Energy Efficiency Baseline Survey for Rural, Peri-Urban and Urban Households (REEECAP 1.1)

1. Executive Summary

The Energy Efficiency Baseline Study for Namibia is one of several projects that are funded by the Renewable Energy and Energy Efficiency Capacity Building in Namibia programme (REEECAP). REEECAP is implemented by the Ministry of Mines and Energy (MME) through the Renewable Energy and Energy Efficiency Institute (REEEI) in partnership with the Habitat Research and Development Centre (HRDC) and the Desert Research Foundation of Namibia (DRFN). This particular REEECAP project is being administered by the HRDC, and performed by Consulting Services Africa (CSA) and the Desert Research Foundation of Namibia (DRFN). The study focuses specifically on electricity efficiency in the residential sector, and consists of a field study performed in rural and peri-urban areas and a desktop study for urban areas.

The field study was conducted by DRFN in June and July 2007 with the objective of assessing the extent to which energy efficiency is incorporated in rural and peri-urban houses in Namibia. The survey coincided with Namibia's winter months, where climatic conditions are the most extreme and daily temperature fluctuations at their highest. During this period, questionnaire-based surveys were conducted in 30 localities across Namibia focusing specifically on rural and peri-urban communities and low-income households. A total 513 questionnaires were completed and analysed. The following Section 1.1 of the Executive Summary presents the national data analysis for Namibia, while Section **Error! Reference source not found.** of the Report presents the data per individual locality.

The desktop study was conducted by CSA and includes a survey of energy (electricity) efficiency practices and technologies and a review of current policies and programmes regarding energy efficiency. The survey was conducted during October and November 2007; a total of 38 suppliers, manufacturers, distributors and consultants were surveyed for sales and installation figures. Section 1.2 of the Executive Summary contains the combined data of the survey, and Section **Error! Reference source not found.** of the Report presents more detailed data. Section 1.3 of the Executive Summary and Section 8 of the Report present the information reviewed regarding energy efficiency policies and programmes.

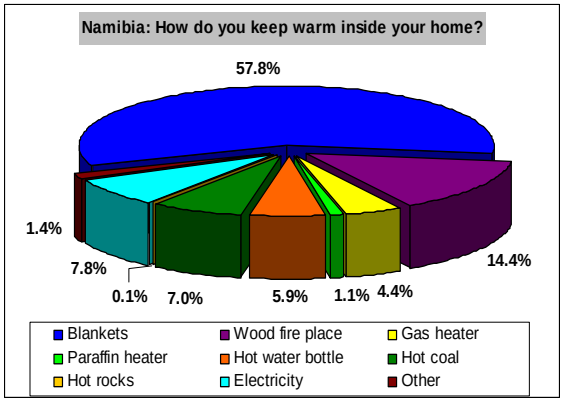
Section 1.4 of the Executive Summary and Section 9 of the Report present general conclusions and recommendations that have been developed based on observations made of the information collect, and on discussions conducted with local suppliers and professional designers.

It should be noted that, for the purposes of this report, energy efficiency is deemed to imply the efficient use of *electrical* energy, unless otherwise stipulated.

1.1. Field study (Rural and peri-urban trends)

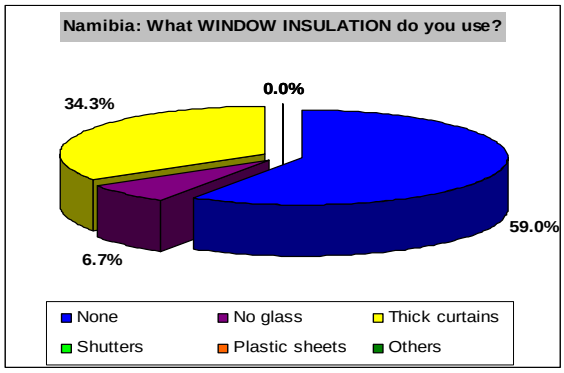
Respondents were selected on a random basis and the data is regarded as representative, where more than 10 respondents were interviewed per locality (for more information on the sample sizes refer to Section **Error! Reference source not found.**).

Over 57% of respondents indicated that they only use blankets to stay warm in winter. Due to low levels of electrification, only 7.8% of respondents have the luxury of using electricity as a heating fuel. Wood fuel used for a wood fire places (14%), hot coal (7%), hot water bottles (to an extent 5.9%), and hot rocks (0.1%), account for about 27% of thermal fuel

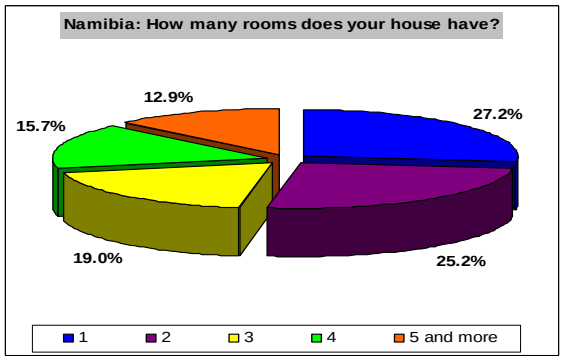


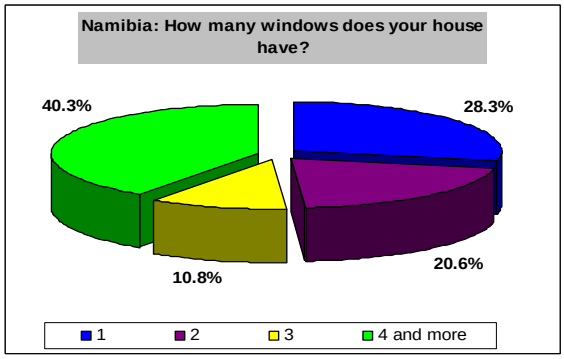
used. This confirms the high dependence on wood as an energy source in rural and peri-urban areas. Gas (4.4%) and Paraffin (1.1%) fuel usage is surprisingly low, which may be due to the high cost of these fuels, especially when used to heat a poorly insulated room.

Windows and doors pose a direct exposure to external climatic conditions. This exposure is maximised if there are no means to close them. Over 6% of respondents indicated that they have no glass in their windows. Although two-thirds (59%) of the respondents have glassed windows, only 34% have an additional form of insulation, in the form of thick curtains. Other types of insulation, such as shutters, do not feature at all.

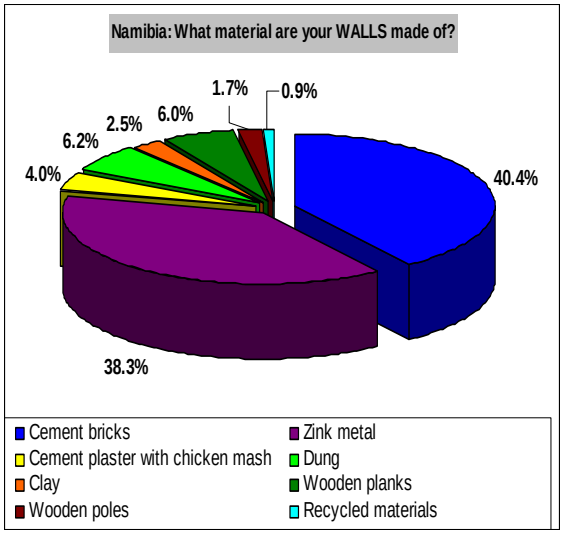


The number of windows in a room is indicative of the amount of passive lighting the room enjoys and the potential to release hot in-door air through cross ventilation. The number of windows should thus be considered within the context of the number of rooms a house has. The ratio between number of rooms and number of windows is almost equal, indicating that there is in most cases one window per room. Passive lighting is adequate, but this also depends on the size of the window. The cross ventilation potential is adequate, but this also depends on the orientation of the window. It can be concluded though that the number of windows compared to number of rooms is at a minimum as regards overall energy efficiency requirements.

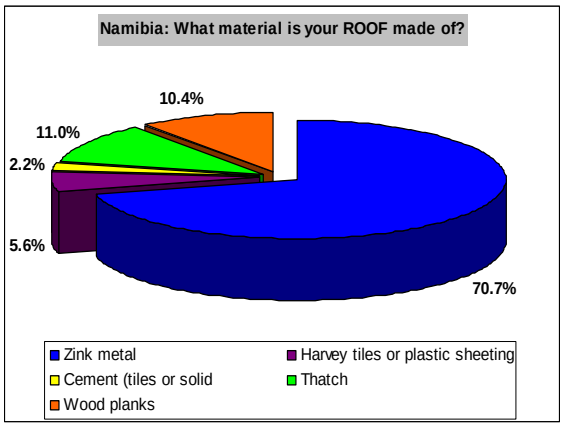




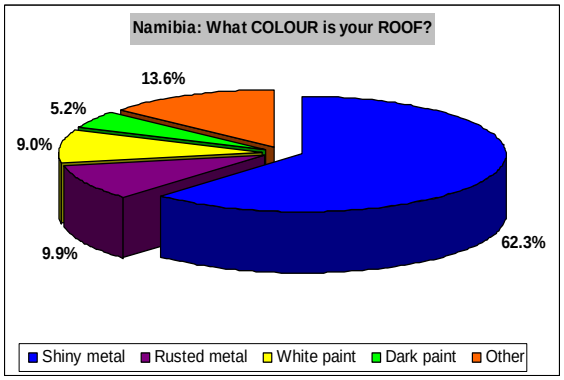
There is an almost equal measure between zink metal walls (38%) and cement brick walls (40%). Zink metal walls have the lowest energy efficiency rating of the given options. Dung, at 6.2%, is used only in remote rural settlements, most commonly in Namibia's northeast at Kamanjab, Fransfontein, Erwee, Anker and Sesfontein. Wooden poles (1.7%) are most often used in combination with clay, dung or cement plaster and as such overlap with these areas. There is also a relatively high utilisation of clay in Noordoewer and Henties Bay, where the material is easily accessible along the banks of rivers, but clay only contributes 2.5% to building materials used overall. Wooden planks (6%) are commonly used in the coastal



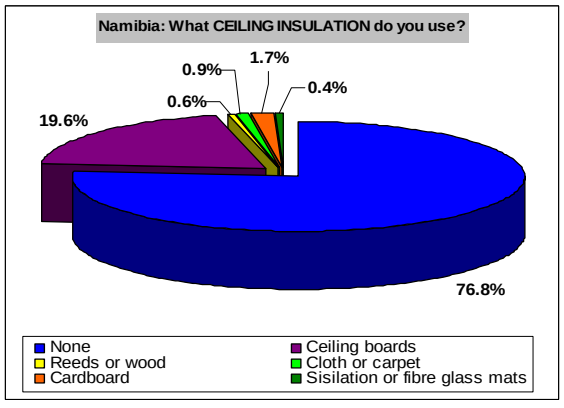
areas such as Hentiesbay and Swakopmund and even further in-land along the Kuiseb River. This can be ascribed to the high rate of corrosion to metal caused by the Atlantic Ocean mist. Cement plaster supported by chicken mesh wire contributes 4% overall and apart from northeast Namibia, is also used in the South (Gibeon, Tses).



At over 70%, Zink metal dominates as a building material for roofs. This applies to most houses in Namibia. It's simplicity to install and large unit surface make it convenient, but without ceiling insulation or insulating paint, it has a very low energy efficiency rating. The use of wooden planks (at 10%) and thatch (at 11%) is common across Namibia. This does not only apply to remote rural areas, but also to some low income peri-urban households. Together with plastic sheeting (5.6%), these materials are used extensively along the coast, where the installation of zink metal roofs is actually uncommon. Also, most "modern" medium to high-income houses in these areas use plastic harvey tiles, cement or clay tiles or have a vulcanised plastic layer covering the roof.

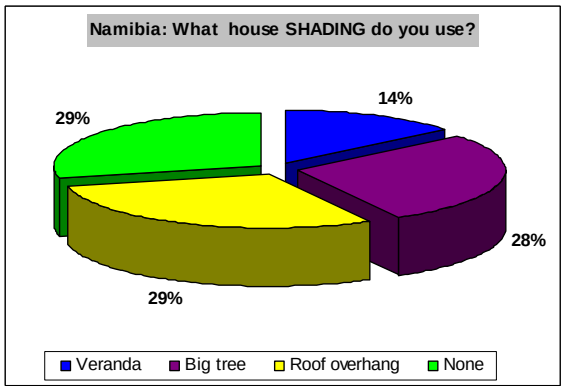


In order to determine the amount of heat a zink metal roof attracts, an assessment of the roof colour was made. A rusted metal roof, dark in colour, has the lowest energy efficiency rating and this applies to almost 10% of surveyed houses. Dark painted roof offer slightly more protection, but this is still inadequate and applies to 5.2% of houses. Shiny metal roofs, at 62%, are the most common and, although being highly reflective, have a lower energy efficiency rating than white painted roofs. The latter only applies to 9% of houses. "Other" (13.6%) applies to roofs with a "natural" colouring such as thatch and unpainted wood and also plastic sheeting.

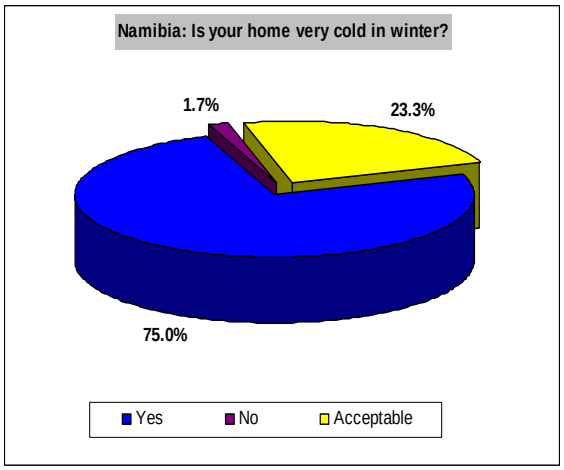


Ceiling insulation is a vital construction technique to reduce the uptake of heat through the roof during the day and the loss of heat during the evenings. Over 76% of houses do not have any form of ceiling insulation, while almost 20% only rely on ceiling boards, which have inferior insulating properties. The remaining 4% are shared between the different other insulation materials. Of these, sisilation and fibre glass have the best thermal insulation performance, but also rate the lowest at a mere 0.4%. Ceiling insulation is thus extremely uncommon in Namibia and this of course has a negative impact on the indoor climate.

Shading1 is used by over 70% of respondents, with 30% using no shading despite Namibia's high solar irradiation levels. The most common shading options are roof overhangs (29%) and big trees (28%). It can be assumed however that in many instances, big trees were already present and were not consciously planted by the current residents. Verandas, at 14%, contribute relatively little in terms of shading option, which can be ascribed to higher construction costs, smaller erven sizes and possibly security risks. Residents, rather than opting for an open veranda, rather opt for an additional closed room.



It is important to determine the perception of household residents regarding the levels of comfort enjoyed inside the house as regards climate. Based on this perception it can be assessed whether there is indeed scope for implementing energy efficiency measures in houses, or whether current comfort levels are acceptable and there is no merit in investing into such measures. Of all respondents, 75% indicated that they experienced their houses as cold during winter. A further 23 % found the temperature acceptable, while a mere 1.7% found that their homes were not cold in winter. Against this background it can be concluded that there would be a high need for energy efficiency in houses. These results also indicate that, despite the majority of households regarding their homes as cold in winter, only very few have made an attempt to initiate improvements.



1.2. Desktop study (Urban areas)

A desktop survey was conducted in November 2007, with the aim of establishing a baseline for energy efficiency practices in urban areas and in the construction industry. A total of 38 suppliers, manufacturers and distributors were surveyed for sales and installation figures. The data collected is regarded as representative when used to indicate averages and trends.

1.2.1. Efficient lighting

The recent Government project to distribute energy savings lamps free of charge has highlighted the case for energy efficient lighting. The efficient technologies have shown increases in sales in the last year (greater than 20%), but due to high costs are still the least favoured alternative among the lower income groups. It seems most likely that cost-conscious buyers will replace their "free," energy saving lamps with cheaper conventional ones.

1.2.2. Solar water heaters (SWH)

Extreme increases (> 300%) were recorded for sales in 2006, due in part to institutional investment, but even with this taken into account there has been

[1] Questions regarding shading were introduced while the survey was already underway; as such shading data applies only for Gibeon, Omaruru, Uis, Kamanjab, Khomnarib, Karibib, Aranos and Stampriet. A total of 156 surveys were obtained.

significant increases in sales and installations. The general consensus is that if the revolving fund were to operate properly, sales would increase even more.

1.2.3. Insulation

Sales indicate that there is only a passing awareness of the importance of proper insulation. More than 25% of roof sheeting sold is done so without an equivalent sale in insulation (overhangs and sloping seem to account for only a 10% - 15% difference on average). Also little or no product information is easily available, nor does it seem to be requested. In-depth research has shown that both in Namibia and abroad there is a significant lack of accurate data regarding insulation performance.

1.2.4. Heat reflecting paint

All of the companies surveyed, except for one, indicated that they have only been selling specialised heat reflecting paint products for the last one or two years. Prices within this segment vary by as much as 400% from cheapest to most expensive. Again, very little hard evidence is available to provide the consumer and designer with facts regarding performance of these products. At least two manufacturers informed us that they recommend to their clients using a normal PVA paints (specifically white paint) as a means of reducing heat loading. Most retailers of heat reflecting paint reported increases in sales greater than 20% over the last year.

1.2.5. Advanced glass technology

Laminated glass with advanced coatings that reduce heat transfer and enhance reflectivity of unwanted radiation is an expensive technology but available in Namibia. One general misconception identified during the study is that glass is cheaper per unit area than the equivalent area brick wall. Laminated glass is more expensive than brickwork by a fair margin and seems to be used as a mitigating factor in designs which would otherwise be impractical in the local climate, rather than optimising already efficient designs. Sales increased more than 20% over the last year.

1.2.6. Load control

The City of Windhoek has had a program in place for the regulation of consumer's electrical loads for a number of years, called "Ripple Control". The system allows the Municipal Authority to shut down consumers' water heaters via a control signal sent over normal mains power supply. The Authority can then return the heaters to normal operation once the power peak has been avoided. There is currently one project underway to refurbish or install up to 600 consumers' ripple controllers.

Controlled load shedding to avoid high peak loads is used by a number of large consumers (who thereby avoid high peak tariffs) in Namibia but is largely unknown under domestic consumers. The technique is largely unknown since it does require some technical knowledge to be appreciated. The main argument behind reducing peak loads lies in reduced infrastructure requirements and lower losses of energy during peak times.

Another technology known as Power Factor Correction (PFC, the correction of capacitive or inductive properties of certain electrical loads) is in wide spread use among large power consumers, and only makes economic sense when implemented on large scales.

1.2.7. LP Gas

Liquefied Petroleum Gas is not a new technology but offers a cost effective option to save on electrical energy. According the retailers of LPG in Namibia, the saturation point for sales has not been reached: a national study conducted indicates a

possible sales volume of 1000ton/a, of which only 600ton/a are being supplied at this moment. Sales figures show that sales growth is extremely low (less than 1%), most likely due to the initial costs required, possible safety issues and the inconvenience of refilling gas bottles.

1.2.8. Air conditioning

Air conditioning is a serious threat to energy efficiency. As with advanced glass technologies, air conditioning is often added to new and existing buildings to ameliorate poor thermal designs. Air conditioning in a poorly designed building usually does not operate as well as expected and in any case consumes much more energy than in a well designed building, due to losses. One factor adding to the importance of air conditioning as a serious contributor to energy waste is the low cost and high availability of imported, low efficiency air conditioners. For this section of the market, increased sales (more than 20%) were noted over the past year, while the higher quality suppliers have noted a depression in sales. There is also a general lack of awareness about the high efficiency air conditioning systems that are available.

1.2.9. Appliances

There are currently no requirements for retailers of electric household and office appliances to display the energy ratings of the appliances. Namibia does not subscribe to a specific rating system, as might be found in Europe. It is believed that most of the common electrical appliances available in Namibia would not meet the high efficiency standards of developed countries; which could only be acquired on special order basis.

1.2.10. Building industry regulations

The current building regulations (mainly based on SANS10400) do not require set performance levels from buildings in terms of energy consumption and wastage. The lack of encouragement, either through penalties imposed for poor design and construction or incentives offered for efficient designs, has caused a laxness with regard to implementing energy efficient design. Lack of information, skills and knowledge regarding these issues hamper consultants and contractors to proactively promoting alternatives to their clients. Architects especially are in a prime position to educate clients and users on the advantages of energy efficiency and cost benefits, but they clearly lack the information that is needed by their clients to make informed decisions based on life cycle costs and cost/benefits.

1.2.11. Other solar and renewable energy products

Though not forming part of this study, information was gathered regarding the state of renewable energy sales in Namibia. All indications are that consumers are showing increased interest in renewable energy generation but are generally put off by the high costs.

1.2.12. Main problem areas identified

In general, whilst conducting the interviews with all respondents, certain trends in market perceptions where established as follows:

- Consumers generally lack education with regard to cost savings calculations (cost/benefit and life cycle costing) and environmental issues. This appears not to be limited to low income groups.
- Consumers generally lack information, specifically regarding effectiveness of certain energy efficient technologies. It can also be said with confidence that the general populace have very little experience working with the energy consumption figures of most general household devices.

- Lack of incentives. The relatively low costs of electricity per unit and of energy inefficient devices (as opposed to efficient devices) provide little incentive for consumers to change their current consumption patterns.
- High costs of energy efficient devices and a lack of subsidisation create low volumes of sales which in turn do not facilitate reductions in costs due to increased volumes, keeping prices high.
- It can be said that, on-average, most energy efficient technologies require more maintenance and effort due to their higher levels of refinement. Even in cases where this is not true, some consumers feel that this is indeed the case.
- As a general rule, large towns and cities tend to have higher percentage of rental properties than do small towns, villages, rural areas and even peri-urban areas. There is little motivation for landlords and developers to invest in energy efficient designs and technologies since they are typically not the ones living the rental house or paying the electricity bills.

1.3. Desktop study (Policies and programmes)

In conjunction with the desktop survey for urban areas, a study was made to establish a baseline for energy efficiency policies and programs being implemented in Namibia.

1.3.1. Energy Efficiency Initiatives of the Namibian Government

Government is driving towards the implementation of a national demand-side management program to reduce peak loads. A motivating factor for the introduction of demand side management measures is the reduced strain and associated losses on the network (which was designed to cope with a certain, fixed maximum, load). Lowering and/or flattening the demand curve holds financial benefits for utilities and possibly for consumers. Government's involvement with energy efficiency is guided by Article 95 of the Constitution, but energy efficiency and renewable energy issues are not covered by the Vision2030 plan, and only sparsely in the Second National Development Plan (NDP2) plan. In an early draft chapter of the energy sector contribution to the compilation of NDP3, concrete reference is made with regard to the active financial and institutional promotion of EE.

The Ministry of Mines and Energy (MME) has adopted the *White Paper on Energy Policy*, and implemented two other reports: the *Strategic Action Plan for the Implementation of Renewable Energy Policies as Outlined in the White Paper on Energy Policy*, and the *Development of a Regulatory Framework for the Renewable Energy and Energy Efficiency with the Electricity Sector*. Although the White Paper and two reports are not approved regulatory documents that requiring energy efficiency measures in the building and related sectors, they by implication create a supportive atmosphere for the future implementation of energy efficiency programmes and regulations. The *Development of a Regulatory Framework*, in particular, recommended the drafting and approval of an Energy Efficiency and Conservation Act which would support the following activities and regulations:

- National target for energy efficiency
- Appliance labelling programme regulations
- Minimum energy performance standard regulations
- Regulations requiring solar water heaters for public institutions
- Regulations requiring energy audits of public institutions
- Energy efficient building regulations

The Electricity Control Board (ECB) has implemented a *Demand Side Management (DSM) Study for Namibia* which identified six demand side management options for further investigation:

- Launching a consumer education and awareness campaign
- Introducing time of use electricity tariffs
- Disseminating compact fluorescent lights
- Replacing electric water heaters with solar water heaters
- Expanding ripple control systems
- Conducting energy audits in the commercial and industrial sector

1.3.2. Externally Supported Activities

In its continued drive to introduce energy efficiency measures, the Namibian Government and its state-owned entities are supported by various externally funded programmes, listed below in order of completion, current and planned.

- *Cleaner Production Project (CP)*

  The Danish Government through the Danish International Development Assistance (DANIDA) is supporting a Cleaner Production Project with the following overall objective: "A significant reduction in the environmental impact of the Namibian industry/services, due to the application of cleaner production and adoption of the preventative approach – leading to improved occupational health and safety within the industry/service sectors, improved external environmental sustainability and improved productivity and industrial/service competitiveness through introduction of continuous technology adaptation."

- *Renewable Energy and Energy Efficiency Capacity Building in Namibia (REEECAP)*

  The overall objective of the Danish-funded REEECAP Project is to "increase the capacity of the Namibian resource base in selected areas to enable it to contribute to the implementation of national policies for renewable energy and energy efficiency as stated in the White Paper on Energy (1998) and the Second National Development Plan (NDP2, covering 2001-2005)".

- *Namibia Renewable Energy Programme (NAMREP)*

  The goal of the NAMREP Programme is to "increase affordable access to sustainable energy services through the further development of a market for Renewable Energy Technologies (RET) in Namibia that contributes to climate stabilization by reducing CO_2 emissions through the removal of capacity, institutional, public awareness and social acceptability, financial and technical barriers". The NAMREP Programme has five distinct outcomes, namely:

  - build capacity within institutions of the Government of Namibia (GRN), RET Industry, NGOs and the Programme Management Unit (PMU)
  - new policies, laws, regulations and actions in support of RETs in place within Ministries and other stakeholder institutions
  - increased public awareness and social acceptability of RESs amongst stake-holders
  - increased accessibility of RETs as a result of more affordable financing scheme(s) and policies/strategies to reduce costs

- *Namibia Energy Efficiency Programme (NEEP)*

  An application has been prepared with the assistance of the UNDP for the co-funding of the NEEP by the Global Environmental Facility (GEF). It is anticipated that a preliminary approval for the design of the programme will be granted by March 2008, when funds will be released for a 6-month project preparation period. It is anticipated that the NEEP initiative will contribute to a 120 GWh reduction in energy consumption per year by the end of the project

implementation phase (probably January 2008 to December 2011). Over 15 years, the energy efficiency contribution is expected to total 1,560 GWh.

1.4. Conclusions and Recommendations

1.4.1. Conclusions

Field Study (rural and peri-urban trends):

In order to place the results of the field survey into perspective one needs to define what features would constitute an energy efficient house, within the constraints of low-cost housing. There are four fundamental elements regarding the improvement of the temperature inside a house:

- **Colour**: Light colours reflect heat, while dark colours absorb heat. In Namibia, roofs and walls should be painted in light colours in order to minimise heat absorption.
- **Shading**: Casting shade onto a wall or roof will avoid direct sun light. Blocking off direct sunlight will minimize the absorption of heat. The reverse applies in winter, where solar heat might be beneficial in warming up a house. Ideally, shading should be able to accommodate this seasonal shift.
- **Insulation**: Insulation creates a barrier to prevent the movement of heat. Insulating materials can be obtained as commercial products, but also be made from recycled materials.
- **Ventilation**: Air movement helps to carry heat away. Windows and other ventilation openings will prevent heat from accumulating inside a room, by allowing heat to escape or to be transferred to the outside.

There is no indication that a comprehensive approach towards integrating these elements is being pursued in low-cost housing. The choice of colour is arbitrary and the prevalence of reflective metal sheeting is due to the fact that this is the manufactured quality of the material and not a conscious selection criterion of home owners. The use of shading is not as commonplace as one might expect for a desert country. Although there is a prevalence of shading from trees, this is in all likelihood a subconscious selection criterion, rather than a conscious tree planting initiative. The use of insulation is not commonplace. It is interesting to note that there is a strong correlation between the use of insulation and the perception of in-door climate. In the case of Anker for instance, 13% of respondents use sisilation or fibreglass wool and 13% have indicated that they do not experience their house as being cold in winter. Windows are generally used and perform a vital ventilation function; however in most instances there are fewer windows than there are rooms in the house (this especially applies to shack-type housing). The result is stagnant air and trapped heat.

In conclusion, it can be stated that the penetration of energy efficiency measures to improve the indoor climate of low-income houses in Namibia is very low and that there is little indication of a generally conscious aspiration to improve the perceived discomfort.

Desktop Study (urban trends):

With reference to the desktop study of trends in urban areas, it can be concluded that energy efficiency is largely misunderstood, unknown or ignored. The single most important issue to be addressed is education. There is no group of people that can be singled out with regard to education: lack of information is affecting the person-on-the-street as well as the expert alike. The building industry especially could benefit from good, clear and concise information regarding energy efficiency that would outline the availability of relevant technologies; their costs and benefits; their life cycle costs and payback periods. The same holds true for all commercial

sectors. It is yet unclear how widespread information distribution should be effected in the public sector, but it will have to be simple, precise and interesting if it is to be widely accepted.

1.4.2. Short Term Recommendations

Target	Milestone / Deliverable	Timeline	Est. Cost
Regular implementation of baseline studies	Establish network with relevant parties (distributors, installers, rural residents etc.) who can provide information regularly and without question	Based on other projects; Possibly annually	Free – N$ 10k
Address short term short-comings identified through this report	Strive to provide the industry (especially) with non-biased, easy-to-read technical information	< 1 year	N$ 10k – N$ 100k

It is recommended that future baseline studies be conducted after implementing renewable energy or energy efficiency programs or on a periodic basis – as a feedback mechanism for gauging effectiveness.

The shortcomings identified in this report, in the various sectors, can be directly targeted by other programs to promote awareness and change.

1.4.3. Long Term Recommendations

Target	Milestone / Deliverable	Timeline	Est. Cost
Decision makers should review previously-made recommen-dations: these should be refined and implemented	Review of said recommen-dations in the past reports; planning for refinement of recommendations	-	-
Implementation of refined recommendations at executive and legislative levels	Bills are passed and institutions are founded, with the aim of enforcing implementation of RE & EE	-	-
Launch education programs that would disseminate the information gathered through this and other REEECAP projects	Provision of a program and training materials, launching of a sustainable education venture	-	N$ 1mil – N$ 10mil
Form and motivate consumer action groups	-	-	Free

Decision-makers in the MME, ECB and Cabinet, and other key stakeholders, should review the recommendations previously made in the MME and ECB reports mentioned in this report, since most of the recommendations are still valid at the time of writing this report, though they would require further study and refinement before they could be approved and implemented by Cabinet, MME, regional and local authorities.

The education and awareness raising needs to targeted at several different sectors of the Namibian society: key decision makers and approval agencies within Government, regional and local authorities; consultants; developers; building owners; and the public at large. People generally need better access to information that informs them about the various technology and design practice options, the costs and benefits of those options, and the life cycle costs of those options.

It would also beneficial if a consumer action group(s) were formed that would encourage suppliers and distributors to better inform clients about the energy efficiency performance levels of their products.