The efficacy of innovative technologies in subsidised housing in South Africa: A case study

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General Introduction

Millennium Development Goals

- Includes lack of adequate shelter, exclusion
- Slum numbers growing, slum conditions deteriorating
- Promote vibrant urban areas…upgrade slums, provide alternatives to slum formation
- Need to scale-up pilot projects with measurable impact on national indicators
- Progress of MDGs in sub-Saharan Africa is slow
- Very slow diffusion of technology
Local Context

Housing backlog 2.2 million units
40% of households do not have refuse collected once a week
14.5% of households live in informal dwellings
20% of households do not use electricity for lighting
42% of households do not use electricity for heating
34% of households do not use electricity for cooking
53% of households have no access to piped water inside the dwelling
45% of households have no access to flush toilets connected to sewerage
8% do not have access to any toilet facility
Resource (ab)use

Buildings are significant users of resources

- Materials: 50% of all resources globally go into construction
- Energy: 45% of energy generated is used to light, heat and ventilate buildings, and 5% during construction
- Water: 40% of water globally is used for sanitation and other uses in buildings
- Land: 60% of prime agricultural land lost to farming is used for buildings
- Timber: 70% of global timber products end up in construction
Project Background & Context

Department of Science & Technology

- Mdantsane (2000 houses)
- Kleinmond
  - Mthimkhulu Centre (2 houses)
  - Overstrand Municipality (411)

- “Develop, test and implement innovative technologies aimed at improving the performance of the houses and contributing toward sustainable human settlements”
40 sq.m. subsidy house
- 140 mm hollow concrete masonry block
- 75 mm concrete slab
- Steel roof sheet
- Electrical board with 2 plugs and single light
- No hot water
- 16.1% and 14.7% reported weak walls and roofs respectively
- 30% + in EC and WC reported problems with walls and roof
Evaluating Different Building Technologies

Suburban house  Default house  CSIR house  LSF house  EPS house

constructed 3 test houses on CSIR Innovation Site
Industry stakeholders built an additional 2
Innovative CSIR technology application

Analysed across 5 construction elements
Development of Innovative Building Technologies

Substructure

• Conventional subsidy house
  • Shallow excavations
  • Shallow foundations
  • Inferior hardcore material
  • Inadequate compaction
  • Poor control of dpc

• CSIR-developed alternative
  • Carefully controlled ground preparation
  • 50 mm CRCP slab
  • Significant reduction in material use
CRCP Slab

Approved selected fill, stabilised with 3% lime, compacted in 7mm layers, cut to level, top and sides slashed with 2 coats, 1:8 (emulsion to water). Emulsion to be 60% stable grade anionic emulsion.

- 20MPa concrete foundation & slab, powerfloated
- Steel mesh of 193 (6x2.4) bent into ground beam on 2 sides
- 12.5mm Thermoperl plaster in designated coastal regions
- Hollow cone block
- 30mm wide weep hole in bedding course on top of foundation every 600mm if not plastered
- Initial external compaction level to be removed later
Development of Innovative Building Technologies

Superstructure

- Conventional subsidy house
  - Solid block
  - Poor control of mortar thickness
  - High wastage
- CSIR-developed alternative
  - Carefully controlled mortar bed thickness
  - Modular dimensions
  - Hollow block
  - Significant reduction in material use
Design to eliminate waste
Roof assembly

- Conventional subsidy house
  - Cranked steel roof sheet
  - No insulation
  - Cracking between sheet and wall

- CSIR-developed alternative
  - Modular use of roof sheet
  - Altered sheet direction
  - Roof overhangs
  - Reinforced ring beam
  - Roof acts as gutter, and no cracking
Services

- Conventional subsidy house
  - Individual piping
  - Un-coordinated planning
  - Poor quality control
- CSIR-developed alternative
  - Modular plumbing design
  - Grouped sanitaryware
  - Single plumbing manifold
  - Reduced piping
  - Better quality control
Development of Innovative Building Technologies

Finishes
- Conventional subsidy house
  - Cementitious coating
  - Poor weatherproofing
  - Poor impression of quality
- CSIR-developed alternative
  - Enhanced plaster coat
  - Improved weatherproofing
  - Improved thermal performance
  - Better quality
Roll-out of 2000 Houses in Mdantsane
Roll-out of 411 Houses, Kleinmond
Foundations
Walls
Walls
Roof
Services
Finishes
Performance Modelling

Thermal

<table>
<thead>
<tr>
<th>House</th>
<th>Heating load (GJ)</th>
<th>Cooling load (GJ)</th>
<th>Total load (GJ)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subsidy house</td>
<td>12.29</td>
<td>7.50</td>
<td>19.78</td>
</tr>
<tr>
<td>CSIR house</td>
<td>8.66</td>
<td>0.00</td>
<td>8.66</td>
</tr>
</tbody>
</table>

Material resource input
- CSIR house 35% less material resource input by weight than subsidy house
- CO$_2$ reduction of 685 kg equivalents excluding operational use
- CSIR house contributes less to water depletion than subsidy house
### National Resource Impact

<table>
<thead>
<tr>
<th>Innovative technology</th>
<th>Per house</th>
<th>National</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy reduction (heating cooling)</td>
<td>11.12 GJ</td>
<td>23 352 000 GJ</td>
</tr>
<tr>
<td>CO₂ reduction</td>
<td>0.685 ton</td>
<td>1 438 500 ton</td>
</tr>
<tr>
<td>Material weight reduction</td>
<td>18.8 ton</td>
<td>39 480 000 ton</td>
</tr>
<tr>
<td>Water from materials</td>
<td>19.73 m³</td>
<td>41 433 000 m³</td>
</tr>
<tr>
<td>Water, through tanks</td>
<td>22 m³</td>
<td>46 200 000 m³</td>
</tr>
<tr>
<td>Electricity (SWH)</td>
<td>1762.95 kWh/annum</td>
<td>3.7 billion kWh/annum</td>
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<tr>
<td>Electricity (PV)</td>
<td>36 kWh/annum</td>
<td>75.6 million kWh/annum</td>
</tr>
<tr>
<td>CO₂ reduction (SWH)</td>
<td>2.11 ton/kWh/annum</td>
<td>4.4 million t/kWh/annum</td>
</tr>
<tr>
<td>CO₂ reduction (PV)</td>
<td>0.04 ton/kWh/annum</td>
<td>90 300 ton/kWh/annum</td>
</tr>
</tbody>
</table>
The development and application of innovative technologies can demonstrably improve quality of life, contribute to sustainable human settlements, and assist Government in meeting national imperatives at no or relatively low additional cost.
Houses as Homes
Human Settlements as a Contributor Towards National Imperatives

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