify** _____

ASK ABOUT WINTER FOR SPACE HEATING

20. How often is the **space-heating** fuel bought or obtained in one month? Who is normally responsible for paying and getting the fuels? How much is the transportation cost **per trip** for obtaining the fuel? What amount of the fuel do you normally buy? How much does this amount cost? Is the fuel used **only** for **space-heating**? If the fuel is used for other services and not just **space-heating**:- What proportion of the total fuel bought is used for space-heating? How long does the amount used for space-heating last?

Fuel type	Number of times buying per month	Person responsible for paying getting		Transport cost per trip	Amount of fuel bought	Cost of fuel	% used for space-heating	Time space-heating fuel lasts
a) gas					kg			
b) electricity					units			
c) paraffin					litres			
d) coal					kg			
b) wood-bought					Kg bundles			
c) collected								

21: Do you use electricity for **space-heating**? Yes No

: **If yes**, in what type of electrical heater or do you use the electric stove for space-heating? Use electric heater type : Use electric stove

using both electric heater and electric stove . How many electric heaters do you have? What is the capacity of the appliance (wattage)? How many hours are each of these heaters used per day? During which months do you use each of these appliances?

Electric heater type	Number of electric heaters	Capacity of heater _W _Hz	Hours used per day	Months heater used
How much did you spend on electricity in a month during last winter ?				
Did you use an electric heater last month? Yes <input type="checkbox"/> No <input type="checkbox"/>				
How much are you spending on electricity in a month now ?				
Are you using an electric fan? Yes <input type="checkbox"/> No <input type="checkbox"/>				
Have you bought any new electrical appliances since July this year Yes <input type="checkbox"/> No <input type="checkbox"/> which ones?				
22. Do you use the hotplate or other electric stove for space-heating ? Yes <input type="checkbox"/> No <input type="checkbox"/>				
: If yes how many hours per day and for how many months per year? What is the capacity of these hotplate or stove?				
Hour per day using hotplate or electric stove for space-heating	Number of months using hotplate or electric stove for space-heating	Capacity of hotplate or electric stove		
Do you use electric fans? How many fans do you use? Which months of the year do you use the fans? How many hours per day do you use the fan? What is the capacity(Watts) of the fan?				
Use electric fan	Number of fans	Months using fan	Hours per day using fan	Capacity/ Watts of fan
Yes <input type="checkbox"/> No <input type="checkbox"/>				
23. what other energy services do you use electricity for? In what type, number and capacity of appliances? How many hours per day do you use electricity for this service?				
Using electricity for	Type of appliance	Number appliances	of	Capacity appliance
			of	Hours electricity is used per day
Cooking	1 hot plate <input type="checkbox"/>			
	2 hot plates <input type="checkbox"/>			

	4 hot plate without oven <input type="checkbox"/>			
	4 hot plate with oven <input type="checkbox"/>			
Lighting	Incandescent bulbs <input type="checkbox"/>			
	Fluorescent bulbs <input type="checkbox"/>			
Fridge				
Ironing				
TV				
Radio				
Space-heating				

24. Do you have a pre-paid (card) meter system for electricity or the conventional meter?

Pre-paid card:

Conventional meter:

If you have a **pre-paid card** system how much money do you normally spend for the card? How long does this card last during the months when you are using the electric heater and in those months that you are not using the heater?

Money spent on card normally	Time the card lasts when using electric heater or stove for space-heating	Time the card lasts when NOT using electric heater or stove for space-heating

25. If you have a **conventional electricity meter** how much do you spend on electricity per month- during the months when you are using the electric heater and in those months that you are not using the heater

Cost of electricity in months when using heater	Cost of electricity in months when NOT using heater

26. what **other electrical appliances** do you have and which ones do you use at the same period when you are using the electrical heater
other appliance

Has appliance	Uses appliance together with electric heater
(A) electric stove <input type="checkbox"/>	Yes <input type="checkbox"/> No <input type="checkbox"/>
(B) electric fridge <input type="checkbox"/>	Yes <input type="checkbox"/> No <input type="checkbox"/>
(C) microwave <input type="checkbox"/>	Yes <input type="checkbox"/> No <input type="checkbox"/>
(D) other (please specify) <input type="checkbox"/>	Yes <input type="checkbox"/> No <input type="checkbox"/>

27. What are the costs of the different types of heaters used? duration before replacement or lifetime of heater

Heater type	heater cost	Lifetime of heater
Electric heater		
Gas heater		
Paraffin heater		
Coal heater		

28. What type of space-heating fuel were you mainly using before moving into the eco-home? Has this space-heating fuel changed since moving into the eco-home? If yes, why did you change?		
Space-heating fuel used before move to the eco-home	Is fuel still the same	Why the change in space-heating fuel
29. Is the fuel you are now using for space-heating your favourite fuel? Yes <input type="checkbox"/> No <input type="checkbox"/> :If no - what fuel would you really like to use for space-heating? Why would you like to use this fuel?		
Fuel would like to use for space-heating	Why like this fuel	
Is the fuel you are now using for space cooling your favourite fuel? Yes <input type="checkbox"/> No <input type="checkbox"/> :If no - what fuel would you really like to use for space cooling? Why would you like to use this fuel?		
Fuel would like to use for space cooling	Why like this fuel	
Perceptions of eco-homes		
30. How did you move into the eco-home? Did you choose this eco-home or was it allocated to you?		
a) choose the eco-home <input type="checkbox"/>		
had the eco-home allocated to them <input type="checkbox"/>		
31. Were there show houses built in the neighborhood: yes <input type="checkbox"/> no <input type="checkbox"/> how many showhouses		
Where did they obtain the information about eco-homes from?		

33. what does the house not have ?

- a) ceiling
- b) eco-windows (placement and size)
- c) insulated walls
- d) facing North
- e) overhang

34. Do they like the eco-home? Yes No

35. What do they **like most** about the eco-home?

What do they **dislike most** about the eco-home?

37. Is it better than standard house? Yes No:

In what ways is the eco-home **better** from the standard home?

In what ways is the eco-home **worse** than the standard home?

38. Have you noticed any difference in the **total** amount of money you spend in **the cold months** (May-July) on energy since occupying the house? Yes No

If **yes**, are you spending more or less? how big is the difference? Why do they think there is a difference in the amount you are spending now compared to the amount you spent before?

Spending more or less in winter	How big the difference is	Why is there a difference in amount spent on energy
Spending more <input type="checkbox"/>	Big <input type="checkbox"/> Small <input type="checkbox"/> Moderate <input type="checkbox"/>	

Spending less <input type="checkbox"/>		Big <input type="checkbox"/> Small <input type="checkbox"/> Moderate <input type="checkbox"/>	
39. Have you noticed any difference in the total amount of money you spend in summer or hot months on energy since occupying the house? Yes <input type="checkbox"/> No <input type="checkbox"/> If yes , are you spending more or less? how big is the difference? Why do they think the difference occurred?			
Spending more or less in summer	How big the difference is	Why is there a difference in amount spent on energy	
Spending more <input type="checkbox"/>	Big <input type="checkbox"/> Small <input type="checkbox"/> Moderate <input type="checkbox"/>		
Spending less <input type="checkbox"/>	Big <input type="checkbox"/> Small <input type="checkbox"/> Moderate <input type="checkbox"/>		
40. Are you aware that the house you live in is an eco-home? Yes <input type="checkbox"/> No <input type="checkbox"/>			
What does the interviewee consider to be the characteristics of an eco-home?			
Have you told anyone else outside the community about the eco-home? Yes <input type="checkbox"/> No <input type="checkbox"/>			
41. Would you advice your friends to construct or buy an eco-home? Yes <input type="checkbox"/> No <input type="checkbox"/> : If yes , Why? If No , why not?			

42. Do your windows have security bars? Yes <input type="checkbox"/> No <input type="checkbox"/>					
45. Do you open your windows in winter during the day, at night; how long do you keep the windows open? Why do you open or not open the windows?					
Open windows in the day	Time windows are open in the day	Reason for window open or not in the day	Open windows at night	Time windows are open at night	Reason for window open or not at night
Do you open your windows in Summer during the day, at night; how long do you keep the windows open? Why do you open or not open the windows?					
Open windows in the day	Time windows are open in the day	Reason for window open or not in the day	Open windows at night	Time windows are open at night	Reason for window open or not at night
How many types of curtains do you have? Thick ones <input type="checkbox"/> thin ones <input type="checkbox"/> both <input type="checkbox"/>					
46. Have you ever had a fire in the house before moving to the eco home and after moving into the eco-home? What was the cause of the fire?					
Had a fire before moving to the eco-home: yes <input type="checkbox"/> no <input type="checkbox"/>			Had a fire after moving to the eco-home: yes <input type="checkbox"/> no <input type="checkbox"/>		
Cause of fire before the eco-home: a) Candles <input type="checkbox"/> b) paraffin lamp <input type="checkbox"/> c) paraffin heater <input type="checkbox"/> d) wood heater <input type="checkbox"/> e) other heater <input type="checkbox"/> f) other (please specify)			Cause of fire after moving to the eco-home: a) Candles <input type="checkbox"/> b) paraffin lamp <input type="checkbox"/> c) paraffin heater <input type="checkbox"/> d) wood heater <input type="checkbox"/> e) other heater <input type="checkbox"/> f) other (please specify)		

Social Benefits

47. In what ways do you think the community has benefited from having eco-homes ?

48. Did you participate in the construction of the eco-homes?

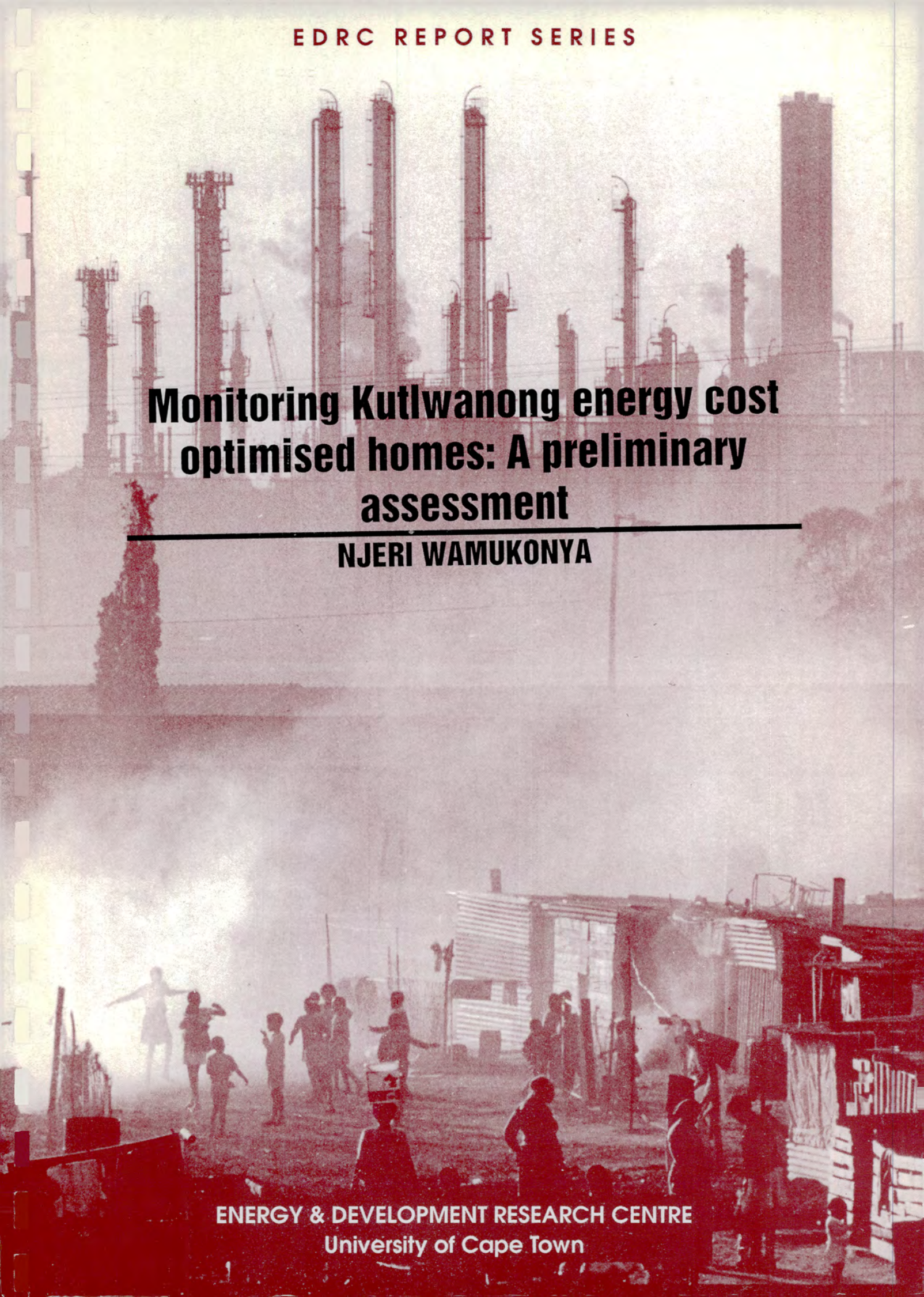
49. Were you trained on how to construct eco-homes? Yes No:

If **yes**, have you ever used the training you received ? Yes No: How?

Do you think the training will be useful in future? Yes No: How?

50. Do you know someone who was trained to construct the eco-homes? Yes No: Do you know if these persons are using the training they received for constructing houses? Yes No: Are they getting paid for the construction of houses? Yes No: Are they construction eco-homes or standard houses ? eco homes standard houses

Comments: Please include any comments from the household or your observations that would relevant to this survey.



**Monitoring Kutlwanong energy cost
optimised homes: A preliminary
assessment**

NJERI WAMUKONYA