DEVELOPING ENERGY SOLUTIONS FOR A SOUTH AFRICAN INFORMAL SETTLEMENT

Executive Summary

An Interactive Qualifying Project submitted to the faculty of Worcester Polytechnic Institute in partial fulfilment of the requirements for the Degree of Bachelor of Science

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Abstract:

Through interaction with the community and planning officials from the City of Cape Town, we identified key issues with energy services in informal settlements in Cape Town, South Africa. Electricity access is insufficient, and heating and cooking methods are expensive and dangerous. We proposed solutions for both immediate improvement and long term redevelopment. These ideas culminated in a proposal for a centralized energy facility, which would provide essential services and products to the community, and serve as a way to introduce alternative energy practices.

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Residents of shanty towns, or informal settlements as they're called in South Africa, often struggle to obtain all of the energy services they need, such as heating, cooking and electricity. Fuel for heating and cooking can be expensive and electricity is often unreliable and expensive. Much of the housing is built from recycled materials, resulting in poor insulation and heating efficiency. Development of energy services in a situation like this relies on either expanded infrastructure or new, innovative sustainable solutions to current energy issues.

The people of Monwabisi Park currently use multiple fuel sources for cooking, heating, etc. Electricity is provided only to those residents who have an official address registered with the municipality. Those who do not have access are forced to buy electricity from their neighbours. Although this electricity used for cooking and heating is fairly inexpensive, it is sometimes unreliable. Burning paraffin fuel for cooking and home heating is common throughout the informal settlements. When electricity is not available people must use paraffin as an effective yet slightly more expensive energy source, despite the dangers. This paraffin can be dangerous and cause fires which do extensive damage in the congested settlements.

Goals and Objectives

Our intentions coming to Monwabisi Park were to first gather quantitative and qualitative data regarding the existing conditions in the area, and then to use that information to find solutions to the energy problems of the area. In addition to the current conditions, our objectives were as follows:

- Help the community learn about electricity conservation and provide them with various ways to accomplish it.
- Find more efficient alternatives to their current cooking methods.
- Improve home heating in the winter by providing safer and more cost effective alternatives.
- Suggest ways these goals could be incorporated in the future redevelopment of Monwabisi Park.

We explored the following questions: 1) Why the community was using its current energy practices. 2) What was preventing the community from exploring other methods of cooking and heating? 3) How would new cooking and heating technologies work with their informal living structure? These questions would help us analyze our suggestions to be more adapted to Monwabisi Park and other informal settlements.

Methods

In order to gather the necessary data, we employed various methods to learn about the community. On a basic qualitative scale, we made simple observations on the ground, gathered important photos of current conditions, and learned about the overall feel of the community. To gather more specific information, we conducted key informant interviews with people working at the community center, as well as community members themselves, and city officials with experience working in Cape Town informal settlements. Lastly, we conducted surveys with larger groups of the community to gain more statistical data regarding the issues we had examined through our

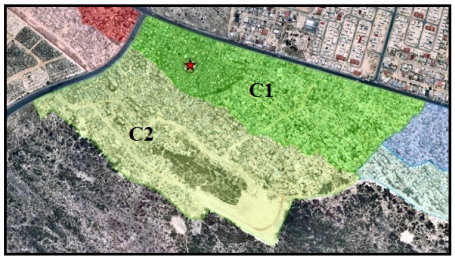

Figure 1 : Monwabisi Park's sections C1 and C2

interviews. All of this data gathering was made possible by the hard work of the 6 Xhosa-speaking co-researchers. These community members were employed to help us with our research by performing interviews, conducting surveys, and assuring our safety as we traveled through Monwabisi Park. The close contact with the community through the co-researchers and the community center allowed us to collect accurate data in a way that gave us a complete understanding of the intricacies of life in the informal settlement.

Key Findings

Residents of informal settlements, like Monwabisi Park, have limited access to electricity. Electricity is commonly used throughout Monwabisi Park, however some areas are not provided access to the electrical grid. One of these areas is referred to as "C2" and the residents in this area do not have access to formal connections to the municipal electrical supply. The people in this area told us they were promised that after a road was built between them and their neighboring section, C1, the electrical company would install electrical poles so that they could have independent electricity. This never happened and the residents of C2 must rely on their neighbors in C1 to sell them electricity from their formal connection.

Figure 2: Example of informal connections in C2 section

Figure 3: Eskom Electricity Dispenser

Formal connection to the electricity grid is obtained through an electricity dispenser, ED, which is directly connected to the nearest electricity supply pole. The box is delivered and installed by an Eskom (the local energy supplier) worker and costs R200. This is 13% of the average Monwabisi Park resident's monthly income and is often a monetary burden on the family. Therefore people are also forced to purchase their electricity from a neighbor and informally connect to their ED. During windy and rainy times these informal connections often stop working and people can be without power for a substantial period of time until the connection is fixed. Also, because so many people try sharing one ED, it can be overloaded and stop working. In order to prevent this overloading people often offset their cooking times and try to be mindful of other's electricity uses.

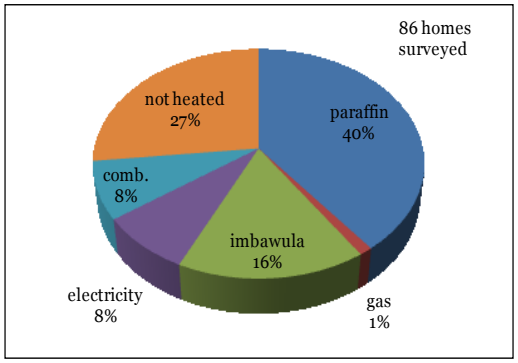

Figure 5: Home heating fuel analysis

While electricity is unreliable, residents rarely try to conserve the electricity when it is available. Electrical appliances are often left running resulting in a great deal of money and electricity being wasted. Heat conservation is also a pressing concern in Monwabisi Park. Almost every shack is constructed using corrugated metal, which is a poor insulation material. This metal is rarely covered with a better insulation material, thus leading to an energy inefficient home. A simple wood-burning Imbawula is popular heating device because it is free; the fuel comes from gathered scraps of wood. While this is a

popular form of heating, with 16% of our surveyed homes admitting to using one, it is often something the community members do not admit to unless asked directly. Our research also shows that 40% of the eighty-six home surveyed use paraffin as the fuel of choice when heating their homes. This paraffin must be lit all day in order to replace the heat lost to the outdoors due to poor insulation. Paraffin can be dangerous and it is common for lit stoves to tip over and start fires, which is a problem in such a congested area. The paraffin can also be dangerous to young children who often ingest the clear liquid mistaking it for water.

Due to the costs and unreliability of electricity identified by this study, we investigated the topic of electricity and energy conservation. We found that electricity conservation is not a common practice, nor is it widely accepted. The people in Monwabisi Park do not fully understand the money they could save through electricity conservation, and therefore do not attempt to conserve energy. As shown in Figure 4, we calculated the cost of running typical appliances used by the residents based on electricity cost,
and the time people use them based on interviews with people. This data could be used to make recommendations to people for electricity conservation.

Appliance	Wattage	Hours Used / day	Monthly kWh	Monthly Cost
Electric Heater	1500	2.5	112.5	R 66.29
Electric Stove	1500	1	45	R 26.52
Electric Kettle	2000	0.5	30	R 17.68
Refrigerator	225	24	27	R 15.91
Microwave	1500	0.5	22.5	R 13.26
Stereo	110	6	19.8	R 11.67
Television	100	6	18	R 10.61
Radio	70	6	12.6	R 7.42
Fan	200	2	12	R 7.07
60 Watt Incandescent	60	5	9	R 5.30
VCR	40	2	2.4	R 1.41
15 Watt CFL	15	5	2.25	R 1.33
Cell Phone	5	3	0.45	R 0.27

Figure 4: Electricity use analysis

Another key finding is that proper insulation is never used in shacks because of two main reasons. Firstly, the insulation costs a great deal of money and would be difficult for an average family in the community to afford, and secondly, due to the poor construction of the shacks, there are often holes and leaks in the walls and ceilings. These holes need to be accessible for repair and if insulation is installed it makes this accessibility much more difficult.
Insulation is the most beneficial when installed on the ceilings because heat rises and escapes through the holes and the thin non-insulated ceilings.

We found that Hot Boxes, also called “wonder boxes” in the community, could be used to cook meals using adiabatic cooking in order to conserve energy. Hot Boxes are insulated bags that cooking pots are put in after being heated on a stove that allow the contained heat to continue cooking the food off the stove. While we found some people who used Hot Boxes, we also heard of many people who did not know about them and others who knew about them yet were skeptical. We found many variables responsible for the lack of Hot Boxes in Monwabisi Park. The first variable, like many stated before, is that Hot Boxes impose a steep upfront cost

for residents. Even if the resident does have enough money, they often do not know where to purchase such a device. The next reason is based on the skepticism of the community members. Until they see the Hot Box work first hand, they rarely believe that it actually works. In addition, people do not often plan their meals in advance and they generally do not like waiting long periods for their meals to cook. Both of these outlooks would need to change in order for the Hot Box to be a successful alternative to current cooking techniques.

Recommendations

Based on our investigation into community needs and concerns, we see the need for a centralized facility to provide the energy products and services required by the community. In order to teach the community about energy alternatives and make them more available, we recommend the implementation of a Monwabisi Park Alternative Energy Center. As a model for this center, we used "Integrated Energy Centers(IeCs)" . These centers, created as part of a program of the South African Department of Minerals and Energy, are one-stop shopping centers which provide all of a community's energy needs, including gasoline, paraffin, and candles. Along with energy products, they are also information centers, providing the community with information regarding the safe use of various energy sources.

Figure 6: Caba Mdeni Integrated Energy Centre located in Magadla village in the Eastern Cape

A Monwabisi Park Alternative Energy Center would provide similar services as the IeC, but would have a strong focus on sustainable alternative energy practices. Energy information would be provided here, especially information regarding the benefits of alternatives. We believe that brochures for the community to take, as well as monthly information sessions about alternative energy practices, will help educate the community. The center would employ an energy specialist who would be trained and well educated about safe use of current energy practices as well as information regarding innovative alternatives. The energy specialist could also offer electricity audits to the community. These audits would break down a home's electricity use by monthly cost of each appliance, similar to the analysis in Figure 4. This would allow the energy specialist to make recommendations to the homeowner as to how to conserve electricity and save money.

Another aspect of the energy center would be the sale of energy products. These sales would focus on making current practices safer (i.e. colored paraffin and safer paraffin primus stoves) as well as the wide range of alternatives which are not currently readily available in the community (i.e. hot boxes, insulation, solar hot water bags, and solar ovens). This center would maintain a list of contacts of all energy related companies in

Household Electric Appliance Audit Sheet					
1	2	3	4	5	6
Appliance	Power use (watt)	Hours/day in use	Number of appliances	Ave kWh per day (watt x hours/1000)	Ave kwh per month
e.g. light bulb - Incandescent	60w	4	7	60x4x7=1680/1000 =1,68	x30=5,04
Electricity consumption total					

Figure 7: Energy specialist audit for residents

the area so the people of the community would know exactly who to contact in different energy related situations. This center would encourage safe use of current energy practices, which is currently a pressing need for the community, while also recommending and teaching various energy alternatives.

Combined with the energy centre, we propose to have centralized hot water provided to the community. Hot water is a service needed by the community, and is currently obtained by individuals through heating their own water on a kettle or plate stove. The Alternative Energy Center could be equipped with multiple roof mounted Solar Water Heaters (SWH), which provide hot water from solar thermal radiation. The water could be provided in the buckets community members already use, with an insulated sleeve to fit over and keep the water hot. The water could be purchased at a lower price than it would cost them to heat the water on their own. This would provide a vital service to the community in a sustainable and eco-friendly way. We introduced these ideas to the community, and they were receptive.

We also believe that proper insulation is vital to future redevelopment and should be installed in every future community center building. These buildings must be checked for leaks prior to installation. We also notice the need for roof redesign in the informal houses in Monwabisi Park. New, leak-proof roofs are the only way that people would be able to have properly insulated shacks and be able to heat efficiently.

Figure 8: Solar Water Heaters mounted on the old Guest House at the Indlovu Community Center

All of our ideas and recommendations came from an understanding of the Monwabisi Park community and research regarding potential energy options for informal settlements. Our suggestions are based on the needs of the community; needs which we observed through our research, and needs which were expressed by community members during surveys and interviews. They take into account the unique social environment of the informal settlement, as well as bringing together our principles of sustainability and an eco-friendly mindset. The ideas are core considerations for energy service provisions, which must be included in a successful plan for redevelopment in the area.

These core issues have been explored as part of an integrated research and planning project conducted in Cape Town in 2008 and detailed in a report entitled, *Envisioning Endlovini: Options for Redevelopment in Monwabisi Park*. The document is authored by twenty-two Worcester Polytechnic Institute students and reports on efforts to plan and implement an ecovillage in Monwabisi Park to address problems of informal settlements. The overall effort is a collaboration among community residents and leaders, the WPI Cape Town Project Centre, the Shaster Foundation, the City of Cape Town, the Violence Protection through Urban Upgrading program, Ecobeam Technologies and others. Six WPI study teams investigated several aspects of ecovillage redevelopment including: buildings, water and sanitation, communications, energy, economics, and urban spatial planning. All research data and proposed options for re-development are included in the full report. This team's work is especially detailed in Chapter 5 and Chapter 1, the integrated redevelopment plan. The full report can be accessed at www.wpi.edu/Academics/Depts/IGSD/People/jiusto.html