PROJECT SAM - SOWETO AIR MONITORING

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Soweto Eco-House
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1. INTRODUCTION

The use of coal and other greenhouse gas emitting fuels are the preferred energy sources during the low temperature months for central heating and cooking purposes in the black residential areas of South Africa, although an aggressor to the health and welfare of the users of these energy resources.

High levels of air pollution in these areas have long been recognised as detrimental to the health and welfare of the local people. There has been recognition and acknowledgement that pollution levels in such areas are amongst the highest exposures to which the public is exposed.

The high level unemployment rate in such areas compounds the prevalence of poverty amongst the majority of the urban and rural poor and these conditions severely constrain the provision of energy efficient, environmental-friendly, sustainable and affordable housing and energy infrastructures.

The South African Government's Reconstruction and Development Programme, details broad socio-economic goals. Included in the priority list of the Reconstruction and Development Programme are housing development and electrification, which have been undertaken since 1994 and which will improve the socio-economic status of the disadvantaged communities of South Africa.

In 1994 the Government of National Unity committed itself to providing a mass housing programme which can present an incredible opportunity to introduce energy efficient and environmental friendly features into building designs.

The housing and energy resource programmes need to be integrated into the planning framework. There is a pressing need to consider energy efficiency housing design, construction techniques and passive solar and water heating features. These features were considered in the construction of the Soweto Eco-house.

2. PROJECT BACKGROUND

Soweto Eco-House is a dwelling in Soweto incorporating passive and other energy conservation features. These features have been developed and demonstrated by Peer Africa, an American based civil and environmental engineering firm which is involved in the construction of low cost, energy efficient houses in Kutlwano Township in Kimberly. Peer Africa became involved in these projects as a result of the agreement signed by South Africa and United States of America, the Gore-Mbeki Bi-national Commission.

The process of building this demonstration house has been a case study in itself, in that local resources were used in the construction of this house. The architect who designed the building, is Johannesburg based. A local construction company constructed the house and the building material used was from locally available sources. The only external participants on this project were from the

civil and environment engineering group Peer Africa, who are the developers, the University of Witwatersrand-Geology and Atmosphere and Energy and Research Departments. No building material was imported from outside the country.

This project made it possible to record for the first time, the opportunities and obstacles to energy efficient building design (EEBD) principles in Gauteng and it is the first of its kind in the area.

The driving forces for the initiation this project were concerns about improving the quality and standard of life for communities in South Africa, who can incorporate these techniques into the construction of houses. Some environmental health considerations include indoor comfort derived from solar radiation and the reduction of sources of indoor pollutants, that is, the reduction of gas emitting fuels used for heating. Some features do not require any additional building construction costs, for example the orientation of the house and the sizing of windows, which are thus affordable.

3. PARTNERS IN THIS PROJECT ARE:

- Peer Africa (Pty) Ltd- Developers
- Atmosphere and Energy Research Group, Geology Department; and Department of Architecture, University of Witwatersrand
- Project SAM- Soweto Air Monitoring (AER Pty Ltd)
- RFB Moleko Consulting Architects- Architects IIEC-Green Professional Scheme
- Monyaku Construction cc- Building Contractor

The co-sponsors in this endeavour are:

- International Institute for Energy Conservation (IIEC)
- Sagex (Pty) Ltd
- Corobrick (Pty) Ltd
- Solco (Pty) Ltd
- Cobra Watertech (Pty) Ltd
- Alpha Cement Ltd
- Phillip Electrical S Africa
- Randfontein Trading Co
- Eskom Electrowise

4. WHY ECO-HOUSE

In South Africa, the energy economy is largely based on coal. It is estimated that the primary energy used is coal i.e. 73%. The use of coal for domestic central heating and cooking purposes is one of the large consumers of this energy resource. The coal dependency is likely to continue, although an aggressor to the health and welfare of the user.

The source apportionment of air pollution studies conducted in Soweto, a major user of bituminous coal, revealed that the burning of coal during low temperature months (June-worst month) contributes to 74% of fine particulate matter in the form of ash, 53% of sulphur dioxide (SO_2) and 28% of oxides of nitrogen (NO_x).

Several innovations to address residential air pollution as a result of the use of coal have been implemented and have not as yet, been as successful as was anticipated.

- The 'mini' smoke stoves programme was introduced in 1976 in the black residential areas of South Africa. The aim of the project was to encourage the use of a processed desulphurised coal into the market and to increase the burning efficiency of the coal and in-turn, reduce smoke emissions. The project did not meet expectations and due to a number of social reasons, it failed.
- The massive electrification programme in Soweto, which began in the early eighties and was accelerated in the nineties to all formal and informal structures, was another attempt to reduce

air pollution. There were hopes that the electrification programme would drastically reduce air pollution build up during winter months. This did however not occur, due a number of economic and social reasons. The community of the area still preferred their coal stoves to electrical heating for social and economic reasons.

- The Low Smoke Coal Programme currently incorporates studies on the social aspects, use and attitude towards the various energy sources available on the market. The ultimate objective is to draw up a policy on the use of a socially accepted form of energy that meets the demands of the people and at the same time meets environmental considerations.

Energy efficiency, environmental considerations and the health and economic benefits are very low priority in the mass delivery of houses in South Africa.

The purpose of building the ECO-House (Energy Cost Optimised) in the area is a paradigm shift towards an integrated concept of humans and their living structure as part of the global environment, rather than distinct from it. The driving force of this project is centered on quality of life, environmental health, affordability and sustainability.

It is also a response to the global call of not only providing shelter for the needy, but to incorporate passive solar and other energy features that will provide comfort and reduce the cost for energy production.

Increasing the thermal efficiency of the dwelling will not only benefit the individual, but the Nation as well in that the reduction in the production of 'greenhouse' gasses that bear a negative impact on the receiving environments through the burning of coal for energy generation will be decreased.

As the South African Government ratified the United Nations Framework Convention on Climate Change in 1997 as a non-Annex 1 or developing country, it has no obligations to reduce greenhouse gas emissions. However one way in which South Africa can meet the spirit of the convention, is through increasing thermal efficiency in the housing construction industry. The production of energy from power stations through the use of coal will reduce and the demands for coal energy generation will be minimal.

The response of South Africa to this call is a proactive responsibility to see beyond the urgent pressures of today whilst thinking of the future, striving to live in productive harmony with nature and seeking to fulfil the social and economic needs of future generations. One of the objectives of Eco-House is meeting this demand for future generations as well. It is a proactive call for the house construction industry to get it right once and for all. A house that is built with thermal comfort considerations will improve the health and welfare of the immediate population as well as that of future generations.

The Eco- House is intended as a demonstration and teaching home aimed at facilitating the community, trade, administrative and academic learning opportunities of incorporating thermal efficiency in the provision of shelter, as well as facilitating the drafting of energy efficiency policies in the building industry.

5. ENERGY CONSERVING FEATURES

5.1 Orientation

The climatic zoning of the Eco-house is in the highveld region approximately 26,1° to 31,2° East and 24,5° to 30,8° South. The climate of the area is temperate/benign with distinct rainy and dry seasons. The area has daily large temperature variations and strong solar radiation. The siting and internal demarcations were based on these climate factors. The orientation of the house and main rooms are facing north approximately

15°. The mode of energy conservation is to maximise use of solar radiation to warm the house in winter months in living rooms with highest use i.e. lounge, main bedroom and the secondary bedroom. It is estimated that energy consumption can be reduced by between 50% to 70%.

5.2 Building Envelope

The building envelope is made up of a 280mm cavity wall surface stuffed with 25mm X grades Styrofoam insulation pressed against the inner surfaces of the cavity wall. The outer surface of the brick wall is built with Montana Travertine face bricks and the inner wall surface is of African stock brick with 50mm smooth finished cement plastering. The winters demand a well-insulated envelope that will allow heat gained through solar radiation to be absorbed and stored through this envelope. The envelope will also reduce heat loss and gain by conduction.

5.3 Roof

The extended roof overhangs on the northern and southern sides of the house approximately 600mm to allow windows in the shade at summer solstice, that is 21 March/23 September and maximum solar radiation on the window during winter solstice, that is 22 June. The roof is covered with light coloured clay tiles which will aid in minimising solar heat gain in the overheated period and keep the house cool. The roof is also insulated with X grade 75mm Styrofoam and is provided with flat ceiling surfaces in all the rooms.

5.4 Floor

The floor tiles of the front rooms i.e. lounge and dinning room are black/dark coloured. The choice of these tiles is to maximise heat absorption during winter when solar radiation falls on the floor.

5.5 Air-bricks

The house is air tightly constructed with no provision for airbricks to reduce uncontrolled energy leakage especially at night and in winter, thus reducing the use of imported energy for the thermal efficiency of the building.

5.6 Water

Water heating is by a secondary circuit solar geyser with electrical backup to reduce energy consumption. The hot water pipes in the ceiling and wall surfaces are insulated to reduce energy loss and wastage. Low flow water taps to the hot water taps outlets are provided to reduce hot water usage and reduce electricity consumption. A 5000-litre tank is provided on the premises to harvest rainwater from the roof and reducing water consumption. The harvest water is solely used for garden watering and for household washing. Hot water usage is only used as and when it is necessary.

5.7 Lighting

Compact fluorescent lights with low energy are provided in the house light fittings to reduce electricity consumption for lighting.

6. CONCLUSIONS

The Energy Efficient Building Design technique as demonstrated in the Soweto Eco House project was jointly conceived by the Project SAM, the University of the Witwatersrand and Peer Africa (Pty) Ltd, as a model for owner friendly and environmental friendly housing.

The driving social forces to these innovations are quality of life, environmental health, affordability and sustainability. The man on the street and decision-makers in South Africa are lacking knowledge on building design techniques and energy consciousness. Very few institutions are making inroads into research on energy efficient building designs.

The Eco-House is intended as a demonstration and teaching home, to help communities to learn energy features to be considered in the construction processes.

The trade, especially the building industry, need to integrate the concept of humans and their living structures as part of the global environment, rather than distinct from it. It is also intended to help educate housing administrators about energy efficiency in the mass provision of houses to the people of South Africa. It is a learning opportunity for the academics to monitor and research the effectiveness and the energy conservation of the Eco-House in terms of economic value, health and other benefits that are 'spin-offs'.

Other benefits of Energy Efficient Building Design

- Cost savings through energy savings available naturally- solar energy
- Reduction in the generation of energy from coal fired power plants
- Reduction in the production of greenhouse gases
- Increase in the health and well-being of the population
- Optimum usage of other available renewable and hydrocarbon energy resources
- Energy efficient techniques can be practised in both urban and rural areas

REFERENCE

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