WWF TECHNICAL REPORT ZA 2015

In collaboration with

Low carbon frameworks

# SOCIAL HOUSING GREENING DEMONSTRATION PROJECT – BOOM FLATS, BROOKLYN, CAPE TOWN

## INDEX




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# 1. INTRODUCTION AND BACKGROUND

## 1.1 PROBLEM STATEMENT

Internationally, concern continues to grow about increased greenhouse gas emissions and associated negative effects on the environment, growing threats to future global security of food and water, concepts such as “peak oil” and the necessary end of the “carbon economy”. These fuelled tremendous growth over the last century or so, while at the same time wreaking environmental havoc, and in general, impacting earth’s capacity to support its growing population with limited resources. The way in which we produce, use, and dispose of the things that underpin modern consumptive lifestyles has placed huge strain on earth’s ability to sustain the exploitation of its finite resources, and maintain its capacity to act as a sink for the waste and pollution resulting from the above processes (the so-called source-sink constraint). Although we are only beginning to understand the complex interactions between different natural systems, and between man-made and natural systems over time, it is universally agreed that continued high-level emissions play a significant role in climate change and other environmental problems.

South Africa is largely a semi-arid country, facing huge challenges in the allocation of scarce natural resources to the large users in the food-water-energy nexus that consume them. It is now becoming obvious that many of these resources are already fully allocated, and there is a growing concern over whether primary resources, such as fresh water being placed on them by (both quantity and quality), are sufficient to satisfy the simultaneous demands being placed on it by the various user sectors. Energy is another major factor in development. At national level ambitious and costly plans are being made for expanding electricity generation capacity and securing future energy supply, but it is clear that the cost of energy will keep rising at a rate well above general inflation, while supply will remain constrained for a long time to come.

It is within the context painted above that closer to home social housing institutions (SHIs) report that rising utility charges are driving tenants out of their stock and back into informal and backyard accommodation in increasing numbers. The cost of services to common areas are a concern, posing a growing threat to the viability of projects and organisations, and the survival of households. Maintaining affordable rentals, within the tight constraints of the cost of provision and management and the levels of government subsidy, is increasingly a challenge.

Specifically the problem is that ignorance within the social housing sector, and a lack of any formal experimental intervention with measured and published results and impacts, together act as a serious inhibitor to the introduction of ‘green’ initiatives in the capital development and operational phases unless there is additional subsidy specifically to support this. **SHIs simply need evidence of, and credible guidance in what works and what is not worth the trouble.**

This is even more urgent and relevant since the November 2011 introduction of the SANS 10400 XA and SANS 204 that compels developers to introduce at least minimum energy efficiency measures as described in the SANS 10400 XA.

**In a nutshell, these are:**

- Orientation - this should be true north or within the range in each climatic zone;
- 50% of hot water generationby means other than electricity;
- Roof insulation thickness according to the climatic zone;
- Fenestration area - the SANS 10400 XA is specific in a minimum requirement of 15% of the net floor area. This is because within this range the heat gain or loss is not greatly affected by orientation. Once this area is exceeded, other measures must be put in place through rational design in order to offset the effects of lack of, or excess of sun radiation and this is covered in SANS 204.

The new EE regulations are based inter alia, on the combination of external thermal resistance of the external envelope and its effective thermal capacity (CR). The greater the product, the smaller the indoor temperature swing.

## 1.2 MAIN OBJECTIVES OF THE PROPOSED INTERVENTION

NASHO is setting up a project together with the WWF to help to develop and strengthen the information base that will help inform the interventions of SHIs and other key sector stakeholders and, in doing so, help to develop the relevant policy frameworks and financing streams for the effective and efficient 'greening of Social Housing'.

The main objectives of the capital product interventions considered and proposed below are to test, measure and compare the impact and feasibility of a range of design and technology options aimed at reducing the environmental impact of the buildings, improving energy efficiency, water conservation, waste management, living environment health, and support for tenant comfort and reduced cost of living, specifically to:

- develop a practical understanding of the 'green' alternatives and possibilities in social housing, their relative costs and impact and the approaches to financing of these initiatives;
- better understand the impact that these have on the lives of tenants living in these 'green' social housing buildings, including quality of life and affordability;
- use this information to inform 'green' policy for the sector as well as helping to structure financial and other instruments to make the greening viable and sustainable.

The project aims to create two green social housing buildings of 20 units each. One will be a new build and the other a retrofit. One will be an in-land site and the second on the coast. Each will be owned and managed by an accredited social housing institution. The management standard will be the same as those for the other buildings in the cluster. The development will be financed using the normal grants and loan financing for social housing. The green additions will be financed by a separate capital amount raised on a grant basis. Once completed, the units will be occupied by tenants meeting all the usual conditions for a social housing tenancy. The pilot project that was selected is Communicare's Boom Flats, Brooklyn, Cape Town – a retrofit of 20 existing units.

A 2-year research project will then monitor the cost, financial and other benefits of the 'greening' initiatives as well as the financial implications. These findings will be shared with key sector stakeholders to help inform their future greening initiatives as well as helping with the structuring of the capital and operational finances to make these initiatives possible. The research will also study the impact of these green components on the quality of the life of the tenants.

# 2. EXISTING PROJECT INFORMATION - COMMUNICARE BOOM FLATS RETROFIT, BROOKLYN, CAPE TOWN

## 2.1 SITE CONTEXT



**Location:**

- Between Amsterdam Crescent and Ceres Str, Brooklyn, Cape Town, approximately 7km by road east-north-east of the Cape Town CBD (5km as the crow flies)
- Approximately 33° 55’ S latitude, 18° 29’ E longitude
- GPS co-ordinates: 33° 54.586’ S; 18° 28.771’ E
- Altitude approximately 9m above MSL. The site is on an open, flat, low rise, low density developed plain approximately 750m from the south-eastern Table Bay shore, and 6km north-east from the nearest high massiff (Devil’s Peak).

**Climate (data: Weather station 688160 (FACT) – CT International Airport):**

- Mediterranean “warm-summer” type winter rainfall area (although it can rain throughout the year), with cool wet winters and warm dry summers. Winter is from June to August with temperatures generally between 7 and 20°C. SE Atlantic highs bring frequent cold fronts, with strong NW winds and precipitation. Summer is from November to February, with temperatures generally between 15 and 27°C. Hot bergwinds blow in from the Karoo in February/early March.

- Average temperatures (2013):
  - Annual average: 17.1°C
  - Annual average maximum: 23.0°C
  - Annual average minimum: 12.2°C
  - Highest, 4th March 2013: 37.3°C
  - Lowest, 28th June 2013: 1.8°C

- Rainfall: Annual 2013: 576mm, Jan-Dec: J18, F37, M13, A39, M30, J62, J18, A164, S73, O13, N105, D5; 1973-2013 average: 387 – 675mm p.a.

- Prevailing wind direction and speeds (air density not measured): NW in winter, SE in spring/early summer. Average windspeed 1973-2013 varied beteen 15.6 and 20.4 km/h (2013 average: 19.3, highest: 77.8km/h on 1 June 2013).

- Humidity: Annual average 2013: 67%, varied between mid-60s and mid-80s throughout the year.

- Average sunshine: 3100h p.a., 8.5h/day.

## 2.2 DESCRIPTION OF EXISTING PREMISES

**Site plan (N.T.S.)**


**Aerial view of site**

### 2.2.1 THE GROUNDS AND SITE LAYOUT

The buildings, low density dispersed clusters, are evenly spaced in a staggered radial layout on a piece of land in a truncated cone shape facing roughly north west, and approximately 5500m2 (0.55ha) in size. No contour survey was done, but the gradient for all practical purposes is flat. Most of the surface is grassed, with a few trees and shrubs spread out over the site. There are no paved areas or constructed storm water disposal. The soil is mostly sandy.

### 2.2.2 ORIENTATION OF BUILDINGS

Because of radial layout, orientation of buildings is inconsistent and varies from roughly west of north (west-northwest) through northwest to roughly north-northwest. Also in two blocks (1 and 2) the bedroom and bathroom face the main roughly northwest orientation, while blocks 3, 4 and 5 are turned around with the living rooms and kitchens facing the main roughly northwest orientation. Kitchens, regardless of orientation, are in the middle of the buildings, deeply recessed behind a patio/foyer and its external wall and window will not be touched by direct sunlight in any season.

## 2.2.3 EXISTING BUILDINGS

- Twenty one-bedroom units in five identical rectangular double storey blocks each approximately 15m long x 7.4m wide.

- Each block contains four units, two on each floor mirrored either side of a central staircase.

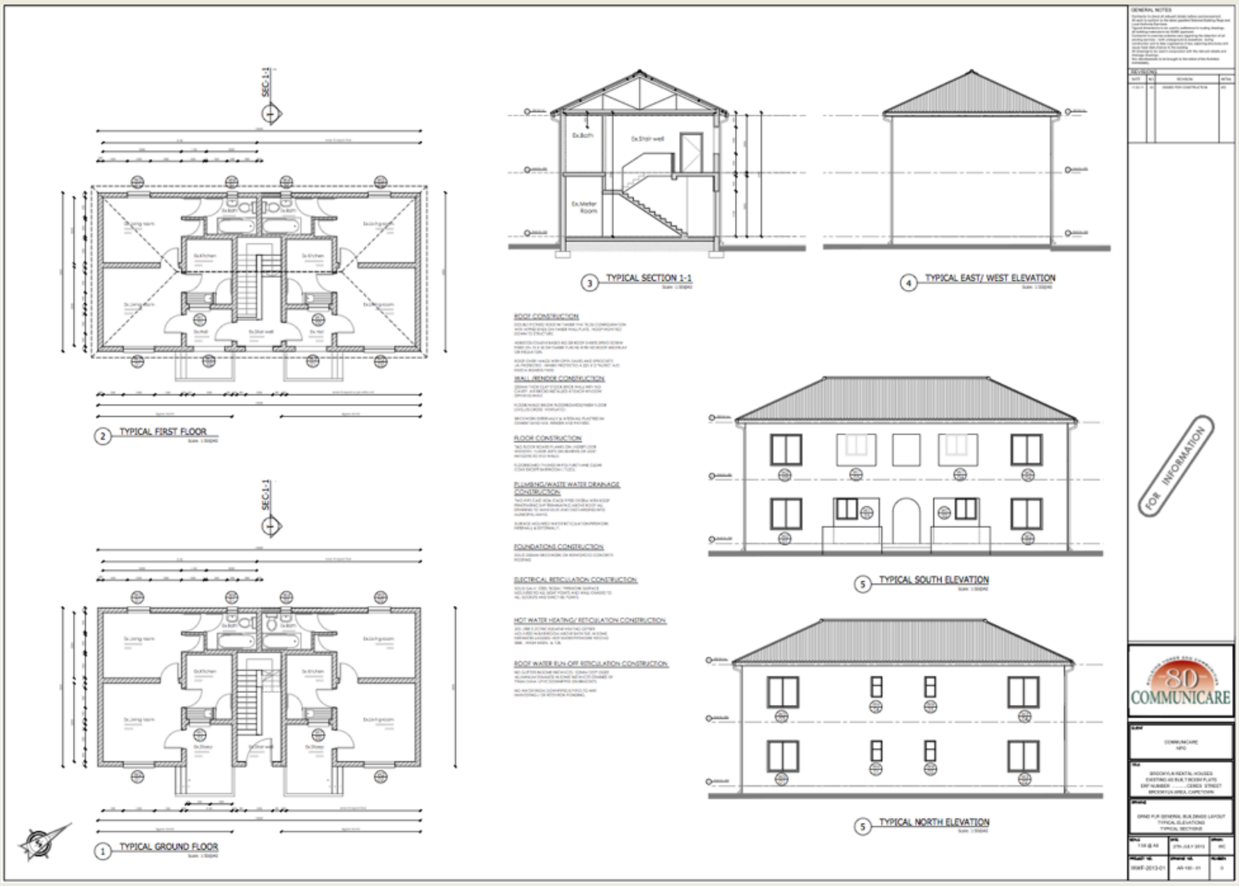
- Buildings are not shaded by existing trees or shrubs, or by each other, or by the small eaves overhangs to any significant extent.

- Unit layout is compact and roughly square in shape, each with three sides completely exposed, but in different directions ranging from roughly south-southwest to roughly north-northwest.

- Each room has one window and one internal door, except the living room which has an external door recessed deeply in the patio/foyer. No testing was done, but normal cross-ventilation performance is assumed (when windows and internal doors are open).

- Construction:
  - 230mm solid load-bearing clay brick walls plastered and painted white/off-white inside and out (face brick up to plinth).
  - Part concrete slab, part suspended timber floors, finished. Voids below suspended floors are said to be ventilated, but no testing done to verify effectiveness.
  - Hipped double pitch roofs, unclear whether it is asbestos or Nutec (if asbestos it should be replaced), cement profiled sheet (Everite Big Six) roof covering on timber trusses at approximately 25° pitch. Eaves overhangs are small (approx. 375-400mm) and open.
  - Seamless, pre-painted aluminium guttering and downpipes are being installed, and all buildings will have these when retrofit starts.
  - Nailed up boarded ceilings, no insulation.
  - Conventional plumbing installation (cast iron waste pipes and soil stacks, galvanised steel water piping – in process of being replaced with PVC).
  - 200 litre electric element geysers above bath tubs – some with blankets and lagged piping.
  - Bath, wash basin and WC with high level cistern in bathrooms, sink in kitchen (some have shower cubicles).
  - Full pre-paid electrical reticulation.

**Selected images of typical exteriors and interiors**



TYPICAL FIRST FLOOR
TYPICAL GROUND FLOOR
TYPICAL SECTION 1-1
TYPICAL EAST/ WEST ELEVATION
TYPICAL SOUTH ELEVATION
TYPICAL NORTH ELEVATION
FOR INFORMATION
COMMUNICARE

# 3. METERED CONSUMPTION AND TENANT CONSUMPTION BEHAVIOUR IN EXISTING PREMISES

## 3.1 METERED WATER CONSUMPTION PRIOR TO INSTALLATION OF INDIVIDUAL ELECTRICAL METERS

The consumption figures for water usage in a typical year (in this case from January 2012 to January 2013) were obtained from Communicare records (2013 summarised records not yet available) are shown in the tables below. According to rainfall figures, 2012 was an average, if slightly dry year. There were some gaps and inconsistencies in the data provided, and some minor extrapolation was used to complete the record without having any substantial effect on the overall results. The figures per person are based on an average occupancy across all blocks as metering was done per block anyway rather than per unit. There is unfortunately no separate metering for water used generally for watering, car washing, etc. outside of the units. Sewage effluent charges are charged at 70% of water usage, so the difference between water consumption and effluent can also not be used as a proxy for watering, etc.

**Metered water usage for BOOM FLATS, Blocks 1-3 - 2012**

| | | Block 1 | | | | | Block 2 | | | | | Block 3 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Month | Days | Total kl | Daily ave | Pers | Total kl/ person | Daily kl/ person | Total kl | Daily ave | Pers | Total kl/ person | Daily kl/ person | Total kl | Daily ave | Pers | Total kl/ person | Daily kl/ person |
| Feb | 30 | 26.000 | 0.867 | 9.0 | 2.889 | 0.096 | 20.000 | 0.667 | 9.0 | 2.222 | 0.074 | 70.000 | 2.333 | 9.0 | 7.778 | 0.259 |
| Mar | 28 | 24.000 | 0.857 | 9.0 | 2.667 | 0.095 | 17.000 | 0.607 | 9.0 | 1.889 | 0.067 | 61.000 | 2.179 | 9.0 | 6.778 | 0.242 |
| Apr | 30 | 24.000 | 0.800 | 9.0 | 2.667 | 0.089 | 19.000 | 0.633 | 9.0 | 2.111 | 0.070 | 49.000 | 1.633 | 9.0 | 5.444 | 0.181 |
| May | 32 | 26.000 | 0.813 | 9.0 | 2.889 | 0.090 | 17.000 | 0.531 | 9.0 | 1.889 | 0.059 | 66.000 | 2.063 | 9.0 | 7.333 | 0.229 |
| Jun | 30 | 22.000 | 0.733 | 9.0 | 2.444 | 0.081 | 16.000 | 0.533 | 9.0 | 1.778 | 0.059 | 42.000 | 1.400 | 9.0 | 4.667 | 0.156 |
| Jul | 29 | 22.000 | 0.759 | 9.0 | 2.444 | 0.084 | 22.000 | 0.759 | 9.0 | 2.444 | 0.084 | 32.000 | 1.103 | 9.0 | 3.556 | 0.123 |
| Aug | 33 | 27.000 | 0.818 | 9.0 | 3.000 | 0.091 | 16.000 | 0.485 | 9.0 | 1.778 | 0.054 | 41.000 | 1.242 | 9.0 | 4.556 | 0.138 |
| Sept | 29 | 25.000 | 0.862 | 9.0 | 2.778 | 0.096 | 15.000 | 0.517 | 9.0 | 1.667 | 0.057 | 41.000 | 1.414 | 9.0 | 4.556 | 0.157 |
| Oct | 29 | 25.000 | 0.862 | 9.0 | 2.778 | 0.096 | 15.000 | 0.517 | 9.0 | 1.667 | 0.057 | 52.000 | 1.793 | 9.0 | 5.778 | 0.199 |
| Nov | 33 | 48.000 | 1.455 | 9.0 | 5.333 | 0.162 | 48.000 | 1.455 | 9.0 | 5.333 | 0.162 | 48.000 | 1.455 | 9.0 | 5.333 | 0.162 |
| Dec | 23 | 25.000 | 1.087 | 9.0 | 2.778 | 0.121 | 59.000 | 2.565 | 9.0 | 6.556 | 0.285 | 13.244 | 0.576 | 9.0 | 1.472 | 0.064 |
| Jan 13 | 39 | 67.000 | 1.718 | 9.0 | 7.444 | 0.191 | 21.000 | 0.538 | 9.0 | 2.333 | 0.060 | 107.000 | 2.744 | 9.0 | 11.889 | 0.305 |
| TOTAL | 365 | 361.000 | 0.989 | 9.0 | 40.111 | 0.110 | 285.000 | 0.781 | 9.0 | 31.667 | 0.087 | 622.244 | 1.705 | 9.0 | 69.138 | 0.189 |

| | | Block 4 | | | | | Block 5 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Month | Days | Total kl | Daily ave | Pers | Total kl/ person | Daily kl/ person | Total kl | Daily ave | Pers | Total kl/ person | Daily kl/ person |
| Feb | 30 | 17.274 | 0.576 | 9.0 | 1.919 | 0.064 | 32.000 | 1.067 | 9.0 | 3.556 | 0.119 |
| Mar | 28 | 16.123 | 0.576 | 9.0 | 1.791 | 0.064 | 17.000 | 0.607 | 9.0 | 1.889 | 0.067 |
| Apr | 30 | 17.274 | 0.576 | 9.0 | 1.919 | 0.064 | 17.000 | 0.567 | 9.0 | 1.889 | 0.063 |
| May | 32 | 18.426 | 0.576 | 9.0 | 2.047 | 0.064 | 19.000 | 0.594 | 9.0 | 2.111 | 0.066 |
| Jun | 30 | 13.243 | 0.441 | 9.0 | 1.471 | 0.049 | 18.000 | 0.600 | 9.0 | 2.000 | 0.067 |
| Jul | 29 | 22.000 | 0.759 | 9.0 | 2.444 | 0.084 | 22.000 | 0.759 | 9.0 | 2.444 | 0.084 |
| Aug | 33 | 22.456 | 0.680 | 9.0 | 2.495 | 0.076 | 16.000 | 0.485 | 9.0 | 1.778 | 0.054 |
| Sept | 29 | 13.244 | 0.457 | 9.0 | 1.472 | 0.051 | 15.000 | 0.517 | 9.0 | 1.667 | 0.057 |
| Oct | 29 | 16.698 | 0.576 | 9.0 | 1.855 | 0.064 | 15.000 | 0.517 | 9.0 | 1.667 | 0.057 |
| Nov | 33 | 48.000 | 1.455 | 9.0 | 5.333 | 0.162 | 48.000 | 1.455 | 9.0 | 5.333 | 0.162 |
| Dec | 23 | 19.000 | 0.826 | 9.0 | 2.111 | 0.092 | 37.000 | 1.609 | 9.0 | 4.111 | 0.179 |
| Jan 13 | 39 | 22.456 | 0.576 | 9.0 | 2.495 | 0.064 | 34.000 | 0.872 | 9.0 | 3.778 | 0.097 |
| TOTAL | 365 | 246.194 | 0.675 | 9.0 | 27.355 | 0.075 | 290.000 | 0.795 | 9.0 | 32.222 | 0.088 |

| | | All Blocks | | | | |
|---|---|---|---|---|---|---|
| Month | Days | Total kl | Daily ave | Pers | Total kl/ person | Daily kl/ person |
| Feb | 30 | 165.274 | 5.509 | 45.0 | 3.673 | 0.122 |
| Mar | 28 | 135.123 | 4.826 | 45.0 | 3.003 | 0.107 |
| Apr | 30 | 126.274 | 4.209 | 45.0 | 2.806 | 0.094 |
| May | 32 | 146.426 | 4.576 | 45.0 | 3.254 | 0.102 |
| Jun | 30 | 111.243 | 3.708 | 45.0 | 2.472 | 0.082 |
| Jul | 29 | 120.000 | 4.138 | 45.0 | 2.667 | 0.092 |
| Aug | 33 | 122.456 | 3.711 | 45.0 | 2.721 | 0.082 |
| Sept | 29 | 109.244 | 3.767 | 45.0 | 2.428 | 0.084 |
| Oct | 29 | 123.698 | 4.265 | 45.0 | 2.749 | 0.095 |
| Nov | 33 | 240.000 | 7.273 | 45.0 | 5.333 | 0.162 |
| Dec | 23 | 153.244 | 6.663 | 45.0 | 3.405 | 0.148 |
| Jan 13 | 39 | 251.456 | 6.448 | 45.0 | 5.588 | 0.143 |
| TOTAL | 365 | 1804.438 | 4.944 | 45.0 | 40.099 | 0.110 |

**Metered water usage for BOOM FLATS, Blocks 4-5, and all blocks summary - 2012**

The average daily usage per person of 0.11 kl is low. Not surprisingly, usage is higher in the hot, drier summer months than in winter, peaking at an average 0.162 kl in November. Water usage behaviour by category was determined through recent tenant engagement (individual interviews and weekly meeting with a core group), and is summarised below (excluding what seemed to be very small amounts used in daily cooking):

**Washing:**

- 1 bath a day (sharing) = 50%
- 1 bath a week (sharing) = 12.5%
- Every second day = 12.5% (one of which is a shower)
- 2 x baths per week = 12.5%
- 2 baths a day = 12.5%

**Clothes washing:**

- 70% have washing machines. All wash on cold. All use it about once a week.

At this stage of analysis of the tenant engagement data, the above is not yet linked to units or blocks, nor does it show monthly/seasonal fluctuations meaning that the information can't be compared directly with the metered monthly consumption figures. Nevertheless, the combined information would suggest that the bulk of water usage goes towards bathing (also implications for hot water production), and laundry, with very little being used for general outdoor use such as gardening and car washing. This also affects any decision about the extent of rainwater harvesting required, unless food gardening were to be added to the intervention.

## 3.2 METERED ELECTRICAL CONSUMPTION SINCE INSTALLATION OF INDIVIDUAL ELECTRICAL METERS AT THE BEGINNING OF 2014

Prior to installation of individual electricity meters through this demonstration project, all electricity was on prepaid meters only and figures for consumption per unit is therefore, not available. The consumption per unit and per block metered since February 2014 is shown in the tables below (some meters in from January, but meaningful metering only from February. Where apparent discrepancies in metering and/or occupancy observed, the results were not included below):

| CHESTNUT | Feb-14 | | | Mar-14 | | | Apr-14 | | | May-14 | | | Jun-14 | | | Jul-14 | | | Aug-14 | | | Sep-14 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Block and Unit | Total kWh | HH size | kWh/ per-son | Total kWh | HH size | kWh/ per-son | Total kWh | HH size | kWh/ person | Total kWh | HH size | kWh/ per-son | Total kWh | HH size | kWh/ per-son | Total kWh | HH size | kWh/ per-son | Total kWh | HH size | kWh/ per-son | Total kWh | HH size | kWh/ person |
| Chestnut 1 | 107 | 2 | 54 | 182 | 2 | 91 | 177 | 2 | 89 | 232 | 2 | 116 | 258 | 2 | 129 | 386 | 2 | 193 | 303 | 2 | 152 | 247 | 2 | 124 |
| Chestnut 2 | | | | | | | | | | | | | | | | | | | | | | | | |
| Chestnut 3 | | | | | | | 119 | 1 | 119 | 131 | 1 | 131 | 135 | 1 | 135 | 137 | 1 | 137 | 137 | 1 | 137 | 125 | 1 | 125 |
| Chestnut 4 | | | | | | | 273 | 3 | 91 | 304 | 3 | 101 | 318 | 3 | 106 | 276 | 3 | 92 | 258 | 3 | 86 | 285 | 3 | 95 |
| **Total** | **107** | **2** | **54** | **182** | **2** | **91** | **569** | **6** | **95** | **667** | **6** | **348** | **711** | **6** | **370** | **799** | **6** | **422** | **698** | **6** | **375** | **657** | **6** | **344** |
| **Average/ month** | **107** | **2.0** | **53.5** | **182** | **2.0** | **91.0** | **190** | **2.0** | **99.5** | **222** | **2.0** | **116.1** | **237** | **2.0** | **123.3** | **266** | **2.0** | **140.7** | **233** | **2.0** | **124.8** | **219** | **2.0** | **114.5** |
| Units occupied and metered in month | | 1 | | | 1 | | | 3 | | | 3 | | | 3 | | | 3 | | | 3 | | | 3 | |

| CHESTNUT | CHESTNUT - Feb - Sept 2014 | | | | |
|---|---|---|---|---|---|
| Block and Unit | Months metered | Total kWh for period | Ave kWh pupm | Ave HH size for period | Ave kWh/ person for period |
| Chestnut 1 | 8 | 1 892 | 237 | 2 | 118 |
| Chestnut 2 | | | | | |
| Chestnut 3 | 6 | 784 | 131 | 1 | 131 |
| Chestnut 4 | 6 | 1 714 | 286 | 3 | 95 |
| Total | | 2 236 | | 6 | |
| **Average/ month** | | **938** | **218** | **2.0** | **115** |

| EIKEHUIS | Feb-14 | | | Mar-14 | | | Apr-14 | | | May-14 | | | Jun-14 | | | Jul-14 | | | Aug-14 | | | Sep-14 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Block and Unit | Total kWh | HH size | kWh/ per-son | Total kWh | HH size | kWh/ per-son | Total kWh | HH size | kWh/ person | Total kWh | HH size | kWh/ per-son | Total kWh | HH size | kWh/ per-son | Total kWh | HH size | kWh/ per-son | Total kWh | HH size | kWh/ per-son | Total kWh | HH size | kWh/ person |
| Eikehuis 1 | 224 | 2 | 112 | 266 | 2 | 133 | 301 | 2 | 151 | 314 | 2 | 157 | 297 | 2 | 149 | 367 | 2 | 184 | 336 | 2 | 168 | 278 | 2 | 139 |
| Eikehuis 2 | 133 | 1 | 133 | 161 | 1 | 161 | 130 | 1 | 130 | 143 | 1 | 143 | 179 | 1 | 179 | 222 | 1 | 222 | 140 | 1 | 140 | 115 | 1 | 115 |
| Eikehuis 3 | | | | 158 | 1 | 158 | 139 | 1 | 139 | 152 | 1 | 152 | 188 | 1 | 188 | 181 | 1 | 181 | 164 | 1 | 164 | 152 | 1 | 152 |
| Eikehuis 4 | | | | | | | 154 | 2 | 77 | 188 | 2 | 94 | 206 | 2 | 103 | 218 | 2 | 109 | 185 | 2 | 93 | 222 | 2 | 111 |
| **Total** | **357** | **3** | **119** | **585** | **4** | **146** | **724** | **6** | **121** | **797** | **6** | **133** | **870** | **6** | **145** | **988** | **6** | **165** | **825** | **6** | **138** | **767** | **6** | **128** |
| **Average/ month** | **179** | **1.5** | **122.5** | **195** | **1.3** | **150.7** | **181** | **1.5** | **124.1** | **199** | **1.5** | **136.5** | **218** | **1.5** | **154.6** | **247** | **1.5** | **173.9** | **206** | **1.5** | **141.1** | **192** | **1.5** | **129.3** |
| Units occupied and metered in month | | 2 | | | 3 | | | 4 | | | 4 | | | 4 | | | 4 | | | 4 | | | 4 | |

| EIKEHUIS | EIKEHUIS - Feb - Sept 2014 | | | | |
|---|---|---|---|---|---|
| Block and Unit | Months metered | Total kWh for period | Ave kWh pupm | Ave HH size for period | Ave kWh/ person for period |
| Eikehuis 1 | 8 | 2 383 | 298 | 2 | 149 |
| Eikehuis 2 | 8 | 1 223 | 153 | 1 | 153 |
| Eikehuis 3 | 7 | 1 134 | 162 | 1 | 162 |
| Eikehuis 4 | 6 | 1 173 | 196 | 2 | 98 |
| Total | | 2 236 | | 6 | |
| **Average/ month** | | **971** | **202** | **1.5** | **140** |

| HIBISCUS | Feb-14 | | | Mar-14 | | | Apr-14 | | | May-14 | | | Jun-14 | | | Jul-14 | | | Aug-14 | | | Sep-14 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Block and Unit | Total kWh | HH size | kWh/ per-son | Total kWh | HH size | kWh/ per-son | Total kWh | HH size | kWh/ person | Total kWh | HH size | kWh/ per-son | Total kWh | HH size | kWh/ per-son | Total kWh | HH size | kWh/ per-son | Total kWh | HH size | kWh/ per-son | Total kWh | HH size | kWh/ person |
| Hibiscus 1 | 217 | 2 | 109 | 228 | 2 | 114 | 237 | 2 | 119 | 244 | 2 | 122 | 268 | 2 | 134 | 261 | 2 | 131 | 256 | 2 | 128 | 216 | 2 | 108 |
| Hibiscus 2 | 143 | 3 | 48 | 156 | 3 | 52 | 168 | 3 | 56 | 177 | 3 | 59 | 217 | 3 | 72 | 216 | 3 | 72 | 194 | 3 | 65 | 185 | 3 | 62 |
| Hibiscus 3 | | | | | | | 364 | 4 | | 390 | 4 | 98 | 429 | 4 | 107 | 487 | 4 | | 413 | 4 | 103 | 410 | 4 | 103 |
| Hibiscus 4 | 221 | 2 | 111 | 229 | 2 | 115 | 231 | 2 | 116 | 223 | 2 | 112 | 192 | 2 | 96 | 184 | 2 | 92 | 217 | 2 | 109 | 226 | 2 | 113 |
| **Total** | **581** | **7** | **83** | **613** | **7** | **88** | **1 000** | **11** | **91** | **1 034** | **11** | **94** | **1 106** | **11** | **101** | **1 148** | **11** | **104** | **1 080** | **11** | **98** | **1 037** | **11** | **94** |
| **Average/ month** | **194** | **2.3** | **88.9** | **204** | **2.3** | **93.5** | **250** | **2.8** | **96.7** | **259** | **2.8** | **97.5** | **277** | **2.8** | **102.4** | **287** | **2.8** | **98.2** | **270** | **2.8** | **101.1** | **259** | **2.8** | **96.3** |
| Units occupied and metered in month | | 3 | | | 3 | | | 4 | | | 4 | | | 4 | | | 4 | | | 4 | | | 4 | |

| HIBISCUS | HIBISCUS - Feb - Sept 2014 | | | | |
|---|---|---|---|---|---|
| Block and Unit | Months metered | Total kWh for period | Ave kWh pupm | Ave HH size for period | Ave kWh/ person for period |
| Hibiscus 1 | 8 | 1 927 | 241 | 2 | 120 |
| Hibiscus 2 | 8 | 1 456 | 182 | 3 | 61 |
| Hibiscus 3 | 6 | 2 493 | 416 | 4 | 103 |
| Hibiscus 4 | 8 | 1 723 | 215 | 2 | 108 |
| Total | | 4 334 | | 9 | |
| **Average/ month** | | **1 183** | **263** | **3** | **98** |

| KEUR-BOOM HUIS | Feb-14 | | | Mar-14 | | | Apr-14 | | | May-14 | | | Jun-14 | | | Jul-14 | | | Aug-14 | | | Sep-14 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Block and Unit | Total kWh | HH size | kWh/ per-son | Total kWh | HH size | kWh/ per-son | Total kWh | HH size | kWh/ person | Total kWh | HH size | kWh/ per-son | Total kWh | HH size | kWh/ per-son | Total kWh | HH size | kWh/ per-son | Total kWh | HH size | kWh/ per-son | Total kWh | HH size | kWh/ person |
| Keurboom 1 | 292 | 2 | 146 | 299 | 2 | 150 | 265 | 2 | 133 | 262 | 2 | 131 | 263 | 2 | 132 | 256 | 2 | 128 | 264 | 2 | 132 | 262 | 2 | 131 |
| Keurboom 2 | 116 | 2 | 58 | 121 | 2 | 61 | 113 | 2 | 57 | 108 | 2 | 54 | 107 | 2 | 54 | 112 | 2 | 56 | 108 | 2 | 54 | 97 | 2 | 49 |
| Keurboom 3 | | | | 365 | 4 | 91 | 366 | 4 | 92 | 389 | 4 | 97 | 497 | 4 | 124 | 547 | 4 | 137 | 476 | 4 | 119 | 422 | 4 | 106 |
| Keurboom 4 | | | | 392 | 3 | 131 | 359 | 3 | 120 | 387 | 3 | 129 | 403 | 3 | 134 | 435 | 3 | 145 | 432 | 3 | 144 | 402 | 3 | 134 |
| **Total** | **408** | **4** | **102** | **1 177** | **11** | **107** | **1 103** | **11** | **100** | **1 146** | **11** | **104** | **1 270** | **11** | **115** | **1 350** | **11** | **123** | **1 280** | **11** | **116** | **1 183** | **11** | **108** |
| **Average/ month** | **204** | **2.0** | **102.0** | **294** | **2.8** | **108.0** | **276** | **2.8** | **100.0** | **287** | **2.8** | **102.8** | **318** | **2.8** | **110.9** | **338** | **2.8** | **116.4** | **320** | **2.8** | **112.3** | **296** | **2.8** | **104.8** |
| Units occupied and metered in month | | 2 | | | 4 | | | 4 | | | 4 | | | 4 | | | 4 | | | 4 | | | 4 | |

| KEUR-BOOM HUIS | KEURBOOMHUIS - Feb - Sept 2014 | | | | |
|---|---|---|---|---|---|
| Block and Unit | Months metered | Total kWh for period | Ave kWh pupm | Ave HH size for period | Ave kWh/ person for period |
| Keurboom 1 | 8 | 2 163 | 270 | 2 | 135 |
| Keurboom 2 | 8 | 882 | 110 | 2 | 55 |
| Keurboom 3 | 7 | 3 062 | 437 | 4 | 109 |
| Keurboom 4 | 7 | 2 810 | 401 | 3 | 134 |
| Total | | 5 104 | | 10 | |
| **Average/ month** | | **1 378** | **305** | **3** | **108** |

| SILVER-BOOM | Feb-14 | | | Mar-14 | | | Apr-14 | | | May-14 | | | Jun-14 | | | Jul-14 | | | Aug-14 | | | Sep-14 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Block and Unit | Total kWh | HH size | kWh/ per-son | Total kWh | HH size | kWh/ per-son | Total kWh | HH size | kWh/ person | Total kWh | HH size | kWh/ per-son | Total kWh | HH size | kWh/ per-son | Total kWh | HH size | kWh/ per-son | Total kWh | HH size | kWh/ per-son | Total kWh | HH size | kWh/ person |
| Siverboom 1 | 158 | 2 | 79 | 165 | 2 | 83 | 193 | 2 | 97 | 225 | 2 | 113 | 164 | 2 | 82 | 216 | 2 | 108 | 204 | 2 | 102 | 186 | 2 | 93 |
| Siverboom 2 | | | | | | | | | | | | | | | | | | | | | | | | |
| Siverboom 3 | 212 | 3 | 71 | 260 | 3 | 87 | 260 | 3 | 87 | 279 | 3 | 93 | 324 | 3 | 108 | 379 | 3 | 126 | 330 | 3 | 110 | 279 | 3 | 93 |
| Siverboom 4 | 235 | 2 | 118 | 258 | 2 | 129 | 254 | 2 | 127 | 287 | 2 | 144 | 299 | 2 | 150 | 304 | 2 | 152 | 307 | 2 | 154 | 274 | 2 | 137 |
| **Total** | **605** | 7 | **86** | **683** | 7 | **98** | **707** | 7 | **101** | **791** | 7 | **113** | **787** | 7 | **112** | **899** | 7 | **128** | **841** | 7 | **120** | **739** | 7 | **106** |
| **Average/ month** | **202** | **2.3** | **89.1** | **228** | **2.3** | **99.4** | **236** | **2.3** | **103.4** | **264** | **2.3** | **116.3** | **262** | **2.3** | **113.2** | **300** | **2.3** | **128.8** | **280** | **2.3** | **121.8** | **246** | **2.3** | **107.7** |
| Units occupied and metered in month | | 3 | | | 3 | | | 3 | | | 3 | | | 3 | | | 3 | | | 3 | | | 3 | |

| SILVER-BOOM | SILVERBOOM - Feb - Sept 2014 | | | | |
|---|---|---|---|---|---|
| Block and Unit | Months metered | Total kWh for period | Ave kWh pupm | Ave HH size for period | Ave kWh/ person for period |
| Siverboom 1 | 8 | 1 511 | 189 | 2 | 94 |
| Siverboom 2 | 0 | | | | |
| Siverboom 3 | 8 | 2 323 | 290 | 3 | 97 |
| Siverboom 4 | 8 | 2 218 | 277 | 2 | 139 |
| Total | | 3 573 | | 7 | |
| **Average/ month** | | **1 191** | **252** | **2** | **110** |

| ALL BLOCKS | Feb-14 | | | Mar-14 | | | Apr-14 | | | May-14 | | | Jun-14 | | | Jul-14 | | | Aug-14 | | | Sep-14 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Block and Unit | Total kWh | HH size | kWh/person | Total kWh | HH size | kWh/person | Total kWh | HH size | kWh/person | Total kWh | HH size | kWh/person | Total kWh | HH size | kWh/person | Total kWh | HH size | kWh/person | Total kWh | HH size | kWh/person | Total kWh | HH size | kWh/person |
| All units total | 2 058 | 23 | 89 | 3 240 | 31 | 105 | 4 103 | 41 | 100 | 4 435 | 41 | 108 | 4 744 | 41 | 116 | 5 184 | 41 | 126 | 4 724 | 41 | 115 | 4 383 | 41 | 107 |
| All units average | 114 | 2.1 | 89.5 | 180 | 2.2 | 104.5 | 228 | 2.3 | 100.1 | 246 | 2.3 | 108.2 | 264 | 2.3 | 115.7 | 288 | 2.3 | 126.4 | 262 | 2.3 | 115.2 | 244 | 2.3 | 106.9 |
| Units occupied and metered in month | | 11 | | | 14 | | | 18 | | | 18 | | | 18 | | | 18 | | | 18 | | | 18 | |

| ALL BLOCKS - Feb - Sept 2014 | | | | |
|---|---|---|---|---|
| Months metered | Total kWh for period | Ave kWh pupm | Ave HH size for period | Ave kWh/person for period |
| 8 | 18 580 | 235 | 38 | 108 |
| 79 | | | | |

**The overall average consumption trend is as follows:**

| SEASON | SPRING | SUMMER | AUTUMN | | | WINTER | | |
|---|---|---|---|---|---|---|---|---|
| MONTH | SEPT | FEB | MAR | APR | MAY | JUN | JUL | AUG |
| AVE kWh/person | 108 | 89 | 99 | 101 | 116 | 113 | 129 | 120 |

The metering period does cover a full winter, but not yet a full summer. As to be expected, overall average consumption is lowest late summer, starts increasing from late autumn, early winter, and does peak around mid to late winter, probably due to more heating and hot water usage (the tenant survey indicates that 50% of tenants use heaters, but also that they bath sparingly, with many sharing one bath per day, or even per week in a few cases). There is, however, considerable variation in consumption between units over the period regardless of income, season, number of people per household, or which block they are in. This could simply be that for some, consumption is driven largely by what is available in the budget for that month.

From the table below, it appears there is no consistent correlation between consumption and the income band the tenant is in. With a few exceptions, people in the lower income band in all blocks have a higher consumption per person than people in the higher income band. Analysis of the rent roll reveals that people in the higher income band generally have more people (and dependents) per household than those in the lower band. A detailed demographic profile of tenants for each unit was not available from the tenant engagement process (other than a split of 64% pensioners: 36% employed), and although the rent roll listed the number of occupants and dependents per unit, it also did not give an indication of age distribution, making it difficult to try and match consumption with possible behavioural differences between say older and younger people respectively.

Also, the tenant interviews show general percentages for ownership and use of various types of appliances and how people use them, including washing and cooking habits, but these are not linked to specific units, and it is therefore, not possible to draw comparisons between consumption and appliance use or behaviours per unit.

| Average Usage in Kwh per Block, Unit and Person for the Period February to September 2014 | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Colour Coding per Income Band: | | | | | R0 – R3500 | | | | | R3501 – R7500 | | | | | | | | | | | | | | |
| Block: | CHESTNUT | | | | EIKEHUIS | | | | | HIBISCUS | | | | | KEURBOOM | | | | | SILVERBOOM | | | | ALL BLOCKS |
| Unit No.: | 1 | 3 | 4 | All | 1 | 2 | 3 | 4 | All | 1 | 2 | 3 | 4 | All | 1 | 2 | 3 | 4 | All | 1 | 3 | 4 | All | All Units |
| Kwh/Unit | 237 | 131 | 286 | 218 | 298 | 153 | 162 | 196 | 202 | 241 | 182 | 416 | 215 | 263 | 270 | 110 | 437 | 401 | 305 | 189 | 290 | 277 | 252 | 235 |
| Hh Size | 2 | 1 | 3 | 2.0 | 2 | 1 | 1 | 2 | 1.5 | 2 | 3 | 4 | 2 | 2.8 | 2 | 2 | 4 | 3 | 2.8 | 2 | 3 | 2 | 2.4 | 2.3 |
| Kwh/ Person | 118 | 131 | 95 | 115 | 149 | 153 | 162 | 98 | 140 | 121 | 61 | 104 | 108 | 98 | 135 | 55 | 109 | 134 | 108 | 95 | 97 | 139 | 110 | 108 |

From the tables above, the following general pattern seem to emerge: Average usage per person for the 8 month period is low at 108kWh per month (235 kWh per household per month), indicating perhaps careful and somewhat frugal use of electricity by most tenants. Household incomes as at September 2013 as supplied by Communicare vary between a very low R1260 per month and R8000 per month, the average is R4275, and the median income is R3315. The average prepaid electricity spend at that stage was R203.68 for the month, or a very low 4.8% of average income, supporting the frugality hypothesis. This is further corroborated by the tenant engagement statistic below where 81.9% of tenants reported electricity spend per month of less than R300, with 31% even spending less than R100 per month.

**In order to further establish a realistic power demand and consumption, it would be interesting to ascertain the general indoor comfort level experienced by tenants within the current consumption level and so the future design for energy efficiency would take this into account.**

## 3.3 TENANT ENGAGEMENT FEEDBACK ON ASPECTS OF BEHAVIOUR THAT POTENTIALLY AFFECT ELECTRICITY USAGE (SUMMARY SUPPLIED BY WWF RESEARCH TEAM)

The following trends have emerged through conducting a series of in-depth interviews with the tenants of Boom regarding their consumption patterns of utilities and how they experienced the quality of living in the flats – both internally and externally. The purpose of the interviews was also to get an idea of the social capital and appetite for change that the project could work with in instituting the retrofit. A basic demographic section revealed the profile of each unit. At the date of preparation of this report, 2 units are empty, 14 units were interviewed, and 4 units still had to be interviewed. Tenants were asked about their consumption in the following general areas:

*Please note that this is a work in progress as the interviews are still being transcribed, and thus percentages might change once interviews are completed for all units. This is also not a full list of the fields of questions.*

**1. Demographics**

A full demographic profile is in progress, most important to note here is the amount of pensioners and employed in the units.

- Pensioners – 64%
- Employed – 36%

**2. Spatial heating/cooling**

*Heaters*

- 50% used heaters
- The rest used bathing, dressing warmly, using blankets

*Fans*

- 20% used a fan in summer sparingly
- 80% did not use fans

**Fridge and deep freeze**
- 100% had fridge/deep freeze
- 20% had additional deep freezers

**Kettle**
- 70% has from 8-12 cups a day
- 30% had from 1-5 cups a day

**3. Sources of energy used**
- Electricity was the primary source of energy
- Batteries for small appliances like a clock radio or a torch – negligible

**4. Lighting**

*Number of lights*
- 4 lights (one not working) = 33 %
- 5 lights = 50%
- 6 lights – 17%

**Light hours (rounded up)**
- 3hrs = 17%
- 4hrs = 17%
- 5hrs = 17%
- 6hrs = 33%
- 9hrs = 17%

**Type of bulb**
- Incandescent = 50%
- Normal = 40%
- Some bulbs don't work

**5. Cooking**
- 1 hour a day (stove) = 75%
- 1 hour every 2 days = 25%

**6. Water heating**
- Turn off geyser (manually or timer) – yes = 76 %
- No = 24%

**7. Electricity consumption**
- R50-R100 - 31%
- R101-R150 = 12.5%
- R151 = R200 =18,7%
- R201 – R300 = 18,7%
- R301 –R400 = 18,7%

**8. Information and communications**
- 80% had mobiles
- 63% had both mobiles and landlines

*Computers*
- 30% had computers which they hardly ever used

**9. Water use/expenditure**

*Washing*
- 1 bath a day (sharing) = 50%
- 1 bath a week (sharing) = 12.5%
- Every second day = 12.5% (one of which is a shower)
- 2 x baths per week = 12.5%
- 2 baths a day = 12.5%

*Clothes washing*
- 70% have washing machines. All wash on cold. All use it about once a week.

**10. Appliance use**

*TV*

- 3hrs = 8.3%
- 4hours = 58.3%
- 6hrs = 8.3%
- 7hrs = 16.6%
- 8 hrs = 8.3%

*Toasters*

- all had toasters, not used that often

*Hairdryers*

- 30% had but used seldom

*Sound systems*

- 100% had, but most were broken, and not used often

*Irons*

- Most had irons

**11. Waste**

- 1x plastic shopping carrier bag a week = 90%
- 2 x plastic shopping carrier bags a week = 10%

**12. Transport**

- 40% had cars (most only use it for shopping once a week, or going to visit families on the weekend)
- 60% used public transport

## 3.4 RECOMMENDATIONS RESULTING FROM TENANT ENGAGEMENT

- Significant improvements in comfort levels in summer can be realised with **natural ventilation.**

- The idea raised by tenants of having **another door** in the bedroom should be considered. It would also serve the purpose of improving security and developing social cohesion (with direct access to the outside communal area). *What material? Timber door or glass?*

- **Enclosing the stoep area** to allow more light in. *How would this allow more light?*

- In addition, replacement of **existing windows and frames.** In the flat occupied by the WWF team for instance, they were unable to use the windows (bedroom and bathrooom) with the Southeaster blowing as they do not have latches (opening these resulted in breakages in a few flats).

- **Internal plants** have been shown to increase the indoor air quality – can this perhaps be considered this as part of a solution to the **mould** problem? *Is it feasible? Is there evidence that it helps reduce mould? Mould is a result of stagnant humid air trapped indoors. Not sure that the use of plants would improve the mould syndrome, people that keep plants are perhaps more prone to keep the rooms aerated. I would think a better and more efficient solution for the mould would be the use of airbricks, either to outside or to inside, between rooms.*

- Green waste compost - Compost can be collected for use in landscaping or the community garden. *For this, a **centralised waste handling & recycling collection facility** could be considered.*

- Can a case also be developed for the **"greening on the outside"** - which has shown to significantly increase well-being in greening projects elsewhere *(perhaps further funding could be sought if it can't be sourced through this project). Feedback from tenants indicates a desire for a better external environment - improved safety, security and more social interaction. Next to the mould issue, this comes out tops! Social spaces will foster informal and spontaneous interactions between tenants.*

- Drought resistant landscaping design ensures the landscape does not require supplemental irrigation. Indigenous plants, once established, require less maintenance, are more tolerant to the local environmental conditions and improve biodiversity. A landscaping plan should include provision of appropriate foot paths, garden layouts and access to front doors to cater for **all levels of physical ability** - at the moment the uneven pathways are a problem for some tenants.

- A centralised **parking** area and children's **play** park should also be considered. *There is an assumption that the fencing will go ahead as planned. Has the suggestion from tenants to enclose the **two adjacent vacant plots** been considered? The problem of vagrants occupying the place is often mentioned - and is associated with theft. Crime is becoming a serious concern and should not be ignored.*

## 3.5 CONCLUSIONS

The above indicates sparing engagement in almost all activities that consume energy (and water), with only 50% using heaters, much sharing and skipping of days in bathing, and little time spent cooking. Low car ownership (40%) probably also means low water use for car washing, etc. The exceptions seem to be 100% fridge ownership, and fairly long hours of watching TV. When comparing water usage and electricity usage (both low), bathing appears to be the biggest consumer of water (next to laundry), and by inference hot water, with a substantial impact, together with heating, on electricity (not directly quantifiable with currently available data).

Verbal communication with the research team indicates that heating of cold rooms in winter is more of an issue than cooling in summer. It appears this can be ascribed mainly to the following factors:

- No insulation in roofs;
- The off-north orientation of all the blocks, especially blocks 1 and 2 with living rooms facing southeast;
- The recessed kitchens which get no direct sun – kitchens normally generate heat, therefore their orientation is usually south.

With regard to lighting, 50% reported using incandescent, and 40% "normal" bulbs (not clear what the other 10% use). Also, it is not clear what is meant by "normal" as opposed to incandescent which traditionally has been the "normal" form. Perhaps one of the two refers to fluorescent? Nevertheless, 67% reported lighting use of 5 hours and more (something to do with the perpetually "dark" interiors of many of the units and rooms?), so introducing energy efficient lighting should be justified.

**There is no common area electricity or water usage on the site. Stair and foyer lighting is included with the metered units. This means that the benefit of reducing water and energy costs will go directly to tenants and none of it will accrue directly to Communicare. The benefit to Communicare will be counted in a reduction of long-term maintenance costs through reduced element geyser repairs and replacement, although any energy efficiency measures such as solar or heat pumps implementation will require a regular (between 6-12 months) maintenance plan and indirectly presumably through increased tenant satisfaction and retention. Also, although this point is moot, should the units ever be offered on the open market rather than in the restricted social housing market, the green features should enhance marketability and rental rates.**

**It is proposed that due to the low consumption by sitting (and anticipated future) tenants, there will not be large savings achieved, but rather tenant comfort will be considerably improved without pushing up the rates and costs of water and electricity usage.**

# 4. APPROACH TO THE INTERVENTION

## 4.1 INTRODUCTION

Ideally the motivation for selection of greening options should contain three aspects:

1. A baseline audit (current status)
2. Benchmark levels for anticipated benefits
3. Actual anticipated benefits against the benchmarks

### 4.1.1 THE CURRENT STATUS, OR BASELINE AUDIT, INCLUDES THE FOLLOWING ELEMENTS:

| Item | Comment |
|---|---|
| Water usage | Such information as could be supplied by the landlord has been analysed in 3.1 above. Water usage is generally very low, and restricted mostly to domestic use inside the unit (very little evidence of car washing and garden irrigation by tenants) |
| Energy usage | Comprehensively analysed in detail in 3.2 above. Usage is quite low compared to social housing patterns generally. Not able to link usage to appliance use or other behavior within specific units |
| Waste | The following came out of the tenant engagement:<br>• 1x plastic shopping carrier bag a week = 90%<br>• 2 x plastic shopping carrier bag a week = 10%<br>The above indicates minimal waste generation by occupants in units. Other waste removal from site includes occasional plant material from shrub pruning and other garden trimming, but is also minimal in scope |
| Indoor air quality and health, thermal comfort, ventilation and lighting | Lack of ventilation and resultant mould growth is the main issue. Some rooms have inadequate natural light due to orientation and placement of windows – see 3.3 and 3.5 above. There are no measurements available (for instance indoor humidity, air flow, etc.). |
| State of the external environment | Described in detail in 2.2 above. |
| Current occupant satisfaction | No resident satisfaction survey available. The tenant engagement process showed up some concerns that residents have, and recommendations to address these (see 3.3, 3.4 and 3.5 above) |
| Facilities management process – to determine the capacity for uptake of technologies by the Communicare maintenance team | This is not an issue – Communicare has a fully-fledged and capacitated maintenance system |

### 4.1.2 BENCHMARKS

The BOOM flats are unlike any other social housing buildings – newly built or existing, and there are therefore, no reliable or meaningful benchmark statistics that could be meaningfully applied in this case

### 4.1.3 MATRIX OF ANTICIPATED BENEFITS - QUANTIFIED

It is not possible for instance, with information currently available about the buildings, to estimate potential heat losses and/or gains and where and how they might occur. The justification for interventions such as insulation, solar performance glass, solar water heating, and energy efficient panel heating relies therefore, on the analysis of issues of comfort/discomfort raised by tenants during the tenant engagement process.

Several Computer modelling software are available to try and quantify the benefits.

## 4.2 BUILDING OWNER'S VIEW

As these demonstration projects would be implemented in real life situations rather than laboratory settings, the building owners requested that the following factors be considered:

- Practical feasibility in context of the setting and building and site configuration;
- Replicability;
- Capital cost and viable payback period;
- Finance mechanisms (leasing vs purchase, rebates and incentives) - ESCOs;
- Intrusiveness (disruption to tenants in retrofitting);
- Equity and tenant acceptance – avoiding material changes and obvious differences in expected benefits/ease of living for tenants in different units;
- Reliability and durability;
- Maintenance and management, including after sales service/availability of spares and warranties (reliable/trustworthy suppliers).

After consultation with the clients, the following intervention types were deemed to be impractical in the context of the urban setting, the area and site characteristics, costs and local supply economics (unviable pay-back periods, etc.), surplus power storage issues, and small scale of both projects and therefore, not considered from the outset:

- **On-site alternative source power generation of any kind, for instance:**
  - PV or concentrated solar, including thin film PV glass and tiles (Integrates PV clean power generation into design of building. Suitable for large glass facades, skylights, etc.)
  - Small wind turbines
  - Solar/wind hybrids
  - Co-generation or combined heat and power
  - Biogas digesters using food and/or human waste for steam turbines
  - Biomass burning (e.g. compressed wood pellets) for steam turbines
  - Small-scale hydro

After elimination of the above options, and further consultation the following broad categories of interventions were then considered (The arrangement of topics under headings may differ in some instances from conventional classification in this field):

*Use of building materials with low embodied energy and environmental impact, including use of recycled materials. Use of recycled materials is more of a wishful thinking than a reality in SA, particularly with the materials' and performance guarantees requirements by any building and professional contract.*

*A Construction Energy Efficiency Plan should be put in place from the project onset. This should include:*
*– sourcing of local materials*
*– recycling the excess or damaged construction materials (broken bricks or tiles)*
*– careful use of water and electricity for the works.*

- **Energy efficiency:**

*Passive climate design:*

- North Orientation when possible, compact building form, thermal mass and transmittance;
- Use of thermal plaster and different paint colours to enhance heat gain or loss darker colours on the southern side, lighter on the north and western sides;
- Shading – natural (trees and planting), overhangs, screens, louvres;
- Fenestration (size, positioning of windows) – To begin with, a calculation of the existing fenestration area should be carried out to ascertain whether it falls within the min 10400 XA requirements;

- Double glazing and use of solar reflective/absorptive glass/film in windows – this should be necessary, only if fenestration area is larger than the min 10400 XA requirements and even then not all of the measures mentioned might be necessary! This is calculated in terms of Conductance aggregate and the solar heat gain coefficient which, in turn, depends on the window orientation.

Thermal insulation (roofs, walls, slabs and floors) - roof insulation is very important, the rest is quite expensive but thermally efficient if it can be afforded. Draught exclusion (sealing windows and draught excluders under doors) - this, however, could have a counter effect on mould creation, VOC and general air quality. Air-tightness regulations call for a pressurization test result of n50 <= 1h-1 which is not entirely airtight.

*More efficient and alternative domestic water heating methods:*

- Reduced energy consumption for domestic water heating (also see section on water conservation below) – geyser timers and blankets, pipe lagging, these are NBR requirements now anyway, cold water supply only to washing machines is not clear, etc;
- Solar hot water – individual or central systems, or;
- Heat pumps – individual or central systems- individual system is very expensive, noisy and aesthetically unattractive, they look like hanging AC's and unless they are installed next to the geyser, it is difficult to connect the pipes to the storage unit;
- Magnetic induction geysers;
- Instant water heaters – electrical and gas;

*Energy saving devices/installations:*

- Lighting and lighting controls – use of LED light bulbs internally and motion activated light fittings for common areas;
- Alternative fuels (Gas, etc.) for cooking, etc. Although more planet friendly, not much more cost efficient;
- Energy efficient area/space heating;
- Energy monitoring and control systems which are usually for large office blocks, intelligent buildings, etc;

**Water conservation (including hot water savings):**

*Water saving devices:*

- Low flow shower heads and aerator/timer taps
- Dual flush/multi-flush toilet cisterns
- Replacing baths with showers
- Groundwater well-points and boreholes
- Rainwater harvesting
- Grey water recycling
- Waterwise landscaping and gardening, including stormwater attenuation

**Healthy living environments, and tenant support measures**

- Non-toxic building materials
- Other, including energy efficient appliances
- Facilities on site for waste recycling and composting
- Food gardens

## 4.3 CONCLUSION

Informed by observations of metered consumption and tenant behaviour and experiences above, the above was then condensed to the following final proposal. NOTE: The interventions proposed below will result in all buildings being SANS10400-XA compliant. Both water and electricity usage are quite low overall, but occupant comfort seems to be an important consideration, especially cold unit interiors in winter. Taking all the observations in 3 above together, the following interventions are indicated:

### 4.3.1 REDUCING ENERGY CONSUMPTION AND IMPROVING OCCUPANT THERMAL COMFORT:

- Install appropriately sized solar panels for hot water generation with geysers;
- Fit showers above baths to create opportunity for reduced hot water usage, without taking away the utility of having baths for laundry, bathing of children, etc. In some units, baths should be replaced altogether with showers suitable for use by the aged (pensioners);
- Install energy efficient lighting;
- Install economic Econoheat convection panel heaters on living room walls;
- Replace window glass with “Low E” glass generally, and double glazing in blocks where main windows face more west than others (heat gain), or more south (heat loss);
- Install insulation in roof spaces;
- Provide ambient energy monitors;
- Insulate hot water piping;
- Draught exclusion (sealing windows and draught excluders under doors);

### 4.3.2 REDUCING WATER CONSUMPTION AND GREENING THE EXTERNAL ENVIRONMENT:

- Replace all shower heads with low flow heads (installation of showers covered in 4.1.1 above);
- Replace all taps with aerator taps;
- Replace old high level high volume WC cisterns with smaller low level dual flush cisterns;
- Provide appropriately sized rainwater harvesting tanks and irrigation system for gardens and food gardens;
- Introduce water-wise gardening;
- Install individual water meters;

## 4.4 FOR MEASUREMENT, THE FOLLOWING VARIATIONS ARE PROPOSED IN THE ABOVE:

- Replace window frames with double glazing, Blocks 1 and 3;
- Replace window glass with low E glass, Blocks 2, 4, 5;
- Fit loose fill insulation in ceiling, Blocks 1, 2;
- Fit mineral wool blanket insulation, Blocks 3, 4;
- Replace ceilings with rigid board insulation Block 5;
- Replace baths with showers in two of the blocks;

The below provides the following configurations for measurement:

| BLOCK | Double glazing | Low E glass | Loose fill insulation | Blanket wool insulation | Rigid board insulation | Hot water pipe lagging | Shower i.l.o. bath |
|---|---|---|---|---|---|---|---|
| 1 | | | | | | | |
| 2 | | | | | | | |
| 3 | | | | | | | |
| 4 | | | | | | | |
| 5 | | | | | | | |

## 4.5 ESTIMATED CAPITAL COST SUMMARY – BOOM RETROFIT:

| No. | Description | Cost/Unit | No. of Units | Cost/ Block | No. of Blocks | Estimated Total Cost | Average Cost/ Unit |
|---|---|---|---|---|---|---|---|
| **4.5.1** | ***Reducing energy consumption and improving occupant thermal comfort*** | | | | | | |
| 4.5.1.1 | Solar water heaters | R18 500 | 4 | R74 000 | 5 | R370 000 | R18 500 |
| 4.5.1.2 | Showers i.l.o. baths, with low flow heads | R8 000 | 4 | R32 000 | 3 | R96 000 | R4 800 |
| 4.5.1.3 | LED lighting | R2 400 | 4 | R9 600 | 5 | R48 000 | R2 400 |
| 4.5.1.4 | Econoheat heater panels | R750 | 4 | R3 000 | 5 | R15 000 | R750 |
| 4.5.1.5 | Low E glass – only if necessary | R6 040 | 4 | R24 160 | 3 | R72 480 | R3 624 |
| 4.5.1.6 | Double glazing – only if necessary | R9 160 | 4 | R36 640 | 2 | R73 280 | R3 664 |
| 4.5.1.7 | Loose fill insulation | | | R7 600 | 2 | R15 200 | R760 |
| 4.5.1.8 | Blanket wool insulation | | | R8 500 | 1 | R8 500 | R425 |
| 4.5.1.9 | Rigid board insulation | | | R14 800 | 2 | R29 600 | R1 480 |
| 4.5.1.10 | Ambient energy monitors which ones? | | | | | R20 000 | R1 000 |
| 4.5.1.11 | Insulate hot water piping | | | | | R36 000 | R1 800 |
| 4.5.1.12 | Draught exclusion | R650 | 4 | R2 600 | 5 | R13 000 | R650 |
| **4.5.2** | ***Reducing water consumption*** | | | | | | |
| 4.5.2.1 | Low flow shower heads | incl above | | | | R0 | R0 |
| 4.5.2.2 | Aerator taps and mixers | R3 200 | 4 | R12 800 | 5 | R64 000 | R3 200 |
| 4.5.2.3 | Dual flush cisterns | R1 200 | 4 | R4 800 | 5 | R24 000 | R1 200 |
| 4.5.2.4 | Rainwater tanks | R20 000 | 2 | R40 000 | 5 | R200 000 | R10 000 |
| 4.5.2.5 | Install individual water meters | R2 600 | 4 | R10 400 | 5 | R52 000 | R2 600 |
| **4.5.3** | ***Tenant support*** | | | | | | |
| 4.5.3.1 | Food garden facility | | | R25 000 | 1 | R25 000 | R1 250 |
| 4.5.3.2 | Recycling facility | | | R20 000 | 1 | R20 000 | R1 000 |
| **SUB-TOTAL** | | | | | | **R1 182 060** | **R59 103** |
| Project management and professional fees 5% | | | | | | R59 103 | R2 955 |
| Contingency: 10% | | | | | | R118 206 | R5 910 |
| **TOTAL** | | | | | | **R1 359 369** | **R67 968** |

# 5. EVALUATION AND SELECTION OF SOME OF THE MAIN OPTIONS SELECTED

## 5.1 GREEN BUILDING

### 5.1.1 MATERIALS WITH LOW EMBODIED ENERGY AND ENVIRONMENTAL IMPACT

Evaluating building materials and products for their environmental impacts has to do with two aspects:

- Impact on outdoor environment (sustainable use of resources and minimising effects of waste, pollution and greenhouse gas emissions)
- Impact on indoor environments (health and thermal comfort)

***Environmental labeling***
Environmental labeling is a means of communication from producer to consumer to inform the latter of the environmental consequences of his or her consumption choices. Many environmental labeling methods and systems have evolved all over the world since the 1980s, the standard is ISO14020 – Environmental Labels and Declarations, and specifically for the building sector ISO21930 – Sustainability in Building Construction and Environmental Declaration of Building Products. All this means little to the ordinary consumer who must be constantly on the lookout for so-called "greenwashing" – vague and spurious claims of the greenness of a product by marketers.

A number of "whole building" labeling systems already exist in SA, most notably the GBCSA's Green Star Rating Tool, and SANS 204/SANS 10400-XA, but while useful in looking at overall impacts, these have no way of verifying the environmental impacts of individual products and materials. In addition there is Ecostandard SA, a non-profit third party certification body that relies on voluntary participation from industry, and the SA National Ecolabelling Scheme (SANES), set up by Department of Environmental Affairs to promote self-regulation.

In South Africa, leading building product groups already market many self-declared green brands, mainly in flooring, wall coatings, particle and fibre boards, and insulation materials. A quick survey of the Environmental Product declarations (EPDs) associated with these brands reveal that they all deal with impacts on the external environment, and are silent on their known negative effects on the indoor environment. Proper labeling must be done in conjunction with appropriate Indoor Air Quality (IAQ) assessment standards.

Proper environmental labeling is closely related to Life Cycle Assessments of the environmental impacts of products. To be truly effective, the national standard for labelling should be ISO Type 1 Ecolabels, based on:

- Multiple Life Cycle criteria
- Public participation
- Third party certification

The Sustainable Building Alliance (SBA), an international coalition of standard setting and construction industry organisations, has developed a set of quantitative indicators and criteria for assessing outdoor environmental effects, while recognizing the indoor effects as well.

At this stage, the long and the short of it is that the current state of environmental labelling of building products in SA is, to say the least, unsatisfactory and confusing.

## 5.2 ENERGY EFFICIENCY

### 5.2.1 PASSIVE SOLAR DESIGN

Passive solar design uses building orientation, solar energy, natural convection and the inherent properties of materials to heat and cool a building naturally. Passive solar design operates on the principle that as sunlight enters a building, it can be reflected, absorbed or transmitted, depending on the properties of the building materials used. A passive solar design building can achieve greater energy efficiency and cut heating and cooling operational costs. By using natural light and ventilation instead of air conditioning, the running costs of the building can be reduced, while also creating a more comfortable and healthy indoor environment. Passive solar building design is the practice of making windows, walls, and floors collect, store, and release/distribute solar energy in the form of heat in the winter and reduce solar heat gain in the summer without involving the use of mechanical and electrical devices. This includes size and placing of windows, type of glazing, thermal insulation, thermal mass (and lag), and shading.

**Thermal mass - Heat sinks:**
All building materials transmit energy in different ways. Some are good conductors of heat (corrugated iron), some prevent heat from passing through and are therefore good insulators (cardboard, wood and glass fibre) and some have a high thermal mass and can store heat well (clay brick, concrete, stone and water). A basic principle of passive solar design is to make use of these materials to absorb and store heat during the day, thereby keeping the building interior cooler. At night, when the outside temperatures drop, this heat is released, warming up the interior of the building, helping to offset the dramatic daytime temperature changes that are often experienced in Cape Town, and on the highveld.

Walls and floors constructed from concrete for precisely these purposes are termed ‘thermal mass walls and floors’. Certain rules apply to making use of thermal mass, for example thermal mass materials, ideally should be evenly spread throughout work and living spaces, and not concentrated in isolated areas.

**Minimise summer heat gains**:
The idea is to create buildings that are comfortably cool in summertime, while maintaining an environment that is warm in winter, without requiring expensive and environmentally unsustainable air conditioning. All new buildings should be elongated along an east-west axis, with large windows on the northern side of the building. However, to prevent overheating in summer months, windows should be shaded. Window awnings or other types of fitted shades are probably too expensive and a more economical way may be the planting of tall growing deciduous trees to shade windows in summer. A building should also be orientated to work with the wind. It should prevent strong winds from entering, but allow gentle breezes to ventilate the building naturally. It should also be positioned so as not to create wind tunnels.

**Efficient building design:**
The floor plan of any building should be designed to avoid wasted space, which also wastes materials. However, one must be careful not to compromise the ‘liveability’ of the building by creating unpleasant spaces. Generous common areas make for more habitable buildings. The rooms that are used most, such as living rooms and kitchens, should face north so that they are naturally light and warm. Rooms such as bathrooms and storerooms should be placed so that they screen unwanted western sun, or positioned so as to prevent heat loss from south-facing walls. A compact plan exposes less wall area to the outside, reducing heat loss from the building.

**The applicability of passive design principles to our demo projects:**

- ***BOOM FLATS*** - Due to its conventional design and construction, with no real incorporation of thermal mass/lag principles, inconsistent and less than ideal orientation, and small roof overhangs, the cost and disruption of introducing passive design features through retrofitting would be unacceptable. It would probably require substantial breaking out and moving around of windows, extension of roof overhangs, bolting on of canopies/shading devices, etc.

| | Item | Function | Suitable for retrofit | Estimated costs | Selected for BOOM | Reason/s |
|---|---|---|---|---|---|---|
| 5.2.1.1 | Orientation, compactness of building form, unit layout, etc | Optimise regulation of heat flows/ retention thermal performance through judicious use of principles of thermal mass and lag | Only at great cost and disruption | N/a | N/a | Existing buildings in fixed position, impractical to change |
| 5.2.1.2 | Natural shading through trees and planting | Minimise summer heat gains | Yes | N/a | N/a | The problem is more one of cold interiors in winter rather than hot ones in summer |
| 5.2.1.3 | Shading through shading devices such as overhangs, screens, louvres | Minimise summer heat gains | Yes | N/a | No | See above |
| 5.2.1.4 | Fenestration (size, positioning of windows) | Minimise summer heat gains, maximise winter heat gains and minimise losses | Yes | N/a | No | Too expensive and disruptive to break out and change size/position of existing windows |

## 5.2.2 TYPE OF WINDOWS AND GLAZING

| | Item | Function | Suitable for retrofit | Estimated costs | Selected for BOOM | Reason/s |
|---|---|---|---|---|---|---|
| 5.2.2.1 | Double glazing | Minimise solar heat gains/losses | Yes, but costly and intrusive | R9160/unit | Yes for 2 blocks | To mitigate effects of poor orientation on heat gain and loss respectively |
| 5.2.2.2 | Use of solar Low E glass in windows: | Minimise solar heat gains/losses | Yes | R6040/unit | Yes for 3 blocks | To mitigate effects of poor orientation on heat gain and loss respectively |
| 5.2.2.3 | Reflective/absorptive film | Minimise solar heat gains/losses | Yes | N/a | No | Maintenance issues |
| 5.2.2.4 | Electrochromic windows (smart glass) | Based on electrochemical cell and layer. Reversibly change colour to voltage change, managing glare and heat | Yes, but costly and intrusive | N/a | No | Expensive to install and replace. Needs current and control |
| 5.2.2.5 | Thermochromic windows | Contains vanadium Oxide layer which allows sunlight to penetrate when temp below 25° C, above that reflects infrared but does not impede visible light | Yes, but costly and intrusive | N/a | No | Expensive to install and replace. Suitable for buildings with large glass facades in hot climates |

## 5.2.3 THERMAL INSULATION

In uninsulated buildings of conventional construction, depending on a number of variables, up to 40% of heat loss is through the roof, and up to 35% through walls and floors. Resistance to heat flow (gain or loss) is achieved with either bulk or reflective insulation or both in combination.

**Roof/ceiling insulation:**

*Types of roof/ceiling insulation:*

- Batt blanket/mat – comes in rolls (blanket) and cut to lengths (batts) to fit on top of ceiling between beams. Insulation bulk provided by materials such as mineral (slag) or glass wool, rock or cellulose fibre, polystyrene, polyurethane and polyisocyanurate;
- Loose fill – cellulose fibre (shredded and milled recycled paper treated for fire and fungus resistance) supplied loose and poured, blown or pumped into roof space;
- Rigid board – pre-cut boards can be used as ceilings or in walls and slabs, insulation material includes vermiculite, expanded polystyrene, polyurethane, polyisocyanurate and phenolic foam;
- Radiant barrier (reflective foil) type – usually laid under roof covering, reflects large amounts of and does not transmit heat. More effective in reducing summer heat gain and cooling loads than retaining heat and reducing winter heat loss;
- Reflective roof paint (Snocote) – suitable for metal sheet roofing;

Any of the above could theoretically be used in the FLEURHOF newbuild.

*For BOOM FLATS retrofit the following considerations apply:*

- Blanket type could be fitted by removing and refitting/replacing alternative ceiling panels although limited crawl space in corners would make it difficult and it would cause some disruption for occupants;
- Loose fill could be relatively easily injected into roof space by making openings in ceilings and making good again;
- Existing ceilings could be replaced with certain types of rigid board;
- Radiant barrier type not practical as it would require lifting and re-fixing or even replacing of roof sheets;

**Wall insulation:**
- Sandwich panels, or cavity walls with insulated cores/cavities;
- Insulating plasters on walls (expanded fibre and polymers mixed into plaster);
- Reflective external paints;

**Floor and slab insulation:**
- Rigid board;

| | Item | Function | Suitable for retrofit | Estimated costs | Selected for BOOM | Reason/s |
|---|---|---|---|---|---|---|
| 5.2.3.1 | Polyisocyanurate insulation – Rigifoam Lambdaboard faced rigid insulation board | Claimed to have lowest thermal conductivity of all insulation materials, allowing use of thinner boards than with other types of rigid board. No CFCs/HCFCs or ODS. Thermal performance not affected by air movement, moisture or dust. No melting, dripping or flame spread in fire, chars only. Low toxicity – can be used in confined spaces .Can be used as ceiling boards | Y – in replacing existing ceiling boards | R3700/unit | Yes | To provide variation for measurement |
| 5.2.3.2 | Polyisocyanurate insulation - Rigifoam Ecospray | Closed cell thermoset foam sprayed onto soffits of roof sheeting or ceiling boards, resulting in zero thermal bridges. Thermal performance not affected by air movement, moisture or dust. No melting, dripping or flame spread in fire, chars only. Low toxicity – can be used in confined spaces | No | N/a | | Suitable for retrofits, e.g. sprayed to soffits of roof sheets where there is no ceiling. Not selected due to cost and impracticality/ unacceptable aesthetics of spraying to ceiling soffits |
| 5.2.3.3 | Expanded Polystyrene (EPS) rigid insulation boards | Thermal and sound insulation in walls, roofs, floors. No CFCs or ODS. Moisture resistant, and contains fire retardant. | No | N/a | | Suitable for new builds. Retrofitting would require lifting of existing roofs – not practical and too costly |
| 5.2.3.4 | Super Sisalation Aluminium foil insulation membrane | Radiant barrier-type insulation fitted under roof covering | No | N/a | | Suitable for new builds. Retrofitting would require lifting of existing roofs – not practical and too costly |
| 5.2.3.5 | African Thermal Insulations Alububble | Fitted under roof covering | No | N/a | | Suitable for new builds. Retrofitting would require lifting of existing roofs – not practical and too costly |
| 5.2.3.6 | Mineral wool blanket insulation | Fitted loose on top of ceiling Check XA requirements for thickness according to Zone 4 with R value of 3.7 | Yes | R2125/unit | Yes | Tried and trusted method. Lasts forever. Relatively cheap and easy to install as retrofit. Good R-values |
| 5.2.3.7 | Loose fill recycled paper (cellulose) | Blown/pumped into roof space. Same as above | Yes | R1900/unit | Yes | Relatively cheap and easy to install as retrofit. Good R-values. Green building material (recycling product) Fire and mould resistant |

## 5.2.4 MORE EFFICIENT DOMESTIC WATER HEATING METHODS - REDUCED ENERGY CONSUMPTION FOR DOMESTIC WATER HEATING

Reducing energy usage in domestic water heating can be achieved in a number of ways, some of which require little or no capital spending, including, for instance, the following measures where existing element-type geysers are not replaced:

- Turning down thermostat temperature settings (retrofit or new build);
- Installing geyser timers (retrofit or new build);
- Insulating geysers with geyser blankets (retrofit or new build);
- Hot water pipe lagging (insulation) (retrofit or new build);
- Reducing hot water demand/flow rates with low flow shower roses, aerator taps and mixers, cold water supply only to washing machine and dishwasher points, and even replacing baths with showers (retrofit or new build);
- Timed hot water taps (retrofit or new build);
- Solar or other means of pre-heating, for instance heat recovery for pre-heating by fitting hot water spiral supply line submerged in drain water (retrofit or new build);

| | Item | Function | Suitable for retrofit | Estimated costs | Selected for BOOM | Reason/s |
|---|---|---|---|---|---|---|
| 5.2.4.1 | Geyser timers | Switches geysers on for short periods (2-3 hours) at certain times of day. Reduces electricity used in keeping water hot all day. Will be integral part of retrofit and new solar geyser/heat pump installations | Yes | N/a | Yes (part of solar geysers) | See section on solar geysers below |
| 5.2.4.2 | Geyser blankets | Reduces standing heat losses. Not applicable here as all conventional geysers to be replaced with solar/ heat pump or other alternative | Yes | N/a | N/a | See section on solar geysers below |
| 5.2.4.3 | Hot water pipe lagging | Reduces standing heat losses. Will be integral part of retrofit and new solar geyser/heat pump installations | Yes, partly-depends on access | N/a | Yes (part of solar geysers) | See section on solar geysers below |
| 5.2.4.4 | Cold water supply only to washing machines, dishwashers, etc | Reduces need for water heating by geyser | Could be costly and intrusive | N/a | N/a | Already in place |
| 5.2.4.5 | Install geysers vertically rather than horizontally | Reduces standing heat losses – vertical geysers provides less area to volume ratio for heat to escape. Not applicable here as all conventional geysers to be replaced with solar/ heat pump or other alternative | Costly and intrusive | N/a | N/a | N/a - See section on solar geysers below |
| 5.2.4.6 | Timed hot water taps | Controls flow of hot water | Yes | N/a | No | Inconvenient to tenant |
| 5.2.4.7 | Pre-heating with solar or grey water | Hot water pipes coiled inside greywater wastepipe | Yes, but costly | N/a | No | Costly and impractical |

### 5.2.5 ALTERNATIVE DOMESTIC WATER HEATING METHODS

Alternative means of providing hot water – replacing existing element-type electrical geysers, or combining the alternative technology with the existing geysers (retrofit or new build):

- Solar geysers – individual
- Solar geysers – central/communal
- Heat pump - individual
- Heat Pump - Central with ring main
- Solar/heat pump combo
- Induction geysers
- Instant water heaters – gas/electrical
- "Outback shower"

#### 5.2.5.1 SOLAR WATER HEATING

There are many options that need to be evaluated and considered, each with its own pros and cons, for instance:

**Flat plate or evacuated tube collectors:**

- Flat plate is usually cheaper, but less efficient, and more difficult to service (sealed unit construction). However, the flat panels tend to last and stay effective for much longer compared to the tube systems, which can lose their vacuum over time and get damaged more easily.
- Evacuated tubes are more expensive, but more efficient in climates with more rain and cloud, and easier to service. Can be damaged by hail.

**Direct (open loop) or indirect (closed loop) heat transfer systems:**

- In direct systems, the water circulates through the collector and is heated directly. There is a danger of freezing and bursting of pipes in colder areas, and also scaling (mineral deposits).
- In indirect systems, an antifreeze liquid (glycol, etc) is circulated and heated in the collector, and transfers heat to the water separately in a more protected space. This is more costly and reduces efficiency by about 10%.

**Thermosiphon or pumped systems:**

- Thermosiphon systems relies on natural convection (rising of hot water) for circulation of water, meaning that the storage tank has to be higher than the collectors.
- In pumped systems, the storage tanks are mounted indoors away from collectors, and circulation relies on electric pumping.

**Sizing of geyser to provide sufficient hot water under normal conditions of use**

The energy efficiency factor of a solar system is a measure of energy output relative to any auxiliary energy input (such as electricity or gas). In South Africa, solar geyser systems are graded by the SABS with a Q factor (in mega joules (MJ)), which relates the amount of energy the system can produce. Initially, ESKOM also based their rebate amounts on this principle. By calculating the hot water energy requirements of a unit, it is possible to size the solar geyser as a cost benefit (solar geyser expenditure costs + auxiliary energy input cost), where the auxiliary energy input cost is calculated as the cost per unit power needed relative to efficiency of the solar geyser. The following example illustrates the amount of energy needed to heat 100 litres of hot water to 70°C from unheated water temperature (20°C);

E_kWh=((litres * delta temp * SHC)kj)/36000Mj = (100*50*4.2)/36000 = 5.83kWh; where, delta temp is taken as the difference between unheated water temperature (20°C) and desired temperature of 70°C, and SHC is the specific heat capacity of water = 4.2J/g/°C. If we assume an average of 8.5 kWh/day/person/unit in Boom Flats based on preliminary readings from the SEM database, and that 60% of that is for water heating, then solar geysers should not be less than 150 litres for a 2-person family and not less than 200 litres for 3-4 people.

Records from Madulammoho Housing Association and various other sources put average hot water demand at around 50 – 60 litres per person per day, or 100 – 120 litres for a household of 2, 150 – 180 litres for 3, and 200 – 240 litres for 4.

Based on the above, we would recommend solar geyser size of not less than 200 litres to be installed.

Using Q-factor calculations based on the above, Bruce Whittaker of Solar Water Performance rated the top 12 reasonable quality geysers available in SA on their efficiency as follows:

| Indirect Systems, Inclusive Of Plumbing And Connections | Estimated Installed Cost Quoted By Eskom Listed Installers (Cape Town) | Direct Systems, Inclusive Of Plumbing And Connections | Estimated Installed Cost Quoted By Eskom Listed Installers (Cape Town) |
|---|---|---|---|
| **Capacity and Make** | | **Capacity and Make** | |
| **150 Litres** | **Mean = R20 820** | **150 Litres** | **Mean = R19 780** |
| Solsquare TS | R21 592 – R28 000 (mean: R23 000) | Nupower DDFT 150 | R16 000 – R25 720 (mean: R19 740) |
| Afrilanga-Chromgen | R18 900 – R22 500 (mean: R21 600) | Pacific Solar 150 HP | R18 000 – R26 000 (mean: R20 800) |
| Kwiksol 150-I xl | R17 380 – R22 500 (mean: R20 200) | Genergy 150 TS | R15 500 – R23 000 (mean: R16 500) |
| **200 Litres:** | **Mean = R21 640** | **200 Litres:** | **Mean = R22 660** |
| Kwiksol 200-i x2 | R18 453 – R41 290 (mean: R24 180) | Solardome SBS200 | R19 400 – R23 120 (mean: R21 200) |
| Solardome SBS 200 | R19 400 – R23 120 (mean: R21 200) | Kwiksol 200-d x2 | R23 500 – R29 000 (mean: R25 100) |
| Alte GH200 | R21 338 – R23 000 (mean: R22 400) | Sunscan 200D | R19 000 – R24 000 (mean: R21 400) |

Cheaper systems such as TASOL go for R14 000 – R19 000 installed (a 100 litre model from Builders Warehouse even at around R6250, or R8000-R9000 installed), whereas the top quality Australian make Solahart (30 year guarantee) is priced from R34 000 for a 175 litre to R51 000 for a 300 litre system, all excluding the ESKOM rebate.

In 2008, Communicare installed Duratherm Solartherm 400 Kpa 150 litre evacuated tube direct pumped system, with controller solar geysers in their Bothasig project. This is a local make with SABS mark, approved by ESKOM, and used widely. Despite this, the system is giving serious problems, including:

- Corrosion in pumps (not 100% brass),
- Controllers not functioning well,
- Pressure reliefe valves not functioning properly (some failures) with pressure build up on hot days when water is not drawn off, and release of large volumes of hot water,
- Back up element failure.

(The above illustrates that each component of a system needs to be specified separately to ensure acceptable quality, and then workmanship also needs to be closely monitored). At current prices, the above geyser costs around R9000 (R12500-R15000 installed), and the 200 litre Duratherm around R12000 (R15000 – R17500 installed).

The less than ideal orientation of BOOM FLATS probably means that evacuated tube collectors will provide better performance, but due to the problems experienced with this type of installation at Bothasig and elsewhere, we would recommend flat plate collectors.

In December 2013, Karin Kritzinger and colleagues of the Centre for Renewable and Sustainable Energy Studies developed a financial modelling tool for comparing 10 year life cycle costs between solar hot water, heat pumps and conventional geysers. The results, ranked according to lowest cost pump over the 10 years are tabled below, and shows 25 individual 200 litre solar geysers in both Johannesburg and Cape Town to have the lowest cost pump, but with capital costs in the middle of the range at just over R9000 per unit after the ESKOM rebate, and of the alternative water heating systems the 500 litre shared heat pumps having lowest capital cost, followed closely by 500 litre shared SHW geysers. Pricing based on local make Kwikot.

| Rank 10 yr cost/unitpm | Option | Cap cost | Cap cost/ unit | Capcost/u rank | R 10 yrs | R/unit 10 yrs | R/Pupm |
|---|---|---|---|---|---|---|---|
| 1 | 200 l swh Jhb x 25 | R462 295.31 | R9 245.91 | 10 | R954 028.78 | R19 080.58 | R159.00 |
| 2 | 200 l swh Cape Town x 25 | R462 295.31 | R9 245.91 | 10 | R988 796.53 | R19 775.93 | R164.80 |
| 3 | 100 l swh Jhb x 50 | R372 500.00 | R7 450.00 | 8 | R1 047 707.73 | R20 954.15 | R174.62 |
| 4 | 500 l swh Jhb x 10 | R352 500.00 | R7 050.00 | 7 | R1 116 620.52 | R22 332.41 | R186.10 |
| 5 | 100 l swh Cape Town x 50 | R372 500.00 | R7 450.00 | 8 | R1 153 097.47 | R23 061.95 | R192.18 |
| 6 | 500 l swh Cape Town x 10 | R352 500.00 | R7 050.00 | 7 | R1 203 974.49 | R24 079.49 | R200.66 |
| 7 | 150 l swh Jhb x 50 | R887 095.83 | R17 741.92 | 13 | R1 265 987.83 | R25 319.76 | R211.00 |
| 8 | 3 000 l swh Jhb x 2 | R610 320.00 | R12 206.40 | 12 | R1 367 450.48 | R27 349.01 | R227.91 |
| 9 | 500 l heat pump x 10 | R345 520.00 | R6 910.40 | 6 | R1 371 377.57 | R27 427.55 | R228.56 |
| 10 | 500 l heat pump x 10 | R345 520.00 | R6 910.40 | 6 | R1 752 664.18 | R35 053.28 | R292.11 |
| 11 | 3 000 l swh Cape Town x 2 | R610 320.00 | R12 206.40 | 12 | R1 902 546.57 | R38 050.93 | R317.09 |
| 12 | 200 l heat pump x 25 | R524 824.56 | R10 496.49 | 11 | R2 074 476.62 | R41 489.53 | R345.75 |
| 13 | 3 000 l heat pump x 2 | R447 798.00 | R8 955.96 | 9 | R2 325 504.78 | R46 510.10 | R387.58 |
| 14 | 500 l conventional x 10 | R191 052.63 | R3 821.05 | 3 | R2 477 068.47 | R49 541.37 | R412.84 |
| 15 | 200 l conventional x 25 | R173 684.21 | R3 473.68 | 2 | R2 658 039.31 | R53 160.79 | R443.01 |
| 16 | 150 l heat pump x 50 | R925 010.96 | R18 500.22 | 14 | R2 807 972.34 | R56 159.45 | R468.00 |
| 17 | 100 l conventional x 50 | R260 964.91 | R5 219.30 | 4 | R2 943 645.29 | R58 872.91 | R490.61 |
| 18 | 150 l conventional x 50 | R271 491.23 | R5 429.82 | 5 | R2 970 326.20 | R59 406.52 | R495.05 |
| 19 | 3 000 l conventional x 2 | R165 998.00 | R3 319.96 | 1 | R4 527 829.86 | R90 556.60 | R754.64 |

From all the above, it is our considered opinion that an allowance of no less than R22 500 per unit should be made for retrofitting individual 200 litre SHW geysers, inclusive of installation, plumbing and connections at BOOM FLATS

| | | | | | | |
|---|---|---|---|---|---|---|
| 5.2.5.1 a | Solar hot water – individual 150 litre geyser (detailed specification to be advised) | Solar water heating for domestic use | Yes | R18 500/ unit | Yes | Client prefers not to have heatpumps due to risk of rusting at the coast and because heat pump installations for small blocks are not economical either in capital or operating cost and maintenance terms |
| | | | | | | |
| 5.2.5.2a | Heat pumps – individual and central systems | Not considered | Yes | N/a | No | Client not keen on heatpumps due to possible corrosion/maintenance issues at coast |
| | **Other Types Of Water Heaters** | | | | | |
| 5.2.5.3a | Split magnetic electric Induction geysers (WACO, HARVER, HI-TEMP, etc) | Electrical energy from AC supply converted to high frequency magnetic field which induces high frequency electric currents in internal receiver and heating coils – claimed to heat water in 30% less time than conventional element geyser. Available in 2kW (30 litre), 3.5-4kW (50 – 75 litre) models. Easy to install, no scale build-up, claimed 15 year life expectancy and no maintenance. Costs around R4000 to R5000 for unit, installed cost around R6000 to R7500, not much different from conventional 150 litre geyser for a much smaller capacity. | Yes | R6000 – R7500 installed | No | Maximum 75 litre capacity too small for a household. Experts consulted indicated that savings are quite a bit smaller than claimed |
| 5.2.5.3b | Instant water heaters – electrical | Compact electricity and water saving devices that don't store hot water, but rather instantaneously heat water flowing through it on demand, and therefore, heating only the amount of water that is drawn for immediate use, usually with a 8kW element. These devices are easy to install and wire up to the electrical system with minimal disruption to occupants, and take up very little space (e.g. under basin or sink). These are more suitable for showers, basins and sinks rather than baths. One unit could serve up to three hot water points in close proximity to each other but not simultaneously. In one particular type (Alpha unit) water is heated to 50° C (safety shut-off at 53° C), and some studies indicate savings in electricity usage for showering of up to 40% compared to a 150 litre conventional geyser. The unit comes with a shower head on a flexible hose that can be attached to slide on a rail for use over a bath. Units cost around R5 000 – R6 500. | Yes | R5000 – R6500 installed | No | Depending on distance between points where hot water is required, more than one device per unit may have to be installed, increasing cost substantially.<br><br>Another potential problem in a multi-unit building is that simultaneous use of a number of units will cause power demand to spike, requiring increased supply capacity (larger circuit breakers, thicker cabling, etc) |
| 5.2.5.3c | Instant water heaters – gas | As above, but needs gas supply installation | Yes | N/a | No | Gas installation and empty bottle replacement |

## 5.2.6 OTHER ENERGY SAVING DEVICES/INSTALLATIONS

### 5.2.6.1 LIGHTING AND LIGHTING CONTROLS

LED (light-emitting diode) or CFL (compact fluorescent light) bulbs. Normal (incandescent) bulbs are being phased out anyway, and will no longer be allowed, by law, to be manufactured or used.

LED cluster bulbs are the latest in cutting-edge lighting technology – with a life span of 15 to 30 years (up to 50 000 hours) and drawing as little as 1,08 W per bulb. That constitutes a 95% saving per bulb compared to the conventional incandescent version.

LEDs are still fairly costly, but prices are coming down all the time, and when one looks at their total life cycle, including the cost of the electricity they will use, they are dramatically cheaper than incandescent bulbs. They require virtually no maintenance. They are available for a variety of applications, including down-lighting, and now also as a fluorescent tube replacement.

| | Item | Function | Suitable for retrofit | Estimated costs | Selected for BOOM | Reason/s |
|---|---|---|---|---|---|---|
| 5.2.6.1 a | LEDs | Reduce energy consumption for lighting and longer bulb life | Yes | R2400/unit | Yes | Savings |

### 5.2.6.2 ALTERNATIVE FUELS FOR COOKING, ETC.

| | Item | Function | Suitable for retrofit | Estimated costs | Selected for BOOM | Reason/s |
|---|---|---|---|---|---|---|
| 5.2.6.2 a | | | Yes | N/a | No | Not considered – safety and convenience |

### 5.2.6.3 SPACE OR AREA HEATING

| | Item | Function | Suitable for retrofit | Estimated costs | Selected for BOOM | Reason/s |
|---|---|---|---|---|---|---|
| 5.2.6.3a | Hot water radiators, oil/gas heaters, air conditioners, floor heating | Convection heating of rooms | Costly and intrusive | N/a | No | Cost, disruption and maintenance |
| 5.2.6.3b | Open/closed wood/ gas fireplaces/heaters | Radiation heating of rooms | Costly and intrusive | N/a | No | Cost, disruption and maintenance |
| 5.2.6.3c | Econoheat wall mounted panels | Convection heating of rooms. Considered a cost effective option. The question is where should it be installed – bedroom/s, living room? Suggested one each in bedroom and living room, but the decision should be informed by the tenants' general preferences? | Yes | R600 – R750 per panel | Yes | Relatively easy to retrofit, inexpensive, low maintenance, safe (no burn/fire hazard) |

### 5.2.6.4 ENERGY MONITORING AND CONTROL SYSTEMS

In South Africa, electricity supply voltages fluctuate up and down around the nominal 220 voltage. All electrical equipment has been designed to operate within a certain voltage range to their power (or 'work') rating, meaning that the machine will do its job at varying rates of power consumption. This also reduces equipment life. There are devices on the market (for instance Power Optima), whose function is to simply re-move and manage the excess voltage levels where they are above a safe range and to optimise them very efficiently and reliably back to a safe range well within required Eskom service levels. This is critical, reducing voltages to the lower extreme of Eskom's service level range. The optimisation system continually monitors power and voltages within a series of custom pre-set intervals (known as 'taps') up to 100 times per second. It then adjusts the received power as required, avoiding the wasted and unnecessary energy that would otherwise have been received, but was not required or could not be controlled, typically yielding energy savings

This is not being considered at this stage as the cost:benefit ratio is not deemed worthwhile on small consumption as in BOOM.

## 5.3 WATER CONSERVATION (INCLUDING HOT WATER SAVINGS):

If consideration is given to the layout of the plumbing system during the design stage, significant water savings can be achieved. One of the primary causes of ongoing water wastage in domestic dwellings is the "dead leg" in the hot water system, a long pipe run from the geyser to a tap. This causes much cooled water to be drawn off before hot water is discharged, wasting not only water, but also energy. Pipe sizing and pressure at which water is distributed within a building can have an effect on water consumption for a number of reasons. Water which flows out at a higher pressure than necessary results in wastage because more water is discharged from the tap or shower in a given period of time.

**Watering of Gardens:**
Gardens can consume as much as 40–60% of all the water used in the home. This is treated, drinkable water, and one should therefore think carefully about using it in the garden. It is more efficient to water gardens in the cooler parts of the day, or to use a drip irrigation system, which loses less water through evaporation than a sprinkler, for instance. Drip irrigation is also more effective as it feeds the roots of the plants. Composting regularly and adding mulch to gardens also reduce surface moisture loss. Some indigenous endemics do not require watering at all, except during establishment.

**Water-wise lawns and plants:**
Large grassed areas and lawns require plenty of water. If having a lawn is a priority, avoid kikuyu grass, and replace it with indigenous drought-resistant buffalo grass (Stenotaphrum secundatum) or couch grass ('fynkweek'). These grasses require half the amount of water, and are low in maintenance. Xeriscaping gardening with indigenous plants which don't need water along with automatic drip irrigation systems with rain shut-off and soil moisture sensors check valves are options.

**Landscaping:**
The use of lawn fertilisers should be limited as far as possible, and only phosphorus-free lawn fertilisers should be used. Most lawns already have sufficient phosphorus, and when more is added, it runs through the watercourse, where the excessive nutrients cause algae growth in surrounding rivers, wetlands and lakes.
The more water-wise a garden from the start, the easier and cheaper it is to maintain.

"Waterwise" gardening or means of making a garden that uses less water includes:

1. Plant choice
2. Use of Mulching
3. Zoning (high water need plants together etc)
4. Irrigation/ watering control (leaks, not when it rains)
5. Soil preparation (water holding cap to keep water with plants)
6. Maintenance

### 5.3.1 WATER SAVING DEVICES

All the usual domestic devices such as low flow shower heads, aerator taps and mixers, dual flush toilet cisterns ("hold down/demand flush"), replacing baths with showers, have been selected as a matter of course. Costs are per the cost table 4.5 above.

### 5.3.1 GROUNDWATER WELL-POINTS/BOREHOLES

| | Item | Function | Suitable for retrofit | Estimated costs | Selected for BOOM | Reason/s |
|---|---|---|---|---|---|---|
| 5.3.2.1 | Well-points | Shallow ground water extraction shafts, tapping into aquifers usually less than 10m deep, and fitted with small pumps for garden irrigation. Cape Flats aquifer from surface to about 10m deep, recharged during winter rains. Table Mountain Group aquifer much deeper (80m+) with much slower recharge rates. | Yes | R4500 – R10000 each, depending on depth and pump size (excluding irrigation system). Geotech needed to determine water table first, and test of water quality? Allow 3xR10000 additional to rain tanks = R30000 plus R12000 for irrigation=R42000/20 = R2100/unit. | No | A number (3-5 points) would be needed to irrigate the spacious grounds, though 2 or 3 would be adequate if to be used only for food garden in restricted area. Water consumption across BOOM is low, and additional water for gardening will be provided via rain tanks, making well-points superfluous. They do present some functional and maintenance challenges anyway, and some reports surmise that the sandy cape flats aquifer is slowly being depleted with water tables sinking ever deeper below the surface. |
| 5.3.2.2 | Boreholes | Deeper lined shafts with more powerful pumps for larger scale supply. | Yes | R45000 – R120000 depending on depth, lining and pump size (excluding irrigation system). | No | Cost of installation, and maintenance issues (solar pump can reduce energy costs of pumping). |

### 5.3.3 RAINWATER HARVESTING

Rainwater harvesting is a relatively easy and environmentally friendly way to reduce potable water demand, especially for watering gardens or cleaning. Systems are easy to install and operate, and are cost-effective. Although it is illegal to connect a rainwater tank to your drinking supply, rainwater harvesting still makes sense:

- It provides a source of water in case of emergencies.
- It reduces storm drainage load and flooding in city streets.
- It teaches us about water conservation.
- It leads to food security by encouraging vegetable gardening.
- It can be used to flush the toilet, for bathing, washing up and cooking, garden watering and car washing.

There are limitations though. A single 25mm rain shower on a 400m2 roof theoretically fills one 10 000 litre tank, so if you really want to make good use of a full season of rain, you would need quite a few tanks – where could one place them all, and how valuable is the amount of piping needed to supply the tanks?

The most frequently used method is diverting water off the roof through gutters, and storing it in plastic tanks. Rainwater tanks can be relatively big, and, due to the weight of a full tank, need a large area and structurally strong enough base. To save space, a vertical rather than a horizontal tanks can be favoured. Placing the rainwater tank in the shade will help to keep the water as cool as possible.

Algae will grow in the water if exposed to sunlight. Also rainwater from roofs often contains dead leaves and other organic material, and may be contaminated by bird or rodent droppings. Gutters must therefore be kept clean and this is easier said than done in multi-storey buildings. Collector pipes must also be fitted with screens or filters to keep out debris and solid material. Water quality is improved to some extent by diverting the first flush. A first flush diverter is simply a chamber or container installed in the feed line to capture and dissipate the first quantity of water containing impurities, before it enters the storage tank. The obvious economics of rainwater harvesting is that it pays itself off better the more municipal water you replace.

### How is rainwater harvested and stored?

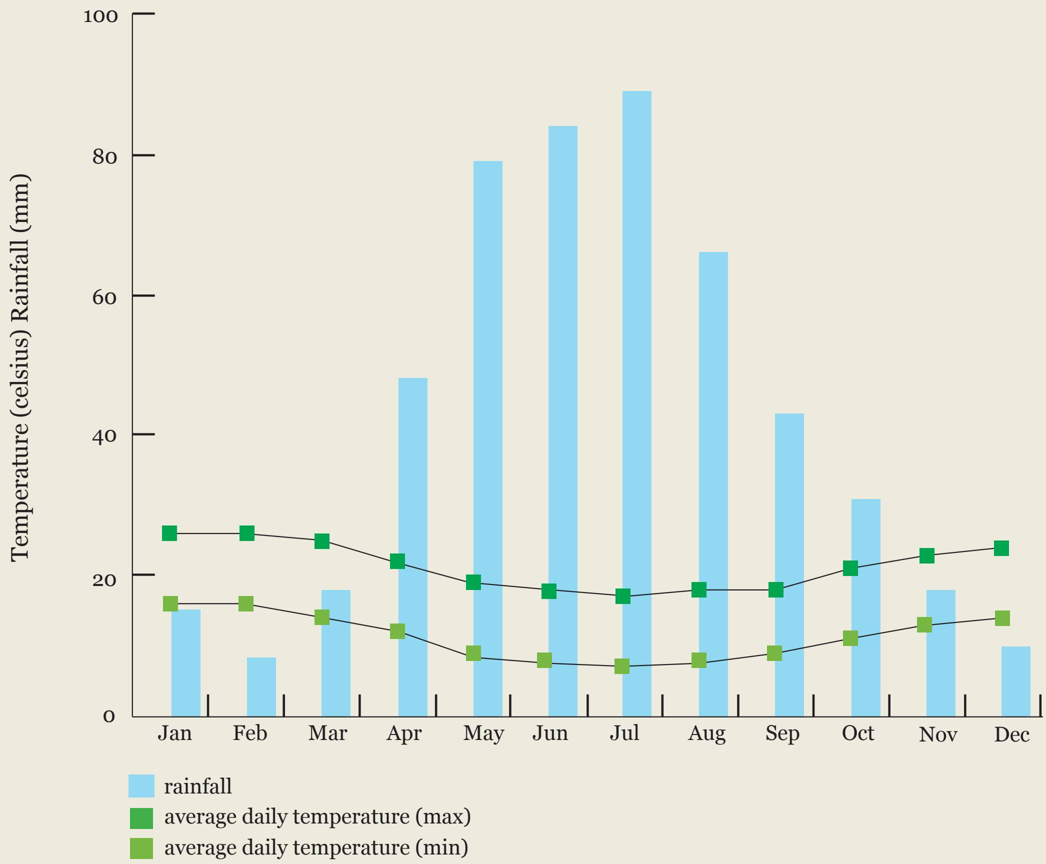
There are various ways, but the most frequently used method is diverting water off the roof through gutters, and storing it in plastic tanks. Rainwater tanks hold different amounts of water, from 200 l to 10 000 l. As these tanks are relatively big, a large area and solid base is required to install one. A 10 000 l tank appears to be the most economical, but is a significant intrusion on space and aesthetics.

### How much water can be harvested off the roof?

Determine the average annual rainfall for the area. To allow for drier-than-usual years, calculate for only two thirds of the average annual rainfall, and then assume another 10% is lost to evaporation, overflow and first-flush diversion. Now use this formula to calculate the total litres harvested: roof area (m2) x 0,66 x 0,9 x average annual rainfall (mm). Various sources give annual rainfall for Cape Town from 475 – 554mm. At 450mm one block of the BOOM roofs would yield 140m2 x 450mm x 0.66 x 0.9 = 37 472 litres p.a. If two x 10000 litre tanks were installed at each block it would allow for two complete fills per year.

| | Item | Function | Suitable for retrofit | Estimated costs | Selected for BOOM | Reason/s |
|---|---|---|---|---|---|---|
| 5.3.3.1 | Rain water harvesting system – 2 x 5000l tanks/block, including pedestals, leave catchers, first flush diverters | Collect and store rainwater from the roof for garden irrigation to replace treated municipal water | Yes | Tank, including leaf catcher, first flush diverter, labour and plumbing: R15000 | Yes | See below |

Although precipitation in cape Town occurs mainly in winter, rain does fall throughout the year, as the graph below illustrates:



One of the companies supplying rainwater harvesting equipment estimates the harvesting potential throughout the year as follows (of course these figures must be treated with circumspection given their interest in promoting the concept and their product, but the figures have indicative value nevertheless):

| Month | Average Cape Town Rainfall | Rainwater Harvest: Metal Roof | Rainwater Harvest: Tile Roof |
|---|---|---|---|
| | (mm) | (litre/100m2) | (litre/100m2) |
| Jan | 11.6 | 1,055 | 725 |
| Feb | 18 | 1,636 | 1,125 |
| Mar | 22.1 | 2,009 | 1,381 |
| Apr | 55.5 | 5,045 | 3,469 |
| May | 76,7 | 6,973 | 4,794 |
| Jun | 98,3 | 8,936 | 6,144 |
| July | 96,6 | 8,809 | 6,056 |
| Aug | 73,7 | 6,700 | 4,606 |
| Sep | 41,7 | 3,791 | 2,606 |
| Oct | 32,7 | 2,973 | 2,044 |
| Nov | 13,7 | 1,245 | 856 |
| Dec | 13,9 | 1,264 | 869 |

BOOM has painted asbestos roofs, perhaps slightly more porous, but closest to the figures for metal roof in the table above. BOOM roofs are 200m² in area so the figures above could be more or less doubled. The figures suggest that replenishment during April through to August should be sufficient to keep up with irrigation usage, but for the drier summer months some reserves built up at the end of winter would be needed. For this reason, 2x5000 litre tanks per block is proposed – one for usage in winter and the other to keep reserve levels higher for summer.

### 5.3.4 GREYWATER RECYCLING

Recycled water from baths, showers and basins is called greywater, and can be used once cooled off to water gardens. This can result in a substantial saving on the water bill. Laundry water with phosphate detergents is also nutritious and can encourage plant growth. However, soaps, cleaning products and washing-up liquids also contain harmful chemicals, which are bad for the garden. Greywater, especially from the kitchen, may not always be safe as it contains increased bacteria, and should be used with caution to water the garden. If one wants to recycle greywater, one must safely monitor what is entering the water, and manage the system properly. For health reasons, greywater should not be used to water any crops meant for eating, such as vegetables, herbs or fruit.

When using greywater in the garden, it is important that the water droplets are large and that the spray is low, so that the greywater does not travel to other areas. One should avoid spraying or sprinkling this water on the lawn on windy days. This water should be rather be used through a drip system, which drops the water directly onto plant roots. An even better greywater drip system uses underground piping. Care should also be taken not to allow greywater onto surfaces that drain into the street, as this will pollute the stormwater system, which runs into our rivers and streams. Professionally installed greywater systems are available, but are complex to install and can be costly.

The key to using grey water is to filter it first (remove hair and other matter) and to allow it to stand for a while (a few hours) for sediment to settle. Greywater should be kept away from very sensitive plants such as roses, seedlings, ferns, orchids and delicate plants. Choosing safer, biodegradable or organic soaps and chemicals will also be a great help. There are a number of very practical grey water systems on the market today. Most of them filter, collect and pump greywater out into the garden. A plumber should be hired to connect them, and all plumbing adjusted to suit.

Of vital concern to gardeners is the level of salts, chemicals, soaps and fats that greywater may contain, and its effect on their gardens. Prolonged use of most greywater is not recommended in the garden as it does affect the soil and health of plants. Greywater used over a long period in the same position will ultimately damage the soil, causing the build-up of salts and deflocculation (finer soil particles that filter downward), leaving the surface of the soil barren and sandy and low in beneficial micro organisms. For this reason, outlet pipes should be moved around to different parts of the garden, to spread the load. The quality of greywater is a major concern. Bath and shower water, and rinse water from washing dishes by hand, is the best greywater to use, as it contains the least harmful chemicals. It can be used on most plants with little negative affect. Washing machine water (particularly from the first rinse) and dishwasher water should only be used on well-established trees and large shrubs or lawns, as it contains harmful chemicals and fats that could have hazardous effects on the plants and also the soil.

There are two ways in which to use greywater, one simple, and one more complex and costly:

- **Simple systems** – capture the greywater from source (usually by means of gravity feed), do basic filtering, and re-use immediately (within 24 hours).

- **Complex systems** – capture from source, treat, store for longer than 24 hours, and re-use.

The simplest greywater system consists of gravity feed via a macro filter (removal of hair fluff and lint) on an underground sump, from where it is immediately pumped or drip-irrigated into the garden. This system is not recommended because if the water is not used within 24 hours, it turns into so-called black water which is toxic and foul-smelling, and needs some kind of sewage treatment before it can be re-used. A more advanced system is one where the water is first pumped into an above-ground tank, passing through a Venturi valve that injects ozone into it to clean and disinfect it, thereby increasing storage life.

Retrofitting greywater systems to certain building types such as for instance inner city tower blocks may prove to be quite complex and costly undertakings as it may well require extensive alterations to waste pipe layouts, and expensive pumping if the tanks have to be on the roof.

| | Item | Function | Suitable for retrofit | Estimated costs | Selected for BOOM | Reason/s |
|---|---|---|---|---|---|---|
| 5.3.4.1 | Grey water recycling system | See above | Yes | R9000 – R12000 per block at BOOM = R45000 – R60000 total or R2250 – R3000/unit | No | With cost of greywater systems and municipal water at current and projected levels, payback periods are unacceptably long (up to 30 years). Also managing and maintaining such a system without dedicated tenant involvement would present a challenge |

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