Energy Demonstration Trailer:

Spreading Renewable Energy and Energy Efficiency throughout Namibia

Project Site: Windhoek, Namibia D '05

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An Interactive Qualifying Project Report
submitted to the Faculty of
WORCESTER POLYTECHNIC INSTITUTE
in partial fulfilment of the requirements for the
Degree of Bachelor of Science
by

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Date: 6 May 2005

EXECUTIVE SUMMARY

In Namibia, energy availability is becoming an issue that needs to be addressed. Currently, 50% of Namibia's energy is purchased from South Africa. Initially, the energy imports were beneficial for both countries; however, as South Africa's internal energy demand increases, less power is available to sell to Namibia. It is estimated that by 2013, South Africa will no longer have any excess power to provide to Namibia.

After learning of this situation, we established our two project goals. The first was to educate communities throughout Namibia about renewable energy and energy efficient (RE and EE) technologies and methods using an energy demonstration trailer. The other was to investigate low cost, commercially available roof insulation that is a viable energy efficient alternative for inhabitants of informal settlements. After the trailer is completed, it will transport a variety of RE and EE products and information, including the results of our insulation investigation, to rural and urban communities throughout Namibia.

Within Namibia, there is a variety of living conditions ranging from rural areas to informal settlements to urbanized cities. A major focus is informal settlements because they account for approximately 30% of Windhoek's population. Informal settlements do not always have access to electricity, and when they do, only homes directly adjacent to power lines are connected to the grid, as we observed when visiting the Barcelona settlement. These communities can especially benefit from RE and EE technologies and methods that bring modern conveniences, such as lighting, radios, wood efficient stoves, and temperature stability to shack dwellers.

However, all Namibian communities can also benefit from employing RE and EE technologies and methods in their everyday lives, although sensitivity to social and economic conditions in each community must be taken into account when recommending technologies. Urban communities that already have electricity in individual homes can also benefit from RE and EE technologies, since the areas are currently facing rolling blackouts. RE technologies can provide a reliable source of energy in homes, while EE can assist homes in conserving energy used. In addition to providing electricity, products such as solar water heaters and energy efficient light bulbs are recommended for urban areas, since the products reduce the required electricity for homes and therefore save money over time.

In order to determine which RE and EE technologies and methods are most applicable in Namibia, we conducted a number of interviews with stakeholders of our project. By speaking with individuals who specialize in the RE and EE industry and leaders of non-profit organizations, we were able to inquire into the products' beneficial effects and importance to daily life, methods of effectively demonstrating, and ease of transport. Using the information collected, we were able to establish an outline of the trailer's contents.

After determining what the contents were to be, we were able to ascertain the required specifications of the trailer. We then investigated several trailer possibilities until we found one that met the project's needs and stayed within the budget. Since there is a limited amount of space and many technologies and models must be contained within the demonstration trailer, we compiled a list of suggested modifications, which will increase available space.

In order to ensure that the contents of the trailer are properly demonstrated to communities, we established a training methods for the facilitators who will educate residents about RE and EE. The first step in training the facilitators was to compose a teaching manual that will supply the facilitators with the necessary information to travel with the trailer. Since the facilitators will be trained at a later date, compiling the teaching manual beforehand allowed us to be certain that the correct information will be spread to communities.

Since our target audience is broad, we investigated past teaching methods that were effective in a variety of settings. Using the expertise of the stakeholders we interviewed, determined several methods of educating residents. For example, to assist in the presentation of abstract concepts, such as solar energy, we designed several models that show resource management, energy consumption, solar water heating, and shack improvement techniques in an easy to understand and interactive manner. By utilizing these models, the audience will better understand the products, thereby gaining the audience’s trust and facilitating the products’ use.

The second facet of our project was the continuation of a Worcester Polytechnic Institute project carried out in 2004. The project’s task was to investigate locally available, low cost materials to be used as insulation for shacks in informal settlements. The group concluded that reeds were the best locally available material. Because of difficulties obtaining and installing reeds as insulation, we investigated easy to implement, low cost commercially available materials that would serve as a substitute for reeds. By visiting local hardware stores and assessing the availability of different materials, we determined that Sisilation™ would be an appropriate material to test further.

Using three identical sample roofing sections, we tested two installation methods for Sisilation™ against a control sample, which contained no insulation. Two different tests were conducted over the course of three days. These tests included a daytime test to observe the temperature change within the sample during the hottest hours of the day, and an evening test to observe how well heat was retained in the evening. At the conclusion of our testing, we determined that the sample containing Sisilation™ with an air pocket installed approximately ten centimeters away from the corrugated iron roof was the most effective. We reached this conclusion because the Sisilation™ with airspace creates a more stable interior temperature. When comparing our data to the data obtained by the 2004 project, as well as analyzing the difficulties with transporting and installing reeds, it became clear that Sisilation™ is a suitable substitute for reeds as insulation. Using the information gathered in the Sisilation™ testing, we designed the shack model that will be included in the trailer.

Since the Energy Demonstration Trailer project spans over two years, some tasks remain. Therefore, we set forth a list of objectives, which includes modifying the trailer, training the facilitators, performing field tests, and holding a stakeholders' workshop. After these tasks are completed and the necessary changes are made to the trailer and its contents, the demonstration trailer will be ready to travel throughout Namibia to educate communities on RE and EE.

ABSTRACT

Namibia has few power plants to produce electricity of its own and imports 50% of its electricity from South Africa. For this reason, Namibia will need to begin researching and developing other methods of energy generation. Renewable energy (RE) and energy efficiency (EE) are alternatives that could alleviate Namibia's energy problem. Unfortunately members of both rural and urban communities have very little knowledge about RE and EE and therefore are unable to employ any of these technologies or techniques to conserve energy. In an effort to disseminate information on these topics and find new energy efficient materials, four students from Worcester Polytechnic Institute in conjunction with Habitat Research and Development Centre designed a demonstration trailer, which will be used to travel to settlements, schools, villages and farms spreading RE and EE concepts and products. This proposal provides background information and methodology for creating the trailer as well information on RE and EE technologies and materials.

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ACKNOWLEDGMENTS

We would like to extend a special thanks and our sincere gratitude to the following people without whom none of this would have been possible. Mr. Robert Schulz, our knowledgeable liaison, who helped us appreciate and understand the importance of our project every step of the way. Mr. Nils Wormsbächer supplied invaluable technical insight and assisted us in brainstorming about the trailer contents and modifications. Professors Bland Addison and Professor Stephen Weininger who provided us with never ending advice and were always willing to assist us in our endeavors. Our sponsor, Habitat Research and Development Center gave us the opportunity to participate in such a beneficial project. Our project would not have been possible without the gracious funding of the United Nations Development Programme. Without the help of our supportive stakeholders and their vast knowledge of renewable energy and energy efficient technologies, our project would never have gotten off the ground. Finally, we would like to give special thanks to the Polytechnic of Namibia, especially Mr. Mbahupu H. Tjivikua for creating a relaxed and pleasurable environment for us to stay in during the duration of our project.

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CHAPTER 1: INTRODUCTION

In developing nations throughout the world, houses often lack modern conveniences that create comfortable living conditions, such as electricity and running water, which are not readily available due to the structure of the homes, and organization of communities. Another problem is the fact that most of the housing is impermanent and inadequate since, as shown in Table 1, many of the people do not reside on land officially designated for housing. Public utilities do not serve the communities that have developed on the undesignated land (Schultz, personal communication, March 2005). Even though the residents of the communities do not have access to grid electricity, there are other ways to ensure that they receive basic comforts.

Housing Conditions in Developing Countries

	GNP per capita (US$)	Level of Urbanization (%)	Squatter Housing (%)	Unauthorized Housing (%)
Bangladesh	210	16	10	78
India	350	27	17	48
Ghana	390	33	0	40
Indonesia	570	31	3	70
Colombia	1,260	70	8	8
Thailand	1,420	23	3	17
Jamaica	1,500	52	33	50
Chile	1,940	86	0	20
Malaysia	2,320	43	12	12
Mexico	2,490	73	4	16
South Africa	2,530	60	22	34
Singapore	11,160	100	1	1
Developed Countries	14,000- plus	---	---	---

Note: The Indicators Program uses key cities (usually capitals) to represent 'countries.' The cities are Dhaka, New Delhi, Accra, Jakarta, Bogotá, Bangkok, Kingston, Santiago, Kuala Lumpur, Monterrey, Johannesburg, and Singapore. Income is converted to Purchasing Power Parity.

Table 1: Housing Conditions in Developing Countries (Datta, 2002).

Namibia is a developing nation with communities whose residents are currently struggling to receive basic utilities in their own homes. Although informal settlements in Namibia typically do not receive electricity because the grid usually does not reach them, urban areas are facing energy supply problems of their own in the form of rolling blackouts. (See Table 2 for details on electrification of each region within Namibia.)

Unelectrified Localities in Namibia				
Region	**Total Rural Localities**	**Total Unelectrified Localities**	**Future Grid Connected Localities**	**Off- Grid Localities**
Caprivi	126	118	109	9
Erongo	110	100	90	10
Hardap	61	44	37	7
Karas	144	126	126	0
Kavango	613	522	509	13
Khomas	26	16	13	3
Kunene	290	285	247	38
Ohangwena	309	250	250	0
Omaheke	219	200	200	0
Omusati	328	289	289	0
Otjozondjupa	162	139	88	51
Oshana	182	152	152	0
Oshikoto	285	245	245	0
TOTAL	**2855**	**2486**	**2355**	**131**

Table 2: Unelectrified Localities in Namibia
Source: Rural Electricity Distribution Master Plan, 2000

With Namibia receiving 50% of its electricity from South Africa, there is not enough internal power generation to combat the blackouts and ensure that they will not increase in severity and frequency (Hite, 2005). South Africa is concurrently facing higher energy demands internally and does not have the power surplus to supply Namibia with its increasing energy demands (Brueckner, personal communication, March 29, 2005). By 2013, the energy demands of Namibians will surpass the available supply, leaving many Namibians without any reliable source of electricity (Menges, 1998).

An emerging solution to the coming energy crisis in Namibia is utilizing renewable energy (RE) and energy efficient (EE) techniques. The definition of RE is utilizing natural resources, such as the sun, wind, and water flow to produce energy for communities. EE is defined as methods of conserving energy using products and concepts such as fuel efficient stoves, as well as building material selection, and building design. Using RE and EE technologies and techniques makes it is possible to run a household using no grid electricity and no fuel for cooking (Schultz, personal communication, March 2005). Due to high initial costs, it is not realistic to have a home completely independent from grid electricity; however, implementing some RE technologies and EE measures can greatly reduce dependency on grid electricity. In addition, RE and EE technologies can introduce new appliances to remote areas in Namibia.

In order to reach out and train the residents of communities, the Renewable Energy and Energy Efficiency Bureau of Namibia (R3E) submitted a project proposal to the United Nations Development Programme/Global Environment Facility's Small Grants Programme entitled "Energy Demonstration Trailer" (Appendix T). The purpose of the R3E proposal is to create a demonstration trailer focusing on RE and EE technologies and methods using practical demonstrations and presentation materials that can be universally understood. The trailer will contain the presentation materials in multiple languages and will be used to distribute RE and EE information throughout Namibia. In addition to the training materials, the trailer also will contain portable RE and EE technologies and provisions for the facilitators traveling with the trailer (Figure 1).

Figure 1: Trailer donated to the project by the Desert Research Foundation of Namibia

The presentation materials included in the trailer will be translated into several different languages that are prevalent in Namibia. In order to effectively teach a community about the RE and EE technologies that will be present in the trailer, the presentation materials must be easy to understand. If members of a community are struggling to interpret instructional materials that are not written in their native language, important messages may be lost in translation.

Achieving all of the goals in this project could have international ramifications that will enable communities in many other developing countries to improve their general welfare using RE and EE technologies and techniques. Furthermore, a long-term goal for this project is to have the same RE and EE teaching methods included in the trailer make their way into the mainstream primary school curriculum of Namibia.

With an educational base this broad, RE and EE methods could eventually become a part of everyday life even in developing countries.

CHAPTER 2: BACKGROUND & LITERATURE REVIEW

In a modern society, energy plays a fundamental part in most individuals' lives. Approximately 50% of the electricity in Namibia is imported from South Africa (Hite, 2005). In the past, importing electricity was never a problem, but the internal energy demands of South Africa are growing, and the surplus energy being sold to Namibia is not as plentiful as it once was. For Namibian homeowners this means higher prices for electricity, and in some cases sporadic blackouts (N. Brueckner, personal communication, March 29, 2005).

Emerging technologies can alleviate, if not solve, Namibia's energy problems as Namibia becomes an increasingly developed country. Currently, there are multiple RE and EE products available for homes and businesses, but due to the lack of knowledge and familiarity with the products and the high initial costs of installing them, most homeowners are hesitant to use RE and EE technologies. However, as power plants reach maximum capacity and electricity rises in cost, the use of alternative energy is becoming a necessary part in continuing Namibia's development as a nation.

RENEWABLE ENERGY AND ENERGY EFFICIENT TECHNOLOGIES

Since Namibia receives a large amount of sunlight, solar energy is a prime candidate as an alternative to grid electricity (Konttinen, 1995). Solar energy can be harnessed in several different ways. For example, a solar water heater uses a black heat exchanger to heat water in an insulated holding tank (NEC, 2005) (Figure 2).

Figure 2: Typical Solar Water Heater
Source: www.reactual.com/metaefficient/archives/images/solar-water-heater.jpg

Solar panels are used to generate electricity, which can be stored in batteries and to power appliances. Coupled with a power inverter, energy captured by solar panels can power lights, a television, a radio, or any other device that can run on standard household current. This entire system of solar panels, inverters, batteries, and appliances make up a solar home system (Figure 3).

Figure 3: Small Solar Home System, which powers only lights
Source: www.eslsolar.com/IMAGES/solar-power-station.jpg

Cooking appliances, such as paraffin cookers, open fires, and gas stoves, are among the least energy efficient appliances found in homes throughout Namibia

(Steuber, personal communication, March 29, 2005). EE alternatives to traditional stoves and ovens are commercially available. A solar box cooker, for instance, can cook a meal to feed an entire family in one to three hours without using any electricity, wood, or paraffin (The Solar Stove Project, 2004). There are also parabolic solar cookers, which focus the sun's energy on a small area, such as a pan, which then can become hot enough to stir fry (Schultz, personal communication, March 2005). Wood efficient stoves, particularly the Vesto cooker and Tso-Tso stove, are also viable options since they use 60% less wood while cooking when compared to traditional wood burning stoves (R3E Bureau, 2004) (Figure 4).

Figure 4: Solar Box Stove (left), Parabolic Solar Cooker (center), and a Vesto (right)

In addition to cooking, RE technologies can also be used to generate electricity. Natural forces, such as wind energy, can be harnessed using a wind generator that has blades like a fan. Wind energy, like solar energy, can generate electricity to power basic household appliances such as radios and televisions (Hipangelwa, personal communication, March 31, 2005) (Figure 5).

Figure 5: Wind Generator
Source: www.reenbuildingcookbook.com/images/BGWind-1.jpg

Wind and solar energy do have some limitations that need to be considered, for example when the sky is overcast or there is no wind, neither solar nor wind energy, respectively, is attainable. However, these types of weather related problems are not a major concern in Namibia, since it has approximately 300 sunny days a year (Getaway Africa, 2005). For more information about RE and EE technologies and how they will be presented to communities, see Appendix J.

THE ENERGY DEMONSTRATION TRAILER

Using an energy demonstration trailer, educators will be able to inform Namibians about available alternative energy options. The energy demonstration trailer will travel to both rural and urban areas of Namibia, specifically targeting schools, in order to spread knowledge of RE and EE alternatives. By educating communities throughout Namibia, the use of the energy demonstration trailer will instill a confidence in RE and EE technologies in communities, which will encourage the incorporation of RE and EE products into homes. By decreasing Namibia's dependence on South Africa for electricity, RE and EE will save consumers money in the end.

While looking at ways to accomplish the task of distributing RE and EE information, we had to consider both the geographic distribution and cultural diversity of the Namibian population. Two million people residing in the nation are spread throughout the country, and there are often large distances separating them (*The People of Namibia,* 2005). In addition to the distances separating the people, there are also social, economic, and environmental differences throughout Namibia that impact communities' receptiveness to RE and EE technologies. For instance, in the north, large open wood fires are typically used to cook meals; hence, the presentation of a wood efficient stove would be more effective than the presentation of a solar cooker. An example of an environmental difference in Namibia is the coastal breeze, which is only present in the southern and coastal areas of Namibia. A wind generator would generate electricity almost constantly near the coast; however, in the interior of the country where there is very little wind, a wind generator would be of no use (Odada, personal communication, April 12, 2005).

Housing all of the demonstration materials in a trailer is convenient. Since the materials are stored in one place, the trailer can be hooked up to a towing vehicle and driven to its destination. There would be no worry about forgetting a crucial demonstration material or piece of information, as it would all be inside the trailer. In addition, the trailer can be used to carry provisions and camping equipment for the facilitators.

Trailers have been used successfully in the past for similar endeavors. Mobile libraries are used around the world to help spread literacy by bringing books to remote areas. Mobile libraries are usually large vans or busses, and are not designed for prolonged off road usage (Learsuriyakul, 2000). The Red Cross uses both trailers and large vans to bring medicine and other medical equipment to places that are remote and far away from modern hospitals. Red Cross trailers are meant for hauling large loads and being towed by large vehicles, such as heavy-duty trucks and off road vehicles (Smith, 2000). However, the trailer that we are designing must be towed by a jeep or small truck.

Trailers come in many different sizes, shapes, and styles. They range from professional use, heavy-duty welded steel frame trailers to personal use, wooden sided trailers. There are many different types of prefabricated safari trailers available for purchase in Namibia; however, the budgetary constraints limited us to relatively basic designs. For the purposes of this project, a simple safari trailer with doors at the rear and folding panels on the sides will be sufficient, since shelves and storage space can be engineered for the contents in order to increase ease of usage. It will also be cheaper to buy a standard trailer and modify the inside to fit our needs rather than buy a custom trailer specifically built to our specifications.

COMMUNITY INTERACTIONS

To effectively prepare the facilitators for demonstrating RE and EE technologies to various settlements we first had to gain a comprehensive background regarding both positive and negative interactions with communities. Since the facilitators will be spending a substantial amount of time with communities, it was essential that we researched communities' interactions with people and/or organizations that educated or assisted to develop communities. With this knowledge, we were able to focus our efforts on ensuring that beneficial relationships form between the facilitators and the communities. By looking into both successes and failures of past development projects throughout developing nations, we learned lessons that helped us create the methodology.

Community Involvement

In Namibia, community involvement is a vital long-term portion of our project. The presence or absence of community participation and enthusiasm will shape the effectiveness of the demonstration trailer and of the proposed housing improvements. Because of the need for participation, it is necessary to learn from previous successes and failures of community involvement throughout developing nations.

For example, after World War II Mexico had rapid industrial growth, which led to the swift urbanization of industrial centers. In a period of forty years, the urban Mexican population increased by 33% (Chant, 1987). Because of this rapid growth, informal settlements began to pop up on the outskirts of Mexico's newly formed industrial centers.

One of the centers was Querétaro, where the shack dwellers faced a multitude of issues that left them unable to find affordable materials to build adequate housing. Continual increases in the need for land and building materials were the main economic limitations in the area (Chant, 1987). In addition, the residents faced the fear of eviction on a daily basis, which resulted in the shacks being lightweight, mobile, and easily disassembled.

In order to address the housing problems, the Economic and Social Research Council of Great Britain funded a project in which Ms. Sylvia Chant, a published authority on socioeconomic issues, created a plan to instruct residents on flooring, roofing, and bricklaying. However, the techniques were too advanced and costly for the basic building changes that would improve the housing situation in the end. Another problem with the basic methodology was the lack of community involvement. Although facilitators did teach residents advanced building techniques, the residents were unable to utilize them. The project's failure occurred partly because the residents had no say in the matter, which discouraged them from continuing shack improvements after the facilitators left.

A program put into action in Nairobi, Kenya also demonstrates serious failures in the execution of effective community involvement and community education. The case study warns us of the effects of ignoring the two important issues. The Nairobi City Council (NCC) developed a program in the mid-1970s to foster improvements in the squatter settlement by providing water and building materials to the shack dwellers. The project required community involvement during the construction process. The downfall of the project was in the NCC's assumption that an individual who usually has no background in construction could utilize sophisticated building techniques and that the people chosen for the program had to fit particular criteria including having a steady income and the ability to make a down payment on the project materials (Nimpuno-Parente, 1987). These requirements simply exposed a bigger problem since several of the residents had to take out loans, often through non-legitimate sources, in order to obtain sufficient funds to cover their financial obligation to the NCC project. The additional burden of debt combined with the lack of quality improvements to their homes left the majority of the residents worse off after their involvement in the project. Also, despite the need for strong community involvement in the project, the NCC failed to initiate community development before construction began. The failure to produce an effective project implementation plan led to an uneven distribution of the shack improvements. In the end, only half the participants had substantial changes made to their housing (Nimpuno-Parente, 1987).

In Guayaquil, Ecuador, a completely different approach was taken to get communities involved. The city was a booming industrial center that attracted many people after a decline in the selling prices of marketable agriculture products, causing a variety of settlements to form around the city as farmers and their families began to look for industrial jobs. The physical structure of housing within the settlements consisted of corrugated iron roofs, split-cane walls, and wooden floors (Moser, 1987). Since one million people from many different backgrounds resided in the city and its surrounding area, it was difficult for the diverse population to unite and work as a whole. Any positive changes that could have been made were initially lost because of the lack of community activism; therefore, the changes did not reach the majority of the population.

Residents of the area became aggravated with their living conditions. These common frustrations enabled the Department for Community Development (DCD) to facilitate community development. Committees were formed, which helped to alleviate frustration and find a common meeting ground. The committees began by helping to promote the use of construction techniques and the spread of residential building experience within the community. Although the group began as a partnership of three residents, it evolved into a complex organization that included nineteen officials. The elected officials then formed subcommittees that were able to efficiently deal with identifying and solving problems such as inadequate transportation, lack of electricity and running water, sanitation problems, and other basic housing issues (Moser, 1987). Because of the community involvement and initiative, the residents of Guayaquil were able to make substantial positive changes to their daily lives.

Motivating and Educating Communities

In order to effectively use the energy demonstration trailer throughout Namibia, it will be crucial to understand how to effectively motivate and educate communities. One of the simplest ways to encourage residents in a community to make changes on their homes is to educate them about the benefits of modifications one can make. The need to be aware of these two issues was made clear to us after we learned about how past successes and failures effected community motivation in both Namibia and other developing countries.

Community motivation in the Barcelona settlement in Windhoek, Namibia proved to be a vital part of sustainable development. Like many people in Namibia, the new residents of the Barcelona community were drawn to Windhoek by the promise of employment opportunities after the end of apartheid. Due to rapid urbanization, the workers needed immediate low cost housing, which took the form of corrugated iron shacks lacking ventilation, insulation, and other means of creating a comfortable living environment (Mumford, 2004). The hastily built shacks provide very little protection from the elements.

The Namibian climate is extremely hot during the day and cold at night, which creates an uncomfortable living environment for shack dwellers. However, with simple modifications, shacks can be made much more temperate (Mumford, 2004). In 2004, Worcester Polytechnic Institute students, Andrew Mumford, Jessica Sulzmann, and Jesse Tippett, worked to improve living conditions in the Barcelona settlement. The group did make many positive changes to the stability of the shacks' temperature and they attempted to instruct the community residents on how to make the changes on to their own homes. However, due to time constraints, the group was only able to show representatives of the community the guideline brochure they created, which was not as effective as models or other hands-on forms of demonstrations. The lack of emphasis on the training process was a significant shortcoming of this project, which was shown by the community being excited about the changes but not actually implementing them for themselves (Schultz, personal communication, March 2005). However, the residents were willing to have the improvements made for them, which could signify that they realized the benefits, but were unsure of some part of the installation process. The lack of the community's motivation shown here raises the important issues of how much outside assistance should be given to implement improvements and how much emphasis should be placed on training residents to carry out the improvements themselves. Since the residents did not take the initiative in making the improvements, the project has not continued since the departure of the group.

However, in another community, located in Ntuthukoville, South Africa, community motivation changed the way the settlement developed. After apartheid ended in South Africa, there was a sudden movement of blacks to industrial areas since they now had the freedom to obtain adequate wages. Ntuthukoville attracted many people since the average employee earned over R800 a month (Built Environment Support Group, 2004). The opportunity led to a flood of people to the area making industrial occupations more competitive, and creating difficulties for the workers in finding sufficient housing. The result was a settlement that formed with no cohesive sense of community, despite the fact that many of the inhabitants faced similar hardships, including oppressive shack lords, outbreaks of political violence, and the threat of eviction.

In the 1990s, residents were brought together to work on upgrading their shacks to help create a temperature stable environment. Although the sense of community was unstable in the beginning, it eventually grew into something lasting. Here the driving force that created this sense of community was the formation of a residents' association that involved community members in every step of the association's processes and allowed them to plan the needed changes (Built Environment Support Group, 2004). Not only did the community improve its housing, but also the surge of community development positively affected other problems such as sanitation and water supply. In

1994, the community contacted the Built Environment Support Group (BESG), which assisted the shack dwellers in gaining ownership of the land, ensuring that the residents would no longer fear the threat of eviction. In addition, the demand for clean water created jobs for twelve members of the community, who were then able to assist in providing the community with sanitation and plumbing. Since the BESG educated the shack dwellers on the steps to gain ownership of their own land, as well as ways to make changes in sanitation and water supply, positive changes took place. Organizing the community and educating them about their options was enough to motivate them to push for better living conditions. Because of the resulting community development that formed after one program was installed, the long-term accomplishments have been greater than any one goal that an individual resident could have achieved.

The aforementioned case studies teach us the importance of a positive relationship between communities and the facilitators. Establishing this relationship will ensure that RE and EE information will be distributed in the best possible manner. Community interactions will also lend credence to RE and EE technologies since if communities respect the facilitators, they will be more likely to trust the products and measures.

CLIMATICALLY STABLE HOUSING

In Namibia, poverty and unemployment lead to poor housing conditions since settlers cannot afford adequate building materials to construct their homes. The overall lack of knowledge regarding RE and EE technologies prohibit settlers from making affordable changes that will increase their homes' comfort and create healthy living conditions in informal settlements. The harshness of Namibia's climate heightens these housing problems, often leaving residents physically uncomfortable; however, establishing a stable and comfortable temperature within dwellings can prove difficult. The economic limitations of inhabitants of shacks and the overall simplicity of the dwellings give added emphasis to the importance of energy efficiency.

In order to regulate the temperature within a shack it is essential to apply energy efficient methods; they are simple, effective, and can be implemented at little to no cost. One essential concept in controlling the climate within a dwelling is identifying the points at which heat can enter and escape. Using energy efficient techniques helps establish a constant temperature within a dwelling. Insulation and building materials containing a high thermal mass can be very effective at controlling heat flow. A high thermal mass material, such as brick or stone, will store heat during the day and then release the heat slowly overnight (Baker, personal communication, February 15, 2005).

Heat naturally flows from warm areas to cooler areas. In the winter, heat flows from the inside of a building to the outside. The flow of heat cannot be stopped completely, but the rate at which it flows can be reduced by using materials that have a high resistance to heat flow (Holman, 2002). To maintain comfort, heat must be kept inside a building when it is cold outside and kept outside the building when it is hot outside.

ENERGY EFFICIENT MATERIALS

Insulation is any material that slows the rate of heat flow from a warm area to a cooler one. Insulating ceilings, walls, and floors decreases heat transfer by providing an effective resistance to the flow of heat. The effectiveness of the insulation depends on the types of construction materials, their thickness, and density. Best insulation results will be achieved with a thick, low-density material (California Energy Commission, 2002).

The geographic and financial limitations of some community residents make finding a low-cost, yet abundant resource such as insulation a necessity. Mumford, Sulzmann, and Tippett, of the 2004 WPI project group, found that materials such as cloth, cardboard, straw, and reeds were able help regulate the temperature within the shacks. Although these materials were effective to some extent in controlling the temperature, the results failed to win the enthusiasm of the community (Schultz, personal communication 2005). Commercially available materials could prove to be a suitable substitute for local materials if they are relatively inexpensive and their ease of implementation and effectiveness can spark enthusiasm that previously tested local materials did not create. Materials such as Sisilation™ and plastic sheeting which are available commercially, are more expensive compared to the materials that were used in the 2004 study; however, they are much better insulators than most low cost locally available materials.

After researching the preceding topics, it became clear that using simple modifications to housing as well as utilizing RE and EE technologies, that there could be a considerable improvement in the livability of housing throughout Namibia. This information in combination with an energy demonstration trailer and practical educational techniques that will reach a broad target audience, we were able to identify the necessary steps to accomplish our goals.

CHAPTER 3: METHODOLOGY

The goals of our project were to create an energy demonstration trailer that will be used throughout Namibia to inform communities about RE and EE, and to find low cost, commercially available materials that are energy efficient and can be used in housing regardless of geographic location. Our goals complemented each other since we were able to demonstrate our findings about energy efficient materials using the trailer. The demonstration trailer will be used to travel to various rural and urban communities with stops at settlements, schools, villages, and farms. The trailer includes brochures, videos, models, low cost materials, and other practical presentation materials that will be used to educate communities. In addition to the presentation materials, the trailer contains food, shelter, and water for the facilitators traveling along with it. In order to maximize the demonstration trailer's impact on communities, the facilitators will spend two to three days at each location, which creates the need for adequate camping supplies. Energy efficient demonstration materials such as a solar refrigerator, a solar home system, a solar water heater, and a wood efficient stove serve as both demonstration materials and camping equipment for the facilitators.

We employed the various tasks outlined below to accomplish our goals:

1. Obtained a trailer that, once modified, will carry RE and EE demonstration materials and technologies throughout communities in Namibia.
2. Devised means to educate communities about RE and EE technologies using the energy demonstration trailer so they are aware of low cost products and methods to make their homes more energy efficient.

3. Found low cost commercially available material that will be used for insulation in houses in various geographic locations.

Please refer to Appendices C, D, and E for descriptions of the steps we took to accomplish these objectives.

TRAILER DESIGN

In order to demonstrate RE and EE methods and materials, we needed a trailer that incorporated all essential materials for traveling and training. In addition to housing the materials, the trailer was required to be resilient and capable of traveling through various terrains, which added to its complexity and cost. Because of these restrictions, it was imperative that we investigated all of the available resources before making any final decisions regarding the design.

Before we determined the contents of the trailer, we first identified our target audience with the help of our liaison, Mr. Robert Schultz, who has gained expertise in the areas of RE and EE through multiple projects and nine years of experience. The audience we concentrated on included all citizens of Namibia from rural and urban communities, informal settlements, and schools. With a broad target audience, we had to ensure that our instructional material covered RE and EE in a manner that applied to people of different ethnic and social backgrounds.

To identify RE and EE resources that would be of practical use to our audience, we conducted interviews with our stakeholders, who consisted of various suppliers and non-profit organizations that specialize in RE and EE products and methods (Appendix F). Using their expertise, we compiled a list of commercially available products as well as pamphlets, brochures, and posters that could be used for instructional purposes. After creating the contents list, we then sent faxes to all major RE and EE suppliers in order to obtain formal quotes of each item to ensure the most cost efficient products were purchased (Appendix N).

In addition to the demonstration materials, the trailer also needed to contain two to three days worth of camping equipment for the facilitators who will be presenting the contents of the trailer at various locations. Our group, with the help of Mr. Schultz and Mr. Nils Wormsbächer, the mechanical engineer who assisted with trailer design, initially compiled a list of camping essentials. We then visited various camping equipment suppliers within the Windhoek area to ensure that we identified all of the necessary camping materials. After gathering information, we were able to put together a list of essentials. We compared prices and quality of the products before choosing the exact suppliers for the equipment. Along with basic camping equipment, the RE and EE technologies will be used to sustain the facilitators while on the road. By showing we believe in the usefulness of the trailer's contents, the facilitators validate the RE and EE equipments' effectiveness and encourage the communities to invest in alternative energy methods.

In order to determine the trailer that would be the most effective for our project we first had to assess the volume and mass that trailer needs to sustain. We accomplished this by evaluating the technical specification of each individual item and summing their volumes and masses, which yielded the minimum specifications for the trailer. To ensure that the trailer was capable of containing all of the materials that will be added in the future, we used a safety factor of 1.5 in our calculations, which means to multiply the volume and mass quantities by 1.5 to give a safe margin of error.

After obtaining the required volume and mass capacities, we visited various safari trailer manufacturers and distributors under the guidance of Mr. Nils Wormsbächer to find a trailer with the closest specifications to our requirements. In addition, we went to the Desert Research Foundation of Namibia (DRFN), which had a trailer it was willing to donate to our project. After gathering all of the trailer options available to us, we weighed the pros and cons of purchasing a trailer versus using the DRFN trailer, which did not fit our exact specifications but would leave sufficient money to modify the trailer to meet our requirements. Based on this analysis, we chose to work with the DRFN trailer and began to investigate and design modifications that will need to be made in order to ensure that the trailer fits our specification. For more information on the final trailer decision and modifications, see the Energy Demonstration Trailer section in Chapter 4.

CONCEPTUAL DESIGNS OF INSTRUCTIONAL MODELS

Since some of the concepts that we are going to present to the communities, such as energy, are abstract, we determined that conceptual models were necessary. The purpose of the models will be to portray abstract concepts, or products that cannot be included in the trailer because of space constraints.

One of the demonstration materials is a solar water heater, but because of its size, the actual product cannot be included. To show the basic concept of a solar water heater to our target audience, we included a camping shower, that when filled with water and set in the sun for a few hours produces hot water.

Another model we designed allows communities to understand energy. For many residents, electricity is an abstract concept; hence residents of informal settlements and rural areas usually only have a basic understanding of how grid electricity works. There is a finite amount of solar energy that can be captured, which differs from the seemingly infinite amount of electricity available from the grid. To explain this concept, we designed a model that shows how energy is used by various appliances. The model uses beads to represent solar energy, which are poured into a section representing a solar panel. A facilitator can then open a slider so the beads can flow into the section of the model, which represents the batteries. From here, there will be three passages of different sizes, each representing a different appliance. Lighting will have the smallest passage, as it uses the least energy. A radio will have a slightly larger passage, since a radio uses more energy than lighting. A television will have the largest passage, as this is the most energy consuming appliance we will include. Using these models will instill an understanding of RE and EE technologies in communities throughout Namibia.

TRAINING THE FACILITATORS

In order to ensure that the facilitators are prepared to educate communities on RE and EE, we compiled a training manual for them. We began by composing a table of contents in order to identify all the subjects that we needed to research. Next, we gathered information on the subjects inspecting the brochures obtained from the stakeholders, as well as investigating the library at Habitat Research and Development Center (HRDC) and exploring the internet. Before compiling the training manual, we considered a number of factors ranging from clarity to accuracy of the material presented. Most importantly, we knew our manual had to be easy to read and understand so we kept our explanations simple and straightforward. We avoided technical jargon and when technical details were necessary, we went through the explanation systematically. We also included diagrams and pictures of each RE and EE technology shown so that the facilitators would be familiar with them. Another important factor was verifying the content to ensure accuracy and reliability. Therefore, while composing the manual, we ensured that we had at least two concurring sources for each example. In some instances, this meant searching for three to five sources that verified that we indeed were passing along correct data. We also asked Mr. Schultz, who has been working with RE and EE technologies for nine years, to review our manual and ensure that it was accurate.

TESTING COMMERCIALLY AVAILABLE INSULATION

The second main goal of our project was to investigate commercially available insulation. The 2004 WPI project group used reeds as roof insulation in houses; however, the use of reeds did little to inspire the Barcelona Settlement to include reeds in their own homes. Using easy to acquire and install commercially available materials, we worked to spark enthusiasm in informal settlements throughout Namibia.

By visiting local hardware and building supply stores, building consultants, and engineers we were able to identify two locally available commercial materials, Sisilation™ and plastic sheeting, to be used as insulation. After pricing them, we realized that the plastic sheeting was too costly for an average citizen, which made it a poor alternative. We also considered other materials, such as tarpaper; however, the limited availability of tar paper in Namibia made it an impractical choice.

Using previously built sample roof sections constructed out of wood and corrugated iron, commonly used as roofing, we were able to test both the effectiveness of the insulation and the effectiveness of different installation techniques. Figure 6 shows a diagram of the basic construction of a sample roof.

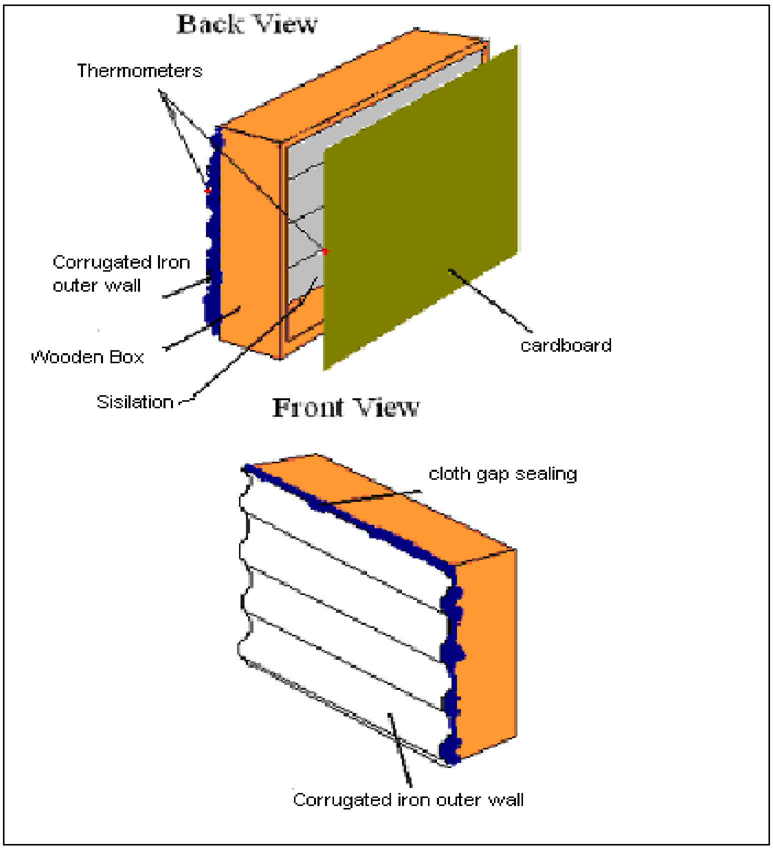

Figure 6: Diagram of Basic Construction of Sample Roof Section Insulated with Sisilation™
Source: Mumford, 2004

In addition, we constructed the samples to make certain that they were all assembled in the same manner as the 2004 WPI project group's, which ensured that any results obtained would be comparable to their results. Before testing began, we plugged the gaps in between the wood and corrugated iron in all of the samples to reduce airflow (Figure 7).

Figure 7: Nathan and Elizabeth plugging the air gaps in the sample roof sections.

The first sample consisted of Sisilation™ placed directly underneath the corrugated iron. We constructed a second sample with an air pocket of ten centimeters separating the corrugated iron and the Sisilation™ (Figure 8).

Figure 8: First Sample- Sisilation™ directly underneath (left) and Second Sample- Sisilation™ with an air pocket (right)

Simultaneously, we ran the experiment on a control model roof section, which is constructed like the first two samples shown above in Figure 8 but is lacking the

Sisilation™. We compared the control results to those with various types of insulation installations.

By comparing the temperature inside the insulated roof sections with that of the control, we were able to determine the relative effectiveness of the materials and the insulation techniques. In addition, we were able to evaluate the effectiveness compared to the cost of implementation, and were therefore able to determine which materials and techniques were economically feasible. For results and cost / benefit analysis see the Chapter 4.

Materials Demonstration Model

Based on the materials testing results we constructed a shack model using the material that we found to be most effective. The shack demonstration model will be used in the trailer to educate communities on energy efficient materials and building methods. Figure 9 shows an existing shack model, which was created for a previous project at the HRDC. The model will be made entirely out of corrugated iron, and will have hinges on the sides so that it can fold flat when not in use. The roof will be removable so that insulation can be added and EE building techniques can be easily explained.

Figure 9: Shack Demonstration Model

CHAPTER 4: DISCUSSION AND DATA PRESENTATION

The following sections will show the final contents list of the trailer, the training manual, and the results of our materials testing. The examination of the information and analysis of the data allowed us to make the final decisions on our project.

TRAILER CONTENTS RESULTS

In order to construct the energy demonstration trailer, we needed to examine applicable RE and EE technologies and determine their costs and dimensions. After completing the stakeholder interview process, we analyzed the stakeholders' recommendations which allowed us to determine the final contents list for the trailer (Appendix G). All of the products that were selected for the trailer are commercially available, which will allow residents who are interested in the products to easily access them. The items universally recommended were solar cookers, a solar home system, and wood efficient stoves. For the completed trailer contents list and an explanation of each item included see Appendix I and Appendix K, respectively. The trailer contents explanation brochure will be translated into various Namibian languages to ensure all residents can understand the RE and EE products being presented. Using the information gathered from the stakeholders and Mr. Schultz, we decided to present several RE and EE concepts, focusing on those that would be most beneficial to the communities.

We also investigated income generation using RE and EE products. Although they have a considerable initial cost, in some situations they can be used to provide services for a small fee. For example, using a small to medium sized solar home system, residents could power a radio, lights, a cell phone charger, or even a television. A larger solar home system could power a small refrigerator in addition to the aforementioned items. These appliances can also be run at night by using the energy stored in the batteries from daytime power collection. Other small appliances using solar or wind generated electricity could also generate income for a business owner. For example, hair clippers plugged into a solar home system, coupled with a radio, would allow an individual to set up a barbershop. In addition, providing an outlet where people can come to plug in their own small appliance for a fee would be a viable source of income. Though the recharging of the product may take a few hours, the facilitators will be in most communities for a few days, which would allow the appliances time to charge to full capacity. The solar box cooker also has potential for income generation. By baking loaves of bread in a solar box cooker, an individual could earn a small profit.

In Namibia, water is very scarce. A common way to obtain water is to drill a borehole to an underground aquifer and pump water to the surface using a submersible electric pump. Since boreholes can be quite far from grid electricity, solar powered water pumps are a solution. A single solar panel powers a pump large enough to provide a household with sufficient water throughout the day (Brueckner, personal communication, March 29, 2005). The power requirements of solar water pumps increase with desired output, and it is possible to have a few solar panels powering a pump large enough to provide water to a small community.

One service the trailer will offer is an energy consumption tester. Using a small electric motor attached to a large disk, we will be able to display how much power an appliance is using. With no appliances plugged into the same circuit as the electric motor, the disk will spin rapidly. However, when an electrical item is plugged into the same circuit as the electric motor, the motor will slow down depending on the power consumption of the appliance being tested. The more power the appliance draws, the slower the motor will spin.

Solar home systems have always been at the mercy of heating appliances, which draw a large amount of power continually and in a very short time will drain a solar home system. One concern raised during the stakeholder interviews was that people always ask about plugging irons into a solar home system. Irons are of major importance to many Namibians, especially the Herero since women have to iron their entire outfit when dressing in traditional attire, which for many is on a daily basis. A problem arises when encouraging these individuals to invest in a solar home system since irons consume a large amount of electricity, which quickly depletes the battery and prohibits the use of irons on a daily basis. We investigated possible solutions to this problem such as a gas fired iron or a black iron that could be heated using a solar cooker, but we were not able to find a commercially available alternative to an electric iron.

Larger heating appliances, such as electric ovens or stoves, consume more energy than even a large solar home system can supply. Similarly, gas stoves and open fires use a substantial amount of fuel to cook a meal. Our solution to this waste of energy was to include a parabolic solar cooker as well as a solar box cooker in the trailer. The parabolic cooker can boil a pot of water in less than ten minutes (H. Schütt, personal communication, March 30, 2005). We were able to test the parabolic cooker when we cooked a chicken stew for lunch on the parabolic cooker at the HRDC. Using no energy input other than the sun, we were able to cook a meal for ten people in two hours. To cook the same meal on a gas stove or an electric stove would have required the use of non-renewable energy.

There are additional RE and EE cooking methods that can be used even on cloudy days. The Vesto and Tso-Tso wood efficient stoves for example, use 60% less wood than would be required to cook over an open fire (*The Vesto Stove,* 2004). In addition, the stoves have a temperature control so, unlike an open fire, they can be adjusted from a simmer to a rolling boil by moving a lever.

One of the goals for the demonstration trailer is to show as many RE and EE products and methods as possible in order to cover our entire target audience. However, not all RE and EE methods will be practical in all regions of Namibia. For example, in the North where cooking over an open wood fire is the norm, the wood efficient Vesto stove will most likely be better received than a solar cooker. Also, in the southern and coastal areas of Namibia where wind is consistent, the use of a wind generator would be a more viable option than a solar home system (Odada, personal communication, April 12, 2005). The trailer will include as many different RE and EE products and methods as possible, the trailer will be equipped to work with different environmental and social norms throughout the diverse regions of Namibia.

To address the RE and EE technologies that we could not include in the trailer because of their size, we included practical demonstrations that would illustrate the concepts. For example, to address the concept of solar water heating, we could not include a full size solar water heater, so instead a solar camping shower bag will illustrate the concept. Also, using demonstrations, we will illustrate abstract concepts in an easy to understand manner. A shack model will show an insulation option and installation techniques. The other two models, the energy resource model and energy consumption model, illustrate abstract concepts such as energy, which makes them necessary additions to the trailer.

In addition to all of the RE and EE technologies in the trailer, it will also be equipped with camping gear. After visiting several safari and camping stores in the Windhoek area with Mr. Wormsbächer we found the largest variety and lowest prices at Cymot. Using the list of camping supplies we compiled with the help of Mr. Schultz and

Mr. Wormsbächer we were able then to access Cymot's website to find the exact camping supplies for our needs (Appendix L).

CONCEPTUAL DESIGNS OF INSTRUCTIONAL MODELS

While designing the conceptual models to be included in the trailer, we had to make sure that the models were easy to understand and informative. After conducting our stakeholder interviews, we had a better understanding of the educational level that the visited communities possessed. We decided that it would be best to have an energy resource model that would show that there is only a finite amount of energy to be had per day from a solar home system. In addition, since solar water heaters are very large, it was not practical to include an actual solar water heater. We investigated alternatives that would demonstrate the concept, and we decided on a camping shower bag. The third model is an energy consumption model, which uses a small 12 volt electric motor attached to a spinning disk to visually measure how much energy an appliance is consuming. We would have an outlet on the trailer where residents of the communities could plug in any 12 volt appliance. The disk will slow down in speed depending on how much energy the appliance is using; the more energy it uses, the slower the disk will spin.

THE TRAILER

After completing visits to several local trailer manufacturers and the DRFN (to see the trailer that they were willing to donate), and completing multiple internet searches, we gained sufficient cost and technical information on all possible trailers to perform an informed trailer analysis. In the end, the two best options were the Venter Model C three-quarter ton Workshop trailer with a hefty price tag of N$19,041.63 (*Venter Trailers*,

2005) or the DRFN trailer that we could acquire for free. Purchasing a new trailer would not leave sufficient money to complete the necessary modifications. By using the DRFN's trailer, which we knew would require substantial modification to fit our specifications, we saved a great deal of money. Also, by starting with a trailer that will have to be heavily modified, it will be much easier to incorporate all of the changes we deemed necessary. For technical specifications of the trailer, see Appendix P.

TRAINING THE FACILITATORS

A key element in utilizing the energy demonstration trailer to disseminate RE and EE knowledge will be training the facilitators, who are the individuals educating communities about RE and EE technologies and methods. Due to time constraints, we were unable to train the facilitators ourselves; however, we did prepare a comprehensive training manual that will relay the information we gathered to them. We included definitions of RE and EE, climate change, RE resources, EE measures, RE and EE technologies, appliances, models, displays, demonstration materials, camping equipment and trailer set up, and regional considerations. To view the completed training manual, see Appendix O.

COMMERCIALLY AVAILABLE INSULATION TESTING RESULTS

The project group performed the experiment as outlined in our methodology to determine which method of installing Sisilation™ provided better temperature stability. We placed thermometers in two locations on the samples, above the insulation (thermometer one) and below the insulation, which represents the interior of the shack (thermometer two). On the control sample, a third thermometer was placed directly on top of the corrugated iron. The samples were placed in the direct sunlight for the duration of the day and temperatures were recorded every half hour (Table 3). The test was repeated on three sunny days to ensure consistency and to eliminate external environmental factors, such as rain and strong winds, as much as possible. The tests consisted of taking readings every 30 minutes from 10:00hrs until 15:30 hrs, the time during which the sunlight is most intense.

DAY 1							
4/1/2005	**Sisilation™**		****Sisilation™ with airspace**		**Air Space (Control)**		
Time	**Before(°C)**	**After(°C)**	**Before(°C)**	**After(°C)**	**Before(°C)**	**After(°C)**	**Iron(°C)**
10:00	31	26	30	25	36	30	36
10:30	43	32	42	30	43	38	46
11:00	49	35	47	31	49	40	50
11:30	49	37	49	33	45	45	40
12:00	50	36	49	33	50	40	53
12:30	55	39	50	34	50	41	50
13:00	49	39	45	35	44	40	44
13:30	47	37	45	33	45	40	45
14:00	39	33	37	31	40	35	46
14:30	37	32	35	30	37	34	39
15:00	35	30	34	30	36	32	37
15:30	35	32	33	30	34	32	35

**The highlighted data shows the sample with the best results.

Table 3: Day 1 Materials Testing Results showing Sisilation™ with airspace to be the most effective

The weather on the first day of testing was partly cloudy in the morning but opened up to bright sunny sky into the afternoon hours. The following two days of testing produced nearly identical results due to the consistency of the weather. For further results, see Appendix H.

Figure 10 shows the average temperatures from thermometer two throughout the three days of testing.

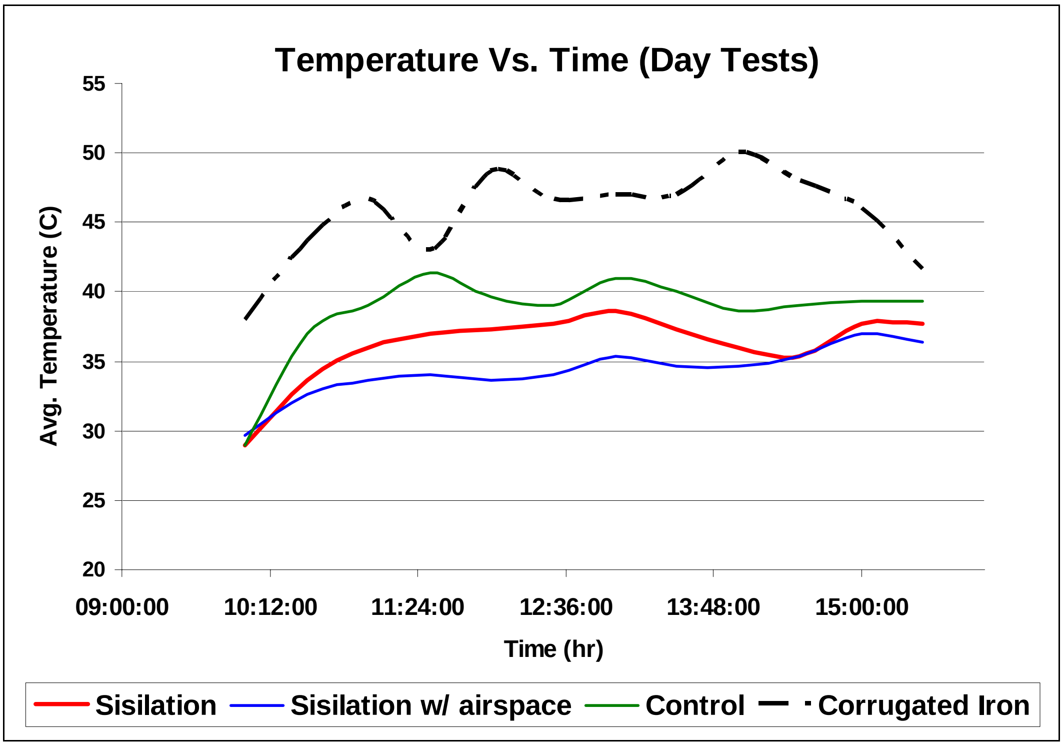

Figure 10: Temperature vs. Time Graph for the Materials Daytime Tests

The graph shows how the two different methods of installing Sisilation™ compared to both the control (air space) and the corrugated iron. The Sisilation™ plus a small airspace consistently produced the lowest average temperature inside of the sample during the day. The point on the graph where the Sisilation™ alone crosses lines with the Sisilation™ with airspace could possibly be due to clouds passing over a sample. Our data does not seem to conflict with our conclusions for it is still the Sisilation™ with air space that consistently provides the best results.

A statistical analysis was carried out on the data gathered during the three days of testing by using a one-way analysis of variance (ANOVA) of mean temperatures (Table 4).

				95 %confidence interval for mean			
Insulation	N	Mean	Std. Deviation	lower bound	upper bound	Min	Max
Sisilation™	36	36.11	2.606	35.25	36.96	25	42
Sisilation™ with air	36	34.25	1.880	33.63	34.86	25	41
Control	36	38.52	3.198	37.48	39.57	25	45

Table 4: Statistical Analysis of the Materials Tested Showing the Maximum and Minimum Temperatures of the Materials

The first column specifies the sample tested and the following column shows the number of data points observed per sample over the course of three days. The analysis was carried out using a 95% confidence interval meaning that there is a ninety five percent chance that results fall between the lower and upper bound.

Figure 11 shows the average temperatures taken from thermometer two during the two days of evening testing.

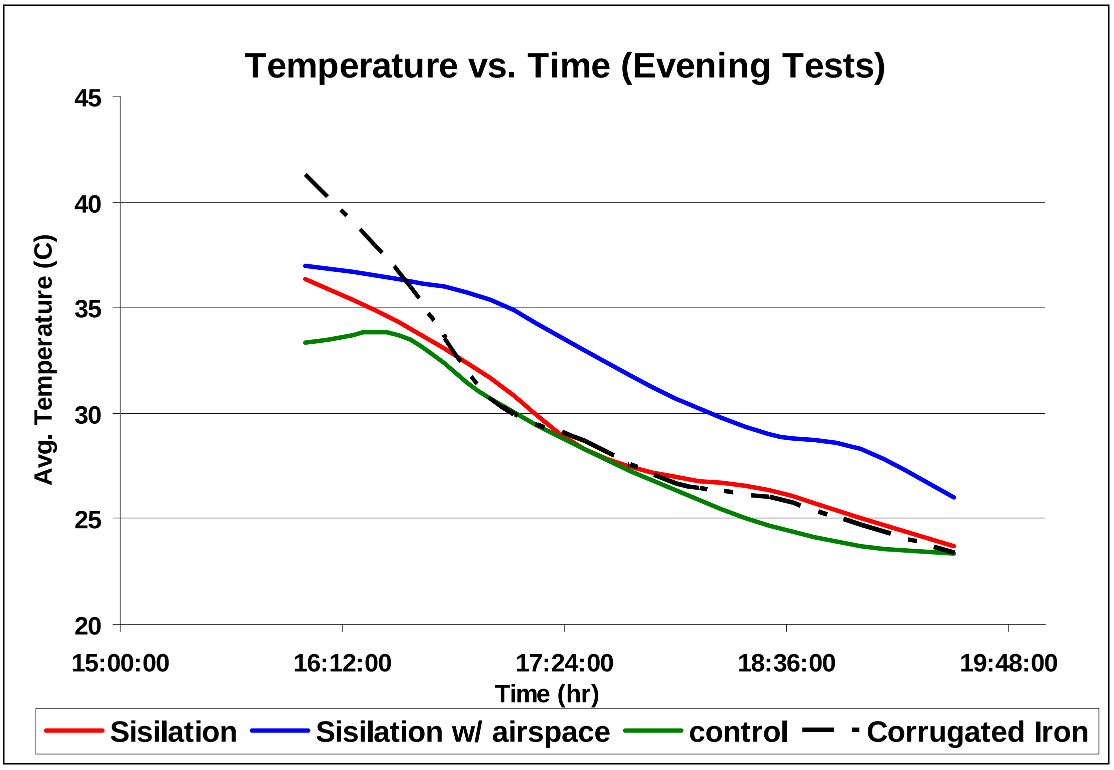

Figure 11: Temperature vs. Time Graph for the Materials Evening Tests

The graph shows evidence that Sisilation™ with an airspace is the most effective insulation technique for keeping heat inside of the sample during the cooler hours. While performing the experiments, we undertook certain precautions to reduce the number of external factors that could possibly affect the data. Layers of cardboard were placed under the samples to reduce the heat transferred from the ground into the sample. Cloth and duct tape were used to seal the sample in an attempt to reduce airflow within the sample. Despite these precautions, there are sources of possible error in our experiment that could not be avoided. Weather conditions were an aspect over which we had little control. Choosing sunny days ensured sunlight; however, wind and clouds could not be avoided. If clouds passed underneath the sun and only shaded some samples, it could create inconsistent temperature readings. Others sources of error include difficulty reading the thermometer, calibrating of individual thermometers, and using cloth to seal the air gaps.

CHAPTER 5: RECOMMENDATIONS AND CONCLUSIONS

In Namibia, energy conservation is not simply about protecting the environment and saving fossil fuels. There is not enough electricity generating to sustain the growing needs of both South Africa and Namibia. The immediate energy concerns in Namibia mirror the continuing need for energy efficiency throughout the world. A RE and EE solution to the increasing demand for energy in Namibia could possibly be a case study for other nations.

COMMERCIALLY AVAILABLE INSULATION TESTING CONCLUSIONS

As a result of our experiments, we concluded that Sisilation™ in combination with a small air space provided the best results of the three samples tested. On average, the Sisilation™ with air space tested 6˚C cooler than the control sample. Comparing this data to the test results presented in *Energy Efficiency Guidelines for Low-Cost Housing* (Mumford, 2005), which recommended reeds as the optimum material for insulation, proved that Sisilation™ was the better insulator.

Sisilation™ was not investigated in previous research because prior work done focused on low-cost, materials found in nature or throw aways and not on materials available commercially. Although Sisilation™ comes at a higher cost, its simplicity of use, from purchase to installation, gives it a clear advantage over reeds.

Reeds are only found in Namibia near sources of water and the quantities available are limited. Their limited accessibility makes transportation of the reeds a problem. Since most shack dwellers do not have cars, taxis are their only option. A taxi, which is typically a small sedan, cannot hold a large amount of reeds so multiple trips are necessary. Other issue that arises when using taxis is that the small size of the car limits the length of the reeds that can be transported. Reeds must be cut down to be transported in a taxi, which means additional effort and money will be required to install support beams for the reeds (Mumford, 2004). Reeds are a free material; however, after considering the cost of transportation in a taxi as well as adding support beams to the shack, reeds will actually cost close to N$60 to install in a shack.

Sisilation™ is commercially available so it can be purchased at any local hardware store. The cost for a roll of Sisilation™ initially may intimidate a shack dweller, but one roll is sufficient for multiple shacks in an informal settlement. If residents pool money together for a roll, the cost would decrease considerably and obtaining and installing Sisilation™ will cost approximately the same as using reeds (Table 5).

Cost Analysis

Reeds	(N$)	**Sisilation™**	(N$)
Taxi	40.00	Amount per shack	65.00
Support Beams	15.00	Thumb Tacks	5.00
Nails	5.00		
TOTAL	**60.00**	**TOTAL**	**70.00**

Table 5: Cost Analysis of Reeds vs. Sisilation™

Sisilation™ is appealing in part due to the simplicity of installation, especially because Sisilation™ comes with an easy to read, pictorial instruction manual that advises residents on installation techniques. Its thin foil like properties means that Sisilation™ can be easily cut with scissors and then tacked or to stapled to existing support beams. Because of the ease of installation, no additional modifications to existing shacks would be required. Fire safety is another added feature of Sisilation™.

Exposing it to a direct flame will first cause it to melt and then after 30 seconds a slow spreading flame will occur, unlike the behavior of reeds, which will almost immediately catch fire (Schütt, personal communication, March 30, 2005).

After multiple days of testing the roofing samples, we proved that Sisilation™ with approximately 10 centimeters of air space gave the best results. For Sisilation™ to be effective it is important that the area between the insulation and the roof have as little airflow as possible. To achieve a sealed gap, cloth must be stuffed into any visible air gaps and any gaps in Sisilation™ must be sealed using tape.

CONCEPTUAL DESIGNS OF INSTRUCTIONAL MODELS

After we conceptualized the four practical demonstration models that we designed, we determined that time constraints would not allow us to build them to the quality we desired. For this reason, we sketched drawings outlining the materials to be used and the design of the models. With this information, whoever follows up on our work will have enough information to construct the models. See Appendices Q, R, and S for our sketches of the models.

FUTURE DIRECTIONS

Future plans for the energy demonstration trailer are quite extensive because R3E's proposed project was set up to be accomplished over a two year period. During our two month work period in Namibia we were able to acquire the trailer, determine the final contents, create a training manual for the facilitators, and make recommendations about the necessary camping supplies. Several steps need to be completed before the trailer can be taken into the field. The remaining steps that need to be completed are the following:

1. Modify the trailer for both durability and ease of use.
2. Train the facilitators on how the demonstration trailer and its contents function and where certain RE and EE technologies are applicable in Namibia.
3. Perform three field tests to determine the effectiveness and appropriateness of the RE and EE technologies, the models and posters, and the training manual.
4. Hold a stakeholders' workshop, which will allow those who contributed to the project to understand the goals and future uses of the energy demonstration trailer.

Trailer Modifications

There is a need for large-scale adjustments on the DRFN trailer before it is operational. Shock absorbers and a hand brake are the first modifications that must be carried out, since they will be added to the basic framework of the trailer. Other modifications include: sand proofing the interior by installing rubber seals on all compartments, inserting sliders inside the trailer to ease loading and unloading, adding a ventilation hole in the front to reduce the air pressure in the interior during travel, mounting solar panels on the roof to ensure maximum exposure, and placing batteries, water canisters, and the parabolic cooker on the exterior of the trailer to leave space for the more fragile contents in the interior.

Training of Facilitators

Two facilitators are needed in order to bring the trailer to the various communities it will visit throughout Namibia. The facilitators will be junior management from the stakeholders' companies or volunteers from local Non-Governmental Organizations. Ideally eight to ten volunteer will be trained, which allows for broader scheduling options for the trailers in the field; however, typically only two to three people will accompany the trailer on a regular basis. Future project participants, in conjunction with Mr. Schultz and Mr. Wormsbächer, will train all of the volunteers. In order to train the volunteers, a training session must be organized. During the training sessions, it is essential to emphasize both community involvement and community development. Ensuring that the entire community is participating by engaging residents in discussion or having a resident assist the facilitators with demonstrating the models can greatly increase the effectiveness of the trailer. Also, community development will help to ensure that the community works together. Since many of the RE and EE technologies are expensive, it would be a good idea for multiple residents to save up together for the technologies, and then use the products as a group.

Once the training session is completed, the future project participants must review and amend all of the training materials that were found to be confusing or ambiguous. After the first generation of facilitators is well versed on how to effectively present RE and EE technologies throughout Namibia, they will be able to train replacements that will accompany future energy demonstration trailers.

Field Testing

Before using the trailer, field testing must occur. The trailer and its contents will be used as they would be in the field to ensure the effectiveness of the included RE and EE technologies and to ensure ease of handling, loading, unloading, and presenting. In order to analyze the trailer's effectiveness, it be involved in three separate field tests that will include rural and urban communities. Future project participants will make the final decision on the test sites. Testing at the Barcelona settlement is an ideal option because residents have previously worked with Robert Schultz during the 2004 WPI project. Testing at a school will allow the facilitators to determine the age range that is the most receptive. In addition, presenting RE and EE technologies to schools allows children to understand and become more accepting of RE and EE technologies at a young age, which could help the spread of RE and EE products in the future. The field tests will be performed under the supervision of Robert Schultz as well as any future participants in the project, which will allow for assessment after the tests completion, leading to the updating or modifying of any necessary information or contents.

Stakeholder Workshop

The final step in completing the *Energy Demonstration Trailer Proposal* is to conduct a stakeholder workshop. After the field tests are completed, the future participants in the project will need to compose a draft report to present to the stakeholders at the workshop. (See Appendix M for the list of stakeholders and their contact information.) This report should include the contents list, trailer design and modifications, list of camping supplies, training manual with the facilitators' comments, and the results of the three field tests with the communities' and facilitators' comments. The draft report should then be presented to the stakeholders in order to receive comments and feedback. After the workshop, all of the comments from the stakeholders, communities, and facilitators should be compiled and analyzed. The forthcoming participants in the project will then compose the final report and make any necessary changes to the trailer or contents. In addition to creating the report, the group will also need to ensure that two or more of the facilitators understand the changes made to the manual in order to teach new facilitators. Upon completion of these tasks, the trailer is then ready to be taken throughout Namibia.

Renewable energy and energy efficiency are viable options that should be considered not only by Namibia, but by all developing nations. Using these technologies, the residents of these nations will have the opportunity to use modern conveniences that they did not have access to before. Since the majority of residents in developing nations are from lower income bracket, it is essential that these technologies be presented to the lower class. For these residents, RE and EE will serve a dual purpose by providing reliable energy access and being cost effective in the long run. Utilizing the energy demonstration trailer to inform communities about RE and EE can reduce nations' dependency on grid electricity. These problems emphasize the need for our project's continuation.

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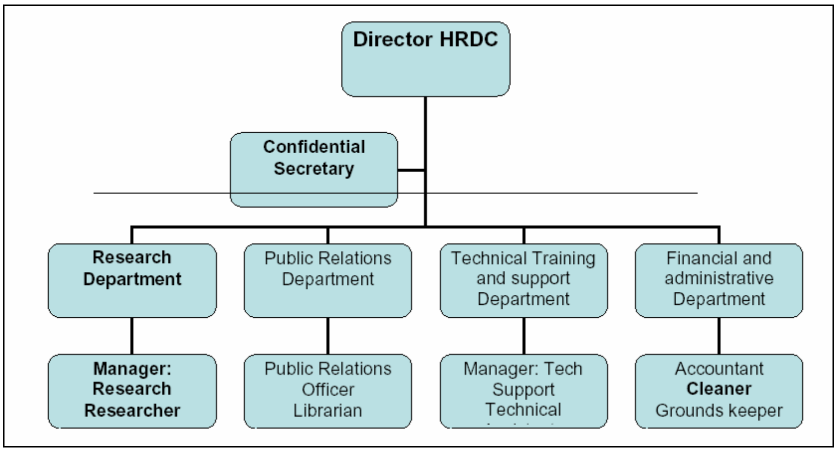
APPENDIX A: HABITAT RESEARCH AND DEVELOPMENT CENTRE

The mission statement for the Habitat Research and Development Centre (HRDC) in Windhoek, Namibia, is “to promote the use of indigenous building materials and designs, to engage multi-disciplinary teams in the basic research, the adaptation of existing knowledge and applied research to achieve a holistic approach to problem solving in the field of housing and related issues” (Korrubel, 2005).

The vision of HRDC is “to be the center of excellence in housing research and development by applying new methods and ideas of science and technology for the sustainable development of Namibia’s housing sector” (Korrubel, 2005).

HRDC establishment was started by three organizations: the Ministry of Regional and Local Government and Housing, National Housing Enterprise, and the City of Windhoek. The first HRDC staff was appointed on February 1 2004. Currently the HRDC staff includes the Director, the Manager, a Researcher, a Librarian and a Secretary/ Receptionist. When the HRDC requires more staff members, they will be added (Figure 12).



Positions in **Bold** text have already been appointed.
Figure 12: HRDC Organizational Hierarchy
Source: Background and organizational structure of the HRDC

HRDC's budget is N$7.2 million for the next three fiscal years. All operational and construction funds are obtained from the Ministry of Regional and Local Government and Housing. The HRDC also raises additional funds by conducting activities and projects at the HRDC. The N$7.2 million as well as the money raised will go towards Phases 2 and 3 of the implementation plan to finish the construction of the new facilities (Figure 13). Phase 2 is the excavation and ground works that must be done to accommodate the building. Phase 3 will be the construction of 2 lecture rooms, which can seat 160 persons each and 4 workshops for practical training in masonry, welding, woodwork as well as a clean lab for the testing of building materials. In addition, an amphitheatre, a garage, store, and public amenities will be built. This construction will not be completed for a few years, however the staff was able to move into the office block of the HRDC on April 18, 2004.

Date	Activities	Responsible institution
August & September 2004	Detailed design and planning	Professional consultant team
October 2004	Costing and finalisation of contracts	Professional consulting team and contractor
November 2004	Start of Construction on Phase 2	Contractor
July 2005	Start of construction on Phase 3	Contractor
December 2005	Completion of Phase 2 & 3	Contractor
January 2006	Implementation of training programmes	HRDC Staff

Figure 13: HRDC Phase 2 and 3 Implementation Plan for Facility Construction
Source: HRDC Project Documents

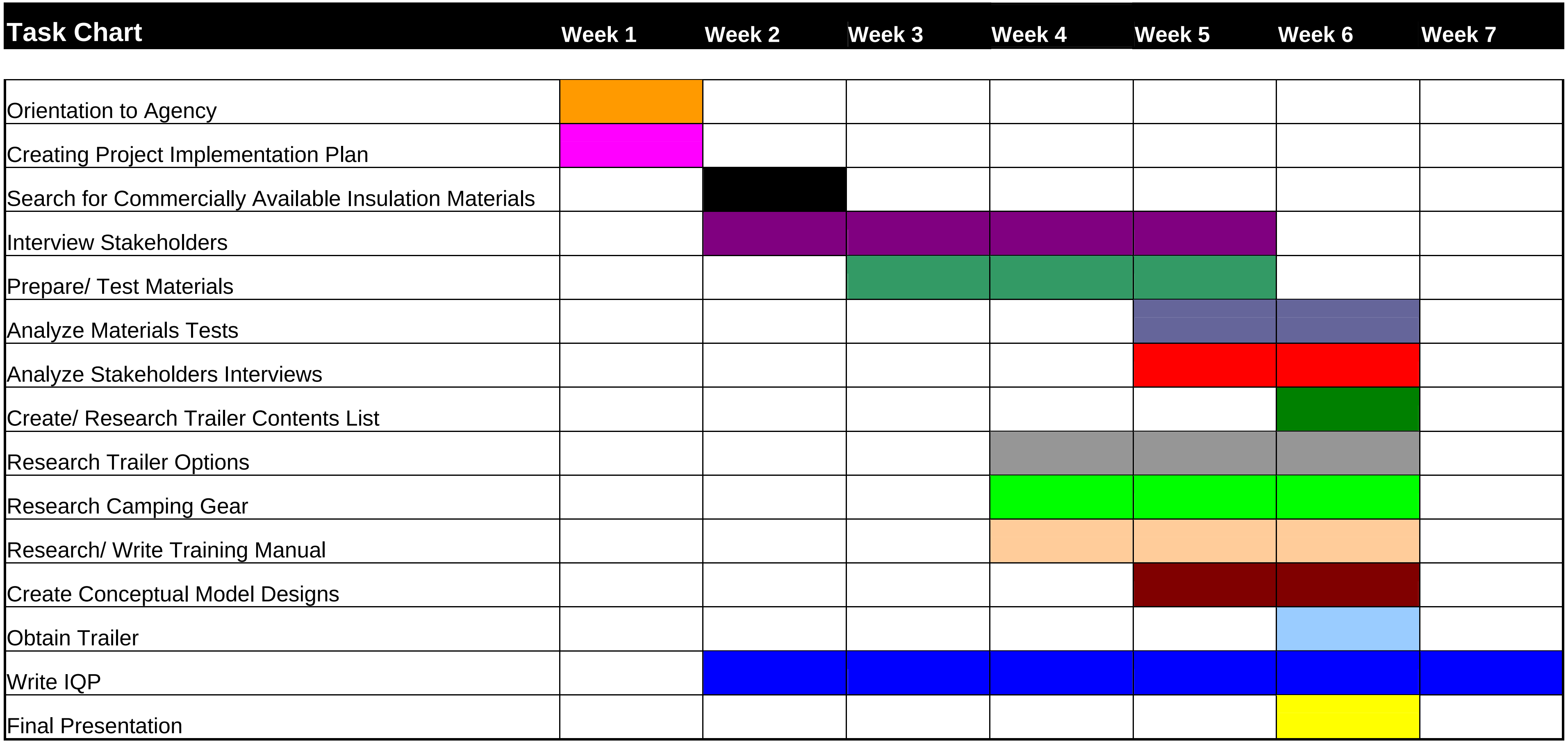
APPENDIX B: WHAT IS AN IQP AND HOW DOES YOUR PROJECT QUALIFY?

A WPI Interactive Qualifying Project (IQP) is defined as an interdisciplinary project that has a technical as well as a social aspect. The purpose of an IQP is to allow technical thinkers at WPI to expose themselves to a real-life engineering problem with social implications. The standard engineering curriculum does not often leave room for interdisciplinary project work, yet it is this type of teamwork that every engineer will be exposed to in their professional life.

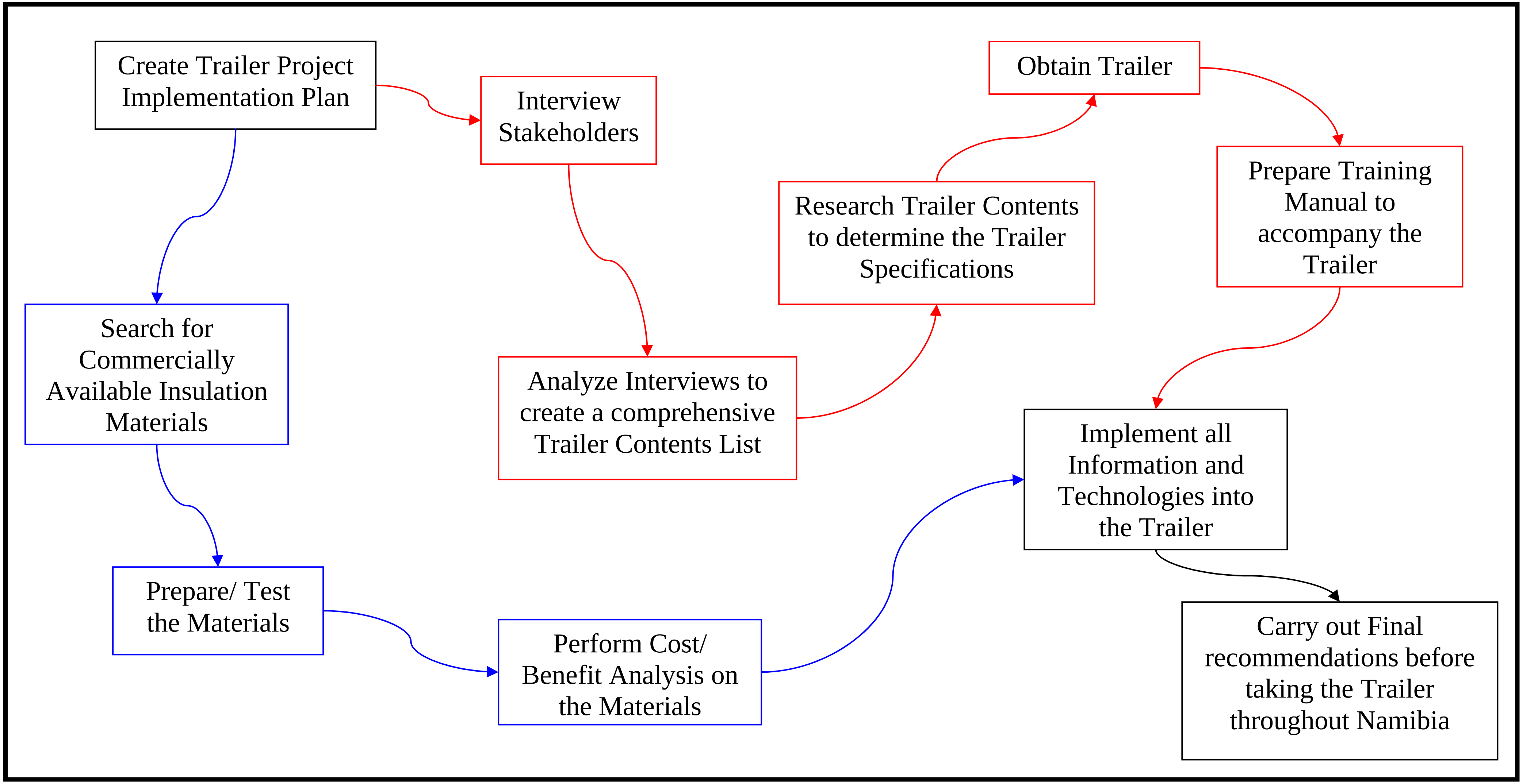
Our project is considered an IQP for many reasons. In addition to the technical aspect of researching RE and EE technologies that would be useful to Namibians, there is a vast social dimension that we had to be sensitive to in order to be successful in achieving our goals. Not everyone will be immediately accept RE and EE technologies in their everyday lives. We had to understand and recognize both the social norms and economic limitations of every community we wished to bring the trailer to, and address them in designing presentation materials applicable to each case. In order to gain the trust of the people, we had to conceptualize some simple and easy to understand presentation materials. Since people in rural Namibia often lack even basic math skills, a concept such as electricity is very abstract. In order to show the difference between solar power and grid electricity, we designed a very simple resource model. The resource model will use sand to show that there is only a finite amount of electricity to be had from a solar home system each day, and that different appliances use different amounts of this power. In addition, the dissemination of information about RE and EE technologies in an easy to understand manner should help convince communities that RE and EE are viable alternatives they can incorporate in their everyday lives.

The social aspect of our project is just as, if not more important, than the technical aspect. For this reason, our project fulfills the goals of the WPI project plan as an international IQP.

APPENDIX C: TASK CHART



APPENDIX D: PROCESS FLOW CHART



APPENDIX E: PIP- ENERGY TRAILER- MATERIAL TESTING

PIP- Energy Trailer- Material Testing

Estimated Total Hours: 534

	Outputs	Time (hrs)	Total (hrs)
Energy Trailer			**660**
1. Trailer Design (Hardware)			**338**
1.1 Contents [EE and RE]	-Preliminary Contents List, with Cost Analysis	**55**	
1.1.1 Demand Assessment/ Target Audience		5	
1.1.2 Identify Stakeholders		8	
1.1.3 Compile Interview Questionnaire		2	
1.1.4 Interview Stakeholders		12	
1.1.5 Desktop Study		10	
1.1.6 Information Evaluation (Ranking)		2	
1.1.7 Contents Determination		6	
1.1.8 Find Cost of Contents		6	
1.1.9 Finalize Contents		4	
1.2 Camping Equipment	-Preliminary Contents List, with Cost Analysis	**22**	
1.2.1 Needs Assessment (length of stay- 2 to 3 days)		4	
1.2.2 Market Availability and Cost		10	
1.2.3 Evaluation (Cost/ Benefit Analysis)		4	
1.2.4 Final Selection		4	
1.3 Trailer	-Trailer Completed with All Contents	**88**	
1.3.1 Identify a Trailer	-User Guidelines and Maintenance Plan	12	

1.3.2 Identify Trailer Modifications	-Trailer Specifications Manual	8		
1.3.3 Cost of Trailer and Modifications		8		
1.3.4 Implement Trailer Design (purchase and modifications made)		8		
1.3.5 Incorporate Contents and Camping Materials (purchase)		16		
1.3.6 Compile User Guidelines and Maintenance Plan		16		
1.3.7 Trailer Specifications Manual		20		
1.4 Document Process, Information, and Lessons Learned	-Written Report		**8**	
2. Presentation/ Training Materials				**134**
2.1 EE and RE [existing]	-Compilation of All Existing Training Materials		**29**	
2.1.1 Revaluate Contents		5		
2.1.2 Identify Sources (brochures, videos, models, etc.)		8		
2.1.3 Cost Sources		6		
2.1.4 Obtain training materials		6		
2.1.5 Improve Durability		4		
2.2 EE and RE [produce]	-Compilation of All Newly Produced Training Materials		**18**	
2.2.1 Identify Information Gaps		4		
2.2.2 Find Information		6		
2.2.3 Compile Information		8		
2.3 Training Techniques	-Training Manual		**16**	
2.3.1 Identify Techniques		6		
2.3.2 Consolidate techniques with materials		2		
2.3.3 Compile training manual		8		
2.4 Document Process, Information, and Lessons Learned	-Written Report		**8**	
3. Training of Trainers				**70**
3.1	-List of Possible Trainers		**8**	
3.2	-Place, Time and Date of Session		**16**	

3.3		-Trained Trainers	**30**	
3.4		-Amended List of Training Materials	**8**	
3.5		-Written Report	**8**	
4. Field Test				**72**
4.1		-3 Test Sites Identified	**8**	
4.2		-Itinerary Created	**8**	
4.3		-List of Observations Made	**40**	
4.4		-Amended Documents	**8**	
4.5		-Written Report	**8**	
5. Stakeholder Workshop				**46**
5.1		-Full Draft of Report	**4**	
5.2		-List of Stakeholders	**8**	
5.3		-Time, Date and Place of Workshop	**8**	
5.4		-Completed Workshop	**10**	
5.5		-Amended Documents	**8**	
5.6		-Final Written Report	**8**	
Materials Testing				**102**
1. Identify EE measures for insulation				**16**
1.1		-List of Materials by Rank	**10**	
1.2			**3**	
1.3			**3**	
2. Evaluate different commercially available materials				**20**

2.1 Desktop Review	-Preliminary Material Comparison	8	
2.2 Identify Sources and Distribution		8	
2.3 Obtain Material Cost		2	
2.4 Preliminary ranking and comparison		2	
3. Test Common Materials			**38**
3.1 Identify Materials	-Final Material Test Results and Evaluation	2	
3.2 Prepare Test Criteria		4	
3.3 Prepare Test procedure		4	
3.4 Obtain Testing Equipment		4	
3.5 Test		16	
3.6 Test Evaluation		8	
4. Cost/ Benefit Ratio			**28**
4.1 Identify Costs for Selected Materials installed (new and old)	-Cost/Benefit Ratio Written Report	6	
4.2 Calculate Cost/ Benefit Ratio		6	
4.3 Compile comparison		8	
4.4 Conclusion, Compile Report		8	

APPENDIX F: ENERGY TRAILER QUESTIONNAIRE

Project Summary: The goal of our project is to create an energy trailer that will be used throughout Namibia to inform communities about renewable energy and energy efficiency. This demonstration trailer will travel to various rural and urban communities with stops at places such as: settlements, schools, villages, and farms. The trailer will include brochures, videos, models and other practical presentation materials used to educate the communities. In addition to the presentation materials, this trailer will also have to house food, shelter, and water for the crew traveling along with it. In order to maximize trailer impact, the trailer crew might spend two to three days at the community, and as such the trailer should include adequate camping materials. Energy efficiency demonstration materials such as a solar refrigerator, a solar home system, and a wood efficient stove could also double as camping gear.

Name of Respondent:
Company:
Contact Details:
Area of Expertise:

1. In your opinion what technologies should be included in the trailer?
    - **a.** What technologies can they supply? Can you supply any brochures or documentation?

        For each item, how would you present them? Stand alone? How would you Integrate these items into the working of the trailer? How would you present in a compact fashion? (video, brochures, small model, etc.)

2. If you could only take one item, what would it be and why?

3. [Supplier] During the development of this trailer we will be going on three field tests the locations haven't been confirmed but we are thinking, one at the Barcelona Settlement, and one at a rural settlement and the final one at a school. If you are provided with free advertising what would or could you contribute?

    Good practical demonstration of their products (ie. distribution of business cards, brochures, logo on the trailer) They must supply brochures and logo but we will give specifications for it (explain the process- assess value of placement by contribution) give a value for the contribution- some form of indication

1. [Non- Profit] During the development of this trailer we will be going on three field tests the locations haven't been confirmed but we are thinking, one at the Barcelona Settlement, and one at a rural settlement and the final one at a school. Do you know of any company or suppliers that have been friendly donation or sponsorship?

Process of Project: We are currently in the information gathering stage and trying to nail down a list of renewable energy and energy efficient products should be included on the demonstration trailer. We are also in the primarily planning stages of a workshop to train the educators that will accompany the trailer.

2. We will be conducting training sessions; do they have any junior staff who would like to attend (max. 2)? The outcome of these training sessions will hopefully be the selection of two volunteers to accompany the trailer.

3. Do you have any suggestions or comments on the general construction of the trailer?

APPENDIX G: ENERGY TRAILER QUESTIONNAIRE RESPONSES

Respondent: Werner Schultz **Date/Time:** March 29, 2005- 7:00am
Company: Terrasol
Contact Details: Address: P.O. Box 6036, Windhoek, Namibia
Location: 9 Nobel St (Southern Industrial)
Telephone: (264) 61 239454
Fax: (264) 61 239454
Area of Expertise: Boreholes, Solar Cookers, Wind Generators
Supplier or Non-Profit: Supplier

1. In your opinion what technologies should be included in the trailer?
   - Biogas stove
   - Wind charger
   - Solar home system

   a. What technologies can they supply? Can you supply any brochures or documentation?
      - Biogas stove (donation)
      - Wind charger (N$2500 reduced price)
      - Solar Panels (connection with supplier)

2. If you could only take one item, what would it be and why?

3. During the development of this trailer we will be going on three field tests the locations haven't been confirmed but we are thinking, one at the Barcelona Settlement, and one at a rural settlement and the final one at a school. If you are provided with free advertising what would or could you contribute?
   - Did not want any advertising on the trailer, only small stickers on components acquired through Terrasol

4. We will be conducting training sessions; do they have any junior staff who would like to attend (max. 2)? The outcome of these training sessions will hopefully be the selection of two volunteers to accompany the trailer.
   - Staff too small to send volunteers

5. Do you have any suggestions or comments on the general construction of the trailer?
   - We were offered facilities to build the trailer at Terrasol
   - Design considerations
     -Rubberized axle for suspension rather than springs, as springs are too stiff
   - Contact Vender Trailers, South African company that makes what we need
   - Trailer should focus on awareness rather than product placement

Respondent: Heinrich Steuber **Date/Time:** March 29, 2005- 10:00am
Company: SolTec c.c.
Contact Details: Address: P.O. Box 315, Windhoek, Namibia
Location: 51 Marconi St (Southern Industrial)
Telephone: (264) 61 235646
Fax: (264) 61 250460
Cell: (264) 81 124 3056
Email: h.steuber@soltec.com.na
Area of Expertise: Solar Panels and Trackers, Solar Home Power Systems, Solar Water Heaters, Solar Stills
Supplier or Non-Profit: Supplier

1. In your opinion what technologies should be included in the trailer?
   a. What technologies can they supply? Can you supply any brochures or documentation?
      - Solar Home System ($7,068.45)
        - Use a 75W panel to power, 2 lights, TV, and radio
      - Solar Hot Water Heater ($8,500.00)
      - Solar Panel Tracker
      - Gas Fired Irons
      - Wind Turbine

2. If you could only take one item, what would it be and why?
   - Solar Stove

3. During the development of this trailer we will be going on three field tests the locations haven't been confirmed but we are thinking, one at the Barcelona Settlement, and one at a rural settlement and the final one at a school. If you are provided with free advertising what would or could you contribute?
   - Can't afford to help out with anything other than information at this time

4. We will be conducting training sessions; do they have any junior staff who would like to attend (max. 2)? The outcome of these training sessions will hopefully be the selection of two volunteers to accompany the trailer.
   - Staff is too small to be interested

5. Do you have any suggestions or comments on the general construction of the trailer?
   - Can help with doing solar calculations for the trailer
   - Talk to Noddy at the MME because they are also creating a trailer
   - Gave us print out of prices

Respondent: Niko Brueckner **Date/Time:** March 29, 2005- 2:00pm
Company: Namibia Engineering Corporation
Contact Details: Address: P.O. Box 5052, Windhoek, Namibia
Location: 21 Joule St

Telephone: (264) 61 223926
Fax: (264) 61 232890
Cell: (264) 81 1244740
Email: nbrueckner@namencor.com.na
Web: www.namencor.com.na

Area of Expertise: Solar Water Heaters
Supplier or Non-Profit: Supplier

1. In your opinion what technologies should be included in the trailer?
    - Solar water heating- need a working system (access to water necessary); needs to be folded up for transport;

    - Solar water pumping- folded for transport; components should be mounted on boards when demonstrating; have a description panel showing how it works and explain it out; explain to people why the system should be used (current water conditions, etc); try to target urban areas since most rural areas use solar heaters;

    - Electrical submersible pump- operated from solar or battery, which allows for usage even when it's not sunny out (make sure people know this); modular system; 2 or 3 different pump types; easy to install on your own (hence no added on installation fees, etc)

    a. What technologies can they supply? Can you supply any brochures or documentation?
    - Solar water heater and electrical submersible pump; also will look into brochures

2. If you could only take one item, what would it be and why?
    - Solar water heater- usually ½ of the average home's energy bill is water heating; since the cost of power continue to rise in Namibia and power outages will increase because of the energy situation in South Africa (Namibia's main source of energy) so it will save home owners money in the end; also the implementation of these types of systems will allow Namibia to become more self reliant

    - Problems to be aware of:
      Expensive process (N$10,000-15,000) and usually paid with a 5% interest over 5 years; because of this only 500-600 systems over the past 6-7 years; needs to be a subsidization and loans; Market needs to be aware of the possibility and the benefits of the installation (includes: users, architects, developers, governments, policy makers) if these people are aware they can recommend as houses are being built, which is crucial;

    - Municipalities make money by buying water and electricity then selling it to the communities at higher prices; would need to replace these revenues in order to get municipalities to recommend energy efficient methods

3. During the development of this trailer we will be going on three field tests the locations haven't been confirmed but we are thinking, one at the Barcelona Settlement, and one at a rural settlement and the final one at a school. If you are provided with free advertising what would or could you contribute?
    - Will look into a possible sponsorship after talking to his manufacturers; send email

4. We will be conducting training sessions; do they have any junior staff who would like to attend (max. 2)? The outcome of these training sessions will hopefully be the selection of two volunteers to accompany the trailer.

5. Do you have any suggestions or comments on the general construction of the trailer?
    - Use lighting as energy source; keep it simple otherwise people will be overwhelmed and won't know where to start; make sure to use all resources possible in order not to waste time and money; look into getting revolving funds

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Respondent: Rolf Seiferth **Date/Time:** March 29, 2005- 4:00pm
Company: Alemdar
Contact Details: Address: Box 2409, Windhoek
Location: 9 Bach St.
Telephone: (264) 61 260338
Fax: (264) 61 260338
Area of Expertise: Built previous trailer, Solar Home Systems
Supplier or Non-Profit: Non- Profit

1. In your opinion what technologies should be included in the trailer?
    - Solar water pump
    - Solar water heater
    - Typical solar home system

    a. What technologies can they supply? Can you supply any brochures or documentation?

2. If you could only take one item, what would it be and why?

3. During the development of this trailer we will be going on three field tests the locations haven't been confirmed but we are thinking, one at the Barcelona Settlement, and one at a rural settlement and the final one at a school. Do you know of any company or suppliers that have been friendly donation or sponsorship?

4. We will be conducting training sessions; do they have any junior staff who would like to attend (max. 2)? The outcome of these training sessions will hopefully be the selection of two volunteers to accompany the trailer.

5. Do you have any suggestions or comments on the general construction of the trailer?
    - Don't use fridge (explain that it's not practical)
    - Don't use wind generators (sand gets embedded)
    - Most resident of rural areas will not use solar cookers
    - Find energy consumption of TV, radios, ect.
    - Try to offer alternative TVs if possible (not black and white) that use less energy

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Respondent: Harald Schütt **Date/Time:** March 30, 2005 – 10:00am
Company: Amusha
Contact Details: Address: Box 21146, Windhoek Namibia
Location: HRDC
Telephone: (264) 061 232333
Fax: (264) 061 237823
Cell: (264) 081 1291223
Email: herald@namibnet.com
Area of Expertise: EE and RE technology, rural education
Supplier or Non-Profit: Non- Profit

1. In your opinion what technologies should be included in the trailer?
    - Solar stove
    - Solar water heater
    - Low energy consumption refrigerator, TV and radio

    a. What technologies can they supply? Can you supply any brochures or documentation?

2. If you could only take one item, what would it be and why?

3. During the development of this trailer we will be going on three field tests the locations haven't been confirmed but we are thinking, one at the Barcelona Settlement, and one at a rural settlement and the final one at a school. Do you know of any company or suppliers that have been friendly donation or sponsorship?

4. We will be conducting training sessions; do they have any junior staff who would like to attend (max. 2)? The outcome of these training sessions will hopefully be the selection of two volunteers to accompany the trailer.

5. Do you have any suggestions or comments on the general construction of the trailer?
   - Rural communities have no abstract view of things such as electricity, so visual representation (ex. Blue water to represent electricity) is key
   - Energy efficiency must be addressed on a lifestyle level in Namibia to make a difference
   - Rural communities think on a linear level rather than a process/goal level, so it is important to remember this
   - Actual demonstrations of solar water heater and solar stove, so the people can see them working are very important
   - Write large, older decision makers often do not have glasses
   - Mount solar panels to top of trailer
   - Rural communities will relate to a TV much more readily than a projector and a screen, so use of a TV is essential

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Respondent: Noddy Hipangelwa and Prem Jain **Date/Time:** March 31, 2005 – 9:00 am
Company: Ministry of Mines and Energy
Contact Details: Address: 1 Aviation Road
Eros Airport
Private Bag 13297 Windhoek
Location: Ministry of Mines and Energy
Telephone: (264) 061 2848168/11
Fax: (264) 061 2848200
Cell:
Email: pjain@mme.gov.na
Area of Expertise:
Supplier or Non-Profit: Non- Profit

1. In your opinion what technologies should be included in the trailer?
   - Solar lighting (solar home system)
   - Solar water heating
   - Solar cooker
   - Solar water pump
   - Biogas? (may be too large)

2. If you could only take one item, what would it be and why?

3. During the development of this trailer we will be going on three field tests the locations haven’t been confirmed but we are thinking, one at the Barcelona Settlement, and one at a rural settlement and the final one at a school. Do you know of any company or suppliers that have been friendly donation or sponsorship?

4. We will be conducting training sessions; do they have any junior staff who would like to attend (max. 2)? The outcome of these training sessions will hopefully be the selection of two volunteers to accompany the trailer.
    - Contact director of Ministry of Mines and Energy

5. Do you have any suggestions or comments on the general construction of the trailer?
    - They were interested in sponsoring the project in some way. The ministry is pursuing a similar project and they were interested in funding our trailer if they could use it when we were finished.

Respondent: Conrad Roedern **Date/Time:** April 4, 2005- 4:00pm
Company: Solar Age Namibia
Contact Details: Address: P.O. Box 9987, Windhoek
Location: 2 Jeppe St (Southern Industrial)
Telephone: (264) 61 215809
Fax: (264) 61 215793
Email: roedern@iafrica.com.na
Area of Expertise: Solar Home Systems and Appliances
Supplier or Non-Profit: Supplier

1. In your opinion what technologies should be included in the trailer?
    - Solar Home System
    - Solar Water Heater
    - Energy Efficient Stove
    - Solar Box Cooker
    - Parabolic Cooker
    - Solar Water Pump
    - Cell Phone Charger
    - Barber Kit
    - Refrigerator
    - Television
    - Iron

    a. What technologies can they supply? Can you supply any brochures or documentation?
    - Solar Home System and all parts necessary to run it
    - TV
    - Iron

2. If you could only take one item, what would it be and why?
    - Solar Home System because it shows all of the important devices that can be run with solar power

3. During the development of this trailer we will be going on three field tests the locations haven’t been confirmed but we are thinking, one at the Barcelona

Settlement, and one at a rural settlement and the final one at a school. If you are provided with free advertising what would or could you contribute?

4. We will be conducting training sessions; do they have any junior staff who would like to attend (max. 2)? The outcome of these training sessions will hopefully be the selection of two volunteers to accompany the trailer.

5. Do you have any suggestions or comments on the general construction of the trailer?
   - Need to create a plan of attack
   - Use a TV to show technologies that don't fit into the trailer
   - Make announcements in local papers to see if there are communities who are interested in having the trailer come to their area
   - Look into the 12V Grundig Color TV
   - The use of a large refrigerator can decentralize the business loop and allow things like women selling cold fresh produce to occur
   - No need for BioGas anymore
   - Be sure to prepare wood with the stoves to show their effectiveness
     -Have people answer questions like where to place the stove and such. For those who get the answers correct they receive a plate of food.
   - Appearance must be "sexy"
   - Videos in local languages
   - Can have solar run shop
     -Would have: Cash Til Machine, Music, Lighting, Refrigerator
   - Solar Water Heater- simple system with black jerry cans
   - Don't use makeshift materials- things must be able to last
   - Need to make it clear that it's better to own things then pay a fee for service

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Respondent: Catherine Odada **Date/Time:** April12, 2005- 3:00pm
Company: UNDP
Contact Details: Location: Sanlam Center, 13th Floor
Telephone: (264) 61 6232
Email: catherine.odada@undp.org
Area of Expertise: Renewable Energy and Energy Efficiency throughout Namibia
Supplier or Non-Profit: Non- Profit

1. In your opinion what technologies should be included in the trailer?
   - Full agreed with our contents list that we have compiled
   - Look into photovoltaic systems
   - Vesto stove- asses why haven't they worked well, not enough marketing
   - Rocket Stove

   a. What technologies can they supply? Can you supply any brochures or documentation?

2. If you could only take one item, what would it be and why?

3. During the development of this trailer we will be going on three field tests the locations haven't been confirmed but we are thinking, one at the Barcelona Settlement, and one at a rural settlement and the final one at a school. Do you know of any company or suppliers that have been friendly donation or sponsorship?

4. We will be conducting training sessions; do they have any junior staff who would like to attend (max. 2)? The outcome of these training sessions will hopefully be the selection of two volunteers to accompany the trailer.

5. Do you have any suggestions or comments on the general construction of the trailer?
    - Focus on producer/ supplier chain
      -If products are produced where they are supplied it reduces the cost greatly because there are no transportation fees involved
    - GECO technology, cheaper, charcoal, burns slowly and cleanly
    - Target SMEs
    - Be sure to fit the trailer contents to cover all 13 regions
      -North- depends on wood, no wind, Vesto is perfect
      -South/ Coast- wind is important
    - Social acceptance- positive improvements for environment, health, economy
    - Individuals and Business can/ will soon be able to receive loan and subsidies for RE and EE product
    - Kitchen Management Techniques- no stoves in closed rooms
      -Cover things like where to place stoves, etc.
    - Schools- put RE and EE information into school curriculum
      -Possibly work with the Ministry of Education
      -Kids see things when they are young and then they are more willing to accept them
    - This project is a "stepping stone" because right now "people basically are going on nothing"
    - Create all documents in other languages

Respondent: Georgie Frohlich **Date/Time:** April 22, 2005- 8:30am
Company: Desert Research Foundation of Namibia
Contact Details: Address: Box 20232, Windhoek
Location: 7 Rossini Street, Windhoek-West
Telephone: (264) 061 229855
Fax: (264) 061 230172
Area of Expertise: Educational Materials

Supplier or Non-Profit: Non- Profit

1. In your opinion what technologies should be included in the trailer?
   a. What technologies can they supply? Can you supply any brochures or documentation?

2. If you could only take one item, what would it be and why?

3. During the development of this trailer we will be going on three field tests the locations haven't been confirmed but we are thinking, one at the Barcelona Settlement, and one at a rural settlement and the final one at a school. Do you know of any company or suppliers that have been friendly donation or sponsorship?

4. We will be conducting training sessions; do they have any junior staff who would like to attend (max. 2)? The outcome of these training sessions will hopefully be the selection of two volunteers to accompany the trailer.

5. Do you have any suggestions or comments on the general construction of the trailer?
   - Namibian Environmental Certification Course
     -Teaches interested parties how to develop curriculum or courses
   - EnviroTeach
     -Aimed at schools
     -Brochures written to be incorporated into curriculum
   - Graham Wilson
     -Keeps DRFN library of teaching materials
   - Most important thing in order to teach people is to listen to what they already know and then build on that knowledge
     -Participation is key
   - Find out what campaigns have already been done
     -Catherine Matthews (61) 237627
     -John Pallett

Respondent: Kaatry Imalwa **Date/Time:** April 22, 2005- 10:00am
Company: Office of the President- National Planning Commission Secretariat
Contact Details: Address: Private Bag 13356, Windhoek
Location: Luther Street, Government Office Park, Block D, Room 111
Telephone: (264) 061 2834144
Fax: (264) 061 226501
Cell: (264) 081 1228299
Email: kimalwa@npc.gov.na
Area of Expertise: Regional and Sectoral Planning

Supplier or Non-Profit: Non- Profit

1. In your opinion what technologies should be included in the trailer?
    - Wood Efficient Stoves

    a. What technologies can they supply? Can you supply any brochures or documentation?

2. If you could only take one item, what would it be and why?

3. During the development of this trailer we will be going on three field tests the locations haven't been confirmed but we are thinking, one at the Barcelona Settlement, and one at a rural settlement and the final one at a school. Do you know of any company or suppliers that have been friendly donation or sponsorship?

4. We will be conducting training sessions; do they have any junior staff who would like to attend (max. 2)? The outcome of these training sessions will hopefully be the selection of two volunteers to accompany the trailer.

5. Do you have any suggestions or comments on the general construction of the trailer?
    - Rural Electrification Project- electricity to centers (schools, clinics, etc), free of charge
    - People will want it **but** can they afford it?
    - She thinks we have covered all of the necessary technologies
    - Go through Regional Councilors to contact people
    - Go to the people it better than just RE and EE meetings

APPENDIX H: MATERIAL TESTING DATA

Day Test 1							
4/1/2005	Sisilation™		Sisilation™ with air space		Air Space (Control)		
Time	Thermometer 1	Thermometer 2	Therm. 1	Therm. 2	Therm. 1	Therm. 2	Iron
1000	31	26	30	25	36	30	36
1030	43	32	42	30	43	38	46
1100	49	35	47	31	49	40	50
1130	49	37	49	33	45	45	40
1200	50	36	49	33	50	40	53
1230	55	39	50	34	50	41	50
1300	49	39	45	35	44	40	44
1330	47	37	45	33	45	40	45
1400	39	33	37	31	40	35	46
1430	37	32	35	30	37	34	39
1500	35	30	34	30	36	32	37
1530	35	32	33	30	34	32	35

* Party cloudy/ Overcast

Day Test 2							
4/3/2005	Sisilation™		Sisilation™ with air space		Air Space (Control)		
Time	Thermometer 1	Thermometer 2	Therm. 1	Therm. 2	Therm. 1	Therm. 2	Iron
1000	45	36	44	35	45	39	42
1030	49	39	46	38	47	40	45
1100	54	41	50	39	50	43	49
1130	53	41	48	38	50	44	48
1200	53	41	51	38	52	44	51
1230	48	39	46	36	46	40	45
1300	57	43	53	38	53	45	52
1330	48	39	48	37	49	41	51
1400	49	40	49	38	50	41	54
1430	49	41	48	42	49	43	58
1500	48	41	48	42	49	44	49
1530	47	40	46	39	48	43	46

*Clear skies in morning, a little cloudy in afternoon/ Sunny/ Windy

Day Test 3							
4/7/2005	Sisilation™		Sisilation™ with air space		Air Space (Control)		
Time	Thermometer 1	Thermometer 2	Therm. 1	Therm. 2	Therm. 1	Therm. 2	Iron
1000	36	25	35	29	35	30	36
1030	40	30	41	30	38	33	40
1100	42	32	42	31	40	34	41
1130	43	33	43	31	40	35	41
1200	44	35	43	30	42	35	42
1230	45	35	47	32	45	36	45
1300	45	35	49	33	44	38	45
1330	47	36	46	34	44	39	45
1400	50	35	50	35	48	40	50
1430	49	30	48	35	45	40	47
1500	50	43	49	45	49	42	52
1530	46	36	45	43	42	38	44

*clear blue sky / strong breeze

Evening Test 1							
4/7/2005	Sisilation™		Sisilation™ with air space		Air Space (Control)		
Time	Thermometer 1	Thermometer 2	Therm. 1	Therm. 2	Therm. 1	Therm. 2	Iron
1600	45	40	42	40	45	40	46
1630	40	38	38	40	38	38	40
1700	32	32	35	38	34	34	32
1730	30	30	30	35	30	31	30
1800	29	29	24	32	28	28	27
1830	27	29	25	30	27	28	28
1900	25	28	25	29	27	27	27
1930	25	26	25	27	25	26	25

Evening Test 2							
4/11/2005	Sisilation™		Sisilation™ with air space		Air Space (Control)		
Time	Thermometer 1	Thermometer 2	Therm. 1	Therm. 2	Therm. 1	Therm. 2	Iron
1600	40	35	35	36	39	35	39
1630	34	32	35	35	35	34	35
1700	30	30	30	35	30	30	30
1730	29	29	29	34	29	29	29
1800	27	28	26	31	26	26	26
1830	27	27	24	29	23	23	25
1900	23	25	23	29	23	23	24
1930	23	24	23	26	23	23	23

Evening Test 3							
4/13/2005	Sisilation™		Sisilation™ with air space		Air Space (Control)		
Time	Thermometer 1	Thermometer 2	Therm. 1	Therm. 2	Therm. 1	Therm. 2	Iron
1600	38	34	38	35	35	35	39
1630	37	39	37	34	33	34	35
1700	35	35	35	33	32	30	30
1730	30	26	32	30	30	29	29
1800	28	24	30	29	27	26	26
1830	25	23	24	28	23	23	25
1900	23	22	24	27	23	23	24
1930	22	21	23	25	23	23	23

APPENDIX I: TRAILER CONTENTS LIST

Trailer Contents List

Total Cost= 20,439.47 Total Volume (m^3)= 0.0583

Key:
= Final Selected Product
= Removed from List

Contents	Energy Type	Supplier	Specifications	Approximate Dimensions: Length	Width	Height	Volume (m^3)	Exact Dimensions: Length	Width	Height	Volume (m^3)	Actual Cost (N$)	Donation (N$)	Product Choice	Quantity	Final Cost (N$)
Battery	Electricity	Willard	Deep System, 105 Amp/hr, Sealed/ Maintenance Free	0.3	0.15	0.15	0.00				0.00				2	0.00
		Kalahari Sun	Willard (LS 105) 10008-WS semi-sealed maintenance free lead-acid battery with a capacity of 95Ah @ C20 @ 25°C or 105A/h @C100 @ 25°C @ 1.260 S.G. with a life cycle of 800cycles @ 10% cycle duty @ 25°C, 12 month guarantee	0.3	0.15	0.15	0.00	0.35	0.18	0.25	0.02	433.04		X	2	866.08
Lights	Electricity	Kalahari Sun	Rectangular Bulkhead Solar Lamps, 12V, 7W Energy Saving Bulb, toggle switched	0.05	0.05	0.1	0.00				0.00	109.57		X	2	219.14
Radio	Electricity	HiFi Corp.	with CD player	0.4	0.2	0.15	0.01				0.00	224.95		X	1	224.95
TV	Electricity	Websearch		0.5	0.25	0.5	0.00				0.00				1	0.00
		HiFi Corp.	26" LCD (TV)	0.5	0.25	0.5	0.00				0.00	16,949.95			1	0.00
Refrigerator	Electricity	Safari Den	Engel- 40L	0.631	0.369	0.508	0.00	0.631	0.369	0.508	0.00	4,995.00			1	0.00
		Cymot	Engel- 40L	0.631	0.369	0.508	0.00	0.631	0.369	0.508	0.12	4,590.00		X	1	4,590.00
		Safari Den	Engel- 60L	0.79	0.49	0.441	0.00	0.79	0.49	0.441	0.00	6,920.00			1	0.00
		Cymot	Engel- 60L	0.79	0.49	0.441	0.00	0.79	0.49	0.441	0.00	5,950.00			1	0.00
Solar Water Pump	Electricity	Solar Age	Shurflo pump, 9300, max 60m	0.2	0.15	0.15	0.00				0.00	4,519.50	2,259.75	X	1	2,259.75
		Terrasol		0.2	0.15	0.15	0.00				0.00				1	0.00
Inverter	Electricity	Kalahari Sun	SMART Inverter with integrated Charge Regulator	0.2	0.2	0.1	0.00				0.00	1,129.56			1	0.00
		Solar Age	Inverter, Phoenix 12V/301Va	0.2	0.2	0.1	0.00				0.00	1,552.50	776.25	X	1	776.25
DVD-Player	Electricity	HiFi Corp.		0.25	0.3	0.1	0.01				0.00	329.95		X	1	329.95
Cell Phone Charger	Electricity	Solar Age	12V	0.1	0.1	0.1	0.00				0.00	48.00	24.00	X	4	96.00
Power Drill	Electricity	Game	Black and Decker 3.6V- 220V Cordless Drill	0.3	0.3	0.2	0.02				0.00	244.95		X	1	244.95
Tire Compressor	Electricity	Game	AutoGear-12V mini compressor	0.25	0.25	0.25	0.02				0.00	86.95		X	1	86.95
		Safari Den	12V	0.25	0.25	0.25	0.00				0.00	799.95			1	0.00
Clippers	Electricity	Game	220V	0.1	0.1	0.2	0.00				0.00	105.00			1	0.00
		HiFi Corp.	220V	0.1	0.1	0.2	0.00				0.00	52.95		X	1	52.95
Energy Consumption Model	Electricity	Terrasol	Small Electric Motor 12V	0.4	0.4	0.4	0.06				0.00	200.00	Donation	X	1	0.00
Solar Panels	Electricity	Kalahari Sun	75W, 25 year warranty Weight & dimensions 520mm x 1200mm (35mm)	1	0.3	0.05	0.00	0.52	1.2	0.035	0.02	2,130.00		X	4	8,520.00
		Terrasol	75W Panels	1	0.3	0.05	0.00				0.00				4	0.00
		Willard	75W Panels	1	0.3	0.05	0.00				0.00				4	0.00
Iron	Stand Alone	Web search	Non-electric, work with wood efficient stove, southern Africa	0.1	0.05	0.1	0.00				0.00				1	0.00
Solar Box Cooker	Stand Alone	Solar Stove Project	Chicken size	0.5	0.5	0.5	0.13				0.00	550.00		X	1	550.00
Solar Parabolic Cooker	Stand Alone	Safari Den	Medium	1	1	0.5	0.50				0.00	730.00		X	1	730.00
		Safari Den	Small	1	1	0.5	0.00				0.00	640.00			1	0.00
Wood Efficient Stove (Vesto)	Stand Alone	Terrasol	3kg	0.4	0.4	0.75	0.12	.31	.31	.4	0.04	399.00	Donation	X	1	0.00
Wood Efficient Stove (Tso-Tso)	Stand Alone	R3E		0.5	0.5	0.6	0.15				0.00	180.00		X	1	180.00
Wood Water Heater	Stand Alone	Terrasol					0.00				0.00					0.00
Wind Generator	Stand Alone	SolTec		0.35	0.35	0.75	0.00				0.00				1	0.00
		Terrasol	9 kg	0.35	0.35	0.75	0.09	.25	.25	.6	0.04	2,375.00	650.00	X	1	650.00
Shack Model	Model	Create/ Build		0.4	0.4	0.1	0.00				0.00				1	0.00
Solar Water Heater Model	Model	Cymot	Solar Water Shower	0.4	0.01	0.3	0.00				0.00	62.50		X	1	62.50
Energy Resource Model	Model	Create/ Build		1	0.1	1	0.00				0.00				1	0.00
BioGas Stove	Model	Create/ Build	Video and Posters				0.00				0.00					0.00

APPENDIX J: CONTENTS BREAKDOWN

Energy Demonstration Trailer

Contents and Purchasing Information

Habitat Research and Development Center
Box 40765, Windhoek
(061) 268222

Product Name: **Solar Box Cooker**

Supplier: The Solar Stove Project Valombola
Address: Private Bag 5516, Windhoek
Telephone: (065) 231463
Email: robeh@iway.na

Cost: N$ 500,00-chicken size (April, 2005)

Purpose:

- Replaces the place of a conventional oven
- No fuel necessary for operation
- Cooks your meal in 1-3 hours using only sunlight

Why Chosen:

- Uses no fuel at all
- Cost of stove can be recovered in less than a year from money saved on firewood

Product Name: **Solar Home System**

Supplier: SolTec c.c.
Address: Box 314, Windhoek
Telephone: (061) 235646
Email: h.steuber@soltec.com.na

Cost: N$ 7.068,45 (April, 2005)

Purpose:

- Stores solar energy in batteries until needed
- Provides home with 220V AC current
- Ordinary appliances can be plugged in directly
- Powers TV, radio, lights, refrigerator, and other household appliances

Why Chosen:

- Gives homeowners a viable alternative to increasingly expensive electricity
- Can power any 12 or 220V appliance through use of an inverter

Product Name: **Solar Water Heater**

Supplier: SolTec c.c.
Address: Box 314, Windhoek
Telephone: (061) 235646

Cost: N$ 8.500,00 (April, 2005)

Purpose:

- Uses solar energy to heat water for cleaning, bathing, etc
- Uses no electricity at all
- Requires running water for operation

Why Chosen:

- Cost of unit is recovered after only a few years worth of energy savings

Product Name: **Solar Water Pump**

Supplier: Solar Age Namibia
Address: Box 9987, Windhoek
Telephone: (061) 215809

Cost: N$ 4.519,50 (April, 2005)

Purpose:

- Uses solar energy to pump water from boreholes
- Batteries store energy for use at night and on cloudy days

Why Chosen:

- Allows boreholes to be dug in remote locations away from line power
- Completely standalone system requires little maintenance or attention during operation

	**Product Name: Vesto Stove** **Supplier:** Terrasol **Address:** Box 6036, Windhoek **Telephone:** (061) 239454 **Cost:** N$ 399,00 (April, 2005) **Purpose:** • Can be used to replace a stove • Uses 60% less the amount of firewood as compared to an open fire • Has an integrated heat regulator to control cooking temperature **Why Chosen:** • Uses very little fuel • Small and compact size makes it easy to transport

	**Product Name: Wind Charger** **Supplier:** Terrasol **Address:** Box 6036, Windhoek **Telephone:** (061) 239454 **Cost:** N$ 5.000,00 (August, 2005) **Purpose:** • Captures wind energy in batteries until needed • Provides home with 220V AC current • Ordinary appliances can be plugged in directly • Powers TV, radio, lights, refrigerator, and other household appliances **Why Chosen:** • Gives homeowners a viable alternative to increasingly expensive electricity • Can power any 12 or 220V appliance through use of an inverter

APPENDIX K: CONTENTS LIST EXPLANATION

Trailer Contents List Explanation

Contents	Demonstration Style	Why?
Solar Home System	Actual Working System	Power source for trailer
	Water Model	Shows the power consumption visually
	Board of all of the pieces	Shows technical side
Solar Cooker	Actual Working Solar Box Cooker	Trainers can cook with the box cooker for the communities
	Small Parabolic Cooker	The parabolic cooker is much more impressive in action than that box cooker
Wood Efficient Stove	Actual Working Cooker	Trainers can cook with it when there is no sun and to show communities how it works
Solar Water Heater	Model: Use Camping Shower	Full size water heater is too big and this demonstration will show the principle of the water heater just as sufficiently
Wind Generator	Actual Generator	Shows alternative power source
Shack Model	Small Model Shack	Shows insulation and other change benefits
	Better Home Brochure	Show how to do modifications
Overall List	Poster and Brochure	To give exact information on the contents: where they can be purchased, how much they cost, etc. In addition, it is especially important for those items that are too large to fit in the trailer to have detailed information be available.

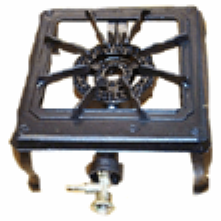
APPENDIX L: CAMPING SUPPLIES

Camping Gear from Cymot

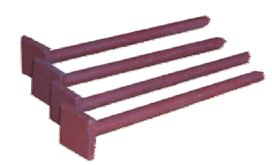
Total Cost: N$ 8,592.30

Gear	Name	Order Number	Unit Price (N$)	Quantity	Total Cost (N$)
Braai grid	Chicken Grill	9119350030	50.00	1	50.00
Canvas wash sink	Bundu Safari Wash Stand	9119230110	210.00	1	210.00
Chairs	Fishing Chair D-250	9119200020	240.70	2	481.40
Cups	Tumbler Mug	9119310420	11.60	2	23.20
Cutlery	4 pce Chow Kit	9119300850	25.80	2	51.60
	3 pce Kitchen Set	9119350830	235.80	1	235.80
First aid kit	Professional First Aid Kit	9119660040	373.00	1	373.00
Gas cooker	Burner Table Model CA3	9119320050	85.70	1	85.70
Gazebo	Polyprop Gazebo Junior	9119070050	705.00	1	705.00
Ground sheet	Polyethylene Tarpaulins/Groundsheet	9119070340	163.00	1	163.00
Ground sheet stakes	Groundsheet anchor pegs	9119070410	19.60	1	19.60
Jerry cans	20 liter Jerry Can Water	9131012023	159.00	4	636.00
Mosquito net	Mosquito Net Nylon Double	9119120040	62.80	2	125.60
Ordinary tent (2 people)	Kaoko	9119010200	3,098.00	1	3098.00
Pots and pans	Pot No. 2	9119330120	257.40	1	257.40
	Fry Pan Black	9119310010	99.50	1	99.50
Sleeping/bedrolls	Roll-Up Canvas Covered Mattress	9119110220	357.00	2	714.00
Storage bins	Storage Box	9119210630	251.00	4	1004.00
Table	Family Table 70x70cm	9119210010	259.50	1	259.50

Cooking- Food Supplies

	Braai grid	Cups	Cutlery		Gas cooker	Pots and pans	
Name:	Chicken Grill	Tumbler Mug	4 pce Chow Kit	3 pce Kitchen Set	Burner Table Model CA3	Pot No. 2	Frying Pan Black
Price (N$):	50.00	11.60	25.80	235.80	85.70	257.40	99.50
Order Number:	9119350030	9119310420	9119300850	9119350830	9119320050	9119330120	9119310010
Size:	440 x 340 x 50 mm	375 ml				4.8 Liter 8.7kg	30 cm diameter
Material:						Cast Iron	Steel
							

Shelter- Furniture

	Chairs	Gazebo	Ground Sheet		Mosquito Net	Ordinary Tent	Sleeping/Bedroll	Table
Name:	Fishing Chair D-250	Polyprop Gazebo Junior	Polyethylene Tarpaulins/Groundsheet	Groundsheet anchor pegs	Mosquito Net Nylon Double	Kaoko	Roll-Up Canvas Covered Mattress	Family Table
Price (N$):	240.70	38,538.00	163.00	19.60	62.80	3,098.00	357.00	259.50
Order Number:	9119200020	9119070050	9119070340	9119070410	9119120040	9119010200	9119110220	9119210010
Size:		280 x 330 x 180 cm	3 x 3 m 1800 g	13 x 8 mm		210 x 210 x 150 cm	190 x 65 x 7 cm	70 x 70 cm
Material:	D-250 ripstop canvas cover	Polyprop	Polyethylene			Canvas		Steel
								

Miscellaneous

	Canvas Wash Sink	First Aid Kit	Jeery Cans	Storage Bins
Name:	Bundu Safari Wash Sand	Professional First Aid Kit	20 liter Jerry Can Water	Storage Box
Price (N$):	210.00	373.00	159.00	251.00
Order Number:	9119230110	9119660040	9131012023	9119210630
Size:				39.5 x 50 x 26 cm
Material:			Metal	
				

APPENDIX M: STAKEHOLDERS CONTACT INFORMATION

Stakeholders Contact Information

Name	Company	Location	Address	Telephone	Fax
Amalwa, Kaatry	National Planning Commission	Block D2, Government Office Park, Lüther Street	Private Bag 13356, Windhoek	(061) 283 4144	(061) 226501
Amanyanga, G.	Ministry of Mines and Energy	1 Aviation Rd., Eros Airport		(061) 2848322	(061) 2848200
Amputu, Fillipus	Ministry of Mines and Energy	1 Aviation Rd., Eros Airport		(061) 2848294	(061) 2848200
Brueckner, Niko	Namibia Engineering Corporation	21 Joule St., Southern Industrial	Box 5052, Windhoek	(061) 236720	(061) 232375
Frohlich, Georgie	Desert Research Foundation of Namibia	7 Rossini Street, Windhoek-West	Box 20232, Windhoek	(061) 229855	(061) 230172
Haashela, Hendrina	Ministry of Mines and Energy	1 Aviation Rd., Eros Airport		(061) 2848297	(061) 2848200
Hipangelwa, Noddy	Ministry of Mines and Energy	1 Aviation Rd., Eros Airport		(061) 2848171	(061) 2848200
Jain, Prem (Ph.D)	Ministry of Mines and Energy	1 Aviation Rd., Eros Airport	Private Bag 13297, Windhoek	(061) 2848168/11	(061) 2848200
Nangolo, Veiko	Ministry of Mines and Energy	1 Aviation Rd., Eros Airport		(061) 2848170	(061) 2848200
Nghitila, Teofilus	Ministry of Environment and Tourism	6th Floor Capital Centre, Levinson Arcade, Windhoek		(061) 249015	(061) 240339
Odada, Catherine	UNDP			(061) 2046232	
Prada, Nelson	Namibia Rural Development Programme	Oponganda Community Centre, Grysblok, Katutura	Box 24886, Windhoek	(061) 237279	(061) 234378
Roedern, Conrad	Solar Age	2 Jeppe St., Northern Industrial	Box 9987, Windhoek	(061) 215809	(061) 215793
Schutlz, Robert	HRDC	HRDC Building	Box 40765, Windhoek	(061) 268222	(061) 268201
Schultz, Werner	Terrasol	9 Noble St., Southern Industrial	Box 6036, Windhoek	(061) 239454	(061) 239454
Schutt, Harald	Amusha		Box 21146, Windhoek	(061) 232333	(061) 237823
Seiferth, Rolf	Alemdar	9 Bach St., Old Windhoek	Box 2409, Windhoek	(061) 260338	(061) 260338
Steuber, Heinrich	Soltec c.c.	51 Maconey St., Southern Industrial	Box 315, Windhoek	(061) 235646	(061) 250460

APPENDIX N: FORMAL QUOTE REQUEST EXAMPLE

Habitat Research and Development Center:

Energy Trailer Project

Andrew Thayer **Nathan Birmingham**
Amanda Otterman **Elizabeth Gottardi**
Phone: 061-268-231
Cell: 081-229-7620
Fax: 061-268-201
Email: athayer@wpi.edu

6-April-2005

Mr. Werner Schultz
Terrasol
9 Nobel Street
Windhoek, Namibia
Fax: 061-239454

Dear Mr. Schultz:

We are working on a project to create an energy demonstration trailer that will be used throughout Namibia to inform communities about renewable energy and energy efficiency. This demonstration trailer will travel to various rural and urban communities such as: settlements, schools, villages, and farms. The trailer will include energy technologies, brochures, videos, models and other practical presentation materials used to educate the communities.

We herewith kindly request a quotation from you for the below items that will be incorporated into the trailer:

1. **Small solar water pump, Shurflo or similar**
2. **Small 12V DC electric motor for energy consumption model**
3. **75 watt solar panels (quantity 4)**
4. **Vesto wood efficient stove**
5. **75 watt wind generator**

Please include the weights and dimensions of the items into the quotation.

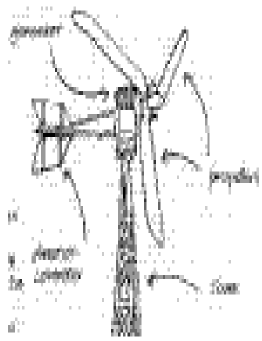
The trailer will offer an ideal platform for you to market your products. As such, we would also like to offer you an opportunity to sponsor any items at no or reduced costs. Please indicate the value of your sponsorship on the quotation. The value of your sponsorship will determine where we will display stickers with your logo and contact information on the trailer. In addition, we would distribute brochures of your company at various demonstrations. Please note though that the cost for producing the stickers and brochures cannot be covered by us.

Sincerely,

Andrew Thayer

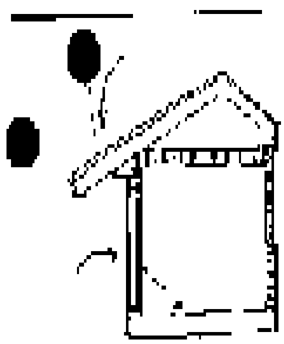
APPENDIX O: TRAINING MANUAL

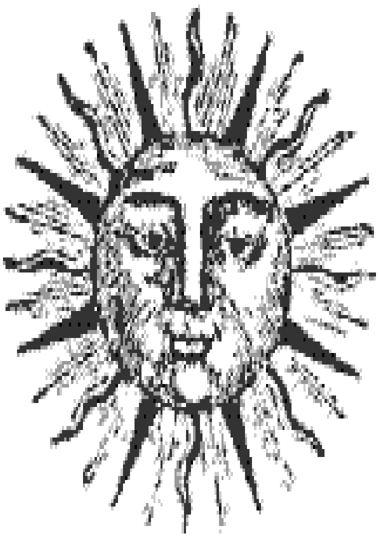
Energy Demonstration Trailer: Spreading Renewable Energy and Energy Efficiency throughout Namibia

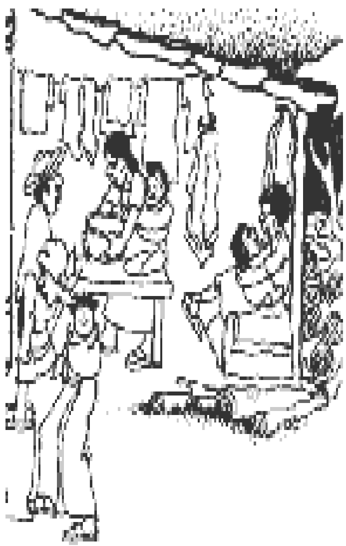


Teaching Manual:

Training the Facilitators







Compiled by:
Nathan Birmingham
Elizabeth Gottardi
Amanda Otterman
Andrew Thayer

* Table of Contents:

*Since this project is continuing, many sections will be written at a future point

INTRODUCTION TO RENEWABLE ENERGY AND ENERGY EFFICIENCY

Renewable energy (RE) and energy efficiency (EE) allows residents to generate and/ or conserve energy usage. RE is defined as resources, such as the sun, wind, and water that occur naturally and can be harnessed for energy use (Hui, 2003). EE are measures that conserve energy by reducing the amount of electricity or fuel required to perform a function (NRDC, 2005). In Namibia, RE and EE concepts could prove to be invaluable because of the alternative energy sources and reduction in energy use RE and EE supply. Although many of these technologies and techniques have a high initial cost, in most instances the long term benefits and savings outweigh the preliminary expenditure. It is necessary to educate communities about these alternative methods, which will reduce residents' hesitancy about the concepts and technologies that exist. The following manual gives you, the facilitator to these communities, a more in depth understanding of RE and EE technologies, methods, and benefits.

CLIMATE CHANGE (this section will be completed by future HRDC projects)

RENEWABLE ENERGY RESOURCES

SOLAR

The sun is a major source of energy. The thermal energy emitted from the sun's rays can be used to heat matter. In addition to heating, the sun's energy can also be converted into electricity using solar panels. Despite the vast amounts of energy that the sun produces, solar sources are not used to their full potential. In fact, if we could properly harness the sun's energy, we could meet the Earth's power demands for a year with only one minute of solar energy (Darvill, 2005). Solar energy could be especially valuable in Namibia since there are approximately 300 sunny days a year that the sun that can be utilized for cooking, water pumping, and generating electricity (Getaway Africa, 2005).

BIOMASS

Biomasses are organic materials, such as plants, animal waste, and even human waste that are available on a regular basis (Iowa State University, 2005). This can produce energy by the burning of dry biomass or by converting biomass to gas using biological or chemical processes.

BIOGAS

Biogas is formed from decomposing biological waste. The gas gathered from these wastes usually contain about 50-60% of methane, which makes it easily flammable (Biogas Works, 2000).

WIND

Wind is created due to the sun's heating of our atmosphere. Since the atmosphere is heated unevenly, parts of the atmosphere become warmer than others. The heated air pockets rise causing new air to rush in to take the warm air's place, which is how a breeze is created (Darvill, 2005). By utilizing this natural occurrence, energy can be generated through devices such as wind turbines (Office of Energy Efficiency, 2004). However, in Namibia there are places that generate large amounts of wind and others that do not. It is important to identify these locations and make the correct recommendations. See Regional Considerations for more details.

WATER

Moving water creates a strong current that can be harnessed to gather electricity. Using dams or the natural flow of water can be used to turn an electrical generator that can capture electricity (Office of Energy Efficiency, 2004). However, this is only available where there are substantial water supplies, so these types of RE technologies are not suited for most of Namibia.

ENERGY EFFICIENT MEASURES

HOUSING

Energy efficient housing is dwellings that reduce the use of materials and energy needed during construction and operation (Mumma, 2002). Using various materials and construction techniques, energy costs of a home or business can be reduced by up to 60%, which in addition will save residents money in the end (CMHC, 2005).

The five key areas in conserving energy are the building envelope, passive solar design, ventilation**,** lighting and power, and water conservation. The building envelope, or the outer protection of the building, should have increased insulation, and sealed gaps to prevent unnecessary heat loss or gain (CMHC, 2005). Passive solar design relies on the orientation and positioning of the structure and the materials used in construction. The building should be positioned facing north, with an overhang over the windows so sunlight does not come directly in (Mumford, 2004). While constructing the structure, heavy materials, such as concrete and brick, should be used since they absorb heat during the day then slowly release it at night (CMHC, 2005). Ventilation can be achieved simply and cheaply through window placement, where there are windows on both sides of the house, so when the windows are open, there is a cross breeze (Mumma, 2002). The need for lighting during the day can be greatly reduced by window positioning. Large windows strategically placed in a building can ensure that a house can operate with minimal lighting during the day. Energy efficient light bulbs also help a household reduce energy usage. Water is an important aspect to look at, since Namibia is a dry country and water can be expensive. Simple methods, such as turning off taps and conserving water usage, can help to lower household expenses.

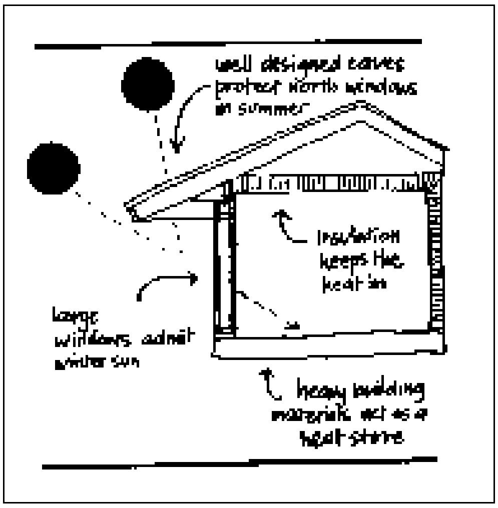


Figure 1: EE Housing Design
Source: http://www.cmhc-schl.gc.ca/en/imquaf/afho/afadv/cote/buenefho/how.cfm

HOUSEHOLD ENERGY USAGE (this section will be completed by future HRDC projects)

COMMERCIAL ENERGY USAGE

The vast majority of commercial energy usage is from lighting, cooling, and heating (DOE, 2004). There are simple and cost effective techniques that can be used in order to reduce energy costs by consuming less energy.

The techniques mentioned in the Housing section can also be applied to commercial buildings when constructing or modifying a structure. Lighting is essential to conserving energy use in commercial buildings since lights are often the largest energy consumers in a building (Commercial Energy Efficiency, 2005). Efficient light bulbs can help to reduce energy output. Another important measure to consider is day lighting, which is using sunlight to light buildings. This can be utilized by ensuring that the commercial building is constructed in a way that allows light to enter the building, such as large windows and/or skylights (Energy and Sustainable Development, 2005). However, this is only one of many measures that can be utilized since all the EE measure mentioned in this chapter can be used in a commercial structure. It is essential to stress that energy efficiency should be utilized not only in individual homes, but businesses also.

INDUSTRIAL ENERGY USAGE (this section will be completed by future HRDC projects)

AGRICULTURAL ENERGY USAGE

Farmers and ranchers can use various EE methods to help their farm run smoothly and to decrease overall costs of production. Artificial lighting uses electricity, which is often costly and unnecessary during the day. By building large efficient windows in a building, a farmer can ensure that natural light can be used to the maximum efficiency. In addition, reflectors can help to maximize the deflection of the light, allowing the light to reach the interior of the building (Mumma, 2002).

Natural ventilation is another technique that can assist in creating a comfortable, energy efficient building. Windows are key here since well placed open windows create a cross breeze that can lower the temperature inside a building. In addition, a cupola can be added to a barn in order to increase air flow. A cupola works with the fact that heat rises with the tower, placed slightly above a building’s roof, hot air can vent out of the top of the building, which pulls up the cooler air from the lower levels (Mumma, 2002). The effects of a cupola can be increased by introducing moisture to air closest to the ground, which allows the evaporated, cooler air to be drawn up throughout the building (Mumma, 2002). Wind catchers are also viable options since they capture the wind current and distribute a breeze through a building (Mumma, 2002).

Figure 2: Barn Cupola (left) and Barn construction using insulated materials (right)
Source: http://www.attra.org/attra-pub/agbuildings.html

Since most agricultural buildings in Namibia will be primarily concerned with preventing overheating, it is important to utilize basic building techniques that can help to keep the structures cool. Shading is essential and can be provided using a number of various methods. Nearby vegetation, such as trees, block sunlight from entering a barn. Also, minor construction changes can help to alleviate the warmth radiated from the sun. Building overhangs that shield windows is usually a cheap method that will benefit a farmer in the long run (Mumma, 2002). In addition, insulation can decrease heat flow and help to maintain warm or cool air.

However, it is important to note that not all techniques apply to every farm, since differences in location, environment, design, construction materials, and purpose of the building determine how effective any of the aforementioned measures would be (Mumma, 2002).

RENEWABLE ENERGY TECHNOLOGIES

SOLAR HOME SYSTEM

A solar home system consists of solar panels, batteries, an inverter, and a regulator. Combined these technologies can power homes and supplement or replace grid electricity. For further information on each of these technologies, see the following sections.

Figure 3: Solar Home System that powers lights
Source: www.eslsolar.com/IMAGES/solar-power-station.jpg

SOLAR PANELS

Solar panels convert light energy from the sun into electrical energy that can be utilized by individuals. A panel usually contains multiple solar cells wired together in order to produce the necessary voltage and current required to produce usable electricity. Depending on the type of panel one uses, between 4% and 22% of the light that hits a panel is converted to electricity (ATA, 2005). Panels perform best at low temperatures, since as the sun becomes more intense and the panels rises in temperature, the panels output decreases (JC Solar Homes, 2005). Although solar panels have a high initial cost, they usually last over 20 years with minimum maintenance, which makes it a cheaper option than grid electricity. The three types of solar panels are monocrystalline, polycrystalline, and amorphous.

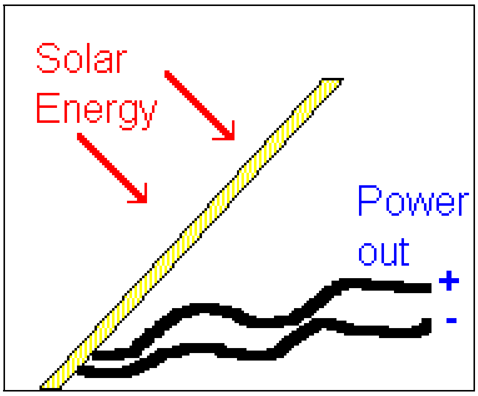


Figure 4: Basic workings of a solar panel
Source: http://www.darvill.clara.net/altenerg/solar.htm

Monocrystalline panels were the first type of panels to be developed. They are constructed from silicon slices that are cut from a large crystal (ATA, 2005). While these panels have the highest efficiency, they are also the most expensive, which makes many potential buyers weary. Polycrystalline panels are often used by manufacturers since they are cheaper to produce and purchase. In polycrystalline panels, the silicon is cast into blocks (ATA, 2005). However, these panels are less efficient as the temperature increases. The amorphous panels, constructed of amorphous silicon, are much cheaper than the other options. Amorphous panels are manufactured by spreading the silicon in thin layers on a glass plate or other backing material. These panels can serve a dual purpose as both energy acquirers and the roof of a dwelling, which also helps to lower the prices for consumers. However, it is important to note that this panel is the least efficient out of the three choices. Wattage is also important to consider when choosing a solar panel. Most solar panels usually fall between 50 and 83 watts, which is usually 1000 x 400mm (ATA, 2005). Higher wattages are the better choice for long term use. Although the individual initially spends a larger amount of money setting up the system, it produces a greater number of watts.

Figure 5: Solar Panel
Source:www.science.siu.edu/plantbiology/PLB117/JPEG%20files/SolarPanel.jpg

BATTERIES

Batteries serve as storage for the energy captured from solar panels and wind generators. This is a crucial part of an RE system, so it is necessary to understand how to properly utilize batteries in order to prolong its life. Deep cycle batteries are used for holding captured energy from the sun or wind since they are designed to resist damage from repeated deep discharges of 50-80% (deep cycling); however, they will last much longer if they are only discharged to 20% of its capacity (shallow cycling), (Forcefield, 2001).

Battery capacity is measured in amp per/hours (Ah). The amount of energy being used at one time dictates how long the supply will last. For instance, a 100Ah battery could either supply 1 amp of electricity for 100 hours or 4 amps for 25 hours (ATA, 2005). While using batteries however, it is important to remember that shallow cycles will increase battery potential. Deep cycling should be used sparingly, since it will lower the life expectancy of a battery, making a RE system more expensive. A lead acid deep cycle battery usually lasts between 300 to 5000 cycles, while nickel cadmium batteries last up to 50,000 (ATA, 2005). This range is large and depends on how an individual utilizes his/her battery storage. On a sunny day, a solar system should only do one shallow cycle a day; however, there will be times, such as cloudy days, where extra energy will need to be spent. If used sparingly, this should not have an adverse effect on the batteries' life.

Figure 6: Batteries
Source: http://www.ata.org.au/basics/basbatts.htm

INVERTER

An inverter is responsible for converting the energy stored in a RE system's batteries into 110V or 240V electricity, like that found in a typical mains power grid (ATA, 2005). This reduces cost, since an individual does not have to purchase special appliances to run them on the RE system. Inverters range in output ability from about 50 watts to 10,000 watts, which enables even industries to utilize RE systems. The average home only needs about 1000 to 2000 watts to function (ATA, 2005).

The two types of inverters are modified square wave (also known as modified sine wave) and sine wave. The sine wave inverter is the more practical choice for most individuals since it provides the same type of power of the main grid so all appliances function normally when using it. However, the modified square wave only imitates the grid power, which means that some appliances do not run well off of it and energy gets lost (ATA, 2005).

Figure 7: Inverter
Source: http://www.ata.org.au/basics/basinv.htm

REGULATOR

The regulator is essential to protecting the battery in a RE system. This piece of equipment is responsible for stopping the energy source, solar panels, wind generators, ect., after the battery has fully charged. Overcharging batteries can damage a RE storage system, so this device is important.

The two types of regulators are series and shunt. Series are the most commonly used and disconnects the panel from the battery similar to an electronic switch. This is either done like a light switch, where the effects are seen immediately or like slowly turning off a sink, which is a more gradual process (ATA, 2005). A shunt uses a different method to cease storing power since it dumps excess power as heat (ATA, 2005). Shunts work well with wind generators, since they prevent them from spinning too fast by keeping some energy on the charging source. Also, the excess heat dumped by the shunt regulator can be used to heat water or pump water, which further increases its energy efficiency (ATA, 2005).

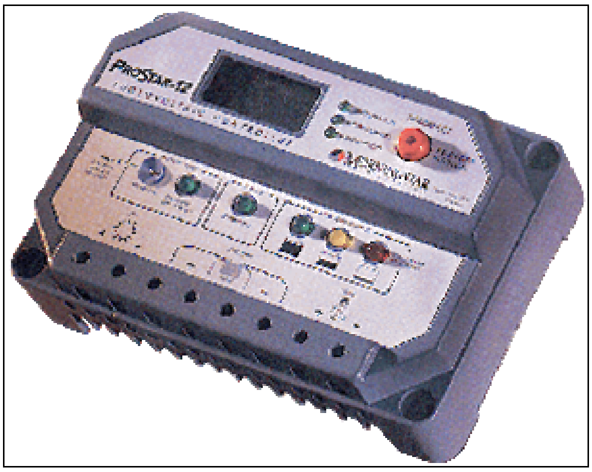


Figure 8: Regulator
Source: http://www.ata.org.au/basics/basregs.htm

SOLAR WATER HEATER

Solar water heaters preheat water for homes and businesses using the sun's energy. The heater consists of water collectors, storage tanks, and for active systems, an electric pump that circulates the heated water. However, it is not necessary to have one of these systems to heat water. By placing a black container in the sun for a few hours, the heat will collect in the container and absorb into the water, which is known as the greenhouse effect. In urban communities, it is important to emphasize that solar water heaters can save individuals significant amounts of money since usually about half of one's electricity bill is from heating water (DOE, 2005).

Figure 9: Solar Water Heater
Source: www.reactural.com/metaefficient/archives/images/solar-water-heater.jpg

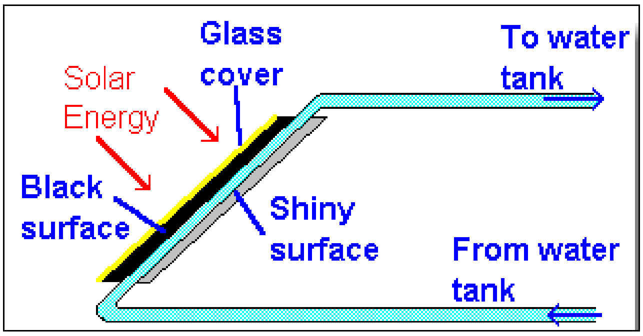


Figure 10: Workings of a solar water heater
Source: http://www.darvill.clara.net/altenerg/solar.htm

SOLAR WATER PUMP

Solar water pumps use the energy of the sun to pump water out of boreholes. A typical water system consists of solar panel(s) that collect energy, a 12V direct current (DC) pump that draws water out of the well, a controller with float switches that sense water availability, a linear current booster that gives the solar water pump the necessary increase of current to begin working even on cloudy days, and storage tanks for extra water (Forcefield, 2005). Solar water pumps are especially helpful on farms, where the alternative water pumping methods are not as energy efficient or effective. For example, hand pumping is usually very time consuming, wind generators do not work without wind and tend to require maintenance, and gas pumping is inefficient and unreliable (Forcefield, 2005).

The two types of solar pumps used are displacement and centrifugal pumps. A displacement pump uses diaphragms, vanes, or pistons to seal water in a compartment The water is then pushed out into the storage tanks where the water is held until needed. Centrifugal pumps add energy to the water using a spinning impeller that pushes it into a storage tank. The displacement pump works similar to a heart pumping blood while the centrifugal pump is like water spraying off a spinning tire (Morris, 2002).

Both pumps come with the option of being submersible, meaning the pump is placed within the water source, or surface operated, which is placed on or near the surface. A submersible pump very reliable since it is not exposed to the elements, hence it does not require special protection, and it does not require priming (Morris, 2002). Surface pumps are useful when moving water through a pipeline since it can then move water to high elevations or through long distances (Morris, 2002).

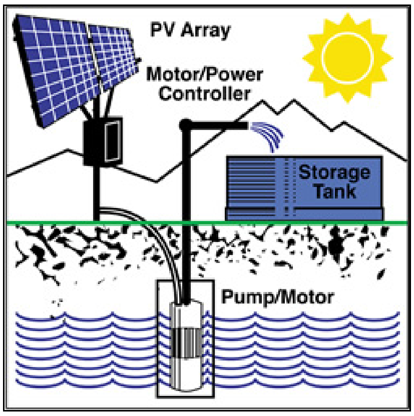


Figure 11: Workings of a solar water pump
Source: http://www.attra.org/attra-pub/PDF/solarlswater.pdf

SOLAR BOX COOKER

Solar box cookers can be used as an alternative to a conventional oven. The cookers consist of an enclosed, insulated inner box where an individual places the meal that needs to be cooked. The clear glass or plastic on the top of the cooker protects the food from bugs and the elements and allows the sun's energy to permeate the box. The reflective material on the lid of the panel directs the sunlight into the box. As the heat becomes trapped in the box, the temperature within the cooker rises and evenly cooks the meal inside (Solar Cooking, 2005).

It is important to note that using the solar box cooker does have some drawbacks since an individual must prepare the meal and begin cooking two to three hours before the meal is served (Dwyer, 1999). However, after the solar box cooker is purchased no other money will be needed for the actual baking other than ingredients, which will minimize expenses in the long run.

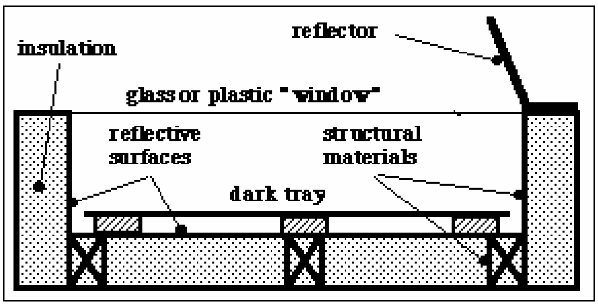


Figure 12: Solar box cooker (left) and Structure of a solar box cooker (right)
Source: http://www.exoticblades.com/tamara/sol_cook/types.html (left) and
http://www.solarcooking.org/sbcdes2.htm (right)

SOLAR PARABOLIC COOKER

Parabolic cookers are renewable energy alternatives to conventional stoves. The cooker focuses the sun's energy on the black pot containing the food, which allows the pot to heat up quickly. The reflective material or parabolic mirror surrounding the pot intensifies the amount of sunlight reflected. Since the pot is black and covered, it retains the heat inside, which warms the food, killing any bacteria and cooking the meal. A cooker can be used to fry, boil, sauté, and stir fry (CCAT, 2005).

Like the solar box cooker, after the cooker and pans are purchased there is no additional costs since all of the energy needed comes from the sun. However, it is important to convey that while using the parabolic cooker, an individual must stay attentive. Leaving the cooker unattended while it is being used could result in uncooked or burnt food when the individual returns. In order to ensure that the focus remains correct on the pot of food, an individual must adjust the cooker every 10-15 minutes so the focal point is reflected to the pot (Solar Cooker, 2005).

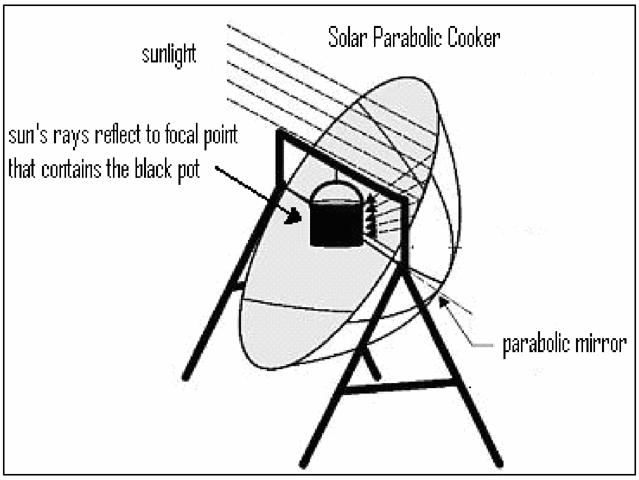


Figure 13: Parabolic cooker components (left) and Parabolic cooker (right)
Source: http://www.energieinfo.org/index_glossary.html (left)

WIND GENERATOR

Wind generators, also referred to as wind turbines or windmills, capture energy from the wind that can be used to power water pumps, homes, businesses, and charge batteries. As the wind turns the propeller around, the attached generator produces electricity (Darvill, 2005). Dwellings can install a wind generator to complement a solar home system. Also, farms and ranches tend to find wind generators extremely helpful since it can pump water for cattle and crops in addition to supplying energy (Morris, 2002).

Several factors need to be taken into account when purchasing a wind generator. An average wind generator begins to produce electricity at around 12kph and can continue to increase in energy output through 72kph (Darville, 2005). However, if the wind speed exceeds 72kph, then it is necessary to slow the propeller in order to protect it from damage (Darvill, 2005). In order to ensure that an individual is receiving maximum energy production from his/her generator, the wind generator must be placed high enough to avoid turbulence and reach strong winds (Darvill, 2005). Standard wind generators are usually about 10m above the ground, however depending on the surrounding environment it may be lower or higher since nearby large trees, buildings and other structures decrease efficiency (Wind Generators, 2005). Another factor is propeller size since larger propellers gather more electricity but also requires more wind to turn (Darvill, 2005).

Figure 14: Wind Generator
Source: www.number1source.net/ eng/products/medwind.htm

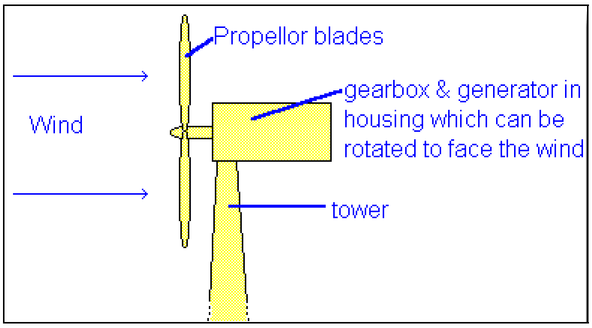


Figure 15: Components of a wind generator
Source: http://www.kansaswindpower.net/wind_generators.htm

BIOGAS DIGESTER

Biogas digesters produce fuel by converting waste products, such as manure and farm waste into gas. This gas can be used for cooking, lighting, electricity generation, and to power combustion engines (Biogas, 2005). Since the waste products are necessary for the digester to run, this technology should especially be encouraged in areas where waste is prevalent such as farms, ranches, waste treatment sites, and animal processing plants (Biogas, 2005). However, it is possible to use human waste to create the fuel also, so there is no real limitation on where the biogas digester can be used.

There are two methods of digesting the waste products. Batch type digesters convert large amounts of waste at once, which makes them more suitable for domestic applications where the waste can be converted as it becomes available (EcoGeneration Solutions, 2005). Continuous flow units are more suitable for large scale applications since the waste is added and processed on a daily basis and the process can continue even as new (EcoGeneration Solutions, 2005).

In addition to providing fuel, biogas digesters also assist in sanitization since waste is being processed and treated instead of simply used as fertilizer or left out in the open where the bacteria could cause sickness. Also, the waste that is left over, known as effluent, can be added to animals' food in order to increase the nutrients or used as fertilizer (EcoGeneration Solutions, 2005).

Figure 16: Biogas Digester
Source: http://www.igadrhep.energyprojects.net/Links/Profiles/Biogas.htm

ENERGY EFFICIENT TECHNOLOGIES (this section and all sub-sections will be completed by future HRDC projects)

LIGHTS

INSULATION

WOOD WATER HEATER

WOOD EFFICIENT STOVE

Wood efficient stoves are designed to do everything a conventional stove would without burning excess fuel. Since 93% of Namibia's homes use wood for cooking, it is important to emphasize that wood efficient stoves save money on fuel in the long run and have other benefits (FAO, 2005). Wood efficient stoves are virtually smoke free and are up to 80% more fuel efficient than its counterparts (SolCo, 2005). Since women, who are often preparing the meals for their families, get sick due to the smoke, wood efficient stoves can provide a healthier alternative. Also, the stoves are safe to use around children and in the house because there is not an open flame that could cause potential danger and fire hazards (FAO, 2005). In addition, wood efficient stoves are small and portable, so they can be easily moved in case of rain, ect.

There are various types of wood efficient stoves. The Vesto is a well-known wood efficient stove and is relatively inexpensive. The product was created in Swaziland, which ensures that it will continue to be locally available for a long time. Another type of wood efficient stove locally manufactured is the Tso-Tso. Both stoves consume about 60% less wood than a conventional stove, hence saving consumers money on fuel in the long run (FAO, 2005).

Figure 17: Vesto Cooker (left) and TsoTso cooker (right)
Source: http://www.uga.edu/bahai/2005/050330.html (left) and
http://www.fao.org/DOCREP/003/y0909E/y0909e00.htm (right)

REGIONAL CONSIDERATIONS

It is important to note that not every technology and technique is applicable in every area of Namibia. Also, there are some RE and EE concepts that may be shocking to many of the cultures in various regions. It is essential that as a facilitator, one is sensitive to the differences while presenting the materials. In addition, some technologies and techniques should be emphasized more than others due to geographic location.

In urban areas, a number of technologies should be emphasized. Since over half of the average resident's electricity bill is spent on heating water, solar water heaters should be encouraged as a viable alternative that helps residents save vast amounts of money over time (Household Energy Usage, 2005). Also, EE housing needs to be stressed as a method of maintaining temperature stability without any energy use. The industry and commercial energy usage sections should be highlighted, since most industry and businesses will be found within urban areas.

Rural areas should also focus on EE housing, since again, there is no energy usage when maintaining stability, and if an individual has no electrical cooling or heating available, he/she can still build a temperature stable structure without using energy. Since many of the rural areas will be composed of farmers, it is important to emphasize agricultural energy usage in these areas. Also, RE technologies such as the solar water pump and the biogas digester, can respectively be used to supply water to cattle and produce energy from waste products.

In Northern Namibia, most individuals utilize wood for cooking. Here we want to encourage wood efficient stoves, such as the Vesto and Tso-Tso. These stoves are not a huge change from what Northern communities already work with so they are more likely to respond to this type of technology than a solar box cooker or parabolic cooker.

In the Southern and Coastal areas of Namibia, there is constant wind generation. Because of this, it is necessary to emphasize wind generators in addition to a solar home system, since it will substantially increase the energy output from the system.

APPLIANCES (this section and all sub-sections will be completed by future HRDC projects)

IRON

CELL PHONE CHARGER

POWER DRILL

CLIPPERS

TIRE COMPRESSOR

REFRIGERATOR

MODELS (this section and all sub-sections will be completed by future HRDC projects)

SHACK MODEL

ENERGY RESOURCE MODEL
ENERGY CONSUMPTION MODEL

DISPLAYS (this section and all sub-sections will be completed by future HRDC projects)

ENERGY REQUIREMENT DISPLAY

12 VOLT DISPLAY

220 VOLT DISPLAY

DEMONSTRATION MATERIALS (this section and all sub-sections will be completed by future HRDC projects)

DVD PLAYER

TELEVISION

POSTERS

BROCHURES

CAMPING EQUIPMENT AND SETUP (this section and all sub-sections will be completed by future HRDC projects)

TENT

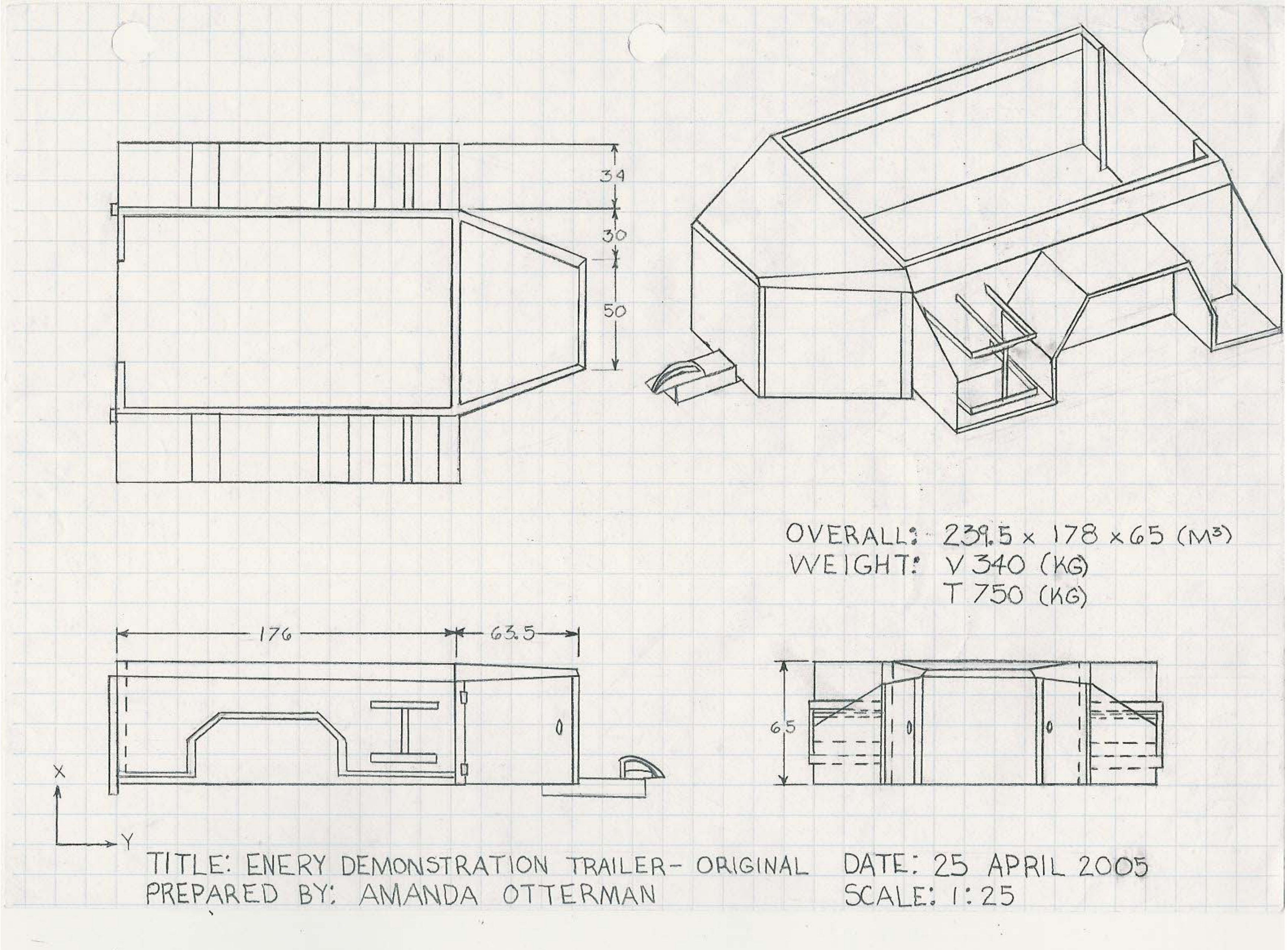
LIGHTS

COOKING

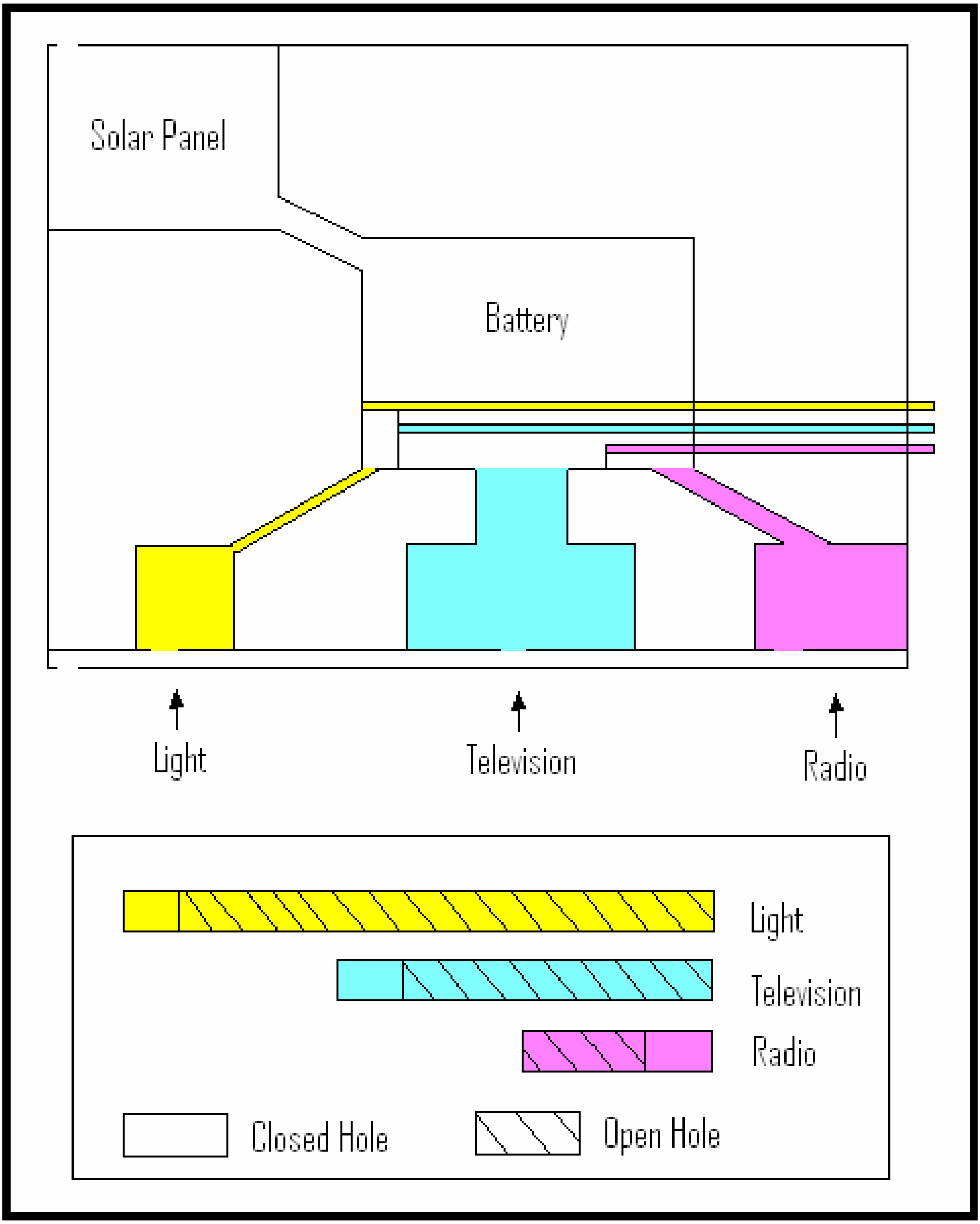
SHADING

POSITIONING AND ORIENTATION

APPENDIX P: TRAILER TECHNICAL SPECIFICATIONS



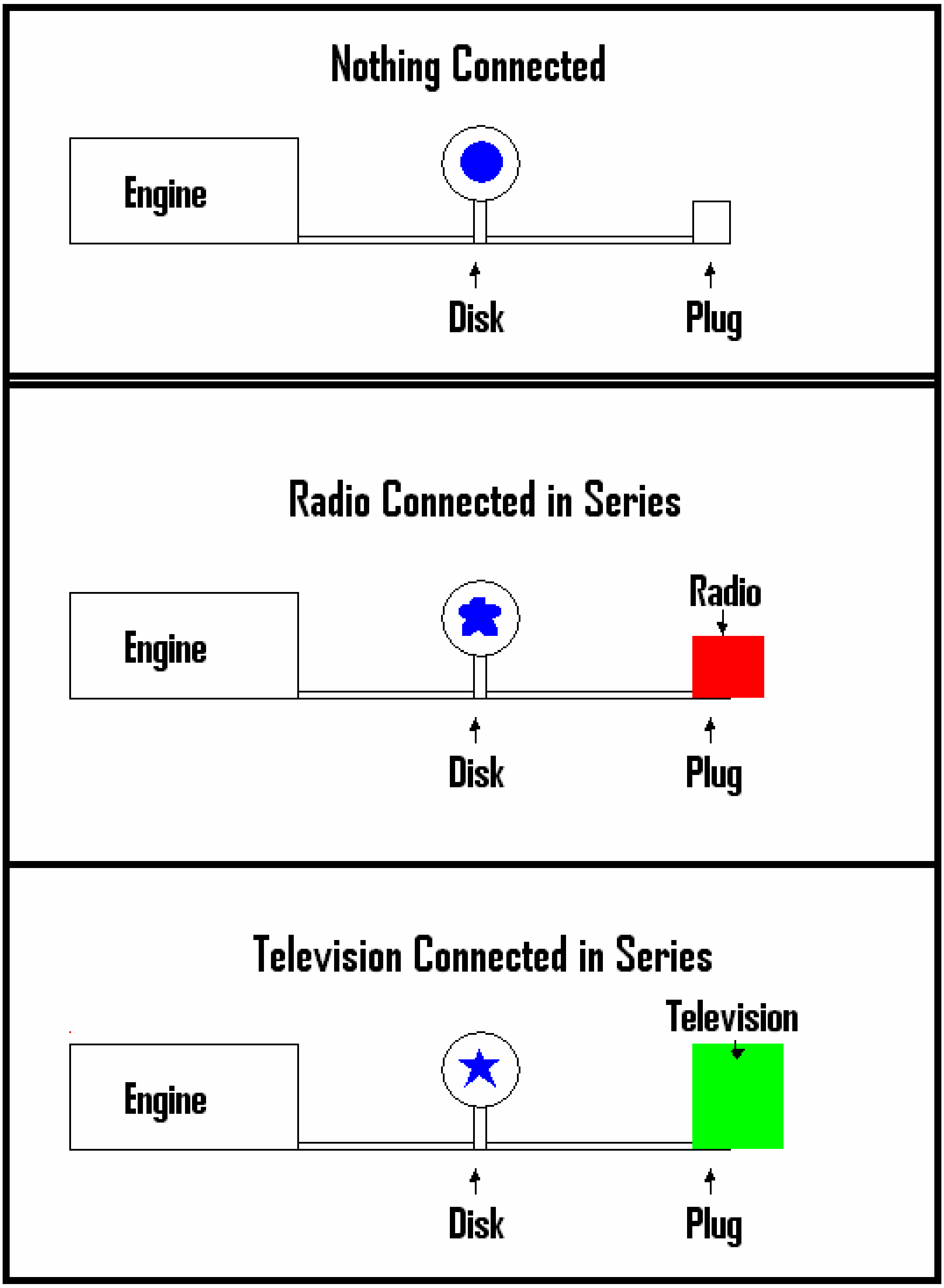
APPENDIX Q: ENERGY RESOURCE MODEL CONCEPTUAL DESIGN



Materials:

Wood, Plexiglas, and Small Beads

APPENDIX R: ENERGY CONSUMPTION MODEL CONCEPTUAL DESIGN



Nothing Connected: Disk looks like a blue spot because nothing is connected and it is spinning very rapidly.

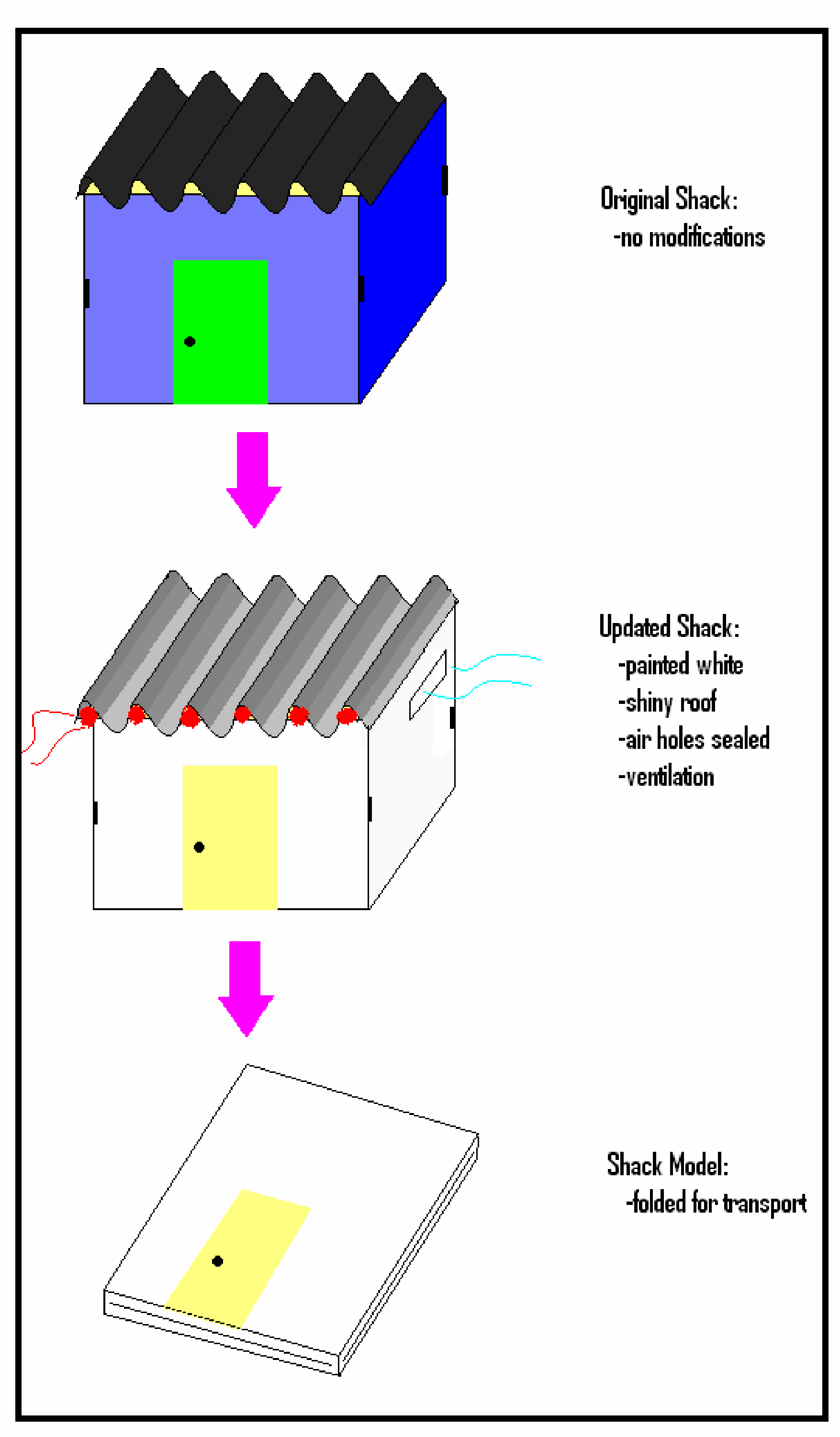
Radio Connected: Disk looks like it has a fat star on it because the spinning at slowed down a little since the radio is now requiring power.

Television Connected: Disk shows its star because the spinning has slowed down greatly since the television is now requiring power.

Materials:

12V Engine, Spinning disk, Standard plug, Wiring

APPENDIX S: SHACK MODEL CONCEPTUAL DESIGN



Materials:

Cardboard, Corrugated Iron, Hinges, Paint

PROJECT PROPOSAL

ENERGY DEMONSTRATION TRAILER

To

UNDP/GEF Small Grants Programme

September 2004

Prepared by

Desert Research Foundation of Namibia
PO Box 20232
Windhoek
NAMIBIA

PROJECT TITLE:

ENERGY DEMONSTRATION TRAILER

Project Goal:

To raise awareness and disseminate information about Renewable Energy and Energy Efficiency technologies, measure and practices in rural and peri-urban Namibian settlements

Project Objectives

To implement the "learning by showing" approach by conceptualising, designing, manufacturing and field-testing a prototype trainer-friendly promotional vehicle-drawn road-worthy trailer.

Proponent Organization

Name of the Proponent Organization:

The Desert Research Foundation of Namibia (DRFN)

Type:

Non-Governmental Organisation (NGO)

Contact Person:

Dr Mary Seely

Contact Address:

PO Box 20232

Windhoek

NAMIBIA

Tel: +264 61 229855

Fax: +264 61 230172

Email: energy@r3e.org / mseely@drfn.org.na

7 Rossini Street, Windhoek North

Legal status:

Non-Governmental Organisation (NGO)

References and previous experience

The DRFN will conduct this project in conjunction with staff of the R3E Bureau. The R3E Bureau has conducted numerous awareness raising and training initiatives these include:

- **HOME POWER Programme**: design and conceptualization of awareness materials for the a solar programme conducted on behalf of the Ministry of Mines and Energy (2003)
- **Solar Training Courses**: Range of short courses for solar technicians and suppliers in marketing, technology development and business principles (2000, 2001 and 2003)

- **Training of Trainers Course**: organized and facilitated a short course for solar technicians and suppliers to boost presentation and marketing skills (2003)
- **Better Home Event**: 1-day event to sensitise communities in Windhoek's informal settlement areas about energy efficiency issues (2004)
- **Wood Efficient Cooking**: conducted demonstrations of wood efficient stoves and assessed preferences in communities of Windhoek's informal settlement areas (2004)
- **Household Energy Consumption**: conducted an assessment into energy consumption habits and expenditures in rural and informal urban settlements and informed participants of energy alternatives (2003 and 2004)
- **Workshops and Seminars**: organized and facilitated workshops, e.g *Poverty, Energy and Gender Regional Seminar* (2002), *Regional Wind Energy Seminar* (2003)
- **Project Management**: coordinated and supervised project implementation, e.g *Namibia Biomass Energy Strategy and Management Tool* (2003), *HOME POWER Supplier Registration Process* (2003)

Governance structure

The DRFN is governed by the Board of Directors and is managed by a management team that is representative of all the heads of departments and heads of operational units. The management team reports to the Board through the Executive Director of the organisation.

Project Location

- **Initially**: Field tests will be conducted at:
  1.) The Barcelona informal settlement community on the outskirts of Windhoek. This community has already been sensitised to REEE measures and should provide a valuable starting point for field tests. Also, its proximity to Windhoek makes it ideal for interactive trail runs of the trailer and its contents.
  2.) The Okondjatu settlement, Okakarara Constituency of the Otjozondjupa Region in Eastern Namibia. The Okondjatu settlement is approximately 110 km from Okakarara with an estimated area size of 70 km². The field test will be conducted in partnership with the SGP Outase Energy Project, which has demonstrated strong willingness and the capacity to handle similar projects, and who have a need for an awareness raising approach.
  3.) A community yet to be identified that has not been involved in any REEE projects. This will allow the trailer and the awareness raising materials to be tested under typical conditions. Such a community might also include schools, kindergartens and other organisations where feasible and applicable.

- **Anticipated**: Nation-wide

Participants and Stakeholders

This proposal will initially interact and cooperate with the following stakeholders:

- **Ministry of Mines and Energy**: as prime custodian of energy awareness activities in Namibia
- **Desert Research Foundation of Namibia**: to assess the suitability of various outreach approaches with focus on the community interaction methodologies

- **Namibian Energy Technology Suppliers and Manufacturers**: for the technical design and manufacture of the Energy Demonstration Trailer
- **Namibia Mathematics and Science Teacher's Association**: to assist with the conceptualisation and compilation of suitable training materials with focus on comprehension and user-friendliness
- **Okondjatu Farmers Association**: liaison with relevant authorities for the field test

Statement of Compliance with GEF and SGP Criteria.

This proposal addresses the criteria "**Climate Change**" through introducing renewable energy and energy efficiency in a direct and interactive way to the targeted communities, with the clear purpose of encouraging the use of said energies/technologies.

Additional, in view of the prevalence for using wood for cooking in Namibia, decreased wood usage through above mentioned energies/technologies would address the issue of "**Land Degradation**" and possibly even "**Biodiversity**".

Evidence of a participatory planning process and agreement by participants with project objectives and activities.

Several discussion were held with Mr Jackson Hindjou, Okondjatu Farmers Association and coordinator of the SGP Outase Energy Project. Mr Hindjou indicated eagerness to participate in this proposal and to conduct the field testing of the trailer at Okondjatu and to act as the vital link between R3E and the Okondjatu community.

This proposal was originally drafted at request of the Ministry of Mines and Energy and submitted in early 2004, but recent budget cuts in specific budget votes stalled progress of the proposal.

Baseline assessment of relevant environmental and, if possible, socio-economic conditions.

This baseline assessment should be undertaken as part of a participatory proposal planning and development process. The baseline assessment is essential so that changes and impact brought about by the project intervention can be evaluated. It is also important to include an overview of other interventions in the area, both ongoing and planned, by local, national, and international organisations.

Clear statement of project goal, objectives, activities, and expected results and how these results will be measured.

Background

Large-scale implementation of renewable energy and energy efficiency technologies and the overall rational use of energy are hampered by two predominant factors: high capital costs and a lack of general energy awareness. Unlike the former, which is an economic problem and requires a totally different approach, the latter is inherently a social problem and must be addressed in conjunction with other social problems experienced in Namibia.

Energy awareness campaigns have been conducted by the Ministry of Mines and Energy on an annual basis for several years now. Most notable is the energy efficiency "Energise – Let's optimise" campaign and the "Home Power" solar home system campaign. These campaigns have to date comprised the distribution of brochures, stickers, calendars, T-shirts and newspaper advertisements, along with ad hoc visits and demonstrations for the target group. The visits often focus on specific aspects rather than offering a total energy awareness approach. The large distances in Namibia and the lack of human resources further hamper the effectiveness of these visits for these visits. This is further compounded by these visits often being constrained by access to suitable accommodation and basic facilities (food, water, sanitation).

In order to streamline the effectiveness of these campaigns dedicated demonstration equipment combined into an easily transportable fashion is recommended. The demonstration equipment should also be accompanied by easy-to-understand training materials and documents that will also allow trainers, who are not deeply familiar with energy concepts, to nonetheless provide comprehensive training and information dissemination sessions to the target group.

This proposal aims to improve the effectiveness of information dissemination regarding the following:

- Renewable Energy (RE) and Energy Efficiency (EE) concepts, measures and technologies
- Awareness raising of Namibia's energy sector and national programmes (e.g. HOME POWER Programme)
- Energy planning and energy management principles
- Data-gathering on present energy situation through questionnaires for later evaluation (e.g. EnPOWER Toolkit)

In addition this proposal also includes addressing the issue of accommodation for field trainers.

An example trailer is described in **Appendix A**.

Activities

Phase 1: Pre-project conceptualisation workshop and resource assessment

1. An assessment of the availability of REEE promotional and educational materials applicable to Namibia will be conducted.
2. Conduct maximum half-day conceptualisation workshop prior to commencing with the design of the Energy Demonstration Trailer in order to determine the REEE technologies as well as other suitable technologies, items and concepts that should be featured to ensure a holistic approach to REEE promotion and training in both the rural and urban settings in Namibia. The workshop should include participants from the Ministry of Mines and Energy, the University of Namibia, the Polytechnic of Namibia, education and training experts, consultants and/or people from the Namibian REEE industry and people with experience in modifying trailers for specialised purposes. The workshop should form the basis of the

conceptual design of the trailer and a strong emphasis should be placed on taking a practical approach to ensure that the results from the workshop can be applied directly to the design of the trailer and other support equipment and aids.

Phase 2: Design of the Energy Demonstration Trailer

1. Use the outcome of the workshop to design the trailer and the necessary accompanying materials (i.e. manuals, flyers, posters, etc.) The design should be done in an iterative manner with interaction between the different stakeholders and during each phase of the design. A strong emphasis should be put on making the trailer practical, durable and easy to use with the whole kit being completely self-contained, i.e. all equipment, materials, tools, etc. should be contained in the trailer itself.
2. During every stage of the design it should be ensured that the technologies and concepts demonstrated are relevant to Namibia and its people and in line with current technologies or concepts that are being promoted by the Ministry of Mines and Energy according to the White Paper on energy.
3. The resulting paper design must be of such a nature that the design can be handed as-is to a manufacturer for construction. This will ensure that additional trailers can be constructed at a substantially lower cost and that any modifications after the field-test phase can be incorporated effectively into the design.
4. The trailer should also include equipment to enable the field facilitator/trainer to stay out in the field for several days on end in reasonable comfort (i.e. provision should be made for a tent, water, fuel, etc.)
5. A description and budget should be provided which includes each item forming part of the trailer's inventory. All equipment should be readily available from suppliers and vendors in Namibia where possible. A strict budget limitation for the Energy Demonstration Trailer as a whole will be put in place with the amended Scope of Work and will be agreed between the Client and the Consultant / Contractor after receipt of the Consultant's / Contractor's proposal / quote.

Phase 3: Training Materials

1. Design a 3-day training course on RE and EE. The course will comprise a full set of training materials on each of the components of energy trailer. The materials will include a detailed description of the energy, the technology and the scientific aspects involved and must incorporate both words and graphic images. The course will further incorporate didactic, presentation and speaking skills, etiquette and inter-personal interactions, group dynamics and teaching/learning methodologies.
2. Identify and select suitable candidates (maximum 10) to be trained as Energy Trainers. Such candidates should be preferably attached to rural-based Non-governmental organisations, energy suppliers and/or have a background in marketing.
3. Organise and facilitate one course. Identify and recruit suitable resource speakers, secure venue and course equipment.

Phase 4: Field Test

1. The completed prototype trailer will be field tested in rural and peri-urban settings to assess the effectiveness of the trailer and the demonstrations that can be done using the equipment integrated into its design. Practical issues like ease of handling, loading and unloading, etc. must also be assessed.

2. The newly trained trainers will conduct these field tests under supervision of R3E.

Phase 5: Presentation, evaluation and finalisation of the Energy Demonstration Trailer

1. The results from field-tests must be well documented and presented to the stakeholders involved in the original design process.
2. Any design deficiencies will then be stipulated clearly and where practicable, the design will be modified and the training materials updated.
3. The design of the trailer and contents of the training materials will be finalised and presented at a final presentation to stakeholders, media and the general public.

A Log frame is attached as **Appendix D**.

Technical Assistance

Technical expertise is available in-house at R3E, however, a significant amount of external technical assistance will be sourced from Namibian energy technology suppliers (for technical materials) and from Namibian teachers/trainers (for training materials).

Work Plan

The Work Plan is attached as **Appendix B**.

Budget

The Budget is attached as **Appendix C**.

Sustainability Plan

It is envisaged that sponsorship from both public and private organisations can be secured. The trailer can be used as an effective awareness raising tool and an educational tool. As such it could assist with initiatives such as rural education, health, environmental protection, civil rights and democracy and many others. As such a leasing option of the trailer, with modified equipment, may be considered.

Furthermore the documentation will allow for the easy duplication of the trailer, through available technical specifications and drawings. This also applies to the training materials and manuals.

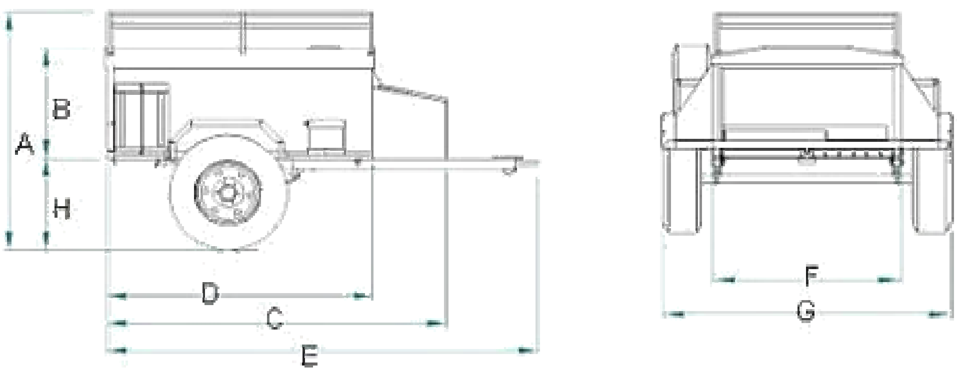
APPENDIX A

Example Energy Demonstration Trailer

Trailer Components
Trailer
Roof tent
Chairs (x2)
Table
Jerry cans
PV modules
Inverter
Compact fluorescent lights
Fridge
Wind charger (<100W)
Camping gear and utensils
Global Positioning System
Demonstration Components
Tso-Tso wood stove
Vesto wood stove
Data Projector
TV or Screen
VCR
Solar Cooker
Energy efficient house model
Solar water heater
Biogas Model
Laptop
HiFi
Solar water pump (miniature)
Solar water heater (miniature)

Typical off-the-shelf 4X4 trailer before modifications

Typical off-the-shelf 4X4 trailer before modifications



APPENDIX B

Work Plan

Project Number:	**Project Name:** Energy Demonstration Trailer	
Name of Grant Recipient: The Renewable Energy and Energy Efficiency Bureau of Namibia		
Brief Description of General Objective of Project: To raise awareness and disseminate information about Renewable Energy and Energy Efficiency technologies, measure and practices in rural and peri-urban Namibian settlements through implementing a "learning by showing" approach by conceptualising, designing, manufacturing and field-testing a prototype trainer-friendly promotional vehicle-drawn road-worthy trailer.		
GEF Focal Area: Climate Change & Land Degradation	**GEF Operational Program:** OP6 Promoting the adoption of renewable energy by removing barriers and reducing implementation costs. The project also contains an element of land degradation and suit under the new **Operational Program on Land Degradation (OP15).**	**Project Start and End Dates:** 1^{st} November 2004 and 31^{st} October 2005
Brief Description of Specific Objective #1: Resource assessment and pre-project workshop to determine available REEE promotional and educational materials relevant to Namibia and to ensure stakeholder involvement.		

List the activities necessary to fulfil this objective. Indicate who is responsible for each activity and an indicator of activity accomplishment.			**Duration of Activity in Months**											
Activity	**Responsible Party**	**Indicator**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
1.1 Assess the availability of REEE promotional and educational materials applicable to Namibia.	R3E, DRFN	List of available promotional and educational materials completed.	**X**											
1.2 Half-day conceptualisation workshop	R3E	Workshop completed successfully with documented stakeholder comments / contributions on trailer design and contents, and promotional / educational materials	**X**											

Brief Description of Specific Objective #2:
Design and Construction of Energy Demonstration Trailer.

Activity	Responsible Party	Indicator	1	2	3	4	5	6	7	8	9	10	11	12
2.1 Recruit experts for trailer design	R3E	Suitable expert(s) appointed	X	X										
2.2 Design Trailer Modifications & inventory	R3E, technical consultant, suppliers	Trailer design completed			X	X	X							
2.3 Recruit manufacturer	R3E, technical consultant	Manufacturer appointed					X							
2.4 Purchase basic 4x4 trailer	R3E, technical consultant, suppliers	Trailer received						X						
2.5 Purchase demo, camping & presentation equipment	R3E, technical consultant, suppliers	Demo, camping & pre-sentation equipment received						X	X	X				
2.6 Trailer modifications	R3E, technical consultant	Trailer modifications completed						X	X	X				

Brief Description of Specific Objective #3:
Design and printing of demonstration / training materials.

Activity	Responsible Party	Indicator	1	2	3	4	5	6	7	8	9	10	11	12
3.1 Recruit experts for promotional / educational materials development	R3E	Suitable expert(s) appointed	X	X										
3.2 Preparation of brochures on REEE technology	R3E, NaMSTA	Brochures' completed			X	X	X							
3.3 Invitation and selection of participants to attend trailer operator course	R3E, NaMSTA, PON, UNAM, suppliers, Outase Energy Project, DRFN	About 10 participants selected						X	X					
3.4 Preparation of training materials for trailer operators	R3E, NaMSTA, DRFN	Training materials completed					X	X	X					
3.5 Recruit facilitator for trailer operator workshop	R3E, supplier, technical consultant	Facilitator appointed							X					
3.6 3-day trailer operator training course	R3E	Course completed successfully								X				

Brief Description of Specific Objective #4:
Field test of prototype trailer and improvements to brochures, training materials and the Energy Demonstration Trailer where required.

Activity	Responsible Party	Indicator	1	2	3	4	5	6	7	8	9	10	11	12
4.1 Liaise with target	R3E, Outase Energy Project,	Communities well-informed,						X	X	X				

communities before field test	DRFN	enthusiastic and committed to demonstration												
4.2 Logistical preparations for field test	R3E, Outase Energy Project, DRFN	Preparations complete							X	X				
4.3 Field test in rural and peri-urban communities	R3E, Outase Energy Project, SDFN, DRFN	Field test completed									X			
4.4 Document results of field test and suggested improvements to trailer / brochures / training materials	R3E, Outase Energy Project, DRFN	Field test results / suggestions documented									X			
4.5 Implement suggested improvements were practicable	R3E, technical consultant, suppliers	Suggested improvements completed										X	X	

Brief Description of Specific Objective #5: Presentation, evaluation and finalisation of the Energy Demonstration Trailer.														
Activity	**Responsible Party**	**Indicator**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
5.1 Update and finalise all brochures, design and training documents.	R3E, NaMSTA, DRFN	Documentation updated.										X	X	
5.2 Compile final report	R3E	Final report completed									X	X	X	
5.3 Prepare for public stakeholder demonstration of the trailer	R3E	Preparations complete										X	X	
5.4 Presentation / demonstration of trailer	R3E, Outase Energy Project, DRFN	Presentation / demonstration complete												X
5.5 Wrap-up and hand over project administrative documentation.	R3E	Completed documentation handed over											X	X
Monitoring & Evaluation														
Indicate persons responsible for monitoring and progress reports:			Monitoring Frequency / Reporting											
Monitoring and Record-Keeping	R3E		X	X	X	X	X	X	X	X	X	X	X	X
Progress Reports	R3E				X			X			X			

APPENDIX C

Budget

BUDGET: Energy Demonstration Trailer

Component	Budget Notes	Unit	No. of Units	Unit Cost (N$)	Total (N$)	Own Contribution
Workshops, Meetings & Training						
P1: Half-day conseptualisation workshop: including preparation, venue & equipment hire, documentation, stationary.		lumpsum	1	8,000	8,000	3,000
P3: 3-day training workshop to train trailer operators	Includes: facilities, equipment, consumables	lumpsum	1	10,000	10,000	1,000
P4: 3-day trailer field test: Outase	Including vehicle hire, consumables, etc.	lumpsum	1	20,000	20,000	1,000
P5: 1-day trailer field test: Informal Settlement Barcelona	Including vehicle hire, consumables, etc.	lumpsum	1	3,000	3,000	1,000
P6: half-day field test: 3rd community, school or other	Including vehicle hire, consumables, etc.	lumpsum	1	2,000	2,000	1,000
P5: Presentation of trailer and field test results to stakeholders	Includes communications, media releases.	lumpsum	1	2,000	2,000	1,000
Technical Assistance, Consultancies & Labour						
P1: Assessment of available REEE promotional and educational materials applicable to Namibia		hours	20	300	6,000	2,000
P2: Design of trailer & inventory		hours	15	300	4,500	1,000
P3: Preparation of descriptive / explanatory brochures on 5 different technologies (e.g. SHS, solar cooking, fuel efficient stoves, every-day energy efficiency and biogas)	5 selected technologies, 10 hours/ technology	hours	50	300	15,000	3,000
P3: Printing of brochures mentioned above		lumpsum	1	5,000	5,000	
P3: Preparation of course material for trailer operators/trainers		hours	10	300	3,000	2,000
P3: Copying of course materials for trailer operators/trainers		lumpsum	1	1,000		1,000
P3: Facilitators for 3-day training workshop to train trailer operators	3 days x 8 hours + 6 hours prep.	hours	30	300	9,000	3,000
P4: Documentation of the results of the field test, update design / brochures, final design report. (Must be complete enough so that the next trailer can be built & operated by other subcontractors / organisations.)	Complete documentation, includes final brochures, CAD drawings, inventories, training and user manuals, lessons-learned, recommendations for future trailers.	hours	30	300	9,000	
Transport &Travel						
Travel general		lumpsum	1	10,000	10,000	
Construction & Equipment						
P2 & P4: Trailer purchase and modification	Including modifications after field test	lumpsum	1	35,000	35,000	
P2 & P4: REEE technologies	E.g.: SHS, cookers, models, etc:	lumpsum	1	50,000	50,000	
P2 & P4: Presentation equipment	Data projector, laptop & screen	lumpsum	1	21,000	21,000	
P2 & P4: Camping equipment for trailer operators	Roof tent, chairs, water cans, etc.	lumpsum	1	7,000	7,000	
Communications						
Communication of Results, Lessons Learned & Reporting	quarterly	hours	20	300		6,000
Stationery general	quarterly reports; workshop and pre-training materials	lumpsum	1	5,000		5,000
Administration & Mgt Costs (10% of subtotal)					17,800	
Sub-total					**237,300**	**31,000**
				Own Contribution Total		**31,000**
				GRANT TOTAL	**237,300**	

APPENDIX D

Logframe

Overall Objective	Immediate Objective	Activities	Sub Activities	Indicators
To raise awareness and disseminate information about Renewable Energy and Energy Efficiency technologies, measure and practices in rural and peri-urban Namibian settlements in order to promote the use of these technologies and measures.	To implement a "learning by showing" approach by conceptualising, designing, manufacturing and field-testing a prototype trainer-friendly promotional vehicle-drawn road-worthy trailer.	1. Resource assessment and pre-project workshop to determine available REEE promotional and educational materials relevant to Namibia and to ensure stakeholder involvement.	1.1 Assess the availability of REEE promotional and educational materials applicable to Namibia.	List of available promotional and educational materials completed.
			1.2 Half-day conceptualisation workshop	Workshop completed with documented stakeholder comments / contributions on trailer design and contents, and promotional / educational materials
		2. Design and Construction of Energy Demonstration Trailer.	2.1 Recruit experts for trailer design	Suitable expert(s) appointed
			2.2 Design Trailer Modifications & inventory	Trailer design completed
			2.3 Recruit manufacturer	Manufacturer appointed
			2.4 Purchase basic 4x4 trailer	Trailer received
			2.5 Purchase demo, camping & presentation equipment	Demo, camping & presentation equipment received
			2.6 Trailer modifications	Trailer modifications completed
		3. Design and printing of demonstration / training materials.	3.1 Recruit experts for promotional / educational materials development	Suitable expert(s) appointed
			3.2 Preparation of brochures on REEE technology	Brochures' completed
			3.3 Invitation and selection of participants to attend trailer operator course	Up to 10 participants selected
			3.4 Preparation of training materials for trailer operators	Training materials completed
			3.5 Recruit facilitator for trailer operator workshop	Facilitator appointed
			3.6 3-day trailer operator training course	Course completed
		4. Field test of prototype trailer and improvements to brochures, training materials and the Energy Demonstration Trailer where required.	4.1 Liaise with target communities before field test	Community meetings conducted
			4.2 Logistical preparations for field test	Preparations complete
			4.3 Field test in rural communities	Field test completed
			4.4 Document results of field test and suggested improvements to trailer / brochures / training materials	Field test results / suggestions documented

			4.5 Implement suggested improvements were practicable	Suggested improvements completed
		5. Presentation, evaluation and finalisation of the Energy Demonstration Trailer.	5.1 Update and finalise all brochures, design and training documents.	Documentation updated.
			5.2 Compile final report	Final report completed
			5.3 Prepare for public stakeholder demonstration of the trailer	Preparations complete
			5.4 Presentation / demonstration of trailer	Presentation / demonstration complete
			5.5 Wrap-up and hand over project administrative documentation.	Completed documentation handed over