# Energy Efficiency In Low-Cost Housing

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# Energy Efficiency In Low-Cost Housing

An Interactive Qualifying Project Report
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by


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**Abstract.**

This report, prepared for the Renewable Energy and Energy Efficiency Bureau of Namibia [R3E], identified and analyzed techniques for increasing the energy efficiency [EE] of low-cost housing in Informally Settled Areas of Windhoek, Namibia. To help facilitate the Energy Efficient Urban Demonstration Village umbrella project, we developed a summary of EE techniques, a working paper to increase EE education, a pre-prepared presentation designed to introduce key EE concepts to general audiences, and a database for R3E designed to organize stakeholder information.

**Primary Authors of Major Sections.**

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## Terms List.

| Acronym | Full Name |
|---|---|
| CoW | City of Windhoek |
| DANIDA | Danish International Development Assistance |
| EEUDV | Energy Efficient Urban Demonstration Village |
| GRN | Government of the Republic of Namibia |
| HRDC | Habitat Research and Development Centre |
| ISA | Informally Settled Area |
| MME | Ministry of Mines and Energy |
| MRLGH | Ministry of Regional and Local Government and Housing |
| NGO | Non-Governmental Organization |
| NHAG | Namibia Housing Action Group |
| NHE | National Housing Enterprise |
| NHP | National Housing Policy |
| OCD | Office of Community Development |
| OHP | Office of Housing and Properties |
| OSD | Office of Sustainable Development |
| PIAB | Presentation-In-A-Box |
| R3E | Renewable Energy and Energy Efficiency Bureau of Namibia |
| R3E-MCD | R3E Meeting and Contact Database |
| SAOTG | South African Online Travel Guide |
| SDFN | Shack Dwellers Federation of Namibia |
| USDOS | United States Department of State |

**Executive Summary.**

Approximately 450 people have migrated to the informal sectors of Windhoek, Namibia, each month since 1991. This has led to the current problematic situation of over 26% of the city's population living in Informally Settled Areas [ISAs]. ISAs are areas of government-owned land that have been settled without formal permission (U.S. Department of State [USDOS], 2001, Section 2; City of Windhoek [CoW], 2003c, p. 1). These ISAs have substandard living conditions, including problems such as little or no running water, little or no waste management, and no electricity (CoW, 1999, pp. 3-7; CoW, 2003b, sect. 1-7). In addition to infrastructural problems, top structure problems—problems with actual buildings, especially housing—are also very common (A. Muller, personal communication, 3/25/03).

A major problem with housing in ISAs is that existing housing is of substandard quality. Most dwellings in ISAs are built inefficiently using whatever materials are available, including corrugated iron sheets, flattened metal drums, or cardboard, and little or no attention is given to energy efficiency—temperature regulation without input of energy. These houses can have dangerously hot indoor temperatures during the summer and uncomfortably cold temperatures in the winter, and increasing demands for relief from the heat have contributed significantly to the decreased quality of life for residents of these settlements. However, some of these temperature problems could be eased using innovative and relatively inexpensive energy efficiency measures. In Windhoek, projects designed to improve conditions in ISAs have relied on a sites and services approach supplemented with self-help loan programs, where permanent land and basic amenities

are provided to ISAs and later upgraded on a full cost-recovery basis. However, these programs have not focused on energy efficiency, an important consideration in the harsh climate of Namibia. Unlike other housing projects, ours focused on increasing energy efficiency of current housing in order to improve the living conditions of ISA residents.

The main goal of the *Energy Efficiency In Low-Cost Housing* project was to develop affordable recommendations to increase energy efficiency of low-cost housing. Our objectives included identifying the roles of major stakeholders in the project, finding techniques to increase energy efficiency, and developing a way to distribute energy efficiency information. This project was the first stage of the Danish International Development Assistance [DANIDA]-funded Energy Efficient Urban Demonstration Village [EEUDV] project currently being undertaken by the Renewable Energy and Energy Efficiency Bureau of Namibia [R3E], which is scheduled to be completed by 2005.

To achieve our goal and objectives, we developed a two-pronged process to collect the data that we needed to complete our project. The two major steps of the process were stakeholder research and energy efficiency research. Stakeholder research was conducted through snowball sampling and semi-structured interviewing to find information on both agencies and affected ISA communities. These methods were ideal for collecting these data because it allowed us to generate a relatively exhaustive sample from which to collect relevant, more detailed information. Energy efficiency research was conducted both by studying texts and by directly observing current ISA housing. These methods were used in order to facilitate the continual development of recommendations realistic for increasing energy efficiency in ISA situations. We

developed our recommendations by synthesizing the information collected from these two steps into energy efficient options that were suitable for the financial and environmental conditions in Windhoek ISAs, and we developed our deliverables—the R3E-Meeting and Contact Database [R3E-MCD], the working paper, the Presentation-In-A-Box [PIAB]—on the basis of our recommendations.

We achieved our first objective through our stakeholder research. One conclusion that we drew from this research was that while similarity between stakeholder projects is quite high, the communication among stakeholders is quite low. While this seems ironic, the explanation may lie in the organization of communication webs. We found that a network of communication exists among and within stakeholders. In this network, information sharing within the agencies themselves is often ineffective, leading to many of the communication problems between offices within a single agency. Thus, while many agencies may have similar projects, the lack of effective communication may prevent information sharing both within and among agencies. These concerns led us to recommend that stakeholder communication, both internal and external, be increased in order to smooth the implementation of EEUDV. To assist R3E in increasing stakeholder communication, we developed the R3E-MCD, which contains all useful contact information for each of the stakeholders, as well as notes from meetings with stakeholders. In the future, R3E will help stakeholders share information by organizing seminars and distributing information about EEUDV and energy efficiency, and the R3E-MCD will aid R3E in this endeavor.

We achieved our second objective through our energy efficiency research and direct observations. The major techniques that we recommended to increase energy

efficiency of low-cost housing included proper site and orientation of the housing in regards to the sun, constructing walls and roofs using energy efficient methods and materials with surface properties conducive to positive temperature regulation, using a variety of insulating materials to prevent heat from entering or escaping the house, adding windows to increase ventilation, and planting vegetation around the house to provide shade and cool the air. All of the suggested techniques were analyzed based on their effectiveness and feasibility in low-cost housing situations. Our recommendations will be further researched by R3E, which will then distribute the information to stakeholders and ISA residents. To assist R3E with this task, we compiled a table, located in Appendix A, of all of our recommendations; this can be updated and revised as necessary. We derived the working paper and PIAB from this table.

To achieve our third and final objective, we developed two methods to distribute energy efficiency information. Our first distribution method was our working paper. This 7-page document, located in Appendix D, was targeted specifically towards stakeholders of the EEUDV project. The working paper contained a list of major stakeholder organizations and the potential roles that they were expected to play in EEUDV, although roles have not yet been distinctly defined. The working paper also contained all of the energy efficiency recommendations that we collected through our research, including justifications and known cultural or social inhibitions for each technique. The working paper served mainly to inform stakeholders about other organizations in the field and which energy efficiency techniques were practical in ISA situations. Our second distribution method was the Presentation-In-A-Box [PIAB], located in Appendix E. PIAB was targeted to ISA residents of any age who may not

speak English as a first language. PIAB relies on pictures and housing component models to illustrate basic energy efficiency concepts, although some verbal explanation is necessary. A trial presentation was conducted with 24 residents from three of the ISAs surrounding Windhoek: Havana, Okahandja Park, and Ongulumbashe. This presentation was very successful; the ISA residents appeared to be very interested in learning more about energy efficiency and participation and interaction during the presentation was high. Officials from the City of Windhoek requested a copy of PIAB to develop further for future use in their educational programs, and R3E is currently in the process of publishing our working paper as an informational brochure on energy efficient techniques that can be distributed directly to ISA residents. In the future, R3E will distribute PIAB to stakeholders in close contact with ISA residents to teach residents the basic principles of energy efficient construction. Additional benefits of PIAB include increasing the amount of community participation in housing projects and stimulating creativity among residents in the area of housing solutions.

After achieving our objectives, we were able to draw major conclusions from our research and make recommendations for future areas of research. After identifying roles and relationships among stakeholders, we concluded that more communication is necessary in order to facilitate effective working relationships among organizations. The stakeholder database will provide one tool to aid R3E in achieving this goal in the future, but more interaction should be encouraged. Following energy efficiency research on techniques used in Windhoek, we concluded that current housing policies do not address energy efficiency in low-cost housing, and we suggest that basic energy efficient concepts be integrated into future legislation and policy. After developing strategies to

distribute information, we concluded that while energy efficiency is a priority for residents, they do not feel that they are able to improve their housing situations. To remedy this problem, we recommend that PIAB or other educational programs be instituted in Windhoek and surrounding areas to increase awareness of energy efficiency and its implications on low-cost housing quality. In addition, distributing the working paper to organizations already affiliated with educational programs will raise awareness about energy efficiency within these organizations. Finally, after compiling our recommendation table, we recommended that more research into energy efficiency in Windhoek be conducted and gaps in our research, including issues of affordability and cultural appropriateness as well as quantifications of energy efficiency, be examined in more detail before implementation of strategies.

## Chapter 1. Introduction.

Increasing urbanization and population growth cause many problems in less developed countries. In Namibia, the effects of urbanization are becoming increasingly prominent, with approximately 450 people migrating and settling in the informal areas of Windhoek, the capital, each month since 1991 (U.S. Department of State [USDOS], 2001, Section 2; City of Windhoek [CoW], 2003c, p. 1). According to Winterfeldt (2002, pp. 50-59), one reason that many people in Namibia migrate to urban areas is the lack of sufficient employment in rural regions. The high immigration rate, in conjunction with a high unemployment rate in Windhoek, has led to the creation of squatter settlements, also known as informally settled areas [ISAs]. ISAs are areas of government-owned land that have been settled without formal permission. With no steady source of income, many immigrants must reside in ISAs already filled with others in the same situation. Currently, over 65,000 of Windhoek's approximately 250,000 residents, or more than a quarter of the population, live in ISAs (CoW, 2001a, p. 6). The rapid expansion of ISAs in Windhoek has had major effects on the city, including a critical housing shortage and related housing problems.

Because the burgeoning population of ISA residents has limited financial resources, there is an urgent and growing need for a plan to improve housing conditions in a cost-efficient manner. ISA residents' extremely limited financial capabilities have led to deficient living conditions within ISA communities, including infrastructural problems, or problems with services, such as little or no running water or waste management and no electricity. In addition to infrastructural problems, top structure

problems—problems with actual structures, especially housing—are also very common in ISAs, where existing housing is of substandard quality (Muller, personal communication, 3/25/03). Most dwellings in ISAs are little more than shacks. They are built inefficiently using whatever materials are available, and little attention is given to energy efficiency – which is defined in this project as temperature regulation without input of energy. These houses can have dangerously hot indoor temperatures during the summer and uncomfortably cold temperatures in the winter. Despite the prevalence of these problems, the government currently focuses on solutions to the housing shortage, not solutions to increase inhabitability of existing structures.

Because housing problems are a worldwide predicament, many approaches to solving them have been developed. The type of method most often used to ease the low-cost housing burden is a 'sites and services' approach, which provides land and basic utilities and services to ISA residents, either communally or individually. The City of Windhoek routinely implements sites and services programs in many of the Windhoek ISAs on a per-block basis. Services are provided at a basic level and ISA communities can later upgrade the services when more funds are available. In addition to sites and services programs, there are also several self-help loan organizations in Windhoek, including both government-based organizations such as the National Housing Enterprise [NHE] and resident-based organizations such as the Shack Dweller's Federation of Namibia [SDFN]. However, little attention is currently being given to energy efficiency in these housing improvement programs.

While many housing rehabilitation and improvement projects have been instituted, few have focused on energy efficiency. In addition to the newly developing

housing problems caused by population growth, the dry climate and scorching temperatures of southern Africa – in particular Namibia – should make energy efficiency in housing a high priority for Namibians, and new, creative ways to improve living conditions in Windhoek ISAs are acutely needed. The Renewable Energy and Energy Efficiency Bureau of Namibia [R3E] is currently undertaking several projects, including the Energy Efficient Urban Demonstration Village [EEUDV] project, designed to increase sustainability and energy efficiency of low income housing complexes. The extreme temperatures have contributed significantly to the substandard quality of life for residents of these settlements, and R3E proposed the EEUDV project to ameliorate some of these problems and to provide a working model for future ISA improvement in Windhoek.

The main goal of the Energy Efficient Lost-Cost Housing project was to develop affordable recommendations to increase energy efficiency of low-cost housing. Our objectives included identifying the roles of major stakeholders in the project, finding techniques to increase energy efficiency, and developing a way to distribute energy efficiency information. This project is the first stage of the Danish International Development Association [DANIDA]-funded EEUDV project, which is scheduled to be implemented by 2005. The future replacement of ISAs by permanent, energy-efficient communities will be beneficial to Namibia as a developing country as it will both improve the quality of life of working class Namibians and promote energy efficient practices. These communities will help combat problems that increasing urbanization and immigration have been causing in Windhoek, and the information gained from the

project can be applied to similar situations in other parts of Namibia, as well as other parts of the world.

## Chapter 2. Background.

Application of energy efficient techniques in the housing of informally settled areas in Windhoek, Namibia, is a relatively unexplored topic with wide consequences on the inhabitability of low-income homes. Energy efficiency is defined in this paper as regulating the internal temperature of a dwelling without the input of any electricity, a major advantage for low-income families who may be unable to afford electricity. An informal settlement, also known as a squatter settlement, is used in this paper to denote illegal residence on small areas of government land that have been settled without formal permission. We will refer to Informally Settled Areas [ISAs]—areas with informal settlements. In this chapter, the causes of Windhoek ISA formation, housing policies directed towards Windhoek ISAs, problems of ISAs, and characteristics of successful improvement programs were examined, and basic information about major housing stakeholders and energy efficiency was collected and discussed. The information contained in this chapter is critical to gaining the understanding necessary to develop a realistic way to increase the energy efficiency of housing in Windhoek ISAs.

### Section 2.1. Windhoek Housing Problems and Policies.

The causes of ISA formation, problems within ISAs, and thus solutions associated with ISAs can vary greatly from country to country. In Namibia, ISAs have been a concern since its independence in 1990, and studies indicate that the problem will only continue to deteriorate (The World Bank, 2002, Section 1.1-1.3). The current housing policies of Namibia, specifically in Windhoek, do not successfully assuage the problems

associated with ISAs, such as substandard housing, crowding, lack of basic services, and insufficient affordable housing. A brief background on ISAs in Windhoek, the capital of Namibia, is presented in this section in order to frame the context in which the *Energy Efficiency In Low-Cost Housing* project will be conducted. The known demographic information for residents of the ISAs will also be presented, in addition to information about current Namibian upgrading strategies and housing policies.

### 2.1.1. The Rapid Urbanization of Windhoek and the Formation of ISAs.

Windhoek is a rapidly growing city that is now facing numerous problems caused by population expansion. As large numbers of people have migrated into the city over a short period of time, both the physical and economic bounds of the city have had to expand. With this expansion has come the need for more housing and more jobs. While Windhoek has been addressing these problems since its independence, the extremely large number of people who are affected by the expansion has overwhelmed the city's housing resources. Currently, there is a backlog of 8,000 housing units that need to be built by the National Housing Enterprise [NHE], described in Section 2.3.1, in order to accommodate existing ISA residents, not including housing for any new growth (City of Windhoek [CoW], 1999, pp. 3-9). Windhoek ISA residents currently face a major housing shortage, high unemployment rates, and high poverty rates. These problems, which have detrimental effects on ISA living conditions, are the result of both previous policies in apartheid-era Namibia and the high urban immigration rates.

ISAs in Windhoek are expanding quickly as low-income residents move into the settlements, aggravating an already critical low-cost housing shortage. The expansion of

the immigrant population, in addition to low employment rates and high poverty rates, has created a critical affordable housing shortage in Windhoek. Since 1991, an average of 595 people have been migrating into Windhoek each month, 466 of whom migrate into the ISAs. Currently, 26% of Windhoek's population of 250,000 live in ISAs (CoW, 2001, p. 6). In addition to the rapid expansion of Windhoek ISAs, other problems include high unemployment rates and poverty. Unemployment rates in Namibia were reported to be 35% in 1997, and continue to increase (Winterfeldt, 2002, Inside Cover). While reported figures for populations and unemployment rates fluctuate annually, it is known that a large segment of the Namibian society is underemployed or not employed at all. According to Maanda (2002, pp. 6-11), most residents of Windhoek ISAs are unable to afford to purchase the land on which they live, with prices ranging from N$32,000 to N$50,000 (J. DeKock, personal communication, 4/2/03).

Residents of ISAs generally have monthly incomes that are well below the national average, which hovers just under N$1,000; most residents actually make significantly less than this amount. In the poorer north western area of Windhoek where many ISAs are located, 60% of the residents are below the poverty line, set at N$570 per month (Frayne, 2000, p. 2; The World Bank, 2002, Appendix A; Government of the Republic of Namibia [GRN], 2003b, p. 6). In Windhoek ISAs, around 93% of the residents are able to afford no more than N$46 per month for housing (CoW, 2003c, p. 1). Furthermore, approximately 8,000 Namibian households have no effective income and lack formal housing (GRN, 2003b, p. 7). The combination of an expanding population, low employment rates, and high poverty rates has caused a housing shortage

and decreased living conditions in Windhoek ISAs, a major problem that CoW has only recently begun to address through upgrading strategies and policies.

According to Simon (1995, p. 142), the housing shortage that Windhoek currently faces, while similar to that in other developing countries, is also a product of the apartheid policies previously imposed by South Africa. Namibia, under control of South Africa from the early 1900s until 1990, had a long-standing policy of racial apartheid—officially sanctioned racial segregation and discrimination—that was only recently ended when Namibia gained its independence in 1990 (USDOS, 2001, section 6). During apartheid, non-white Africans in Windhoek were forced to live in Katutura, a segregated settlement for laborers (Winterfeldt, 2002, pp. 46-68). Now that non-white Namibians are no longer restricted in their movements, ISAs are rapidly growing as low income people migrate from rural areas into the informal sectors of the city looking for work (The World Bank, 2002, section 1). As more working class Namibians migrate into Windhoek to work, either for seasonal or indefinite periods of time (Winterfeldt, 2002, pp. 46-68), the problems associated with such a population influx, such as the expansion of ISAs and substandard living conditions, will continue to increase.

### 2.1.2. Current Upgrading Strategies and Housing Policies.

Because the housing problems that Namibia faces are relatively new, the government has only just begun implementation of its upgrading strategies and housing policies. The problem of living conditions in ISAs is one area in which the policies are still lacking. One major problem with current policies is that upgrading strategies are unaffordable to much of the ISA population. In addition, CoW works only on the basis

of eventual full reimbursement from residents over a period of time (A. Muller, personal communication, 3/25/03; B. Harris, personal communication, 3/26/03). However, Windhoek is making much progress in accommodating the informal population, as is evident by the recurrent evaluation of the effectiveness of housing policies and their revision for the ISA population. Current housing specifications are not being met, and current policies focusing on ISA residents exclude some of the residents. The CoW realizes that its housing policies are still in the early stages of implementation and their continual refinement is necessary, and Windhoek has taken this into account by making provisions for continuous improvement. Future policies are also being considered to allow easier ISA development.

Namibian upgrading strategies and housing policies currently do not satisfy the needs of the growing informal population, and residents of Windhoek ISAs are unable to afford expensive solutions to their housing problems, as discussed in the previous section. Namibia's National Housing Policy [NHP] regulates the upgrading and expansion of both formal and informal settlements. The three goals of the NHP are to provide the basis for consistent, pervasive knowledge of the scope and implications of the national housing problem, to promote a common purpose and establish a decision making process, and to introduce housing as a high national development priority (GRN, 2003b, p. 1). Current national minimum standards for housing specified by the NHP (GRN, 2003b, p. 24) include "a minimum of a communal toilet within 30 meters, access to communal potable water within 200 meters and a roofed structure of durable materials of not less than 6 square meters," in addition to housing plots of at least 300 square meters—standards which are currently not being met in all sectors of the informal population.

The CoW's "Development and Upgrading Strategy" (1999, pp. 1-16) is the only current policy that is specifically aimed at ISA populations. However, these policies apply only to the legal ISA population—those who have registered for land titles with or leased land from the city. The illegal ISA population—those who have recently immigrated and are not yet registered with the city—are not currently provided for under Windhoek's upgrading strategies. The CoW's policy on ISA resident housing divides the residents into seven development levels, ranging from Development Level 0 to Development Level 6. In addition, there is also a "welfare" classification. These development levels are defined by community income level. **Table 2.1** summarizes the basic characteristics of development for each level. The policy includes options for upgrading blocks based on environmental and financial conditions. However, no provisions are made for residents in the "welfare" category, and only water and refuse removal are provided for Development Level 0. This is because CoW policies are based on the principle of full cost recovery, which precludes ultra-low income residents from gaining access to basic amenities and services (CoW, 2003b, sections 1-7).

Table 2.1. Development Level Summary.

(Table based on information from CoW, 2003b, Sec. 1-7)

| Development Level | Income Ranges[1] | Water | Sanitation | Electricity | Refuse Removal | Roads |
|---|---|---|---|---|---|---|
| Welfare[2] | N$0-N$99 | n/a | n/a | n/a | n/a | n/a |
| 0 communal | N$100-N$166 | Yes 200 m | No | no | Yes private[3] | no |
| 1 communal | N$167-N$666 | Yes 200 m | yes 100 m | no | Yes private[3] | yes unpaved |
| 2 communal | N$667-N$1202 | Yes 30 m | yes 30 m | no | yes private[3] | yes unpaved |
| 3 communal | N$1203-N$2184 | Yes 30 m | yes 30 m | no | yes private[3] | yes unpaved |
| 4 individual | N$2185-N$3436 | Yes | yes | yes limited[4] | yes bin | yes combined |
| 5 individual | N$3437-N$4505 | Yes | yes | yes full[5] | yes bin | yes combined |
| 6 individual | N$4506 + | Yes | yes | yes full[6] | yes bin | yes surfaced |

[1]income level per month
[2]service standards for the welfare level are not specified
[3]private collection of self-contained refuse or ad hoc open space cleaning
[4]street lights in major roads and service to close institutions and businesses
[5]1 kVA connection
[6]1.5 kVA connection

While the residents do not own the land, the CoW continues to make provisions for this technically illegal population. The possibility of upgrading after the communal purchase of the land and legal recognition of the settlers is recognized by the city through its focus on ISA organization. The development of basic infrastructure and organization within the ISAs makes it easier for future upgrading and expansions to be implemented smoothly. Major principles of land management that are important for implementation to occur smoothly include that low-income housing development be focused on financial, social, and environmental sustainability and that costs associated with housing development, including lease, land, and service prices, be standardized but also be able to

accommodate a wide range of income levels (Maanda, 2002, pp. 6-11). For the lowest development level, Development Level 0, and the Welfare level, only communal water taps are provided to the residents, and substandard living conditions are prevalent. Sites and services are only provided to residents who can afford to pay for them, which means that many residents are unable to upgrade their situations. While solutions to the problem are being developed and planned, the rapid expansion of ISAs makes continual focus on developing working solutions a necessity.

Future plans for housing policies key to ISA development in Windhoek include "Flexible Land Tenure," a bill that has not yet been passed. The plan would help offer tenure to people who are building their own residences through the creation of a block survey, where a unit of several houses would be registered and owned communally. This would allow the land to be upgraded slowly over time and later parceled out to individual residents (V. Uisso, personal communication, 3/18/03). In addition, proposed Policy 78 is another housing policy that has not yet been passed. Policy 78 focuses on developing "an enabling environment: for each point listed [in the policy], community participation should be an integral component. Any decision or action taken should be done with proper consultation and involvement of the community" (City of Windhoek, 2003a, pp. 1-2). This focus promotes cooperation and self-help among residents. The cooperative focus of city upgrading strategies allows most ISA upgrading programs to include the purchasing of entire blocks, which works not only to foster group participation, but also makes purchasing a more realistic option for many residents. The sharing of financial burdens allows residents to improve their conditions without extreme financial hardship.

As new policies continue to be proposed, CoW will continue to work to alleviate the housing problems in ISAs.

## Section 2.2. ISA Improvement.

A basic comprehension of ISA problems, both infrastructural and top structure, is necessary to understand how improvement programs can be integrated into existing ISAs. The 'sites and services' method is commonly used to upgrade, rehabilitate, or improve ISAs and forms the core of almost all improvement programs. However, 'sites and services' methods generally address only problems with infrastructure and land acquisition. This omits consideration of top structure problems, which are problems with actual housing and other structures on the land. Despite this, there are several important characteristics of successful sites and services improvement programs that should be considered when trying to handle top structure problems in ISAs.

### 2.2.1. ISA Structural Problems.

Structural problems in ISAs, which can be categorized into infrastructural problems and top structure problems, are commonly targeted for improvement programs (A. Muller, personal communication, 3/25/03). Infrastructural problems refer to problems that arise in the infrastructure of an area. In ISAs, this would include the lack of access to water, waste management, electricity, and transportation systems. Limited space and high population densities contribute to infrastructural problems, as systems are generally only built to service a certain number of people and crowding can overwhelm a

utility (Korpivaara, 2001, p. 6). Characteristics of ISAs in Port Harcourt, Nigeria, include entire families living in only one room, leading to very high crowding. Toilet facilities exist but are primitive, consisting of a pit dug into the ground. In addition, the sharing of housing facilities, such as kitchens and bath places, is common. The settlements often lack organized waste management systems, and the roads are usually in bad condition (Fadare & Mills-Tetty, 1992, pp. 71-79). In ISAs in Okahandja, Namibia, illegal grid connections provide a source of electricity to residents who cannot afford to pay for grid connections. These illegal connections, in addition to overloading the electricity system, also pose dangers from improper wiring practices. Infrastructural problems can cause problems ranging from major inconveniences to health troubles. CoW uses its policies, described in Section 2.1.2., mainly to manage infrastructural problems.

Top structure problems generally refer to problems with housing, such as using inappropriate building materials or building unstable structures. In the South African ISA Alexandra, building materials consist of wood, cardboard, and strips of metal. Roofs are held down by piling rocks or other heavy objects on top of them (Korpivaara, 2001, p. 6). In Okahandja, top structure problems include the lack of insulation, the lack of windows, and generally inefficient housing with gaps in walls and dirt floors, in addition to the use of unsuitable building materials as described above. Top structure problems can greatly decrease the quality of living for residents by demoralizing them, in addition to creating security and health problems. One reason that security issues can arise in ISAs is that informally constructed buildings are often built less solidly and very densely, making them more prone to theft, a problem that could be remedied through creative

construction methods (R. Schultz, personal communication, 3/10/03). Health issues arise because 'leaky' buildings can allow the elements, including rain, heat, and cold, into the structure. In addition, metal houses become dangerously hot inside during the summer, when the sun is most intense. Currently, Windhoek housing policies pay almost non attention to top structures problems; the resident is solely responsible for the construction of housing and ensuring that the housing is safe.

### 2.2.2. Participatory Approaches to ISA Problems.

As mentioned in previous sections, 'sites and services' is the most commonly used method of improvement for ISAs. However, sites and services programs do not always include residents in the decision making process. In this paper, participatory approaches are defined as ways of including residents in decision-making processes, but are not defined as decision-making processes in themselves. If participatory approaches are used to supplement sites and services programs, then the benefits of the core program will increase and the program will be more effective, as described below. If participatory approaches are not used, then the core program will be more limited in its effectiveness. Characteristics of successful sites and services programs used to improve infrastructure conditions are also applicable to methods of improving top structure problems. A careful examination of the traits of successful programs, especially not categorizing "the poor" into one category or stereotype, is advisable in order to increase the future success of top structure improvement programs, including *Energy Efficiency In Low-Cost Housing*.

According to Riley, Fiori, and Ramirez (2001, p.523), there are several characteristics of successful ISA upgrade programs. First, poverty is complex—the

"poor" cannot be classified into one category. There are numerous factors that can influence poverty, and to lump everyone into one monetarily based category is a massive oversimplification. In addition, living conditions at all levels of poverty must be considered to get an adequate representation of how improvement programs are working. While a program may help a specific subpopulation of residents, such as those who make a certain amount of money, this does not necessarily indicate that an entire settlement is being rehabilitated. Scale is also important—these programs affect the city as a whole in addition to the ISAs. Public-private partnerships are key to the successful implementation of rehabilitation programs. Without outside help, it is unlikely that any changes will be made. Finally, the cooperation of residents with each other is essential. If residents are unable to work with each other, then any positive changes that are made will not last. Simply instituting an improvement program does not necessarily guarantee a better quality of life for the residents. By being aware of these guidelines, any improvement program is much more likely to be successful.

While there may be case studies of ISA improvement strategies that have worked well in the past in similar conditions, to simply choose one without considering what current residents want and need is negligent. As Riley, Fiori, and Ramierez (2001, p. 523) note, it is important not to classify all low-income residents into one category. There is a tendency to assume that "the poor" are unable to help themselves and need help from those who are better off, that there is a need for an externally-sponsored program. However, this is often not the case. There are many internal programs that have been started by low-income Namibians, such as the Shack Dweller's Federation of Namibia [SDFN], which manages savings and loans programs, negotiates for land, and

promotes positive health and environmental practices (Homeless International, 2001, p. 2). Edith Mbanga, a low-income Namibian and representative of SDFN eloquently stated her view on the matter at the UN General Assembly in June, 2001:

> In Namibia, … we come together and look at our problems and come up with solutions. Our major problem is land and housing. And we decided to organize ourselves because it is difficult to do things on your own, because you don't have someone to encourage you… The main purpose of starting these savings is because we don't have anything and before you start negotiating with the government or even with the local authorities, as poor people we must show that we can do something on our own. We can't just wait and expect the government to do something. So the main purpose is to meet the government half way so that we can say 'We have got this and what you can do for us is this,' (p. 8).

To forget that low-income residents are people who are capable of managing their own lives and making their own decisions is to fail before starting.

The use of participatory approaches to avoid problems described in Section 2.2.1. is becoming increasingly frequent. Participatory approaches are methods that include the ideas and participation of residents or the local community in the development of improvement programs. These approaches are an especially valuable tool when upgrading ISAs and can dramatically increase the success rate of improvement programs, and are very prominent in Windhoek housing policy (CoW, 1999, pp. 7-16; CoW, 2003a, pp. 1-2). According to Ford (2001, pp. ii-iii), participation of residents in improving their own living conditions has several benefits, including creating stronger community ties,

providing economic benefits, and increasing the likelihood that community initiatives will continue. Participatory approaches do not stand alone, however, but must be used in conjunction with other core programs, such as a sites and services program or a self-help program. If participatory approaches are not used, as in a top-down approach where residents are never consulted about decisions, then the benefits described above will most likely not apply to the program. Participation does not have to be limited to specific groups but instead can be used in a flexible manner, as long as the major practical stakeholders of the program—the residents of the areas being improved—are included in design and implementation of the program.

**Section 2.3. Stakeholders.**

Stakeholders of the *Energy Efficiency In Low-Cost Housing* project include any individuals or groups that are partners in the project, can contribute knowledge to the project, or will be affected by the project. Major stakeholders would include government agencies, such as the Ministry of Regional and Local Government and Housing [MRLGH], NHE, and CoW, as well as Non-Governmental Organizations [NGOs], such as Shack Dwellers Federation of Namibia [SDFN] and the National Housing Action Group [NHAG]. Other stakeholders include the Renewable Energy and Energy Efficiency Bureau of Namibia [R3E] and the Habitat Research and Development Centre [HRDC]. Because the stakeholders will have an enormous influence on the implementation and success of *Energy Efficiency In Low-Cost Housing*, it is important to understand the basic purposes and structures of each of the major stakeholders.

### 2.3.1. Government Agencies.

Government agencies constitute one of the broadest categories of stakeholders for the Energy Efficient Urban Demonstration Village [EEUDV] project. This classification includes not only national government, such as the MRLGH, but also the city-level government, including CoW Offices. The MRLGH was established by the government of Namibia in 1990 to take authority over the control of local governments. The MRLGH was mandated to lead in the efforts towards housing provision by providing central government support to local governments for housing, community development, and physical planning. The MRLGH was also partially responsible for developing the NHP of 1991, the purpose of which was "to make resources available for the development of infrastructure and facilities so that every Namibian family will be given a fair opportunity to acquire land with water, energy and a waste disposal system, and to facilitate access to shelter in suitable locations at a cost and standard which is affordable to the family on the one hand and to the nation on the other hand" (GRN, Section 4, 2003a).

The specific tasks of the MRLGH include "[preparing the] National Housing Policy, National Housing Strategy, and National Housing Implementation Plan; monitoring, evaluating, and reviewing the National Housing Policy, Strategy and Plan on an annual basis; evaluating the success of individual housing projects; funding the public sector programme from its national budget allocation and directing these funds to programmes and agents in terms of the policy, strategy and plan; and [co-ordinating] housing executive agents (including NHE , NGOs and other appropriate agents) for all

public sector funded housing programmes and projects" (GRN, Section 4, 2003a). The MRLGH also has authority over the NHE, which is an agent of the ministry, as discussed below.

The NHE, formerly the National Building and Investment Corporation, was established in 1982 as a parastatal of MRLGH that is mandated by the NHP to act both as a lending institution for people who wish to buy homes and as low-income housing developer (GRN, 2003, p. 7). The mission of the NHE is "to be a customer driven institution that provides housing solutions in order to alleviate the national housing need." The main function of the NHE is to provide permanent housing to low-income households with 100% mortgage financing. To date, the NHE has provided financing for 12,000 households throughout Namibia at a total cost of N$340,000,000. Currently, NHE produces upgradeable housing ranging from N$60,000 to N$150,000. While the operations of NHE are very similar to private housing contractors, a major difference is that NHE can grant loans before land is officially proclaimed. In addition, since NHE is a parastatal, it also has access to foreign funding for development projects (NHE, 2003, para. 1-8).

The CoW has a large stake in the EEUDV. Specific offices that are involved include the Office of Sustainable Development [OSD], the Office of Community Development [OCD], and the Office of Housing and Properties [OHP]. The OSD focuses primarily on providing sites and services to existing informal populations as well as new informal populations by. Major tasks of OSD include determining the feasibility of service options within specific areas of the ISA region by researching whether options are appropriate for a specific environment, community, or income level (B. Harris,

personal communication, 3/26/03). OCD acts as a liaison between ISA communities and the CoW (B. Alcook, personal communication, 4/1/03). OHP deals mainly with land acquisition and registeration for plots (J. DeKock, personal communication, 4/2/03).

### 2.3.2. Non-Governmental Organizations.

NGOs are in closest contact with ISA communities, making them a valuable asset to the EEUDV. The two major NGOs that are key to EEUDV are NHAG and SDFN. NHAG was established in 1987 as a housing self-help group. Eventually, the roles of NHAG were reduced to providing technical support to the SDFN and administering funds for housing, as well as negotiating with the CoW on behalf of the SDFN (E. Mbanga, personal communication, 4/1/03). The seven major objectives of NHAG are to facilitate SDFN activities by acting as treasurer and ensuring equal resource distribution, to advise SDFN representatives and groups, to organize exchanges, to help SDFN access resources from formal institutions, to document savings group experiences, and to administer funds from the Twahangana Loan Fund. The Twahangana Loan Fund is a self-help loan program for households that participate in savings schemes (NHAG, 2003, pamphlet). The tight link between SDFN and NHAG allows NHAG to provide technical support to SDFN mainly by developing plans for the design and layout of both the individual houses and the communities, in addition to helping organize financial aspects of building projects and obtain funding from MRLGH (A. Muller, 3/25/03, personal communication; B. Harris, 3/26/03, personal communication; E. Mbanga, personal communication, 4/1/03).

The SDFN is one of the most well-known NGOs of Namibia. The SDFN broke away from NHAG in October of 1998 in order to focus on the savings scheme part of NHAG. The SDFN is a network consisting of 189 savings scheme groups located throughout Namibia, 90 of which are located in Windhoek. Savings schemes are organized locally by the community and focus on two areas: daily needs and land acquisition. Communities with savings schemes communally save money for daily needs. These funds can be used by all members of the community if money is needed for food or other necessities. Money is also saved communally for the purchase of blocks of land. Communities have complete control over the amount they save and what the money is used for. When communities have purchased land, they then go to the SDFN and a draw a plan for housing. After a plan is agreed upon by the community, the SDFN gives the plans to NHAG, which completes all of the technical work involved with the design process in addition to assisting with regulatory concerns (E. Mbanga, personal communication, 4/1/03). The concerted efforts of both SDFN and NHAG have led to the purchase of 20 plots throughout Namibia and the building of 543 houses for residents averaging an income of N$200-N$400 per month.

### 2.3.3. Other Stakeholders.

Other stakeholders include groups that have special roles to play in EEUDV but are not government agencies or NGOs. Consultants for the government, private sector interest groups, and public resource centers are all examples of other stakeholders. The R3E Bureau, which is based at the Polytechnic of Namibia, is a non-profit organization created by the Ministry of Mines and Energy [MME], in conjunction with the Ministry of

Trade and Industry, the Polytechnic of Namibia, the University of Namibia, Premier Electric, the City of Windhoek, and the Desert Research Foundation of Namibia, among others. The major objective of R3E is to "co-ordinate and advance all renewable energy and energy efficiency related developments and to disseminate reliable information to ensure the efficient and sustainable use of all energy resources for the benefit of present and future generations in Namibia." The R3E Bureau has been mandated by MME to coordinate the "Energy Efficient Urban Demonstration Village" [EEUDV] project funded by the Danish International Development Assistance [DANIDA]. This project is scheduled to commence by mid-2003 and to finish by 2006 (Danish Ministry of Foreign Affairs DANIDA, 2002, pp. 18-36).

Future stakeholders must be identified and considered as they become apparent. New action or research groups are continually being formed and these must be included in the process as they emerge. One such organization is the HRDC. The mission of HRDC is "to promote the use of local, indigenous building materials and designs, to engage multi-disciplinary teams in basic research, the adaptation of existing knowledge and applied research to achieve a holistic approach to problem solving in the field of housing and its related issues" (MRLGH, 2003, pamphlet). Once this organization becomes active, major objectives will include centralizing housing information; promoting sustainable housing; negotiating between interest groups; performing research on housing, building materials, construction, and design; promoting the development of new construction skills and small building management; and educating the public on sustainability in housing (MRLGH, 2003, pamphlet).

## Section 2.4. Energy Efficiency.

Energy efficiency is a key concept in areas where energy is inaccessible or non-existent. In this document, energy efficiency is used to refer to the regulation of temperature without the input of energy. In Windhoek, radiation from the sun causes most of the heat problems associated with low cost housing. Solar radiation is either reflected or absorbed. Absorbed radiation increases the temperature of the outer surface. Heat is then conducted through the material, or convected and radiated to the outside environment. The heat conducted through the material is then convected and radiated to the inside environment (Balaras, 1996b, p. 173). Any heat that is not returned to the outside, via convection or radiation, heats up the inside of a building. There are various techniques that can be used to prevent the heat from entering the house or to release it back to the outside once it has entered. Temperature-regulating techniques that do not use energy include passive cooling, insulation, and energy efficient building features. While the techniques in this section focus on decreasing the heat gain into a building, most can easily be reversed during periods of cool temperatures to increase the temperature inside of the house.

In order to determine the feasibility of options for housing and the problems with energy efficiency in housing, a basic understanding of Namibia's climate is necessary. The South Africa Online Travel Guide [SAOTG] (2003, Section 2) notes that there are usually about 300 days of sunlight each year, although there can be heavy rains during the summer months. The temperatures in the summer can range from 30 to over 40 degrees Celsius during the day and drop to below 15 degrees at night in the desert.

During the winter months, the temperature is cool and at night it can drop to below 0 degrees. The SAOTG (2003, Section 5) also notes that most of the country stays very hot during the day, but Windhoek, because of its high elevation of 1650m, stays slightly cooler than the surrounding area. The varying temperatures make it essential for a house design to be able to withstand extreme heat and severe cold.

### 2.4.1. Passive Cooling Techniques.

Passive cooling is the prevention and modulation of heat gain without the use of energy (Balaras, 1996a, p.6). There are two types of heat gains in a building: external, including heat from solar radiation and the ambient temperature, and internal, including the heat from occupants, appliances, and cooking (Dimoudi, 1996a, p. 38). Proper use of passive cooling techniques can reduce the inside temperature of a building by 35-45% compared to the outside temperature (Dimoudi, 1996a, p. 45). If the outside temperature is 35$^{o}$C, the inside temperature of a passively cooled building could be as low as 20-23$^{o}$C. A temperature decrease of this magnitude without the input of energy would be of large practical value in an ISA, where energy resources are low or non-existent. There are a wide number of different passive cooling techniques, including thermal mass, ventilation, radiative cooling, vegetation, earth cooling, and shading.

#### 2.4.1.1. Thermal Mass.

Thermal mass is the ability of a material to store heat. Large amounts of thermal mass in a building can increase the building's resistance to temperature change. It can

keep a building cooler during the day, and provide heat in the early evening when outside temperatures begin to cool down. There are various techniques to increase the thermal mass of a building and to use thermal mass effectively.

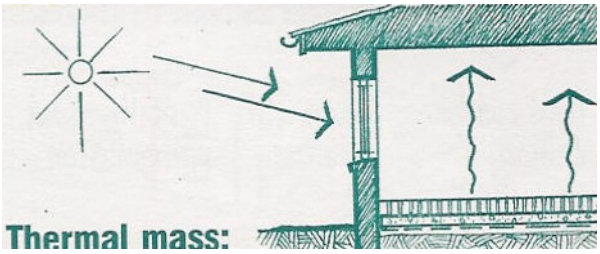



Figure 2.1. Thermal Mass. From S. Ward, 2002, p. 74.

The thermal mass of a building "absorbs heat during the day and regulates the indoor temperature swings … and transfers a part of the absorbed heat into the night hours" (Balaras, 1996a, p.8 ). The absorbed heat increases the temperature of that material and objects around it (Dimoudi, 1996b, p. 90). Heat is convected to the air and objects in contact with the heated material; heat is radiated to materials that are not in direct contact. However, materials that have a high thermal mass have a time delay before passing the heat on (Balaras, 1996c, p. 188), as shown in Figure 2.1. Due to the thermal properties of the material, it takes a long time to fully heat up; it cannot radiate the heat until it has fully heated. The use of high-thermal-storage materials will delay the transfer of heat until night, when it can be used to warm the house (Dimoudi, 1996a, p. 46).

Thermal mass has a positive effect on the indoor conditions during both summer and winter. During the summer, the heat is stored during the day and released at night; during the winter the heat is released in the late afternoon or early evening when it starts to get cool (Balaras, 1996c, p. 188). Large thermal mass works best with large diurnal temperature changes (Nel and Sugrue, 2003, p. 5). Large swings in outdoor temperature require large thermal masses (Dimoudi, 1996a, p. 40) in order to maintain a comfortable

indoor temperature. High thermal mass makes the temperature more constant and changes more gradual (Balaras, 1996c, p. 193).

There are various ways to increase the thermal mass of a building and use it effectively. Building co-joined homes, in which at least one wall is shared, increases thermal mass (Nel and Sugrue, 2003, p. 5). This is due to the fact that there is extra thermal mass, or heat storage, in the shared wall, which is not exposed to heat energy from the sun, as shown in Figure 2.2. Additionally, it is more effective to have high thermal mass in areas that get direct heat gains; those that are hit directly by the sun's radiation (Balaras, 1996c, p. 194). Materials that have high thermal mass include clay, brick, and concrete. Earth bricks, which also have a high thermal mass, are often cheaper and easier to manufacture than clay or concrete (Nel and Sugrue, 2003, pp. 5-6). Hollow cement blocks also have a high thermal mass. Because less material is used, they are cheaper, and the air pockets inside serve as a basic insulator. By filling the air pockets with soil, the thermal mass can be increased further. These materials, due to their high thermal mass, are best used for constructing walls of buildings. Thermal mass is most effective in buildings with high internal heat gains, whereas insulation is best with low internal heat gains, as is the case


Figure 2.2. Shared Walls To Increase Thermal Mass. From S. Ward, 2002, p. 74.

in residences (Balaras, 1996c, p. 204). However, the techniques are cumulative, and both may be applied.

#### 2.4.1.2. Ventilation.

Ventilation, or the flow of air, can be used to help maintain a comfortable temperature in a building, as well as maintaining a proper oxygen level and air quality (Balaras, 1996a, p. 26). Ventilation can be forced, where the air flow is controlled by mechanical means, or natural, where the air flow is determined by differences in air pressure. Forced ventilation requires the expenditure of energy and will not be discussed in this paper. Natural ventilation is caused by differences in pressure at the inlet and outlets of a building, caused by wind or 'stack effects,' where the warm air rises and cool air sinks (Balaras, 1996a, p.9). Air will flow from a high pressure region to a low pressure region, in an attempt to even the pressure distribution (Dimoudi, 1996b, p. 86). Natural ventilation is used to lower the perceived air temperature and is the driving force behind night ventilation and cross-ventilation, which are two techniques used to increase the comfort level of inhabitants. Additionally, certain structural building features, such as wing walls, can aid ventilation throughout the house.

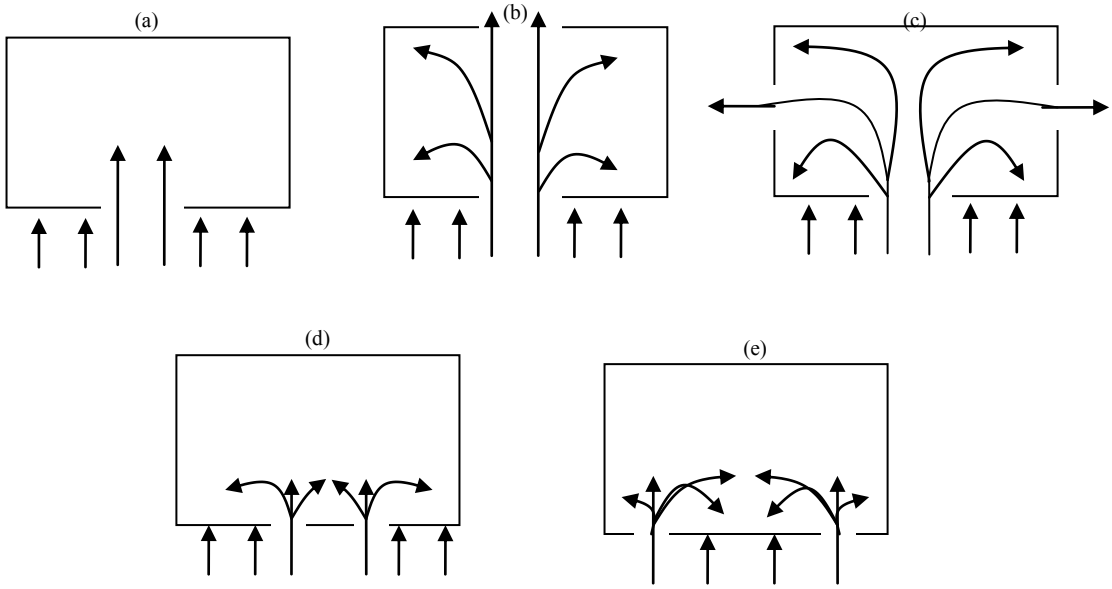
The cooling effect of ventilation is two-fold; there is a direct psychological cooling effect and an increase in the rate of sweat evaporation, both of which serve to decrease the perceived temperature (Dimoudi, 1996a, p.43). Thus, the ambient air temperature can be one to two degrees higher with ventilation than without and still be comfortable to the inhabitants. Balaras (1996a, p. 28) claims that by increasing the air velocity 0.15 m/s, the temperature can be raised $1^{o}C$ without an impact on the perceived

temperature. Natural ventilation will in fact often raise the ambient air temperature by bringing warmer air into a building, but can still make it more comfortable (Dimoudi, 1996a, p. 44). However, when humidity is high, natural ventilation can serve to increase the perceived temperature instead (Balaras, 1996a, p.28). When the humidity is high, the sweat evaporation rate will not be raised, and in fact may even be lowered, making the environment more uncomfortable for the inhabitants.

Keeping the windows open at night, a technique known as night ventilation, can use natural ventilation to keep the building cool. The heat stored in the building's thermal mass is removed by the air flow (Dascalaki and Santamouris, 1996, p. 266). This allows the building to store more heat during the day, keeping the inside temperatures cooler, as well as preventing the stored heat from being radiated out during the night. Night ventilation works better when there is a large temperature difference between day and night. Balaras (1996c, p. 195) notes that there are security and privacy concerns with this type of ventilation. Screens or bars can be placed over the windows to help resolve these issues. Additionally, as Maritz (personal communication, 4/7/03) points out, ventilation does not need to come from large windows. Smaller windows, or missing bricks along the top of a wall, can also serve to allow airflow into a building without the security risks that can be associated with larger windows.

Cross ventilation is another method of improving the ventilation of a building. In this technique, wind is directed through the building, flowing into one window and out another. Cross ventilation is most often applied with two windows on opposite sides of a room, as shown in **Figure 2.3**b, but more effective methods exist (Dascalaki and Santamouris, 1996, p. 222-223). The most effective method of cross-ventilation is to

place one window on the windward wall, and one window on each of the side walls, having a combined opening area equal to that of the window on the windward wall, as shown in **Figure 2.3**c. This circulates the wind throughout the entire room. For rooms



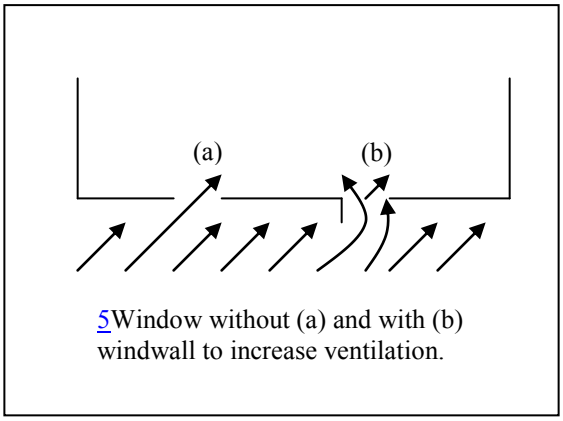

(a) One window. (b) Two windows on opposite walls. (c) Three Windows on adjancent walls. (d) Two tightly spaced windows on the same wall. (e) Two widely spaced windows on the same wall.

Figure 2.3 - Ventilation with Different Window Configurations.

with only one external wall, one window provides very little ventilation at all, as shown in **Figure 2.3**a. Two windows placed closely together, as shown in **Figure 2.3**d, does little to improve the air flow. However, placing two widely spaced windows along this wall will provide substantial cross ventilation for the room, as shown in **Figure 2.3**e.

Another method to increase the ventilation in rooms with only one external wall is to use wind walls (Balaras, 1996a, p.29). Wind walls are structural projections on the outside of a building, placed next to a window. Any breeze hitting the wind wall opposite the window creates a high pressure zone on that side, and a low pressure zone in

front of the window. Air then moves into the low pressure zone, creating a breeze through the window, as shown in **Figure 2.4**. Adding wind walls to two widely spaced windows on the same wall will increase the ventilation even further (Dascalaki and Santamouris, 1996, p. 223-224). The ventilation in rooms with windows in two adjacent external walls can also benefit from the use of wind walls. In this case, the wind walls should be carefully placed, so the prevailing wind creates a positive pressure in one window a negative pressure in the other. This will help the air flow from one side to the other.




5Window without (a) and with (b) windwall to increase ventilation.

Figure 2.4. The effect of windwalls on ventilation.

### 2.4.1.3. Radiative Cooling.

The roof of a house faces the sky, and thus the sun, for most of the day, causing it to absorb much of the sun's radiation (Balaras, 1996a, p. 10). Dimoudi (1996a, p. 46) points out that the roof of a house can reach up to 65$^{o}$C during the day, causing it to radiate a significant amount of heat into the building. However, its position towards the sky also allows the roof to serve as a radiator. Radiative cooling is based on the principle that most objects radiate heat energy, in the form of long-wave radiation, to another cooler object (Argiriou, 1996b, 424). In the case of the building, the roof will radiate heat energy to the sky, which is always cooler than the roof and thus serves as a heat sink.

There are various ways to increase the radiative abilities of the roof, including increasing the surface area, and using insulation and wind screens.

Increasing the surface area of the roof will increase the amount of heat energy it can radiate (Dimoudi, 1996a, p.46). Although the larger surface area also means that more heat energy is absorbed, the amount of energy radiated out exceeds this. Additionally, the roof can be shaped so that not all of its area is receiving energy directly from the sun at any given point in the day. However, the entire surface still acts to radiate the heat out. Vaulted roofs, in addition to having a larger surface area, also have a large storage area under the point, which can serve to store the heat energy (Dimoudi, 1996b, p. 92). This can be increased further by adding a ceiling and insulation, as discussed in Section 2.4.2. Hemispherical roofs work even better than vaulted roofs because of their high volume to surface area ratio, but can be costly and difficult to build. A roof that slopes only in one direction is often cheaper and easier to build than a vaulted roof (Nel and Sugrue, 2003, p. 11). The roof should slope downwards towards the east, if possible. This allows for most of the solar radiation to hit the roof during the morning, and not as much in the afternoon, when the building is the hottest. Any of these roof shapes--vaulted, hemispherical, or sloped—also serve to help prevent water leaks into the house. The rain flows down the roof and falls off instead of collecting in puddles, as would be the case with a flat roof, and leaking through the roof into the building.

Applying insulation under the roof can help to increase its energy efficiency, as discussed in Section 2.4.2 below. However, applying insulation to the outside of the roof during certain times of day can also help. By insulating the roof during the day and not at night, the amount of energy absorbed by the roof is reduced, but the amount radiated at

night, when the most energy is radiated due to the colder air temperature, is not significantly decreased (Balaras, 1996a, p.11; Argiriou, 1996b, p. 433). This process can be reversed in the winter; insulate the roof at night to prevent heat from being radiated out, and not during the day to allow the roof to absorb as much heat as possible. This technique works best with clear skies and low humidity, such as the conditions often found around Windhoek. The insulation can be in the form of moveable or hinged panels to make removing and applying it easier, however the cost and time involved is often prohibitive.

Hot winds can reduce the roof's ability to radiate heat (Dimoudi, 1996a, p. 46). The heat being radiated to the sky is blocked by the heat from the warm wind, and remains in the roof. To prevent winds from interfering with the roof's radiation, wind screens can be placed around the edges of the roof. These screens should block the wind going over the roof, allowing heat to escape to the sky.

#### 2.4.1.4. Vegetation.

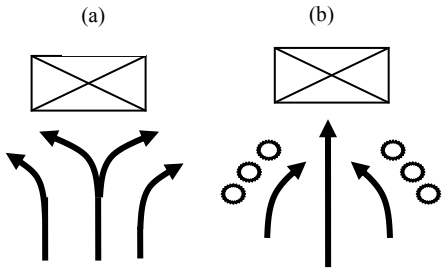
Vegetation, whether trees, bushes, or even grasses, serves a variety of uses. Increasing the vegetation cover by 10-30%, or one to three properly placed trees per house, can lower air temperatures by two to three degrees Celsius (Balaras, 1996a, p. 7). According to Dimoudi (1996c, p. 106), vegetation has many beneficial passive cooling uses, including lowering temperature, providing shade, and channeling wind flow.

Vegetation can replace air conditioning by cooling air with evapotranspiration. When the sun's radiation hits a tree, the water in the leaves evaporates, releasing the water into the air (Dimoudi, 1996c, pp. 108-109). This serves to cool the air. During the

night, trees make the air warmer by blocking long range radiation from the ground. For this reason, the diurnal temperature range is also smaller.

Trees are better than manmade shading because they also serve to lower the air temperature as discussed above (Dimoudi, 1996c, p. 109). For hot dry climates, including Windhoek's, trees with a dense canopy provide thick shade to reduce direct sunlight and diffuse radiation. Broadleaves and deciduous trees are good as they drop leaves in fall and so allow for solar radiation in the winter (p. 113). However, even dead branches will block some sun. Planting trees on the west side of a building will reduce the heat in the afternoon (Nel and Sugrue, 2003, p. 8) by reducing the amount of heat energy that can reach the building. Trees on east-north-east and west-north-west provide good shade, because the sun is low and will cast long shadows. Climbing plants on walls reduce the solar heat that goes through the wall by as much as 50%. Trellises can also be used to provide large areas of shade (Dimoudi, 1996c, pp. 111-116). Used properly, this technique can reduce the temperature by 11$^{o}$C.

Vegetation can also change the wind patterns around a house (Dimoudi, 1996c, p. 109). Trees and bushes can be used to help guide the wind through the building and to prevent the wind from spilling around the edges (p. 116-117), as shown in Figure 2.5. Windblocks can also be used to slow the wind. A solid barrier can be used for this purpose, however it creates a lot of turbulence—fast, chaotic




Wind near a house (a) without and (b) with vegetation as wind guides.

Figure 2.5. Vegetation as Wind Guides.

wind—whereas a vegetation belt will slow the wind better (Ward, 2002, p. 74). Vegetation windblocks should be placed at least two meters away from the house and should not be more than 1 to 1.5 times as tall as the building on the windward side (Dimoudi, 1996c, p. 117). Anything taller will direct the wind over the house.

#### 2.4.1.5. Earth Cooling.

The temperature of the ground remains fairly constant throughout the entire year at depths exceeding one meter (Balaras, 1996a, p. 9). This is due to the high thermal capacity of the soil. Earth cooling, or ground cooling, techniques use this constant temperature to help regulate the inside temperature of a building by placing the building in direct contact with the ground. There are two types of earth cooling: direct, where the building is at least partially buried, and indirect, where the air flow into the building is piped underground.

Direct earth cooling is accomplished by constructing buildings underground or partially underground (Dimoudi, 1996a, p. 51). The semi-buried buildings on the island of Santorini, Greece are a classic example of this type of passive cooling (Argiriou, 1996a, p. 362). The earth remains at a fairly constant temperature, which is cooler then the ambient air temperature in the summer and, depending on the specific climate, can be cooler or warmer during the winter. In the summer, the heat from the air is transferred to the earth which remains at the same temperature due to its extremely high thermal mass. Direct earth cooling also makes the building more air-tight, which helps to protect from leaks and noise but does require additional ventilation. Additionally, this technique can be very costly (p. 365), especially if the ground has a high rock content. The ceiling must

be able to support the weight of the earth and requires additional support. Structural elements in the shape of domes can be used, as these support higher weights. Alternatively, a normal roof can be used if the walls are surrounded by earth, instead of the entire building. Fewer windows are required for this type of building, as many of the walls are covered with earth. This can lead to ventilation problems, particularly due to the air-tightness of the building; Section 2.4.1.2 on ventilation discusses various techniques to improve ventilation for buildings with few windows.

Indirect earth cooling, shown in Figure 2.6, consists of holes in the ground inside the house that lead to holes outside (Dimoudi, 1996a, p. 52). The air goes into the pipes and cools off, due to the lower ground temperature, before entering the house. Pipes are generally 10-30 cm in diameter and 12-60 meters in length (Dimoudi, 1996a, p. 52; Nel and Sugrue, 2003, p. 13). The pipe must be buried more than 1.5 meters for indirect ground cooling to be completely effective (Argiriou, 1996a, p. 391). This technique, if used properly, can lower the inside temperature by as much as 10$^{o}$C (Dimoudi, 1996a, p. 52). Indirect earth cooling can also be closed-loop, where both the inlet and outlet of the pipes is inside the house (Argiriou, 1996a, p. 367). It is harder to receive a good air flow in a closed-loop system, but the air becomes cooler, as it is re-circulated underground many times.

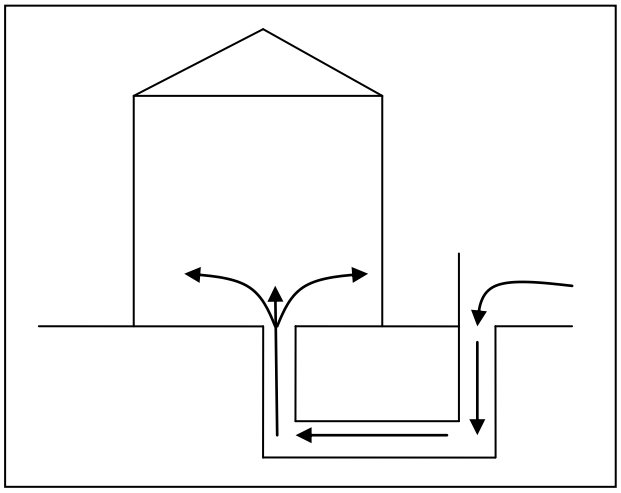


Figure 2.6. Indirect Earth Cooling.

### 2.4.1.6. Shading.

Another method of passive cooling is shading. Shading prevents solar radiation, and thus heat, from entering the building. According to Dimoudi (1996b, p. 92), in hot and dry climates, shading is more important than ventilation and should be provided for the hottest hours of the day (1996c, p. 113). The most effective methods of shading are to shade windows and walls.

A *mashrabiya*, a lattice used to cover windows, is made from small wooden strips (Baker & Steemers, 2002, p. 6). These allow light and air to pass through. From the outside, only the screen is visible; however, from the inside it is possible to see out. Dimoudi (1996b, p. 92) claims that few, small windows with shutters, should be used. These should be closed during the day to prevent heat energy from entering and opened in the evening to allow heat to escape. Windows can be covered with a fine mesh to prevent dust from entering (Ward, 2002, p. 78). Some additional privacy is also gained with this technique.

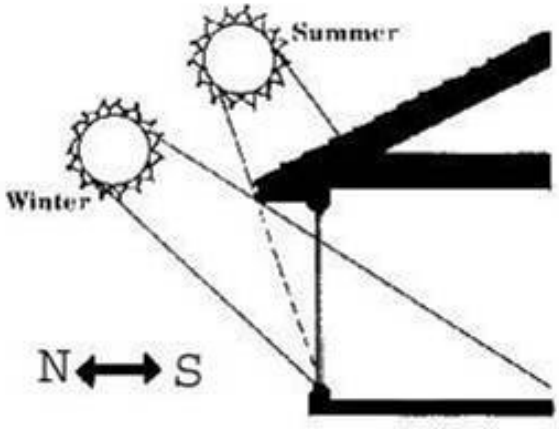



Figure 2.7. Roof Overhang. From S. Hui, 2000.

In addition to shading windows, shading of walls can be very beneficial. Roof overhangs will prevent the sun's radiation from being absorbed into the building mass and being convected to the inside environment. In the southern hemisphere, horizontal overhangs are best when used on the north side, as the sun is

highest in the sky here (Dimoudi, 1996c, p. 113). Roof overhangs will shade the sides of the houses in the summer, when the sun is highest (Schutze and Worthington, 2002, p. 38). In the winter, the sun is lower in the sky, so the overhang will not block as much solar radiation, as shown in Figure 2.7. A roof overhang of 60 cm can protect the northern side of a building from the sun in the summer and still allow the sun to hit the building in the winter (Schutze and Worthington, 2002, p. 42).

### 2.4.2. Insulation.

Insulation is used to prevent heat from entering or escaping a building. By placing insulation, any material that does not radiate heat, next to a material that does, such as a wall, the heat is prevented from radiating into the building. Insulation serves a dual purpose of controlling heat gains and losses and ensuring an equal distribution of heat throughout the house. Insulation is effective when used on the roof and on walls, however there are several points to remember in order to use insulation effectively.

There are two main advantages to insulation (Flipts and Zibetta, 1994, p. 2): fewer heat losses in winter and less heat gain in the summer, and a more equal heat dispersal throughout the house. Insulation does not radiate heat; any heat from the outside is not radiated into the house, and any heat from inside the building is not radiated to the outside. Because of this, the heat energy inside the house cannot escape and additional heat energy cannot enter. A study done in South Africa showed that low-income houses with ceilings and insulation needed to burn 26% less coal during the winter months (Nel and Sugrue, 2003, p. 5). The insulation traps the warmth inside, keeping the house

warmer during the winter, reducing heating needs, and in the same way keeps the heat out in the summer, keeping the house cooler.

According to Ward (2002, p. 75-76), adding a ceiling to a house, even without adding additional insulation, will greatly reduce the amount of heat entering the house in summer and escaping the house in winter, as shown in Figure 2.8. The benefits are gained for two reasons. First, the space between the ceiling and the roof is made of dead air, which is an insulator in itself. Additionally, the ceiling is often made out of an insulating material, such as cardboard, masonite, gypsum board, or polystyrene, further blocking the heat. Filling the air space with insulation, such as layers of newspaper or pieces of polystyrene (Schutze and Worthington, 2002, p. 43), will further increase the energy-efficiency of the ceiling. This can be done at a later date, when more time and/or money is available.

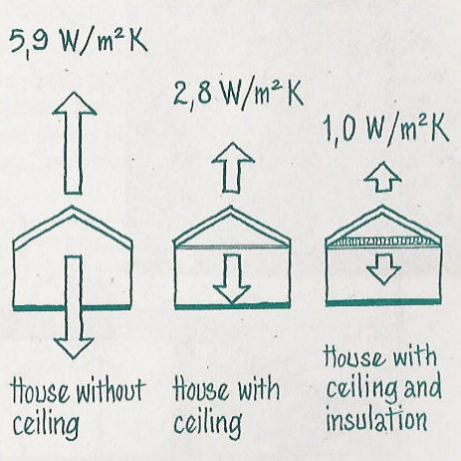



Figure 2.8. Heat Loss With Ceiling and Insulation. From S. Ward, 2002, p. 75.

Insulation of the walls will also serve to increase the energy efficiency of the house. Creating "a buffer zone in between the heated zone and the outer walls can drastically reduce the heat loss" (Flipts and Zibetta, 1994, p. 5) during the winter and the heat gain during the summer. The buffer zone can take the form of air cavities in the wall, either by using materials that have air pockets or building two layers of wall separated by an air gap, which will trap the heat and prevent it from entering or leaving the house (Ward, 2002, p. 76). Good insulators for the wall include cardboard, paper,

polystyrene, bubble plastic, mud, straw, and sawdust. For a given volume of insulation, it is best to spread the material evenly throughout the house, rather than concentrating on a specific area (Flipts and Zibetta, 1994, p. 2). This is most important in the winter months, as the heat can escape from anywhere in the house. Ward (2002, p. 76) argues that when material is limited, the best materials should be used on the walls that get the most sun, as this is where the greatest heat gains are found. This will prevent as much heat from entering in the summer, and as much heat from escaping in the winter months. It is important to note that insulation greatly loses its effectiveness when wet (Flipts and Zibetta, 1994, p. 2), so it is important to have a waterproof roof. This can be accomplished by covering the roof with plastic or slanting the roof, as the rain water will run off, rather then collect in pools. Additionally, as the insulation of a building increases, the amount of ventilation needed to maintain a comfortable environment also increases (p. 4), as the insulation serves also to stifle airflow through the building.

### 2.4.3. Building Features.

The use of energy efficient features in houses can greatly reduce energy problems without overly increasing housing costs. By adjusting various building features, such as surface properties, external and internal building shape, and the site of the building, the temperature of the house can be made cooler in the summer, and warmer in the winter.

### 2.4.3.1. Surface Properties.

The surface properties of a material, including the color and texture, are one factor determining how much energy is absorbed and how much energy is reflected. Reflected energy is returned to the outside environment, while absorbed energy is transmitted to the inside. The less energy that is transmitted, the cooler the inside environment will be.

Irregularities in texture make the surface cool faster (Dimoudi, 1996a, p. 40). This is due to the fact that not all of the surface area of the surface is hit by the solar radiation at once. However, the entire surface area radiates out the heat that is absorbed. Therefore, while the same amount of heat is being absorbed as with a flat surface, more heat can be radiated back out.

The color of a material has a large effect on the amount of heat energy absorbed and transmitted through the material (Dimoudi, 1996c, p. 124). As the amount of light, and thus heat energy, reflected increases, the amount of heat absorbed decreases. In general, solar absorptivity--the amount of heat absorbed--is indirectly proportional to the reflectivity, which is directly proportional to the lightness (Dimoudi, 1996c, p. 124). In simpler terms, the lighter a color, the more the heat energy is reflected and, thus, not absorbed into the material. A dark surface, with absorptivity of 0.9, can be as much as 27$^{o}$C hotter than if the surface had an absorbtivity of 0.2. By painting a house a light color, more of the heat energy is reflected and the

**Table 2.2. Solar Reflectance of Various Materials**

| | |
|---|---|
| White paint | .5-.9 |
| Red Brown Tile | .1-.35 |
| Brick Stone | .2-.4 |
| Tar & Gravel | .08-.18 |
| Tree | .15-.18 |
| Concrete | .1-.35 |
| Asphalt | .05-.2 |
| Grass | .25-.3 |

Based on Dimoudi, 1996b, p. 90

house stays cooler. In the same way, by painting the roof of the house white, it remains cooler, and so it can be cooled by radiative cooling more easily (Argiriou, 1996b, p. 432-433). See Section 0 for more information on radiative cooling. Non earth-based ceramic materials, such as white cement, gypsum, and lime, as well as whitewashed materials, also have a high reflectivity and are good for hot climates (Dimoudi, 1996c, p. 125). The solar reflectance of various materials is given in Table 2.2. The solar reflectance of a material is the percentage of light, or heat, energy that is reflected. White paint, with a reflectance of 0.5 to 0.9, reflects 50 to 90% of the light energy that hits it, making it stay cooler then concrete, which reflects only 10 to 35% of the light.

#### 2.4.3.2. Building Shape.

The external shape of a building determines the amount of exposure to solar radiation, daylight, and wind (Balaras, 1996a, p.7), and thus has a large impact on the energy efficiency of the building. The relative sizes of the different walls of a building affect the heat gain to the building. Additionally, the internal layout of the house and ceiling height can also greatly affect the energy efficiency of the building.

According to Flipts and Zibetta (1994, p. 5), having a high internal volume to external surface area ratio will minimize heat loss and gain. The volume determines how much heat can be stored in the building (Dimoudi, 1996c, p. 119), while the surface area determines the rate at which heat is gained and lost. Having a relatively small surface area means the building will take a long time to heat up, as it does not receive much solar radiation. A large volume will store more heat, so more solar radiation can be absorbed before an increase in temperature is felt. As such, compact buildings with a smaller

surface area for the same volume, work well for hot, dry climates, such as that of Windhoek.

In some situations, due to topography, space limitations, or residents' preferences, it is not possible to have a compact building. In these cases, the east and west walls should be minimized whenever possible (Dimoudi, 1996c, p. 120). The sun is at its lowest at these two points, and so these walls will experience the most exposure to solar radiation. By minimizing the east and west walls, the amount of heat energy from the sun absorbed by the house can also be minimized. The longest side should face within 15 degrees of north (Schutze and Worthington, 2002, p. 42). This will help the house get more solar radiation during the winter.

The internal layout of a building also affects the energy-efficiency. Internal partitions should not restrict air flow paths through the building (Dimoudi, 1996c, p. 121). The positions of walls should serve to help channel the wind through the occupied areas of the buildings. This will increase the ventilation in the building, which will lower the perceived temperature, as discussed in Section 2.4.1.2. Having a large space on the windward side of the building can help to improve air flow as well. Additionally, rooms with no windows or without any external walls can get secondary light and ventilation by adding a window to an inside partition (Baker & Steemers, 2002, p. 58). This allows the air to flow through the room and daylight to enter.

The ceiling height does not affect air flow; however, a high ceiling will allow thermal stratification, assuming there are high heat gains through the roof. Thermal stratification allows the warmer air to remain closer to the ceiling, thus reducing the amount of heat transferred from the roof.

### 2.4.3.3. Site Location.

The location and orientation of a house can have a large impact on its energy efficiency. The amount of wind, rain, and solar radiation are all largely affected by the site and are responsible, in part, for the inside temperature of the building. By using hill slopes and adjusting the altitude of the house, the temperature can be controlled.

When compared to a horizontal site, sites on slopes receive more radiation during winter and less during summer (Dimoudi, 1996b, p. 85-87). Slopes are also warmer at night than valleys and plateaus and have a smaller temperature difference between night and day. Additionally, higher windspeeds are found on the tops of hills and on the windward slopes. During the day, warm air rises up the slopes of a mountain. At night, cool wind goes down the mountain. This is particularly strong in narrow valleys. Houses on south-facing slopes will be colder than north-facing slopes due to the position of the sun (Ward, 2002, p. 74), as shown in Figure 2.9. Buildings on west-facing slopes will experience harsh sun in the afternoons, and so should be avoided.

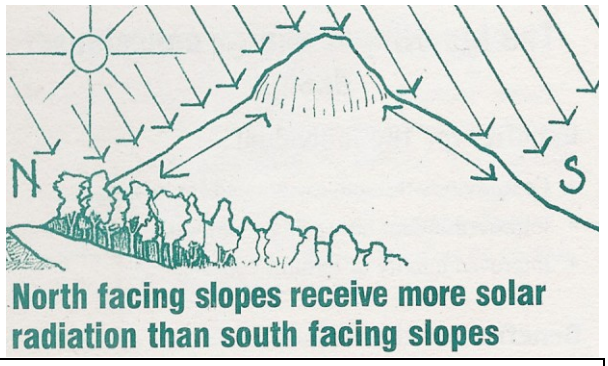



Figure 2.9. Sites on North Slopes. From S. Ward, 2002, p. 74.

The position on the slope of a hill also affects the temperature and amount of rain a building receives. There is a decrease of about 0.65$^{o}$C for every 100 m increase in altitude (Dimoudi, 1996b, p. 88). Additionally, windward sides of a hill get less rain, as

the wind pushes it over to the other side.  Therefore, in dryer climates, such as Windhoek, leeward sides of hills will provide more rain, which will help to keep temperatures cool. Building on a slope also makes it easier to construct the building at least partially in the ground, a form of direct earth cooling, which is discussed in Section 2.4.1.5

## Chapter 3. Methodology.

The goal of the *Energy Efficiency In Low-Cost Housing* project was to provide affordable recommendations to increase the energy efficiency of low cost housing. The specific objectives achieved were identifying the roles of major stakeholders in the project, finding techniques to increase energy efficiency, and developing ways to distribute energy efficiency information. We developed a two-pronged process, shown in Figure 3.1, to collect the data that we needed to complete our project. The two major steps of the process were stakeholder research and energy efficiency research. Stakeholder research was conducted by studying both agencies and the affected communities; energy efficiency research was conducted by studying texts and speaking with and observing the community. Final recommendations were developed by synthesizing the information collected from these two steps. By approaching the problem with information from multiple stakeholders, we were able to identify and understand major implementation considerations for low-income housing as well as gather existing information about how to increase energy efficiency.

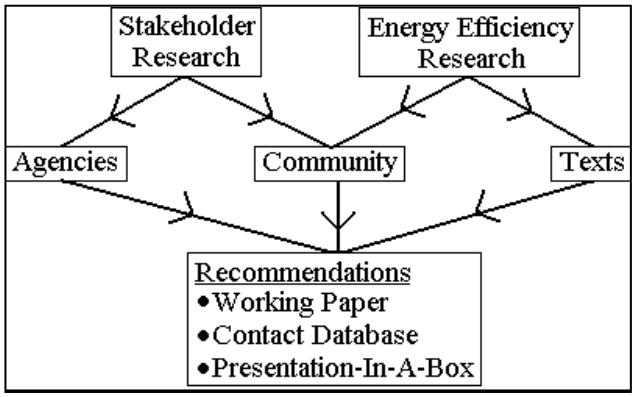



Figure 3.1. Methods Scheme.

## Section 3.1. Stakeholder Research.

Our first objective was to identify the roles of major stakeholders in the EEUDV project. Achieving this objective was critical to the success of our project because the stakeholders will be responsible for implementing EEUDV, so it was important to understand their roles in order to develop end products useful to the stakeholders. During stakeholder research, major stakeholders were identified by modified snowball sampling and semi-structured interviews were used to collect data. In the course of identifying stakeholders and determining their roles, the stakeholders were also familiarized with the EEUDV project. Relationships among stakeholders were also recognized and documented.

Stakeholders are groups that have financial, technical, regulatory, or practical interest in the Energy Efficient Urban Demonstration Village [EEUDV] project and include government housing authorities, non-governmental organizations [NGOs], urban planning or architectural specialists, and ISA residents. Specific examples of stakeholders include the National Housing Enterprise [NHE], the City of Windhoek Office of Sustainable Development, the Shack Dweller's Federation of Namibia [SDFN], and the Namibia Housing Action Group [NHAG], among many others. Because the EEUDV will eventually be implemented by many different organizations, it was important to identify all the main stakeholders involved in the process and to facilitate discussion of the project. Due to the large number of stakeholders, the R3E Meeting and Contact Database [R3E-MCD], discussed in Section 3.3, was created to centralize contact information for all of the known stakeholders.

To identify the main stakeholders in this project, we used a modified form of snowball sampling, a method where interviewees provide names of more contact people. We started by obtaining two contact names and four interested organizations from Mr. Robert Schultz, director of R3E. After speaking with these individuals and organizations, we were able to identify other interested individuals and organizations to generate a relatively exhaustive sampling frame within which to conduct our research. According to Bernard (2002, pp. 185-186), snowball sampling is effective for obtaining a complete sample when dealing with smaller populations of people who are likely to be in contact with each other. This was applicable in our situation because many of the organizations we were interested in were routinely in contact with each other for normal business purposes.

As major stakeholders were identified, they were contacted and interviews were arranged to familiarize them with the EEUDV project and to determine their potential roles in the project. This was a necessary step, since the EEUDV project had not yet officially begun and awareness of the project was low. In addition to introducing the project to the stakeholders, we also collected information on the stakeholders' roles in designing and implementing low-income housing. This information was necessary to determine stakeholder priorities, such as low cost housing versus energy efficiency. Understanding the priorities and goals of each stakeholder was critical to discern what information was most useful for each organization and to determine how the working paper, discussed in Section 3.3, should be written to be most useful to the stakeholders. For instance, if an organization was focused mainly on social aspects of low-cost

housing, then they were most likely uninterested in costs of building materials, and to include only this information in the working paper would have been less useful.

The interviews used to collect data from the stakeholders were semi-structured, using open-ended questions. This method was chosen because it was the most suitable and realistic option for gathering detailed data from professional organizations that had few or no written documents on their goals or priorities. Other methods, such as surveys or focus groups, were likely to be ignored, take up too much time, or not provide us with the information we needed. Interviewing allowed us the flexibility to guide our discussions without a major time commitment from the interviewee. According to Bernard (2002, p. 205), an interview guide must be developed and followed in order to get accurate, reliable data. Our basic interview protocol was designed to collect information mainly on current housing situations and housing plans, future housing plans, energy-efficiency in existing designs, and similar projects, as well as identifying other stakeholders and stakeholder priorities, as discussed above. The protocols are located in Appendix F, including questions that were specifically tailored for certain stakeholders. For example, questions for the SDFN were more focused on resident needs and resources, while questions for NHE focused more on planning processes and housing regulations. Interviews were structured to last approximately one hour in order to prevent us from taking up too much of the interviewee's time and to stay focused on the issues at hand, although actual interview times varied. For each interview, there was one main interviewer and one recorder, although both were free to take notes and ask questions.

## Section 3.2. Energy Efficiency Research.

Our second objective was to find techniques to increase energy efficiency. This was important in order to develop useful recommendations for upgrading housing in ISAs. We used two primary methods to find techniques to increase energy efficiency of low-income housing: text research and direct observation. Both methods were used to identify energy efficient techniques, while direct observation was also used to determine whether energy efficient techniques were practical and culturally acceptable in an ISA setting.

We gathered detailed technical information on energy efficiency from technical sources such as energy efficiency books and building design handbooks. The energy efficiency techniques that we found in the books were evaluated on the basis of appropriateness for conditions in the Windhoek ISAs. If the energy efficiency information from the text research was determined possibly be appropriate according to the criteria of increasing energy efficiency and being suitable for the Windhoek environment, it was added to Chapter 2. This prevented us from further analyzing blatantly unrealistic options during our analysis stage. The information collected from our text research was organized into passive cooling techniques, insulation, and building features categories. In addition to including text information, data were also converted to pictorial form in order to facilitate future uses of the information in ISAs, where literacy rates can be low. Pictures and models of how to implement a technique were also useful in developing our presentation protocol, described in Section 3.3.

To determine the energy efficiency of existing housing in Windhoek ISAs, we used direct observation. We accomplished this by accompanying other WPI project teams working in the field and taking detailed notes on how houses were put together, what and how insulation was used, which building materials were used, how houses were set up, the vegetation around the houses, and any other energy efficient features being used. These notes were cross-referenced with the information found in text resources in order to find energy efficient features that currently are not being used and to determine which theoretical techniques would work best in the Windhoek climate. After directly observing housing in the ISAs, we were able to obtain a more accurate grasp of what specific problems plagued residents, what the residents currently do to increase energy efficiency, and how to best design housing improvements for Windhoek ISAs. This information was critical to produce feasible, useful recommendations for ISA upgrading. Data collected through direct observation were analyzed by evaluating energy efficiency techniques from the perspectives of energy-efficiency and appropriateness to stakeholders and residents, as described in Section 3.3.

### Section 3.3. Recommendations and Deliverables.

Our third objective was to develop a method to distribute energy efficiency information to both stakeholders and ISA residents. This was a particularly challenging objective to achieve because of the diversity of languages and educational levels among stakeholder organizations and residents, in addition to the varying levels of information given to different stakeholders and the lack of information given to residents. However, a method of information distribution was necessary in order to both inform stakeholders

about energy efficiency information and to give ISA residents ideas on what they could do to improve the energy efficiency of their own homes. To solve this problem, we decided to develop one method to distribute information and facilitate communication among stakeholders, and a second method to distribute information to ISA residents. From the synthesis of our stakeholder and energy efficiency research, we developed three deliverables: R3E-MCD and a working paper, targeted to stakeholders, and Presentation-In-A-Box, targeted to ISA residents. In addition to our deliverables, we also developed our energy efficiency recommendations in the form of an energy efficient technique recommendation table.

To produce our recommendation table, we evaluated our energy efficiency data for potential use in ISA situations, taking into account the energy efficiency of the technique, and, if known, any stakeholder or resident inhibitions towards the technique. Data were synthesized by compiling and cross-referencing the data gathered from our text research and our direct observations. We did this by compiling a complete listing of energy efficient techniques and then listing whether or not there were any known cultural or practical inhibitions towards the recommendations and if so, what they were. If an option was acceptable for both criteria, it was suggested as a recommendation in the working paper. In producing the table, we considered only one scenario: an ISA household with little or no money. For each section of the table, there are different possible recommendations for each income level. However, we examined only our one scenario since many of the improvements obviously cost more than the residents had to spend on housing.

Only methods that were known to be energy efficient from text research and stakeholder interview or were observed directly in ISAs were included on the table. During our research, we conducted ISA site visits to Katutura, Okahandja Park, and Oshetu One. When we observed a particular method being used, we noted it in the table. If a method had been observed being used in an ISA, then it was considered to be acceptable for recommendation. In addition, if stakeholders were aware of any social or cultural inhibitions to specific techniques, we included a discussion of the limitations of the technique in Chapter 4. Due to the limited timeframe in which this project was conducted, we were unable to collect an exhaustive list of methods and materials. Instead, we set up a list organized by house section, such as wall or roof, which can be easily amended when information is collected in the future.

The first deliverable that we developed was the R3E-MCD. Stakeholder contact information collected during stakeholder research was centralized in the R3E-MCD. The database, designed in Microsoft Access 2002, was intended to store and organize information related to the EEUDV project. All notes from meetings with stakeholders were added to the database, and other collected information, including general notes on stakeholders and helpfulness ratings, were entered into their respective database fields. After initial development of the R3E-MCD, it was preliminarily tested on a small group of students to determine functionality, cohesiveness, and usability of the database. The latest version of R3E-MCD was given to R3E along with the user manual.

The working paper, located in Appendix D, was produced by summarizing and synthesizing our results and data into a brief, easily readable paper that R3E can distribute to stakeholders. After identifying feasible options for energy efficiency

recommendations from the recommendation table, Appendix A, they were added to the working paper and explanations and justifications of each technique were described. In addition, basic information about stakeholder organizations was also included. No individuals were included as stakeholders in the working paper because solidly defined roles have not yet been assigned. The working paper was written in bulleted pamphlet form for simplicity and ease of reading. Since the document will be distributed to a large number of stakeholders with diverse interests, it was most expedient to display information in an easily-scanned format, which will enhance the usefulness of the document, as stakeholders will be more likely to read a short, condensed paper rather than a long, detailed technical paper. The full *Energy Efficiency In Low-Cost Housing* report, however, will be on file with R3E in the case that a stakeholder wants a more detailed explanation of a technique.

Our final deliverable was Presentation-In-A-Box [PIAB], located Appendix E. PIAB is a method of distributing energy efficiency information and techniques directly to stakeholders and residents. PIAB was created by developing pictures and models to illustrate how to apply energy efficient techniques and to demonstrate how the technique worked, when possible. This was done in order to help overcome possible language barriers. The simplicity of the design also allowed broad concepts to be explained without the necessity of a formal education. All pictures used in PIAB were pre-tested on a small group of students by showing the pictures and having the students explain what they thought the pictures represented. If a picture was explained by a test student incorrectly, then the picture was revised to more accurately reflect the technique. Preliminary speaking protocols were also included in PIAB to facilitate the presentation

process. The speaking protocol was also given to a small group of testers in order to determine whether our explanations were received correctly by the audience and to determine whether the order of concepts worked well. While this protocol was tested only preliminarily in this project, it will be evaluated and used by R3E in the future for raising awareness among stakeholders and ISA residents.

A trial presentation of PIAB given to ISA residents was arranged through the City of Windhoek Office of Sustainable Development and Office of Community Development. The presentation was conducted in a classroom setting at the Katutura Community Center in Windhoek. A classroom setting was used because the presentations occurred after working hours, when lighting in the field would be insufficient and because conducting a presentation in the ISAs could create large, distracting crowds. At the session, there were 24 residents from Havana Section 2, Ongulumbashe Sections 1 and 2, and Okahandja Park A, B, and C. Because of the ethnic and educational diversity of the audience, translators were used during the presentation to allow the entire audience to grasp each concept. After an explanation was given in English, it was then translated into Afrikaans and then to Oshiwambo. All questions and explanations were repeated in all three languages to ensure complete understanding of the audience. The complete speaking and demonstration protocol used during the presentation is specified in PIAB, located in Appendix E. At the end of the presentation, feedback on the presentation was collected through informal interviewing techniques by asking the audience for comments, suggestions, and questions, as specified in Appendix E.

The final products of this project—the working paper, Presentation-In-A-Box, and the R3E-MCD—will help R3E implement the Energy Efficient Urban Demonstration Village and will provide some of the tools necessary to inform and keep track of stakeholder and ISA resident opinions as the project is implemented, steps that are critical to the successful continuation of the project.

## Chapter 4. Results and Analysis.

After collecting our data, they were analyzed in three major parts: stakeholder findings, energy efficiency recommendations, and energy efficiency awareness problems. This analysis allowed us to achieve each of our objectives of identifying stakeholder roles, finding feasible energy efficiency increasing techniques, and developing ways to distribute energy efficiency information. We determined the roles of the stakeholders of the Energy Efficient Urban Demonstration Village [EEUDV] project and identified relationships among stakeholders. In addition, we developed the R3E Meeting and Contact Database [R3E-MCD]. Energy efficiency data were compiled into an analysis table, which allowed us to determine and recommend suitable energy efficiency increasing techniques and develop these recommendations into our working paper and the Presentation-In-A-Box [PIAB].

### Section 4.1. Stakeholder Findings.

The stakeholders of the EEUDV project will eventually be responsible for its implementation and continuation. While each stakeholder plays a unique role, all will have major parts to play in the planning and execution of the project and its continuation. Due to the cooperative nature of the project, stakeholder communication is also necessary. Relationships among stakeholders exist but are fragile, and communication levels are low. To help facilitate communication among stakeholders, we developed a stakeholder contact information database.

### 4.1.1. Stakeholder Roles and Relationships.

Through research and interviews, we determined the role that each stakeholder plays in the EEUDV in addition to general background information about each stakeholder, as discussed in Section 2.3. It is especially important for stakeholders to have clearly defined roles within the EEUDV since there are many key players. If each organization has a good understanding of its responsibilities, there will be less conflict over who has authority in a given situation. As well as identifying the stakeholder roles, we also identified relationships that exist between specific stakeholders. It is imperative to understand these relationships because, like every project that includes more than one organization, there are lines of communication that must be followed and if these are understood, more work can be accomplished in the same amount of time. If these relationships are not fully understood, progress of the EEUDV project and future projects trying to utilize connections among these organizations will be greatly hindered.

Stakeholders of the EEUDV included government agencies, NGOs, and other associated groups. As noted in Section 2.3, the government agencies included the Ministry of Regional and Local Government and Housing [MRLGH], the National Housing Enterprise [NHE], and the City of Windhoek [CoW]. The major role of MRLGH will be to facilitate the implementation of the project by relaxing housing regulations that impede the progress of EEUDV and helping the project get expedited approval. NHE will finance EEUDV through normal procedures, assign architects and civil engineers to work on the project, construct the houses, and identify which residents will eventually live in the housing. CoW will also play an important role in facilitating

project implementation. Specific tasks of CoW include identifying a site for the project, assigning town planners to work on the project, and supplying services through the normal servicing protocols.

The major NGO players included the Namibia Housing Action Group [NHAG] and the Shack Dwellers Federation of Namibia [SDFN]. These stakeholders will promote the use of energy efficient measures in housing and will provide information directly to its members. Associated groups include R3E and the future Habitat Research and Development Centre [HRDC]. In addition to fulfilling the roles described in Section 2.3.3., R3E will coordinate EEUDV and distribute information to stakeholders. HRDC will eventually become a resource for the project. Other potential stakeholders may exist, but all of the major stakeholders were identified in this report and are shown in Figure 4.1. The roles of stakeholder groups will overlap to some extent at the onset of the project, but clearly understanding the job of each organization will both simplify the process and reduce overlap.

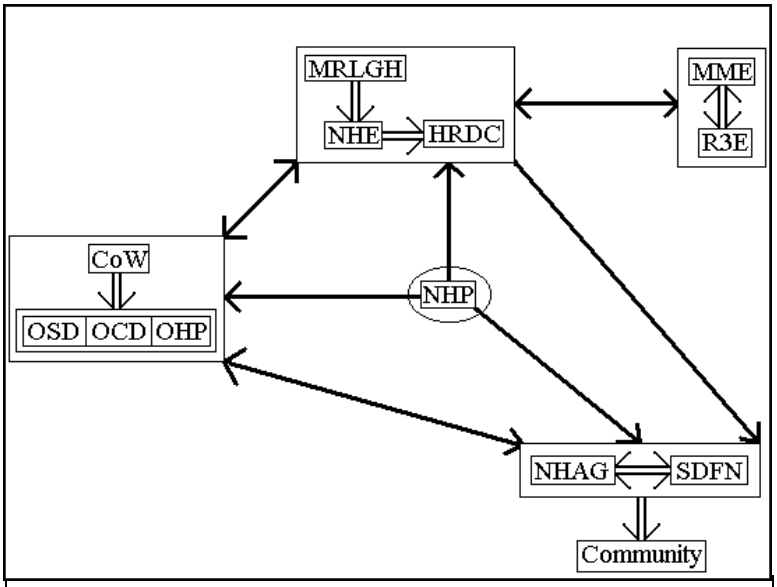


Figure 4.1. Stakeholder Relationship Diagram.

As stakeholder research was conducted, a pattern of relationships and lines of communication became evident. A diagram of the stakeholder connections we identified is shown in Figure 4.1. In the

figure, the National Housing Policy [NHP] is the central unifying element that connects the Namibian Government on the top level, the City of Windhoek on the middle level, and NGOs and communities on the lowest level. Double-headed arrows indicate reciprocal relationships; for example, NHAG and SDFN are partners and work together to design and implement low-income housing. NHAG and SDFN exchange information and have effects on each others' work. Single-headed arrows indicate one-way relationships; for example, MRLGH and NHAG do not exchange information. NHAG must follow any guidelines set by the MRLGH, since the Ministry is a government agency. The complex web of interrelationship shown in the diagram reveals the intricate nature of stakeholder communication and interaction.

Although communication occurs among almost all of the stakeholders, as shown in Figure 4.1, actual levels of communication are low. As with many bureaucracies, the City of Windhoek has a top-down organization where information is passed from supervisor to subordinate and lateral communication is effectively absent. However, this method of information distribution is ineffective and lines of communication are often broken for various reasons, including information being passed to the wrong person or information being put aside indefinitely. Anecdotal evidence indicates that this is a problem for the City of Windhoek [CoW] government. An agreement was made between the City and DANIDA for CoW to play specific roles in the EEUDV project. However, when the Offices of Sustainable Development and Community Development were contacted for this project, they were surprised to learn that it even existed, an example of vertical intra-agency communication failure. In addition, NHE and NHAG both work on similar projects of designing housing for low-income households. However, after

contacting both organizations, we learned that neither communicated with each about designing or construction strategies, although there was significant overlap in their plans, an example of horizontal inter-agency communication failure. While we did not conduct a systematized study of the lack of communication on housing projects in Windhoek, our evidence suggests that it is a major problem and could have serious repercussions for large-scale projects including EEUDV.

### 4.1.2. Stakeholder Database.

As noted in Section 3.1, contact information for stakeholders was often difficult to find. Because we only performed the beginning stages of the EEUDV and others will need to follow up on our research, we determined that a way to store the information that we collected in an orderly and easy-to-use manner was necessary. To accomplish this, we developed a meeting and stakeholder database with a simple 'point and click' interface, which centralized information for all known stakeholders into one source.

The R3E Meeting and Contact Database [R3E-MCD] was created in Microsoft Access 2003 for R3E as a utility to help administer the EEUDV project. For simplicity, the user interface is divided into two main sections, the Contacts section and the Meetings section. Throughout the application, straightforward button-driven menus are used to guide the user through the various options. The first menu that the user encounters after starting the application, shown in Figure 4.2, has four options that will bring the user to the next respective menu: Contacts, Meetings, Administrative, and Quit.

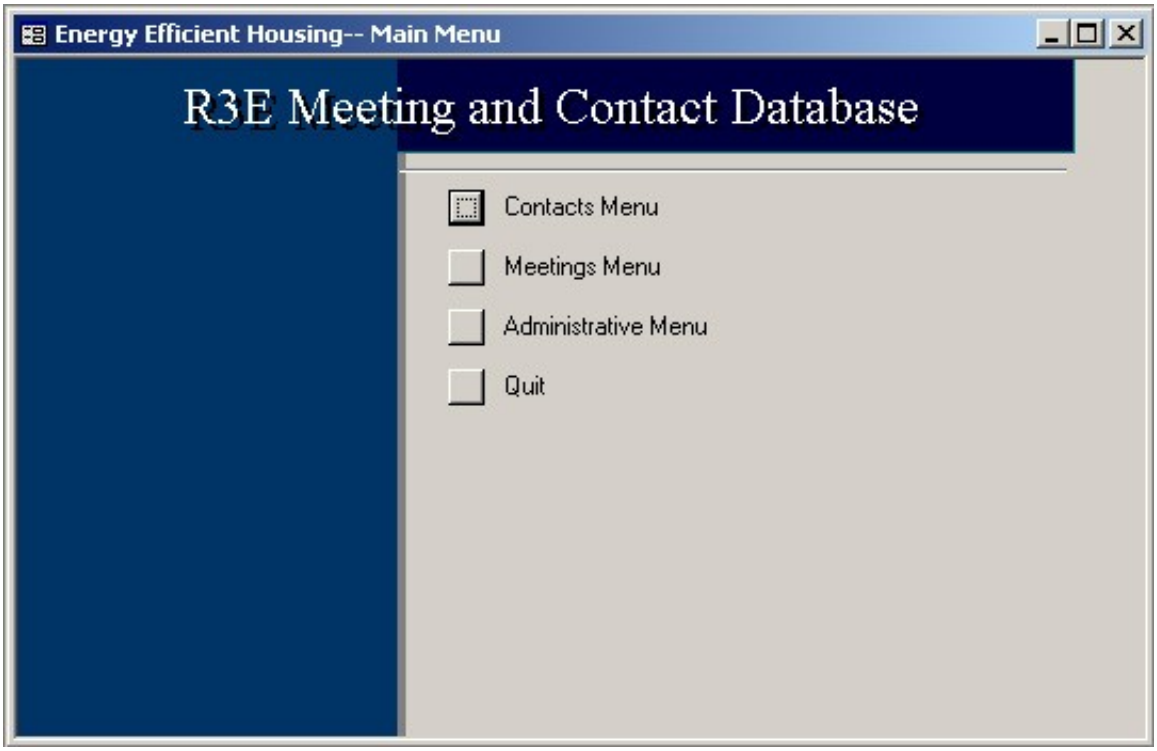



Figure 4.2. Main Menu.

The two major components of the database, the Contact Menu and the Meetings Menu, can be accessed from the Main Menu. The 'Contacts Menu' button brings the user to the Contacts Menu. This menu gives the user options such as editing and adding contacts, printing a list of all the contacts in the database, or listing all of the organizations associated with the EEUDV project. To get to the Meetings Menu, the user can click the 'Meetings Menu' button in the main menu or the 'Jump to Meetings Menu' button in the Contacts Menu. The Meetings Menu gives the user options to manipulate meetings, such as adding and editing meetings, displaying all meetings that are scheduled for a future date, and displaying a short description of all the meetings that have been flagged as useful. The maintenance of R3E-MCD will eventually be transferred to R3E, and R3E will become responsible for continuing to update it as new stakeholders are

identified or contact information changes. Maintaining an updated database is critical to keeping the lines of communication open. The complete instruction manual on the R3E-MCD can be found in Appendix C.

The graphical user interface, or GUI, drives the more technical side of the database in which there are six tables. Tables are a database tool used to store the information that the database uses to power the GUI. The tables in the R3E-MCD are *contact*, *helpRating*, *meeting*, *meetingCross*, *meetingType*, and *organization*. The *contact* table holds various information about the contact: his or her last name, first name, title, department, organization, work phone number, cell phone number, fax number, email address, street address, date added to the database, the next scheduled meeting date and time, the overall project the person is involved in, and any additional notes about them.

Most of the contacts who we talked to were also part of an organization, such as the City of Windhoek. Information about each organization is held in the *organization* table. We found it useful to have a list of organizations to choose from in a dropdown menu rather than to have to type it in each time a contact is added to the database, specifically when many contacts came from the same organization. Specific fields stored about each organization are the organization's name, description, phone number, cell number, fax number, address, email address, website, map directions, and extra notes.

We also found that it was convenient to keep track of how helpful each contact and meeting was. The *helpRating* table holds a list of descriptions used to rate how helpful a contact or meeting is. The descriptions range from 'Very Helpful' to 'Very Unhelpful.' In the GUI, these descriptions are put into a dropdown menu to let the user choose which best describes the specific contact. Having a limited selection to choose

from allows the application to sort the contacts by how helpful they are, a system also used to describe meetings. As described above, the database is designed to hold contacts and the minutes and notes from each meeting all the contacts have participated in. The *meeting* table holds the meeting's date, time, minutes, agenda, a brief description of the meeting, the meeting type, extra notes, the helpfulness rating, and the overall project the meeting was for. Because we had different kinds of meetings, it was necessary to distinguish the type of each meeting, i.e., face-to-face interview or on-site visit. This was accomplished by creating the *meetingType* table which holds a list of different meeting types which gives the user a list of meeting types in a dropdown menu in the GUI. The most important table in the database is the *meetingCross* table because it associates each contact with each meeting he or she has participated in. This table allows the database to cross-reference both the *contact* and *meeting* table allowing the GUI to figure out who participated in which meeting.

### Section 4.2. Energy Efficiency Recommendations.

Our energy efficiency research resulted in a large number of materials and methods that can be used to make houses cooler during the summer and warmer during the winter. For ease of reference, this information was compiled into Appendix A, our Recommendation Analysis Table. This table is a composite of theoretical and observed energy efficiency increasing techniques. By compiling and cross-referencing the data gathered from our text research and our direct observations, we were able to identify which materials and techniques were best suited to reduce amounts of heat in ISA houses during the summer and increase the amounts of heat during the winter. It is important to

note that many of the techniques suggested in this section focus on reducing amounts of heat during the summer. During the winter, these methods should not be utilized, if possible. With all techniques, the residents must weigh the costs and benefits of each technique to determine whether it will be suitable for them. When applicable, we have included a discussion of this problem for each affected technique, including the possibility of seasonal housing upgrades.

Our Recommendation Analysis Table, Appendix A, is a compilation of our energy efficiency observations and findings and is divided into seven categories: site location and orientation, walls, windows, roof, insulation, shading, and other. When available, these categories were further broken down into materials, methods, and surface properties. Each row of the table contains a different technique to increase the energy efficiency of low-cost housing. There are two columns, *Direct Observation* and *Energy Efficient*, that were used as criteria on which to base our recommendations, as described in Section 3.3. In this section, specific recommendations, based on information and categories in the table, are detailed and justified.

In considering the orientation of a house, there are a few options. If there is a slope nearby, the house should be built on the slope, as described in Section 2.4.3.3. If possible, build on a south-facing slope, which will provide more shade. Although there are benefits to building on a slope, it is important to note that it can be problematic. Water runs faster on a slope so there could be problems with ground shifting under the house when it rains. This technique will also cool the house during both the summer and winter, so this must be considered before implementation.

Overhangs can be very beneficial, as described in the roof section below, and orienting the longest side of the house to face north will further increase energy efficiency. However, it is important to note that the overhang must be measured carefully to have the maximum impact, which is different in every situation. An overhang that is too short will not block the sun during the summer and an overhang which is too long will block the sun in the winter. To make this simpler, it may be easier to construct an overhang during the summer, and remove it during the winter. This will ensure that the overhang does not cool the house in the winter. Similar to the concept underlying overhangs, reducing the size of the walls that face east and west will also increase energy efficiency. Because the sun shines the lowest on the east and west sides, the house will stay cooler if there is less material available to absorb the sun's heat. Also, the smaller the surface area of the house, the cooler it will stay, as described in Section 2.4.3.2. It is important to understand, however, that this design is efficient in the summer, but in inefficient during the winter.

The location of a house is also an important consideration, especially whether or not to build a house into the ground, the benefits of which are described in Section 2.4.1.5. There are many options for how deep into the ground to build a house, but most of them require very expensive excavation. In many Windhoek ISAs, the soil has a very high rock content, making excavation even more unrealistic for low-income households. There are, however, benefits to having the house placed directly on the ground. Because soil has a very high thermal capacity, as stated in Section 2.4.1.1, the soil will pull heat from the house. In the winter, depending on the specific climatic conditions, this

technique could serve to keep the house cooler in the winter. If this is the case, insulation, such as a rug, could be added during the cooler months.

*In terms of orientation and house design, we recommend that, if possible, the house be built on a south-facing slope with the smallest surface area possible. Walls on the east and west sides should be the smallest walls, while long sides of the house should be on the north and south sides. In addition, an overhang should be placed on the north side. We also recommend that the door be placed on the south side to prevent heat from entering the house when the door opens and closes.*

The wall section of the Recommendation Analysis Table is divided into three categories: building materials, building methods, and textures and colors. It is important to consider many aspects of the future building materials when constructing a house, specifically whether the material is energy efficient. Clay, for example, is energy efficient because it has a high thermal mass. However, it is not generally culturally acceptable. Most informal residents are moving from rural areas into the city looking for work. They reject traditional building materials and methods because they think that it is not 'modern' enough (T. Fox, personal communication, 3/19/2003). Instead, most residents are currently using corrugated iron and flattened oil drums as walls. The flattened oil drums are not energy efficient; the corrugated iron is a slightly better option because it has a higher surface area to absorb heat and the ridges prevent the entire sheet from always receiving direct sunlight. Bricks made out of earth, discussed in Section 2.4.1.1, are energy efficient and more affordable than most other types of manufactured brick; however we have not seen them in the field. Hollow bricks are more energy efficient than traditional bricks, but they are more expensive than corrugated iron.

Building walls with energy efficient materials is important, but it is also necessary to investigate the methods for wall construction. On a blueprint, building residences that share internal walls is an ideal way to cut costs. It is also an energy efficient method because there are fewer walls that face the outside, which means that there is a smaller surface area facing the outside for the thermal mass of two houses, as stated in Section 2.4.1.1. Although beneficial, this system has not worked in actuality. After being tried in the field by SDFN, it was noted that the four-inch thick walls were not thick enough to block the sound coming from the adjoining houses (E. Mbanga, personal communication, 4/1/03). Because of this sound problem, the method was discarded. Constructing walls thicker than 4 inches on the sides of the house that receive the most sunlight would be very beneficial because of the increase in thermal mass; however, the extra material needed would be more expensive. As in the previous example of wall-sharing, the cost of building thicker walls can be prohibitive.

Another way to increase energy efficiency is to make walls more airtight. Filling in gaps in walls, such as where the corrugated iron sheets fit together, will greatly decrease the amount of heat that enters the house. However, if there is no ventilation at all, the house can become dangerously hot or cold. One way of solving this problem is the use of airbricks for ventilation. This is a building method in which the bricklayer strategically leaves out certain bricks when constructing a wall. This is energy efficient because the holes in the wall are intentionally placed so maximum ventilation can occur. In an ISA situation, this method may be modified to leave intentional gaps in the interior corrugated iron walls. The major disadvantage to this technique is that this will also allow air to flow into the house during winter, cooling it. A possible solution to this

problem would be to block up the holes with some other material, such as cardboard or cloth insulation, during the winter months. Wind channeling will also increase ventilation in the house. Purposefully placing the internal walls so that they direct natural breeze into all of the rooms will help keep the rooms cooler and more ventilated. This method needs to be done very carefully. If internal walls are constructed more for the purpose of directing wind than holding the house up, the house could easily collapse.

Ventilation and building materials are both very important and both are made more energy efficient with strategic use of color and texture. Texturing an outside wall so that it is not totally flat, as described in Section 2.4.3.1, is one way to increase energy efficiency. Because the surface is not flat, there is more surface area to radiate out the same amount of heat, allowing some areas to stay cooler, as in the corrugated iron example discussed previously. As also noted in Section 2.4.3.1, using a light color of paint or whitewash on the exterior of the housing will prevent the house from absorbing as much heat as a darker-colored house would. In the field, we noticed that there were a number of houses with light colors of paint on them, although it may have been done for aesthetic reasons. Building walls out of a reflective material, such as clean corrugated iron, will also decrease the amount of heat that enters the wall and is eventually transmitted into the house. These color and texture methods compliment the first two sections, building materials and methods, in constructing and maintaining energy efficient walls. These techniques will make the house considerably cooler in the summer, but will also serve to cool the house in the winter. It may be possible for the walls to be changed or covered during the winter months, depending on the availability of materials.

*Of the above mentioned materials and methods for walls, we suggest using either earth bricks or corrugated iron for wall material. Earth bricks are one of the cheapest types of bricks and act as a good insulator. If earth bricks are used, the air brick technique can also be used. If corrugated iron is the best building material available, make sure that all of the seams of the metal are as airtight as possible, but also use an organized form of ventilation, if possible. For both materials, all walls should be airtight. With either approach, earth brick or corrugated iron, we recommend that light colored or reflective material be used to reflect as much heat as possible. This can be done with reflective corrugated iron, whitewash, texturing the outside material, or combining any of these techniques. We also recommend that internal walls be used to channel wind into all of the rooms.*

Windows in the wall of a house increase ventilation, which can cool down the house considerably, as discussed in Section 2.4.1.2. Many current ISA houses do not have windows, as theft is a major problem (R. Schultz, personal communication, 3/10/2003). The windows that do exist are often just spaces with no wall material, which is the cheapest and easiest way to construct them. This can cause privacy and theft problems, however, so if bars or shutters are available they should be utilized. Placing curtains on the windows is an affordable way to increase privacy and will also help increase the energy efficiency of the house because the material of the curtains will help block some of the solar radiation from entering and heating the house. Glass windows were observed on a few houses, and while they did address the security issue, they could not be opened. Because of this, the windows did not help to improve ventilation and in fact they allowed additional solar energy into the house. Another problem with glass

windows are that they are expensive to purchase and install. Window placement also has a significant effect on the amount of ventilation through a building. Placing windows of approximately the same size on opposite walls will provide good ventilation throughout the house. Windows on the same wall should be widely spaced to improve ventilation, as shown in Figure 2.1. If possible, shutters of some sort, even made of cardboard, should be placed on the windows so they can be covered during the cooler months.

*If windows are an option, then they should be placed on the north and south sides of the house. Additionally, security measures should be taken to prevent theft and curtains should be used to prevent heat from entering the house.*

The roof section of the Recommendation Analysis Table is divided up similarly to the wall section with material, method, and surface property categories. Currently, most ISA dwellings have metal or corrugated metal roofs. This is energy efficient in that metal can radiate heat well; however, if it is in direct sunlight for long periods of time, metal tends to radiate heat into the house as well as outside of the house. One solution to the problem of metal radiating heat into the house is to build a roof made out of thatch. Thatch is made of insulating material already, so it tends to radiate less heat into the house. However, thatch can pose fire hazards and there are cultural and social inhibitions towards using thatch due to its rural connotations, similar to the inhibitions for using earth bricks. Both of the previous options, metal roofing or thatch, would be made more effective by lining them with plastic to make them more airtight. The more airtight the roof is, the less heat can enter the house in the summer and the less heat can escape during the winter.

As with the wall section, it is important to use energy efficient materials for the roof, but it is also crucial to use energy efficient building methods. Implementing an overhang, as described in Section 2.4.1.6, can make a difference to the temperature inside the house. Overhangs of about half a meter can and should be implemented on every type of roof. A pitched roof, slanted at a slight angle, is an improvement over the flat roofs that are currently being used. The pitched roof also provides a little more vertical room on the inside of the house because one side must be taller than the other. This space can be filled with insulation as discussed in Section 2.4.2 to further increase energy efficiency. However, this method is slightly harder to implement as it involves more sophisticated construction and slightly more materials. A vaulted roof is even more energy efficient then a pitched roof, as discussed in Section 0, however the construction and costs associated are prohibitive.

Most of the surface properties that apply to walls, such as texture and reflective material, also apply to the roof. One different method is to paint the outside of the roof a lighter color, if it is not already a reflective material, and then to paint the underside of the roof a darker color. The theory behind this is that the light colors on the outside will not absorb as much heat. The heat that does get through will be absorbed by the dark underside, leaving little heat to radiate into the house. We observed this technique on roofs in our field research, but we also believe that it could be a beneficial technique to use on walls. As with other coloring techniques, this will also cool the house during the winter.

*For the roof, we recommend either a thatch or corrugated metal roof. Thatch is an attractive option because in building the roof, insulation is already being installed,*

*although there are cultural and social inhibitions towards this method. If corrugated metal is chosen instead, it should be airtight and insulated, as mentioned in Section 2.4.2 and Appendix A, so that there is a layer between the living space and roof. Overhangs should also be utilized, as described above.*

Insulation, as discussed in Section 2.4.2, can be a very effective technique to keep heat out of a house during the summer and in during the winter. We noticed insulation in very few houses; insulation that did exist was mainly in the form of rugs or cloth placed directly on the walls, possibly for aesthetic reasons. Materials such as cardboard, cloth, plastic shopping bags, newspaper, mud, straw, and sawdust are good insulators that are generally available for free. Most of these materials are flammable, so great care needs to be taken when using them around fires or stoves. Cardboard, plastic bags, and crumpled newspaper are the easiest materials to use as they are less likely to deteriorate. In addition, some materials, such as grass and sawdust, may collect insects and would need to be maintained on a regular basis without the use of possible hazardous insecticides. Insulation should be about 10 cm thick, when possible. This can be accomplished most effectively by making an inner wall out of cardboard or tightly pulled cloth about 10 cm from the wall and filling the gap with the insulation material.

Insulating the roof is also an important energy efficiency increasing technique which can be implemented with no additional cost. To accomplish this, a ceiling must first be constructed. Ceilings can be made of cardboard, wood, or wire mesh. If needed, the ceiling can be placed on wires strung on top of the walls as support, and then the insulating material can be placed between the ceiling and the roof. Though like with

insulating walls with these materials, great care must be taken to keep open flame far from all insulation.

*We suggest that insulation be used on the roof and walls, whenever possible. Cardboard, plastic bags, and newspaper are the best materials, as they are cheap and easily accessible. Insulation will increase the effectiveness of most of the other measures listed here.*

Shading is an easy and important way to increase energy efficiency, and there are many ways to do it. There are three methods of shading that work particularly well in ISA situations. Having trees around housing is beneficial because they can provide shade and they release water which cools the air, as noted in Section 2.4.1.4. Climbing plants such as ivy are beneficial because they attach directly to a wall of a house, protecting it from the sun while providing the same cooling effect as trees. Finally, plants can be used as wind guides. A wind guide is a plant, or any other object, that directs the wind into the house. If no plants are available, any large object, including a neighbor's house, can be used. When possible, trees and bushes which lose their leaves during the winter should be used to avoid shading the house during these months. In addition, some species of plants require large amounts of water that may be unavailable in the ISAs, and these plants would not be good candidates for shading.

*We recommend that as many shading and wind guiding techniques be used as possible. Shading techniques do not have to be implemented in any particular order and can be done at any time.*

Some of the methods that we recommend are already in use in informal settlements, and we noticed that when some potential techniques were not applied, there

were usually reasons for it. Although we were unable to determine all the reasons that a method may not have been used, we were able to deduce three basic explanations. Sometimes techniques would not work in ISA situations or would produce changes that seemed negligible to residents. Other methods are soundly-based ideas that have not been thought of by the residents. For example, using bushes to channel wind into a house, as described above, was not a commonly observed method, although it potentially could significantly increase ventilation. In addition, it is also possible that a method was objectionable for some reason; either the method was too expensive, unrealistic, or offensive for some reason. For example, building a brick house with very thick walls and insulation is too expensive for most residents. Building a domed roof could also pose feasibility problems because residents may not have the tools or equipment necessary to arch the roof. In our recommendations, we tried to include only methods that were simple to implement and materials that can be easily found by ISA dwellers. We could have recommended energy efficient methods that were more expensive, but they would have been useless to residents unless the materials were accessible and implementation was feasible.

### Section 4.3. Energy Efficiency Awareness Problems.

When conducting our research, we noticed that there was not a strong understanding of energy efficiency among any of the stakeholders, whether the stakeholders were government agencies, NGOs, or residents. The prevalent understanding of the concept of energy efficiency is that it involves energy or electricity, which is untrue. Because there is not a solid understanding of what energy efficiency is,

there is little information in the Windhoek area about how energy efficient techniques can be applied in low-income housing. While all stakeholders seemed interested in the idea of making houses energy-efficient, they generally had not thought about the problem enough to have any suggestions. Because the lack of energy efficiency awareness was so significant, it was necessary to develop a method of distributing energy information to both residents and government and NGO stakeholders. To help alleviate this need, we developed the PIAB and the working paper. In addition, because energy efficiency in low-cost housing is not a concept that is well known in Windhoek, it was necessary to develop ways to introduce the idea of energy efficiency and promote discussion about it, and this feature is inherent in both the PIAB and working paper.

The Presentation-In-A-Box, Appendix E, is targeted to residents of low-income housing. The PIAB is simplistic in design, both to overcome language and age barriers and to hold the attention of the audience. The PIAB introduces the concept of energy efficiency and then provides the audience with several ideas to increase the energy efficiency of houses. It serves not only to give the residents ideas, but also to help stimulate the residents to come up with more ideas. The theory behind the PIAB is that while residents are intelligent, they have other problems to worry about. However, if they were educated about energy efficiency and given simple things to improve in their homes, they could enhance their living conditions with little or no money. Currently, residents are using some of the techniques, like painting their houses light colors, for aesthetic reasons. If the residents knew that the techniques could improve the temperatures of their houses, however, they would have a stronger incentive to use them.

This method of distributing information has the added benefit of providing directly applicable information to the residents.

During the trial presentation of PIAB, the 24 residents in attendance were enthusiastic about the ideas and wanted more information about how to specifically implement the techniques. Participation during the presentation was very high, and the residents had a lot of questions and suggestions. Officials from the City of Windhoek Office of Sustainable Development were also interested in adapting PIAB for their educational programs, and R3E is currently modifying the working paper and PIAB into a short informational pamphlet that can be distributed directly to ISA residents. These three factors are a strong indicator that there is a strong need for more education about energy efficiency.

The working paper, Appendix D, was targeted mainly to government agencies, NGOs, and other associated stakeholders. The working paper, unlike the PIAB, was a complete listing of all of our findings and was written in a more technical manner. In addition, stakeholder roles were also included in the paper. The purpose of the working paper was to familiarize stakeholders with more detailed knowledge of energy efficiency without a large expenditure of effort on the stakeholders' parts. Because stakeholders were likely to have other, more pressing projects, the working paper had to be brief enough to keep their attention but detailed enough to convey a significant amount of information. This method of distribution allows the stakeholders to become more informed and spread the knowledge to other stakeholders and residents.

A major energy efficiency concern is the lack of energy efficient housing policies. None of the current government housing policies focus on increasing the energy

efficiency of low-cost housing, as discussed in Section 2.1.2. A large part of this problem stems from the fact that energy efficiency applied to low-cost housing is a relatively new concept. In addition, the rapid expansion of ISAs has made housing quantity a higher priority than housing quality, and housing policies have been written to reflect this. While the mass production of houses is rightfully a high priority, the quality of the house need not be compromised. With increased education and exposure, awareness about energy efficiency can be increased.

## Chapter 5. Conclusions and Recommendations.

The goal of the *Energy Efficiency In Low-Cost Housing* project was to develop affordable recommendations to increase energy efficiency of low-cost housing. In addition to achieving that goal, we also were able to make recommendations for potential future directions of the project. Our major findings, as discussed in Chapter 4, were divided into three categories: stakeholder findings, energy efficiency recommendations, and energy efficiency awareness problems. To make recommendations for future areas of research, we first summarized each set of findings and then developed conclusions upon which our recommendations were based. If these recommendations are taken, then gaps in our research will be filled and stakeholders and residents will become more knowledgeable about energy efficiency.

The stakeholders of the project, described in Section 2.3, are vital to the success of the Energy Efficient Urban Demonstration Village [EEUDV], the umbrella project for *Energy Efficiency In Low-Cost Housing*, and any other efforts to increase the energy efficiency of low-cost housing. Our stakeholder findings, Section 4.1, indicated a lack of stakeholder communication, both among multiple stakeholders and within organizations, which hinders progress towards increasing energy efficiency in low-cost housing, in particular the EEUDV project. We therefore recommend that stakeholders communicate more effectively with each other. We have developed the working paper and the R3E-MCD in order to facilitate communication on energy efficiency projects, specifically EEUDV. Our working paper, included in Appendix D, describes the roles of each of the stakeholders for easy reference. These roles are important for each stakeholder to know

in order to help avoid duplication of work and ensure efficient information sharing. In addition, the stakeholder database, R3E-MCD, will help R3E fulfill its role of facilitating effective communication among stakeholders.

We also recommend that government stakeholders modify housing policies and procedures to incorporate energy efficiency techniques. Current government housing policies, discussed in Section 2.1.2, focus on mass producing housing and providing 'sites and services' to the residents. While these policies are doing their part to help alleviate the current housing problems in Windhoek, energy efficiency is not a priority for government and NGOs working in the housing sector, and the policies are doing little to address energy efficiency in housing. Government agencies and NGOs should integrate energy efficiency concepts into their policies and procedures, including the National Housing Policy [NHP], wherever possible. A discussion of the problem of temperature regulation within houses should be included, at the very least. Additionally, the use of energy efficient techniques should be encouraged whenever possible. By including encouragement to include energy efficient concepts in housing design in housing policies, such as slightly increasing government subsidies for housing with overhangs on the north sides of buildings, awareness of energy-efficiency and use of energy efficient techniques could be increased.

Our findings on energy efficiency recommendations, Section 4.2, also indicated that there are many ways to increase the energy efficiency of a house without increasing the cost, such as modifying the orientation of the house. Also, there are many techniques which can be applied with little extra cost, such as paint color and roof overhangs. We recommend that these features be included in basic housing designs. This would cause

the temperatures inside of the houses to be lower during the summer and warmer during the winter. A complete listing of our recommendations for increasing the energy efficiency of low-cost housing is located in both Appendix A and the working paper, and a summary of the most affordable, effective energy efficiency recommendations are summarized in Table 5.1.

Table 5.1. Summary of Energy Efficient Recommendations.

| | Section | Page Number | | Section | Page Number |
|---|---|---|---|---|---|
| ***Site Location / Orientation*** | | | | | |
| Build house on south facing slope | **2.4.3.3** | 44 | Build house directly on ground | **2.4.1.5** | 35 |
| Minimize size of east and west walls | **2.4.3.2** | 43 | Large volume to surface area | **2.4.3.2** | 42 |
| Orient longest side of house to face north | **2.4.3.3** | 43 | | | |
| ***Walls:*** | | | | | |
| *Materials:* | | | | | |
| Clay | **2.4.1.1** | 27 | Corrugated Iron | -- | -- |
| Earth | **2.4.1.1** | 27 | | | |
| *Method:* | | | | | |
| Channelling wind with internal walls | **2.4.3.2** | 43 | | | |
| Air-tight walls | -- | -- | | | |
| Air bricks | **2.4.1.2** | 29 | | | |
| *Surface properties:* | | | | | |
| Texture | **2.4.3.1** | 41 | Reflective | **2.4.3.1** | 41 |
| Light colors | **2.4.3.1** | 41 | | | |
| ***Windows*** | | | | | |
| *Method:* | | | | | |
| Hole in wall | -- | -- | Widely space windows if they are on the same wall | **2.4.1.2** | 30 |
| Place windows on opposite walls | **2.4.1.2** | 29 | | | |
| *Materials:* | | | | | |
| Curtains | **2.4.1.2** | 29 | | | |
| ***Roof*** | | | | | |

| | Section | Page Number | | Section | Page Number |
|---|---|---|---|---|---|
| *Material:* | | | | | |
| Metal | -- | -- | Plastic covering | **2.4.2** | 40 |
| Thatch | -- | -- | | | |
| *Method:* | | | | | |
| Pitched | **0** | 32 | Overhang on north | **2.4.1.6** | 38 |
| *Surface properties:* | | | | | |
| Textured | **2.4.3.1** | 41 | Light color on the outside | **2.4.3.1** | 41 |
| Reflective | **2.4.3.1** | 41 | Dark interior ceiling | -- | -- |
| ***Insulation*** | | | | | |
| *Method:* | | | | | |
| Ceiling | **2.4.2** | 39 | | | |
| *Material:* | | | | | |
| Cloth | **2.4.2** | 39 | Newspaper | **2.4.2** | 39 |
| Cardboard | **2.4.2** | 39 | Rugs | **2.4.2** | 39 |
| Plastic Bags | **2.4.2** | 39 | | | |
| ***Shading*** | | | | | |
| Plants | **2.4.1.4** | 33 | Climbing plants | **2.4.1.4** | 34 |
| ***Other*** | | | | | |
| Cook outside | -- | -- | | | |

The materials needed to utilize many of these techniques are not readily available in the ISAs, making it difficult to employ them. We recommend establishing 'building material depots,' or specific sites in ISAs where used building materials and tools can be dropped off for residents to use in improving their homes. Implementing these depots would significantly help residents in finding suitable, affordable building materials. There are issues that would need to be addressed in order for the depots to be successful, such as management, safety, cost, and security. If this idea were implemented, special care would need to be taken so that ISAs would not turn into dumping areas for the City of Windhoek.

Another major problem we observed, described in Section 4.3, was the lack of awareness of energy efficient techniques among ISA residents. Increasing the energy

efficiency of housing is important to residents, but they often do not feel that there is anything they can do to improve it. We recommend that residents be educated about increasing the energy efficiency of their housing. We have created an energy efficiency Presentation-In-A-Box [PIAB] which was designed to help residents become more aware of the problem, and suggest some easy and affordable things they can do to increase the energy efficiency of their houses. This presentation can also be used for new stakeholders as a basic introduction to the problem and possible solutions, as well as encouraging creative thought on the subject. The working paper will also help distribute information about increasing energy efficiency to the stakeholders. These presentations do not need to be all-inclusive or cover every aspect of energy efficiency, but they should serve to encourage both stakeholders and residents to begin thinking about the problem in new ways. In the future, the information in PIAB will be combined with the information in the working paper in order to produce a short informational pamphlet that will be available from R3E and can be distributed to audiences during PIAB presentations. This will allow residents to obtain a more concrete grasp of concepts as well as allow the information to spread more readily.

In addition to the three major problems described above, gaps in our research need to be filled. More information needs to be found on the affordability of the various techniques. In many cases, an agency, such as NHE, may be able to obtain building materials at a bulk rate, which would make some solutions more affordable for some residents. The social or cultural acceptability of the various techniques also needs to be determined, as this project was unable to access this type of information for many of the solutions. In addition, the actual energy efficiency of each technique should also be

determined quantitatively. Although we have identified many different materials and techniques that can increase the energy efficiency of a house, we were unable to provide any sort of measurement as to which techniques work better than others. The techniques should be re-evaluated to determine which combination will provide the greatest energy efficiency for the least amount of money. Finally, the amount of labor needed to implement for each technique should also be considered, as some residents may not have as much time to make improvements on their houses as others.

Our recommendations for the *Energy Efficiency In Low-Cost Housing* project, if implemented, will serve to increase awareness among ISA residents and other major stakeholders about energy efficiency and what can be done to improve it in an affordable way. Increasing stakeholder communication, via the working paper and the R3E-MCD, will allow housing projects, specifically the EEUDV, to be completed more effectively and efficiently. Education of the residents and other stakeholders, accomplished with the PIAB and the working paper, will increase the energy efficiency of both current housing and newly built houses, improving the quality of life of the residents. By introducing energy efficiency measures into future housing projects, the city of Windhoek and Namibia as a whole can improve the quality of life for ISA residents without increasing their cost of living and can promote sustainable, energy efficient practices in housing design and construction.

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# Appendix A: Recommendation Analysis Table.

## Recommendation Analysis Table

Shaded techniques, materials, or methods are not recommended for use in Windhoek ISAs.

| | Section | Page Number | Direct Observation | Energy Efficient? |
|---|---|---|---|---|
| ***Site Location/Orientation*** | | | | |
| Build on a slope | 2.4.3.3 | 44 | - | Yes |
| Build on leeward side of slope | 2.4.3.3 | 45 | - | Yes |
| Build house on south facing slope | 2.4.3.3 | 44 | - | Yes |
| Minimize size of east and west walls | 2.4.3.2 | 43 | - | Yes |
| Orient longest side of house to face north | 2.4.3.3 | 43 | Yes | Yes |
| Put large room with window on windward side | 2.4.3.2 | 43 | - | Yes |
| Build house directly on ground | 2.4.1.5 | 35 | Yes | Yes |
| Build house into the ground (2m) | 2.4.1.5 | 35 | - | Yes |
| Large volume to surface area | 2.4.3.2 | 42 | Yes | Yes |
| | | | | |
| ***Walls:*** | | | | |
| *Materials:* | | | | |
| Clay | 2.4.1.1 | 27 | - | Yes |
| Brick | 2.4.1.1 | 27 | Yes | Yes |
| Cement | 2.4.1.1 | 27 | - | Yes |
| Earth | 2.4.1.1 | 27 | - | Yes |
| Hollow Bricks | 2.4.1.1 | 27 | - | Yes |
| Hollow bricks filled with soil | 2.4.1.1 | 27 | - | Yes |
| Corrugated Iron | -- | -- | Yes | No |
| Flattened metal drums | -- | -- | Yes | No |
| *Method:* | | | | |
| Bottle caps as washers | | | Yes | Yes |
| Shared walls | 2.4.1.1 | 27 | Yes | Yes |
| Channelling wind with internal walls | 2.4.3.2 | 43 | - | Yes |
| Higher thermal mass in direct sun | 2.4.1.1 | 27 | - | Yes |
| Air-tight walls | -- | -- | - | Yes |
| Air bricks | 2.4.1.2 | 29 | - | Yes |
| *Surface properties:* | | | | |
| Texture | 2.4.3.1 | 41 | - | Yes |
| Light colors | 2.4.3.1 | 41 | Yes | Yes |

| | | | | |
|---|---|---|---|---|
| Reflective | 2.4.3.1 | 41 | Yes | Yes |
| White cement | 2.4.3.1 | 42 | - | Yes |
| Lime | 2.4.3.1 | 42 | - | Yes |
| Whitewash | 2.4.3.1 | 42 | Yes | Yes |
| ***Windows*** | | | | |
| *Method:* | | | | |
| Glass windows | -- | -- | Yes | Yes |
| Hole in wall | -- | -- | Yes | Yes |
| Place windows on opposite walls | 2.4.1.2 | 29 | - | Yes |
| Put windows in three of the four walls | 2.4.1.2 | 29 | - | Yes |
| Widely space windows if they are on the same wall | 2.4.1.2 | 30 | - | Yes |
| Night ventilation | 2.4.1.2 | 29 | - | Yes |
| Screens | 2.4.1.2 | 29 | - | Yes |
| Bars | 2.4.1.2 | 29 | - | Yes |
| Wind Walls | 2.4.1.2 | 30 | - | Yes |
| Indirect earth cooling | 2.4.1.5 | 36 | - | Yes |
| *Materials:* | | | | |
| Shutters | 2.4.1.2 | 29 | - | Yes |
| Curtains | 2.4.1.2 | 29 | Yes | Yes |
| Mesh | 2.4.1.2 | 29 | - | Yes |
| ***Roof*** | | | | |
| *Material:* | | | | |
| Metal | -- | -- | Yes | Yes |
| Thatch | -- | -- | Yes | Yes |
| Plastic covering | 2.4.2 | 40 | - | Yes |
| *Method:* | | | | |
| Pitched | 0 | 32 | - | Yes |
| Vaulted | 0 | 32 | - | Yes |
| Domed | 0 | 32 | - | Yes |
| Overhang | 2.4.1.6 | 37 | - | Yes |
| Overhang on north | 2.4.1.6 | 38 | - | Yes |
| *Surface properties:* | | | | |
| Textured | 2.4.3. | 41 | - | Yes |

| | | | | |
|---|---|---|---|---|
| Reflective | 2.4.3.1 | 41 | - | Yes |
| Light color on the outside | 2.4.3.1 | 41 | - | Yes |
| Dark interior ceiling | -- | -- | Yes | Yes |
| ***Insulation*** | | | | |
| *Method:* | | | | |
| Ceiling | 2.4.2 | 39 | - | Yes |
| High Ceiling | 2.4.2 | 43 | - | Yes |
| Moveable insulation | 2.4.2 | 32 | - | Yes |
| *Material:* | | | | |
| Cloth | 2.4.2 | 39 | Yes | Yes |
| Cardboard | 2.4.2 | 39 | - | Yes |
| Plastic Bags | 2.4.2 | 39 | - | Yes |
| Newspaper | 2.4.2 | 39 | - | Yes |
| Mud | 2.4.2 | 39 | - | Yes |
| Straw | 2.4.2 | 39 | - | Yes |
| Sawdust | 2.4.2 | 39 | - | Yes |
| Rugs | 2.4.2 | 39 | Yes | Yes |
| None | -- | -- | Yes | No |
| ***Shading*** | | | | |
| Plants | 2.4.1.4 | 33 | Yes | Yes |
| Dense canopies | 2.4.1.4 | 34 | - | Yes |
| Trees on west | 2.4.1.4 | 34 | - | Yes |
| Trees on ENE | 2.4.1.4 | 34 | - | Yes |
| Trees on WNW | 2.4.1.4 | 34 | - | Yes |
| Climbing plants | 2.4.1.4 | 34 | Yes | Yes |
| Wind guides | 2.4.1.4 | 34 | - | Yes |
| ***Other*** | | | | |
| Cook outside | -- | -- | Yes | Yes |

# Appendix B: Stakeholder Contact Information.

## Stakeholder Contact Information

| | | | |
|---|---|---|---|
| ***Organization Name*** | *City of Windhoek* | | |
| ***Last Name*** | Cronje | ***Email Address*** | |
| ***First Name*** | Heike | ***Address*** | |
| ***Title*** | | ***Date Added*** | 3/27/2003 |
| ***Department*** | Sustianable Development | | |
| ***Work Phone*** | 290 2048 | | |
| ***Cell Phone*** | | | |
| ***Fax Number*** | | | |
| ***Pager Number*** | | | |
| ***Last Name*** | de Kock | ***Email Address*** | jdk@windhoekcc.org.na |
| ***First Name*** | Jana | ***Address*** | |
| ***Title*** | Head of Housing and | ***Date Added*** | 3/27/2003 |
| ***Department*** | Housing and | ***Help Rating:*** | Helpful |
| ***Work Phone*** | 290 2090 | | |
| ***Cell Phone*** | | | |
| ***Fax Number*** | | | |
| ***Pager Number*** | | | |
| ***Last Name*** | Harris | ***Email Address*** | ach@windhoekcc.org.na |
| ***First Name*** | Braam | ***Address*** | |
| ***Title*** | Town Planner | | |
| ***Department*** | Sustainable Development | | |
| ***Work Phone*** | +264 61 2902377 | | |
| ***Cell Phone*** | | | |
| ***Fax Number*** | +264 61 2902111 | | |
| ***Pager Number*** | | | |
| ***Last Name*** | Rust | ***Email Address*** | rus@windhoekcc.org.na |
| ***First Name*** | Hugo | ***Address*** | |
| ***Title*** | Town Planner | ***Date Added*** | 3/27/2003 |
| ***Department*** | Sustainable | | |
| ***Work Phone*** | +264 61 2902025 | | |
| ***Cell Phone*** | | | |
| ***Fax Number*** | +264 61 2902111 | | |
| ***Pager Number*** | | | |
| ***Organization Name*** | *Namibian Housing Action Group* | | |
| ***Last Name*** | Muller | ***Email Address*** | |
| ***First Name*** | Anna | ***Address*** | |
| ***Title*** | Director | ***Date Added*** | 3/27/2003 |
| ***Department*** | | | |
| ***Work Phone*** | | | |
| ***Cell Phone*** | | | |
| ***Fax Number*** | | | |
| ***Pager Number*** | | | |

| | | | |
|---|---|---|---|
| ***Organization Name*** | *National Housing Enterprise* | | |
| ***Last Name*** | Maritz | ***Email Address*** | |
| ***First Name*** | Nina | ***Address*** | |
| ***Title*** | Architect | ***Date Added*** | 3/27/2010 |
| ***Department*** | | | |
| ***Work Phone*** | 22 0752 | | |
| ***Cell Phone*** | | | |
| ***Fax Number*** | | | |
| ***Pager Number*** | | | |
| | | | |
| ***Last Name*** | Wienecke | ***Email Address*** | wieneckea@nhe.com.na |
| ***First Name*** | Andreas | ***Address*** | |
| ***Title*** | Director | ***Date Added*** | 3/27/2003 |
| ***Department*** | | | |
| ***Work Phone*** | 292 7111 | | |
| ***Cell Phone*** | | | |
| ***Fax Number*** | | | |
| ***Pager Number*** | | | |
| ***Organization Name*** | *Shack Dwellers Federation of Namibia* | | |
| ***Last Name*** | Mbanga | ***Email Address*** | |
| ***First Name*** | Edith | ***Address*** | |
| ***Title*** | | ***Date Added*** | 3/27/2003 |
| ***Department*** | | ***Help Rating:*** | Very Helpful |
| ***Work Phone*** | 22 8697 | ***Note*** | |
| ***Cell Phone*** | | | |
| ***Fax Number*** | | | |
| ***Pager Number*** | | | |

# Appendix C: R3E Meeting and Contact Database Instructions.

# R3E Meeting and Contact Database Instruction Manual

**Table of Contents:**

# R3E Meeting and Contact Database Instruction Manual

## List of Figures:

# R3E Meeting and Contact Database Instruction Manual

## 1. Starting the Program.

There are two ways to start the R3E Meeting and Contact Database [R3E-MCD]. You can either:

- Open Microsoft Access® and choose the file 'R3E Meeting and Contact Database.mdb' to open.
- Or if you know where the 'R3E Meeting and Contact Database.mdb' file is located, double click on the file to open it.

## 2. Navigating the R3E-MCD.

When the R3E-MCD application successfully starts, you will be presented with the "Energy Efficient Housing Main Menu," as seen in Figure 2.1. This menu has four options:

1. Contacts Menu
2. Meetings Menu
3. Administrative Menu
4. Quit

Each option will bring you to its respective menu.

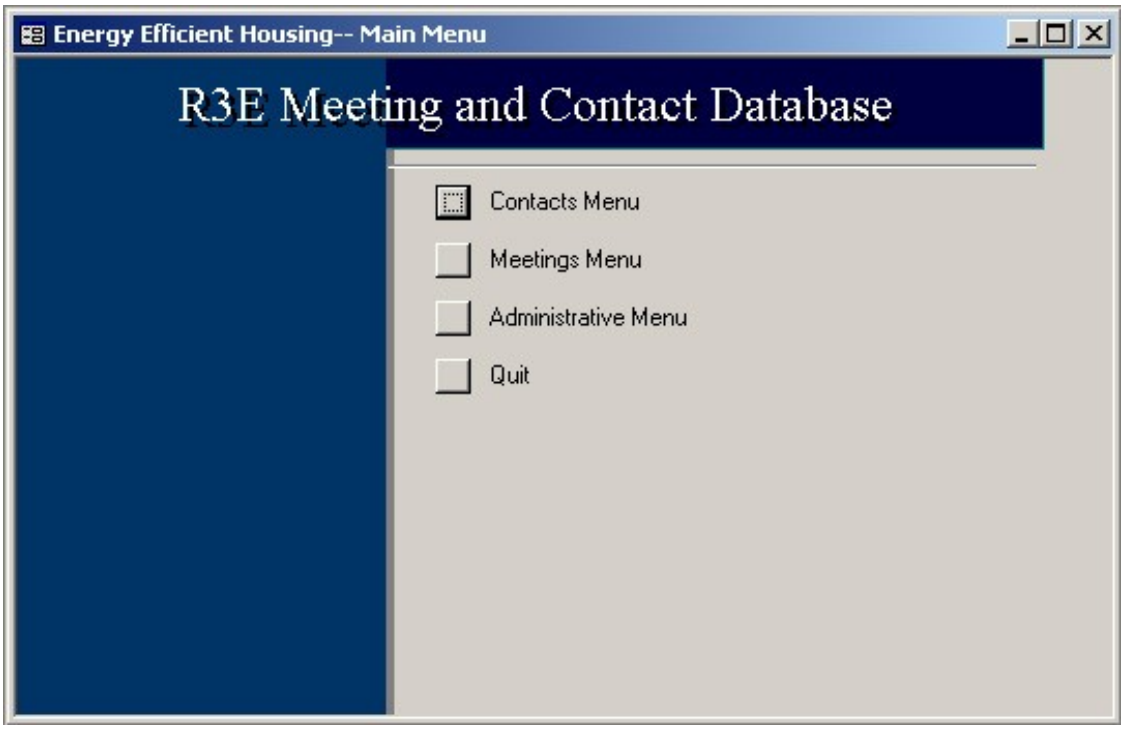



**Figure 2.1. Main menu.**

# 3. Contact Menu.

In the Contact Menu there are seven options that allow you to display and edit various contacts of the Energy Efficient Housing project. The Contact Menu is shown in Figure 3.2.

1. Edit/Add/Find Contacts
2. Display All Contacts
3. Display People Not Yet Contacted
4. Display Particularly Helpful Contacts
5. List Organizations which EEH contacts are associated with
6. Jump to Meetings Menu
7. Go Back

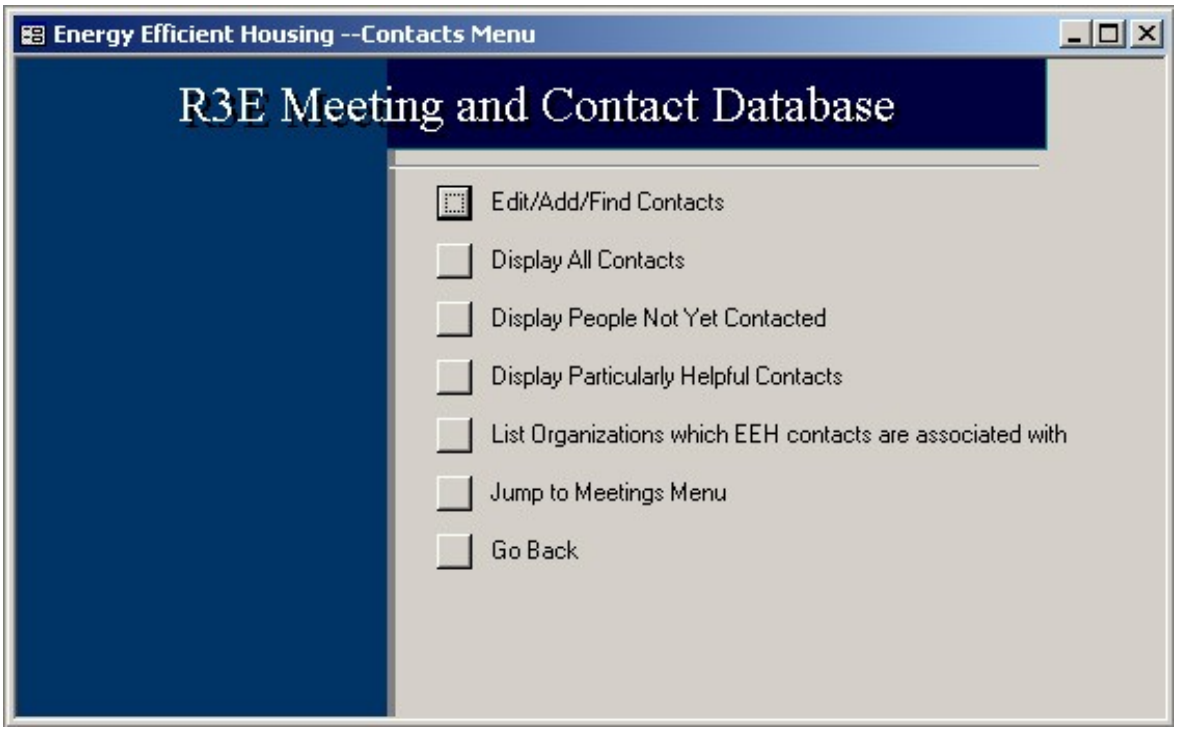



**Figure 3.2. Contact menu.**

## *3.1. Edit/Add/Find Contacts.*

If you push the Edit/Add/Find Contacts button, a menu which looks like Figure 3.4 will pop up.

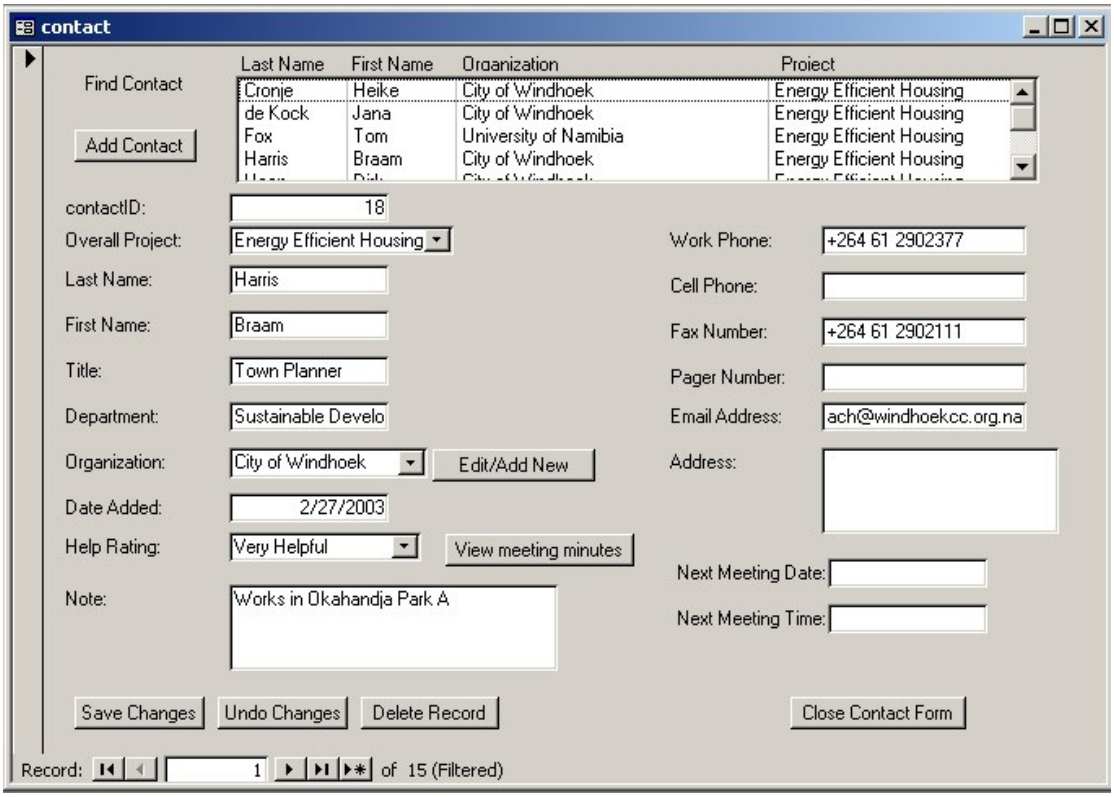



**Figure 3.3 - Edit/Add/Find contact form.**

If you push the Edit/Add/Find Contacts button, a menu which looks like Figure 3.4 will pop up.

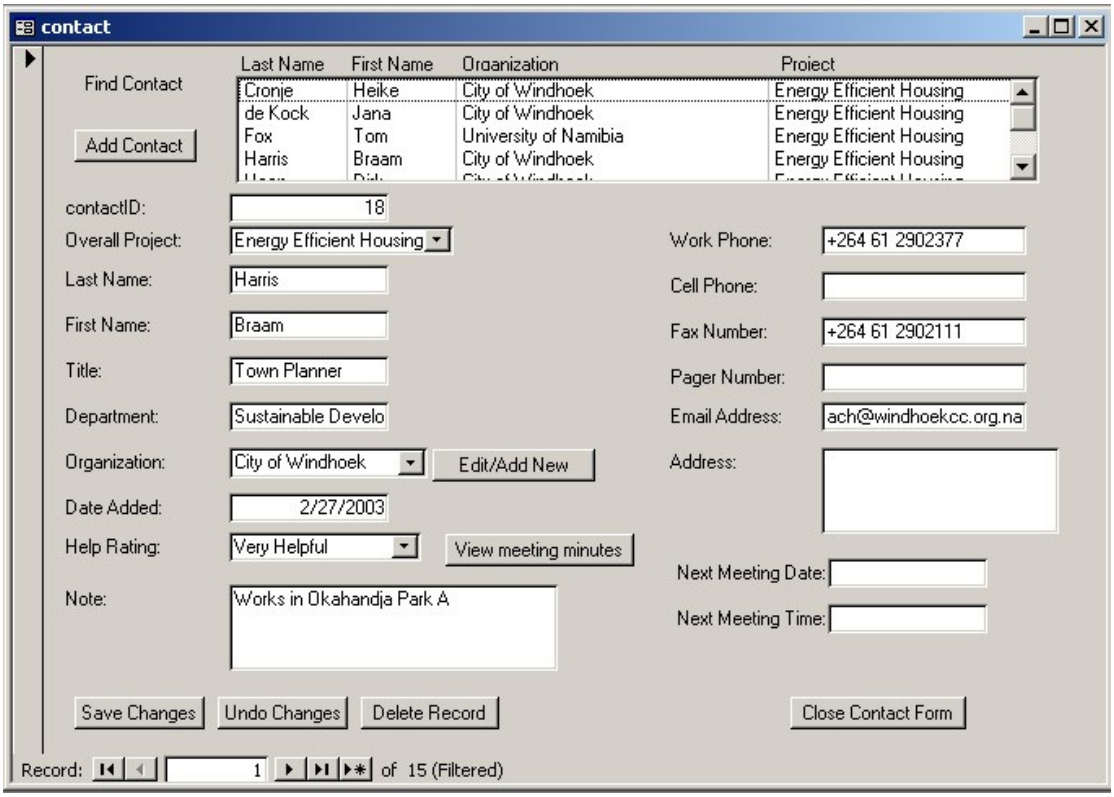



**Figure 3.4. Edit/Add/Find contact form.**

### 3.1.1. Contact Form Explanation.

There are three sections of this menu which you should be familiar with: the search box at the top, the contact information fields in the middle, and the function buttons at the bottom.

The search box at the top is a tool that allows you to find a contact by last name. You can scroll the box to find all the contacts in the Energy Efficient Housing project. When you click on a name in box, the selected person's contact information will automatically fill into the contact information fields in the middle of the screen.

The contact information fields hold the information about each person in the database. Each time you finish making changes to the contact information for a person, make sure to click the 'Save Changes' function button.

When you first add a contact to the database, he or she will have a 'Help Rating' of "Not Contacted." Be sure to change this after you have your first meeting.

The buttons on the Add/Edit/Find contact form are:

1. *Save Changes button*
2. *Undo Changes button*
3. *Delete Record button*
4. *Close Contact Form button*
5. *Edit/Add New button*
6. *View Meeting Minutes button*

**1.**


The 'Save Changes' button will save all the changes you have made to any of the contact information fields. Make sure to push it after you are finished making changes to a contact.

**2.**


The 'Undo Changes' button will undo any changes you have made to a record before you have pressed the 'Save Changes' button or gone to another record. Note that if you make changes and then move to a different record, you cannot undo your changes.

**3.**


The 'Delete Record' button will delete the contact which is currently being displayed. Once pressed, a dialogue box will pop up to ask you if you are sure you want to delete the selected contact so that you cannot delete people by mistake.

**4.**


The 'Close Contact Form' button closes the contact form. Make sure that you have finished making your changes and have saved your work before closing the form.

**5.**


The 'Edit/Add New' button allows you to edit and/or add the organizations that are stored in the database. When you push the button, the menu shown in Figure 3.11 appears. Directions for adding an organization can be found in Section 3.1.3.

**6.**


Please see Section 3.1.2 for directions on exporting the minutes report.

---

## 3.1.2. Printing and Exporting the Minutes Report.

The 'View meeting minutes' button will display all of the minutes from each meeting that the selected contact has participated in.

After pressing the 'View meeting minutes' button, the screen shown in Figure 3.5 will appear. This is the preview mode for the minutes that you want.

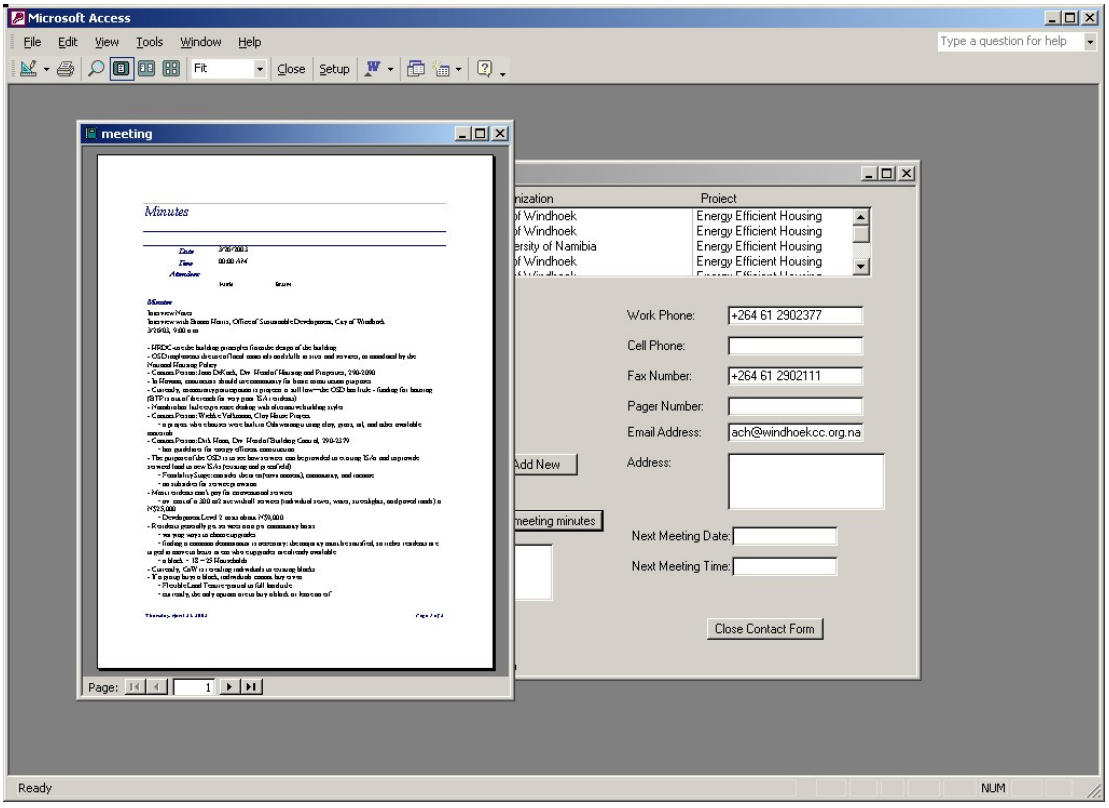



**Figure 3.5. Preview of report.**

At this point you have two options; you can either:

1. *Print it directly from this screen.*
2. *Export it to Microsoft Word® where you can alter it.*

It is important to note that any changes that you make to the report in Word® will not be saved to the database; that is, they are not permanent. Exporting to Word® is a good way to change a few things in a report, but sometimes the formatting deteriorates during the export. If you choose to use the export function, be sure to skim the document to make sure that everything looks correct.

#### 3.1.2.1. Printing.

To print directly from Microsoft Access®, click on the file menu in the toolbar at the top of the screen shown in Figure 3.6. Choose the print option.

From this screen, choose the printer you wish to use and set any page layout changes that you wish to make. An example of what the screen should look like at this point is shown in Figure 3.7.

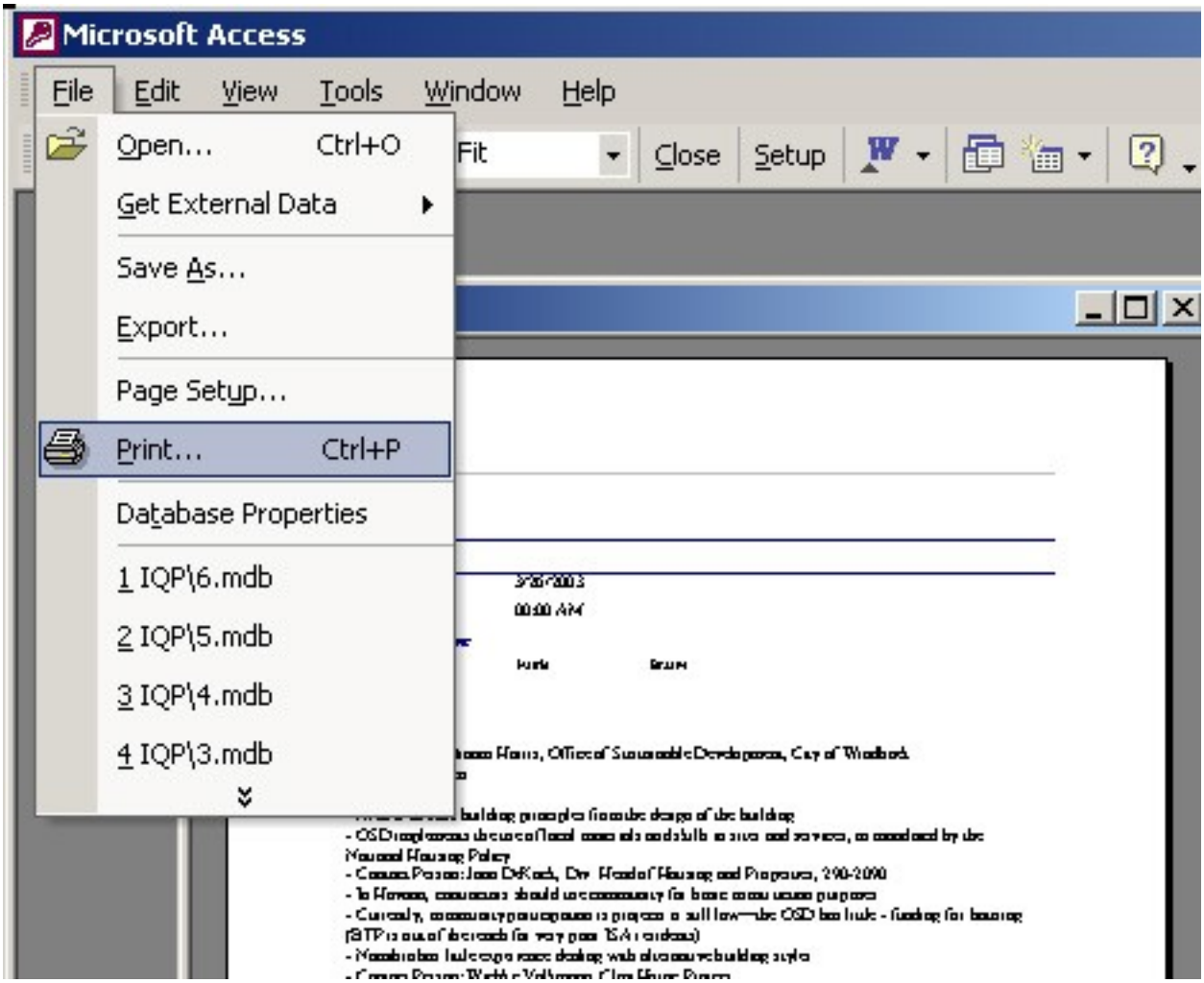



**Figure 3.6. Print command.**

From this screen, choose the printer you wish to use and set any page layout changes that you wish to make. An example of what the screen should look like at this point is shown in Figure 3.7.

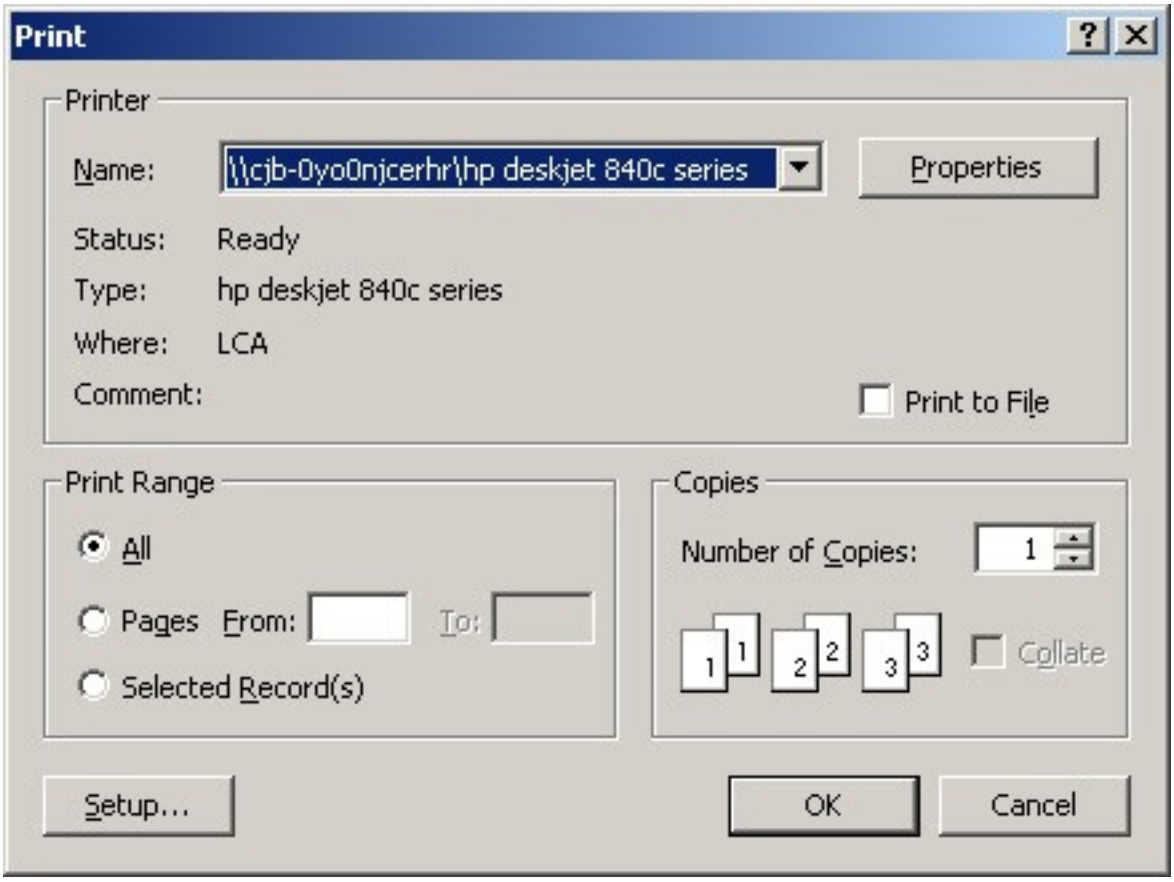



**Figure 3.7. Print dialogue.**

### 3.1.2.2. Exporting

To export the report to Microsoft Word® for editing and formatting, press the blue 'W' (Figure 3.8) which is located in the top middle of the screen. Again, it is important to understand that any changes made to the report in Microsoft Word® will not be permanent.

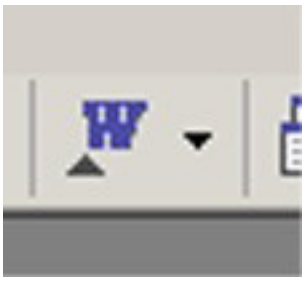


**Figure 3.8. Export button.**

Sometimes you may get a warning such as in Figure 3.9 during an export. If it asks you to replace a file, just click the 'OK' button. This is not an error; Microsoft Word® is just making sure you don't overwrite anything important, which you're not.


**Figure 3.9. Sample warning.**

Figure 3.10 shows an example what an exported report looks like.

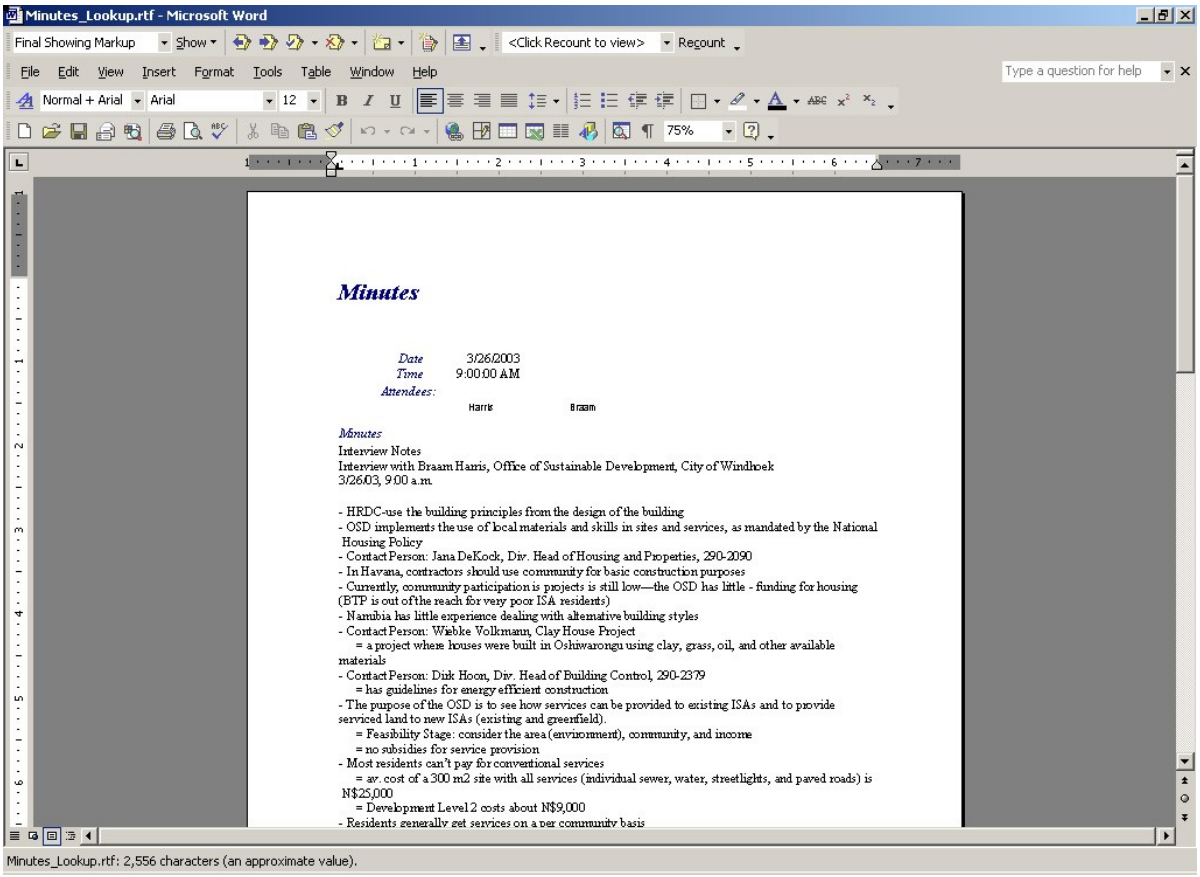



**Figure 3.10. Sample exported report**

### 3.1.3. Adding and Editing Organizations.

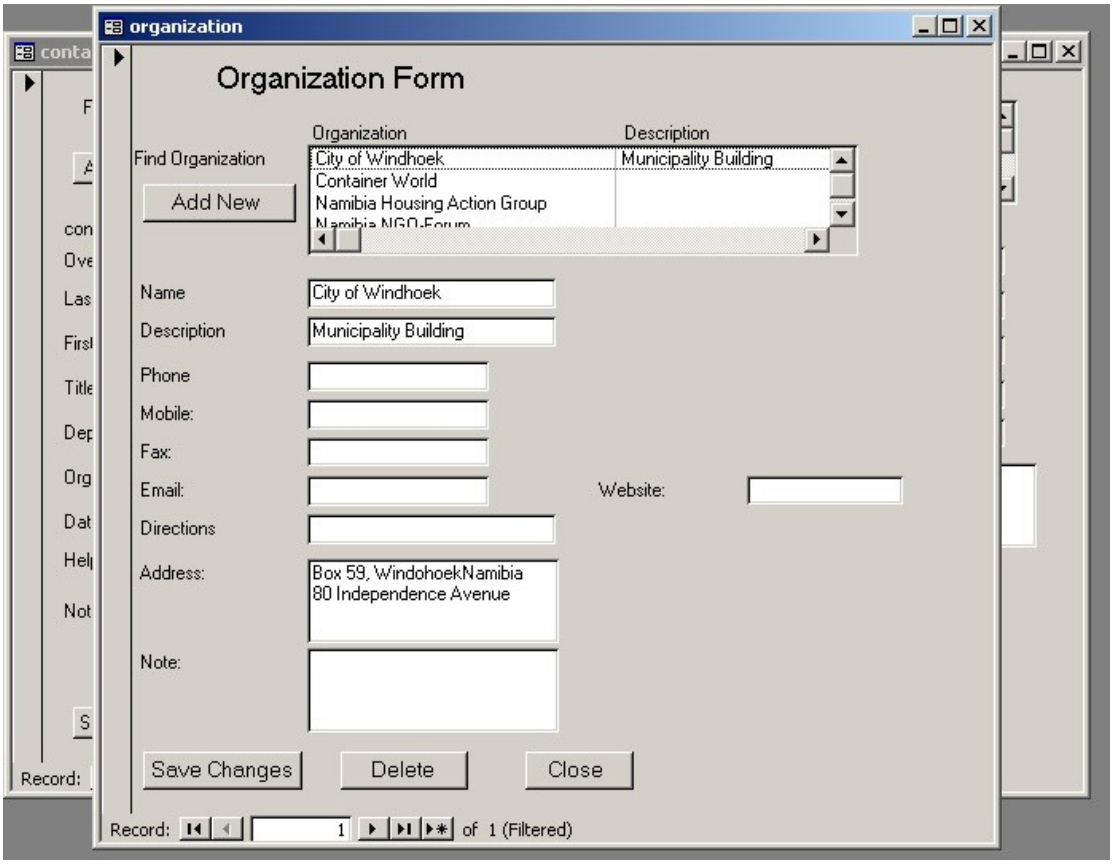



**Figure 3.11. Organization form.**

In the Organization menu shown in Figure 3.11, there is a search box just like in the contact menu. Scroll in this box to find the desired organization to edit. Click on the name in the search box to edit the information.


Make sure to press the 'Save Changes' button before closing the menu.


There is a button in the top left of the menu called 'Add New.' Press this button if you wish to add another organization to the database.


Push the 'Delete' button in the middle bottom of the screen to delete the organization that is currently being displayed.

---

## *3.2. Display All Contacts.*


If you push the 'Display All Contacts' button, you will be presented with a preview of the report of all the people in the database.

The steps for printing or exporting the report are the same as for the 'Exporting the Meeting Minutes' report in Section 3.1.2.

---

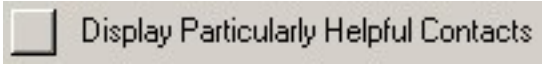
## *3.3. Display People Not Yet Contacted.*


If you push the 'Display People Not Yet Contacted' button, you will be presented with a preview of the report of all the people in the database who have not yet been contacted.

The steps for printing or exporting the report are the same as for the 'Exporting the Meeting Minutes' report in Section 3.1.2.

---

## *3.4. Display Particularly Helpful Contacts.*

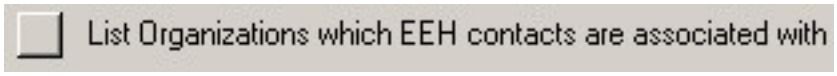


If you push the 'Display Particularly Helpful Contacts' button, you will be presented with a preview of the report of all the people in the database who have a useful rating of either 'Helpful' or 'Very Helpful'.

The steps for printing or exporting the report are the same as for the 'Exporting the Meeting Minutes' report in Section 3.1.2.

---

## *3.5 List Organization which EEH contacts are associated with.*




If you push the 'List Organizations which EEH contacts are associated with' button, you will be presented with a preview of the report of all the organizations which contacts in the database are members of.

The steps for printing or exporting the report are the same as for the 'Exporting the Meeting Minutes' report in Section 3.1.2.

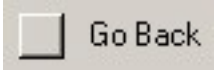
---

## *3.6. Jump to Meetings Menu.*


If you push the 'Jump to Meetings Menu' button, you will be brought from the Contact Menu to the Meetings Menu without having to go through the Main Menu.

---

## *3.7 Go Back.*



If you push the 'Go Back' button, you will be brought from the Contact Menu to the Main Menu.

---

# 4. Meetings Menu.

If you choose the Meetings option from the Main Menu (shown in Figure 4.12), you will be brought to the Meetings Menu.

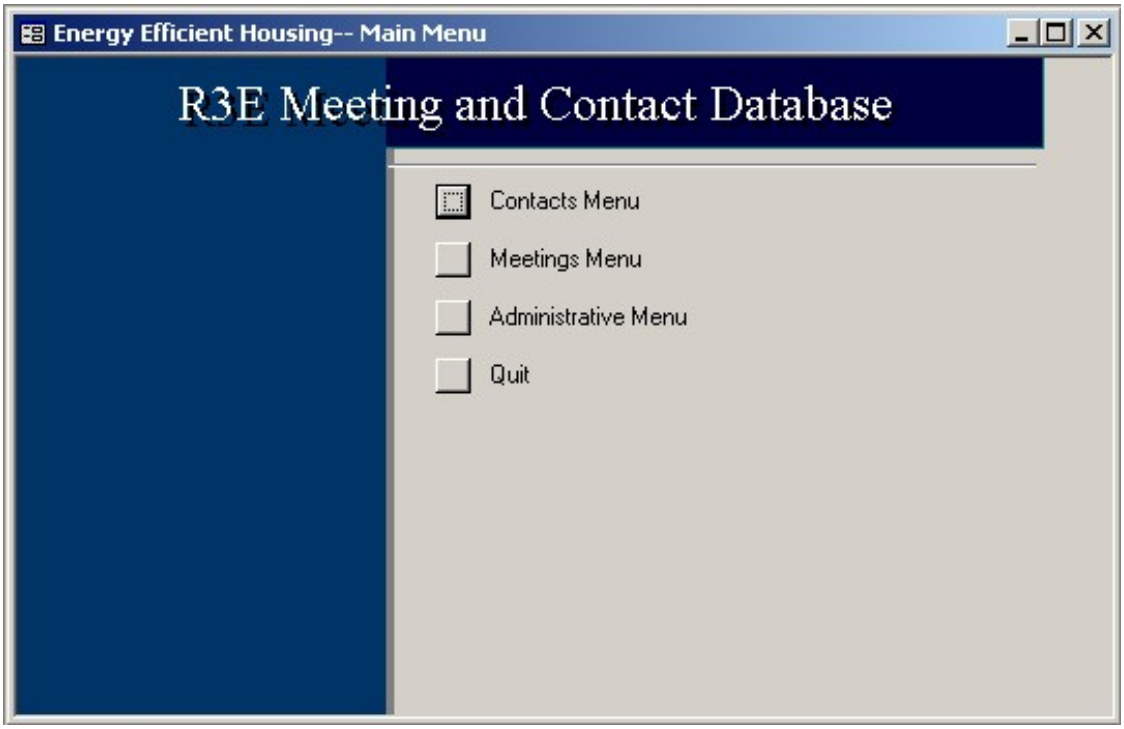



**Figure 4.12. Main menu.**

The Meetings Menu, shown in Figure 4.13, has six options that allow you to display and edit various meetings of the Energy Efficient Housing project.

1. *Edit/Add/Find Meetings*
2. *Display Future Meetings*
3. *Display All Meetings*
4. *Display Particularly Helpful Meetings*
5. *Jump to Contacts Menu*
6. *Go Back*

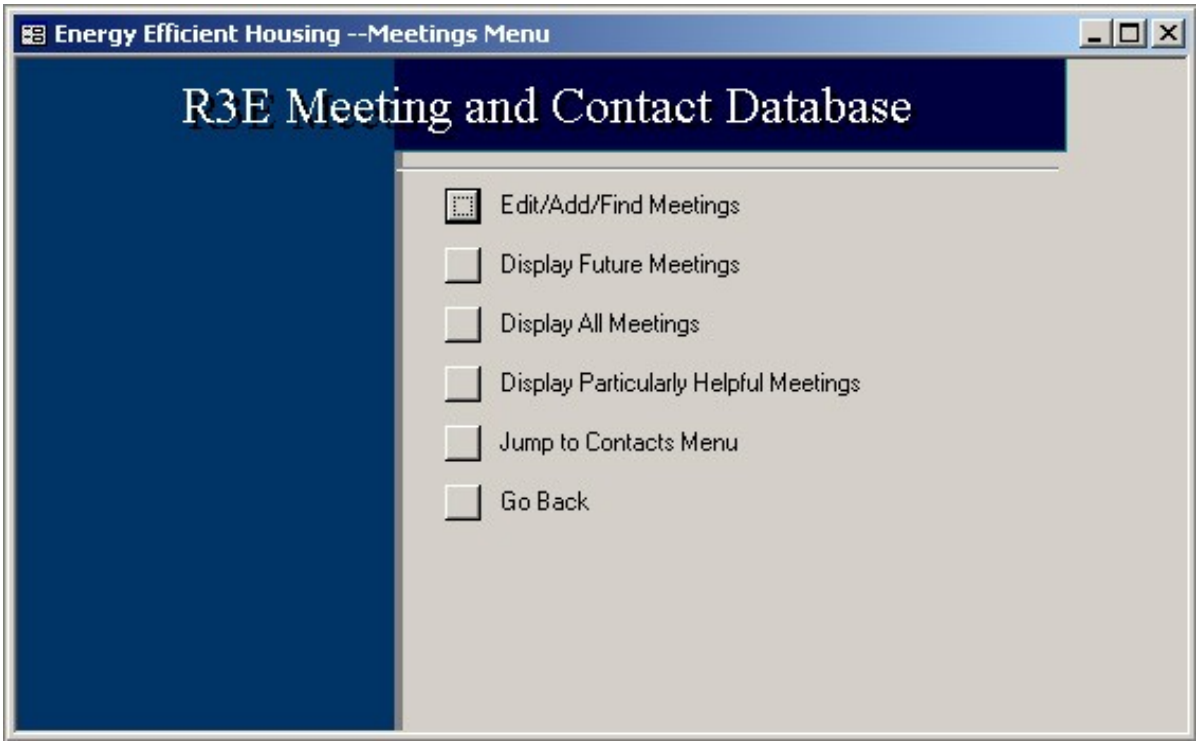



**Figure 4.13. Meetings menu.**

## *4.1 Edit/Add/Find Meetings.*


If you press the 'Edit/Add/Find Meetings' button, you will be brought to the menu shown in Figure 4.14.

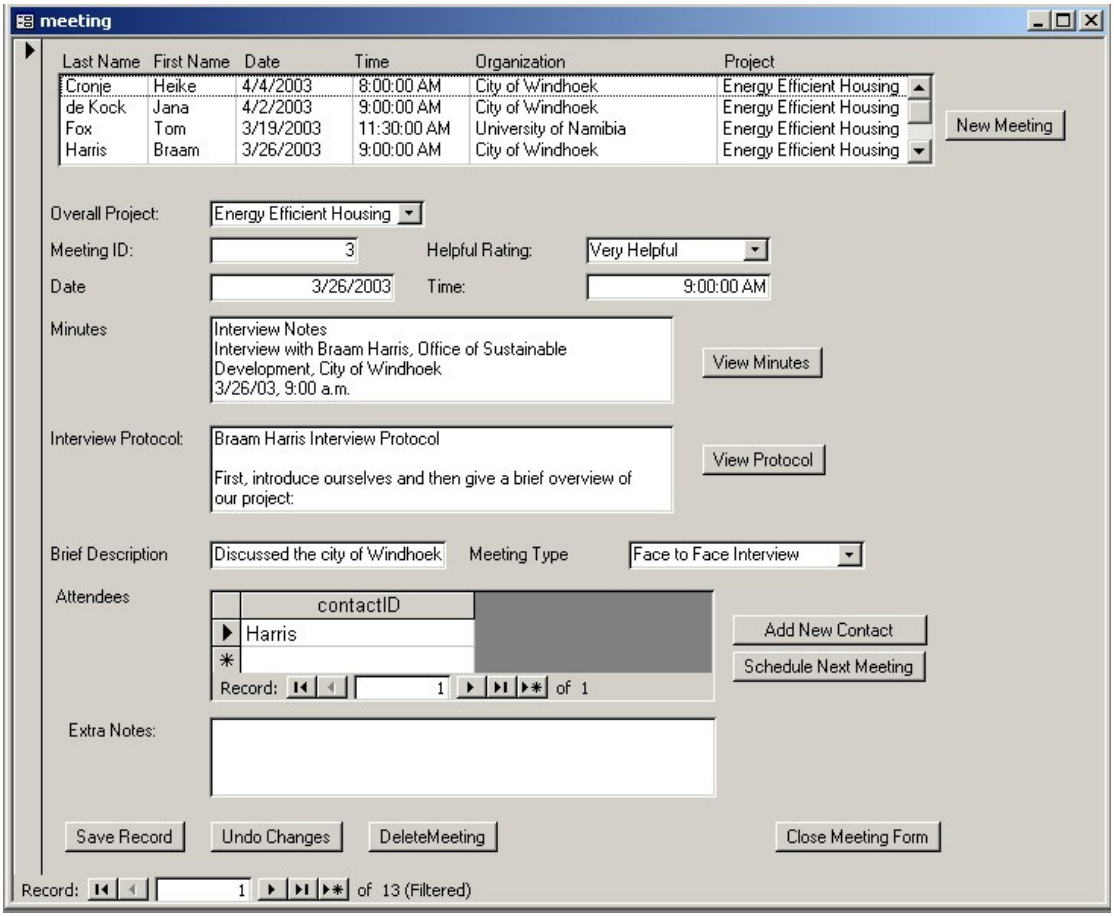


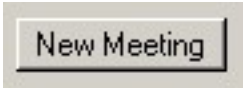

**Figure 4.14. Edit/Add/Find meetings form.**

There are a number of fields which you should be familiar in this menu:

1. *The search box at the top*
2. *The helpful rating field*
3. *The minutes and protocol fields*
4. *The attendee field*

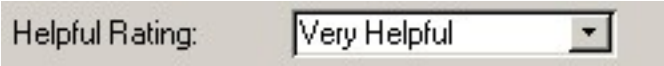
**1.**
The search box at the top of the screen lists all of the meetings in the database. You can scroll through them. By clicking on a meeting, the fields in the form will automatically fill in with that meeting's information.

**2.**




Next to the search box is the 'New Meeting' button. By clicking it, a blank form will appear to allow you to insert a new meeting.

**3.**




The helpful rating field is important because it is used in some of the application's functions, so be sure to remember to rate how helpful each meeting is.

**4.**

The minutes and interview protocol fields hold the minutes and interview protocol for the specified meeting. Just copy the text from a file into the box and click the 'Save Record' button.

**5.**

The attendee field is where you enter who was present at each meeting. You cannot put a person in this field unless he or she is already a contact in the database. This is why there is a button next to the field labeled 'Add New Contact'.

---

### 4.1.1. Adding New Contacts from the Meeting Menu.


When you push the 'Add New Contact' button in the Meeting Menu, you will be brought to the menu shown in Figure 4.15.

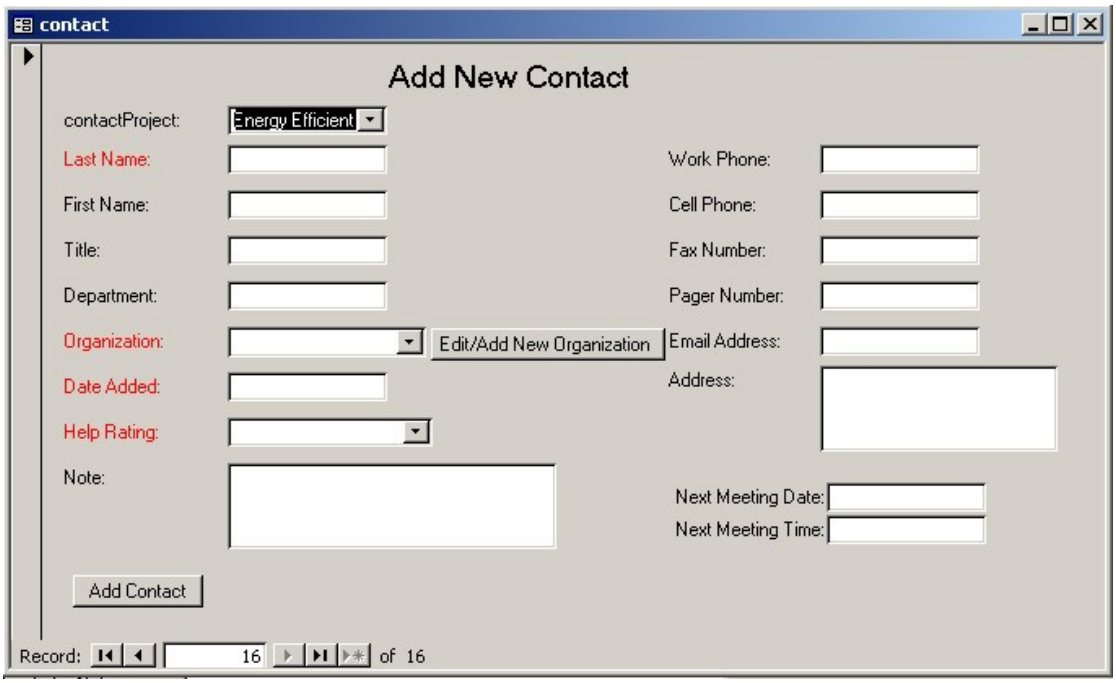



**Figure 4.15. Add new contact menu.**

The red labels indicate a field which you have to enter information into. Push the 'Add Contact' button when you are finished entering the data. If the organization for your contact is not in the dropdown box, push the 'Edit/Add/New Organization' button to add it. Directions for adding and editing an organization can be found in Section 3.1.3.

---

### 4.1.2 Schedule Future Meeting.


To schedule a meeting, click on the 'Schedule Next Meeting' button. After you click, the contact form will appear and a dialogue box, seen in Figure 4.16, telling you to use the search box to select the contact you wish to schedule the meeting with will pop up.

The contact menu will have the 'Next Meeting Date' and 'Next Meeting Time' highlighted in yellow to show you where they are. This is shown in Figure 4.17 below. Enter the date in the date field and the time in the time field. You may schedule one

meeting for each person at a time. When finished with each record, remember to click the 'Save Changes' button and then use the 'Close Contact Form' button to close the form.


**Figure 4.16. Schedule meeting directions box.**

The contact menu will have the 'Next Meeting Date' and 'Next Meeting Time' highlighted in yellow to show you where they are. This is shown in Figure 4.17 below. Enter the date in the date field and the time in the time field. You may schedule one meeting for each person at a time. When finished with each record, remember to click the 'Save Changes' button and then use the 'Close Contact Form' button to close the form.

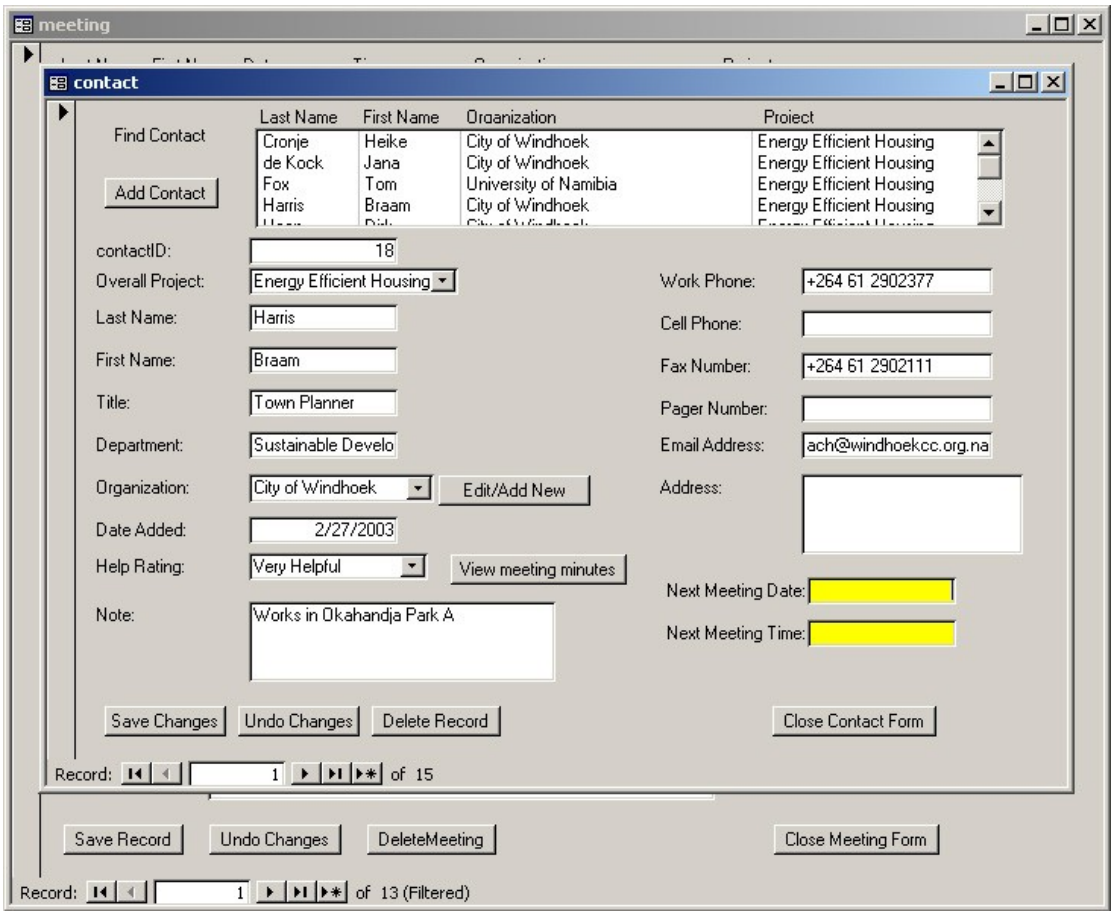


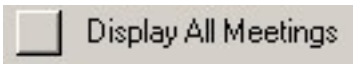

**Figure 4.17. Edit/Add/Find meetings form with date and time highlighted.**

## *4.2. Display Future Meetings.*


If you push the 'Display Future Meetings' button, you will be presented with a preview of the report of all the contacts whom you have future meetings scheduled.

The steps for printing or exporting the report are the same as for the 'Exporting the Meeting Minutes' report in Section 3.1.2.

## *4.3. Display All Meetings.*

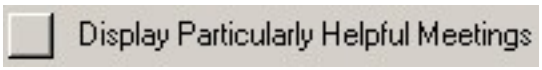



If you push the 'Display All Meetings' button, you will be presented with a preview of the report containing a brief description of all the meetings which are in the database.

The steps for printing or exporting the report are the same as for the 'Exporting the Meeting Minutes' report in Section 3.1.2.

---

## *4.4. Display Particularly Helpful Meetings.*




If you push the 'Display Useful Meetings' button, you will be presented with a preview of the report containing a brief description of all the meetings which have a helpful rating of either 'Helpful' or 'Very Helpful.'

The steps for printing or exporting the report are the same as for the 'Exporting the Meeting Minutes' report in Section 3.1.2.

---

## *4.5. Jump to Contacts Menu.*


If you push the 'Jump to Contacts Menu' button, you will be brought from the Meetings Menu to the Contacts Menu without having to go through the Main Menu.

---

### *4.6. Go Back.*


If you push the 'Go Back' button, you will be brought from the Meetings Menu to the Main Menu.

---

## 5. Administrative Menu.

When you click on the 'Administrative' button from the Main Menu (shown in Figure 5.18) you will be brought to the Administrative Menu.

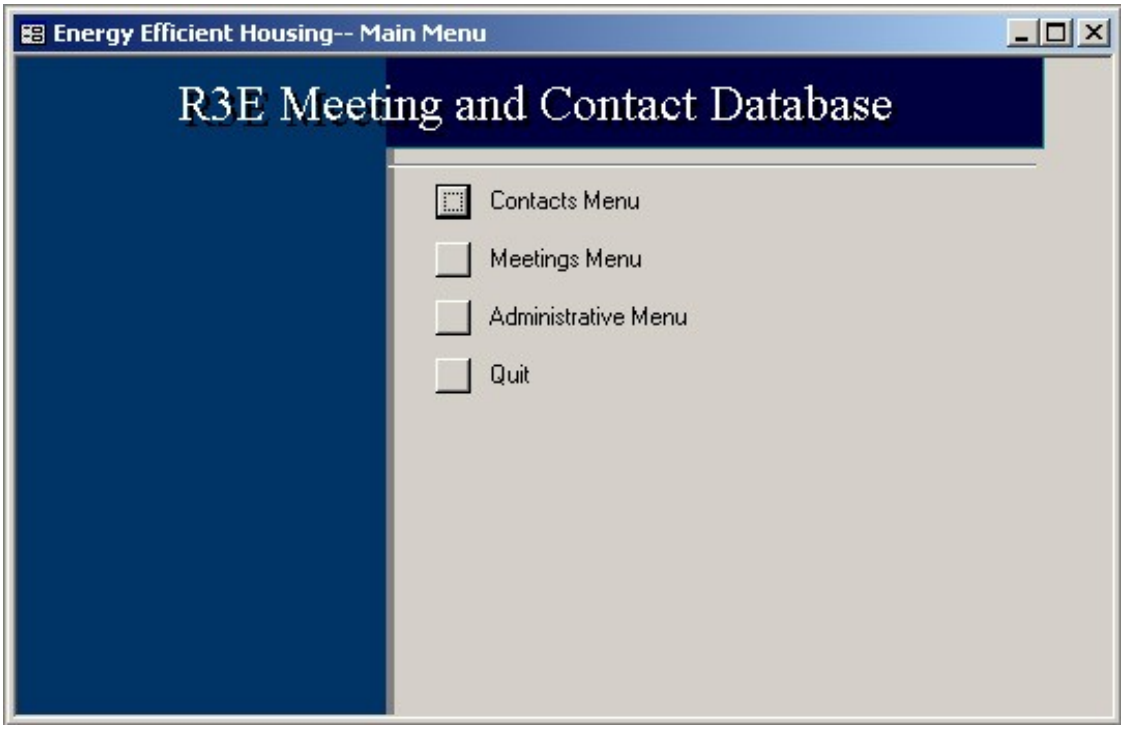



**Figure 5.18. Main menu.**

## *5.1. Listing and Editing Organizations.*

The only option available in the Administrative Menu is the 'List/Edit Organization' button which is shown in Figure 5.19.

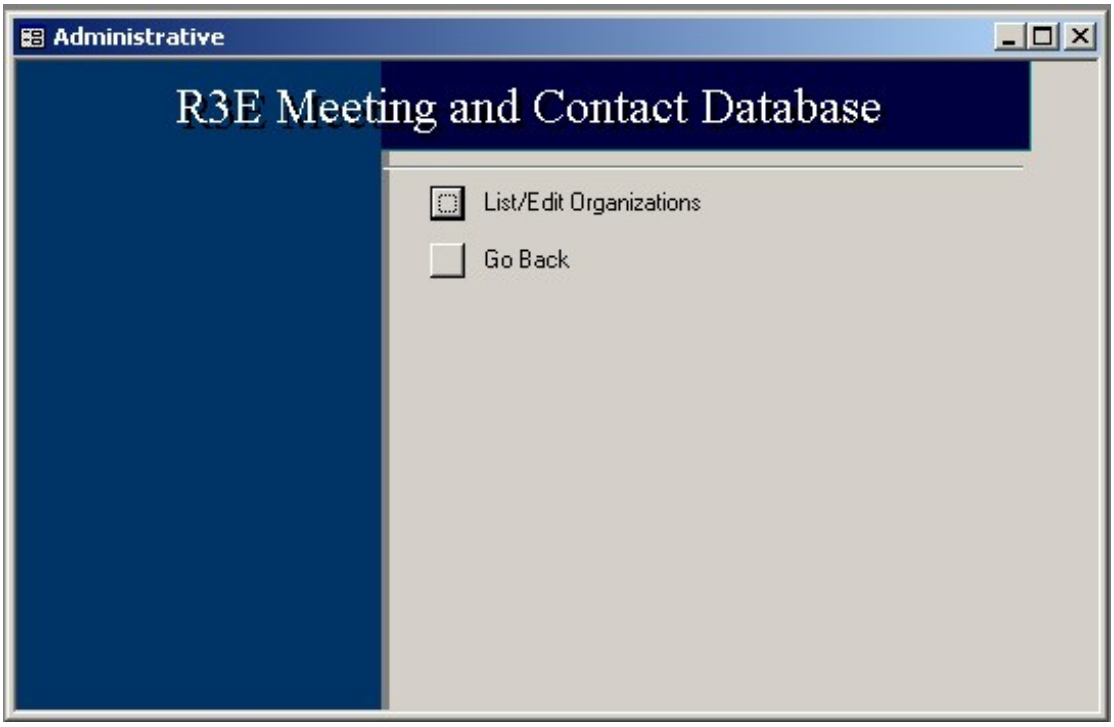



**Figure 5.19. Administrative menu.**

How to use the organization editing tool is described in Section 3.1.3.

# Appendix D: Working Paper.

# Energy Efficiency In Low-Cost Housing

Working Paper No. 1

This is the first draft of the working paper. Changes will be made in the future. If you have any comments or suggestions, please contact Mr. Robert Schultz of R3E at the number listed in Appendix A.

Table of Contents:



Prepared by
Christopher J. Bean, Elizabeth A. Norgard, and Lindsay S Wright

For
Renewable Energy and Energy Efficiency Bureau of Namibia [R3E]

## Section 1. What is the **Energy Efficiency In Low-Cost Housing** project?

The **Energy Efficiency In Low-Cost Housing** project is a Danish-funded housing initiative designed to increase the energy efficiency of Namibian housing. Energy efficiency includes a wide range of topics, including using renewable materials, regulating temperature without the input of energy, and using materials that do not require energy to produce or transport.

This project will result in an energy efficient urban demonstration village that will house approximately 100 low-income households. Housing materials and construction costs for three housing plans will total N$10,000, N$50,000, and N$75,000, respectively. This village will include affordable housing and space for businesses and communal recreation areas, as well as providing basic utilities and services, such as clean water, electricity, and waste management.

## Section 2. Who is involved in the project?

Relevant organisations of **Energy Efficiency In Low-Cost Housing** include government agencies, NGOs, and other associated groups. These organisations will be responsible for various steps in the planning and implementation of the project and its continuation.

### Government agencies and their roles:

- Ministry of Regional and Local Government and Housing
  - To facilitate the implementation of the project by relaxing housing regulations that hinder its success
  - To help the project get expedited approval

- National Housing Enterprise
  - To finance the project through normal procedures
  - To assign architects and civil engineers to the project
  - To construct the houses
  - To identify future residents

- City of Windhoek
  - To identify a site for the project
  - To assign town planners to the project
  - To supply services through the normal servicing protocols

### NGOs and their potential roles:

- Namibia Housing Action Group
  - To promote the use of energy efficient measures in housing
  - To provide energy efficiency information to members

- Shack Dwellers Federation of Namibia
  - To promote the use of energy efficient measures in housing
  - To provide energy efficiency information to members
  - To provide a direct link to ISA residents

### Associated groups and their potential roles:

- R3E
  - To coordinate relevant organisations of **Energy Efficiency In Low-Cost Housing**
  - To provide information to relevant organisations
  - To organize education seminars for relevant organisations

- Habitat Research and Development Centre
  - To act as a future resource of housing information

# Section 3. How can energy efficient techniques be used in low-cost housing?

In this section, various techniques to increase energy efficiency of low-cost housing are discussed. There are two major sections: building considerations and recommendations for existing structures. Under each of these sections, recommendations are further broken down by housing component, i.e. orientation, walls, windows, roofs, insulation, shading, and other. The Energy Efficient Techniques List, Appendix B, is organized in the same manner. Under each subsection, recommendations are bulleted with a triangular arrow and explanations of concepts or implementation are listed below with white circular bullets.

## Building Considerations:

Orientation and house design:

- Build the house on a south-facing slope.
  - The south side receives less solar radiation, so the house remains cooler, as shown in Figure 1.

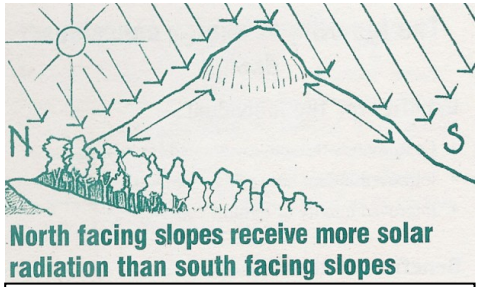



**Figure 32. South Facing Slope. From S. Ward, 2002, p. 74.**

- Build the house with the smallest surface area possible.
  - In this way, there is less surface area to absorb solar radiation.
- Minimize walls on the east and west sides.
  - The sun is the lowest on the east and west sides, exposing these walls to more solar radiation.
- The door should be placed on the south side
  - Less solar radiation will enter through the doorway, as there is less sun on the south side.

Walls:

- Use either earth bricks or corrugated iron for wall material
  - Earth bricks have a high thermal mass and insulate well.
  - Corrugated iron is not as energy efficient as earth brick, but is better than flat metal.
- Walls should be airtight
  - This will allow for less solar radiation and unintended drafts to enter the house.
- Internal walls should be used to channel wind into all of the rooms
  - Walls should channel wind throughout the house, not block it.

Windows:

- Windows should be placed on the north and south sides of the house.
  - The sun is lowest on the east and west sides, so any windows on these sides will be very hard to shade.

Roofs:

- A thatched should be used, if possible.
  - Thatch is insulated and water-tight.
- A corrugated metal roof is the next best choice.
  - Metal roofs will radiate out more heat, if kept clean.

Insulation:

- Insulation should be used on the roof and walls, whenever possible, as shown in Figure 2.
  - Good materials include cardboard, plastic bags, and crumpled newspaper.
  - Insulation will increase the effectiveness of other energy efficient techniques.

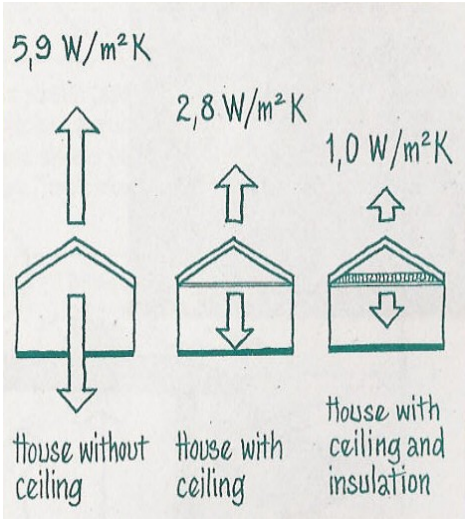



**Figure 33. Heat Resistance with Ceiling and Insulation. From S. Ward, 2002, p. 75.**

## Recommendations for existing structures:

Orientation and house design:

- An overhang of approximately 60cm should be placed on the north side.
  - The overhang will block the sun during the summer, but not during the winter, when the sun is lower, as shown in Figure 3.

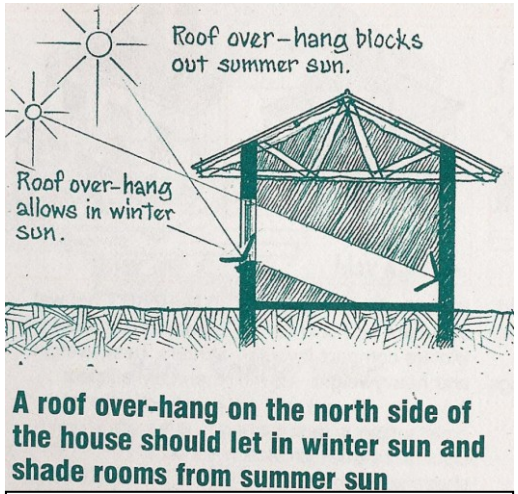



**Figure 34. Overhang. From S. Ward, 2002, p. 76.**

Walls:

- Light coloured or reflective material should be used to reflect heat
  - Effective techniques include using reflective corrugated iron, whitewashing, texturing the outside material, or combining any of these techniques.

Windows:

- Security measures should be included on windows, including bars, shutters, or mesh, to prevent theft.
- Curtains should be used on windows to block heat that could enter from outside.

Insulation:

- Insulation should be used on the roof and walls, when possible, as described in the Building Considerations section.

Shading:

- Shading should be used in any form whenever possible.
  - Trees that lose their leaves during the winter are most effective.
- Use vegetation or other structures to guide wind into the house when possible.
  - This will increase the ventilation through the house.

Other:

- Cooking should be done outside when possible.
  - This will minimize heat gains from within the house, and reduce the risk of fires.

All illustrations reproduced from S. Ward, 2002, The Energy Book for Urban Development in South Africa, Noordhoek, South Africa: Sustainable Energy Africa.

# Appendix A. Relevant Organisation Contact Information.

Renewable Energy and Energy Efficiency Bureau of Namibia [R3E]
PO Box 40765
Windhoek
energy@polytechnic.edu.na
Mobile: 81 244 3063
Tel/Fax: 61 207 2088

Ministry of Mines and Energy [MME]
1 Aviation Road
Private Bag 13297
Windhoek
postmaster@mme.gov.na
Phone: 61 284 8111
Facsimilie: 61 284 8363

If you would like your contact information to be listed here in future versions of this paper, please contact R3E at the number listed above.

# Appendix B. Energy Efficient Techniques List.

This list contains a variety of energy efficient techniques that can be implemented in any housing situation. However, some of these methods require financing and so may be unsuitable for some income ranges. This list is not meant to be all-inclusive.

***Site Location/Orientation***
Build on a slope
Build on leeward side of slope
Build house on south facing slope
Minimize size of east and west walls
Orient longest side of house to face north
Put large room with window on windward side
Build house directly on ground
Build house into the ground (2m)
Large volume to surface area

***Walls:***
*Materials:*
- Clay
- Brick
- Cement
- Earth
- Hollow Bricks
  - Hollow bricks filled with soil
- Corrugated Iron

*Method:*
- Bottle caps as washers
- Shared walls
- Channeling wind with internal walls
- Higher thermal mass in direct sun
- Air-tight walls
- Air bricks

*Surface properties:*
- Texture
- Light colors
- Reflective
- White cement
- Lime
- Whitewash

***Windows***
*Method:*
- Glass windows
- Hole in wall
- Place windows on opposite walls
- Put windows in three of the four walls
- Widely space windows if they are on the same wall
- Night ventilation
  - Screens
  - Bars
- Wind Walls
- Indirect earth cooling

*Materials:*
- Shutters
- Curtains
- Mesh

***Roof***
*Material:*
- Metal
- Thatch
- Plastic covering

*Method:*
- Pitched
- Vaulted
- Domed
- Overhang
- Overhang on north

*Surface properties:*
- Textured
- Reflective
- Light color on the outside
- Dark ceiling

***Insulation***

*Method:*
- Ceiling
- High Ceiling
- Moveable insulation

*Material:*
- Cloth
- Cardboard
- Plastic Bags
- Newspaper
- Mud
- Straw
- Sawdust
- Rugs

***Shading***

Plants
Dense canopies
Trees on west
Trees on ENE
Trees on WNW
Climbing plants
Wind guides

***Other***

Cook outside

# Appendix E: Presentation-In-A-Box Protocol.

# Presentation-In-A-Box

Pre-prepared presentation protocol on energy efficiency in low-cost housing

Prepared for the Renewable Energy and Energy Efficiency Bureau of Namibia [R3E]

by
Christopher J. Bean
Elizabeth A. Norgard
Lindsay S Wright

1 May, 2003

## Table of Contents.



### Section 1. Overview.

This presentation kit includes the materials and speaking protocol necessary to give a 20-minute interactive presentation to 10-15 participants on energy efficiency in low-cost housing. This package was designed to introduce residents to methods of home improvement that keep a house cooler in the summer and warmer in the winter. All materials in this kit are intended to facilitate the presentation of energy efficient techniques to audiences of any age who do not speak English as a first language. However, this presentation is also appropriate for introducing authorities to the basic ideas encompassed by energy efficiency. Other materials or speaking protocols may be substituted or added as necessary.

### Section 2. Materials.

Included Materials:

- Presentation protocol
- Housing model:
  - Walls:
    - corrugated iron (dark and non-reflective)
    - corrugated iron (light and reflective)
  - Roofs:
    - flat
    - pitched (with insulation)
    - vaulted (with insulation)
  - Insulation for walls
  - Model base with compass directions
  - Synthetic Corrugated Iron with cardboard insulation holder
  - Standing Vegetation

- Technique Illustrations (on disk and in paper form):
    - Roof Insulation and Ceiling
    - Roof Overhang
    - Light Colours for Walls
    - Light Colours for Roofs

Other Materials (not included):

- Chart Paper and Markers (if desired)
- Newspaper
- Tape
- Classroom
- Translators (if applicable)
- Flashlight

**Section 3. Preparation.**

Before beginning the presentation, check to make sure that the room or presentation area is set up appropriately. If possible, set up chairs in a semi-circular shape in order to allow all participants to have a good view of the presentation area. A low table should complete the semi-circle. The models should be placed on a low table in view of everyone. The illustrations should be set on an easel or taped to a wall for easy viewing. Extra chart paper can also be set on the easel or taped to a wall. If handouts of illustrations are desired, they should be made prior to the presentation. Check to make sure that all materials are not damaged during the preparation step. For example, if the corrugated iron material is flattened, reposition the ridges to their original shape of pointing out.

**Section 4. Presentation.**

The presentation consists of three major parts. First, the topic, energy efficiency, must be introduced. Next, the energy efficiency information must be presented. Finally, the presentation must be concluded and any feedback collected. This section will include suggested speaking protocols and explanations of techniques.

**Section 4.1. Introduction.**

**Note:** Speak slowly. Your audience most likely does not think about these concepts every day, and many are likely to be completely new to them. If you have to communicate through a translator, speak in short segments so that the translator can concentrate on translating.

1. Introduce yourself and your organization, if applicable.

2. Explain why you are here doing this presentation.

3. Explain that there are steps you can take to cheaply regulate the temperature of your house.

4. Briefly outline the presentation.
    a. House orientation
    b. Important building material characteristics
    c. Insulation
    d. Types of roofs

Sample dialogue:

*(1) Good evening. My name is <George Smith>. I am working with the <City of Windhoek> (2) to help distribute information about keeping your houses cooler in the summer and warmer in the winter at little or no cost to you. (3) Tonight we will be discussing ways to help regulate the temperature of your house using things that you can find easily. (4) We will be using models and pictures to illustrate concepts that you can use in your own home. These concepts include which way your house should face, important things about building materials, some tips about insulation, and different styles of roofs that you can use. If you have any questions, please feel free to ask them during the presentation or afterwards.*

**Note:** You will notice throughout the sample dialogues that the term 'energy efficiency' is not used. This is due to the association many people have between 'energy efficiency' and 'electricity.' This is a particularly critical point for residents of informal settlements, as it is very important that they do not believe you are going to provide them with electricity.

**Section 4.2. Presentation of Energy Efficient Information.**

5. Get the audience's attention by asking what techniques they currently use to keep their houses cool.

Sample Dialogue:

*(5) We are interested in what you are currently doing to keep your house cooler in the summer and warmer in the winter. We are here to learn as well. Is there anything that you've tried that has worked really well? How about anything that didn't work so well?*

6. After getting some initial ideas, lead in to the ideas in the box.

**Note:** Be sure to keep in mind that no one may want to speak at first, and it might be necessary to suggest some initial ideas. The most important part of this presentation is

that the audience is interested. They more they participate, the more they will get out of it.

**Note:** In this section, there are steps that call for moving models, showing pictures, and discussing and explaining concepts. For clarification, whenever the step calls for a discussion or explanation, the first word of the step has been bolded.

7. Place the Dark and Non-Reflective Corrugated Iron walls on the base with the flat roof, oriented on the compass base with the longest side facing west.

8. Shine the flashlight on the overhang so that it shows a shadow.

9. Show the Roof Overhang picture and move the flat roof so it overhangs.

10. **Discuss** why overhangs are beneficial.

*Sample Dialogue:*

*(10) We have noticed that many of you have overhangs on your houses already. These are very good at keeping the house cool, as those who have them already know. As the picture shows, the overhang shades the wall keeping some of the sun from directly shining on the wall, thus keeping your house cooler.*

11. **Discuss** the orientation of the house while pointing out the orientation of the house in regards to the compass.

12. Use the flashlight to demonstrate the sun: higher for the summer (with the overhang blocking the light) and lower in the winter (with the overhang not blocking the light).

Sample Dialogue:

*(11) An overhang on the north side of the house is more effective than any other side because the sun shines in this direction for the longest. In the summer, the sun is higher and does not shine directly on the wall which is facing north if there is an overhang. [Refer to the picture] In the winter, the sun is lower and shines directly on the wall facing north, shining underneath the overhang. A good length for an overhang is about 60cm, this will allow the roof to block the sun during the summer and for the sun to hit the wall in the winter.*

13. Orient the house so that the overhang points north.

**Transition**: *Overhangs will protect the walls from some sun, but can't protect them completely. It is also beneficial to use some techniques to help your walls stay cooler.*

14. Replace the walls to the Light and Reflective Corrugated Iron walls and show the Light Colours for Walls picture.

15. **Discuss** light/reflective materials versus dark materials.

Sample Dialogue:

*(15) We have noticed that there are a number of houses that are painted light colours and have reflective materials on them. This is very important when trying to keep you house cool. Light colours do not absorb as much heat as dark colours. Reflective materials, such as clean corrugated iron, reflect much more heat than dirty metal or dark coloured material, keeping the house cooler.*

**Transition:** *Now that we've covered a little bit about what can be done on the outside of the house, let's talk about some things that can be done from the inside.*

16. Place the insulation on the wall.

17. **Discuss** the benefits of insulation and include examples.

Sample Dialogue*:*

*(17) Insulation, a material used to prevent heat from entering or escaping a building, can make a large difference in how comfortable your house is both in the winter and the summer. What materials and techniques are you currently using?*

*Lining your walls with crumpled newspaper, plastic bags, corrugated cardboard, or cloth can keep a lot of the heat out in the summer and keep it in during the winter. It is important to remember that insulation becomes less effective when wet so try to keep your insulation dry.*

*Additionally, cardboard, paper, and cloth are all flammable, so extreme caution must be taken. Do not insulate with flammable materials around open fires or heat sources; for instance, do not pack paper around a stove.*

18. Crumple newspaper and bags now. Place the newspaper next to the synthetic corrugated iron and hold in place with cardboard insulation holder.

19. **Discuss** how to crumple it.

Sample Dialogue*:*

*(19) Here you want to crumple the paper a little bit [demonstrate], but not pack it solid. The air pockets in the paper and bags will act as further insulators to keep out the heat.*

20. **Discuss** how much insulation would be useful

Sample Dialogue*:*

*(20) Using about 10cm of insulation for each wall will help your house stay cool during the summer and warm during the winter. Putting insulation between the outside wall (corrugated iron) and the inside wall (perhaps cardboard or a sheet) will make a noticeable difference.*

21. Show the Roof Insulation and Ceiling picture.

22. **Discuss** how insulating the roof as well as the walls can be beneficial.

*Sample Dialogue:*

*(21) Insulating the roof is perhaps even more important than insulating the walls. The more insulation between you and the sun, the cooler it will be in the summer and warmer in the winter.*

*In order to insulate the roof, you first must make some kind of a ceiling to hold the insulation in place.*

23. Replace the flat roof with the pitched roof.

24. **Discuss** the advantages of a pitched roof over the flat roof.

Sample Dialogue:

*(24) A pitched roof is better than a flat roof because it will increase the space in your house slightly; this allows for the hot air to rise out of the living space. The additional material will absorb the same amount of sun, but is able to release the heat faster. Additionally, a pitched roof allows rain to flow off more efficiently instead of leaking into the house. Facing the slope of the pitched roof towards the north provides the additional benefit of being able to have a good overhang on that side.*

25. Show the Reflective/Light Colours for Roofs picture.

26. **Discuss** the fact that the advantages of light/reflective materials, overhangs and insulation apply to all roofs.

Sample Dialogue:

*(26) As with walls, light colours and reflective materials are the best choices for roofing materials to keep a house cool. Additionally, overhangs can be made with any type of roof and will add to the benefits. Insulation of any type of roof is very beneficial, and should be added whenever possible.*

**Section 4.3. Conclusion.**

27. Conclude the presentation and collect feedback on the presentation from the audience.

28. Invite the audience to ask questions and give them your contact information so that they may contact you later if the need arises.

29. Thank the audience for their participation and time.

Sample Dialogue:

*(27) Now that you have seen these ideas, what do you think? Do you think these methods might be useful for you, or are they unrealistic? (28) Do you have any questions? [Answer any questions that arise, if possible.] This handout contains the illustrations that I showed you tonight and it also has information on how to contact me, if any of you have any questions that you think of later. [Distribute handout, if applicable.] This concludes the presentation. (29) Thank you all for your participation and time.*

**Section 5. Post-Presentation.**

After the audience has vacated the classroom or presentation area, make sure that everything is as you found it. This includes returning chairs to their original positions and removing all materials from the walls. Carefully repack the model into the box and replace all materials. Be sure to thank any people or organizations that aided you in the presentation and give them your contact information in case they have any questions.

**Section 6. Other Topics.**

There are a variety of other topics which could be covered in this presentation or subsequent presentations. Some topics and sample dialogues are included below.

1. Placing the door on the south side of the house.

Sample Dialogue:

*The sun shines less on the south side of every building. A simple trick such as putting the door to your house on the south side, where there is less sun, can make a difference in how hot your house gets during the day. Areas near doors are usually not air-tight and often open and close, so having your door face the north will result in a hotter house, as more heat can enter through the openings.*

2. Vaulted Roofs

Sample Dialogue:

*A vaulted roof has the same benefits as a pitched roof: it will increase the vertical space in your house slightly and it will allow rain to flow off more efficiently. However, the vaulted roof has even more surface area to release heat. The sun also does not hit the entire surface of the roof at once, so less heat is absorbed. The downside of vaulted roofs is that they are harder to construct and they are more expensive. Are there any other drawbacks that you have run into when building your roofs?*

3. Shading and the benefits of Vegetation

Sample Dialogue:

*Planting trees on the north, west, and east sides will cause the sun to cast shadows on your house. This will cause the house to receive less sunlight and thus to be cooler. Additional vegetation near the house is useful, regardless of its positioning, because the high water content of the plants cool the air. If you choose to use this method, you should look into trees and vegetation that lose their leaves in the winter. Otherwise, you will also be blocking the sun in the winter when you want it to shine on your house. If vegetation is not available, shading on the east and west sides can be made using other materials or even by constructing the houses close together in that direction. Also any vegetation such as grape vines which can grow directly on the walls will be useful.*

4. Windows

Sample Dialogue:

*Windows are useful to help increase ventilation in your house. They should not be placed on the east or west side of the house whenever possible. The sun is lower in these two directions, and so more heat will enter windows on the east and west. It is helpful to have windows on both the north and south side of the house, to create a breeze through the house. Keeping the windows widely spaced will help the breeze*

*flow throughout the entire house. Bars or screens can be used to reduce the risk of theft and increase privacy. Additionally shutters can be used to keep out the wind in the winter.*

**Section 7. Illustrations.**

Figure 7.1 Roof Overhang
Figure 7.2 Dark/Light Colours for Roofs
Figure 7.3 Dark/Light Colours for Walls
Figure 7.4 Roof and Ceiling Insulation

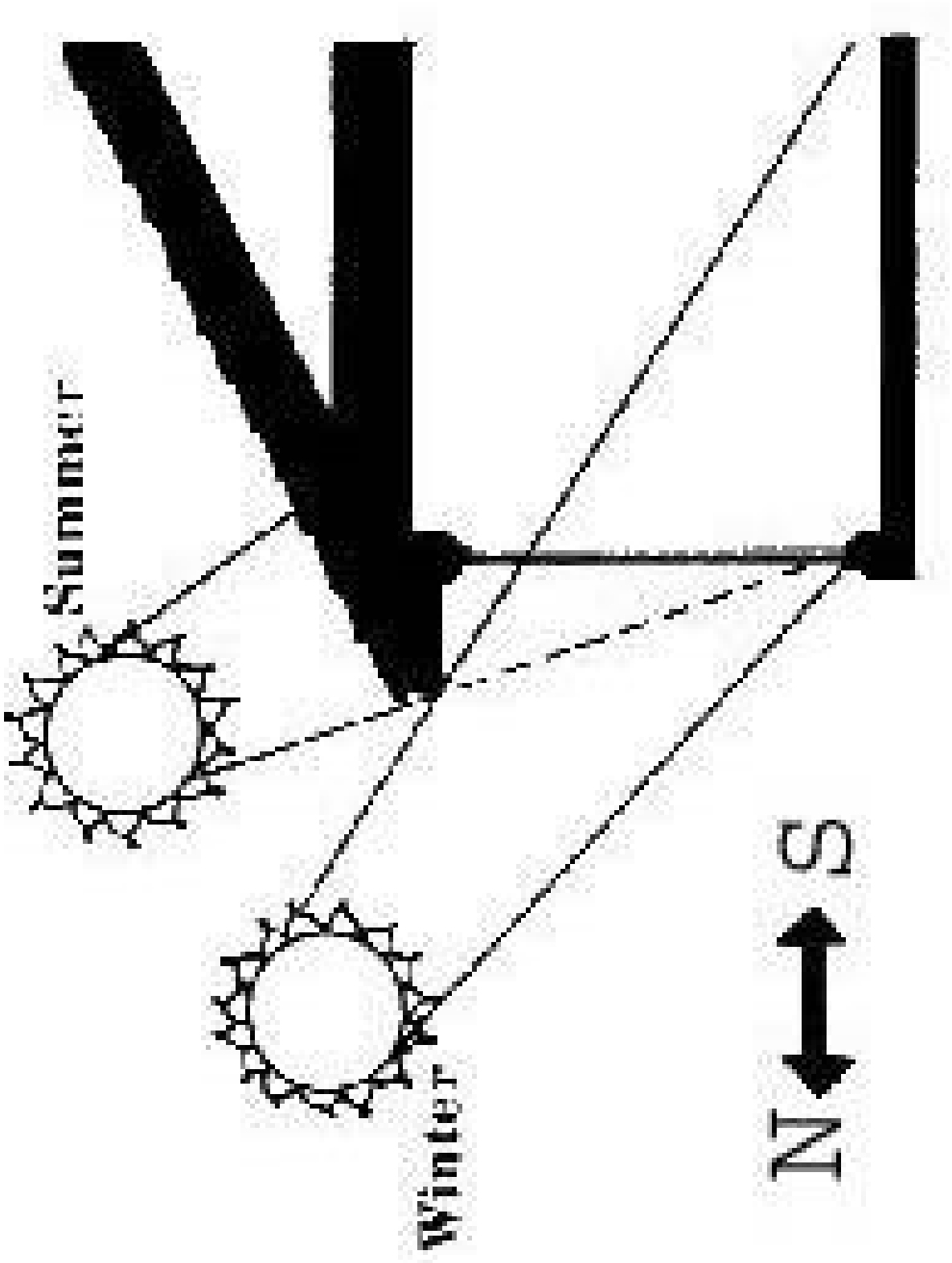



Figure 7.1. Roof Overhang. From S. Hui, 2002.

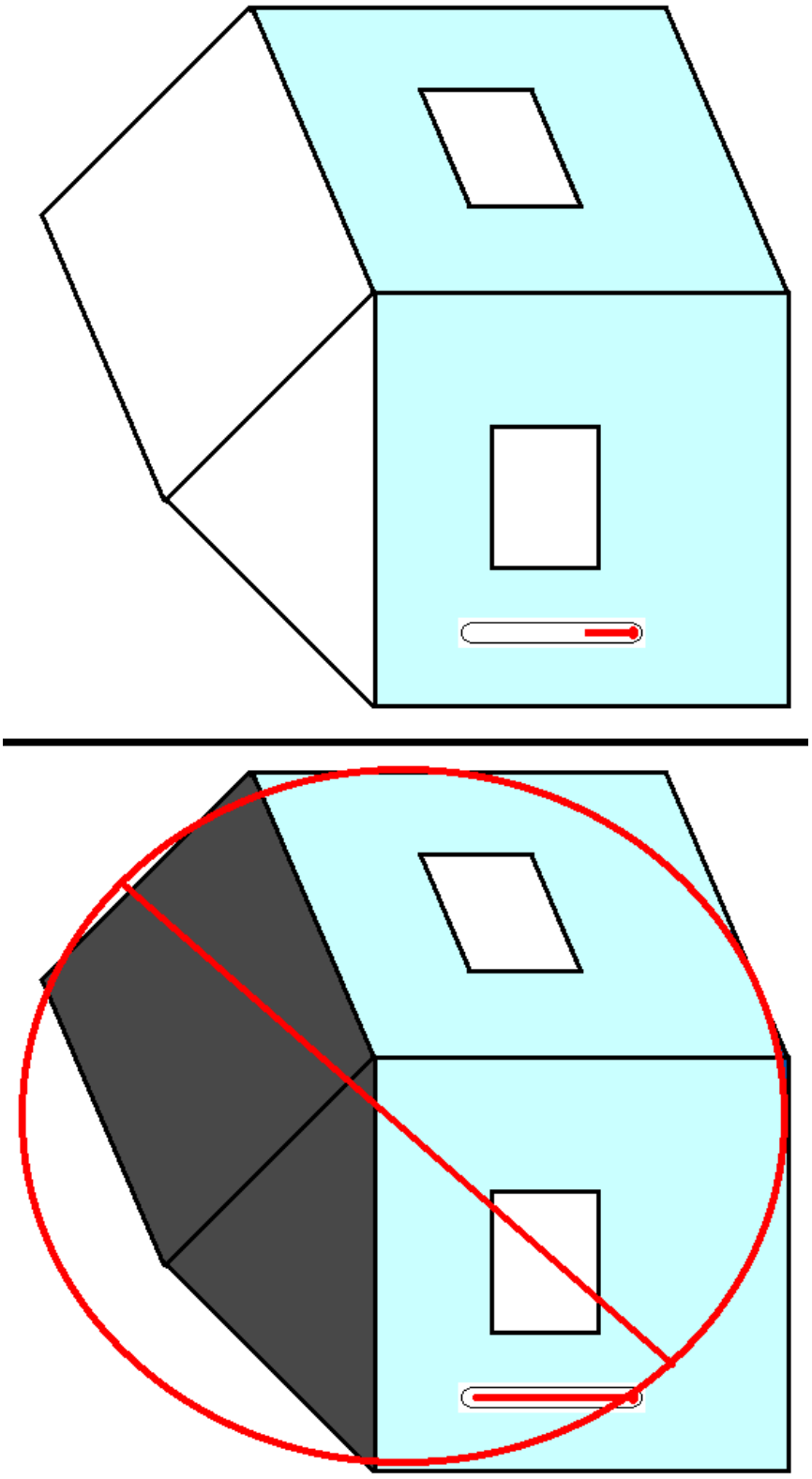


Figure 7.2. Dark/Light Colours for Roofs.

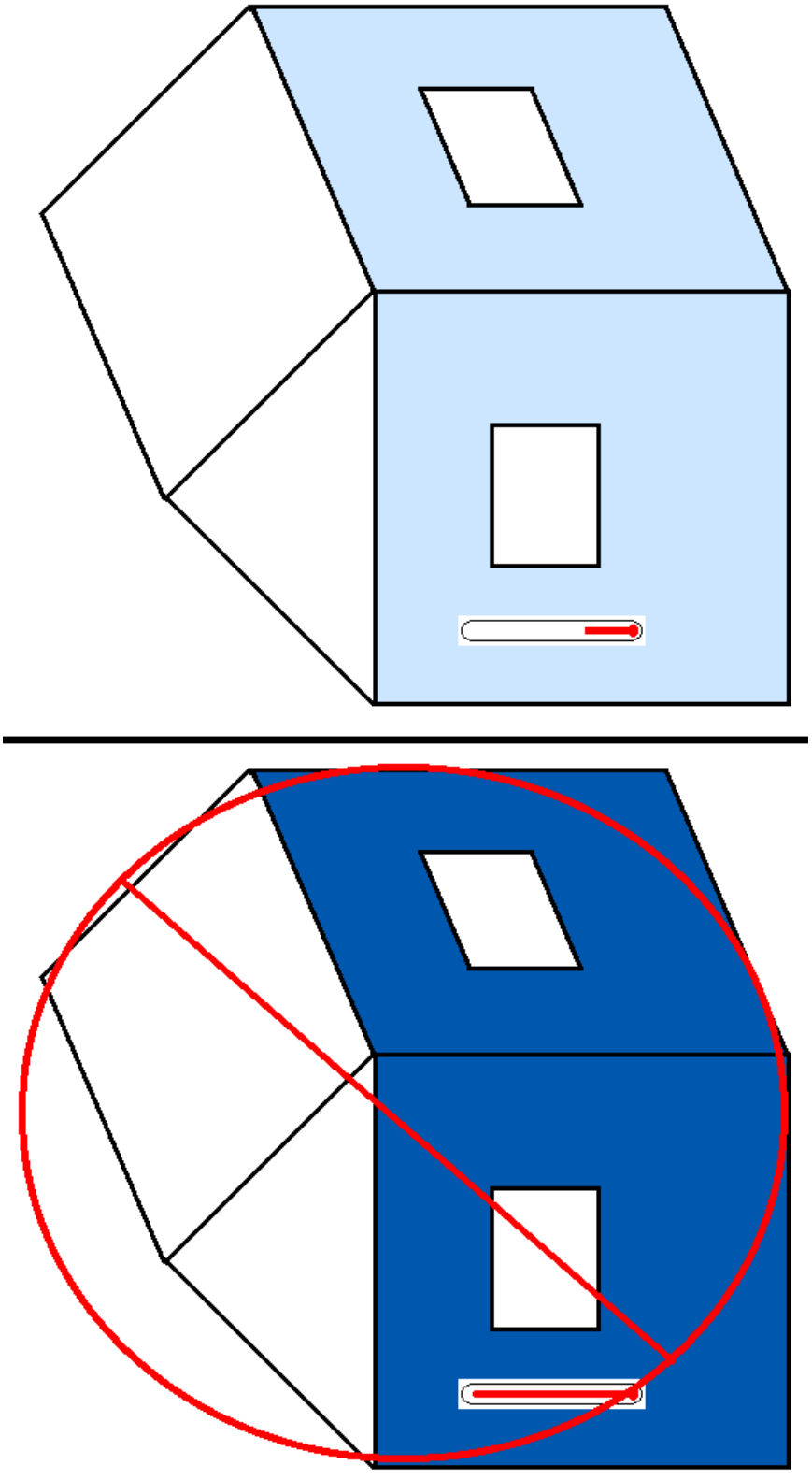


Figure 7.3. Dark/Light Colours for Walls.

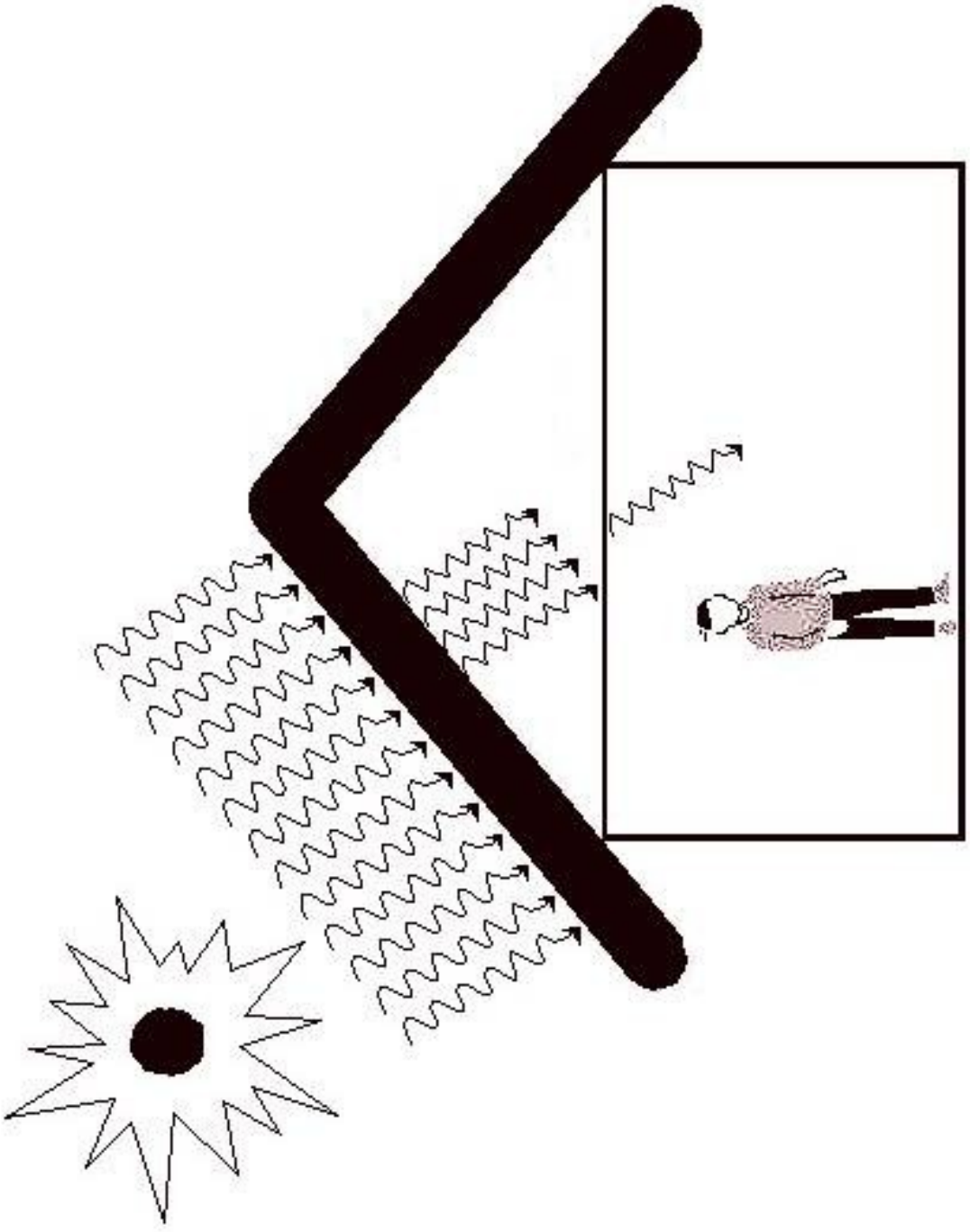


Figure 7.4. Roof Insulation and Ceiling. From NESEA, 2001.

# Appendix F: Interview Protocols.

**Interview Protocols**



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***Name:*** Vence Uisso (Polytechnic of Namibia)
***Date:*** 3/18/2003
***Time:*** 9:00:00 AM
***Attendees:*** Vence Uisso, Christopher Bean, Lindsay S Wright

First, introduce ourselves and then give a brief overview of our project:

- Design a village for 50-100 low income families
- Have three different housing costs: N$10 000; N$50 000; N$70 000
- To be implemented in 2005
- Area for village is roughly two hectares (20 000 square meters).
- Upgradeable over time

Situation assessment questions

1. Are there any projects similar to ours that you know of?
2. Do you know of any other interested organizations?
3. What sources of energy do you suggest we look into using? Why?
4. How would you recommend distributing water
   a. Communal tap
   b. Indoor plumbing
5. What kinds of cost efficient building materials have been used in this area??
   a. Are there any cost effective substitutes that are commonly found? (i.e.: beer can lids)
6. Do you know of any good sources for finding housing and development policies?
7. How would you arrange the housing clusters, in terms of housing cost?
   a. What would you do to make it pleasing to the eye? – not katatura
8. Where would you place businesses?
   a. What kinds of businesses should we be encouraging?
9. Where would you place recreational areas?
10. If you were doing this project and you had to focus on three major topics, what would they be and why?

---

***Name:*** Tom Fox (University of Namibia)
***Date:*** 3/19/2003
***Time:*** 11:30:00 AM
***Attendees:*** Tom Fox, Christopher Bean, Elizabeth Norgard

First, introduce ourselves and then give a brief overview of our project:

- Design a village for 50-100 low income families
- Have three different housing costs: N$10 000; N$50 000; N$70 000
- To be implemented in 2005
- Area for village is roughly two hectors (20 000 square meters).
- Upgradeable over time

Situation assessment questions

1. Are there any projects similar to ours that you know of?
2. Are there any people that you know of that might be able to help us?
3. What sources of energy do you suggest we look into using? Why?
4. Do you know of any good sources for finding housing and development policies?
5. If you were doing this project and you had to focus on three major topics, what would they be and why?

After completing the interview, thank the interview for his or her time and leave.

---

***Name:*** Andreas Wienecke (National Housing Enterprise)
***Date:*** 3/24/2003
***Time:*** 8:30:00 AM
***Attendees:*** Andreas Wienecke, Christopher Bean, Lindsay S Wright

Explain briefly about our project:

- Design energy efficient modular housing
- Cost ranges: N$ 10 000; N$ 50 000; N$ 70 000
- To be implemented in 2005
- Upgradeable

Situation assessment questions

1. Are there any similar projects that we could look into?
2. Are there any other interested organizations/stakeholders that we should talk to?
3. What are the current energy conservation/efficiency policies in place in NHE housing?
4. Cost effective building materials (beer caps)
   a. scrap yard dealer
5. What is the process of thought to bought: From the thought of wanting a house to the actual purchase of the house?
6. Are there any architects that we could talk to about housing plans?
7. How much do houses cost?
   a. Where did that number come from
   b. What is included in that cost
8. Is the current focus on affordability or reproducibility
9. What is NHE's role in the bigger project?
10. If we were doing this project for you, what deliverables would you want out of it?

---

***Name:*** Hugo Rust (City of Windhoek: Office of Sustainable Development)
***Date:*** 3/25/2003
***Time:*** 9:00:00 AM
***Attendees:*** Hugo Rust, Christopher Bean, Lindsay S Wright

First, introduce ourselves and then give a brief overview of our project:

- Design modular housing
- Have three different housing costs: N$10 000; N$50 000; N$70 000
- To be implemented in 2005
- Upgradeable over time

Situation assessment questions

1. Are there any projects similar to ours that you know of?
2. Do you know of any other relevant organizations to be included in our project?
3. What is the role of the Office of sustainable development doing in terms of Informal Settlements?
4. What is the average income for an informal settler?
5. Could you please define 'basic services'?
6. What is the typical housing situation settlers are facing around Windhoek?
7. What sources of building materials do you suggest we look into using? Why?
   a. What kinds of building materials are being used now?
8. What kinds of cost efficient building materials and building designs are you aware of?
   a. Are there any cost effective substitutes that are commonly found? (i.e.: beer can lids)

After completing the interview, thank the interview for his or her time and leave.

---

***Name:*** Anna Muller (Namibian Housing Action Group)
***Date:*** 3/25/2003
***Time:*** 12:00:00 PM
***Attendees:*** Anna Muller, Christopher Bean, Elizabeth Norgard, Lindsay S Wright

First, introduce ourselves and then give a brief overview of our project:

- Design modular housing
- Have three different housing costs: N$10 000; N$50 000; N$70 000
- To be implemented in 2005
- Upgradeable over time

Situation assessment questions

1. What is the relationship between the Shack Dwellers Federation and the National Housing Action Group?
1. What is the process for buying land?
2. What kinds of cost efficient building materials and building designs are you aware of?
   a. Are there any cost effective substitutes that are commonly found? (i.e.: beer can lids)
3. Typically, what kinds of waste management systems and access to other basic services are available in informal settlements around Windhoek?
4. Which would be more efficient, a wet or dry toilet?
5. Does the final cost include land and labor or just materials?
6. Where does all the corrugated iron come from?
7. What are the kinds of energy being most used currently?

After completing the interview, thank the interview for his or her time and leave.

---

***Name:*** Braam Harris (City of Windhoek: Office of Sustainable Development)
***Date:*** 3/26/2003
***Time:*** 9:00:00 AM
***Attendees:*** Braam Harris, Christopher Bean, Elizabeth Norgard

First, introduce ourselves and then give a brief overview of our project:

- Design modular housing
- Have three different housing costs: N$10 000; N$50 000; N$70 000
- To be implemented in 2005
- Upgradeable over time

Situation assessment questions

1. Are there any projects similar to ours that you know of?
2. Do you know of any other relevant organizations to be included in our project?
3. What is the office
4. The Flexible land tenure policy is currently in the pipeline, are there any other policies that are currently being proposed?
5. Do you have any maps that we could use?
6. Do you know of any building material alternatives that are being used?
7. How do you register a house/plot?
8. Do you know of any good sources for finding housing and development policies and regulations?

After completing the interview, thank the interview for his or her time and leave.

---

***Name***: Edith Mbanga (Shack Dwellers Federation Of Namibia)
***Date:*** 4/1/2003
***Time:*** 9:45:00 AM
***Attendees:*** Edith Mbanga, Christopher Bean, Elizabeth Norgard, Lindsay S Wright

First, introduce ourselves and then give a brief overview of our project:

- Design modular housing
- Thermal comfort
- Have three different housing costs: N$10 000; N$50 000; N$70 000
- To be implemented in 2005
- Upgradeable over time

Situation assessment questions

1. How does your organization work? (brochures etc.)
   a. How much contact do you have directly with the residents?
   b. How much contact do you have with the government?
2. Are there any projects similar to ours that you know of?
3. Do you know of any other relevant organizations to be included in our project?
4. What is the typical housing situation settlers are facing around Windhoek?
5. What types of building materials are being used? Why?
6. What sorts of designs are currently being used? Why?
7. If we were working for you, what would you want out of this project? Why?
8. We are creating a working paper to be used by all the organizations involved. What sort of information would you find most helpful?
9. Are you aware of any constraints (cultural, financial, and technological) regarding energy efficiency in housing; give examples
   a. Examples:
      i. Sharing of walls (external)
      ii. Use of solar energy
      iii. Use of communal showers, water points
      iv. Use of clay and thatch

After completing the interview, thank the interview for his or her time and leave.

---

***Name:*** Jana de Kock (City of Windhoek: Office of Housing and Properties)
***Date:*** 4/2/2003
***Time:*** 9:00:00 AM
***Attendees:*** Jana de Kock, Christopher Bean, Eliznorgard

First, introduce ourselves and then give a brief overview of our project:

- Design a village for 50-100 low income families
- Have three different housing costs: N$10 000; N$50 000; N$70 000
- To be implemented in 2005
- Area for village is roughly two hectors (20 000 square meters).
- Upgradeable over time

Situation assessment questions

1. What does the Office of Housing and properties do?
2. What are the average costs for buying land?
3. What is Top Structure?
4. What is the process for buying land?
5. Are there any documents that we could look at in regards to land purchase?

After completing the interview, thank the interview for his or her time and leave.

---

***Name:*** Heike Cronje (City of Windhoek: Office of Sustainable Development)
***Date:*** 4/4/2003
***Time:*** 8:00:00 AM
***Attendees:*** Heike Cronje, Hugo Rust, Christopher Bean, Lindsay S Wright

First, introduce ourselves and then give a brief overview of our project:

- Design modular housing
- Have three different housing costs: N$10 000; N$50 000; N$70 000
- To be implemented in 2005
- Upgradeable over time

Situation assessment questions

1. Are there any projects similar to ours that you know of?
2. Do you know of any other relevant organizations to be included in our project?
3. Could you please tell us about Havana Section 1?
4. Do you know of any building material alternatives that are being used?
5. How do you convey information to the informal settlers?
6. What is currently being done about energy efficiency?

After completing the interview, thank the interview for her time and leave.

---

***Name:*** Nina Maritz (Architect)
***Date:*** 4/7/2003
***Time:*** 2:15:00 PM
***Attendees:*** Nina Maritz, Christopher Bean, Lindsay S Wright

First, introduce ourselves and then give a brief overview of our project:

- Design modular housing
- Thermal comfort
- Have three different housing costs: N$10 000; N$50 000; N$70 000
- To be implemented in 2005
- Upgradeable over time

Situation assessment questions

1. Are there any projects similar to ours that you know of?
2. Do you know of any other relevant organizations to be included in our project?
3. What sources of building materials do you suggest we look into using? Why?
   a. Cost
   b. EE
   c. Availability
4. What kinds of cost efficient building materials and building designs are you aware of?
   a. Are there any cost effective substitutes that are commonly found? (i.e.: beer can lids)
5. What kinds of energy efficient building materials and building designs are you aware of?
6. We are creating a working paper to be used by people/organizations like you. What sorts of information would you like to see in it?
7. Are you aware of any constraints (cultural, financial, and technological) regarding energy efficiency in housing; give examples
   a. Examples:
      i. Sharing of walls (external)
      ii. Use of solar energy
      iii. Use of communal showers, water points
      iv. Use of clay and thatch
8. Costs of every little thing: windows, brick, doors, paint, labor, etc.
9. Can we talk to you in a couple weeks with our ideas/designs?

After completing the interview, thank the interview for his or her time and leave.

# Appendix G: Renewable Energy and Energy Efficiency Capacity Building.

# Danish Ministry of Foreign Affairs Danida

# Renewable Energy and

# Energy Efficiency Capacity Building

# Namibia

## Final Project Document

This Report Contains Restricted Information and is for Official Use Only

J.nr. 104.Namibia.1.MFS.6
November 2002

**COVER PAGE**

**Country** **:** Namibia **Sector:** Environment

**Project Title** **:** Renewable Energy and Energy Efficiency Capacity Building

**National Agency** **:** Ministry of Mines and Energy

**Duration** **:** Three Years (36 Months)

**Starting Date** **:** April 1, 2003

**Overall Budget Frame** **:** DKK 9,959,384 million

**Description:**

The development objective of the project is to contribute to a sustainable socio-economic development process in Namibia. This is to be achieved through the immediate objective of capacity building of the Namibian resource base for promotion and utilisation of renewable energy and energy efficiency measures. Three types of interventions are proposed, each constituting one main output, characterised by a number of benchmarks for each output.

Firstly, the **R3E Bureau**, a recently established outsourcing institution for the Government of non-core activities in this field, will be strengthened to enable this institution to perform such out-sourced functions effectively and efficiently. In addition to performing outsourced function of the government, the R3E Bureau will also act as a focal point for sector-wide capacity development activities performing co-ordination, networking, information dissemination and consulting tasks. The R3E Bureau will be charged with overall project coordination, ensuring that poverty reduction and key cross-cutting issues are adequately mainstreamed into intervention design and implementation. Secondly, a **housing demonstration** Intervention is planned with the intention of demonstrating energy efficient concepts with respect to both town planning and building construction. This Intervention will address the housing needs of especially peri-urban poor, involving them in all relevant aspects of energy efficient housing planning. A key task will be to document the replicability of the Intervention and disseminate the findings. Thirdly, an Intervention is prepared with the objective of increasing energy efficiency consciousness and **improve community energy planning** among the rural population groups, who at present depend heavily on biomass for their energy supply. The main beneficiaries of this Intervention will include the rural poor, in particular women.

**Signatures:**

| | |
|---|---|
| **Ministry of Mines and Energy** | **National Planning Commission Secretariat** |
| **Danida** | |

# ABBREVIATIONS

| | |
|---|---|
| CBO | Community based organisations |
| CDC | Constituency Development Committees |
| CDG | Carl Duisberg Gesellschaft |
| CIDA | Canadian International Development Assistance |
| Danced | Danish Cooperation on Environment and Development; was merged with Danida in December 2001. |
| Danida | Danish International Development Assistance |
| DRFN | Desert Research Foundation of Namibia |
| FINESSE | Financing Energy Services for Small-scale Energy Users |
| FIRM | Forum for Integrated Resource Management |
| GARUEN | Group for the Advancement of the Rational Use of Energy in Namibia |
| GDP | Gross Domestic Product |
| GEF | Global Environment Facility (co-operation between UNDP, UNEP, and WB) |
| GTRC | Gobabeb Training and Research Centre |
| GTZ | Gesellschaft für Technische Zusammenarbeit (German government's corporation for international co-operation) |
| MME | Ministry of Mines and Energy |
| MRLGH | Ministry of Regional and Local Government and Housing |
| NAPCOD | Namibia's National Programme to Combat Desertification |
| NDP1 | National Development Plan, number one |
| NDP2 | National Development Plan, number two |
| NGO | Non-Governmental Organisation |
| NHE | National Housing Enterprise |
| NORAD | Norwegian Agency for Development Co-operation |
| NPCS | National Planning Commission Secretariat |
| R3E | Renewable Energy and Energy Efficiency Bureau of Namibia |
| REEECAP | Renewable Energy and Energy Efficiency Capacity Building |
| REINNAM | Renewable Energy Information Network of Namibia |
| SADC | Southern African Development Community |
| SIEMP | SADC Industrial Energy Management Project |
| UNCCD | United Nations Convention on Combating Desertification |
| UNDP | United Nations Development Programme |
| UNFCCC | United Nations Framework Convention on Climate Change |
| VDC | Village Development Committees |

# 1 INTRODUCTION

## 1.1 Project Background

Ministry of Mines and Energy, requested 2 July 2000, via the National Planning Commission Secretariat (NPCS), for Danced support to various interventions of the project, which was being developed in collaboration with the UNDP/GEF "Barrier Removal to Namibian Renewable Energy" project.

A programme formulation mission took place 13 – 24 November 2000 with the objective of investigating possible future areas of co-operation regarding sustainable use of energy. The mission report from January 2001 identified a number of project areas and proposals on both renewable energy and energy efficiency (REEE). Early April 2001 representatives from the Danish Energy Agency visited Namibia to follow up on the programme mission. Talks with high ranking Namibian officials resulted in a formal request of 3 April 2001 by Permanent Secretary of the Ministry of Mines and Energy, Mr. Joseph Iita, on developing the project ideas as outlined by the programme formulation mission into proper project documents. At the bilateral annual consultations on 13 September 2001 it was emphasised that the project idea "Renewable Energy and Energy Efficiency Capacity Building in Namibia" and the "Gobabeb Training and Research Centre Support" should become prime focus of Danced's attention.

The tendering process of the project at Gobabeb has been finalised.

Two project missions on the renewable energy and energy efficiency capacity building project were conducted on 29 October – 8 November 2001 and on 18 February – 1 March 2002. The draft project document was presented in April 2002.

During the planning process, the project has been developed as a project separate from the planned UNDP/GEF project, but feeding into a joint effort of promoting REEE issues in the further development of the energy sector in Namibia. The UNDP/GEF project focuses on promotion of solar energy, while the present project has a wider perspective on sustainable energy. But the project will to some extent support and facilitate the UNDP/GEF project by strengthening the capacity of the newly established network organisation, R3E Bureau, which is foreseen to also promote solar energy issues.

## 1.2 Process Action Plan

The present Project Document (September 2002) is a revision of the earlier document (Project Document (April 2002)). This revised Project Document is prepared in connection with the appraisal of the project by the Appraisal Mission, visiting Namibia 1 - 12 September 2002. During the appraisal, meetings were also held with UNDP concerning finalisation of the coordination between the UNDP/GEF project and the present project.

A separate Appraisal Report (September 2002) finds that the project is needed and has scope for important impact. Implementation of parts of the project could, however, involve risks, which could not be fully identified and assessed.

The Process Action Plan, indicating the further process towards implementation, is attached as Annex 5.

# 2 CONTEXT ANALYSIS

Namibia has 1.8 million inhabitants, living on 824,000 $km^2$ of land; approximately the same size as France and Germany combined. 70 percent live in rural areas mostly practising subsistence farming, with some 60 percent residing in the northern regions. UN estimates that 20 percent of the population are illiterate and that 23 percent of all adults are infected with HIV/AIDS, making Namibia one of the worst affected countries.

Economy activity is concentrated in primary sector activities – mining, large-scale commercial farming and fishing and subsistence farming – although services account for the major share of GDP. Gross national income per capita was USD 1,960 in 2001 well above the Sub-Saharan Africa average of USD 470 per capita (World Bank 2002), but income distribution is highly uneven with a small minority enjoying high incomes. The land ownership structure is similarly unevenly configured, though the government initiated a land reform programme on a willing buyer, willing seller principle.

Politically Namibia is a unitary republic with a multiparty democratic system. The former liberation movement SWAPO has been in power since 1990. Many credit SWAPO and its charismatic leader (and president of Namibia) Mr Nujoma for ensuring a peaceful and democratic transition.

## 2.1 The Energy Sector

The Namibian economy has a high energy intensity measured both as energy consumption per capita and per GDP unit. This is due to high transportation costs resulting from the low population density and economic reliance on mining and fishing industries.

Namibia's total energy consumption amounted to approximately 43,000 terajoules in 1999 of which 82 percent derived from commercial energy sources (e.g. liquid fuels, electricity and coal), and 18 percent derived from traditional sources (e.g. wood charcoal and animal waste). While commercial fuels thus dominate total consumption it should be noted that traditional fuels are the primary energy source for about 60 percent of the population, indicating unequal access to – and consumption of - energy.

All petroleum requirements are imported as refined products. Electricity generation by the state-owned Nampower is the main form of primary energy production although wood and charcoal are used extensively by rural households. Most of Namibia's electricity supply is normally derived from the 240-mw hydropower station at Ruacana on the Kunene river, but in recent years generation has been erratic, owing to low water flow caused by recurrent drought and poor condition of water control facilities upstream in Angola. Imports from South Africa cover the remainder of Namibia's electricity needs. Obviously these figures vary considerably due to changes in demand and, more importantly, water levels in the Kunene River. In 1998/99 Ruacana was able to produce 57 percent of the 2,085 giga watt total supply, mainly due to good rains, enabling a 27 percent reduction in imported power – mainly from South Africa's Escom – lessening Namibia's overall dependence on imports to 42 percent from 57 percent in the preceding year. Plans for a new

dam and a 450–mw hydro-power-station downstream from Ruacana have been effectively shelved due to the civil war in Angola, environmental uncertainties and due to the prospects of constructing a gas power project in connection with the Kudu gas project. However, with the cease-fire in Angola and the (partial at least) abandoning of the Kudu project, key stakeholders have expressed renewed interest in the construction of the additional hydro powerstation at Epupa on the Kunene river.

In addition to the Ruacana hydro-power station, Nampower has the 120-mw Windhoek coal fired station and a smaller Paratus station at Walwis Bay kept on stand-by. Combined, Namibia's electricity generation thus amount to approximately 400 mw, including a large number of small diesel generating units throughout the country, mainly on commercial farms.

Consumption of wood fuel in urban and peri-urban areas is about 175,000 tonnes yearly whereas the rural annual consumption is estimated to around 200,000 tonnes (REINNAM 2000). In certain areas this consumption is clearly unsustainable, as the biomass is not replaced at a viable rate, leading to localised deforestation and desertification.

## 2.2 Renewable Energy and Energy Efficiency in Namibia

**Renewable energy** in the form of hydropower constitute a major part of Namibia's energy consumption as stated above, and if the second hydropower station at Epupa is constructed, the vast majority of Namibia's electricity needs will be covered by renewable energy supplies. However, there are local environmental concerns that will have to be addressed before the Epupa project can commence.

Apart from the hydropower station, the use of renewable energy for power production is negligible despite the fact that Namibia is endowed with one of the best solar regimes in the world. This makes the use of solar voltaic systems for schools, clinics, telecommunication, water pumping and home lightning potentially feasible. However, lack of awareness, high investment costs and some maintenance requirements, coupled with the availability of cheap electricity in grid areas, are significant barriers to the increased adoption of solar energy technologies.

Concerning wind power, the relative high wind speeds in the coastal areas, which on an average are between six to eight m/s, indicates a significant potential. However, the utilisation of wind energy is mainly limited to the approximately 30,000 water-pumps on remote farms. The most ambitious wind power plan to date, the proposed wind farm at Luderitz, has not materialised as the authorities have not agreed to let the wind farm connect to the grid due to too high production costs (between three to 13 times more expensive than imported electricity according to GTZ sponsored feasibility study).

Generally, the available financing options and mechanisms seem to have been insufficient or inappropriate thus hindering the widespread use of REEE especially among poorer segments of the society. Thus the Revolving Fund for the promotion of New and Renewable Energy Sources has not been able to gain the expected reach and turnover (see Performance Evaluation, MME 2000). This problem also adversely affects the adaptation of energy efficiency measures.

Concerning **energy efficiency,** the extremely low cost of electricity implies that little incentives and measures are available to stimulate the use of energy efficient appliances and practises in the Namibian domestic and industrial sectors. Furthermore, most energy efficient electrical appliances are relatively expensive, partly due to the recent fall in the value of the Namibian currency. Conservation measures and corresponding awareness programmes are restricted to occasional MME initiated fuel-saving campaigns and initiatives of civil society organisations such as GARUEN and REINNAM.

Some efforts in the mining and fisheries sectors, mainly driven by the SADC Industrial Energy Management Project (SIEMP), have taken place more recently. In particular, large mining operations such as the Rössing uranium mine near Swakopmund, have implemented energy saving procedures and measures. Some of the larger fish-canning factories in Walwis Bay have adopted energy saving measures. Generally however, the level of awareness and willingness to change is underdeveloped, mostly stemming from years of cheap electrical energy supply.

In other Namibian industries, such as in the breweries, meat processing and the leather manufacturing industry, elementary energy efficiency measures are in place. The Namibia Breweries' Windhoek plant for example has been constructed with general energy saving measures in mind, such as those found in the design of the buildings, while some manufacturing processes have been optimised to save energy.

In the building sector, only the most elementary energy efficiency and corresponding design criteria have been put into practise. As more than 75 percent of the architects working in Namibia have been trained in South Africa (with somewhat similar climatic conditions and electricity prices as those found in Namibia), the application of energy efficient building design practises is a concept understood in theory, but seldom applied to the fullest extent in practise. Energy efficient practises are incorporated into the design of building plans if and when requested by a customer. However, as many customers focus more on immediate cost-saving measures, rather than on minimising long-term operating and maintenance costs of buildings, the public demand for the inclusion of energy improving measures is mostly absent.

For public buildings, the Ministry of Works Transport and Communication mostly follows the recommendations of consulting engineers and architects. There are no specific requirements regarding energy efficiency measures, or long-term maintenance and operational cost calculations taking energy efficiency measures into account, which has often resulted in the acceptance of building plans and energy management measures that once again reduce immediate capital costs of the project without taking long-term cumulative operation and maintenance costs into consideration.

For commercial and residential buildings, a similar picture emerges, and once again, energy efficiency measures and designs are mostly used if explicitly requested by the client.

The traditional homesteads found in Namibia's rural areas are often constructed from felled trees (northern Namibia) or roofing materials (central and southern Namibia). Generally, very little, if

any, effort is currently being made to raise the level of awareness of people regarding energy efficient building designs and building measures. As the rural to urban migration pattern in Namibia continues, no substantive programme is in place to ensure that even elementary energy efficiency measures are implemented in the fast growing peri-urban and urban areas. There is clearly a need for public intervention to address this problem.

Wood fuel is still the predominant energy source of rural Namibians. It is used for cooking, lighting and heating, and is seen by many as one of the important pillars of a traditional life style. Although a number of wood efficient and solar cookers have been developed and tested in Namibia, a large-scale dissemination has never taken place up to now. It is believed that the rigorous rural electrification effort currently underway in Namibia will slowly replace wood fuel as the main household energy source in rural Namibia, a process which could take one or more decades. The rapid deforestation of parts of Namibia, and the associated emergence of a market, and market principles, geared at the provision of wood fuel, is expected to be one of the important vehicles to create awareness and opportunities for energy efficient (wood fuel burning and other) appliances in future.

## 2.3 Government Policies and Programmes

Renewable energy and energy efficiency was already featured in the first National Development Plan (NDP1) approved in 1993, as a priority area of the government, partly inspired by the Rio Conference in 1992.

While the NDP1 stated the intentions of the government in the field of REEE issues, the **White Paper on Energy Policy**, issues in 1998, contained slightly more concrete policy objectives and tangible actions that the government committed itself to. Generally the White Paper stipulated the need to increasingly meet developmental energy-related challenges by improving access to renewable energy source. It also recognised the need to establish a better institutional framework and raise awareness and human capacities. More specifically the White Paper made ten explicit government commitments concerning renewable energy and energy efficiency:

1. To ensure that institutional and planning frameworks treat renewable energy on an equal footing with other forms of energy when assessing their financial, economic and social costs and benefits
2. To ensure that education in renewable energy and the rational use of energy is included in the curricula of schools, universities, polytechnics, vocational training centres and other institutions of instruction
3. To develop and implement renewable energy awareness programmes
4. To facilitate adequate financing schemes for renewable energy applications, and to encourage government agencies, investors and users to make decisions based on the life-cycle costs of alternative energy options
5. To promote sound energy planning principles throughout all government ministries

6. To promote the use of economically viable renewable technologies, as a complementary to grid electrification, to improve energy provision to rural areas
7. To ensure that funds made available for rural electrification will be allocated between grid and off-grid energy supply options, on the basis of their relative social and economic costs and benefits
8. To promote the use of photovoltaic pumps and solar stills to supply water of sufficient quality and quantity for human consumption in off-grid areas, where this is appropriate and cost-effective
9. As government believes that solar water heating can make an important contribution to rational use of energy in Namibia, it will analyse the economic savings which can be attained through wider use of solar water heaters and develop appropriate promotion strategies
10. To ensure the optimal mix of energy resources, the Government will evaluate all proposals for power generation according to their expected costs and benefits, and environmental and socio-economic impacts.

However, while the above commitments demonstrate the government's interest in and ownership of the promotion of REEE technologies, progress so far has mostly been limited to analytical work, studies and small-scale awareness campaigns. Part of the problem is that the Energy Department of the MME has limited human capacity to implement the policies. At the same time all central ministries have to contain expenditures as a part of the government's overall drive to contain public expenditures. This has clearly not been conducive to the promotion of REEE.

The recently published Second **National Development Plan** (NDP2, covering 2001-2005) acknowledges that only limited results have materialised since the White Paper. It also states that it may not always be possible to combine environmental concerns with economic development objectives and that trade-offs will have to be made, accentuated by the decision to abandon the Lüderitz wind farm project. The new approach outlined in the NDP2 is centred on the need to outsource non-essential task to organisations and companies outside government. The creation of an co-coordinating body on REEE is explicitly mentioned. Moreover the government will extent the reach of the solar home system scheme and generally promote solar energy more aggressively in partnership with UNDP/GEF. Other priority areas include biomass conservation, prevention of deforestation and charcoal production. Finally the NDP2 commits the government to the promotion and dissemination of energy efficient technologies, training and other incentives on energy efficiency measures in the industrial and household sectors and public awareness campaigns through media advertising and promotional material.

## 2.4 Donor Support

**Danida** has recently agreed to support a project entitled 'Gobabeb Renewable Energy and Energy Efficiency Demonstration Project' with the objective of implementing energy efficiency and energy supply systems based on renewable energy in Gobabeb Training and Research Centre (GTRC). During this process the project intends;

- to make local stakeholders able to design, implement and maintain mini grid systems with energy efficient and renewable energy technologies, and
- monitor and disseminate the results of the project and the possibilities for other Namibian and Southern African Development Community (SADC) end-users to replicate the system.

The project is tentatively scheduled to commence in the last quarter of 2002, lasting two years.

The German Gesellschaft für Technische Zusammenarbeit (**GTZ**) is implementing a German funded 7-year development programme for the GTRC, which is divided into three phases. The programme focuses on the construction of supplementary buildings and the refurbishment of existing buildings. The project will be completed by 2004 or 2005 and incorporates energy efficiency and appropriate building designs. The GTRC is not scheduled for grid electrification within the next 20 years, but is considered a high priority for off-grid electrification. GTZ has implemented an energy audit and load analysis for the GTRC in 2000.

GTZ and MME have implemented a wind-monitoring project at Walwis Bay and Lüderitz to establish a basis for the feasibility of wind power at these locations. The equipment from this project has been dismantled and handed to the Polytechnic of Namibia, who, through its GARUEN (Group for the Advancement of the Rational Use of Energy in Namibia) initiative, will continue monitoring Namibia's wind energy potential.

GTZ has implemented a German funded study on the current status of renewable energy mini–grid systems. This study concludes that renewable energy mini-grids are a feasible solution for the electricity provision to remote settlements (such as GTRC) and that "Pilot projects in carefully selected villages would be an appropriate step in the development of a commercially viable market for renewable rural energy solutions".

A project proposal, entitled "Barrier Removal to the Namibian Renewable Energy Programme", has been prepared (June 2000) for **GEF** funding (UNDP; Windhoek, project coordinator). The proposal, which builds on the SADC FINESSE activities undertaken in 1992, focuses on solar technologies. The project will assist local stakeholders in building local capacities to promote, finance, install and maintain solar applications, help to develop and implement favourable regulatory frameworks, and facilitate the establishment of viable financial mechanisms (micro lending and mortgage additions). The intended outputs include an increase of solar technologies from about 7,500 systems in 2000 to about 42,000 systems by the year of 2016. The project is co-ordinated with Danish assistance to the REEE sector with its focus on strengthening the R3E Bureau, which will have a facilitating and monitoring role in relation to the UNDP/GEF project.

Another UNDP/GEF activity, referred to as Enabling Activity, is conducting green house gas inventories and establishing a mechanism for updating data on greenhouse gas emissions.

**CIDA** has funded a 7-year SADC project on energy efficiency in industry (SIEMP) for 1995 – 2002. The project includes the development of energy auditing tools and training. The Polytechnic of Namibia is participating in the project.

The **Indian Government** funded, with co-funding from MME, two solar village projects, as well as being instrumental in the launch of Namibia´s National Biogas Programme.

Norwegian Assistance for Development (**NORAD**) provided funds for the establishment of the Home Power! project revolving fund and loan scheme, while the GTZ contributed by funding the training of 100 solar technicians.

The German based **Carl Duisberg Gesellschaft** (CDG) is currently conducting training workshops for renewable energy companies and entrepreneurs entitled "Boost your Energy Business". Objectives of the workshops are to provide skills in business and project management, marketing, tendering, compilation of project proposals as well as on technology issues.

## 2.5 Evolution of the Institutional Set-up within the REEE Sector

Besides the Ministry of Mines and Energy the key actors within the REEE sector include higher education institutions (especially Polytechnic of Namibia), Group for the Advancement of Rational Use of Energy in Namibia (GARUEN, an NGO), and the Desert Research Foundation of Namibia (DRFN). In addition several consultancies in the private sector have considerable experience with REEE Issues (e.g. Bicon and EMCON), as has the parastatal Premier Electric.

Of particular importance to this project is the now dissolved Renewable Energy Information Network of Namibia (REINNAM), which was transformed into the R3E Bureau in mid-2002. REINNAM started in 1997 as a non-profit organization dedicated to the promotion of renewable energy and energy efficiency and generally enhance energy awareness in Namibia. One of the main activities of REINNAM was to collect, monitor a disseminate information regarding all developments in Namibia's energy sector. In addition REINNAM has undertaken several studies, hosted fairs and training workshops some of which outsourced from MME while others have been requested by international agencies such as the Carl Duisberg Gesellschaft. The national telecom operation, Telecom Namibia, has also used REINNAM as an initiator and supervisor for an solar modules campaign. These income-generating activities, combined with support from i.a. GTZ, made REINNAM financial sustainable, though in addition to donor support, REINNAM also received free accommodation from the Polytechnic of Namibia.

REINNAM managed to establish a significant documentation centre with a comprehensive library, but – perhaps more importantly – also managed to establish itself as a central interlocutor in the REEE sector with a wide-ranging network both at the national and international level. All assets and the complete portfolio of projects, activities, and studies have been transferred to the R3E Bureau with the full consent of clients and stakeholders. Moreover, the previous manager of REINNAM has also been transferred to the R3E Bureau, thus ensuring the crucial continuity in institutional memory.

The experiences of REINNAM thus indicate that there is a need for a coordinating and facilitating body and that there is a significant potential to initiate income-generating activities.

# 3 PROJECT JUSTIFICATION

## 3.1 Justification of Selected Interventions

The Government of Namibia is committed to the promotion of use of renewable energy in an environmentally and economically sustainable manner and to the promotion of energy efficient solutions in all sectors of the society. This commitment is elaborated in details in the White Paper on Energy, and reflected in the NDP2.

However, the human capacity is limited in the MME, and the Government has a general policy of outsourcing non-core functions. In accordance with this policy it is stated in NDP2 that one of the activities to be implemented is the establishment of a co-ordinating body on renewable energy and energy efficiency. This institution, the R3E Bureau, has been formally established by August 2002. It is still a young and fragile organisation, which needs support to developing its capacity.

Energy conservation in the housing sector and construction of thermally efficient buildings have been identified as areas of concern in the Energy White Paper. To support implementation within this policy area it is necessary to develop new concepts for town planning and building design with focus on improved energy efficiency. In addition the Intervention will take into consideration the environmental and social aspects. National Housing Enterprise (NHE) is a parastatal, responsible for housing schemes and supplier of permanent houses (brick houses) to the lower income groups with incomes between N$ 1,500 and 3,000 per month. A demonstration project conducted in collaboration with among others NHE is envisaged.

During the development of the project it has been discussed whether the energy consumption of buildings in high-income areas, commercial centres and public administration should be included. This could e.g. be via development of general building regulations. According to Namibian legislation and principles of decentralisation such regulation would be in the hands of the local authorities. At this stage, Namibian authorities have expressed no wish for Danish support to this area. Furthermore, the planned UNDP/GEF project on promotion of solar energy will among others has the higher income groups as target groups for solar-based energy solutions.

The White Paper on Energy has a number of statements on promotion of efficient energy technologies in rural areas and improved access to energy services. A nation wide programme on rural electrification is in progress, based on both grid-electrification and decentralised supply. In spite of this it is foreseen that the major energy consumption in rural areas will still depend on utilisation of biomass. Building upon experience gained by the Desert Research Foundation of Namibia, Danida will support development of a community based capacity development scheme on efficient and sustainable energy solutions in rural areas and small urban settlements. Through improved use of natural resources, the scheme will contribute to implementation of Namibia's national strategy within the frame of the UN Convention on Combating Desertification, the Convention on Biological Diversity and the UN Framework Convention on Climate Change.

The industrial and mining sector is the second largest energy consumer in Namibia, but absent in the project. The reasons for this is mainly that a comprehensive 5-year energy efficiency programme in the industrial sector, conducted via SADC, is being completed by 2002. The Namibian government has expressed no need for supplementary support in this field.

The transport sector is by far the largest energy consumer in Namibia, with a share of about 55 percent of the total consumption (of approximately 43,000 terajoules). This high and growing figure is mainly due to the vastness of the country, the growing population and the increased interaction between regions and between rural and urban areas. It is presumed to be outside the reach of the Danida project to influence this development.

***R3E Capacity Development***

The human resource base on renewable energy and energy efficiency is relatively limited and spread over a number of professional fields and institutionally fragmented. The Government is committed to promote increased use of energy from renewable sources and to reduce inefficient use of energy. The White Paper on Energy outlines the key areas and main policies in this respect.

Resources within Government are, however, particularly limited and the Government has a general policy of outsourcing non-core functions from the public to the private sector. The newly established R3E Bureau is a clear option for the Government in this respect as far as renewable energy and energy efficiency is concerned. It has also been clearly stated by MME that the Government intends to use R3E in such an outsourcing capacity and has in the State Budget allocated a core funding of N$ one million to R3E for that purpose.

The Energy Division of the Ministry of Mines and Energy includes a sub-division on renewable energy and energy efficiency, headed by a Chief Energy Researcher and with one additional staff. This would appear a rather limited human resource base for the MMe to perform its functions, even if non-core functions are outsourced. The MME does, however, to a large extent draw upon expertise available in public or semi-public institutions outside the MME, which are part of the R3E stakeholder network. This expertise includes the present day-to-day manager of the R3E Bureau and members of the Executive Committee as well as professional staff of public and semipublic institutions. On this basis MME has explicitly expressed the opinion that there is no need to strengthen the capacity in the Ministry itself. Thus, MME considers strengthening of the R3E Bureau as the main need in the present situation. R3E is already functioning as an outsourcing institution for MME, cf. its taking over of the REINNAM activities.

Though the R3E Bureau is formally established with a Constitution signed by its present members, it is a very recent establishment and the institution is still in a building up phase. Membership is very open and the Governing Authorities, i.e. the Committee and the Executive Committee, are elected by the General Meeting of all members. It is thus an “open” institution and it has no staff, apart from the day-to-day manager, who at the time of the appraisal was employed for an interim period of four months only. During this time the manager’s prime responsibility would be to firmly establish an operational structure for R3E and to recruit additional staff. His position at R3E will be re-evaluated after the 4-month period.

***Energy Efficiency in Low Cost Housing***

In spite of Government of Namibia's effort on promoting rural development, it is inevitable that economic development and population growth will lead to increased urbanisation. The Government and City Councils strive therefore to ensure a well-guided development of new urban areas, both regarding squatter areas and areas with permanent structures.

The investment costs needed for construction of new housing schemes are very high and tends to grow, making it imperative to develop new and innovative solutions to keep costs down without compromising on fundamental construction principles and standards. But due to limited budgets, limited staff and strict (and to an extent outdated) regulations, efforts have also been limited on developing new planning concepts and building designs in the low cost housing schemes in Namibia.

There is a high technical capacity among Namibian architects and growing understanding of the above issues, but budget restrictions and regulations on urban planning have given little room for new and innovative solutions. There is therefore a perceived need for demonstration projects where new solutions may be developed and tested in real life. There is also a clear understanding that end-users should have a better possibility of influencing the design of their coming living quarters, bringing their needs and aspirations into the process at an early stage, and participating in decisions and solutions on an informed basis. It is foreseen that close collaboration between planners, architects, engineers and end-users will be supportive to the development of new concepts and innovative solutions.

Present regulations on urban planning regarding eg. plot size and minimum distance between buildings and property lines result in very high costs for plots and infrastructure as well as rather rigid urban designs. Smaller plots, maybe combined with common areas, semi-detached or non-detached houses, will reduce the costs of land and infrastructure, leaving more economic space for improvements of the thermal qualities of the buildings. Conscious urban planning may increase living qualities at no-cost or low-cost. Use of construction principles and building materials in an optimal way, with focus on the thermal and environmental qualities of the buildings, will lead to improved indoor climate, at the lowest possible extra costs.

It would therefore be appropriate to conduct a demonstration project, where innovative urban planning ideas and principles as well as innovative building design concepts can be developed and implemented, with the view of demonstrating that resource conscious urban planning with high living qualities and energy conscious building design can be implemented in a cost efficient manner. With the aim of securing replicability in other low income urban development schemes in the future, the economic figures per house unit should be similar to those in traditional housing schemes for the same income groups, with the exception of additional planning costs. Focus of the demonstration project should be on improved energy efficiency, but also high environmental and social concerns should be integral parts of the project.

The demonstration project should be conducted in a process involving end-users in decision making on a well-informed basis with the view of meeting their needs to the extent possible. The major part of the houses should be for the lower income groups eligible for houses under the NHE housing

schemes, but a certain proportion should also be for higher income groups eligible for these housing schemes. With the aim of securing a lively environment, the detailed planning should also consider possible incorporation of buildings for public services, shops and small non-polluting economic activities, as well as green areas, playing grounds etc.

The project should furthermore be conducted in a way allowing for capacity building of the directly involved town planners, building designers and contractors. Systematic documentation of the process, of decisions and choices made and of experience gained from living in the new urban scheme should allow for the further dialogue within the Namibian resource base, and with interested parties in the region.

A number of local projects regarding town planning, building design and use of materials have been conducted in South Africa, from which it may be possible to draw experience, even though cultural and climatic conditions are somewhat different in Nambia. The inter-regional dialogue will promote innovative solutions both in the planning phase, and when lessons learnt are to be discussed and widely disseminated.

National Housing Enterprise and City of Windhoek are both members of the R3E network.

***DRFN - REEECAP***

Desert Research Foundation of Namibia, DRFN, is a large and well-established NGO. The mission statement of the organisation reads, "The DRFN is dedicated to increasing understanding and furthering awareness and skills to improve management of arid environments for sustainable development." DRFN strives to take a holistic approach to fulfil its mission by operating a desert research centre of international reputation at Gobabeb in the Namibian desert and by working on a project basis with a wide range of ministries, other NGOs, educational institutions and at grass root level with community based organisations like Village Development Committees (VDC) and Constituency Development Committees (CDC).

DRFN is an advocate for sustainable development, operating within the triangle of the three important conventions on combating desertification (UNCCD), on biological diversity (CBD) and on climate change (UNFCCC).

DRFN has focused on environmentally sustainable agricultural practises, but is realising the need for increased focus on energy issues. It realises that in spite of large national tree planting projects, it is inevitable that increased deforestation will lead to land degradation and loss of biodiversity etc. The deforestation has many reasons of which some are related to agricultural practices, while others are unsustainable building practices and unsustainable use of firewood.

Against this background DRFN has increased its focus on energy issues and wants to use the opportunity of increasing its knowledge on sustainable energy options and practises and on energy planning. By this, DRFN will be able to advocate for sustainable energy solutions on an informed bases, and it will incorporate energy issues into its other activities and projects, notably the FIRM project. The gained experiences will further allow DFRN to disseminate knowledge on sustainable use of energy and energy planning to other NGO's and its close cooperation with the GTRC

(Gobabeb Training and Research Centre) will allow the field testing of various energy technologies.

DRFN is a member of the R3E network.

## 3.2 Expected End-of-Project Situation

***R3E Capacity Development***

There is clearly a need for an institution like the R3E Bureau and for a further organisational development of this Bureau. The Bureau could become the focal point or "centre of excellence" for developmental efforts for increased use of energy from renewable sources and for energy efficiency. In this way, the Bureau would also become an institution through which the Government could outsource non-care activities in this area in an effective and efficient way.

The tasks to be performed by R3E on behalf of MME will be specified in MoUs, according to actual needs. At this stage it is envisaged that R3E will establish an overview of tasks needed for implementation of the relevant outstanding parts of the White Paper on Energy. On behalf of MME, R3E will furthermore monitor projects, which are supported by the government. R3E will not be an implementing body of such projects, but will support project development by assisting the implementing institutions in preparing Terms of Reference of new projects, conducting tenders, facilitating contacts etc. Regarding the present project, R3E will be the link between the project steering committee and the implementing organisations, NHE/City of Windhoek and DRFN. For details, see section 5 Implementation.

In addition to its tasks for Government, R3E will be a driving force in developing the REEE sector in general through information activities, networking etc.

It is first of all necessary to clarify and secure the legal basis for the operations of R3E. It is understood that the Namibian Company Law provides the basis for this. It is thus expected that the R3E Bureau will be established as a "Section 21" company under this law. This will entail an official registration as a "not-for-profit", private organisation, legally permitted to do business, i.e. buy products and services and provide e.g. consulting services to public or private customers on a commercial basis. The requirement under the law is, however, that profits cannot be paid out to the members but shall be used for purposes laid down in the constitution of the company. Members shall consist of minimum seven and maximum ten persons, being members in their personal capacities. A number of further requirements will also govern the organisational set-up, operations, management, etc.

The requirements will include keeping of accounts and auditing procedures, Governing Authorities/decision-making procedures and management system. It is considered that the R3E will need to use outside assistance in setting this up, including rather high profile consulting services in the areas of management, business operations and accounting/auditing systems and procedures.

Furthermore, the Bureau will need additional staff as well as a full-time manager. The present day-to-day manager, appointed for a 4-month interim period, is clearly the driving force of the

institution at present and he should be appointed R3E Manager on a normal contractual basis for this type of position in Namibia and for at least a 2-year period. In addition there should be a person who is (or can be developed to become) able to competently assist and substitute the R3E Manager. Also an Administrative Assistant would be required as a minimum. The extent to which accounting staff might also be required in addition to or included in the Administrative Assistant position will need to be clarified. The Bureau should, however, be able to perform such accounting and auditing functions in relation to implementation of the present project as required by the Danida rules and regulations concerning project accounting and auditing.

An office with computer and standard office software and including access to facilities such as photocopying, meeting rooms, etc. is presently available free of charge to the R3E Bureau and the present day-to-day manager at the Polytechnic of Namibia. More office space and facilities will be needed to accommodate the expanded organisation. This will for the immediate future be made available also by the Polytechnic of Namibia and free of charge. However, a permanent office establishment will need to be secured.

At present, the R3E Bureau does not own assets and has only limited income from activities taken over from the dissolved REINNAM. A tentative 3-year budget forecast, made by the day-to-day manager, does indicate, however, that the Bureau is a financially viable entity, provided the Government core funding is forthcoming. Under this assumption and assuming continued services of the types and levels provided before by REINNAM, the R3E Bureau will be financially viable with an expanded staff, as indicated above, with paid for office facilities for this staff and with other operating expenses required for that level of activity. The institution is thus financially viable without any donor support.

Administration of the present project will add substantially to the activities to be undertaken by the Bureau. These additional activities can, however, be absorbed by the assumed expanded staff, whose salaries are covered by the core funding from Government and by the consulting services from outside, which are financed by project funds. Furthermore, the project provides a vehicle as well as IT-hardware and software to R3E free of charge, needed for a number of the activities to be undertaken by R3E. These include project and other services outsourced from MME activities as well as activities related to R3E's general functions within the sector of which some will provide a basis for fee earning services. The R3E Bureau should thus be financially more viable with the project than without the project. This way, the project will contribute to making R3E a financially sustainable institution both for outsourcing of non-core activities from MME and for business activities with the private sector.

***Energy Efficiency in Low Cost Housing***

By the end of the demonstration project, it is envisaged that the directly involved organisations, notably City of Windhoek and National Housing Enterprise, will have gained valuable experience for future housing schemes. The experience will both be on innovative technical solutions and urban planning, allowing for energy efficient and resource conscious housing developments with high living qualities.

The contacts made to similar institutions in neighbouring countries during planning and implementation of the demonstration project, will allow for future exchange of ideas and experiences.

In Namibia, city councils have a high degree of autonomy on local planning issues and on approval of building design. It is envisaged that the experience gained via the demonstration project will influence the further development of local regulations. Being a leading city council, it is also envisaged that experience gained by City of Windhoek will spread to new urban development schemes in other cities of the country.
It is further foreseen that the Ministry of Regional and Local Government and Housing (MRLGH) will use the experience gained for its further development of regulations regarding town planning and approval procedures and requirements, with the view of allowing a smooth and efficient administration, supporting development of urban areas with high living and environmental qualities.

Finally it is foreseen that architects, engineers, developers and contractors will gain valuable experience on both technical issues like urban planning and energy and resource conscious building design and planning issues, and on the value of processes allowing for involvement of end-users in planning and decision-making.

The coming Habitat Research and Development Centre and the R3E network will be instrumental for disseminating information on gained experience and results of the demonstration project, both internally in Namibia and in the region.

***DRFN - REEECAP***
By the end of the project DRFN will have a built-in capacity on energy planning and sustainable energy issues, allowing the organisation to engage in a qualified dialogue with other important players in the field in Namibia, notably MME, the power sector, and the fuel suppliers.

DRFN will have capacitated its field workers on sustainable energy practises and options (i.e. efficient use of energy, introduction of new technologies for renewable energy and increased understanding and consciousness on energy conservation), especially the Namibia's Programme to Combat Desertification (NAPCOD) facilitators working with CDC and VDC on integrated development planning, thereby supporting the CDC/VDC in their effort of influencing the future economic development of their local communities.

The CDC/VDC will have received support from DRFN's energy resource person to analyse options for improved energy supply, allowing for economic development at community level in an environmentally acceptable manner.

DRFN has in the last part of the project period, based on experience gained in the pilot areas, expanded its activities into new geographical areas and furthermore involved other organisations (NGOs/CBOs) in activities aiming at promoting sustainable energy practises and solutions.

# 4 LOGICAL FRAMEWORK ANALYSIS

## 4.1 Objectives

***Development Objective***

Namibia has a substantial and still untapped potential of both renewable energy resources, especially solar energy for photo-voltaic power generation and solar water heating, wind for power generation and water pumping and biomass in certain areas, as well as for improving energy efficiency and energy conservation. At the same time unsustainable overexploitation of biomass fuels (especially wood) is increasingly occurring in various locations. There are several barriers hindering the adaptation and dissemination of REEE technologies in Namibia, including the lack of information and awareness. The development objective thus becomes:

- *Increased use of renewable energy and energy efficiency measures to promote the environmentally sustainable socio-economic development of Namibia.*

At the policy level, support to capacity development in the REEE sector and the creation of an institutional framework for REEE issues is explicitly mentioned in key policy documents of the Government of Namibia (e.g. the White Paper on energy and the Second National Development Plan). Thus the sector policy framework is already formulated and compatible with the main policy objective of Danish bilateral development assistance, including the sustainable reduction of poverty. The Government of Namibia has shown a strong commitment to effective poverty reduction also in the energy sector e.g. by aggressively promoting a rural electrification programme. This programme is improving access to electricity in remote areas and it is also improving the service-level of key public services such as schools and health facilities. However, it is still only a minority of the rural population who has access to electricity and for the foreseeable future most of these will not be able to be connected to the grid, as the costs are prohibitively high. This is due to the scattered nature of the population in rural areas and their relative low energy consumption. This accentuates the need to promote REEE technologies and energy planning with focus on improved supply in an environmentally acceptable manner.

***Immediate objective***

While the sectoral policy frame is generally conducive to the promotion of REEE technologies, there is very little capacity to implement the policy objectives as stated in the key policy documents. In particular, the Ministry of Mines and Energy (MME) has limited capacity to fulfil the mandate of the White Paper on REEE and is simultaneously facing pressures to contain spending and outsource non-core tasks to the degree feasible. The creation of a separate body to undertake key REEE policy objectives outsourced from the MME is explicitly mentioned in the sectoral policy framework. However, in order to efficiently promote the key objectives of the government's REEE policies, other stakeholders will also have to be mobilised, including key players at the community level as well as relevant private sector organisations. The immediate objective has been formulated as follows:

- *To increase the capacity of the Namibian resource base in selected areas to enable it to contribute to the implementation of the 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).*

The project will support three strategic Interventions; 1) enhancing the R3E Bureau to fulfil its role and being capable of handling outsourced tasks from MME, 2) demonstrating the potential for energy efficiency in housing construction and simultaneously developing the capacity of key private and public stakeholders within the urban planning and construction sector, 3) enhancing the capacity of local, predominantly rural, communities to include REEE issues in daily practices and in energy planning. These three Project Interventions will be further detailed below.

All three Project Interventions are within the policy framework of the White Paper on Energy Policy and the Second National Development Plan.

The three Project Interventions each have one corresponding output, which are dealt with separately. However, all of them contribute directly to the immediate objective and they are also all mutually supportive. In addition, the R3E Bureau will play a pivotal role in gathering information on implementation, analysing progress and disseminating lessons learnt to all relevant parties, thus ensuring that innovative approaches with a high replicability potential will be mainstreamed into government policy and private sector practices to the degree feasible. Moreover the R3E Bureau will be responsible for financial transfers to the two other Project Interventions, as stipulated in the implementation section (see section 5). Each Project Intervention has one output. The R3E Bureau will gain valuable on-the-job practical training experiences by facilitating and supporting the two other Project Interventions. At the same time these two other Project Interventions will contribute to stakeholder capacity development (town planners, architects, policymakers) and towards the upliftment of urban and rural poor.

Below is a presentation of each Project Intervention. Please note that the benchmarks, activities, inputs, budgets and assumptions at output level are all presented in relation to the associated Intervention in order to maintain the coherence and logic of each Intervention, thus providing a better read. For a presentation of the sequencing of these benchmarks and hence also for sequencing of the activities necessary to reach these benchmarks, please refer to Annex 3.

### 4.2 Intervention 1: R3E Bureau Capacity Development

There is a clear need for an organisation capable of data and information gathering, co-ordination and dissemination within the REEE sector. The purpose of the first Project Intervention is to strengthen the R3E Bureau, making it an organisation competent and capable of handling tasks and activities outsourced from MME, related to the implementation of the REEE aspects of the White Paper on energy.

It is envisaged that the R3E Bureau will provide crucial impetus in the promotion of REEE and support the two other Project Interventions, while the Bureau will not become an implementing organisation in itself.

- ***Output 1:*** *R3E Bureau will be fully operational, capable of providing data and information gathering and dissemination, government's REEE policies, including policy analyses and proposals, and initiation of new relevant activities. In addition, the R3E Bureau will play a supportive and facilitating role during the planning and implementation of the two other Project Interventions.*

Capacity of the R3E Bureau and its stakeholder network should be built up to enable the Bureau to play a pivotal role in promoting energy efficiency and use of renewable energy. MME will, of course, continue to have the overall responsibility for developing and implementing this part of energy sector strategies. Core functions, maintained in the Ministry, will include policy formulations as well as overall monitoring of implementation. But MME will need access to data, information and policy analytical work and the capacity of R3E will under the project be strengthened to undertake such functions on behalf of MME. R3E's capacity for undertaking business activities with the commercial and private sector will also be strengthened, contributing to making R3E a financially sustainable entity also after the project terminates.

In implementing sub-sector policies, MME will also rely to a large extent on R3E to administer and facilitate cooperation with and among other institutions, public, semi-public or private, which have to be involved in the policy implementation. The project will support that such cooperations are established, through the activities of R3E, for implementation of policies in the two major areas mentioned above.

The R3E Bureau is already well underway in achieving this output, but support from both government and external development agencies will be crucial in securing that the Bureau obtains the capacity needed for achieving its objectives and for playing an instrumental role in REEE promotion. The government has agreed to finance a substantial part of the core funding needed, while commercial fee-earning services provided by the Bureau are expected to cover the remaining. Danida inputs will cover technical assistance and start up costs such as a vehicle and IT equipment as well as payment (fees) for services provided by R3E to the two other Project Interventions.

**Benchmarks**:
Given the R3E Bureau's crucial role for the implementation of all three Project Interventions, it is important to ensure that the Bureau is operational and legally recognised within a relatively short time span. This is also reflected in the benchmarks presented below. For detailed sequencing of all benchmarks please refer to Annex 3.

- Registration of the R3E Bureau as a legal entity.

In order to enable the R3E Bureau to enter contracts with other entities, handle financial flows on behalf of MME and Danida, and comply with generally accepted accounting principles, the R3E

Bureau should be registered as a legal entity as soon as feasible. This should also lead to a complete clarification of the legal ownership of the Bureau and its assets and help clarify governance structures of the Bureau. This will be essential for enabling the Bureau to fulfil its envisaged role. Section 21 of the Company Law of Namibia appears to be the most appropriate for the R3E Bureau.

- Project implementation plan and detailed budget prepared.

Simultaneously to the registration process, the R3E will also prepare a project implementation plan (PIP), which will include a detailed description of the institutional structures and division of organisational responsibilities, especially in relation to the two other Project Interventions. In collaboration with stakeholders from both the R3E Bureau and the two additional Project Interventions, a detailed budget will be elaborated. While it is the responsibility of the R3E Bureau to draft the PIP and accompanying budgets, it will cover all three Interventions and hence require close cross-institutional co-operation. As the progress of the other Interventions will partly depend on the finalisation of the PIP, it is of outmost importance that it is completed in a timely fashion.

- An accounting system established.

The R3E will need to comply with both the accounting regulation stipulated under Section 21 of the Company Law, as well as being able to comply with the accountability and transparency requirements of Danida and commercial clients. Again this will constitute a priority Intervention in the inception phase of the project.

- Staff of the R3E Bureau expanded to include a Deputy Manager and an Administrative Assistant.

The success of the R3E Bureau depends to some extent on the ability to attract and retain highly motivated and capable staff. However, partly in order to mitigate the adverse impact of staff turnover, it is proposed to complement the current human resource at the R3E Bureau by employing a Deputy Manager and an Administrative Assistant. This will ensure a certain degree of continuity, should staff change become necessary. In addition, the workload of the R3E Bureau is expected to increase significantly as more tasks are being outsourced from MME and the core functions of R3E vis-à-vis the sector are being developed.

- Operating policies and principles of for the organisation established (guidelines, manuals).

As the capacity of the R3E Bureau is being developed and as experiences are being gathered the Bureau will establish its operating policies and principles which, in the form of guidelines, manuals and procedures, will help to institutionalise sound management practices and ensure continuity and reliability, thus mitigating the disruptive effects in the event of staff changes. In addition, by making policies and principles explicit, transparency and accountability will be enhanced towards both financing institutions and commercial partners. An example of such principles is the already drafted Memorandum of Understanding with MME.

- An overview established of R3E Bureau activities in relation to the implementation of the White Paper on energy.

The R3E Bureau has been created with a view to promote REEE technologies, in particular those described in the White Paper. The R3E Bureau will support and monitor the detailed planning and implementation of the two other project areas, which are in line with the main thrust of the White Paper. However, it is important that the R3E Bureau identifies additional areas of intervention and hence establishes a portfolio of activities supportive to the implementation of the White Paper. In addition, the R3E Bureau will undertake policy analyses, mainly based on experience gained through these implementation activities, thus providing crucial feedback to MME and other key policy-makers. However, it is essential that the portfolio does not overstretch the human resource capacity of the Bureau, and that it is broadly consistent with the core competencies of the Bureau. Consequently, the Bureau is not expected to directly implement large-scale projects itself, but rather play a facilitating role, providing support, information and co-ordination, vis-à-vis the Government as well as its stakeholders network.

**Activity Outline for R3E Capacity Development Intervention**

Given the pivotal role of the R3E Bureau, it is important to ensure its full operational status as soon as possible. Fortunately the Bureau is already established and an interim manager is appointed. Government of Namibia has agreed to provide core funding throughout the project period and beyond. However a number of activities, eligible for Danish assistance, are required to achieve the related Intervention output. This includes:

- Establishment of administrative procedure necessary for effective project implementation, including account and auditing systems.
- Documentation and the formulation of guidelines, policies and principles, including policies on pricing, contractual procedures, fees etc.
- Setting up of a stakeholder, product, resource materials, projects and energy statistics information database system.
- The formulation and drafting of an Action Plan (and related budget) for the implementation of selected policies of the White Paper on Energy Policies.
- Policy analyses based on lessons learned and experience gained from implementation activities of the White Paper on Energy REEE policies

In addition to the above activities, R3E will during the project period be responsible for implementation of the project as a whole (cf. Chapter 5) implying activities concerning administration, monitoring, reporting and implementation facilitation related to Interventions 2 and 3, further described below. These activities shall be undertaken in cooperation with the institutions concerned and will include:

- preparing the Inception Report concerning these two Interventions

- setting up quarterly work plans and related detailed quarterly budgets for the approval of the Project Steering Committee and quarterly project progress reports.

After these externally supported activities have been undertaken, the R3E Bureau's main activities in relation to the project will be monitoring, data collection and information dissemination. Analytical work related to policy issues and awareness raising will also be important activities of the outsourced functions on behalf of MME.

In performing its core policy functions, MME needs access to data and information concerning developments in the sub-sector and it needs to be able to draw upon analytic work based upon relevant and reliable data. Such work includes policy analyses related to specific policy issues and policy proposals. Policy formulations and proposals to Government are core functions of MME, but basic data collection, data management and data analyses and related policy analyses are intended by Government to be key functions of the R3E Bureau. The core funding provided by Government to the Bureau is meant as a general funding to cover the basic resources needed for R3E to perform these functions as specified in a general Memorandum of Understanding. Specific activities are also separately outsourced under a separate Memorandum of Agreement, which will include description of the purpose, the responsibilities of the two parties and the financial arrangements for the specific assignment.

R3E will, however, also have business activities with the commercial, semi-public and private sector. Such activities are presently the activities formerly undertaken by REINNAM, but it is envisaged that more business activities will be taken up in the future on a purely commercial basis.

With the project including 2 Interventions, which imply heavy implementation involvement of a number of institutions, the project contributes to strengthening operations and procedures of R3E for its specific role in project implementation. As R3E will be the administrator of all three Interventions in the project, R3E will have to perform a number of functions within its overall role, but specifically related to two actual implementation activities. These functions will include quarterly activity planning, detailed budgeting and activities and output monitoring. Also, data and information collection and dissemination functions will be tried out on these two specific Interventions.

**Inputs for R3E Capacity Development**

A major part of the inputs for this Intervention is technical assistance to the R3E Bureau, to assist the Bureau develop the various areas of the organisation and operations. Part of this assistance will be international consultancies in specialised fields such as accounting and auditing system, business management and database and information systems. Part of the expertise required in these and in other fields of organisational developments is available in Namibia or in the region.

All technical assistance under the project is to be provided in the form of short-term consultancies. There is no need for long-term technical assistance, as the R3E Bureau, as strengthened through the project, is fully capable of administering the project, given the staff assumed and the access to short-term expertise from outside. The short-term assistance, which will be made available to R3E

under the project includes assistance for general professional back-up on implementation and project monitoring.

Computer hardware and software and a project vehicle constitute important investment costs, needed for the R3E Bureau to operate as a business and for setting up its network, data bases and information systems, including a product information data base and information exchange system.

Other costs include a study tour for the R3E Manager to Denmark (for studying networking systems), international communication and miscellaneous costs.

**Budget for R3E Capacity Development Intervention**

| Budget Item | DKK |
|---|---|
| a) National consultancies | 1,080,000 |
| b) International short-term consultancies for accounting, auditing and business management | 960,000 |
| c) International Technical Assistance for back-up and monitoring | 650,000 |
| Hardware (computers, printer, server, etc.) | 175,000 |
| Software (for databases, information systems, accounting, etc.) | 265,000 |
| Study Tour, International Communication | 115,000 |
| Car, including insurance | 240,000 |
| Miscellaneous – 10 percent | 348,500 |
| | |
| **Total** | **3,833,500** |

**Assumptions relating to R3E Capacity Development**

For the project to lead to a substantially strengthened R3E Bureau it is essential that the Bureau, as it exists at present, has both the ability and the willingness to engage in such further development. This in particular implies the following assumptions:

- By the start of the project R3E still exists in its present form, i.e. under the Constitution of July 2002 and with the present actual day-to-day manager.
- R3E can continue its present functions financially viably with its present business market (e.g. organising fairs, acting as consultants) and the core funding of N$ one million per year.
- The core funding of N$ one million per year will continue unchanged for at least the 3-year period of the project.
- No changes will take place in the Constitution of July 2002 and in the present day-to-day management, which will constrain the R3E in performing its functions as envisaged in the Project Document.
- The present day-to-day manager has formally been appointed as R3E Manager for minimum a 2-year period.
- R3E will be legally registered as an entity under Section 21 of the Company Law.

Under these assumptions a good basis for developing the R3E as envisaged in this Project Document exists. There is little doubt that there is willingness as well as ability in the Government (MME) and in the present management of R3E to ensure that these assumptions will be fulfilled once the formal commitments have been provided (cf. pre-conditions below).

## 4.3 Intervention 2: Energy Efficiency in Low Cost Housing

Energy efficiency measures are largely absent in housing design and urban planning, despite regional experiences indicating that there is a substantial potential for implementing such concepts cost-efficiently. Moreover, housing construction tends to be without the involvement of the end-users, especially concerning low-cost housing. The Project Intervention contains initiation of a demonstration project with the aim of raising awareness of the potential of energy efficiency and participatory urban planning and housing construction, and providing amble information on the economics and financial options, thus enhancing prospects of replicability and mainstreaming. Key stakeholders will include town planners and other local authorities, architects, contractors and future residents. Lessons learnt from regional and/or international experiences will be fully utilised.

The second output thus becomes:

- ***Output 2****: Energy efficient housing, primarily for low income groups, has been constructed, demonstrating the possibilities of innovative and participatory urban planning and housing design in a cost-efficient manner*

With the aim of securing replicability in future low income housing schemes, the costs per house unit will be similar to those in traditional housing schemes for the same income groups, with the exception of additional planning costs. However, while the major part of the constructed houses will be designed for the lower income groups among those eligible to the NHE housing schemes, a minor proportion will be allocated to higher income groups, though still eligible to NHE housing schemes, in order to give room for a varied social life and broaden the replicability of the demonstration project.

R3E will support the project design process and monitor the project on behalf of MME. R3E will furthermore be responsible for dissemination of information on the demonstration project, both regarding the planning process, the choices made, and the achievements obtained, in collaboration with the project partners and consultants.

**Benchmarks**
Given the relatively short time-frame of three year (presumably starting early 2003) and the potential regulatory and practical obstacles that will have to be dealt with, it is not envisaged that all houses will be fully completed and inhabited within the project period. Nevertheless, adherence to the following benchmarks should ensure that the output will be substantially – if not fully - achieved by the end of the project:

- City of Windhoek has identified a suitable plot for the new housing scheme.

City of Windhoek will be a key stakeholder in the process and one of the first tasks will be to identify a plot capable of accommodating between 100 to 200 houses built of bricks. Site selection criteria will obviously include potential for optimal use of thermal efficiency and other energy efficiency considerations. City of Windhoek will, in collaboration with relevant organisations,

initiate the process by which all necessary approvals, permissions and authorisations needed for smooth implementation and conformity with relevant legislation and regulations.

- NHE has established and chairs a Task Force/Steering Committee for the demonstration project.

The Task Force will be the pivotal organisation responsible for ensuring that implementation is progressing smoothly, especially concerning the joint development of the project concept, launching of an idea competition for selecting the team of external consultants and subsequent guidance and evaluation of the planning process. Subsequently, the Task Force will be responsible for overall construction supervision with NHE undertaking day-to-day supervision. Other members will include, but not necessarily be limited to, Ministry of Regional and Local Government and Housing and City of Windhoek. See the Section 5: Implementation for further details.

- A group of consultants selected by the Task Force, based on an idea competition.

The Task Force will launch an idea competition with the aim of identifying the best-qualified team of consultants, which will subsequently assume responsibility for the planning process. It will be of outmost importance that the Terms of Reference (ToR) for the competition is of high quality, detailing the distribution of tasks, input, budget and sequencing of processes. The ToR should also reflect lessons learnt regionally from similar schemes. It is consequently proposed that the Task Force, together with a representative from the R3E Bureau, will undertake a study tour to relevant housing schemes in South Africa. In addition the Task Force should consider conducting a workshop prior to the launching of the idea competition, thus further informing key stakeholders about the objectives and intentions of the demonstration project and allowing interaction. This will also help in avoiding misunderstandings and misinterpretations of the ToR. The first review mission is planned to coincide with the selection of the consultants, i.e. after the idea competition, but before contractual arrangements are made .

- Contracts signed with consultants.

The Task Force will enter into a contractual agreement with the selected group of consultants, ensuring that a common understanding of key concepts is developed and that all contractual details adhere to accounting and transparency requirements stipulated by Namibian law and Danida requirements.

- Future house-owners/residents identified and a user group established.

The emphasis on participatory planning and design will require that the future residents are actively involved in the planning process and furnished with information, which will enable them to make well-informed decisions. A user group of future residents will therefore be established by NHE at an early stage of the project. Through participatory processes, the user group will collaborate with the group of consultants and the Task Force on developing new concepts for town planning and building design, with the aim of meeting the users' needs and expectations to the highest extent possible within the given economic constraints. When establishing the user group, it is important to

inform about the scope and limitation of participation in order not to the raise expectations beyond what is feasible and create awareness of the obligations resulting from participating in a demonstration project. NHE will assume main responsibility for identification of the end-users and, in collaboration with the team of consultants, for the information process.

- Final proposal for the demonstration project has been presented by the selected group of consultants.

The consultants will prepare detailed proposals for the urban plan as well as for different housing designs. The key stakeholders, in particular the group of end-users, City of Windhoek, MRLGH and NHE will be involved in the planning process, granting them the opportunity to participate in the development and evaluation of ideas and of voicing their concerns and interests before the final proposal is presented. As part of the capacity building process, decisions made on technical and planning issues during the planning process will be fully documented. As the proposal will form the basis for implementation of the demonstration project, the team of consultants will perform technical back up functions throughout the construction period, explaining and further operationalising the proposal as needed.

- Necessary approvals and permission are in place and infrastructure completed.

Especially City of Windhoek and MRLGH will have to facilitate this aspect of the demonstration project development, as failure to secure necessary permissions, approvals and authorisations could lead to substantial delays in project implementation. Support from these organisations will be particularly pertinent where deviations, dispensations or exemptions from current regulation are needed. Moreover, City of Windhoek will have to ensure that basic infrastructure necessary for the further housing construction is in place in due time. The infrastructure supplied will be delivered according to standard procedures.

- First batch of buildings completed.

NHE will have the main responsibility for overseeing the construction of the buildings with possible back up from the group of consultants. NHE will also be responsible for quality assurance of the completed buildings, possibly in cooperation with the consultants and the future residents.

- First batch of houses in use.

It will be important to maintain the dialogue with the residents once the houses are completed, thus obtaining knowledge on lessons learnt from the end beneficiaries. The R3E bureau will also become involved in distilling the key lessons learnt.

- Information seminar conducted.

Lessons learnt from the planning process, and from technical choices and decisions during development of the demonstration project, as well as the first lessons learnt from living in the new

urban area will be collected and presented to the interested public. R3E will be responsible for dissemination of the information using a fan of suitable media, focusing on different target groups, including city councils, town planners, building designers, contractors and housing groups. R3E will organise a seminar for stakeholders and other interested parties for discussion of the process, the reason for chosen solutions and the achievements of the project.

**Activity outline for Energy Efficiency in Low-cost Housing**
Not all activities can be fully foreseen at this stage, making it very important that the Task Force is established expediently. The Task Force will conduct a study tour to South Africa visiting relevant sites and housing schemes. Subsequently one of the initial activities of the Task Force will be to draft Terms of Reference of the demonstration Intervention detailing the following:

- The tasks for the team of consultants
- The input from City of Windhoek, NHE and other relevant partners
- The budget
- A process action plan, detailing subsequent action and responsibilities

*Assisted by the team of consultants the Task Force will furthermore undertake the following activities:*

- Document lessons learnt
- Describe options and reasons for chosen solutions on town planning
- Elaborate on energy efficiency aspects of building design and explaining the reasons for chosen solutions
- Detail and document the environmental aspects of the demonstration scheme
- Explicitly assess the social implication of the demonstration scheme.

NHE will be the main organisation responsible for construction activities and also identify end-users.

The R3E, in collaboration with the Task Force and the consultants, will disseminate information and organise the final seminar.

**Inputs for Energy Efficiency in Low-cost housing**
For this Intervention, the largest input is also technical assistance, primarily for financing the work of the Consultant Team. This team, envisaged as a multidisciplinary team, is to design the project and provide professional back-up to the Task Force as required during implementation.

Other costs, proposed to be financed under the project, include a study tour to South Africa for undertaking an idea competition for selection of the Consultant Team, and for workshops, material and printing etc. in connection with dissemination of lessons learnt.

All the above are costs, which are additional in such a housing scheme, because the scheme is a demonstration scheme. The normal costs are to be covered by the respective organisations, which have parts of the responsibility for implementing this Intervention. Activities of these organisations under the project are normal activities of these organisations, apart for the demonstration aspect of it, and they are therefore to provide their inputs with their own financing. This is particularly important for securing replicability.

**Budget for Intervention 2: Energy Efficiency in Low-cost Housing**

| **Budget Item** | **DKK** |
|---|---|
| Study tour to South Africa for up to seven persons in five days | 70,000 |
| External costs related to preparation of an idea competition, incl. a seminar/workshop | 50,000 |
| National consultants (33 person-months of DKK 60,000/Month) | 1,980,000 |
| Specific studies/analyses of technical or social issues | 50,000 |
| Dissemination of information, incl. a fee for R3E, printing materials, seminar | 100,000 |
| Miscellaneous – 10 percent | 225,000 |
| | |
| **Total** | **2,475,000** |

**Assumptions for Intervention 2**

For Intervention 2 to be achieved, a number of assumptions must be fulfilled:

- City of Windhoek will identify a suitable area for the pilot project.
- City of Windhoek will participate in the project with professional staff on town planning.
- MRLGH, City of Windhoek and other relevant authorities will consider the project to be a demonstration project of new and innovative solutions, which should be permitted, even if certain deviations from normal regulations may be needed.
- MRLGH, City of Windhoek and other relevant authorities will support the project by facilitating smooth and timely approval procedures, securing implementation of the demonstration project within the overall project period, which is three years.
- City of Windhoek will supply relevant infrastructure according to normal procedures.
- NHE will provide financing of the project according to normal procedures.
- NHE will participate in the project with professional staff on architecture and civil engineering.
- NHE will take responsibility for the construction of the houses, if needed with back up from the team of consultants.
- End-users will be identified at an early stage in the process, being willing to participate actively in a demonstration project.

The validity of these assumptions depends to a very large extent upon the mandates, ability and willingness of the involved institutions and all “stakeholder parties” in the present set-up of R3E to engage in the project activities as required. Representatives (apart from the end-users) from these

institutions have all expressed interest in the idea, and formal commitments are sought through the pre-conditions specified below.

### 4.4 Intervention 3: DRFN - REEECAP

Namibia is characterised by vast deserts and semi-dry areas. The risk for further desertification is overwhelming, partly caused by a fragile nature combined with high population pressure, whose need for energy has contributed to land degradation through inappropriate or unsustainable utilisation of biomass fuels. The Desert Research Foundation of Namibia (DRFN, an NGO) is the one of the leading organisations combating desertification and has considerable knowledge, skills and capacity within this field, but lacks capacity to fully mainstream REEE into its work, especially concerning energy planning at village and community level. This is especially pertinent in the ongoing 'Namibia's Programme to Combat Desertification' where DRFN supports the Forum for Integrated Resource Management (FIRM) in selected rural pilot areas. The field work under the FIRM programme is carried out by so called NAPCOD facilitators. The third Project Intervention will seek to incorporate REEE issues into the ongoing FIRM programme by training the NAPCOD facilitators in use of REEE technologies and in understanding of basic energy planning issues. A specially trained REECAP resource person will assist on local energy planning issues, especially in communities/areas where new economic activities demand improved energy supply. The resource person will also capacitate DRFN in general on sustainable energy issues, enhancing the organisation's ability in advocating on energy at an informed basis. Consequently the third output reads:

- ***Output 3:*** *Increased awareness in DRFN and in Village Development Committees and Constituency Development Committees on REEE and energy planning issues.*

The approach adopted will enhance general capacity building on energy planning issues and particularly on REEE issues within DRFN with the view of both enabling DRFN to be an important advocate for sustainable energy issues in Namibia and supporting the introduction of energy as an element in the FIRM programme. Experience gained in initial FIRM areas will subsequently form the basis for a controlled expansion into other areas, both as part of expanded FIRM activities and in collaboration with NGOs active in other parts of Namibia. The R3E Bureau will monitor the process providing advice and expertise as necessary and support and facilitate the dissemination of lessons learnt.

**Benchmarks**

Detailed benchmarks will only become available once DRFN has produced a proper description of the Project Intervention, named DRFN - REEECAP, including an action plan and detailed budget. The Project Steering Committee will approve the action plan and budget. The following benchmarks are thus only minimum requirements necessary for implementation:

- Training of ten trainers on local energy planning completed.

The training will focus on local planning by analysing the needs, opportunities and economic and environmental implications of different choices facing local communities. International short term

specialists will conduct the main part of the training on energy planning. The participants will include an appointed REEECAP resource person from DRFN, other DRFN staff, professionals from energy services providers, and R3E staff etc. The training will utilise IT-based planning and learning tools, making use of 'real' examples from one of the VDC, participating in the FIRM programme.

- Training of NAPCOD facilitators completed.

The REEECAP resource person will be responsible for training the three NAPCOD field facilitators on main issues on sustainable energy use. The NAPCOD will constitute the front line workers of REEECAP, raising awareness in communities by demonstrating energy efficient technologies and discussing other energy options. If need be, DRFN will provide technical back-stopping (i.e. the above mentioned REECAP resource person) and dispatch other resources persons.

- A number of community development plans reflect relevant REEE issues.

NAPCOD facilitators will assist in drafting integrated workplans as part of community planning, which will incorporate relevant REEE issues. It is important that the REEE technologies introduced are perceived as being helpful and cost-efficient. Where new or expanded energy supply is needed, e.g. because of planned or new economic activities, the REEECAP resource person will support the local community in analysing different options and their economic and environmental implications.

- Midterm evaluation of tangible results in the FIRM Interventions completed.

After approximately one and a half year of implementation, a midterm evaluation will be undertaken by DRFN. Lessons learnt will be analysed and options for expansions into new FIRM areas will be discussed, as well as expansion into non-FIRM areas through collaboration with other organisations. The midterm evaluation should be completed by the time of the second review mission, which will decide on possible future expansion, based on the midterm evaluation and other sources. If it is decided to expand the activities into new FIRM areas, the REEECAP resource person will support the VDCs and CDCs in these new areas.

- Exchange visits for community representatives and training courses for NGOs from non-Firm areas on local energy planning.

With view of disseminating information on REEE planning issues to other local communities, not covered by FIRM, DRFN will strive to raise awareness among other NGOs by way of exchange visits and training courses on local energy planning. If decided after the midterm evaluation to expand the REEECAP activities into areas, where FIRM is not active, but where there are other organisations or programmes suitable for collaboration, the REEECAP resource person will train trainers or other relevant staff from these organisations on energy planning.

- DRFN has developed into a platform for promotion of sustainable energy solutions on an informed basis.

It is the ambition that the DRFN will become an advocate for sustainable energy in Namibia as well as an ambassador for local communities on REEE issues. The DRFN is already involved in advocacy for sustainable use of natural resource and increased emphasis on energy issues (as a result of REEECAP) will only strengthen DRFN and complement its competencies.

**Activity Outline for DRFN – REECAP**
DRFN will prepare a detailed activity and action plan in the inception period. This plan will also include a detailed budget.

At this stage the following activities are envisaged:

- Hiring of two persons by DRFN
- Training of a group of up to ten persons from DRFN and R3E and others on energy planning
- Training of NAPCOD facilitators
- Demonstration of energy efficiency measures

**Inputs for DRFN – REECAP**
The major part of the inputs and hence Danida funds for this Intervention are to be provided to the Desert Research Foundation of Namibia. Funds shall cover their extra costs of including renewable energy and energy efficiency issues in their field work with local communities. In addition there is a technical assistance input, short-term international consultancies in energy planning, for the purpose of training of trainers, who will in turn train DRFN field workers and also provide a resource base for the R3E Bureau and its network.

Extra costs of DRFN include salaries for a REEECAP resource person and an assistant to be employed by DRFN, professional backstopping by the professional staff of DRFN, administrative overheads and other running costs of DRFN. Other costs include transportation costs for exposure exchange visits, etc. and dissemination costs.

**Budget for DRFN – REECAP**

| Budget Item | DKK |
|---|---|
| REEECAP Resource person (30 months) | 300,000 |
| REEECAP Assistant (30 months) | 200,000 |
| Professional backstopping to REEECAP staff and training in community development tasks | 360,000 |
| International technical assistance for training (4 man-months incl. reimbursables) | 750,000 |
| Procure two computers and software | 40,000 |
| Stationary, telephone, fax, etc. at N$ 2,000 per month | 48,000 |
| Document best practice and lessons learnt from FIRM pilot areas | 80,000 |
| Procure and install appropriate demonstration equipment | 112,000 |
| Conduct two exchange visits at N$ 50,000 per visit | 80,000 |
| Provide one training to field facilitators and resource persons from NGOs | 40,000 |
| Transport during both phases (2000 km/month for 36 months at 4.8 DKK/km) | 230,400 |
| Administrative overheads (10 percent) | 224,040 |
| Miscellaneous – 10 percent | 246,444 |
| | |
| **Total** | **2,710,884** |

**Assumptions for DRFN – REECAP**

Intervention 3 is almost entirely to be implemented by the Desert Research Foundation of Namibia. The role of R3E is to provide external consultants under the project, to conduct an initial training course and provide general facilitation services and monitor the Intervention. The crucial overall assumption is therefore that this organisation has the capacity and capability to implement the Intervention as required for the Intervention to lead to rural communities improving their livelihood through increased energy consciousness.

## 4.5 Assumptions by Objective Level

***By Development Objective Level***

Obviously the increased use of REEE measures will depend on a number of factors most of which are external to and thus beyond the control of the project. However, given the generally strong commitment from central government, most of these assumptions are more likely to affect the degree to which the development objective will be achieved rather than being killer assumptions. Nevertheless continued and possible strengthened government commitment to the promotion of REEE issues will be needed, especially in ministry other than MME. A key assumption is thus:

- Government of Namibia will continue and expand its commitment to the promotion of REEE technologies.

Another aspect concerns the current pricing regime of electricity which implies that tariffs in Namibia are among the lowest in the world. In grid connected areas (e.g. urban and peri-urban sectors) this clearly provides a disincentive for the adoption of renewable energy and energy

efficient technologies. A key assumption for a significant boost to REEE technologies, especially in urban and peri-urban areas thus becomes:

- Energy prices, in particular electricity prices, will be raised to a level more reflective of the environmental cost of production.

There are indications that this assumption will be realised, as most commercial energy is imported from South Africa. Here coal fired power stations have provided cheap electricity to i.a. Namibia, but as these power stations will have to upgrade – partly to improve environment standards – prices are likely to rise. Similarly, the partial abandoning of the development of Kudu gas fields is likely to accelerate the development of renewable energy sources e.g. hydro-power.

***By Immediate Objective Level***

The project contains Interventions which have not been fully detailed as regards exact implementation and activity modalities which hence assumes that relevant stakeholders will be willing and able to fulfil the designated responsibilities.

- A main assumption is that the key government ministries and other relevant public institutions at lower levers (e.g. City of Windhoek, VDC, NHE etc.) are able and willing to support and follow up on the initiatives taken by the project.

Concerning the central government and related ministries, key policy statements contained in the White Paper and the NDP2 commits the government to the promotion of REEE albeit in rather general terms. However, judging from interviews and recent statements this commitment seems genuine and strong thorough relevant sections, though capacity to fulfil this commitment is limited and hence the increased emphasis on outsourcing. At lower levels of government and parastatal organisations the ability (also in regulatory and mandatory terms) and willingness to engage in REEE on a long-term basis is still partly untested, though some reassurances have been obtained. Such organisations will become key stakeholders whose commitment and capability will be crucial for successful implementation of especially Intervention 2 and 3.

Another assumption, partly related to output one, but of significant importance to the achievement of the immediate objective, concerns the capacity development of the R3E Bureau:

- Key stakeholders will utilise the R3E Bureau as intended, furnishing it with necessary information/technical advice and procuring a number of services thus allowing it to fulfil its stated function as an information centre and service provider.

This assumption is not entirely externalised in relation to the project, as the key issue is to improve the relevancy, visibility and quality of the R3E Bureau, transforming it into a centre of excellence and natural partner for advice on REEE issues. This in turn will require the continuation of a dedicated team committed to the R3E Bureau and that additional support is forthcoming. On the other hand, key stakeholders will have to continue to (and possibly strengthen) support to the R3E Bureau and be willing to procure services from the Bureau on a cost-recovery basis.

The successful implementation of output two 'Energy Efficiency in Low Cost Housing' will also be crucial in the achievement of the immediate objective and hence an assumption at this level becomes:

- It is possible to construct housing with substantial energy-efficiency gains as compared to conventional housing construction without significant extra costs that proves attractive to the intended beneficiaries.

While regional experiences indicate that it is possible to construct energy efficient housing with limited extra costs, it still has to be seen if such concepts can be successfully replicated in Namibia, considering the generally low energy prices and limited awareness of REEE among key intervention stakeholders. This may limit the replicability of the Intervention.

Quite similar assumptions are present when trying to promote REEE in rural communities, where harsh living conditions, high level of poverty and low level of awareness may prove to be significant obstacles. An assumption related to the third output is thus:

- It is possible to promote a menu of REEE technologies, methods and planning tools which are attractive to and subsequently demanded by the targeted communities with the result that REEE is introduced in the areas.

While there is an urgent need to conserve e.g. scarce biomass resources currently being used in an unsustainable manner in some areas, it is still not entirely clear how to address these problems in a cost-efficient and sustainable manner, ensuring widespread adaptation. Experiences from the promotion of stoves have not been too successful. On the other hand DRFN is an experienced and capable organisation with considerable reach and knowledge.

## 4.6 Indicators and Means of Verification

***Development objective level***

The attainment of the development objective of increased use of REEE measures will be evaluated against the following key *indicators*:

1. Increased use of REEE technologies
2. Slow-down in the process of deforestation
3. Reduced growth in the carbon-dioxide emissions caused by Namibia's energy consumption for non-transport purposes
4. Accelerated socio-economic development benefiting the poorer sections of the Namibian population.

The following *means of verification* will be used to verify the indicators. Each mean of verification corresponds to the numerical identical indicator presented above:

1. Statistics on the application of REEE technologies before and after Project Interventions, based on project documentation from intervention areas mainly supplied by the R3E Bureau, supplemented by surveys covering the informal sector in order to document possible replication outside the project
2. Information from DRFN (and, where available and relevant, from the Directorate of Forestry and UNDP) and smaller qualitative surveys providing information on causal relationships between energy use and deforestation particularly in project areas
3. Socio-economic user surveys among beneficiaries in DRFN / FIRM areas documenting possible time and money savings, as well as financial and socio-economic analysis of energy consumption patterns among the residents in the energy efficient low-cost housing Intervention.

***Immediate Objective level***

The attainment of the immediate objective of increased capacity to implement REEE policies in selected areas will be evaluated against the following key *indicators*:

1. An effective one-stop shop for information and advice on REEE established and operational.
2. Key stakeholders have knowledge of and access to information on energy efficient urban planning and building design.
3. Local Communities including energy in their integrated development plans and adopting energy efficiency measures, reducing unsustainable practices especially concerning consumption of biomass for energy purposes.

The following *means of verification* will be used to verify the indicators. Each mean of verification corresponds to the numerical identical indicator presented above:

1. The R3E Bureau has established a data base and is able to respond satisfactorily to information requests, verified by a client satisfaction survey.
2. Lessons learnt from housing demonstration Intervention have been widely disseminated through at least one seminar and suitable information material produced and made available for key stakeholders (e.g. town planners, contractors, architects, housing financers, housing groups and government organisations).
3. Midterm evaluation of the DRFN - REEECAP, progress reports and other surveys.

### 4.7 Risk Mitigation and Preconditions

As discussed in Section 4.5 above, there are risks attached to this project and not all of the potential risks can be specifically identified and assessed. This is due to the special circumstances for the finalisation of this project. The risks are sought mitigated in a number of ways, i.e. by:

- Identifying clear and tangible output benchmarks and phasing project activities closely towards achieving these benchmarks and thereby making project progress as visible as possible and hence facilitating project monitoring through the project progress reporting.

- Proposing two Danida reviews over the 3-year project period, one towards the end of a relatively short Phase 1 and the other towards the end of Phase 2. Through these reviews the progress in one phase can be assessed before the next phase starts.
- Proposing that a Project Implementation Plan is worked out by the project to be approved by the Project Steering Committee.
- Under the project assist R3E Bureau to establish operational guidelines, policies and principles in setting up cooperation modalities and frameworks for contractual agreements with members of the R3E network and other institutions, private as well as public.
- Undertake the project activities towards the organisational strengthening of the R3E Bureau as early in Phase 1 as practically possible.
- Requiring a number of pre-conditions to be met before the project is approved.

The pre-conditions are:

- **MME** will confirm that the Government is committed to provide a core funding of not less than N$ one million per year over the 3-year period of the project.

- **The Executive Committee of R3E** will confirm that R3E:

  - has approved the obligations specified for R3E under this project in the Revised Draft Project Document,

  - has appointed the present day-to-day manager of R3E to the position of R3E Manager for a period of at least two years, commencing 1 January 2003,

  - will start the process soonest possible towards having R3E legally registered as an entity under Section 21 of the Company Law.

- **MRLGH** will confirm:

  - Its willingness to support and actively participate in the planning and implementation of a demonstration housing scheme in Windhoek, as outlined in the intervention brief, attached to the debriefing note,

  - its willingness in principle to deviate from normal regulations, such as minimum requirements for plot size, if need arises during the development of the demonstration project.

- **City of Windhoek** will confirm

  - its willingness to support and actively participate in the planning and implementation of a demonstration housing scheme in Windhoek, as outlined in the intervention brief, attached to the debriefing note,

  - its willingness to identify a suitable, not too costly, un-serviced plot, which may be purchased by NHE for the demonstration project.

- **NHE** will

  - confirm its willingness to be the driving force in the planning and implementation of a demonstration housing scheme in Windhoek, as outlined in the intervention brief, attached to the debriefing note.

# 5 IMPLEMENTATION

## 5.1 Implementation Strategy

The project will be implemented by the Government of Namibia with the Ministry of Mines and Energy (MME) as the Executing Agency, appointing the Project Director and the Chairperson of the Project Steering Committee. The daily administration of the project will be outsourced to R3E in accordance with specific agreements and procedures, as further described below. The R3E Manager will be responsible for day-to-day management of the project on behalf of MME.

R3E will, as described above, receive assistance under the project in order to strengthen the R3E organisational capacity to enable R3E to effectively perform outsourcing functions on behalf of MME. The Government of Namibia´s core funding of N$ one million per year is a compensation for the Bureau for undertaking this function for the Government. This also implies a strengthening of R3E for performing the administrative functions delegated to the institution for administration of the present project. Fixed assets, e.g. car, computers, etc. shall become the property of R3E, when such assets are purchased for the operations of R3E under the project and financed by project funds. The project will thus, in parallel with the Government core funding, strengthen the capability of the (private) R3E Bureau in performing its general operations, including both its operations on behalf of MME and for the private market.

It is proposed to implement the project in three phases. Towards the end of Phase 1 and 2, respectively, Danida will undertake a review. The review will assess progress during the respective phase and make recommendations concerning implementation of the following phase(s).

Phase 1 will start with an Inception Period during which a ***Project Implementation Plan*** will be elaborated by R3E for the approval of the Project Steering Committee. The Project Implementation Plan shall include, but not necessarily be limited to:

- A Memorandum of Understanding between MME and R3E concerning the role and responsibilities of R3E on behalf of MME for its administration of this project.
- A specification by R3E of the divisions of labour and responsibilities within the R3E organisation with respect to the functioning of the Bureau in this respect.
- A detailed plan for the required organisational strengthening of the R3E Bureau during Phase 1.
- A Memorandum of Understanding between R3E and each of the institutions of Ministry of Local and Regional Government and Housing, City of Windhoek and National Housing Enterprise concerning the modalities for cooperation among these institutions and R3E for implementation of the “Energy Efficiency in Low Cost Housing”, which is in accordance with the procedures of the present Project Document, including the phasing and Overall Implementation Schedule indicated in Section 5.5 below and attached as Annex 3 to the present Project Document.

- A Memorandum of Understanding between R3E and Desert Research Foundation of Namibia, which includes a detailed implementation programme for the REECAP, split up into three phases in accordance with the Overall Implementation Schedule in Annex 5 and detailing the implementation approach and responsibility of the Foundation towards the R3E Bureau.
- The detailed action programme and corresponding budget for the REEECAP Intervention.

## 5.2 Project Organisation and Management

Project organisation is illustrated in the organisation diagram, attached as Annex 4.

The Project Director will be the Chief Energy Researcher heading the Division for Renewable Energy and Energy Efficiency of the Energy Division of MME. This position reports to the Director of Energy, who in turn reports to the Permanent Secretary. The Project Director will have the direct responsibility for management of the project, assisted by the R3E Manager.

A Project Steering Committee shall be established with representatives from

- MME – the Permanent Secretary/Director of Energy - (Chairperson)
- Danida – Counsellor of Danish Embassy in Pretoria (possibly through a representative resident in Namibia)
- Chairperson of Governing Authority (presently Executive Committee) of R3E
- A representative of the Ministry of Housing and Regional and Local Government

The Project Director will be the Secretary of the Project Steering Committee.

The Committee shall have the overall responsibility of monitoring progress of the project, providing guidance on the implementation and discuss and make decisions concerning issues brought up by the project. This includes in particular:

- Approval of the Project Implementation Plan.
- Approval of Quarterly Work Plans, corresponding detailed Quarterly Budgets and Quarterly Progress Reports.
- Approving Memoranda of Understanding and Agreements, to be established between R3E and MME and other parties, which will take part in the implementation of the project.
- Decisions concerning implementation issues raised by any member of the Project Steering Committee, by the Project Director or by the R3E.

Daily Administration of the project will be undertaken by the R3E Manager, in accordance with the role and responsibilities of R3E, as defined in the Memorandum of Understanding between the MME and R3E. The functions of the R3E Manager in this respect shall include the authority of the R3E Manager to dispose of project funds, within the agreement to be established between MME and R3E and within the Quarterly Budgets, as approved by the Project Steering Committee.

## 5.3 Administrative Procedures

Details of the administrative procedures for implementation of the project shall be worked out during the Inception Period (in the form of a Procedures Manual) and included in the Project Implementation Plan. Some main features should, however, be observed:

Funds provided under the project are grants to the Government of Namibia and are thus public funds to be administered and accounted for by MME. As MME wants to outsource the administration of the project to R3E, activities will to a large extent be managed by the R3E Manager and funds will be channelled through R3E. As R3E is a private entity, this outsourcing role of R3E should be specified in a general Memorandum of Understanding between the MME and the R3E. Similarly, any channelling of funds from MME to R3E should be based upon a Memorandum of Agreement between MME and R3E covering the services to be provided by R3E, the activities to be performed and a budget specified accordingly. Memoranda of Understanding and Agreements with R3E shall be approved by the Project Steering Committee.

It is visualised that work will progress in accordance with Quarterly Work Plans submitted by the R3E Manager for approval by the Project Steering Committee. These Work Plans shall specify in details the project activities to be undertaken during the quarter concerned and also who, within or outside of the R3E organisation, will be responsible for the tasks specified. A corresponding detailed budget, covering the specified activities in accordance with the present Project Document, shall be attached to the proposed Quarterly Work Plan. These plans and budgets could form the content of a specific Memorandum of Agreement covering the specified activities. On the basis of such an agreement, project funds can be transferred to a R3E account over which the R3E Manager can dispose (within limits to be set by the Governing Authority of R3E).

The above procedures have been discussed with the present Governing Board of R3E, i.e. the Executive Committee, which in principle agrees to:

- Register R3E as a Section 21 company of the Company Law in Namibia.
- Establish management, decision-making rules, accounting and auditing etc. required by this law for R3E to legally operate as a private company, which can engage in business activities and enter into legally binding contracts with the public sector as well as with private suppliers, consulting firms, etc.
- Appoint the present day-to-day manager as R3E Manager for at least a 2-year period.
- Expand the R3E staff to include a Deputy Manager and an Administrative Assistant.

As a number of the project activities will involve parties other than MME, implementation of the project will also require R3E to enter into contracts with other institutions, e.g. the City of Windhoek, the National Housing Enterprise and Desert Research Foundation of Namibia as well as private architect and consulting engineers companies. Use of project funds to finance activities carried out by such external parties shall be based on a clear contractual agreement between R3E

and the respective parties. These activities shall furthermore be included in the Work Plans and corresponding Quarterly Budgets of the project and hence be covered by a contractual agreement (Memorandum of Agreement) between MME and R3E.

International technical assistance in the form of short-term consultancies for setting up accounting, auditing and business and financial management systems (budget line 2 in Table 2, Annex 2) is to be organised directly by R3E, establishing contractual arrangements with a recognised international auditing firm, through a representative office in either Namibia or South Africa. The remaining international technical assistance (budget lines 3 and 4 in Table 2 in Annex 2) shall be provided by a Danish consulting firm on a contractual basis with Danida, Copenhagen. Terms of Reference for the assistance, to be included in the contract, shall be approved by the Project Steering Committee.

### 5.4 Monitoring, Review and Reporting

The project shall provide Quarterly Progress Reports to the Project Steering Committee. These reports shall provide the basis for the Committee to monitor the performance of the project, vis-à-vis the present Project Document and the Project Implementation Plan. The reports shall be submitted prior to or simultaneously with the Quarterly Work Plan and corresponding Quarterly Budget for the following quarter and shall include financial reporting for the quarter in question and a status to date of the project financial situation. The Project Progress Report shall also contain an assessment by the Project Director and the R3E Manager about the performance of the project, issues concerning the implementation and possible options for action for the consideration and decision of the Project Steering Committee. Recommendations for decisions by the Project Steering Committee shall be clear and well justified for the Committee to be able to make its decision.

R3E shall in connection with the progress reporting develop indicators for assessment of impact of the specific White Paper on Energy implementation tasks, supported under the project, i.e. develop indicators for and report on achievements in terms of the capacity building intended by Interventions 2 and 3.

Danida shall undertake two reviews of the project during the 3-year project period. They shall, to the extent possible, be timed in such a way that recommendations of the review teams can realistically influence the use of project funds in Phase 2 and 3. This means one review towards the end of Phase 1 and the other one towards the end of Phase 2. However, timing should be fine tuned to fit in with the actual progress of the project, cf. further below, Section 5.6.

The first review shall take place after the first three quarters. It shall be a normal review and assess project progress and performance in relation to achieving outputs and objectives as specified in the present Project Document. Special attention shall be given to an assessment of the performance of R3E as an outsourcing institution for MME and in particular for the administration of the present project. The review shall assess progress with respect to capacity building of the R3E in terms of the output benchmarks specified in Section 4.2 above. If required, the review team shall make recommendations concerning changes and improvements to be made for R3E to become an effective and efficient outsourcing institution for MME. In this context, the review shall also assess and make recommendations concerning the performance of R3E as the administrator of the present

project on behalf of MME, including the progress and performance in relation to the two other major outputs, the demonstration project "Energy Efficiency in Low Cost Housing" (Intervention 2) and the "DRFN - REEECAP" (Intervention 3) i.e. in particular with respect to the idea competition/selection of consultants and the training of trainers respectively.
The second review shall follow up on the first review, i.e. on the findings and recommendations and the actions taken by the project. The focus would be on progress towards attaining the outputs of Intervention 2 and 3. The review shall assess the extent to which it is realistic to attain these outputs within the remaining project period and make recommendations for possible actions considered needed for attaining these outputs before the project terminates.

### 5.5 Flow of Funds, Accounting and Auditing

The project is anchored in Government with MME being the agency responsible for executing the project and financially accountable. The R3E Bureau will be responsible for the day-to-day operations on behalf of MME. Flow of funds and related accounting, auditing and financial management procedures shall be specified in details in the above mentioned Procedures Manual to be acceptable to the Government of Namibia as well as to the Danish Embassy in Pretoria. A possible option is as follows:

MME will open a project account to which Danida shall transfer funds according to the Quarterly Budgets and the financial reporting contained in the Project Progress Report. MME will transfer funds from the project account to a special account, to be opened by R3E for project funds transferred by MME from the project account.

Transfers from Danida shall, as mentioned, be based on the Quarterly Budgets submitted by MME after approval by the Project Steering Committee. Rules and regulations of Danida governing such transfers shall apply. As consultant assistance to R3E is needed right from the start of the project i.e. already during the Inception Period, it is essential that the first transfer of funds are based on an interim budget, prepared by R3E for approval of the Project Steering Committee.
Transfers from the project account to the special R3E account shall be based on a Memorandum of Agreement between MME and R3E. The R3E Manager will draft such an agreement, covering e.g. the financial requirements for a given quarter and submit it to the Project Director, who in turn will submit it to the Project Steering Committee for approval.

The R3E Manager shall have the signatory authority to dispose of funds transferred to the special R3E account in accordance with the rules to be established by the R3E Governing Board (presently the Executive Committee) within the legal framework to be established for the business operations of R3E (Section 21 of the Company Law).

R3E shall establish an accounting system, satisfactory to both MME and Danida and accounting and auditing procedures shall be in accordance with the rules and regulations of both the Government of Namibia and Danida.

## 5.6 Overall Implementation Schedule

The project is, as mentioned, proposed implemented in three phases, with the start of Phase 2 and 3, respectively, to depend on a review of the preceding phase. The proposed implementation time schedule is attached as Annex 3.

The project is phased in such a way that the idea competition in Intervention 1 and the training of trainers in Intervention 2 are completed in Phase 1 and that phase 2 starts with setting up contractual arrangements with selected consultants in Intervention 2 and with training of the facilitators in Intervention 3.

Phase 3 is basically the physical construction phase for Intervention 2 and the expansion phase for Intervention 3 into new areas.

Each phase is thus characterised by output benchmarks, which need to be achieved for a continuation of the project into the following phase to be meaningful.