# KISEMVULE ECO-VILLAGE  Simmonds.Mills August 2023 report.

## HOUSE 5 DESIGN - Introduction:

- The Eco-village is a long term project of iHelp Global - Inspired by the green principles inherent in the Islamic faith

- Tz is 35% Muslim (there are more than two billion Muslims worldwide, making Islam the second-largest religion in the world, exceeded only by Christianity)
- The EV built an 'eco-mosque' – low energy use and rainwater harvesting
- Is a secular initiative in the local multi-faith community

- for children who have lost one or both parents, or whose parents can't manage full time care

- proactive – not reactive initiative, longer term v. food parcels/disaster relief: conventional education at local schools, 'greener' practical life skills at EV

- ecosystem-thinking: a community safeguarding nature and balancing with food & fibre production and livelihoods needs – *agroforestry/forest garden approach*

- Agents of change: local networks, inter-village relationships, climate change mitigation & adaptation – demonstration of a model to encourage others to do similar

## DESIGN PROCESS & TEST UNIT:

- A building test unit was built in 2018 and 12 months of data showed what worked and what needed to be improved for the new 10-person house
- An experimental sewage system was built in 2020
- The new 10-person house (House 5) was completed this year – we have 3 months T & RH data
- House 5 improved experimental sewage system built.

Following on from data gathered from the test building we designed in 2018, we worked on the design for HOUSE 5 in 2020-1. The other four houses on site were designed by a different team; study of these has been crucial.  The brief for House 5 was for a single storey dwelling for 10 children, with ensuite room for the carer, together with living / study space and bathrooms.  Cooking for all the children currently happens at outside kitchens.

The intention with the whole eco-village project is to demonstrate sustainable practices; for the buildings, this included use of readily available building materials and techniques, but with a clear emphasis on traditional 'tropical design' techniques and avoidance of future move towards energy / carbon intensive air-conditioning.

Our research visit to Zanzibar in 2019 showed us the history of beautifully crafted timber windows, with sophisticated layers of screens for shade, ventilation, privacy and insect deterrents.

The test building and the existing houses have been monitored since 2019, with staff on site taking readings that are relayed to the design team in the UK. Temperature and humidity have been logged.

In addition, the design was refined based on extensive research and modelling, provided voluntarily by Huda Elsherif - a Sudanese PhD student and young professional currently working in the UK to bridge the gap between academia and industry in energy-efficient design. Huda used computational fluid dynamic software (CFD) to dynamically model airflows throughout the house, painting a picture of 'thermal comfort' in each room looking at different seasons and weather.

# DESIGN PRINCIPLES - What is the building project about?

The 2017 brief: a new 'sustainable' house for 10 children and one house Mother. Later 3 more of same design to be built.

- Understanding the context
- cultural, technical, economic & ecological
- all change: semi-rural now – industrialising & urbanising
- Design – do we need (re)innovation ?
- Precedent: Francis Kere of Burkina Faso, West Africa, buildings of 'Radical Simplicity' in Tropical Savannah + Cold Semi-arid + Hot Desert
- Energy: Passivhaus/building physics **à** Classic Tropical Design approach
- Optimised resource use/improved health building trial. 110 prototype homes, constructed in 60 villages, North East Tanzania.
- Health: applied research e.g. mosquito behaviour, improved ventilation and thermal performance.
- Measuring: data loggers, occupant feedback, airspeeds, thermal imaging
- Analysis: T, RH & use of computational fluid dynamics (CFD, Huda Elsherif, Sudan)
- Feedback loop, creating an evidence base and improving thermal modelling tools

# ROOF

Natural ventilation in all elements was designed in - the split roof section of the test building was replicated – a key feature of the stack effect cooling system; screen ventilation was designed within internal walls and the specialist design of the windows.

To maximise shading, the roof has very wide overhangs and the whole building is orientated to minimise solar access, with the long elevations facing South and North. Prevailing winds come from the Ocean, approx. 40m to the East. Shade is supplemented by trees and vegetation, although kept away from building to allow daily insect and rodent inspection – and 'wind avenues'

The roof uses corrugated steel sheet which is available locally. Choice as per the test building was for white painted finish, to maximise heat reflection.

The roof structure is of Tanzanian timber. We've minimised timber generally since it's not possible to find traceable sustainable sources within the country. The pitch is separated from the flat ceilings, using this volume for ventilation flow. Large vent holes in the flat ceiling move the air outwards encouraging cooling.

# WINDOWS

- Large window opening areas
- Equal ventilation in/out
- no glass
- low cills (full body air movement)

- extra shading and security screen
- Insect mesh

A link we made with two architects who've worked on mass housing in South Tanzania has proved fruitful for specialist design services. Hannah and Otis Sloan-Wood and SMA worked on the window designs together, feeding back to clients as ideas progressed. Perforated steel screens with decorative patterns cut in allowed ventilation the full height of each room, whilst affording security and privacy. Internally lightweight screens have nylon mesh fixed as insect barrier. This is easily repairable.

Using existing contact with steel fabricators in Dar-es-Salaam, Hannah and Otis organised this sub-contractor supply, initially with a window mock-up. Mosquitoes tend to fly low, by raising the building we are lowering the likelihood of mosquitoes flying into the house. Secondly, mosquitoes are attracted to 'hot spots' (high concentrations) of $CO_2$ - from humans breathing, for example. Thus the large (unglazed) window area allows a diffuse (spread out) flow of $CO_2$ out of the house, limiting the likelihood of mosquitoes being prompted to enter the rooms.

Should the children feel cool, blinds can be drawn internally.

## WALLS

The walls are made of locally made concrete blocks. Cement is of course a high carbon material, but concrete blocks have a low carbon footprint here since the area has very sandy soil on the surface everywhere and the blocks can be dried in the sun. They're made in small artisan factories throughout the villages. Patterned perforated blocks are used in some internal rooms to maximise air flow throughout. Because the night-time temperature isn't much lower than daytime, there is no merit here in high thermal mass construction; instead this heat storage capacity would release heat during the night.

## SEWAGE SYSTEM

During the design process and study of the test building, we assessed the current sewage system here. Septic tanks are used, but rarely emptied. A trial hole showed that the water table is only 1m approx. below ground level, therefore the risk to water supply from leaking septic tanks is high.

Referencing off-grid systems we've designed in the past in the UK, and bits of advice from Nick Grant (previously ecological sewage design consultant), we trialled a 'trench arch' system on the test building.

Solid and liquid waste from toilets and showers is funnelled through a trench, lined with gravel and mesh, with concrete slab cover. Micro-organisms in the topsoil process liquid waste, whilst solids decompose quickly in the air. A dry, crumbly odour-free material is produced that is being trialled as fertiliser in the tree-nursery.

This system is now installed at the house, with the addition of a layer of coconut husk fibre in and above the trenches to aid decomposition and reduce 'sand scour' with resorting to the plastic mesh previously used, as well as to prevent residual odours from coming out of the trench.

## DETAIL DESIGN AND CONSTRUCTION PROCESS

A local contracting firm with their own architect, engineers and quantity surveyors were employed for the main contract. The intention is to continue learning from challenges of the construction phase, build on experience gained on site. Intention is to use this house design as a template for three further ones we've planned out on the site. House 5 needs to be lived in to get some further feedback.

## FUTURE DIRECTION – OUTREACH

The eco-village provides a safe, secure home for the children who live here. Outreach and education about the sustainable growing and building practices is part of the work that is ongoing.

There are also interesting links being made to investigate protection for a large wetland area near the eco-village. Pressure for the water usage is of course high and wildlife is under pressure.

# PERFORMANCE HEADLINES SO FAR

Temperature: measurements show House 5 is between 3 to 7ºC cooler inside the house than outside the house

Air movement: imperceptible to strong air movement across the habitable spaces, depending on external conditions and room

Active cooling: ceiling fans successfully cool occupants during hot, humid windless periods

Mosquitos: windows successfully excluding mosquitoes

# What's Next?

New site-wide strategy for EV – under development.

Ecological targets? 50% Food Growing, 25% Nature, 25% Amenity and Buildings

R & D, 'sustainable' living demonstration, education, training

## Specific on-site projects

- Retrofit of existing 4 no. houses & sewage systems *(bats, leaking roofs, overheating, sewage concerns)* ***à***
- teacher and farm manager accommodation
- Multi-use meeting space/classrooms and communal
- Communal site kitchen
- School (innovation centre) and campsite
- Ongoing biodiversity & forest gardening within 'carrying capacity' targets

## Is this a formal R&D or educational program?

- We do want it to become a program - to develop and refine EV activities (R&D rigour, academic structures, Knowledge Transfer (KT)?
- NB: of interest is KT to Barefoot Academy in Pakistan, training in and building teams for bamboo & mud housing construction
- Educational & NGO partnering is planned