## Quality Management

<table>
<thead>
<tr>
<th>Issue/revision</th>
<th>Issue 1</th>
<th>Revision 1</th>
<th>Revision 2</th>
<th>Revision 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Remarks</td>
<td>DRAFT</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Date</td>
<td>2014/10/01</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prepared by</td>
<td>Sandra Serumaga-Zake</td>
<td></td>
<td>Gregory Rice</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Francis Porter</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Signature</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Checked by</td>
<td>Alison Groves</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Signature</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Authorised by</td>
<td>Francis Porter</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Signature</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Project number</td>
<td>018126</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Report number</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>File reference</td>
<td>Z:\Project/018000-018999/018126-GPF Affordable Housing/GBD/3 Reports/4 Guide/FINAL</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## Green Building Guideline

**Medium Density Affordable Housing**

2014/12/19

The Gauteng Partnership Fund

Vinolia Mashiane
82 Grayston Drive
Sandton
2196

Consultant

Francis Porter
WSP House
Bryanston Place, 199 Bryanston Drive
Bryanston
2191
South Africa

Tel: +27 11 300 6174
Fax: +27 11 361 1301

www.wspgroup.co.za

Registered Address

WSP Group Africa (Pty) Ltd
1999/008928/07
WSP House, Bryanston Place, 199 Bryanston Drive, Bryanston, 2191, South Africa

WSP Contacts

Francis Porter
WSP House
Bryanston Place, 199 Bryanston Drive
Bryanston
2191
South Africa
7.4 Exterior ground covering ..........................................................28
7.3 External Shading devices and Fenestration .............................28
7.2 Natural ventilation ....................................................................28
7.1 Space configuration and orientation .........................................28
7. SUSTAINABLE DESIGN PHILOSOPHY ..................................28

SUMMARY COST-BENEFIT ANALYSIS: MATERIALS ...................28
6.8 Flooring Finishing: Terrazzo tiles .............................................27
6.6 External Wall: Honeycomb Clay Block Walls ...........................26
6.4 Flooring Slab: Precast Reinforced Concrete planks and joint system..............................................................26
6.3 Flooring Slab: Concrete filler slab ............................................25
6.2 Flooring Slab: In-situ Concrete with >30% Pulverised Fuel Ash (PFA) ..............................................................24
6.1 Flooring Slab: In-situ Concrete with >25% GGBS ....................24
6. MATERIAl MEASURES .................................................................24
5.1 Low flow Fixtures and Fittings .................................................24
5.3 Recycled Greywater for Toilet Flushing and Irrigation.........21
5.2 Rainwater Harvesting System ..................................................21
5.5 Deep Showers instead of Baths Tub ........................................22
5.4 Sustainable Urban Drainage Systems .....................................22
5.3 Flooring Slab: Concrete filler slab ............................................25
5.2 Flooring Slab: In-situ Concrete with >30% Pulverised Fuel Ash (PFA) ..............................................................24
5.1 Flooring Slab: In-situ Concrete with >25% GGBS ....................24
5. MATERIAl MEASURES .................................................................24
4.12 Metering ...................................................................................17
4.11 External Lighting Control ..........................................................17
4.10 External Lighting Fixtures .........................................................17
4.9 Internal Lighting – Energy Savings Bulbs .................................15
4.8 Solar Photovoltaics: Renewable Energy Generation ............14
4.7 Solar Hot Water Systems .........................................................12
4.6 Heat Pumps for Hot Water ......................................................11
4.5 High Efficiency Geyser for Hot Water .....................................10
4.4 Natural Ventilation and Cross Ventilation ............................8
4.3 Insulation: Roof and External Walls ........................................8
4.2 External Shading Devices ..........................................................7
4.1 Reduced Window to Wall Ratio ................................................6
4.10 External Lighting Fixtures .........................................................17
4.9 Internal Lighting – Energy Savings Bulbs .................................15
4.8 Solar Photovoltaics: Renewable Energy Generation ............14
4.7 Solar Hot Water Systems .........................................................12
4.6 Heat Pumps for Hot Water ......................................................11
4.5 High Efficiency Geyser for Hot Water .....................................10
4.4 Natural Ventilation and Cross Ventilation ............................8
4.3 Insulation: Roof and External Walls ........................................8
4.2 External Shading Devices ..........................................................7
4.1 Reduced Window to Wall Ratio ................................................6
4.10 External Lighting Fixtures .........................................................17
4.9 Internal Lighting – Energy Savings Bulbs .................................15
4.8 Solar Photovoltaics: Renewable Energy Generation ............14
4.7 Solar Hot Water Systems .........................................................12
4.6 Heat Pumps for Hot Water ......................................................11
4.5 High Efficiency Geyser for Hot Water .....................................10
4.4 Natural Ventilation and Cross Ventilation ............................8
4.3 Insulation: Roof and External Walls ........................................8
4.2 External Shading Devices ..........................................................7
4.1 Reduced Window to Wall Ratio ................................................6
4. MATERIAl MEASURES .................................................................24
3. Sustainable Design Measures......................................................5
2. Methodology.................................................................................5
1. About the Green Guideline ..........................................................4
Executive Summary ...........................................................................4

Table of Contents

List of Acronyms

List of Tables

List of Figures

Table 1: Summary of Green Building Initiatives ...............................................4
Table 2: Thermal Insulants Recommended by TIASA ........................................8
Table 3: Heating Energy Reduction vs Insulation ........................................8
Table 4: Depth of Floor to Ceiling height ratio for different room configurations adapted from the EDGE Certification User Guide ..............................................................10
Table 5: Applicable types of cross ventilation, adapted from the User Guide for Homes V1 ..............................................................9
Table 6: The use of Electrical Resistance vs Natural Gas/LPG ..........................10
Table 7: Advantages vs Disadvantages of Individualised vs Communal .................................11
Table 8: Draft Budget 2014/2015 by the City of Johannesburg, released March 2014 .................................17

List of Acronyms

List of Figures

Figure 1: The notional building modelled and utilised for costing ..............................................................5
Figure 2: Highlands Lofts, Ellis Park Johannesburg ..............................................................6
Figure 3: The relationship between the Dh (Depth of the horizontal) and Dv (vertical shading) and W (window width) ..............................................................................................7
Figure 4: Common Exterior Shading Solutions, Lawrence Berkeley Lab’s “Tips for Daylighting with Windows” ..............................................................10
Figure 5:  How a gas water heater works, (source: building doctors) ..............................................................10
Figure 7: Electric ‘Grid-tie, off-grid solar and backup power solution’ ..............................................................14
Figure 7: Residential demand profile with PV Supply Options ..............................................................14
Figure 9: Acceptable and unacceptable external lighting (GBCSA, Office 1 Manual) ..............................................................16
Figure 9: The lighting power required during the evening, from 18:00 to 06:00 ..............................................................17
Figure 11: Typical Unit within the base case development modelled ..............................................................29
Figure 11: Monthly utility costs: Business as Usual vs Energy Efficient Solutions ..............................................................29

List of Tables

Table 1: Summary of Green Building Initiatives ...............................................4
Table 2: Thermal Insulants Recommended by TIASA ........................................8
Table 3: Heating Energy Reduction vs Insulation ........................................8
Table 4: Depth of Floor to Ceiling height ratio for different room configurations adapted from the EDGE Certification User Guide ..............................................................10
Table 5: Applicable types of cross ventilation, adapted from the User Guide for Homes V1 ..............................................................9
Table 6: The use of Electrical Resistance vs Natural Gas/LPG ..........................10
Table 7: Advantages vs Disadvantages of Individualised vs Communal .................................11
Table 8: Draft Budget 2014/2015 by the City of Johannesburg, released March 2014 .................................17

List of Acronyms

List of Figures

Figure 1: The notional building modelled and utilised for costing ..............................................................5
Figure 2: Highlands Lofts, Ellis Park Johannesburg ..............................................................6
Figure 3: The relationship between the Dh (Depth of the horizontal) and Dv (vertical shading) and W (window width) ..............................................................................................7
Figure 4: Common Exterior Shading Solutions, Lawrence Berkeley Lab’s “Tips for Daylighting with Windows” ..............................................................10
Figure 5:  How a gas water heater works, (source: building doctors) ..............................................................10
Figure 7: Electric ‘Grid-tie, off-grid solar and backup power solution’ ..............................................................14
Figure 7: Residential demand profile with PV Supply Options ..............................................................14
Figure 9: Acceptable and unacceptable external lighting (GBCSA, Office 1 Manual) ..............................................................16
Figure 9: The lighting power required during the evening, from 18:00 to 06:00 ..............................................................17
Figure 11: Typical Unit within the base case development modelled ..............................................................29
Figure 11: Monthly utility costs: Business as Usual vs Energy Efficient Solutions ..............................................................29

List of Tables

Table 1: Summary of Green Building Initiatives ...............................................4
Table 2: Thermal Insulants Recommended by TIASA ........................................8
Table 3: Heating Energy Reduction vs Insulation ........................................8
Table 4: Depth of Floor to Ceiling height ratio for different room configurations adapted from the EDGE Certification User Guide ..............................................................10
Table 5: Applicable types of cross ventilation, adapted from the User Guide for Homes V1 ..............................................................9
Table 6: The use of Electrical Resistance vs Natural Gas/LPG ..........................10
Table 7: Advantages vs Disadvantages of Individualised vs Communal .................................11
Table 8: Draft Budget 2014/2015 by the City of Johannesburg, released March 2014 .................................17
Executive Summary

WSP Group Africa Pty (Ltd) was appointed by the Gauteng Partnership Fund (the GPF) to deliver a green building guideline that will outline the green initiatives for medium density affordable rental housing projects. Considering the vast impact the built environment has on the natural environment, human health and the economy, sustainable green building practices must be implemented. The Green Guideline’s aim is to promote sustainability measures which have both an environmental, social and economic benefit while having a beneficial or minimum impact on capital expenditure. The sustainable building initiatives that have been highlighted within the report below, are recommended for use by developers in the Medium Density Affordable Housing (MDAH) market. The main motivation for the Green Guideline, apart from the sustainability imperative, is to boost tenant resilience to pay rent and avoid defaults.

1.1 Background

The built environment has a vast impact on the natural environment, human health and the economy. By adopting green building strategies, we can maximise economic and environmental performance. Green building initiatives can be incorporated into the building at any stage, from design to construction, to renovation to demolition. However, the most beneficial stage to consider and incorporate the presented strategies is the design stage. Potential benefits from green buildings include:

**Environmental benefits:**
- Conserve and restore natural environments
- Enhance and protect biodiversity and ecosystems
- Improve air and water quality
- Reduce waste streams

**Economic benefits:**
- Reduce operating costs
- Improve occupant productivity and well being
- Optimize life-cycle economic performance

**Social benefits:**
- Enhance occupant comfort and health
- Minimise strain on local infrastructure
- Improve overall quality of life.

A green building is a healthy building. Health can be measured in many ways, not just for the body and mind, but from a financial perspective. Building green makes for a wise investment. The benefits far outweigh the costs. Though it may take a little longer to plan and build green which may cost slightly more, the benefits will more than pay themselves back within a few years. What’s not measurable in Rands and cents is the impact on the environment and health - although immeasurable they make a green building more than worthwhile investment.

Table 1: Summary of Green Building Initiatives

<table>
<thead>
<tr>
<th>Sustainable Building Initiative</th>
<th>% Increase or Decrease in Capex (green indicates finance available)</th>
<th>% Reduction in Energy or Water Use</th>
<th>Cost Benefit Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>E: Insulation of Roof</td>
<td>+0.02%</td>
<td>0.56</td>
<td>+++</td>
</tr>
<tr>
<td>E: Insulation of External Walls</td>
<td>+0.66%</td>
<td>0.53</td>
<td>+</td>
</tr>
<tr>
<td>E: Energy Saving Light Bulbs</td>
<td>+1.26%</td>
<td>1.24</td>
<td>++</td>
</tr>
<tr>
<td>E: Lighting Controls</td>
<td>+0.01%</td>
<td>1.59%</td>
<td>+++</td>
</tr>
<tr>
<td>E: High Efficiency Boilers (Gas)</td>
<td>-0.58%</td>
<td>2.1</td>
<td>++</td>
</tr>
<tr>
<td>E: Heat Pumps (Single Unitised)</td>
<td>+3.19%</td>
<td>10.45</td>
<td>++</td>
</tr>
<tr>
<td>E: Heat Pumps (Communal)</td>
<td>+1.86%</td>
<td>10.45</td>
<td>+++</td>
</tr>
<tr>
<td>E: Solar Hot Water (Single Unitised)</td>
<td>+3.73%</td>
<td>16.16</td>
<td>+++</td>
</tr>
<tr>
<td>E: Solar Hot Water (Communal)</td>
<td>+3.31%</td>
<td>16.16</td>
<td>+++</td>
</tr>
<tr>
<td>E: Solar Photovoltaics</td>
<td>+5.16%</td>
<td>25</td>
<td>+++++</td>
</tr>
<tr>
<td>W: Handwash Basin Taps</td>
<td>+0.03%</td>
<td>3</td>
<td>+++++</td>
</tr>
<tr>
<td>W: Kitchen Tap</td>
<td>+0.13%</td>
<td>6</td>
<td>+++</td>
</tr>
<tr>
<td>W: WC (Single Flush)</td>
<td>-0.09%</td>
<td>18</td>
<td>+++++</td>
</tr>
<tr>
<td>W: WC (Dual Flush)</td>
<td>-0.02%</td>
<td>32</td>
<td>+++++</td>
</tr>
<tr>
<td>W: Showerhead</td>
<td>-0.04%</td>
<td>9</td>
<td>+++++</td>
</tr>
<tr>
<td>W: Deep Shower Trays</td>
<td>%</td>
<td>7</td>
<td>+++++</td>
</tr>
<tr>
<td>W: Rainwater Harvesting</td>
<td>+0.80%</td>
<td>1.6</td>
<td>++</td>
</tr>
<tr>
<td>W: Recycled Greywater for Flushing</td>
<td>+2.53%</td>
<td>29.1</td>
<td>+++</td>
</tr>
<tr>
<td>M: In-situ Concrete with &gt;25% GGBS</td>
<td>0.00%</td>
<td>6.80</td>
<td>++</td>
</tr>
<tr>
<td>M: In-situ Concrete with &gt;30% Pulverised Fuel Ash (PFA)</td>
<td>0.00%</td>
<td>5.90</td>
<td>++</td>
</tr>
<tr>
<td>M: Concrete filler slab</td>
<td>-0.71%</td>
<td>15.00</td>
<td>+++++</td>
</tr>
<tr>
<td>M: Finished Concrete Floor</td>
<td>-0.52%</td>
<td>2.60</td>
<td>++</td>
</tr>
<tr>
<td>M: Terrazzo Tiles</td>
<td>-0.12%</td>
<td>3.10</td>
<td>++</td>
</tr>
</tbody>
</table>

The initiatives with the highest cost-benefit are recommended for implementation. Further detail on each initiative is presented within the guideline below.
2. Methodology

2.1 Research

A desk study was conducted with the intention of identifying key sustainability measures that can be implemented within MDAH developments. The initiatives selected were informed by the International Finance Corporation (IFC) Edge certification tool that can be used to calculate the operational savings and reduced carbon emissions of a building as measured against a base case. These were expanded upon by conducting a series of consultations with key stakeholders within the sustainability market and testing the applicability of these initiatives to the South African context. The following considerations were made during the study:

- the accessibility of the product/technology
- the affordability of the product/technology
- the predicted energy/water or embodied energy saving

Finally, a cost-benefit analysis was undertaken, taking the cost of the initiative and the achievable percentage reduction in energy, water and embodied energy into account. The higher the cost benefit, the better. Initiatives that have three or more stars should be implemented.

2.2 Cost-Benefit Analysis

A cost benefit analysis was conducted to determine which initiatives are better positioned to deliver on energy/water savings promised when following sustainable design. The following illustrates the ranking used when determining a product/technology’s cost benefit:

<table>
<thead>
<tr>
<th>Rank</th>
<th>Symbol</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>+</td>
</tr>
<tr>
<td>20</td>
<td>++</td>
</tr>
<tr>
<td>30</td>
<td>+++</td>
</tr>
<tr>
<td>40</td>
<td>++++</td>
</tr>
<tr>
<td>50</td>
<td>+++++</td>
</tr>
</tbody>
</table>

2.3 Assumptions

To facilitate the calculation of cost efficiencies, various assumptions were made regarding a notional building that are detailed within section 9.2. The below Figure shows the notional MDAH project modelled and quoted for:

Figure 1: The notional building modelled and utilised for costing

3. Sustainable Design Measures

The following initiatives were investigated and have been detailed further below:

<table>
<thead>
<tr>
<th>Energy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduced Window to Wall Ratio</td>
</tr>
<tr>
<td>External Shading Devices</td>
</tr>
<tr>
<td>Insulation of Roof</td>
</tr>
<tr>
<td>Insulation of External Walls</td>
</tr>
<tr>
<td>Natural Ventilation</td>
</tr>
<tr>
<td>Natural Efficiency Boilers</td>
</tr>
<tr>
<td>Heat Pumps for Hot Water</td>
</tr>
<tr>
<td>Internal Lighting Energy Efficient</td>
</tr>
<tr>
<td>External Lighting Energy Efficient</td>
</tr>
<tr>
<td>External Lighting Controls</td>
</tr>
<tr>
<td>Solar Hot Water</td>
</tr>
<tr>
<td>Solar Photovoltaics</td>
</tr>
<tr>
<td>Smart Meters</td>
</tr>
<tr>
<td>Alternative Funding</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Water</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water Efficient Fittings/Fixtures</td>
</tr>
<tr>
<td>Rainwater Harvesting</td>
</tr>
<tr>
<td>Recycled Greywater for Flushing</td>
</tr>
<tr>
<td>Sustainable Urban Drainage Systems</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Material</th>
</tr>
</thead>
<tbody>
<tr>
<td>In-situ Concrete with &gt;25% GGBS</td>
</tr>
<tr>
<td>In-situ Concrete with &gt;30% Pulverised Fuel Ash (PFA)</td>
</tr>
<tr>
<td>Concrete filler slab</td>
</tr>
<tr>
<td>Precast Reinforced Concrete planks</td>
</tr>
<tr>
<td>and joint system</td>
</tr>
<tr>
<td>Clay tiles on rafters</td>
</tr>
<tr>
<td>Honeycomb clay block walls</td>
</tr>
<tr>
<td>Medium weight hollow concrete blocks</td>
</tr>
<tr>
<td>Finished concrete screed floor</td>
</tr>
<tr>
<td>Terrazzo tiles</td>
</tr>
</tbody>
</table>
ENERGY EFFICIENCY MEASURES

4.1 Reduced Window to Wall Ratio

Description:
The window-to-wall ratio (WWR) is the ratio of transparent glass (or glazing) to that of the opaque external surface of the home. The glazing area of the home is the area of glass on all facades regardless of their orientation. This formula is illustrated below:

\[
\text{WWR} \% = \frac{\sum \text{Glazing area (m}^2\text{)}}{\sum \text{Glazing exterior wall area (m}^2\text{)}}
\]

Technical Specification:
The desired WWR is 10% not greater than 30%.

Motivation:
The ratio of transparent glass (or glazing) to that of the opaque external surface of the home determines the amount of daylight that enters the home and minimizes heat gain or heat loss during winter. Therefore, the amount of energy used to cool the home during summer or heat the home during winter would be reduced. In this way the daylighting and ventilation benefits of fenestration, the impact of the heat gain potential of glazing and the cooling or heating requirements of the home are balanced.

Key Considerations/Strategy:
Should the optimum WWR be achieved, the need for insulation in external wall applications will be waived. Furthermore, according to the rational design approach of SANS 10400-XA the fenestration of a building per storey cannot exceed 15% of the net floor area of the storey (for buildings that do not comply with orientation and shading).

Financial Considerations:

<table>
<thead>
<tr>
<th>Sustainable Building Initiative</th>
<th>% Increase or Decrease in Capex</th>
<th>% Reduction in Energy Use</th>
<th>Cost Benefit Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>E: Reduced Window to Wall Ratio</td>
<td>0.00%</td>
<td>1.37%</td>
<td>++++</td>
</tr>
</tbody>
</table>

see Sustainable Design Philosophy section

References:
- Guidance on How to Comply with Regulation XA

Figure 2: Highlands Lofts, Ellis Park Johannesburg.

Case Study A:
The Highlands Loft Development, developed by Devco, achieved the desired Window to Wall ratio as specified by SANS-10400 XA and therefore the need to install insulation within its walls was waived.
4.2 External Shading Devices

Description:
Fixed external shading devices are placed on the building’s exterior windows to shield against direct solar gains. To meet the requirements for external shading, vertical shading (preferable for the east and west) and/or horizontal shading (preferable for the north) is required to be provided for SANS-204. The commonly used exterior shading solutions are depicted within Figure 4.

Technical Specification:
The EDGE certification tool assumes a shading device that is 1/3 of the height of the window for the width of the horizontal shading and 1/3 of the width of the window, is assumed, for the width of the vertical shading.

Motivation:
The purpose of having external shading devices built on the façade of the building is to reduce heat gains on glazing and to reduce the discomfort experienced from glare. This will improve occupant comfort within the home.

Key Considerations/Strategy:
The orientation of the façade has to be considered when installing external shading devices.

Financial Considerations:

<table>
<thead>
<tr>
<th>Sustainable Building Initiative</th>
<th>% Increase or Decrease in Capex</th>
<th>% Reduction in Energy Use</th>
<th>Cost Benefit Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>E: External Shading Devices</td>
<td>0.00%*</td>
<td>0.42%</td>
<td>+</td>
</tr>
</tbody>
</table>

*see Sustainable Design Philosophy section

References:

Figure 3: The relationship between the Dh (Depth of the horizontal) and Dv (vertical shading) and W (window width)

Figure 4: Common Exterior Shading Solutions, Lawrence Berkeley Lab’s “Tips for Daylighting with Windows”
4.3 Insulation: Roof and External Walls

Description:
The installation of insulation lowers the U-value or Thermal Conductivity of a building element. Once the U-value of the building element decreases its insulating properties increase. The U-value of the building is defined to be the quantity of heat that flows through a unit area in a unit of time, per unit difference in temperature. It is expressed in Watts per square meter Kelvin (W/m²K). It provides an indication of how much heat is transmitted through a material, but also includes losses due to convection and radiation.

Technical Specification:
For the purposes of Sustainable Design a U-value of 0.18 for roofs and 0.25 for external walls is recommended. The Thermal Insulation Association of Southern Africa (TIASA) recommends the following thermal insulants for Gauteng:

Table 2 Thermal Insulants Recommended by TIASA

<table>
<thead>
<tr>
<th>Generic Insulation Products</th>
<th>Density Kg/m³</th>
<th>Recommended deemed-to-satisfy min thickness (mm) of insulation product</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cellulose Fibre Loose-Fill</td>
<td>27.5</td>
<td>135</td>
</tr>
<tr>
<td>Flexible Fibre Glass Blanket</td>
<td>10-18</td>
<td>135</td>
</tr>
<tr>
<td>Flexible BOQ Polyester Fibre Blanket</td>
<td>24</td>
<td>130</td>
</tr>
<tr>
<td>Flexible Polyester Blanket</td>
<td>11.5</td>
<td>160</td>
</tr>
<tr>
<td>Flexible Mineral/Rockwool</td>
<td>60-120</td>
<td>115</td>
</tr>
<tr>
<td>Flexible Ceramic Fibre</td>
<td>84</td>
<td>115</td>
</tr>
<tr>
<td>Rigid Fibre Glass Board</td>
<td>47.5</td>
<td>115</td>
</tr>
<tr>
<td>Rigid BOQ Polyester Fibre Board</td>
<td>61</td>
<td>115</td>
</tr>
</tbody>
</table>

Estimated minimum added R-Value of Insulation (m².K/W) and direction of heat flow is up

Motivation:
Insulation reduces the heat gained during warm summer months and reduces the heat lost during cold winter months and. As discussed within Case Study A the development would have to be modelled to determine its need for external wall insulation. Insulation in the roof is a prerequisite that must be implemented.

Key Considerations/Strategy:
The building envelope would have to be designed for the use of insulation. The design of the building envelope further depends on the type of insulation used. As depicted within Table 3 below, as the insulation within the unit increases, the need for energy in heating applications decreases.

Table 3: Heating Energy Reduction vs Insulation

<table>
<thead>
<tr>
<th>Sustainable Building Initiative</th>
<th>% Increase/Decrease in Capex</th>
<th>% Reduction in Energy Use</th>
<th>Cost Benefit Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>E: Insulation of Roof</td>
<td>+0.02%</td>
<td>0.56%</td>
<td>+++</td>
</tr>
<tr>
<td>E: Insulation of External Walls</td>
<td>+0.66%</td>
<td>0.53%</td>
<td>+</td>
</tr>
</tbody>
</table>

References:
- Thermal Insulation Association of Southern Africa (TIASA)
4.4 Natural Ventilation and Cross Ventilation

Description:
A dwelling unit must be designed with a natural and cross ventilation strategy for each room. This is achieved when two conditions are met, which are dependent on the room depth to ceiling height ratio and the proportion of openings required for a certain floor area.

Technical Specification:
As aforementioned, either a single sided or cross-ventilation strategy can be employed for a unit. With cross-ventilation, the unit will have openable windows on both opposite ends of the room or living area. In this case, ventilation is driven by the pressure differences between the windward and leeward sides of the space. That being said, a single-sided ventilation strategy can be used to meet the ventilation requirements of a unit, this however, will not be as effective as a cross-ventilation strategy. Single-sided ventilation is recommended for areas or spaces with a greater depth. The maximum depth-of-floor-to-ceiling-height ratio recommended for either single sided ventilation or cross ventilation strategies are indicated below:

Table 4: Depth of Floor to Ceiling height ratio for different room configurations adapted from the EDGE Certification User Guide

<table>
<thead>
<tr>
<th>Ventilation Strategy</th>
<th>Maximum depth-of-floor-to-ceiling-height ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single Sided, Single Opening</td>
<td>1.5</td>
</tr>
<tr>
<td>Single-Sided, Multiple Openings</td>
<td>2.5</td>
</tr>
<tr>
<td>Cross Ventilation</td>
<td>5</td>
</tr>
</tbody>
</table>

Motivation:
The purpose of establishing a natural and cross ventilation strategy is to ensure occupant comfort by designing for adequate amounts of fresh air.

Key Considerations/Strategy:
To achieve an accurate level of natural ventilation the room depth to ceiling height ratio and the proportion of openings required for a certain floor area must be managed.

Table 5: Applicable types of cross ventilation, adapted from the User Guide for Homes V1

<table>
<thead>
<tr>
<th>Type</th>
<th>Image</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single-sided Ventilation</td>
<td></td>
<td>Single-sided ventilation relies on the pressure differences between different openings within a single space.</td>
</tr>
<tr>
<td>Cross-ventilation – Single Spaces</td>
<td></td>
<td>Cross ventilation of single spaces is the simplest and most effective approach. Cross-ventilation is driven by pressure differences between the windward and leeward sides of the space</td>
</tr>
<tr>
<td>Cross-ventilation – Double banked spaces</td>
<td></td>
<td>Cross ventilation with banked rooms can be achieved by creating openings in the corridor partition. This is only acceptable where a residential unit has ownership of both windward and leeward sides of the building, as the ventilation of the leeward space relies on the occupant of the windward space.</td>
</tr>
<tr>
<td>Stack Ventilation</td>
<td></td>
<td>Stack ventilation takes advantage of the temperature stratification and associated pressure differentials of the air. This type of ventilation requires atriums or height differences.</td>
</tr>
</tbody>
</table>

Financial Considerations:

<table>
<thead>
<tr>
<th>Sustainable Building Initiative</th>
<th>% Increase/Decrease in Capex</th>
<th>%Reduction in Energy Use</th>
<th>Cost Benefit Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>E: Natural Ventilation</td>
<td>*0.00%</td>
<td>0.00%</td>
<td>++++</td>
</tr>
</tbody>
</table>

*see Sustainable Design Philosophy section

References:
4.5 High Efficiency Geyser for Hot Water

Description:
This initiative investigates the different energy sources that can be used to deliver hot water to a development. For this purpose three fuels or sources of energy were investigated these include: electrical resistance, Liquid Petroleum Gas (LPG) and Natural Gas. The water heater selected must have a high efficiency. The different sources of energy are discussed further below:

<table>
<thead>
<tr>
<th>Table 6: The use of Electrical Resistance vs Natural Gas/LPG</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Electrical Resistance</strong></td>
</tr>
<tr>
<td>This is a standard storage tank style water heater that suffers inefficiencies or losses in energy due to standby loss. As the hot water sits in the tank, heat may escape through the walls of the tank. Therefore, when considering increasing geyser efficiencies, a geyser blanket would be a good addition</td>
</tr>
</tbody>
</table>

Technical Specification:
The efficiency of the boiler or geyser must be equal to or greater than 95%. The common standard used to define the efficiency of a water heater or geyser is the Energy Factor (EF). Energy Factor is an annual measure of the useful energy coming out of your water heater, divided by the amount of energy going in to the water heater to heat the water. A conventional electric geyser with an EF of 0.95 must be achieved.

Motivation:
The purpose of having a high efficiency geyser specified is to reduce the demand for electricity that would otherwise be required.

Key Considerations/Strategy:
The EF factor of the water heater includes the use of insulation for tanks and pipes curbing against heat losses from thermal bridging. Furthermore, if piping is exposed to sunlight it must be UV protected. It is advisable to reduce the hot water demand before sizing the geyser for the unit, irrespective of whether or not it is a single unitised option or a communal option. The end-user profile must also be accurately estimated to provide sufficient energy. When considering a communal heating system, energy metering, monitoring and billing should be a key consideration. When considering a gas fuelled geyser, Natural Gas provided by Egoli Gas would be preferable. This is a considerably cheaper option when compared to LPG which can be as much as 2 times more than necessary.

Financial Considerations:

<table>
<thead>
<tr>
<th>Sustainable Building Initiative</th>
<th>% Increase/ Decrease in Capex</th>
<th>% Reduction in Energy Use</th>
<th>Cost Benefit Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>E: High Efficiency Geyser (Gas)</td>
<td>-0.58%</td>
<td>2.1%</td>
<td>++</td>
</tr>
</tbody>
</table>

References:
- http://buildingdoctors.com/
4.6 Heat Pumps for Hot Water

Description:
In this case the waste heat generated from heat pumps is used to deliver hot water. Heat pumps for hot water use electricity to transfer heat from one place to another rather than generating the heat using an electrical element. In this instance, a low-pressure liquid refrigerant is vaporized in the heat pump’s evaporator and passed into the compressor. As the pressure of the refrigerant increases, so does its temperature. The heated refrigerant runs through a condenser coil within the storage tank, transferring heat to the water stored there. As the refrigerant delivers its heat to the water, it cools and condenses, and then passes through an expansion valve where the pressure is reduced and the cycle starts over.

Both a modular and a communal solution have been investigated for multiple unit residential, they both harbour advantages and disadvantages that must be considered by the developer. The key advantages and disadvantages of the modular vs the communal solution is presented below:

<table>
<thead>
<tr>
<th>Table 7: Advantages vs Disadvantages of Individualised vs Communal</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Modular Solution (Individual Geysers)</strong></td>
</tr>
<tr>
<td>Advantages</td>
</tr>
<tr>
<td>Maintenance is made easy because of its isolated nature and the resilience of the development increases as a single unit failure has minimum impact</td>
</tr>
<tr>
<td>No need to instigate a basic or advanced metering strategy</td>
</tr>
<tr>
<td>No loss in efficiencies due to pipe run distances</td>
</tr>
</tbody>
</table>

Technical Specification:
The efficiency of the hot water storage tank must be equal to or greater than 95%. Energy Factor is an annual measure of the useful energy coming out of your water heater, divided by the amount of energy going in to the water heater to heat the water.

Motivation:
Heat pumps would be specified to reduce the electricity consumption of the unit and the development at large.

Key Considerations/Strategy:
It is advisable to reduce the hot water demand before sizing the heat pumps required for the unit, using either a unitised or a communal option depending on the building design and circumstances. The insulation of pipe runs must be implemented.

Financial Considerations:

<table>
<thead>
<tr>
<th>Sustainable Building Initiative</th>
<th>% Increase/Decrease in Capex</th>
<th>% Reduction in Energy Use</th>
<th>Cost Benefit Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>E: Heat Pumps: Single Unilised</td>
<td>+3.19%</td>
<td>10.45%</td>
<td>++</td>
</tr>
<tr>
<td>E: Heat Pumps: Communal</td>
<td>+1.86%</td>
<td>10.45%</td>
<td>+++</td>
</tr>
</tbody>
</table>

References:
4.7 Solar Hot Water Systems

Description:
Domestic Hot Water (DHW) is considered to account for around 40% during summer and 50% during winter of building user energy consumption. It is a critical service for building user hygiene, comfort, affordability and enjoyment. The standard approach to DHW was to provide individual electric resistance boilers however SANS 10400 Part XA now requires that at least 50% of DHW to be supplied from alternatives. Solar Hot Water (SHW) units utilise the high solar radiation present in Gauteng to heat and then store hot water. These have a reasonable CAPEX and as a renewable source of energy these have very low operational costs and environmental benefits which would benefit MDAH as long as the following items are addressed:

Finance
Since SHW has a substantial reduction in tenant utility costs the difference, either in total or in part, can be utilised to finance the uplift via alternative financing (see separate alternative finance section). This actively reduces the CAPEX of the DHW system.

System Type
Collective units require less roof area, at 5.5m² associated roof area per residential unit, and have a 25% reduction in CAPEX since per unit sizing is not dependent on individual unit capabilities. While more expensive dedicated individual SHW units reduce overall system failure risk and allow easy phasing, however they require a separate electric metering for their electric resistant back up and a metering strategy which avoids double counting of consumed KWh per litre and electric boiler kWh. Centralised SHW and Heat Pump hybrid require the highest CAPEX input but best payback long term. Note that for all systems there is a wide CAPEX range however lifecycle costs including reliability and maintenance should be included within decision making.

Technical Specification:
Centralised SHW system with metered electrical or gas back up based on consumption of 80L/person. Each unit to have a manual hot water meter connected to the system through insulated pipework.

Motivation:
SHW systems are recommended to achieve regulatory requirements in a cost effective manner. This leads to a reduction of capital costs as the hot water produced using solar energy could be sold to tenants at previously agreed upon rates. This is the case with hot water produced in for the evening. Furthermore, the use of SHW provides operational resilience of the HW system to power disruptions. Reduced energy consumption and associated release of GHGs as per Section 7.5. This is illustrated by the images adjacent to this text, it can be seen that the use of SHW reduces the energy consumption of the unit from a previous 49% (with a conventional boiler) to 7% with a SHW unit with an electrical backup.
Key Considerations/Strategy:

Supply

A roof area of 7m² per unit (individual unit for 4 person occupancy of 2 bedroom units) while flat roof MDAH allows for 10m² per unit. Over-shadowing from surrounding buildings, northern orientation, roof access and roof angle must all be taken into account during early design calculation. Monocline roofs or pitched roofs (at 26 degrees) minimise structural support requirements and cross panel over shadowing.

Metering

Consumption per litre of hot water must be metered. For communal systems an aggregated rate of SHW and communal electrical back up is required to avoid fairly apportion costs between tenants.

Financial Considerations:

<table>
<thead>
<tr>
<th>Sustainable Building Initiative</th>
<th>% Increase/Decrease in Capex</th>
<th>% Reduction in Energy Use</th>
<th>Cost Benefit Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>E: SHW: Single Unitised</td>
<td>+3.73%</td>
<td>16.16%</td>
<td>+++</td>
</tr>
<tr>
<td>E: SHW: Communal</td>
<td>+3.31%</td>
<td>16.16%</td>
<td>+++</td>
</tr>
</tbody>
</table>

References:
**4.8 Solar Photovoltaics: Renewable Energy Generation**

**Description:**
Photovoltaics (PV) utilise solar radiation to produce electrical energy. The outputted Direct Current (DC) voltage requires a solar panel array provision of 10m² for 1kWp/day (required for 25% of project annual consumption). The DC can be converted to standard mains Alternating Current (AC) via an inverter for residential consumption.

**Strategy**

The residential power demand profile and the solar generation power profile are not aligned. PV systems can be sized to:

- **Base Load sizing** of PV allows all generated power to be used immediately onsite, without batteries. Design for scalability to ensure future proofing when tying into the grid becomes possible.

- **Resell to the grid sizing**, requires municipal feed in tariffs (not currently available). Systems can be sized independent of profile with revenue significantly reducing net municipality bill.

- **Battery System sizing** optimises generation to the demand profile by delaying consumption with batteries. Allows systems beyond base load sizing which to gives more flexibility on financial return.

**Metering**

Pre-Paid Metering Companies (PMC) currently manage the distribution of kWh, tenant money and municipality payments. Voucher rates are confirmed in advance based on consumption rate brackets. By metering utilised PV energy finance bodies can also be remunerated.

**Technical Specification:**

The provision of PV array (performance guarantee 20 years, underwritten by third party insurers), solar charge controller and inverter (12 year warranty) with switch gear, to allow onsite electrical consumption from PV.

**Motivation:**
Since PV has a reduction in cost per kWh a proportion of the difference can be utilised to finance the uplift via alternative financing (see separate section). It will also reduce the CAPEX associated with upfront electrical connection charges and provide a resilience buffer to power shortages.

**Key Considerations:**
- A flat roofed development allows for solar panel array provision of 10m² per 1kWp/day, structural engineers to consider load implications. Over-shadowing, orientation, roof access and roof angle must all be taken into account during early design, seeing that these would influence the solar panel array. Base load PV with external financing sizing should be strongly considered. Improvement in battery technology is ongoing and should be monitored. Future proofing via the use of monoline roof angled at 26 degrees and securable space near distribution board for climate controlled battery storage (area) and inverter is recommended. If sufficient space is not available then incorporating array within car parking shading structures may be an alternative.

**Multi-use building strategies could enable a profitable use of peak solar generated energy, creating a revenue stream for landlords and possibly discounted energy for tenants.**

**Financial Considerations:**

<table>
<thead>
<tr>
<th>Sustainable Building Initiative</th>
<th>% Increase or Decrease in Capex</th>
<th>% Reduction in Energy Use</th>
<th>Cost Benefit Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>E: Solar Photovoltaic</td>
<td>+5.16%</td>
<td>25%</td>
<td>++++</td>
</tr>
</tbody>
</table>

**References:** CSIR Guidelines for Human Settlement and Design
4.9 Internal Lighting – Energy Savings Bulbs

Description:
Energy efficient lighting is commonly available in South Africa in the form of Compact Fluorescent Lamps (CFLs) and these have largely replaced traditional incandescent lighting as the preferred lighting choice due to reduced energy consumption and heat generation and longer life spans. While 75W incandescent bulbs require electrical resistance to heat a metallic element ‘white hot’, a 13W CFL bulb contains a gas mixture of argon and mercury which is excited by a small electric current. In 4W Light Emitting Diodes (LEDs) electrons are encouraged to ‘jump’ between energy levels releasing photons. LED prices currently make them unsuitable for MDAH however a comparative study between 13W CFLs and 10W Light Emitting Diodes (LEDs) shows the following:

<table>
<thead>
<tr>
<th>LED Developer</th>
<th>LED Tenant</th>
</tr>
</thead>
<tbody>
<tr>
<td>Advantages</td>
<td>Disadvantages</td>
</tr>
<tr>
<td>30% electricity reduction contributing to lower connection charges</td>
<td>4 fold increase in capital costs</td>
</tr>
<tr>
<td>LEDs have 81 Lumens/Watt compared to CFLs 61 to less units are required.</td>
<td>30% power demand lowering total expected bill</td>
</tr>
</tbody>
</table>

A guide of 45 Lumen/Watt can be used for fittings to ensure best practice efficiency. LED paybacks are suitable, especially communal lighting. With the constantly updating market it is recommended a review of LED products is undertaken.

Technical Specification:
All internal space lighting will be by LED fixtures which have at least 1 year warranty. Quality LED fixtures are expected to last 15 000 hrs versus a CFL that a life expectancy of 6000 hrs.

Motivation:
Energy efficiency lighting reduces the upfront connection charges and the ongoing operational costs.

Key Considerations/Strategy:
Review required number of units as greater luminosity may reduce requirements. Given cost of LED units consider secure fittings to avoid high turnover during tenant switches.

Financial Considerations:

<table>
<thead>
<tr>
<th>Sustainable Building Initiative</th>
<th>% Increase or Decrease in Capex</th>
<th>%Reduction in Energy Use</th>
<th>Cost Benefit Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>E: Energy Saving Light Bulbs</td>
<td>+1.26%</td>
<td>1.01%</td>
<td>+</td>
</tr>
</tbody>
</table>

Cost-Benefit:
A life cycle cost assessment including purchase prices, replacement and utility costs show paybacks between 3 and 5 years.

References:
- Green Star South Africa Multi-Unit Residential Reference Guide – ENE-3 Lighting Energy Use
4.10 External Lighting Fixtures

Description:

Fixture Efficiency

External lighting of communal areas has both a capital and operational cost to the developer. CFL lighting is already standard. A payback calculation below shows the benefit of LED lighting.

Location and Orientation

Lighting design should be reviewed to avoid overspill to neighbouring properties and ingress to the night sky. Preference should be given to avoid light spill into tenant areas as this reduces the quality of sleep. The Green Star South Africa guidance on design is included below:

Key Considerations/Strategy:

The following should be considered when implementing energy efficient external lighting fixtures: Lamp life, warranty, access and maintenance, suitability to embed automatic controls. Furthermore, if dimming of lights is provided for, it is advisable to use either T5 lamps or lighting that permits this feature.

Financial Considerations:

<table>
<thead>
<tr>
<th>Sustainable Building Initiative</th>
<th>% Increase or Decrease in Capex</th>
<th>%Reduction in Energy Use</th>
<th>Cost Benefit Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>E: Energy Saving Light Bulbs</td>
<td>+1.26%</td>
<td>1.01%</td>
<td>+</td>
</tr>
</tbody>
</table>

References:

- Green Star South Africa Office v1 Reference Guide – EMI-7 Light Pollution

Technical Specification:

As per lighting guidance the lighting consultant will arrange external lighting to avoid night pollution, overspill, light ingress into the building.

Motivation:

Avoid unnecessary consumption and operational costs, improve Indoor Environmental Quality of tenants and avoid light pollution to the night’s sky.

Figure 8: Acceptable and unacceptable external lighting (GBCSA, Office v1 Manual)
4.11 External Lighting Control

Description:

Exterior lighting is required for way finding and security. Day-Night switches and timers are an effective way to avoid unnecessary consumption during daylight hours. They reduce the management burden/failure to turn off lighting. A two-tiered level of lighting with sensor could also be utilised to save 30% of exterior lighting power within the early hours of the morning where use of the exterior space is minimum. This requires occupant sensors at key areas, such as vehicles and pedestrian entrances, to only turn on additional power as needed.

Technical Specification:

Provide a two-tiered lighting system which reduces the lighting intensity by 50% during a period where motion sensors go without activation for 15 minutes.

Motivation:

Avoid unnecessary consumption of electricity and operational costs.

Key Considerations/Strategy:

The placement of sensors must be positioned to capture pedestrian and vehicle activity entering the site and exiting the residential units.

Financial Considerations:

<table>
<thead>
<tr>
<th>Sustainable Building Initiative</th>
<th>% Increase or Decrease in Capex</th>
<th>% Reduction in Energy Use</th>
<th>Cost Benefit Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>E: External Lighting Control</td>
<td>0.01%</td>
<td>1.59</td>
<td>++++</td>
</tr>
</tbody>
</table>

4.12 Metering

Description:

Energy

Municipality rates separate out between residential domestic prepay, reseller domestic (conventional) and reseller domestic (prepaid). The rate per kWh increases with consumption as per the example below:

Table 8: Draft Budget 2014/2015 by the City of Johannesburg, released March 2014

<table>
<thead>
<tr>
<th>Reseller Domestic (Prepaid) 230V</th>
<th>kWh</th>
<th>Summer</th>
<th>Winter</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-500</td>
<td>90.27</td>
<td>90.27</td>
<td></td>
</tr>
<tr>
<td>501-1000</td>
<td>103.09</td>
<td>103.09</td>
<td></td>
</tr>
<tr>
<td>1001-2000</td>
<td>110.99</td>
<td>110.99</td>
<td></td>
</tr>
<tr>
<td>2001-3000</td>
<td>125.9</td>
<td>125.9</td>
<td></td>
</tr>
<tr>
<td>&gt;3000</td>
<td>136.77</td>
<td>13.77</td>
<td></td>
</tr>
</tbody>
</table>

It is important to ensure the development is classified as a multi-unit residential complex with the council to ensure that each unit gets access to the lowest rate band. This is recommended to future proof against government requirements to fairly disclose energy consumption costs to tenants. Having clarity of the rate and its make-up is considered both good practice and future proofing to a time when resellers may be required to provide a breakdown explanation of their rate to tenants.

Water

Direct water meters to the council can be installed for each unit. These avoid third party metering companies and associated charges and make the provision of the free 500L/month water easy to access. The metering of hot water consumption requires a management system to record and charge tenants accordingly.

Technical Specification:

The project team should ensure that the correct electrical tariffs are applied to the development. Council water meters should be installed.

Motivation:

Charge tenants appropriate rates to ensure fair charges and reduce the burden on rent paying.
Key Considerations/Strategy:
The location for meters (for easy review within units) and for ease of access for external units should be considered within the design.

Financial Considerations:
See Sustainable Design Considerations

References:
- City Power., Guidance on the Resale of Electricity available https://www.citypower.co.za/

4.13 Alternative Financing

Description:
Alternative Financing bodies provide upfront capital costs for project assets. These assets include the production of utilities such as hot water and electricity. The upfront capital costs are repaid over a set period, normally 10 to 15 years, by the building users via ongoing utility consumption. Consumption rates are tied to mirror or slightly reduce on Business As Usual costs. This is achieved via the purchase of a more efficient or renewable energy sourced device, such as a Heat Pump, Solar Hot Water or PV. The building owner is designated as ultimately responsible for ongoing payments to the financing body. An application will include a credit check from the building owner and a technical report on the proposed system. Providers include many renewable energy system suppliers as well as dedicated financing bodies such as ‘Red Tree’.

Government rebates should also be reviewed for applicability. Examples which may be extended include Eskom SHW rebate scheme for low cost housing. Tax rebates based on energy saved from onsite renewable energy which provide at least 35% of site use can be applied for via the Section 12L of the Income Tax Act, 1962.

The International Housing Solutions (IHS) provides investment equity for rental rehabilitation typically in large urban areas for projects between ZAR 60 – 175 million.

The International Financing Corporation (IFC), apart from providing guidance such as the EDGE tool, fund energy and water efficiency project elements via their Asset Management Company for large institutions and companies with loans ranging from ZAR 11 to 1155 million.

Alternative Finance Process
1. Completed and signed credit application form
2. Detail of the project and associated costs for which finance is required (quotes/invoices/costing etc.)
3. Copies of your latest signed and audited annual financial statements
4. Copies of your latest management account
5. Technical information regarding consumption, charge rates, payback to support developer responsibility to repay.

Technical Specification:
NA

Motivation:
The motivation for alternative financing is that its successful application sees the tenant pay lower utility rates, the owner pay reduced CAPEX and ultimately inherent the asset and the financing body retrieving earning back 30% of the value of the asset in interest.
Key Considerations/Strategy:
See section 8.5 on ‘utility price increase’ for a favourable outlook on renewable cost savings.

Financial Considerations:
N/A

References:
- International Housing Solutions (IHS) [http://www.ihsinvestments.co.za/](http://www.ihsinvestments.co.za/)

### SUMMARY COST-BENEFIT ANALYSIS: ENERGY

<table>
<thead>
<tr>
<th>Project Description</th>
<th>Cost Benefit Analysis (Energy)</th>
<th>%Reduction in Energy Consumption</th>
<th>Increase or Decrease in Capex ZAR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Insulation Roof</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Internal Walls Insulation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Geyser: Individualised: Gas</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heat Pumps: Single Unilised Option</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heat Pumps: Communal Option</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Energy Saving Light bulbs</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lighting Controls</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SHW Collectors (Individual) 60%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SHW Collectors (Individual) 70%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Solar Photovoltaics</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18
WATER EFFICIENT INITIATIVES

5.1 Low Flow Fixtures and Fittings

Description:
In order to reduce the water demand per unit, it is recommended that low flow water fixtures and fittings be utilised. This includes low flow showerheads, hand basin taps, water closets and kitchen taps. The difference between these fixtures and normal fixtures would be the application of a flow restrictor that determines the flow rate of the fixture or fitting.

Technical Specification:
The following flow-rates are recommended:

<table>
<thead>
<tr>
<th>Fixtures and Fittings</th>
<th>Flow Rate ≤ (l/min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hand washbasin</td>
<td>6</td>
</tr>
<tr>
<td>Kitchen Tap</td>
<td>6</td>
</tr>
<tr>
<td>Water Closet (Single Flush)</td>
<td>6</td>
</tr>
<tr>
<td>Water Closet (Dual Flush)</td>
<td>6/3</td>
</tr>
<tr>
<td>Showerhead</td>
<td>8</td>
</tr>
</tbody>
</table>

Motivation:
In this instance, if the water demanded decreases, the load for heat pumps or solar water heaters will decrease, increasing their efficiency and at the same reducing electrical consumption (if a generic boiler were selected). The size of the roof tank can also be minimised, reducing structural requirements. This initiative is highly recommended considering the low cost nature of flow restrictors despite the increase in capital expenditure.

Key Considerations:
To limit the water demand of a unit and to maximise space, shower units are preferable to bath tubs. Please refer to section 7.5

Financial Considerations:

<table>
<thead>
<tr>
<th>Sustainable Building Initiative</th>
<th>% Increase or Decrease in Capex</th>
<th>% Reduction in Water Use</th>
<th>Cost Benefit Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>W: Hand Basin Taps</td>
<td>+0.03%</td>
<td>3%</td>
<td>+++++</td>
</tr>
<tr>
<td>W: Kitchen Tap</td>
<td>+0.13%</td>
<td>6%</td>
<td>+++++</td>
</tr>
<tr>
<td>W: WC (Single Flush)</td>
<td>-0.09%</td>
<td>18%</td>
<td>+++++</td>
</tr>
<tr>
<td>W: WC (Dual Flush)</td>
<td>-0.02%</td>
<td>32%</td>
<td>+++++</td>
</tr>
<tr>
<td>W: Showerhead</td>
<td>-0.04%</td>
<td>9%</td>
<td>+++++</td>
</tr>
</tbody>
</table>

References:
5.2 Rainwater Harvesting System

**Description:**
Rainwater is collected within regions that have a climatic zone with good rainfall and can reduce the use of freshwater from the municipal supply.

**Technical Specification:**
The storage tank will be sized based on the rate of supply (local rainfall data and collection area dependant) and the demand (water use per day). Collected water must be in accordance with local health and sanitary code requirements. It should therefore be treated to acceptable standards for use within the household (i.e. toilet flushing) or irrigation.

**Motivation:**
This initiative will lead to the reduction of domestic water demand reducing freshwater requirements from local municipalities. The water collected could be used for irrigation applications, should the development have landscaping. A rainwater harvesting system may not be material now, however, it is recognised that in future as South Africa water resources become increasingly strained, it will be necessary.

**Key Considerations:**
Before installing a rainwater harvesting system it is advisable to determine whether or not the capital expenditure is warranted. A recycled greywater system may prove to be cost effective. This is dependent on the nature of the development.

**Financial Considerations:**

<table>
<thead>
<tr>
<th>Sustainable Building Initiative</th>
<th>% Increase or Decrease in Capex</th>
<th>% Reduction in Water Use</th>
<th>Cost Benefit Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>W: Rainwater Harvesting System</td>
<td>+0.80%</td>
<td>1.6%</td>
<td>++</td>
</tr>
</tbody>
</table>

**References:**

5.3 Recycled Greywater for Toilet Flushing and Irrigation

**Description:**
A greywater recycling system reuses waste water from kitchens and bathrooms for the purpose of flushing toilets and/or irrigation.

**Technical Specification:**
The collection tank will be sized according to the water demand of the unit per day (specifically water flushing requirements and/or irrigation).

**Motivation:**
This initiative will lead to the reduction of domestic water demand reducing freshwater requirements from local municipalities. The development is more resilient to suspension of utilities.

**Key Considerations:**
The amount of water collected will depend on the efficiency of the water fixtures utilised. The more efficient the water fixture or fitting, the less water is collected for reuse.

**Financial Considerations:**

<table>
<thead>
<tr>
<th>Sustainable Building Initiative</th>
<th>% Increase or Decrease in Capex</th>
<th>% Reduction in Water Use</th>
<th>Cost Benefit Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>W: Recycled Greywater for Flushing</td>
<td>+2.53%</td>
<td>29.1%</td>
<td>++++</td>
</tr>
</tbody>
</table>

**References:**
5.4 Sustainable Urban Drainage Systems

Description:
In accordance with best practice design guidelines, built up areas must be drained to remove surface water. This can be done using conventional drainage methods (conventional stormwater management) or with the use of Sustainable Urban Drainage Systems (SUDS). Therefore, in order to reduce stormwater runoff and to promote greener areas within the development, a Sustainable Urban Drainage System (SUDS) strategy is recommended.

Technical Specification:
In the stormwater management solution employed, the use of permeable paving, attenuation and the like is encouraged.

Motivation:
Using a SUDS approach in dealing with stormwater drainage will contribute to a greener environment and reduce capital expenditure for brick pavers. This solution can be coupled with a greywater reuse option that would reduce water requirements for irrigation. The SUDS approach utilised can be designed to be unique to the housing development.

Key Considerations:
When using permeable paving the depth at which grass is planted will affect its longevity.

Financial Considerations:
see Design Philosophy section

References:

5.5 Deep Showers instead of Baths Tub

Description:
Deep shower trays are used to compensate the use of bath tubs. Showers typically use less water and less space than a conventional bath tub. However, urban families may need a tub space and this can be achieved using a deep shower tray.

Technical Specification:

<table>
<thead>
<tr>
<th>Dimensions</th>
<th>Length</th>
<th>Breadth</th>
<th>Depth*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>800mm</td>
<td>800mm</td>
<td>&gt;250mm</td>
</tr>
</tbody>
</table>

*The depth of the shower tray is critical, neither the length nor the breadth of the tray is prescriptive

Motivation:
This initiative will lead to the reduction of domestic water demand by reducing freshwater requirements from local municipalities. Although they are not readily available within the South African market, they have been included within the Green Guideline to drive market change and encourage the production of deep shower trays in South Africa particularly within the MDAH market. The approximated water use of the bath tub vs the conventional shower vs the shower with a deep shower plate:

<table>
<thead>
<tr>
<th>Approximated Water Use per Bath/Shower</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conventional Bath</td>
</tr>
<tr>
<td>80 litres</td>
</tr>
</tbody>
</table>

Financial Considerations:

<table>
<thead>
<tr>
<th>Sustainable Building Initiative</th>
<th>% Increase or Decrease in Capex</th>
<th>% Reduction in Water Use</th>
<th>Cost Benefit Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>W: Deep Shower</td>
<td>*%</td>
<td>7%</td>
<td>++++++</td>
</tr>
</tbody>
</table>

References:
SUMMARY COST-BENEFIT ANALYSIS: WATER

<table>
<thead>
<tr>
<th></th>
<th></th>
<th>Hand Basin Taps</th>
<th></th>
<th></th>
<th>Kitchen Tap</th>
<th></th>
<th>WC (Single Flush)</th>
<th></th>
<th>WC (Dual Flush)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>7</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>8</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Cost Benefit Analysis

%Reduction in Water Consumption

Increase or Decrease in Capex ZAR
6.1 Flooring Slab: In-situ Concrete with >25% GGBS

Description:
Ground Granulated Blast furnace Slag (GGBS) is a by-product from the blast furnaces used to make iron. Iron ore (amongst other materials) is fed into the blast furnace and reduced to iron and the remaining materials form a slag that floats on top of the iron. This slag is periodically tapped off as a molten liquid which undergoes a quenching process where it is drenched in water in order to break down the material into granulated sand-like composition. This ‘granulated’ slag is then dried and ground to a fine powder. GGBS is then added as a replacement of Ordinary Portland Cement (OPC) to concrete products. This replacement reduces the embodied energy of concrete products while increasing the strength.

Technical Specification:
The contractor shall reduce the absolute quantity of Portland cement by substituting it with the industrial waste product GGBS. The overall percentage of GGBS replacement is to be greater than 25% of the total “original cement content.” That said, the development program will need to be adjusted to accommodate the early strength strip time of formwork.

Motivation:
In situ concrete with >25% GGBS replacement has 6.8% reduction in embodied energy when compared to ordinary concrete. GGBS suppresses efflorescence, thereby reducing maintenance costs. GGBS concrete reduces the penetration of chloride which may induce corrosion of reinforcement.

Key Consideration
The development program will need to be adjusted to accommodate the early strength strip time of formwork. The only specific requirement is for a structural integrity to be confirmed by the necessary team member and signed off when in situ concrete with >25% GGBS is used.

Financial Considerations:

<table>
<thead>
<tr>
<th>Sustainable Building Initiative</th>
<th>% Increase or Decrease in Capex</th>
<th>% Reduction in Water Use</th>
<th>Cost Benefit Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>M: In-Situ Concrete with &gt;25% GGBS</td>
<td>0.00%</td>
<td>6.80%</td>
<td>++</td>
</tr>
</tbody>
</table>

References:
- What is GGBS?: http://www.ukcsma.co.uk/what-is-ggbs_.html

6.2 Flooring Slab: In-situ Concrete with >30% Pulverised Fuel Ash (PFA)

Description:
Pulverised Fuel Ash (PFA), also known as fly ash, is a waste product of coal, fired at power stations. Using PFA as a cement replacement significantly reduces the overall carbon footprint of the concrete construction and helps to reduce risk of air and water pollution. In the promotion of environmental sustainability, PFA usage is one of the most highly recommended construction practices.

Technical Specification:
The contractor shall reduce the absolute quantity of Portland cement by substituting it with fly ash, a waste product from coal fired at power stations. The overall percentage of fuel ash replacement is to be greater than 30% of the total “original cement content.”

Motivation:
PFA concrete improves long term strength retention, improves the surface finish, reduced shrinkage and cracking. In-situ concrete with >30% PFA replacement has 5.9% reduction in embodied energy when compared to ordinary concrete.

Key Consideration
Structural integrity to be confirmed by the necessary team member and signed off when in situ concrete with >25% GGBS is used.

Financial Considerations:

<table>
<thead>
<tr>
<th>Sustainable Building Initiative</th>
<th>% Increase or Decrease in Capex</th>
<th>% Reduction in Water Use</th>
<th>Cost Benefit Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>M: In-Situ Concrete with &gt;30% PFA</td>
<td>0.00%</td>
<td>5.90%</td>
<td>++</td>
</tr>
</tbody>
</table>

Reference:
### 6.3 Flooring Slab: Concrete filler slab

**Description:**

Filler slab construction is technology based on the principal of using filler materials such as brick, clay tiles, and cellular concrete blocks instead of concrete. The filler materials are used in the lower tensile region of the slab, which needs only enough concrete to hold the steel reinforcement together. The air pocket formed by the contours of the tiles makes an excellent thermal insulation layer. The design integrity of a filler slab involves careful planning taking into account the negative zones and reinforcement areas.

**Technical Specification:**

The contractor shall reduce the absolute quantity of concrete in floor slabs by substituting 40% volume with low cost lightweight filler material such as brick, clay tiles, cellular concrete blocks or polystyrene. The depth of concrete above the filler material is to be determined by the structural engineer.

**Motivation:**

Concrete filler slabs have a 15% reduction of embodied energy when compared to ordinary concrete. The replacement of concrete with clay and other filler material reduce the total concrete content. Depending on the selection of filler material, an air gap may be introduced to the slab if two clay tiles are used together, increasing the thermal performance of the slab.

**Key Consideration**

The only specific requirement is for a structural integrity of the system to be confirmed by the necessary team member and signed off when concrete filler slabs are specified and constructed. Currently there are no large suppliers of this system in South Africa. It is recommended that continued research be conducted to investigate the potential use of the concrete filler slab in medium density housing schemes.

**Financial Considerations:**

<table>
<thead>
<tr>
<th>Sustainable Building Initiative</th>
<th>% Increase or Decrease in Capex</th>
<th>% Reduction in Water Use</th>
<th>Cost Benefit Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>M: Concrete Filler Slab</td>
<td>-0.71%</td>
<td>15.00%</td>
<td>++++</td>
</tr>
</tbody>
</table>

**Reference:**

- Filler Slab: [http://www.gharexpert.com/a/ashishbatra/1670/Filler-Slabs_0.aspx](http://www.gharexpert.com/a/ashishbatra/1670/Filler-Slabs_0.aspx)

### 6.4 Flooring Slab: Precast Reinforced Concrete planks and joint system

**Description:**

This system uses precast concrete elements to construct a roof or intermediate floor and consists of two elements:

- The plank, which represents smaller sections of the slab and is therefore of reduced thickness and reinforcement, and
- The joist, which is a beam spanning across the room to provide a bearing for the planks. The joist is partially precast, with the remaining portion being cast in-situ after the planks are installed.

**Technical Specification:**

The contractor shall utilise precast reinforced concrete planks and joint system in order to reduce the total quantity of in-situ concrete required on site.

**Motivation:**

Any precast elements specified for a construction project speeds up construction time as there is inherently no on-site curing time which is required for in-situ installations. With precast elements, preparation is done on site, so weather plays no role in the curing of in-situ elements. Strict control measures ensure quality and concrete strength are met prior to delivery on site. Design changes can occur right up until preparation of precast elements.

**Key Consideration**

Dimensions of readily available precast elements should be sourced prior to design in order to ensure simple construction with the precast elements. Currently there are no large suppliers of this system are available in South Africa. It is recommended that continued research be conducted to investigate the potential use of the Precast Reinforced Concrete plank and joint system in medium density housing schemes.

**Financial Considerations:**

<table>
<thead>
<tr>
<th>Sustainable Building Initiative</th>
<th>% Increase or Decrease in Capex</th>
<th>% Reduction in Water Use</th>
<th>Cost Benefit Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>M: Precast RC Planks &amp; Joint System</td>
<td>*%</td>
<td>12.90%</td>
<td>*</td>
</tr>
</tbody>
</table>

**Reference:**

- Precast vs Cast in Place: [http://www.advanceconcreteproducts.com/1/acp/precast_vs_cast_in_place.asp](http://www.advanceconcreteproducts.com/1/acp/precast_vs_cast_in_place.asp)
6.5 Roofing: Clay Tiles on Rafters

Description:

Even though a clay tiled roof is highly utilised in the South African construction industry, it is a commendable environmental initiative to consider for roofing. With this type of roof construction, clay tiles are laid on steel or timber rafters. Steel rafters ensure durability and strength but the embodied energy content of steel is higher than that of timber rafters, which need maintenance but have less embodied energy. Timber sourced from a responsible forest management agency or from regrowth forests ensures the protection and conservation of natural forest communities.

Technical Specification:

Clay tiles with a valley gutter or verge tiles are to be laid on an tile underlay which is to be laid on the steel/timber rafter system. Joints are to be sealed as to prevent air infiltration and leakage.

Motivation:

A clay roof tile system has a 15% reduction in embodied energy over in-situ concrete slabs. Clay tiles have reflective properties, thereby reducing the heat build-up in the air space between the ceiling and the tiled roof. Clay tiles are not susceptible to mould or rot. Clay tiles do not shrink and expand with the temperature like wood. Clay tiles are non-combustible therefore safe against fires. The only maintenance associated with clay roof tiles are replacement if cracking occurs due to severe hail storms.

Key Consideration

Wall ties to be prepared to allow for timber frames to be held to structure. The combination of roofing elements should be sought within the requirements of the relevant South African Standards.

Financial Considerations:

<table>
<thead>
<tr>
<th>Sustainable Building Initiative</th>
<th>% Increase or Decrease in Capex</th>
<th>% Reduction in Water Use</th>
<th>Cost Benefit Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clay Tiles on Rafters</td>
<td>0.00%</td>
<td>14.30%</td>
<td>++ + + + +</td>
</tr>
</tbody>
</table>

Reference:


6.6 External Wall: Honeycomb Clay Block Walls

Description:

Honeycomb clay blocks are made of fired clay and have a honeycombed cross-section. The large size of the blocks enables rapid construction, and the honeycomb structure means that there is less material per square meter of finished wall. The features listed below make honeycomb clay blocks a more eco-friendly building product: The honeycomb structure leads to improved thermal performance. Blocks can be customized. No mortar is needed in the vertical joints due to a tongue and grooved edge, reducing mortar use by up to 40%. The blocks are strong and have a high impact resistance. Honeycomb clay blocks have post-consumer value if dismantled carefully. Unfortunately this system is not available in South Africa at the moment, however extensive research is underway at a clay brick factory within South Africa’s borders.

Technical Specification:

Interlocking Honeycomb clay blocks with the nominal dimensions 190 x 90 x 90 / 290 x 90 x 90 / 390 x 90 x 190 / 390 x 190 x 190 mm.

Motivation:

Honeycomb clay blocks possess moderate to good thermal mass, an increased insulating property due to the air pockets is inherent in honeycomb clay blocks. Thermal bridging is reduced by the tongue and groove joint system, which also reduces the overall mortar quantity of the wall system. Honeycomb clay blocks are structurally sound to replace a double leaf external wall with consent from the structural engineer on the project.

Key Consideration

The dimensional properties of honeycomb clay blocks are different to that of standard clay bricks. Therefore a variation in floor plan size may be required. Structural integrity of the clay blocks should be verified prior to specification and construction.

Financial Considerations:

<table>
<thead>
<tr>
<th>Sustainable Building Initiative</th>
<th>% Increase or Decrease in Capex</th>
<th>% Reduction in Water Use</th>
<th>Cost Benefit Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Honeycomb Clay Block Walls</td>
<td>XX%</td>
<td>7.5%</td>
<td>XX</td>
</tr>
</tbody>
</table>

Reference:

- Blocks: Concrete and its Alternatives: http://www.greenspec.co.uk/building-design/blocks/
6.7 Flooring Finishing: Finished concrete screed floor

Description:

More commonly referred to as “screed,” cement plaster is often used as a preparation layer for soft or flexible floor finishes or tiles. Cement plaster can be used as a finish layer, provided a high quality screed is used as the surface may be chipped more easily than other hard flooring surfaces.

Technical Specification:

The floor finish is to be a 40mm* (*based on load requirements) finished screed using 20 MPA concrete.

Motivation:

Finished concrete screed floor results in overall embodied energy reduction due to the removal of a floor covering. Finished concrete flooring increases the thermal mass of the floor remaining cool in summer.

Key Consideration

No alternative preparation of the concrete floor slab is required. The concrete screed may be laid upon the concrete slab, it is advisable to lay the screed on top of an insulating material in order to improve the thermal performance of the system under consideration.

Financial Considerations:

<table>
<thead>
<tr>
<th>Sustainable Building Initiative</th>
<th>% Increase or Decrease in Capex</th>
<th>% Reduction in Water Use</th>
<th>Cost Benefit Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Finished Concrete Floor</td>
<td>-0.52%</td>
<td>2.60%</td>
<td>++</td>
</tr>
</tbody>
</table>

Reference:


6.8 Flooring Finishing: Terrazzo tiles

Description:

Terrazzo tiles are a hard-wearing option for flooring which require very little maintenance. Terrazzo floors can be laid in situ by pouring concrete or resin with granite chips and then polishing the surface. Alternatively, terrazzo tiles are manufactured in a factory before being laid onsite.

Technical Specification:

The floor finish for all interior flooring is to be terrazzo tiles with a thickness of 25mm.

Motivation:

One advantage of using terrazzo tiles is that these tiles are extremely sturdy and strong. They are one of the most resilient tiles available in the market and are far stronger than stone and ceramic styles. After a terrazzo tile has been fixed into place properly it is resistant to any stain or water damage, it is not prone to chipping and it can withstand heavy footfall for years. Furthermore, the use of Terrazzo tiles subscribes to the aspirational characteristics that tenants look for when considering renting a unit.

Key Consideration

No alternative preparation is required for the installation of terrazzo tiles.

Financial Considerations:

<table>
<thead>
<tr>
<th>Sustainable Building Initiative</th>
<th>% Increase or Decrease in Capex</th>
<th>% Reduction in Water Use</th>
<th>Cost Benefit Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Terrazzo tiles</td>
<td>-0.12%</td>
<td>3.10%</td>
<td>++</td>
</tr>
</tbody>
</table>

Reference:

SUMMARY COST-BENEFIT ANALYSIS: MATERIALS

**SUSTAINABLE DESIGN PHILOSOPHY**

If current trends in urbanization and income growth persist, by 2025 the number of urban households that live in substandard housing could grow to 440 million worldwide. This is affirmed by the predictions made by McKinsey (2014:2) in the MGI Affordable Housing Report, stating that “the affordable housing gap will grow from 330 million urban households to 440 million by 2025, leaving at least 1.6 billion people living in substandard housing or financially stretched by housing costs”. Therefore as the need for quality housing grows, and the pressure for greater environmental awareness increases, causing key stakeholders to move the sustainability agenda forward, the need for developers to adopt sustainable design philosophies burgeons.

This encompasses sustainability initiatives that present both financial savings in capital (and operational costs) and encourage energy, water and resource efficiency as well as those initiatives that may not necessarily provide savings in monetary terms but are just as important. These are initiatives that are inherent within the design of the development and must be considered when designing a building in line with sustainable building best practice. For the purposes of this guideline, the following precepts

### 7.1 Space configuration and orientation

The configuration of the units in a medium density housing development has the ability to positively impact the comfort felt by building users. The architect of proposed developments should consider the following design principles when designing a development:

- **Well-ventilated homes** are always planned with services spaces, such as bathrooms and kitchens with one wall facing the exterior. The service spaces should be proposed in such a way to prevent prevailing winds from sending odours or heat toward other spaces of the house.
- **Living spaces** should be located on the North or West as this will allow afternoon sun to heat the rooms for the evening when they are most used by the occupants.

### 7.2 Natural ventilation

Medium density housing developments make use of natural ventilation for cooling. In order to promote cross ventilation it is advised that openable windows be installed on opposing walls such as East and West, or North and South.

### 7.3 External Shading devices and Fenestration

External shading devices on the North, West and East windows ensure a reduction in heat gain inside the building. The depth of the shading should be calculated to allow Winter Sun into the interior spaces. Total energy consumption of a building may be reduced by considering reducing the window to wall ratio on the West and East.

### 7.4 Exterior ground covering

In order to reduce heat gain around the building, and reflection into the building, landscaping should be installed around the building instead of hardscape paving. Consideration should be given to sustainable urban drainage systems to decrease storm water run-off while replenishing ground water in developed areas.
7.5 Tenant Utility Costs

It is estimated that Energy utility costs within MDAH add an extra 15% on rental costs. This is a significant proportion to financially constrained tenants and will influence defaulting and the quality of life experienced. With electricity prices increasing in excess of rental cost escalations this proportion is set to increase by 13% going forward, leading to a nominal increase of 50% within the next 20 years (i.e. electricity costs in the year 2035). To curb this increase in energy costs, Solar Hot Water Systems, PV and/or Energy Efficient Boilers must be investigated and implemented. Onsite equipment producing hot water or electricity will reclaim the capital cost via consumption charges to building user. These charges will rise with the market rate to satisfy financial return however escalation can lag behind the national electricity public utility (i.e. Eskom) to share the benefit with both tenants and developer.

As the predictions between base case and alternative show, (see Figure 10 below) the % of the utility bill compared to rental will increase making it an increasingly important factor for Affordable Housing. Raising the onsite utility 33% less than Eskom rates, i.e. 8.9% instead of 13% per annum, for Hot Water (which makes up 50% of the utility cost) will save tenants money immediately. By 2035 this saving will rise to 25% of their utility cost by 2035 reducing the overhead of utility on top of rent from 47% to 37%.

8.1 Key Assumptions

The model used for generating the simulation results for comparative energy use, insulation, window to wall ratio, external shading, orientation has the following assumptions:

- The model is based on architectural drawings obtained from Gary White Architects for a proposed Fleurhof Development in association with Calgro M3 holdings
- Each unit contains 2 bedrooms, 1 bathroom with a bath, kitchen with sink
- The area of each unit is 40m$^2$
- The total number of units per floor is 7
- The total number of units per modelled block is 28
- The overall dimensions of each unit is 6351mm by 6040mm

A representative floor plan for a typical unit is represented within Figure 11 below:

---

**Figure 10: Monthly utility costs: Business as Usual vs Energy Efficient Solutions**

**Figure 11: Typical Unit within the base case development modelled**

---

8.2 Further Considerations: Sustainable Building Design

The following should be considered by the developer and building project teams alike when aiming to optimise the sustainable nature of the development:

- The transfer of knowledge from the construction team to the future users of the building (i.e. tenants) and building management is critical. It is suggested that the Building Users Guide, Operations and Maintenance Manual and training is provided to ensure the realisation of the savings promised by the initiatives previously discussed.