Greening Municipal Rental Units:

A brief guide to sustainable alternative options

CITY ENERGY SUPPORT UNIT

a south african sustainable energy and climate protection initiative

Municipalities continually upgrade, renovate and repair their stock of rental units. By 'greening' the specifications used for the maintenance of these units, municipalities can influence a large number of buildings to become more energy efficient, thermally comfortable and environmentally friendly and therefore, improve the quality of life of the occupants. By upgrading these municipal owned buildings in a sustainable way, the City can be seen to be leading by example in terms of sustainable development. In doing so, the City will also contribute to rendering the communities involved, most of which consist of low-income families, more resilient to the effects of impending climate change.

This document grew out of a project, which is currently underway in the City of Cape Town. The Sustainable Livelihoods and Greening Programmes Unit along with the Environmental Resource Management Department and a donor, DANIDA, are leveraging money to influence the Community Residential Unit (CRU) Pilot Project of the Housing Department to upgrade a portion of the Cities rental stock in a more sustainable way. The overarching goal of the project is to promote and integrate sustainable development mechanisms and in turn to mainstream and replicate these interventions into future projects. Although donor funding was used to help leverage money from the Department of Housing, the bulk of the money involved is from the Housing Department. The project will first upgrade around 8000 units throughout the city and once this has been done successfully, the lessons learnt will be used to upgrade a further 30 000 units in a far more sustainable way.

Sustainable Energy Africa (SEA) was asked to look at the various specifications of the products and materials, which were to be used in the upgrade of the rental units and, where possible, suggest sustainable alternatives. Below is a list of the sustainable options, which were identified to provide suitable alternatives to the original specifications in terms of sustainability, cost, availability and suitability. Where possible, details of costs and suppliers were also given. Supporting documents are provided where needed and attached at the end of this document.

A matrix of sustainable options for developers of low-income housing is also attached (Appendix 4). This document is not specifically designed for municipal rental units but many of the interventions still apply.

This document is aimed to give cities and developers a guide to the most suitable sustainable options available to them in terms of low-income housing and city rental units. This is not an exhaustive list and the suitable options would vary depending on the site, local climate, available funds and various priorities of the parties involved.

A Project of Sustainable Energy Africa
Association Incoporated under Section 21 2000/028082/08 Directors: M L Borchers, P Wolpe
FUNDED BY: THE BRITISH HIGH COMISSION OF SOUTH AFRICA and DANIDA

<table>
<tr><th>Item</th><th>Description of sustainable option including costing where available</th><th>Rating

(Critical, Important, Beneficial)</th></tr>
<tr><td>Bricks</td><td>If new bricks are to be used to replace existing walls, repair broken walls or build new walls, it is suggested that bricks containing recycled materials are used. Currently the only company known is CapeBrick.

Cape Brick produces SABS and CMA approved products, including various stock bricks as well as hollow blocks. Cape Brick crushes construction and demolition waste and uses this as the main constituent to manufacture their products. All of their products contain at least 70% recycled material, which gives them a very low embodied energy when compared to regular bricks. Embodied energy refers to the amount of energy required to manufacture and deliver a product to its point of use. Therefore if a product has a high embodied energy, it has taken a lot of energy to produce and deliver that product. This is very beneficial as the process of manufacturing bricks and cement is extremely energy intensive.

CapeBrick is able to deliver the quantities required for both large and small developments and projects and at no extra cost to standard, non-recycled bricks. This is therefore a very easy to implement intervention with a relatively large impact and comes at no extra cost to the project.</td><td>Important</td></tr>
<tr><td>Floor Covering</td><td>When looking at floor coverings, it is also important to take into account the embodied energy of the products being considered.

Common floor covering options in rental units are either vinyl floor sheeting or ceramic tiles. When comparing the two, vinyl floor sheeting has a higher embodied energy (See table below) and is also generally more expensive than ceramic floor tiles (Ceramic tiles estimated at R70/m^2 and vinyl sheeting estimated at R85/m^2).

<table>
<tr><td>Material</td><td>MJ/kg</td><td>MJ/m^3</td></tr>
<tr><td>Ceramic Tiles</td><td>2.5</td><td>5 250</td></tr>
<tr><td>Vinyl Flooring</td><td>79.1</td><td>105 990</td></tr>
</table>

The units of embodied energy are given as the amount of energy in Mega Joules (MJ) per kilogram or m^3 of product. This table shows that the production and delivery of vinyl flooring is 30 times more energy intensive than that of ceramic tiles.

A table of embodied energies of common building products is attached at the end of the document (Appendix 2). It must be noted however that this is not an exhaustive list and that embodied energies will vary from product to product and location to location. This is just to give an estimate of the relative embodied energy of comparable products.</td><td>Important</td></tr>
</table>

A Project of Sustainable Energy Africa
Association Incorporated under Section 21 2000/028082/08 Directors: M L Borchers, P Wolpe
FUNDED BY: THE BRITISH HIGH COMISSION OF SOUTH AFRICA and DANIDA

<table>
<tr>
<td>Ceilings</td>
<td>
For all units, which are exposed directly to the roof structure (i.e. top floor of flats, single row housing and upper floors of maisonettes), insulated ceilings must be installed. The table below shows the thermal advantage of having a ceiling and insulation over having just a ceiling or neither a ceiling nor insulation. This modelling is based on a typical RDP house in Cape Town so the exact values would not be the same for tenement buildings or even single-row housing but the proportions would be similar. The software used was NewQuick, which was developed in South Africa and widely used and trusted in the industry.
<table>
<tr><th></th><th>Heating Required/yr (kWh)</th><th>Improvement over base %</th><th>Cooling Required/yr (kWh)</th><th>Improvement over base %</th></tr>
<tr><td>No Ceiling</td><td>2685</td><td>0%</td><td>1286</td><td>0%</td></tr>
<tr><td>9mm Rhinoboard</td><td>1505</td><td>43%</td><td>738</td><td>42%</td></tr>
<tr><td>9mm Rhinoboard plus Sisalation</td><td>1216</td><td>54%</td><td>577</td><td>55%</td></tr>
<tr><td>25mm Isoboard Ceiling</td><td>785</td><td>70%</td><td>375</td><td>71%</td></tr>
<tr><td>9mm Rhinoboard plus 50mm Isotherm</td><td>761</td><td>71%</td><td>362</td><td>72%</td></tr>
</table>
From the modelling it appears that 25mm Isoboard performs just as well as a standard Rhinoboard ceiling with 50mm insulation. The advantages of Isoboard include; the fact that it is a single, thin, composite product rather than two separate products; it is fire retardant; it is mould resistant and it is unattractive to vermin. It is also a very easy and quick to install and pleasant looking.
The table below shows the relative costs of the various materials modelled above, obviously prices would vary with bulk orders as these are direct retails prices (installation not included).
<table>
<tr><th>Product</th><th>Cost per m^2</th></tr>
<tr><td>Gypsum Board</td><td>R32.00</td></tr>
<tr><td>Sisalation</td><td>R10.98</td></tr>
<tr><td>Isotherm 40mm</td><td>R14.00</td></tr>
<tr><td>Isotherm 50mm</td><td>R18.00</td></tr>
<tr><td>Isotherm 100mm</td><td>R38.00</td></tr>
<tr><td>Isoboard 25mm *low income</td><td>R51.74</td></tr>
</table>
*Note: Isotherm and Romatherm are essentially the same product but supplied by different companies.
</td>
<td>Critical</td>
</tr>
<tr>
<td>Hot Water Cylinders</td>
<td>
Temperature settings of hot water cylinders to range between 50°C – 60°C and geysers should be installed with analogue timers, awareness of how to use apparatus would be required. It would also be beneficial to educate the users on what the expected cost of heating water is going to be and how controlling the temperature and timer can be used to reduce this cost.
It is critical that all hot water cylinders as well as all hot water pipe runs are fully insulated to prevent heat loss.
</td>
<td>Critical</td>
</tr>
</table>

A Project of Sustainable Energy Africa
Association Incoporated under Section 21 2000/028082/08 Directors: M L Borchers, P Wolpe
FUNDED BY: THE BRITISH HIGH COMISSION OF SOUTH AFRICA and DANIDA

SWH's	It is strongly advised that Solar Water Heaters (SWH's) are installed in all appropriate rental units. Unless tenement buildings have centralised hot water supply, it would be difficult to supply SWH's to these households. It is however very strongly suggested that all single-row and maisonette houses be fitted with solar water heaters. The additional capital needed for the SWH's can be financed and the extra payments can be added onto the rental of the homes. This not only provides the city with a sustainable way of financing SWH's but also gives the tenants a sense of ownership over the SWH's, which is critical as it will vastly reduce vandalism and neglect of the property. In consultation with Carl Wesselink from the Kuyasa project in Cape Town, the fact that the home owners are paying for the SWH's makes the community adamant in protecting them as they now know that they own the SWH's and that they are actually saving them money, they therefore don't want them to be broken or damaged. It would also be advisable to educate the community on the benefits of SWH's and then give them the option to either have a SWH or a regular geyser installed. The amount of money added to the rent each month would be less than the amount of money that would be spend on hot water if a regular hot water cylinder were to be installed. Rental units provide a perfect opportunity for the installation of SWH's in low-income communities as the monthly collection mechanism is already established. . It is therefore a beneficial and sustainable situation for both the community and the city. For more detail on the financial case, please see Appendix 1 at the end of this document.	Critical
Tap Flow Reducers	Tap flow reducers are simple devices, which are installed into the heads of threaded taps. They reduce the flow of water by mixing air into the water as it emerges of the tap. This also gives the feeling that there is more water washing over your hands than there actually is. The price of tap flow reducers ranges from around R25-R60 each and can potentially save 40%-50% of the water used in a basin. This is especially beneficial in basins where hot water is used as the water saving would also result in an energy saving as not as much water would need to be heated.	Beneficial
Efficient Showerheads	If showers are to be installed, the following information should be taken into consideration. The current average flow rate for a standard showerhead is estimated at between 15 and 25 litres per minute (l/min). Efficient showerheads often reduce this consumption to between 6 and 10 l/min, which equates to a substantial water savings of up to 60-70%. This also results in a drastic energy saving since not as much water needs to be heated per shower. Based on a standard shower head using 18 l/min and an efficient shower head using 9 l/min with an average of 4 showers per day of 6min a total of 78 840 litres of water can be saved per year. This equates to a saving of R830 on water and R1236 on electricity per year (using a cost of R10.52/kl for water and R0.52 c/KWh for electricity). This is a 50% cost saving in electricity and 2.4MWh of electricity saved per year per household. Two different showerheads appropriate for city rental units were identified and cost. The first had a rated flow rate of between 7.5 and 9.5 l/min and costs R165 excl vat. per showerhead. The second showerhead has a maximum flow rate of 8.3 l/min and is available from R114 per showerhead. For both products, a cheaper price could be negotiated for larger orders. From the savings above, it can be seen that efficient shower heads pay for themselves in a very short space of time.	Critical

A Project of Sustainable Energy Africa
Association Incorporated under Section 21 2000/028082/08 Directors: M L Borchers, P Wolpe
FUNDED BY: THE BRITISH HIGH COMISSION OF SOUTH AFRICA and DANIDA

<table>
<tr><td></td><td>For comparison, a supplier of regular showerheads was contacted and the prices range from R45.00 for the cheapest showerhead available to R230.00 for the most popular product and up to R500.00 for the most expensive product.</td><td></td></tr>
<tr><td>Multiflush Toilettes</td><td>A regular flush system begins flushing when you pull down the handle and only stops flushing once the cistern is empty. This happens because the flushing mechanism is designed to create a vacuum above the opening valve to hold it open until all the water has escaped. A multiflush system simply prevents this vacuum from forming. A multiflush system therefore only flushes for as long as you hold down the handle. One can therefore flush only as long as is needed to clear the toilette bowl. Water savings from using such a device can be over 20% of the entire water bill in a home.

Multiflush systems are the same price as regular flush systems and can be fitted to almost any toilet. They also save more water and are cheaper than dual-flush systems.</td><td>Important</td></tr>
<tr><td>Lighting</td><td>Below is an example of the straight financial savings of installing compact fluorescent (CFL) bulbs vs. incandescent (Inc.) bulbs. Prices obtained from electrical wholesalers in Cape Town and may vary with large scale purchases.

<table>
<tr><th>Type</th><th>Wattage</th><th>Lifespan</th><th>Price</th></tr>
<tr><td>Inc.</td><td>60</td><td>1000 hrs</td><td>R2.55</td></tr>
<tr><td>Inc.</td><td>100</td><td>1000 hrs</td><td>R2.95</td></tr>
<tr><td>CFL</td><td>11</td><td>6000 hrs</td><td>R17.10</td></tr>
<tr><td>CFL</td><td>20</td><td>6000 hrs</td><td>R25.20</td></tr>
</table>

If one compares total costs (electricity plus bulbs) over 6000hrs using an electricity price of 50c/KWh then the results are as follows.

<table>
<tr><th>Type</th><th>Watts</th><th>KWh Used</th><th>No. Of Bulbs</th><th>Total Cost</th></tr>
<tr><td>Inc.</td><td>60</td><td>360</td><td>6</td><td>R195.30</td></tr>
<tr><td>Inc.</td><td>100</td><td>600</td><td>6</td><td>R317.70</td></tr>
<tr><td>CFL</td><td>11</td><td>66</td><td>1</td><td>R50.10</td></tr>
<tr><td>CFL</td><td>20</td><td>120</td><td>1</td><td>R85.20</td></tr>
</table>

It is therefore strongly suggested that all light bulbs provided should be CFL bulbs.</td><td>Critical</td></tr>
<tr><td>Tree Planting</td><td>Tree planting is a vital part of the greening of any community. Not only does it add overwhelmingly to the aesthetic of an area, and therefore the wellbeing of its people, but it also provides much needed shade in summer as well as providing a local refuge for biodiversity.

While consulting with the CLO's (Community Liaison Officers) as well as the developers and the city parks department in Cape Town, it is essential that trees are planted but most importantly, the trees need to be watered and maintained. City Parks were able to plant the trees and install the tree cages and irrigation but they do not have the funds available for unbudgeted large projects.

Upon consultation with City Parks a rough estimate of the cost per 100 trees is given below.</td><td>Beneficial</td></tr>
</table>

A Project of Sustainable Energy Africa
Association Incorporated under Section 21 2000/028082/08 Directors: M L Borchers, P Wolpe
FUNDED BY: THE BRITISH HIGH COMISSION OF SOUTH AFRICA and DANIDA

Item	Cost
100 Trees, 1.8m tall in 50l bags	R30 000.00
100 Tree Cages	R150 000.00
1 x 32mm Water Connection	R6 000.00
Irrigation system	R10 000.00
Compost and fertiliser	R2 000.00
Planting and installation of cages and irragation	R5 000.00
12 Month maintenance scheme (2 visits per month)	R24 000.00
Total cost for 100 trees	**R227 000.00**

It was also suggested that a landscape architect be used to design a large scale roll-out plan for tree planting for all of the CRU Project's units and include irrigation and maintenance based on the prices given above. A more detailed actual costing can then be done by City Parks.

Paints

Various products were investigated and two companies were selected, which appeared to be able to supply the required paint products. The first company only sells environmentally sound, low VOC (volatile organic compound) paints. This company is B-Earth, which is a South African company located in Pretoria. The second company, which was identified, is Plascon. Plascon has a small range of low VOC paints. Unfortunately, Plascon did not have low VOC alternatives for many of the products needed in the project.

The detail below gives the B-Earth and Plascon product, which is suitable for the spec given as well as the price per litre for the product. It is also noted whether it is a low VOC product (green) or a high VOC product (hVOC) and also if there could possibly be a water based, low VOC alternative available (WBA) this, unfortunately depends on the substrate and is often slightly more expensive.

*Please see Appendix 3 for technical details on B-Earth products as well as contact details.

Substrate	B-Earth		Price	Plascon		Price
Outer Walls	B-Bond (primer) B-Paint (2-coats)	Green Green	R25.00 R45.00	PP700 (primer) Polvin (2-coats)	WBA Green	R36.55 R34.32
Exterior Water Proofing	B-Bond B-Paint	Green Green	R25.00 R45.00	Roofseal	hVOC	R19.25
Roofs	B-Bond B-Paint	Green Green	R25.00 R45.00	AW255 (primer) NuRoof	hVOC hVOC	R73.45 R34.32
Ceilings	B-Bond B-Seal B-Paint	Green Green Green	R25.00 R38.00 R45.00	PP700 PEM 600	WBA Green	R36.55 R21.29
Doors	B-Bond B-Paint	Green Green	R25.00 R45.00	PSB 1000	WBA	R44.55
Interior walls	B-Bond B-Paint	Green Green	R25.00 R45.00	PEM 1000	Green	R38.60

Beneficial

A Project of Sustainable Energy Africa
Association Incoporated under Section 21 2000/028082/08 Directors: M L Borchers, P Wolpe
FUNDED BY: THE BRITISH HIGH COMISSION OF SOUTH AFRICA and DANIDA

Appendix 1: The case for installing SWHs in City owned houses

Broad assumptions for all scenarios:

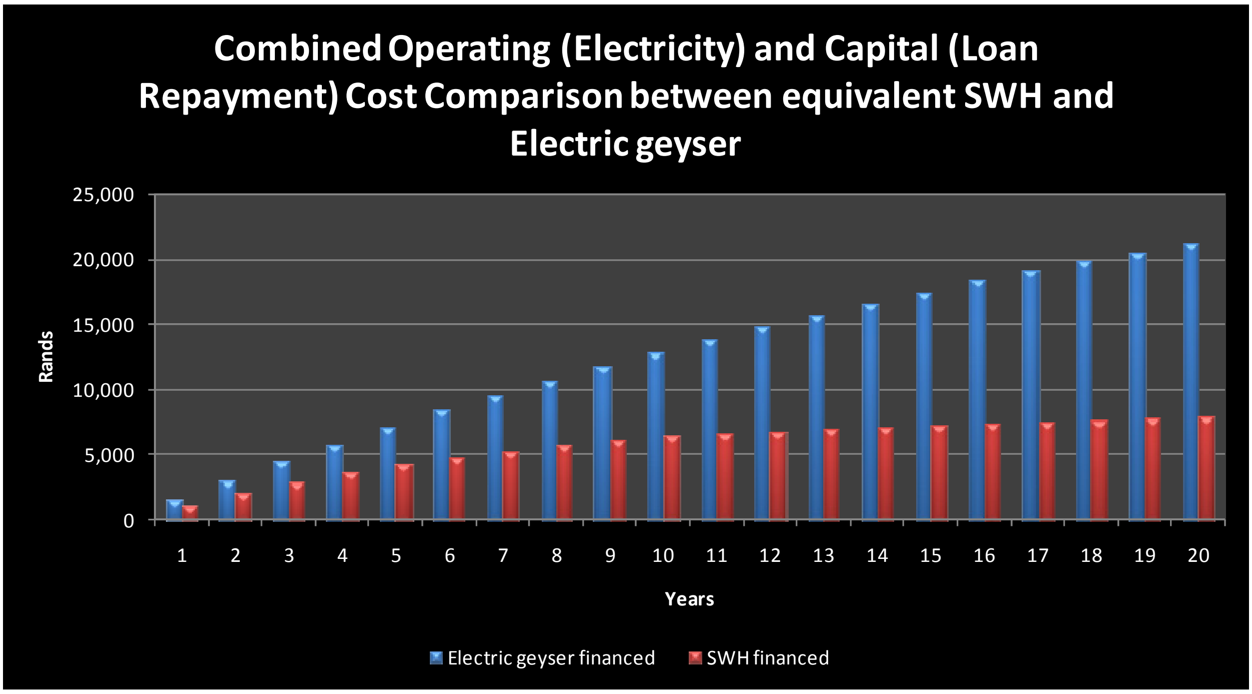
- 100l SWH cost: R6700
- 100l geyser cost: R2500
- City to recover additional R4200 for SWH through increase in rent by a set amount over 10 years
- Annual electricity price increase: 15%
- Discount rate: 20%
- Minimum of 100l of hot water is used per day

Scenario 1:

City pays cash for SWHs, and recovers money through the rent over 10 years with a 15% p.a. increase (same as repayment of a loan @ 15% over 10 years).

Findings:

1. SWH Immediately more financially beneficial to the end user from year 1 thanks to electricity saved– see capital and operating cost graph below.
2. Monthly repayment (addition to rent) of R70 over 10 years .



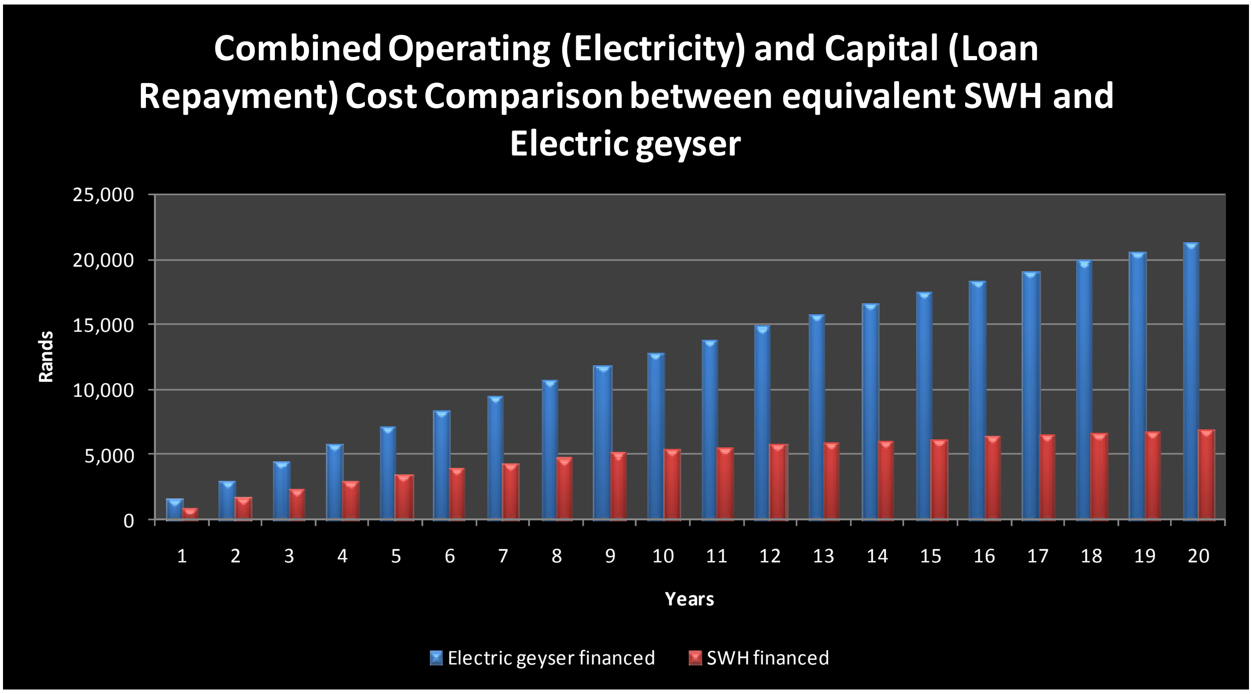
A Project of Sustainable Energy Africa
Association Incoporated under Section 21 2000/028082/08 Directors: M L Borchers, P Wolpe
FUNDED BY: THE BRITISH HIGH COMISSION OF SOUTH AFRICA and DANIDA

Scenario 2:

City pays cash for SWHs, and recovers money through the rent over 10 years with an 8% p.a. increase (same as repayment of a loan @ 8% over 10 years).

Findings:

1. SWH Immediately more financially beneficial to the end user from year 1 thanks to electricity saved– see capital and operating cost graph below.
2. Monthly repayment (addition to rent) of R52 over 10 years .



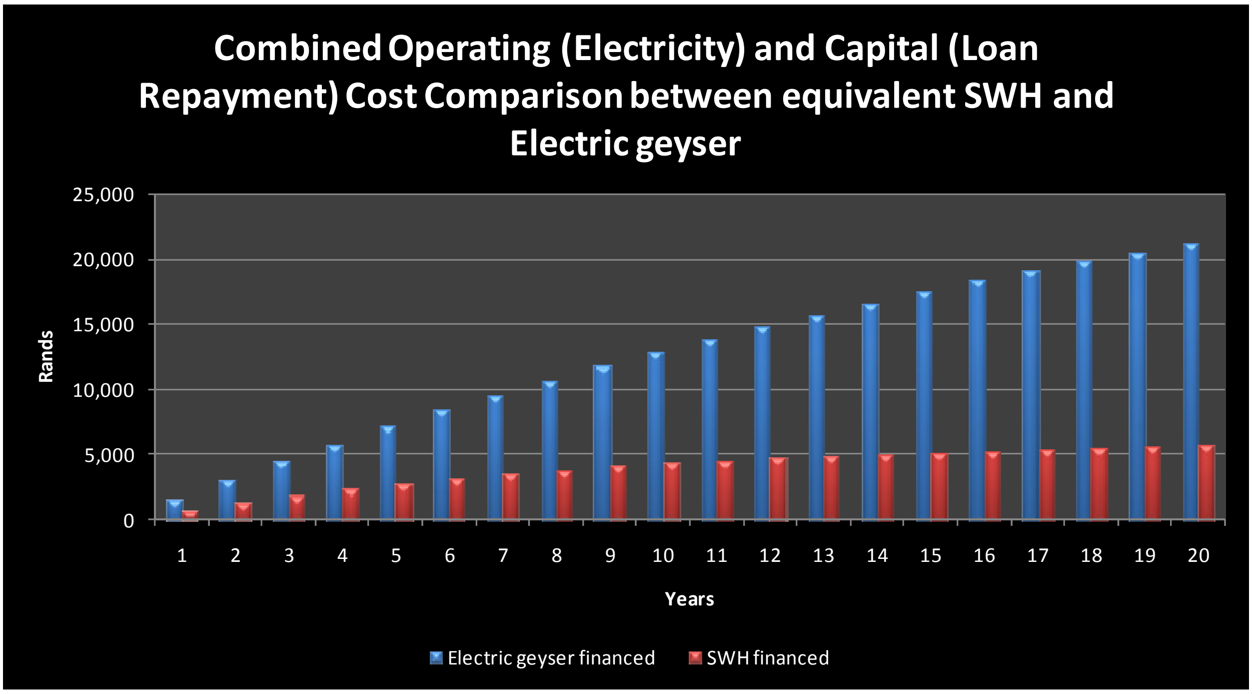
A Project of Sustainable Energy Africa
Association Incoporated under Section 21 2000/028082/08 Directors: M L Borchers, P Wolpe
FUNDED BY: THE BRITISH HIGH COMISSION OF SOUTH AFRICA and DANIDA

Scenario 3:

City pays cash for SWHs, and recovers money through the rent over 10 years with an 0% p.a. increase (same as repayment of a loan @ 0% over 10 years).

Findings:

1. SWH Immediately more financially beneficial to the end user from year 1 thanks to electricity saved– see capital and operating cost graph below.
2. Monthly repayment (addition to rent) of R35 over 10 years .



A Project of Sustainable Energy Africa
Association Incorporated under Section 21 2000/028082/08 Directors: M L Borchers, P Wolpe
FUNDED BY: THE BRITISH HIGH COMISSION OF SOUTH AFRICA and DANIDA

Appendix 2: Embodied energy coefficients (alphabetical)

MATERIAL	MJ/kg	MJ/m3	MJ/m2
Aggregate, general	0.10	150	
virgin rock	0.04	63	
river	0.02	36	
Aluminium, virgin	191	515 700	
extruded	201	542 700	
extruded, anodised	227	612 900	
extruded, factory painted	218	588 600	
foil	204	550 800	
sheet	199	537 300	
Aluminium, recycled	8.1	21 870	
extruded	17.3	46 710	
extruded, anodised	42.9	115 830	
extruded, factory painted	34.3	92 610	
foil	20.1	54 270	
sheet	14.8	39 960	
asphalt (paving)	3.4	7 140	
bitumen	44.1	45 420	
brass	62.0	519 560	
Carpet	72.4		
felt underlay	18.6		
nylon	148		
polyester	53.7		
polyethylterepthalate (PET)	107		
polypropylene	95.4		
wool	106		
Cement	7.8	15 210	
cement mortar	2.0	3 200	
fibre cement board	9.5	13 550	102/7.5mm
soil-cement	0.42	819	
Ceramic			
brick	2.5	5 170	
brick, glazed	7.2	14 760	
pipe	6.3		
tile	2.5	5 250	
Concrete			
block	0.94		
brick	0.97		
GRC	7.6	14 820	
paver	1.2		
pre-cast	2 .0		
ready mix, 17.5 MPa	1.0	2 350	
30 MPa	1.3	3 180	
40 MPa	1.6	3 890	
roofing tile	0.81		
Copper	70.6	631 160	

A Project of Sustainable Energy Africa
Association Incorporated under Section 21 2000/028082/08 Directors: M L Borchers, P Wolpe
FUNDED BY: THE BRITISH HIGH COMISSION OF SOUTH AFRICA and DANIDA

Earth, raw			
adobe block, straw stabilised	0.47	750	
adobe, bitumen stabilised	0.29		
adobe, cement stabilised	0.42		
rammed soil cement	0.80		
pressed block	0.42		
Fabric			
cotton	143		
polyester	53.7		
Glass			
float	15.9	40 060	240/6mm
toughened	26.2	66 020	396/6mm
laminated	16.3	41 080	246/6mm
tinted	14.9	375 450	
Insulation			
cellulose	3.3	112	
fibreglass	30.3	970	
polyester	53.7	430	
polystyrene	117	2 340	
wool (recycled)	14.6	139	
Lead	35.1	398 030	
Linoleum	116	150 930	337
Paint	90.4	118/l	6.5
solvent based	98.1	128/l	6.1
water based	88.5	115/l	7.4
Paper	36.4	33 670	
building	25.5		4.97
kraft	12.6		
recycled	23.4		
wall	36.4		
Plaster, gypsum	4.5	6 460	
Plaster board	6.1	5 890	33/9.5mm
Plastics			
ABS	111		
high density polyethelene (HDPE)	103	97 340	
low density polyethelene (LDPE)	103	91 800	
polyester	53.7	7 710	
polypropylene	64.0	57 600	
polystyrene, expanded	117	2 340	
polyurethane	74.0	44 400	
PVC	70.0	93 620	
Rubber			
natural latex	67.5	62 100	
synthetic	110		
Sand	0.10	232	
Sealants and adhesives			
phenol formaldehyde	87.0		
urea formaldehyde	78.2		

A Project of Sustainable Energy Africa
Association Incorporated under Section 21 2000/028082/08 Directors: M L Borchers, P Wolpe
FUNDED BY: THE BRITISH HIGH COMISSION OF SOUTH AFRICA and DANIDA

Steel, recycled	10.1	37 210	
reinforcing, sections	8.9		
wire rod	12.5		
Steel, virgin, general	32.0	251 200	
galvanised	34.8	273 180	
imported, structural	35.0	274 570	
Stone, dimension			
local	0.79	1 890	
imported	6.8	1 890	
straw, baled	0.24	30.5	15.2
Timber, softwood			
air dried, roughsawn	0.3	165	
kiln dried, roughsawn	1.6	880	
air dried, dressed	1.16	638	
kiln dried, dressed	2.5	1 380	
mouldings, etc	3.1	1 710	
hardboard	24.2	13 310	
MDF	11.9	8 330	
glulam	4.6	2 530	
particle bd	8.0		
plywood	10.4		
shingles	9.0		
Timber, hardwood			
air dried, roughsawn	0.50	388	
kiln dried, roughsawn	2.0	1 550	
Vinyl flooring	79.1	105 990	
Zinc	51.0	364 140	
galvanising, per kg steel	2.8		

A Project of Sustainable Energy Africa
Association Incorporated under Section 21 2000/028082/08 Directors: M L Borchers, P Wolpe
FUNDED BY: THE BRITISH HIGH COMISSION OF SOUTH AFRICA and DANIDA

Appendix 3a: B-Earth Specifications

B-earth™ Eco paint products

Enhanced sustainability performance of infrastructure through the utilisation of the B-earth paint systems

Thank you for the opportunity to introduce to you the B-earth product range. Herewith we would like to provide more information as to the benefit of using the B-earth paint systems on infrastructure from a sustainability perspective.

The enhanced sustainability performance of the B-earth products compared to other similar water-based epoxy and emulsion coatings is achieved throughout the lifecycle stages of the products:

- **Manufacturing and supply:** No hazardous substances are used in the manufacturing of the products, i.e. from cradle-to-gate. Although the most of the raw materials are obtained from elsewhere, e.g. China and Europe, the manufacturing of the products themselves occur entirely within the Cape Town Metropolitan with maximum local socio-economic beneficiation. Apart from resource utilisation, e.g. water and energy, the manufacturing operation has minimal impacts on the environment in terms of air, water, or soil pollution. For example, no metallic compounds are found in any waste material, the limited water discharge poses no bio-threats, and the release of organic substances into the air is negligible. Local manufacturing and supply also minimises the real and potential impacts of the transportation of the products to the Cape Town City Council as end-user.
- **Usage:** The quality characteristics of paint is comparable to other products in terms of resistance to water penetration, resistance to acidic attack, resistance to weathering (humidity, salt spray and temperature change), colourfastness, and bond strength to surface, i.e. abrasion and chip resistance. Similarly the spread rates, and associated costs, are comparable. However, apart from its hardness and impact-absorption ability, the paint product has improved flexibility characteristics. The overall quality improvement ensures a longer lifecycle stage after application, i.e. less maintenance interventions are required, which does reduce cost burdens in the longer term. The environmental and health impact performance of the B-earth systems during and after application is highlighted with respect to the two main toxic factors associated with paint-related products: no metallic releases, e.g. lead and other toxic metals are not found in B-paints; and low to no releases of Volatile Organic Compounds (VOCs). Overall, the non-hazardous characteristics of the products ensure virtually no risks to society during their usage. In addition, the scrub resistance and cleanability of B-earth systems is extremely good, which, together with its low odour characteristics, also makes them superior choices for exterior and indoor applications.
- **Disposal:** Since the final product contains no hazardous substances, the final disposal of either removed products or discontinued substrate on which the products have been applied poses no threat to the society or the natural environment.

Given these lifecycle advantages of the B-earth product range and proposed systems, which are substantiated with real field experiences and laboratory analyses, we believe that, if the B-earth products and systems are used as specified, the sustainability performances of the Cape Town City Council's infrastructure will markedly improve.

If you do require further technical information to support the abovementioned, please do not hesitate to contact myself directly. My contact details are provided at the top of this document.

alan.brent@up.ac.za

Yours sincerely,

Appendix 3b: B-Earth Specifications

Description of the B-earth® Paint System.
The B-earth paint system comprises of:

- One layer of B-bond; and
- Two layers of B-paint.

For smooth internal and external surfaces the following technical specifications and costs apply:

Component	Surface coverage	Cost R/l	Cost R/m²
B-bond (1 layer)	10 – 12 m²/l	25.00	2.50 – 2.08
B-paint (2 layers)	5 – 6 m²/l	45.00	9.00 – 7.50
TOTAL			11.50 – 9.58

For rough internal and external surfaces the following technical specifications and costs apply:

Component	Surface coverage	Cost R/l	Cost R/m²
B-bond (1 layer)	8 – 10 m²/l	25.00	3.13 – 2.50
B-paint (2 layers)	4 – 5 m²/l	45.00	11.25 – 9.00
TOTAL			14.38 – 11.50

These prices are guidelines for semi-skilled applicators.
Skilled painters will get a better spread rate.
The B-earth System is based on thin film technology therefore the 2 final coats.
This system carries a 7 (seven) year guarantee.
The B-earth Contractor System use a coating priced at R 25.00 per liter.
This system carries a 3 (three) year guarantee.

Please contact us if any uncertainties about the product or surface exist.

Willem Cronje
pretoria_plant@b-earth.co.za
Cell: 082 895 3817
Fax: 088 012 8080790

Prof. Alan Brent
alan.brent@up.ac.za

A Project of Sustainable Energy Africa
Association Incorporated under Section 21 2000/028082/08 Directors: M L Borchers, P Wolpe
FUNDED BY: THE BRITISH HIGH COMISSION OF SOUTH AFRICA and DANIDA

Appendix 4: Sustainable Ecosystem Options for low-income developments

Criteria ranking system:

Rating	Number
Very positive	3
Positive	2
Slightly positive	1
Neutral	0
Slightly negative	-1
Negative	-2
Very negative	-3

Option	Information	Financial: Capital cost	Financial: O&M	Environ impact	User acceptability	Established technology?	Ease of implement	Social, employment	CDM / carbon $ potential	Overall rating w.r.t. sustainable developments: (Critical, Important, Beneficial, or Unimportant)
PLANNING & COMMUNITY	The location and planning of developments has a significant impact on the sustainability of settlements and welfare of occupants, although the impacts thereof are often difficult to quantify. It has implications for resource use, economic sustainability and various environmental concerns.									
Location in urban area	Developments should consider proximity to employment opportunities and major public transport services.									
Settlement layout / orientation	Overall settlement layout should allow buildings to be oriented 'facing' north, which allows for effective passive solar design (thermal efficiency) of buildings – increasing their comfort levels and reducing energy needs for little or no additional cost.									
Settlement density	Density: low density residential areas are recognized as inappropriate in most cases as this leads to sprawling cities which are expensive and difficult to service effectively. A more appropriate urban expansion mode is through densification of settlements, implying increased use of double or multi-storey residences. This also allows more people to be located in prime areas of the city close to employment opportunities and other facilities.									
Multi-use settlement	Needs of communities should be met locally where feasible, and thus the inclusion schools, recreation facilities, shops and employment opportunities needs to be considered. This reduces transport costs (a significant burden to many residents) and helps build a sense of 'community'.									

A Project of Sustainable Energy Africa
Association Incoporated under Section 21 2000/028082/08 Directors: M L Borchers, P Wolpe
FUNDED BY: THE BRITISH HIGH COMISSION OF SOUTH AFRICA and DANIDA

Criteria ranking system:

Rating	Number
Very positive	3
Positive	2
Slightly positive	1
Neutral	0
Slightly negative	-1
Negative	-2
Very negative	-3

Option	Information	Financial: Capital cost	Financial: O&M	Environ impact	User acceptability	Established technology?	Ease of implement	Social, employment	CDM / carbon $ potential	Overall rating w.r.t. sustainable developments: (Critical, Important, Beneficial, or Unimportant)
Transport access	In order to participate in the urban economy effectively, access to affordable, safe public transport options is critical. Either ensuring that settlements are located near major public transport facilities or developing such facilities (e.g. interchanges, BRT or train links) thus becomes important, and requires coordination with transport planning authorities.									
Community involvement	Involving communities in decisions around community layout, facilities and housing options is important to direct resources to best meet needs and foster a sense of ownership.									

A Project of Sustainable Energy Africa
Association Incoporated under Section 21 2000/028082/08 Directors: M L Borchers, P Wolpe
FUNDED BY: THE BRITISH HIGH COMISSION OF SOUTH AFRICA and DANIDA

Option	Information	Financial: Capital cost	Financial: O&M	Environ impact	User acceptability	Established	Ease of implement	Social, employment	CDM / carbon $	Overall rating w.r.t. sustainable developments: (Critical, Important, Beneficial, or Unimportant)
	Criteria ranking system: Rating – Number Very positive – 3 Positive – 2 Slightly positive – 1 Neutral – 0 Slightly negative – -1 Negative – -2 Very negative – -3									
ENERGY	Energy efficiency and renewable energy use is a critical component of sustainable developments. Energy use is linked to air pollution and global warming, and currently uses non-renewable resources. A well designed sustainable house will use less than 50% of the energy of a conventional one, with no sacrifice of lifestyle.									
Bulk services: Streetlight efficiency	Street lights are a significant component of bulk services cost, and impact on the quality of the development. Standard options are: Centralized High-Mast Lighting – which is often not preferred by communities, is not effective in more dense settlements, and is more expensive per erf to install and operate than other options; and High-pressure sodium streetlights (70W) - more efficient than the old mercury vapour lights. Can use the poles for electricity reticulation. Efficient options are (1) Compact Fluorescent (CFL) streetlights – cost effective and more efficient than hi-pressure sodium lights. Can use poles for electricity reticulation, (2) Light Emitting Diode (LED) streetlights – these are being piloted, but appear very effective and life-cycle cost-competitive. Can use poles for electricity reticulation.	-1	2	1	2	0	0	0	1	Important
Bulk services: Electricity reticulation ADMD reduction	Energy efficient housing may reduce After-Diversity Maximum Demand (ADMD) and reduce overall reticulation costs. Reduced amperage supply is also being re-introduced in some municipalities (reduced from 60Amp to 40Amp, as opposed to the old 20Amp low-income option). This tends not to reduce overall costs by a large percentage however, as it just tends to reduce transformer costs. It does encourage energy saving in households to some extent though.	1	0	2	-1	2	2	0	0	Beneficial

A Project of Sustainable Energy Africa
Association Incoporated under Section 21 2000/028082/08 Directors: M L Borchers, P Wolpe
FUNDED BY: THE BRITISH HIGH COMISSION OF SOUTH AFRICA and DANIDA

Criteria ranking system:

Rating	Number
Very positive	3
Positive	2
Slightly positive	1
Neutral	0
Slightly negative	-1
Negative	-2
Very negative	-3

Option	Information	Financial: Capital cost	Financial: O&M	Environ impact	User acceptability	Established	Ease of implement	Social, employment	CDM / carbon $	Overall rating w.r.t. sustainable developments: (Critical, Important, Beneficial, or Unimportant)
Passive solar house/building design	The energy use over the house/building lifetime is greatly reduced by applying basic passive solar design principles. Although many technical options can be considered, some are unlikely to be effective when comparing cost of the intervention with energy use/comfort improvements. Reduction in heating and cooling energy requirements of around 50% is achievable.									
	Ceiling: Most effective single option for moderating both summer and winter temperature.	-1	2	2	3	2	-1	0	3	<u>Critical</u>
	Ceiling & insulation: Significantly further improves the thermal performance of houses.	-2	2	2	3	2	-1	0	1	Important
	North orientation with roof overhangs and N window area: Moderately effective, mainly in winter due to increased access to sun's warmth on some days. Small cost implication with roof overhang.	-1	1	1	2	2	-1	0	0	Important
	Double skin wall: Very effective, but expensive	-3	2	2	2	2	-2	0	0	Beneficial
	Exterior light colour (roof and wall): Marginal impact. Reduces summer temp but house becomes colder in winter.	0	1	0	1	1	2	0	0	Unimportant
	Deciduous tree planting: Small impact. Provides some coolth in summer, but can reduce sunshine marginally in winter too.	-1	0	1	2	1	-1	1	1	Unimportant
	Shared walls (e.g. semi-detached houses): Moderate impact. Houses 'keep each other' warm in winter and cool in summer – but also reduces solar gain in winter. <u>*Further modeling required.*</u>	1	?	?	-1	1	1	0	0	Beneficial (but further modeling required)

A Project of Sustainable Energy Africa
Association Incorporated under Section 21 2000/028082/08 Directors: M L Borchers, P Wolpe
FUNDED BY: THE BRITISH HIGH COMISSION OF SOUTH AFRICA and DANIDA

Option	Information	Financial: Capital cost	Financial: O&M	Environ impact	User acceptability	Established	Ease of implement	Social, employment	CDM / carbon $	Overall rating w.r.t. sustainable developments: (Critical, Important, Beneficial, or Unimportant)
	Criteria ranking system: Rating / Number — Very positive 3; Positive 2; Slightly positive 1; Neutral 0; Slightly negative -1; Negative -2; Very negative -3									
Building 'embodied energy' and local materials	Embodied energy is the sum of all energy required to mine, manufacture, and transport all the materials used in building. Embodied energy is often equivalent to the total operating energy of the building over its lifetime. Sustainable design attempts to reduce this by (1) careful choice of materials, (2) use of local materials, and (3) considering recycled material use where suitable (e.g. recycled SABS approved brick).	1	0	2	-1	0	-1	1	0	Beneficial
Solar water heaters (SWH)	This technology is well established and is generally sensible for new residential buildings. Compared with normal geysers, reductions in water heating energy requirements of about 50% can be expected. However low-income houses often do not have geysers, and may not spend enough on water heating to ensure financial feasibility through SWH energy savings.	-1	2	1	1	2	-1	2	3	Important
Well insulated hot water system	If geysers are installed, by using geyser blankets (may not be necessary with modern cylinders) and insulating all hot water pipe runs, savings of 5 to 10% of water heating energy can be achieved.	-1	1	1	1	2	-1	0	0	Beneficial
Daylighting	Levels of daylighting of well over 75% are usually achievable in residential designs, although this may have an implication for window sizes and therefore cost.	-1	1	1	1	1	-1	0	0	Important
Efficient lighting	Lighting typically demands over 20% of total domestic energy consumption in low-income households. Efficient lighting (e.g. CFLs and LEDs) reduce this by at least three quarters, without affecting the quality of lighting.	-1	2	2	0	2	0	0	2	Critical
Renewable electricity generation	Renewable electricity generation (solar PV or wind generation sources are often the most feasible) represents a significant commitment to a sustainable development. Costs are often relatively high for community-scale systems, even considered over	-3	1	3	0	2	-2	1	2	Beneficial (NB: costs vary significantly between options - requires more disaggregated assessment -

A Project of Sustainable Energy Africa
Association Incoporated under Section 21 2000/028082/08 Directors: M L Borchers, P Wolpe
FUNDED BY: THE BRITISH HIGH COMISSION OF SOUTH AFRICA and DANIDA

Criteria ranking system:

Rating	Number
Very positive	3
Positive	2
Slightly positive	1
Neutral	0
Slightly negative	-1
Negative	-2
Very negative	-3

Option	Information	Financial: Capital cost	Financial: O&M	Environ impact	User acceptability	Established	Ease of implement	Social, employment	CDM / carbon $	Overall rating w.r.t. sustainable developments: (Critical, Important, Beneficial, or Unimportant)
(PV, wind…)	system lifetime (although they are reducing steadily). Systems may be (1) stand alone – where each house generates power and stores it in batteries for own-use, (2) mini-grid – where houses share generation sources, or (3) grid-tied – where power not used by the development automatically feeds back into the area electricity network, and the development is credited accordingly. The latter is most financially feasible, as it allows maximum power extraction from the renewable system, and allows use of grid power during peak times. Hydro generation is potentially a low-cost electricity source if adequate perennial water flow is assured. *Caution: Local authority position on feed-in of renewable power to existing grid needs to be established (this is a relatively new concept for many of them, although it is being done in several cities)*									costs of some renewable options are also reducing fast – becoming increasingly viable)
Biogas energy	Methane production from organic waste materials or sewage is an option where adequate waste is produced. Methane gas generated can be used for cooking, heating, or even electricity generation. *Caution: Acceptability of local sewage biogas systems may be an issue in developments. Costs need clarifying in feasibility analysis.*	?	?	2	-1	-1	-2	1	1	Beneficial (tho' feasibility analysis needed)
Electricity appliance provision / bulk purchase	Appliances such as fridges consume a significant amount of energy (around 25% of household energy for fridges in low-income houses). It may be feasible to establish a bulk purchase or other facility to provide low-cost efficient electrical appliances such as fridges, lights and heaters. This could potential be a community cooperative (although the practicalities of running such coops are often difficult).	-3	1	1	2	-1	-2	2	1	Beneficial

A Project of Sustainable Energy Africa
Association Incorporated under Section 21 2000/028082/08 Directors: M L Borchers, P Wolpe
FUNDED BY: THE BRITISH HIGH COMISSION OF SOUTH AFRICA and DANIDA

Criteria ranking system:

Rating	Number
Very positive	3
Positive	2
Slightly positive	1
Neutral	0
Slightly negative	-1
Negative	-2
Very negative	-3

Option	Information	Financial: Capital cost	Financial: O&M	Environ impact	User acceptability	Established	Ease of implement	Social, employment	CDM / carbon $	Overall rating w.r.t. sustainable developments: (Critical, Important, Beneficial, or Unimportant)
WATER	South African houses are typically water wasteful. Savings of 30% to 60% are realizable with sensible design, gardens and fittings, without sacrificing health or comfort.									
Bulk services: Water demand reduction	Water efficient housing and facilities, and rainwater storage, can reduce overall supply needs. This has limited impact on infrastructure costs, though it does reduce resource use in the settlement (water and energy for pumping). This is dealt with in the below options.	0	1	1	0	0	2	0	1	Beneficial
Bulk services: Stormwater runoff reduction	Stormwater runoff should be minimized via promotion of porous rather than impermeable paved surfaces. Some local retention ponds may also be feasible. This could reduce overall drainage infrastructure needs, but is unlikely to have a significant impact on the cost.	1	0	1	0	-1	0	0	0	Beneficial
Rainwater harvesting	Rainwater harvesting from building roofs is an environmentally sensible option, although the cost of adequate rainwater storage is often relatively high, resulting in a slow payback.	-2	1	1	1	3	-1	0	0	Beneficial
Efficient toilet flushing: Dual or multi-flush toilets	This option reduces water consumption volume substantially (toilets often use at least 30% of household water – this can be cut in half, or more, by efficient toilet flushing systems). System functionality or health is not compromised.	-1	2	2	0	2	-1	0	0	Important

A Project of Sustainable Energy Africa
Association Incoporated under Section 21 2000/028082/08 Directors: M L Borchers, P Wolpe
FUNDED BY: THE BRITISH HIGH COMISSION OF SOUTH AFRICA and DANIDA

Option	Information	Financial: Capital cost	Financial: O&M	Environ impact	User acceptability	Established	Ease of implement	Social, employment	CDM / carbon $	Overall rating w.r.t. sustainable developments: (Critical, Important, Beneficial, or Unimportant)
	Criteria ranking system: Rating – Number Very positive – 3 Positive – 2 Slightly positive – 1 Neutral – 0 Slightly negative – -1 Negative – -2 Very negative – -3									
Efficient showerheads	Many efficient showerheads are available which reduce flow significantly, without affecting shower comfort (surprising, but true). Shower consumption can be around 15% of household water use, and reductions of a third to a half of shower water volume are easily achieved. Shower water reduction also reduces hot water energy needs, adding to the financial viability. *Caution: Ensure that showerheads chosen are well designed and do not compromise the quality of the shower.*	-1	1	2	0	2	0	0	1	Important (significant benefit for little cost)
Tap flow reducers	Although taps usually compromise a relatively small part of total domestic consumption, flow reducers may be appropriate for kitchen sinks.	-1	1	1	0	3	0	0	0	Beneficial
Efficient irrigation	Choice of food garden or sports field irrigation system affects water consumption greatly. Drip irrigation systems, although substantially more expensive, save over 80% or water compared with conventional sprinklers, for example.	-2	1	2	1	1	-1	0	0	Beneficial (significant saving, but can be significant cost)
Grey-water re-use	Grey water (washing, shower, bath, handbasins) can be used for garden irrigation, but is not suitable for food garden use. Plumbing needs to facilitate grey water system installation in the construction phase, as retrofitting is usually difficult. *Caution: Grey water is not to be used for food garden irrigation. Local authorities may have concerns around grey water use, particularly near rivers (internationally there is still debate around suitability of untreated grey water use).*	-2	1	1	-1	1	-1	0	0	Unimportant (uses from grey water limited)

A Project of Sustainable Energy Africa
Association Incorporated under Section 21 2000/028082/08 Directors: M L Borchers, P Wolpe
FUNDED BY: THE BRITISH HIGH COMISSION OF SOUTH AFRICA and DANIDA

Option	Information	Financial: Capital cost	Financial: O&M	Environ impact	User acceptability	Established	Ease of implement	Social, employment	CDM / carbon $	Overall rating w.r.t. sustainable developments: (Critical, Important, Beneficial, or Unimportant)
	Criteria ranking system: Rating / Number Very positive 3 Positive 2 Slightly positive 1 Neutral 0 Slightly negative -1 Negative -2 Very negative -3									
Black water (sewage) treatment	Several systems exist for on-site treatment of sewage other than through piped sewerage systems and centralized treatment plants. These include 'Biolytix' systems, dry composting systems, local bacterial treatment and reed bed systems. Some systems are very expensive, others more financially viable. Costs need to be compared to centralized mainstream treatment options. *Caution: Authorities are particularly sensitive to black water release into the ground near rivers. Dry composting systems need to be considered in the light of user perceptions.*	-2	-1	1	-1	1	-1	0	0	Unimportant (some benefits, but costs may be significant, and impact on groundwater is an issue)
WASTE REDUCTION/ RECYCLING	Households produce significant quantities of waste, and the standard solution of simply removing it to landfill is recognized as unsustainable. Waste volume reduction of 60% can be realised in a sustainable settlement.									
Bulk services: Sewage reduction	Water efficient houses and facilities will reduce sewage waste significantly, which can reduce infrastructure costs to some degree (on-site processing is unlikely to be viable given practicalities and current bylaws, unless linked to and energy generation from biogas). Reduction in sewage volumes has design implications, such as sewer slopes etc.	1	0	1	0	-1	-1	0	1	Beneficial
Facilities for organic waste composting	Dumping of organic waste to landfill is environmentally nonsensical. This should be composted and nutrients returned to the soil, preferably for use in food gardens (or possibly used for methane production – see earlier). Facilities for composting of organics should be considered – either centrally for the whole development, or on a per-household basis. *Caution: Fly and other pest control around composting facilities may require some attention.*	-1	0	2	1	2	-1	1	0	Important (link with food gardens)

A Project of Sustainable Energy Africa
Association Incorporated under Section 21 2000/028082/08 Directors: M L Borchers, P Wolpe
FUNDED BY: THE BRITISH HIGH COMISSION OF SOUTH AFRICA and DANIDA

Criteria ranking system:

Rating	Number
Very positive	3
Positive	2
Slightly positive	1
Neutral	0
Slightly negative	-1
Negative	-2
Very negative	-3

Option	Information	Financial: Capital cost	Financial: O&M	Environ impact	User acceptability	Established	Ease of implement	Social, employment	CDM / carbon $	Overall rating w.r.t. sustainable developments: (Critical, Important, Beneficial, or Unimportant)
Facilities for recycling	Recycling (tins, paper, glass, metal and possibly plastics) should be promoted – considering both centralized collection depots as well as within the residences. Here various bulk bin systems are available. Recycling collection, sorting and sales can provide an employment creation opportunity.	-1	0	1	1	0	-1	1	0	Important (particularly employment creation potential)
CHEMICALS /TOXINS	The steady accumulation of harmful synthetic compounds is a cause of global concern, and the long-term impacts on ecosystems are still mostly unknown. Sustainable developments should seek to minimize the use of such chemicals.									
Solvent free paints & finishes	There are several good quality, environmentally preferable masonry and wood finishes on the market in the country. Solvent content in paints and wood treatment products are to be avoided. Water and cement-based alternatives should rather be considered.	1	0	1	1	1	-1	0	0	Beneficial
Household chemical alternatives	Chemicals used in normal suburban house typically have significant harmful content – both for humans (surprisingly) as well as for the natural environment. Households can be encouraged to choose more environmentally sound options, especially if grey and or black water is being processed and released locally.	0	1	2	-1	1	-1	0	0	Beneficial
Organic gardens and food production	Use of non-organic pesticides, herbicides and fertilizers is to be discouraged. Proven organic options are available.	0	-1	2	0	2	-1	0	0	Beneficial

A Project of Sustainable Energy Africa
Association Incorporated under Section 21 2000/028082/08 Directors: M L Borchers, P Wolpe
FUNDED BY: THE BRITISH HIGH COMISSION OF SOUTH AFRICA and DANIDA

Criteria ranking system:

Rating	Number
Very positive	3
Positive	2
Slightly positive	1
Neutral	0
Slightly negative	-1
Negative	-2
Very negative	-3

Option	Information	Financial: Capital cost	Financial: O&M	Environ impact	User acceptability	Established	Ease of implement	Social, employment	CDM / carbon $	Overall rating w.r.t. sustainable developments: (Critical, Important, Beneficial, or Unimportant)
LOCAL BIODIVERSITY	Biodiversity and ecosystem preservation is central to sustainable settlements.									
Trees and food gardens	Both trees and food gardens preserve and promote a measure of natural biosystems in a settlement. Trees can help with beautification as well, but specific attention is needed to maintain them in their early years.	-1	-1	1	2	0	-1	1	1	Important
LOCAL ECONOMY	A sustainable development should explicitly promote local economic growth and poverty alleviation.									
Local food production	This should be seriously considered where there is available land for communities to grow their own food. Not only can it improve nutrition, but can ease the financial burden of households, gainfully occupy the unemployed, and even be a source of income for householders via produce sales. The alternative is to buy in food –typically from out of town – with associated environmental and cost implications. Organisations such as Abalimi Bezehaya could be invited to work with local communities to this end.	-1	1	2	2	1	-1	2	0	Critical
Employment creation	Construction, recycling systems, and food gardens are all opportunities to maximize local employment creation. In addition, options listed elsewhere, such as solar water heaters, generate significantly more employment than conventional alternatives. It must be remembered that construction employment is a short-term benefit. Unemployment is a huge national priority, and needs to be a clear factor in any sustainable development.	-1	0	0	0	0	-1	3	0	Important

A Project of Sustainable Energy Africa
Association Incorporated under Section 21 2000/028082/08 Directors: M L Borchers, P Wolpe
FUNDED BY: THE BRITISH HIGH COMISSION OF SOUTH AFRICA and DANIDA