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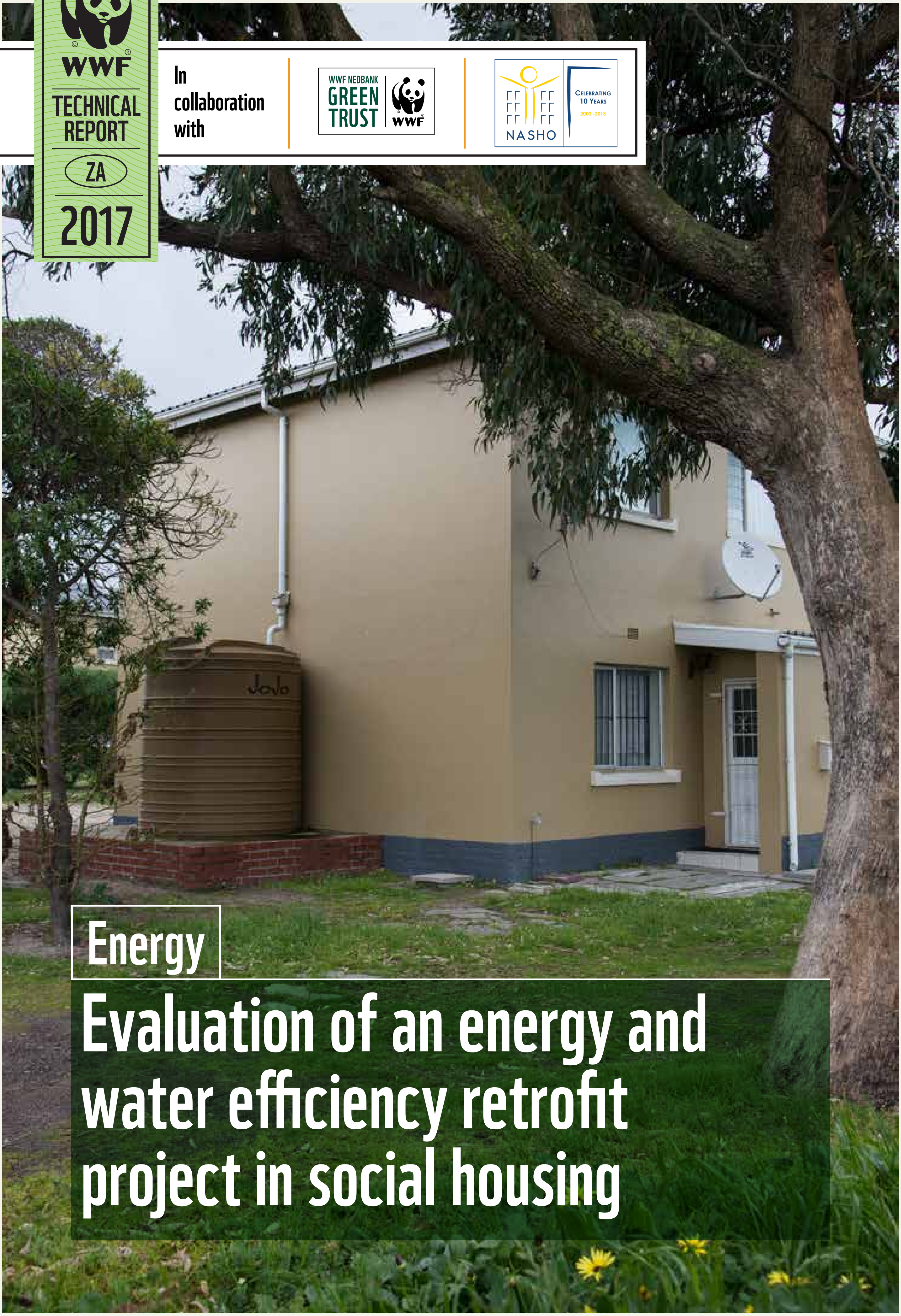

Energy

Evaluation of an energy and water efficiency retrofit project in social housing

WWF is one of the world's largest and most experienced independent conservation organisations, with over 6 million supporters and a global network active in more than 100 countries.

WWF's mission is to stop the degradation of the planet's natural environment and to build a future in which humans live in harmony with nature by conserving the world's biological diversity, ensuring that the use of renewable natural resources is sustainable, and promoting the reduction of pollution and wasteful consumption.

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EXECUTIVE SUMMARY

To assess the impact of energy and water retrofits in the context of social housing, a pilot project was conducted at a social housing development – Communicare's Boom Flats – in Cape Town. Social housing is partially subsidised rental housing aimed at households with regular monthly incomes of below R7 500.

Funding was provided by the WWF Nedbank Green Trust, with the intent to pilot an approach to retrofits for this market and produce learnings for the social housing sector and its main stakeholders. Until now, investment in retrofits of this kind have been limited by complexities associated with constrained usage in lower income households, limited guidance on the most effective and efficient technologies for these settings, and a weak landlord investment case. In particular, landlords have been uncertain of the actual operating costs and savings of resource efficient units, as well as the tenant's propensity to pay a premium that enables cost recovery. Consequently, this study makes an important knowledge contribution to greening the lower income residential sector.

Twenty households were retrofitted with energy and water efficiency measures in March and April 2016, with the key interventions driving unit-level financial savings being solar water heaters, LED lighting, low-flow water fittings, and improved construction materials such as insulation and low-E glass. Reduction in electricity consumption change is fundamental to realising a significant monthly saving. In addition, five rainwater storage tanks were added to the property to provide greywater for common areas. Further, WWF installed electricity and water meters for individual units to allow the landlord Communicare to monitor utilities off-site, not only to allocate accounts correctly, but also address theft and leaks in real-time. For purposes of analysis, data was collected from a range of sources, including the electricity meters, municipal accounts, tenant surveys and focus groups, to enable a comprehensive analysis of the retrofit impact. This report covers the quantitative aspects of retrofit impact.

On average, tenants are saving as a result of enhanced energy efficiency. Estimated electricity expenditure has dropped in both absolute and relative terms, containing increases in the total cost of occupancy (i.e. the total cost to a resident of occupying a unit). In absolute nominal terms, **monthly electricity expenditure fell by an average 12.2% year-on-year in Q4 2016**, from an average of R260 to R229, despite a tariff increase of 6.6% over this time. While the saving appears marginal, it is a valuable finding since average rentals increased substantially over the period; any savings in utilities would have improved tenant ability to service these obligations. As at the end of December 2016, electricity consumption was 16%

lower than it had been during the same month in 2015. Average consumption per unit was 216 kWh, compared with 258 kWh in 2015.

There is some tentative evidence of suppressed demand associated with energy poverty, with electricity savings lower than anticipated and failing to realise at all in most of the units with low initial consumption. Tenants with the lowest baseline electricity expenditure spent 67% *more* on average in Q4 2016 than in 2015. In contrast, those spending most initially, saved 25% post retrofit. This is an indication that the most energy poor households benefitted less (or in some cases not at all) from the retrofit in terms of financial savings. This could be the result of a variety of factors: 1) the rebound effect, where tenants are offsetting savings through increased use, 2) a continued misunderstanding of how best to employ the efficiency technologies, or 3) of changes in occupancy – though there is little evidence of tenant attrition and so this is least likely.

The landlord, Communicare, has also benefitted financially, realising a saving of 95% on their December water bills (2016 vs 2015). Expenditure on water has declined to a far greater extent, from R21 to just R1 per day at the last measured month of December, as a result of post retrofit consumption levels falling largely within the free water allowance. This finding is particularly significant in the context of rapidly rising water municipal tariffs in the city of Cape Town where a prolonged drought persists. **This saving reflects a water consumption reduction of 25.5% year-on-year post retrofit**, falling from an average total of 6.4 kL to 4.8 kL per unit per month (May to December, 2016 vs 2015).

The key short-term financial benefit to the City of Cape Town (CoCT) of social housing retrofits is a reduction in electricity subsidy in the high demand winter season. The Megaflex Municipal tariff imposes a time-of-use linked charge of between R2.50 and R2.86 per kilowatt hour for supply to municipalities during peak hours from June to August from 6–9am and 5–7pm. As redistributor, CoCT can make a substantial loss on sale of electricity during this time, charging as little as R0.97/kWh for consumption at any time of day, all year-round on Lifeline tariffs for indigent households (all figures are ex VAT). This implicit subsidy is currently estimated at R2–3m per annum, potentially increasing as low income households grow in number with in-migration from rural areas.

To maximise the savings benefit to retrofits, it is imperative for both the landlord to take initial usage patterns into account in retrofit design, and for tenants to make effective use of the new technologies installed in their homes. The study showed that in order to do this, baseline measurements of electrical load and utility consumption can be taken and a sample of residents can be surveyed. The latter can be supported by tenant training (prior to retrofit and induction of new tenants), appointing tenant champions to promote correct usage and assist other tenants in doing so, and perhaps even incentivising other tenants to make positive changes to their energy and water consumption behaviour (bearing in mind that subsidised tariffs reduce their direct incentives to do so).

INTRODUCTION

Low income households often carry a disproportionately high utility burden, creating a need for resource efficiency. The reason for this is that electricity and water demand is relatively income inelastic, since they satisfy basic needs (cooking, bathing, etc.). In this context, utility efficiency retrofits (particularly energy) offer low-income individuals an opportunity to save without sacrificing quality of life, while improving financial security. This is particularly relevant in the South African context, where electricity tariffs have escalated far more rapidly than general consumer prices, resulting in substantial increases in total cost of occupancy and so mounting pressure on the affordability of both tariffs and rentals for lower and lower middle income groups.

Other stakeholders can gain too. In the case of rental housing, landlords may benefit through less defaults, bad debts and vacancies (associated with tenant churn). Beyond the market for low-income housing, the providers of electricity and water infrastructure – being municipalities, utilities and other public entities – gain through lower strain from growing demand, and so reduce long term capital budgeting requirements. Additionally, where tariff structures channel subsidies to the poor, government entities such as municipalities are able to become more financially sustainable when the same services can be supplied at lower utility consumption.

However, retrofits in low-income housing applications do not always deliver the anticipated savings. For one thing, there are limited guidelines and reference points to guide choices of technology in this setting. Secondly, the savings delivered by various technologies – notably those offering efficient water heating – can vary a great deal, creating significant impact uncertainty and so undermining the business case for investment. Even where design is correct, considering experience elsewhere in similar settings, site-specific deviations may occur. Baseline consumption levels are critical determinants of savings, as are related tenant patterns of appliance usage. Where an electric geyser is used very little, through active operation of element controllers, the effective saving generated by replacement with solar water heaters or heat pumps may be very low, for example. Thirdly, energy poverty associated with very low baseline consumption levels may result in compensating increases in consumption as basic needs are satisfied, reducing the anticipated saving.

This document reports on the final results of a pilot project retrofit in the context of social housing. Twenty households at Boom Flats, a development owned and operated by Social Housing Institution (SHI) Communicare, in Cape Town were retrofitted with energy and water efficiency measures in March and April 2016, enabling a comparison of electricity and water consumption before and after. A combination of data from tenant surveys and focus groups, municipal utility bills and electricity meters has enabled a detailed analysis of changes in usage. Identification of potential pitfalls and recommendations follow. In aggregate, the results are positive, particularly in respect of water consumption which has shown a measurable and consistent reduction post retrofit. While water savings are substantial, electricity savings are lower than expected and accrue mostly to the those who were the largest electricity users to begin with. This points to the generally constrained electricity usage amongst households with little disposable income, and highlights the importance of retrofit technology choice and operation.

A case can be made for rolling out similar retrofits from this project – as well as promoting energy and water efficient design in new homes – on the basis of reducing strain on government budgets. Well designed and implemented residential retrofits minimise the need for municipal electricity subsidies, provincial water infrastructure and national electricity peaker[1] plants, in addition to supporting critical environmental goals such as sustainable water use and reduction of greenhouse gas emissions.

1 Peaker plants are power plants that generally run only when there is a high demand, known as peak demand, for electricity.

THE RATIONALE FOR RETROFITTING

While the low-income households occupying social housing units are not large consumers of electricity, there are several important factors that motivate the case for a retrofit in this context. In particular, the relatively **high utility burden borne by low income households**, combined with the **low ability of these households to access retrofits through private financing**, is a key consideration. If the financial security of these tenants can be enhanced through reducing their exposure to high and rising electricity costs, without compromising their quality of life, then the retrofit can be judged to have had a significant social impact. Other stakeholders such as rental landlords, the local municipality and the country may also stand to gain from retrofits implemented in social housing. These possibilities are outlined below.

Nonetheless, it is clear that the **overall environmental impact is somewhat limited on a per unit basis**, linked to low baseline water and electricity consumption levels. While middle income and affluent households may consume 230–340 kWh per person per month (Aquarista, n.d.), individuals in lower income households may use as little as 100–150 kWh per month. Similarly, middle income households of four may use in the region of 15–25 kL water per month, whilst most lower income households use less than the free allowance of 6 kL.

The substance of the saving results from the **high number of households in the relevant income category**: not just those in social housing units specifically (as defined by the Social Housing Act of 2008) but those with similar incomes occupying other types of accommodation, for example, rooms in homes, informal housing and backyard dwellings. On an aggregate basis, the impact can be prolific.

The discussion below highlights the impacts for various stakeholder groups, from the individual household to the global community affected by climate change.

Tenant level

Retrofits can alleviate the energy burden borne by low income households, which tend to allocate a greater share of their incomes to essentials such as utilities than higher income homes do. Households earning R7 500 typically may spend 10–15% income on electricity and water, whereas more affluent households spend a maximum of 5%[2].

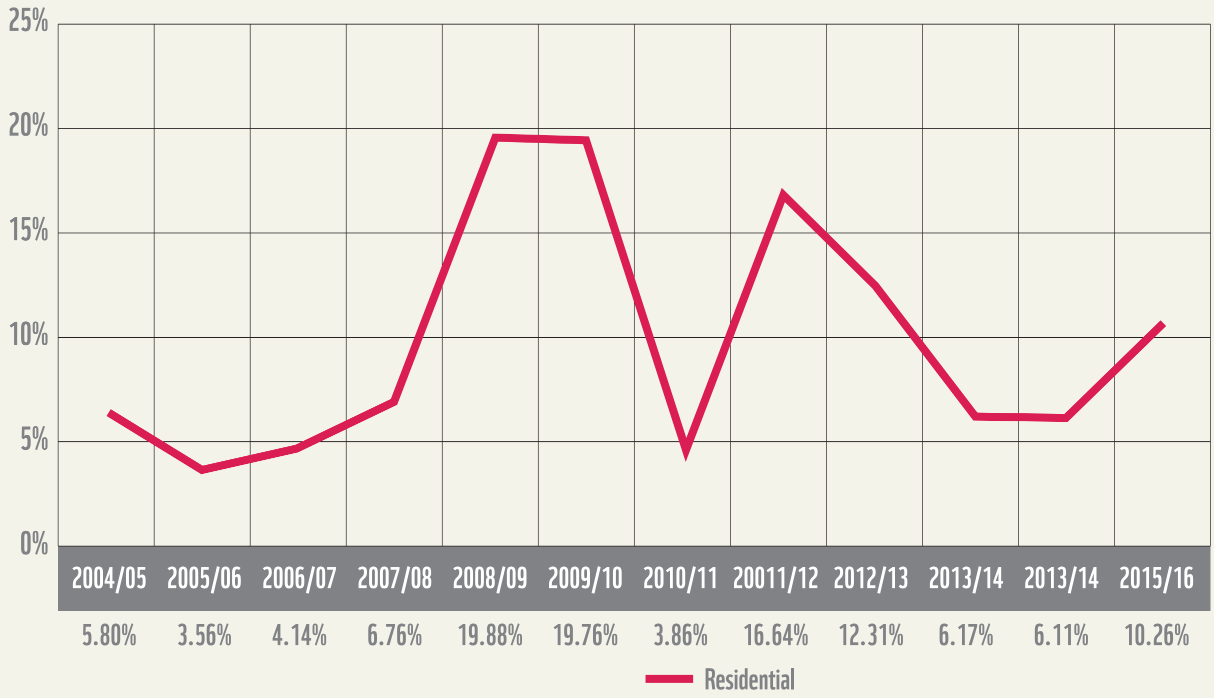
Social housing policy – and indeed rental affordability assessments in general – currently focus on the **burden of rental relative to the tenant's income**. In the

2 This is drawn from commentary by Solid Green as well as analysis on the Income and Expenditure Survey 2010/11 and various other sources.

case of the subsidy for social housing – the Restructuring Capital Grant 0 (RCG)) – the implicit assumption by policymakers is that rentals should not exceed one third of income. This rule of thumb applies equally to private sector rentals. However, omitting the other significant cost of renting–namely utility costs leads to a flawed affordability assessment. An earlier analysis for WWF (Sager, 2014) highlighted a finding that average utility bills amounted to 20–60% of rentals for a sample of social housing tenants in Johannesburg and Cape Town. **Taking a total cost of occupancy view[3] reveals that social housing tenants in general, and particularly those in climates with cold winters (in the interior of South Africa), need to allocate closer to 40–50% income** to rental accommodation[4], implying that many are under significant financial strain.

The challenge relates not just to the existing burden but the possibility of an escalating future one. Between 2008 and 2016, Eskom escalated electricity tariffs in excess of general consumer inflation – measured via the Consumer Price Index (CPI) – to finance new infrastructure, principally the mega projects of Medupi and Kusile coal-fired power plants (Figure 1). During three of the past five years, residential tariffs have escalated by 10% or more, compared with relatively stable consumer inflation in the range of 4.5–6.5%. Eyewatering cost overruns and substantial delays at these sites suggest that the spikes will remain a feature of the electricity tariff trajectory for the foreseeable future. Similarly, an unfolding national water crisis characterised by low rainfall and an urgent need to upgrade storage and distribution infrastructure are starting to push up water tariffs in metros.

Figure 1: Average Eskom tariff change in the residential sector (%)



SOURCE: ESKOM WEBSITE

3 In other words, including related costs of accommodation such as utilities with rent in estimating total expenditure.

4 Rental absorbs up to a third of gross household income, while utilities account for 6–18%.

Low income households faced with these escalations usually have only two options: firstly, to pay more for the same electricity consumption and accordingly sacrifice other items, or secondly to scale back on electricity consumption and forgo the convenience or quality of life associated with that consumption.

Retrofits provide a third option for residents: maintain usage patterns but utilise electricity and water more efficiently. Low-flow water retrofits have the potential to reduce water consumption (kl/day) by up to 25% (Sager, et al., 2016) while water heating technology retrofits have the potential to reduce total energy consumption (kWh) by 20–32% (Kritzinger, 2014). These may deliver savings of 2.5–5.0% social housing tenant income in cases where municipal subsidies do not apply, assuming no suppressed demand occurs from tenant behaviour change[5]. However, technology selection in multi-unit residential facilities is crucial to the recovery of initial investments, especially since these technologies exceed the baseline technology costs.

Landlord level

Landlords arguably stand to gain as much as tenants do from retrofits, although through very different channels as elucidated upon below. Understanding and validating these financial benefits is crucial since **landlords generally finance retrofits** and recover the additional cost (in whole or part) from tenants thereafter.

Direct costs

Landlords carry the burden of common area operating costs, including utility-related costs e.g. lighting for stairwells and pathways. Data from 2014 suggests that a typical social housing unit is associated with a common area operating cost of R250–650 per annum, of which electricity is a large component (Sager, 2014). Since annual escalations in social housing rentals are limited to CPI, financial feasibility declines when operating cost inflation exceeds it due, amongst others, to electricity tariffs increasing above general inflation.

In addition, **many landlords are at risk of underrecovery through being resellers of electricity**, buying bulk electricity from Eskom or the municipality on a medium- or large-user tariff and on-selling at local municipal residential tariffs. These tariffs are structured very differently, with the result that resellers may not be able to recover all of the cost associated with individual units. Typically, landlord electricity charges would include a connection fee, a demand charge (based on peak volt amps) and a consumption charge (based on kWh). By contrast, tenants are charged only for consumption (in kWh). The consequence of this is a possible mismatch in actual electricity costs and tenant recoveries, particularly in cases where the load profile is extremely spiky during peak hours (as one might expect in winter for example). In this example, the bulk user's demand charge might be very high, since Eskom needs to supply substantial generation capacity to meet such concentrated demand, often through expensive diesel 'peaker plants', without a proportionate tenant increase to offset it.

5 Using a baseline utility burden of 10–20% income as has been noted in other analyses e.g., Sager, 2014.

Indirect costs

Social housing landlords have mentioned the growing utility burden is reducing their ability to achieve desired rental escalations (Sager, 2014), creating a longer term risk of underfunding as operating expenses grow faster than revenues.

Landlords may experience losses through bad debts, vacancies, marketing and maintenance when tenant financial strain results in exit. This lost income on affected units results in a smaller pool of funds with which to meet development-level obligations, including debt service and larger maintenance items. Several SHIs have noted that exits spike in the month or two after double digit electricity tariff hikes are implemented. Distressed exits mean unpaid bills and units that need to be filled again (with associated costs of maintenance, running tenant application processes, tenant training, etc.), resulting in lost revenue and increased operating expenses on a financial level. This is particularly problematic in RCG-funded social housing, where rentals effectively are required to reset to 2007/08 levels. In addition, the mission focus of many landlords to provide affordable, quality accommodation for lower income groups is undermined.

Municipal and utility level

Utility-related government entities can gain from retrofits on low-income household homes both financially and in terms of resource management.

While distribution of electricity and water is a revenue-generating activity for municipalities, the subsidies applicable to lower income households may result in losses. For instance, during peak times in winter, municipalities may be paying Eskom upwards of R2.85/kWh for electricity, and yet resell the electricity for prices as low as R0.97/kWh on the subsidised City of Cape Town Lifeline tariff (i.e. recovering less than 50% of cost) – and then only once the tenant has exhausted any free allowance[6]. This loss needs to be subsidised by higher income households and other electricity users, creating a perverse incentive to sell more electricity at higher rates to these users. Pressure on municipal budgets will increase as more households – generally middle and high income – install rooftop solar systems, typically without storage capacity. This will reduce their purchases of grid electricity during off-peak times, when it is most profitable for the municipality to sell it.

Similarly, Eskom's cost of operation for diesel-powered electricity may reach as high as double the rate it charges municipalities (dependent on diesel costs). A requirement to increase peaker plant production, or worse yet, build additional capacity to supply peak demand is extremely costly as a result.

From a resource management perspective, municipalities are able to save significantly on infrastructure when consumption drops. This is particularly the case for water, which is usually retained in local dams. In instances such as the current water crisis in Cape Town, lowering consumption assists with

6 Eskom Megaflex Municipality tariff. All figures exclude VAT; on the Lifeline Tariff, consumption under 250 kWh entitles users to a free allowance of 60 kWh, falling to 25 kWh for consumption above 250 kWh.

managing scarce available resources for which no substitute exists (in the absence of operational desalination plants).

National/international level

Finally, South Africa and, indeed, the global environment gain from **lower emissions of greenhouse gases** associated with fossil-fuel powered electricity generation and **more sustainable use of water**.

In South Africa, a grid emissions factor of between 0.85 and 1.00 tCo_2 per megawatt hour of electricity ranks amongst the highest internationally, owing primarily to extremely high reliance on coal-fired plants. Any activities that permanently reduce reliance on this grid system are beneficial from a climate change perspective.

In addition, coal-fired power is extremely water-intensive, sometimes draining water from sensitive, water scarce ecosystems such as the Waterberg. Coalfields also often overlap with good agricultural land, redirecting both land and water resources towards carbon-intensive electricity production.

FACTORS DETERMINING THE SUCCESS OF RETROFITS

Existing guidelines and reference points

During the design phase of a retrofit, engineers and installers would usually take cognisance of applicable regulation, green building guidelines and experience with implementation in similar building types and contexts elsewhere. This would help to guide the selection of the most appropriate technologies for the identified site. In the case of social housing retrofits, **guidelines and publicly available case studies have been somewhat limited**.

As compulsory standards for new buildings and refurbishments, SANS10400-XA require adherence to minimum energy efficiency requirements from 2011 onwards. If the prescriptive route to compliance is pursued, this implies that certain technologies such as efficient water heating systems would need to be installed while certain design considerations are also included e.g. requiring natural ventilation and limiting the window-to-wall ratio. While a number of these measures can be included for retrofits, some are impractical, particularly those relating to building design and materials. Beyond these formal guidelines, reliable data on the success of social housing retrofits is also hard to come by. This has served as a block to planning further retrofits since it influences the economics of the exercise since the absence of data creates uncertainty regarding the returns to investment. Modifications of water heating, lighting, and water flow fittings require additional investment by landlords. These retrofits are usually undertaken on the basis that they are expected to pay off in both financial savings and improved standard of living for the tenants. In the most successful cases, rental hikes for the tenant are used to recover the cost of the retrofit, while the **utility savings (in a Rand basis) for the tenant allows them to afford a similar or even an improved standard of living despite the higher nominal cost of housing**.

One such example is the use of centralised heat pumps for hot water in a Madulammoho Housing Association development in Johannesburg. The capital cost of the retrofit was added to rentals with recovery of the investment over five years. Electricity consumption due to water heating decreased by over 50%, with tenants realising significant net savings in their overall expenditure despite the higher monthly lease payments[7].

7 Data drawn from documents and discussions with Neil Erasmus of Madulammoho Housing Association in 2013.

Predicting energy and water savings

Technology efficiency

Water heating is one of the sources of highest electricity demand in low income homes, especially where other electricity intensive appliances such as washing machines are absent. It is estimated that 40% to 50% of a household's total electricity consumption is accounted for by electric geysers (Covary, et al., 2016).

The most commonly employed efficient alternatives to electric resistance geysers are **solar water heaters and heat pumps**. These can be deployed at either an individual unit level or – in the case of multi-unit residential buildings, like Boom Flats, in centralised systems. However, savings can only be realised if the technology is adequately selected for the residential set-up and consumption level. For present purposes, individual units are considered as these provide the simplest, like-for-like comparison. Later on, centralised heating systems are discussed as an alternative. There are two critical features of efficient water heating systems: variability in performance (in terms of generating hot water output) as a result of climate or system design that deviates from the optimal, and payback period (which is a function both of variability and baseline hot water usage levels).

There is high consistency among **electric resistance geysers (traditional geysers)** in delivering heat to the water, although standby losses can vary significantly between products. Likewise, the details of specific installations, such as that of ambient air temperature, air circulation and cylinder orientation can be significant in determining the standby loss. Electric resistance geysers have the cheapest initial capital cost of the technologies evaluated here, but highest energy costs per annum at medium and high levels of hot water demand. In addition, their maintenance costs are high; elements often fail after five years and are expensive to replace.

Solar water heaters convert freely available solar radiation into heat, with back-up electrical elements to compensate for demand during overcast days and at night. These systems exhibit significant variance in performance, based on a number of factors including system sizing relative to hot water demand, weather conditions, system type and installation (orientation etc.). These challenges are especially worrisome in winter months and at peak (early morning and evening) hours, when hot water demand is high but solar availability is low.

Heat pumps use electricity to move heat from one place to another instead of generating heat directly. Therefore, they can be two to three times more energy efficient than conventional electric resistance water heaters (US Department of Energy, 2017). The coefficient of performance (COP) of heat pumps is affected by the ambient air temperature, placement of the condenser, incoming water temperature and desired temperature of water flowing out of the system. Disadvantages include loss of efficiency at low temperatures (below 7 degrees Celsius), inability to heat water to more than 50–60 degrees Celsius, and uncertainty regarding the electricity savings and lifespan of smaller units, due to relatively recent market entry (Kritzinger, 2014).

Electricity savings for solar water heaters and heat pumps generally range from 50–80% when compared with equivalent electric resistance systems, with the factors outlined above contributing to significant variation amongst individual installations.

Lighting is perhaps the most straight forward of retrofits for which a financial case is made. Both compact fluorescent (CFL) and light emitting diode (LED) technologies can easily substitute the baseline incandescent light bulb. Incandescent bulbs are far less efficient and require more frequent replacement due to failure. Implementation of CFL or LED is simple because it does not require special fittings or wiring. Further, the incremental cost of installation is small, with a typical payback period of 6 months or less, while the savings in operating costs are significant. Using a 5–10W LED lightbulb saves up to 90% of the electricity consumed by an 80W incandescent bulb.

Low-flow water fittings are included as requirements in most green building certification programmes. EDGE, Green Star, and LEED certifications all require low-flow fittings and other water saving methods as an integral part of protecting this scarce resource. Sink **water taps** (both in the kitchen and hand wash basin) can be fitted with aerators to reduce flow (the amount of water coming out) without reducing the sense of pressure (International Finance Corporation, 2016). The incremental cost of fitting aerators is about 20% of the cost of a standard water tap, while reducing water consumption by 25% or more (Sager, et al., 2016).

Low-flow **shower heads** also offer an opportunity to diminish water use without diminishing quality of life. Showers are deemed more efficient and arguably cleaner than baths. Further, there is no appreciable difference in the cost of a low-flow shower head compared to a normal showerhead, where pricing is primarily based on aesthetic and luxury rather than performance. Water savings of 20% can be achieved through this technology (Sager, et al., 2016).

The commercial sector has quickly adopted **dual-flush systems**, with residential developments also standing to gain as current single-flush systems can drain up to 12L per flush. The dual-flush mechanism is approximately 10% more expensive, but can lead to reductions in use of up to 50% (Sager, et al., 2016).

Causes of deviation from prediction

While technology retrofits described above can deliver promising benefits to landlords and tenants, there exist a number of reasons why special consideration must be given to social housing units. Results in social housing do not always follow industry expectations established in middle to high end homes. Three major factors come into play: baseline consumption level, tenant understanding of the technology and its bottom line effects, and suppressed demand associated with energy poverty.

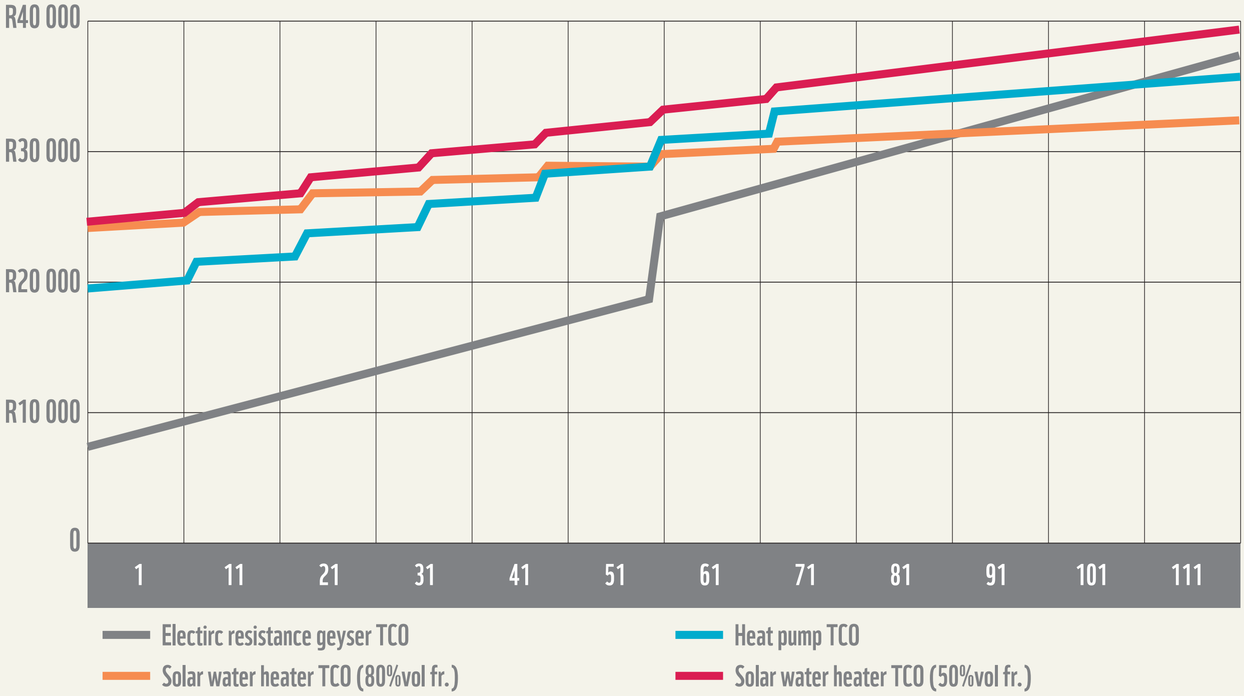
Consumption levels

Low baseline consumption levels in social housing influence the economic viability of a retrofit. At baseline medium hot water consumption levels[8], heat pump and solar water heaters at 80% volume fraction are financially

8 115 L/d of hot water, requiring 8.18 kWh of thermal energy

viable and preferable to electric resistance geysers if the useful life is 5 years or longer. This is a realistic assumption in middle income households. However, baseline consumption levels are very low in absolute terms in low income households. This leads to long payback periods for utility saving retrofits and impacts the landlord's ability to recover the cost of initial installation through rental hikes that mirror the payback of the investment.

Figure 2: Low hot water usage (4.09 kWh Thermal Energy per day): Total Cost of Ownership over 10 Year Horizon



SOURCE: (SAGER, ET AL., 2016)

Figure 2 above describes total cost of different water heating technologies over a 10 year period in a low-usage setting[9]. The observed estimated energy consumption attributable to hot water use is closer to 2.8 to 3.8 kWh/day/unit at Boom Flats, as opposed to the 4.1 kWh/day assumed above, suggesting that payback periods for this technology would indeed be longer than those shown above. For such an application, individual solar water heaters in each flat may be a sub-optimal solution. Instead, centralised heating systems for hot water, such as the heat pumps utilised in the Madulammoho development described previously, would achieve scale by aggregating consumption from multiple units, allowing the landlord to attribute smaller capital cost to individual units. This is not without its challenges, however, since the system would have to be sized appropriately to handle consumption at peak times, and the building layout and piping may require additional modifications, further increasing the cost of initial investments.

9 57.5 L/d of hot water, requiring 4.1 kWh of thermal energy

Tenant knowledge, awareness and technology response

Uninformed tenants may not know how to operate retrofit technologies properly to achieve the desired savings, or may be unwilling to fully adopt them. For example, a water heating retrofit may have very different results in upmarket homes, where residents require continuous hot water supply even at higher utility cost, than in social housing, where low ability to pay is a binding constraint on hot water demand.

Upmarket households typically do not manually control their hot-water supply, instead setting it up as recommended by installers, and keeping it out of reach and functioning at all times. However, low-income tenants may have grown accustomed to turning off electric geyser elements or adjusting the temperature in order to save on utility costs. Solar Water Heaters are a more complex technology, where the backup electric element supplies thermal energy in the absence of available solar energy on an automated thermal monitoring basis. Without properly understanding how these two elements interact, tenants run the risk of increasing their electricity demand and not realizing savings, especially in cases of suppressed demand described in the section below. Successful implementation of energy saving retrofits in social housing requires a significant effort to educate tenants on the technology – both in the way the technology is used and in how it can lead to savings

Energy poverty

Energy poverty in low income households may lead to suppressed demand, implying compensating increases in demand when energy efficiency is improved. This suggests that residents have a fixed electricity budget, which they will continue to expend, simply reallocating it to other uses after a retrofit delivers the same services at lower cost. This is called the “take-back” or “rebound effect” (Winkler & Thorne, 2002). In such instances, energy efficiency assists tenants in achieving a higher standard of living, but may not result in significant cuts in electricity consumption or GHG emissions. Further, based on our knowledge of opportunity costs and overall poverty levels (not only energy poverty), the rebound effect is prevalent where there aren’t other forms of standard of living improvements that are deemed more valuable – more or better quality food, for example – to which the money saved from utilities could be allocated.

There are varying definitions of energy poverty, some linked to energy expenditure and others to non-financial measures such as thermal efficiency. According to the Department of Energy, households spending more than 10% income on energy needs can be classified as income poor, by which definition almost half of South Africans are energy poor. By the thermal efficiency measure, which considers ambient indoor temperature, the inhabitants of around a third of formal dwellings and almost 90% informal dwellings are energy poor (DoE 2012 referred to in (Sustainable Energy Africa, 2014). For this reason, the national norms and standards for fully subsidised homes for the poor were raised in 2014 to achieve compliance with several of the basic requirements of SANS10400-XA, including insulation, waterproofing and natural ventilation.

PILOT PROJECT: COMMUNICARE BOOM FLATS

Introduction

Overview

WWF's intent in funding a social housing retrofit was to test two hypotheses: firstly, that implementing energy and water saving technologies would enable a meaningful reduction in utility burden for lower income households, and secondly that tenants would enjoy improved quality of life after the retrofit, irrespective of extent of financial savings.

The site chosen for the energy and water retrofit is a social housing project known as Boom Flats, operated by Communicare and located in the suburb of Brooklyn in Cape Town. The flats were constructed in the 1960s, comprising five double storey buildings of four units each. The units were all constructed to the same layout: single bedroom, en-suite bathroom, lounge, kitchen and balcony.

Image 1: Aerial view of Boom Flats

SOURCE: GOOGLE EARTH

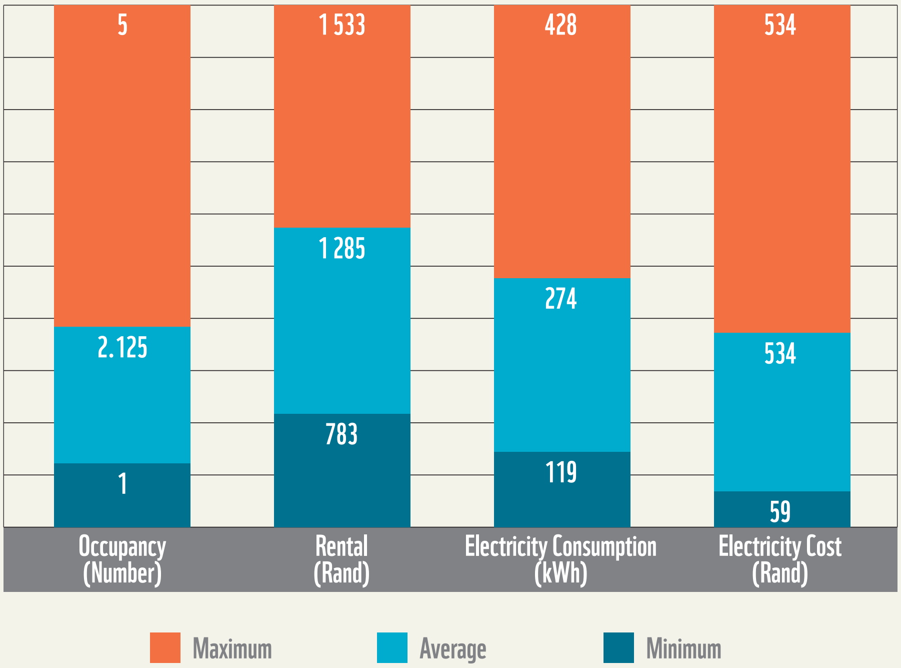
Pensioner households and worker households are represented equally at Boom Flats, with pensioner households typically being one or two person, while worker households include a median of three residents and a maximum of 5. Monthly household incomes are currently generally below R10 000. In households where at least one resident is employed, the median reported income is approximately R7 750 per month and rental costs are ~R1 500 per month. Meanwhile, homes occupied by pensioners have median reported household incomes of ~R2 600 per month and rental costs of ~R1 150. It is clear therefore that pensioner households are far more constrained in terms of disposable income, and are therefore likely to be amongst the lowest utility consumers.

Utility costs must be accounted for in the total cost of occupancy. At Boom, electricity is purchased directly by the tenant from the City of Cape Town (CoCT) via a prepaid meter located in the unit. Water usage and sanitation are billed at bulk development level and covered by Communicare, with no recovery from tenants.

Prior to the retrofit in 2016, electricity increased the costs of occupancy by approximately 17% for the average Boom Flats tenant, where utility costs generally consume 3–6% of tenant income. This is relatively low in context, and is driven by assumed qualification and access to the subsidised CoCT Lifeline tariff which is discussed in greater detail later in this report. However, one should note that some households were utilising 10–13% of their income on utilities. These households with higher utility consumption as a proportion of income also reported higher occupancy levels (three to five people), with average incomes of R4 000–5 000. It is not surprising, then, that utility burden is higher for homes with more dependants who are either children or otherwise unemployed adults.

Figure 3 below provides an overview of the distribution for key parameters prior to the retrofit being undertaken. The majority of households are small (two person) with average electricity consumption of 258 kWh per month. This is substantially lower than the South African household average of 500–750 kWh per month (htxt. africa, 2016), reflecting the constrained incomes and limited access to appliances applicable to the lower income households occupying social housing units. On average, 7.6 kL/month of water was consumed per unit in 2015. This aligns with average household water consumption as reported by other sources.

Figure 3: Summary of the Boom Flats baseline, 2015 monthly averages



SOURCE: OWN ANALYSIS USING OWN CALCULATIONS BASED ON COMMUNICARE DATA AND CITY OF CAPE TOWN LIFELINE ELECTRICITY TARIFFS

Retrofit Process and Timeline

After consideration of feedback from both Communicare and the tenants, a number of energy and water retrofit technologies were selected for implementation, being those considered to be most effective and practical in the context of existing, dated building structures. These comprised fairly standard technologies applicable to affordable housing, with the notable exceptions being low E performance glass which is an expensive item which is still rarely deployed even in middle to high income homes.

Table 1: Retrofit technologies

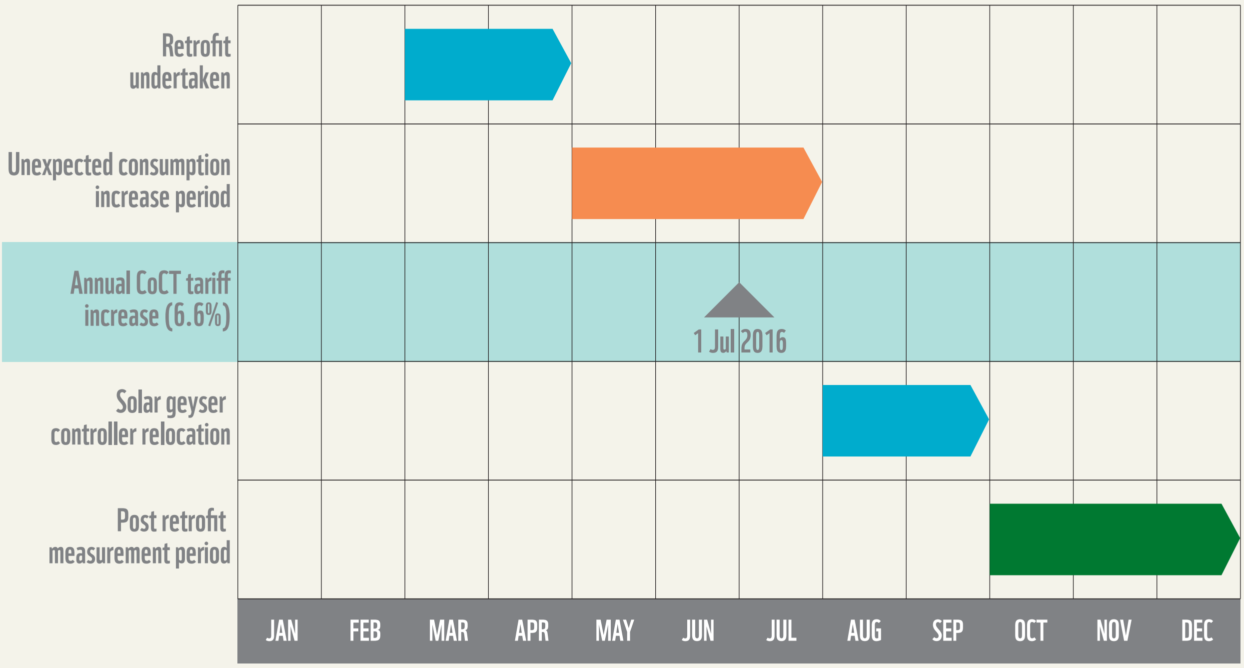
Baseline Technology	Retrofit Technology
Electrical resistance geysers (100 litre)	Solar water heaters (150 litre flat plate collector systems with 2 kW back-up elements and Geyserwise controllers)
Incandescent and CFL light bulbs	LED light bulbs
Conventional baths	Low-flow showers
Standard taps	Low-flow aerator taps
Standard toilet cisterns	Dual flush, lower volume cisterns
Basic construction materials	Insulation, draught exclusion, low E glass
Standard plumbing in all areas	Greywater systems for common areas (jojo tanks)

SOURCE: WWF TECHNICAL REPORT; DISCUSSIONS WITH MENDOMARK

In addition to the above technology changes, WWF provisioned the installation of water meters that would allow Communicare to monitor water off-site, not only to allocate accounts, but also address water theft and water leaks in real time.

The retrofit installation commenced in March 2016 with completion in April. Tenant feedback was gathered and resulted in the solar geyser control units being relocated during August and September. Closeout interviews were conducted with select tenants from November 2016 to February 2017.

Figure 4: Retrofit timeline 2016



SOURCE: OWN ANALYSIS

Crucially, at the time of installation of the solar water heaters, the water cylinder element controller in each unit was moved from an easily accessibly place within the unit into the roof. The choice of roof as controller location follows standard installation practice for solar water heaters and was initially deemed the best solution in this application, based on previously studied consumption patterns at Boom Flats. During September and October, the controllers were again moved back into the units, as a result of unintended spikes in electricity consumption associated with operation of the back-up elements. Tenants are now once again able to control the time periods during which the element heats water.

Data and Methodology

Data

To evaluate the effectiveness of the retrofit from a quantitative perspective, **accurate recording of electricity and water consumption pre and post retrofit** is required.

To facilitate tracking of electricity consumption, an automated meter reading (AMR) system was installed by SEMS. This AMR system comprises smart electricity meters installed in addition to the existing pre-paid meters at the distribution board of a unit. The AMR meters log the energy consumption as well as load levels (applying time of use of consumption). This information is then transmitted via a cellular modem to a cloud-based data storage facility. Via the cloud based facility, one is able to access current data, uploaded every half hour from the meters as well as the historical load and consumption record. Data were drawn on this basis from 1 January 2015 to 31 December 2016.

Similarly, water meters were installed by SEMS to monitor consumption for each unit. However, the remote monitoring service was not activated, with the result that water consumption data was not available for analysis. Consequently, the analysis of water consumption has been conducted utilising the monthly municipal account statements for the period under review, namely January 2015 to December 2016. This allows for daily average consumption per block to be considered on a monthly basis. The limitations inherent in this approach are the high level of aggregation and lack of data on time of use which limit ability to validate inferences relating to the use of water.

Finally, in-depth interviews with four households were carried out by Alexis Scholtz of WWF, both pre and post retrofit. These interviews delve into the lifestyles and perceptions of the tenants to add a **qualitative assessment** of the impact of the retrofit.

Methodology

Electricity

In respect of electricity consumption, **meter data from individual units was collected at half hourly intervals and transformed into hourly consumption data**. The hourly consumption data is retained for analysis of the time-based load profile as well as being summed to determine the monthly consumption for each flat. 2016 data is then compared with 2015, being the pre-retrofit baseline, for analysis purposes.

Four of the twenty units were excluded from the electricity data analysis: Chestnut units 3 and 4, as well as Eikehuis units 2 and 4. The reason for excluding the Chestnut units related to a break in meter data transmission from late November onwards, related either to faulty modems or inadequate telecommunications signal. The Eikehuis units were excluded because the solar water heaters had never been connected to the units (lack of installer access due to repeated tenant unavailability). In respect of tenant billing for electricity consumption, as mentioned earlier the **tenants purchase electricity directly from the CoCT**. Currently the CoCT tariff structure includes multiple tariffs applicable to residential consumers, introducing a degree of uncertainty in this analysis. Arguably the most applicable one in the case of the Boom Flats tenants is the **Lifeline tariff**, a subsidised tariff structure aimed at assisting the poorest electricity consumers through both a lower cost per kWh and the provision of free basic electricity[10]. At present the lifeline tariff provides a 60 kWh free allocation to users who receive less than 350 kWh per month (calculated on the average of the past 12 months). Should the electricity exceed this level but remain below 450 kWh per month, users receive a reduced free allocation of 25 kWh.

To prevent affluent households with low consumption levels from accessing the Lifeline tariff, the CoCT has started applying additional qualification criteria relating to the valuation of the property concerned as well as status of the resident. Since the qualification criteria are generally met at the Boom Flats, it is assumed in the analysis in this report that the Lifeline tariff applies throughout. Currently there is no way of verifying this as a third party as a result of the direct billing arrangement between tenants and the CoCT.

Water

With the installed water meters not transmitting data, the only data source available as an alternative was the **municipal account statements** which reflect consumption and associated cost (for Communicare's account). The City of Cape Town meter readers attend the property approximately monthly to record the meter reading. The readings are noted on the account statements along with the reading date. This allows the consumption to be calculated per day over the approximate monthly measurement period. As in the case of electricity, 2016 data is compared with 2015 to evaluate outcomes of the retrofit.

Water data for the Hibiscus block was excluded from the analysis because there were no reliable readings. All reported water data was shown as an estimate on the municipal accounts, and was held constant throughout all of 2015 and 2016. Therefore, no useful information could be extracted with regard to the impact of the retrofit on this block.

The water tariff applicable is the Domestic Cluster tariff which is applicable to multi-unit residential properties in the city. Each residential unit receives a free allocation of 6kL of water per month, with consumption above this level charged at a progressively escalating rate. The sanitation component is calculated as a fixed component of water consumption, currently 70% thereof, with a no cost allocation of 4.2kL per month and a similar increasing rate thereafter, capped at a maximum of 35kL per unit per month.

10 Free Basic Electricity (FBE) was launched by the Government in 2003, with the aim to support indigent households in meeting their basic energy needs. According to the Free Basic Electricity policy an allocation of 50 kWh per month should be provided to all poor households connected to the national electricity grid.

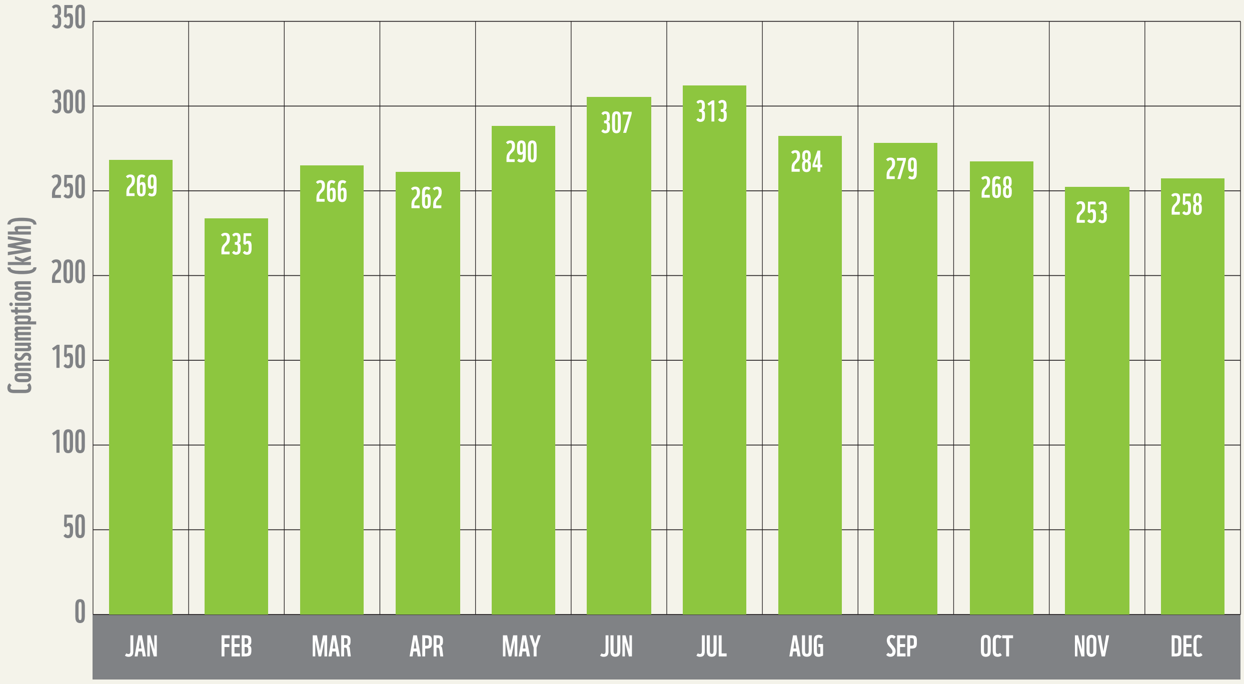
Findings

Electricity usage

Baseline electricity consumption is very low. By contrast with middle income households, which usually consume 20–40 kWh per person per day, households at Boom Flats consumed less than 5 kWh per person per day on average in 2015. This low level of consumption suggests the existence of energy poverty, implying that households are not able to meet all desired basic energy needs within the constraints of their incomes.

The simplest way to measure this is through expenditure on electricity relative to incomes. In this instance, electricity expenditure is generally at 3–6% household income[11], which is well below the 10% threshold the Department of Energy uses to identify the energy poor. This is due to the application of the highly subsidised Lifeline tariff discussed earlier. Nonetheless, electricity expenditure is relatively constant, with variability of just 50% between lowest and highest monthly expenditure[12], suggesting that residents may indeed be maintaining a constant energy budget and so frequently going without meeting basic needs, particularly in the cold winter months. This is corroborated by interviews with the tenants, which highlighted infrequent showering and bathing in some units, as well as going without space heating in winter.

Figure 5: Monthly average electricity consumption per unit, 2015 (kWh)



SOURCE: OWN ANALYSIS USING SEMS METER DATA

11 Based on income data gathered during pre-retrofit tenant surveys for 14 of the units.
12 January and July 2015

After an initial anomalous spike, the retrofit has led to a measurable decrease in electricity consumption. As at the end of December 2016, consumption was 16% lower than it had been during the same month in 2015. Average consumption per unit was 216 kWh, compared with 258 kWh in 2015.

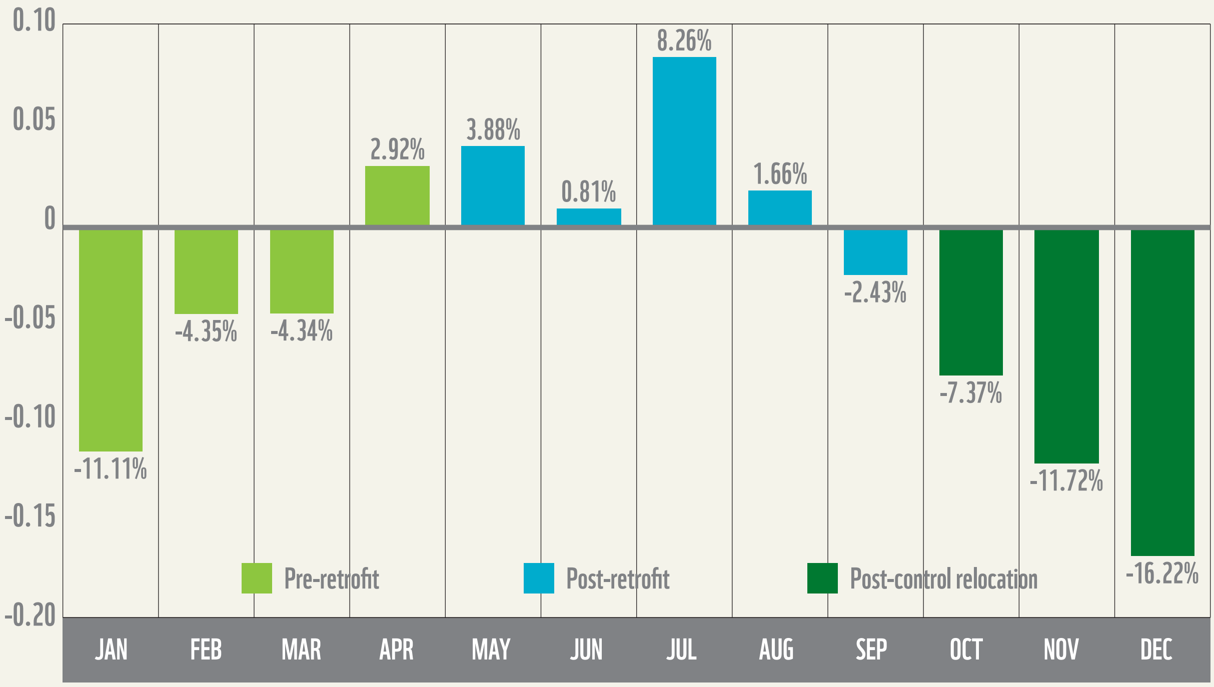
Immediately after the retrofit, consumption increased dramatically and against all expectations. In May 2016, consumption was 13% higher than it had been in 2015. This increase can be attributed to two main drivers:

- The removal of geyser element controllers from inside the units, where tenants could manually switch the element on and off, resulting in automatic activation to reach desired temperature
- Overcast winter weather conditions in Cape Town, which led to lower performance in the solar water heating systems, and therefore more reliance on the electric back-up elements to achieve desired water temperature.

With regards to geyser control, social housing tenants have been observed to manually control the geyser element in several developments where this feature is available. In middle income and affluent households, residents usually allow the geyser thermostat to continuously monitor water temperature, with the element activating automatically when temperature drops too low. However, low-income households may ration water heating to save on electricity through overriding the automatic element activation.

In this instance, geyser controllers were removed from units during the retrofit installation process, removing the capability of residents to manually control element operation. During August and September, controllers were reinstalled as a result of the spikes in consumption and associated electricity expenditure. A pronounced inverted U shape can be seen in Figure 6 below, reflecting this process.

Figure 6: Monthly change in electricity consumption, 2016 vs 2015 (% kWh y-o-y)

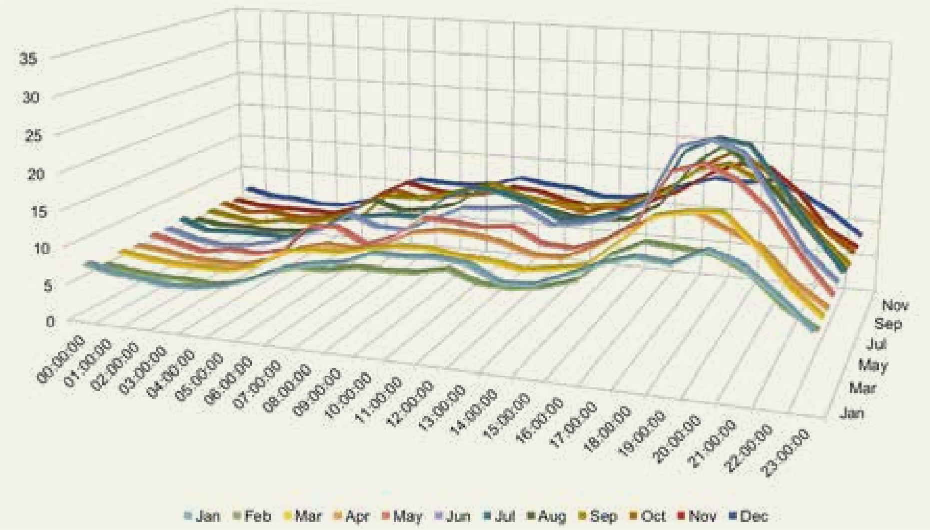


SOURCE: OWN ANALYSIS USING SEMS METER DATA

The unknown variable in explaining changes in electricity usage is the effect of tenant perceptions of usage of efficient electrical equipment. For example, if solar water heaters were perceived to generate hot water without using any electricity, tenants may have increased hot water consumption.

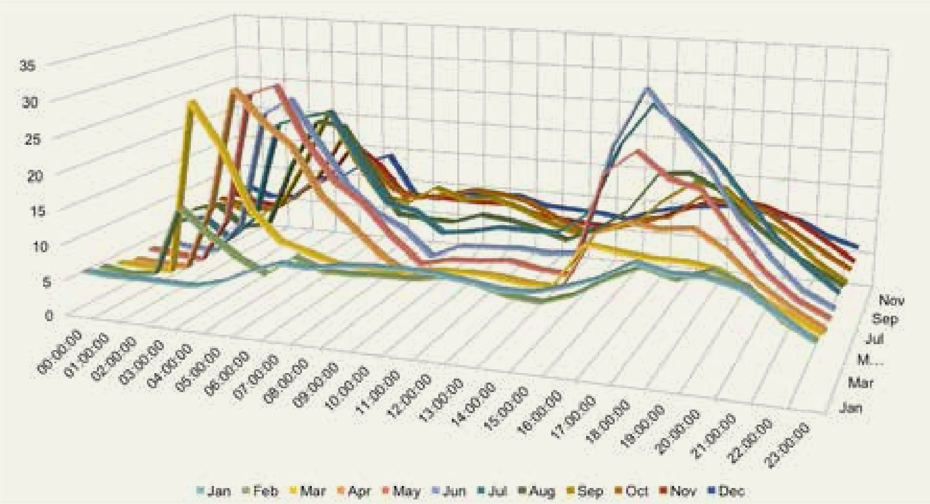
While consumption has dropped overall, load has shifted to earlier in the day. Prior to the retrofit, a pronounced evening peak was visible, suggesting that the vast majority of tenants chose to shower or bath in the evening. Post retrofit, electricity usage during the early hours of the morning (4–6am) has substantially increased while evening usage has declined. It can be seen on Figure 7b that, in recent months, the load profile has somewhat flattened with manual control of geyser elements, after a very pronounced morning and evening peaks immediately after the retrofit. However, usage from 2–6am in December remains at approximately double the 2015 early morning level. This may be due to the programming of geyser timers to early morning slots. Since most tenants appear to prefer bathing or showering at night, and hot water is used for very little else, they should be informed of the potentially wasteful electricity use associated with early morning water heating. Resetting timers may result in a boost to savings.

Figure 7a: 2015 Load Profile (kWh)



SOURCE: SEMS METER DATA

Figure 7b: 2016 Load Profile (kWh)



SOURCE: SEMS METER DATA

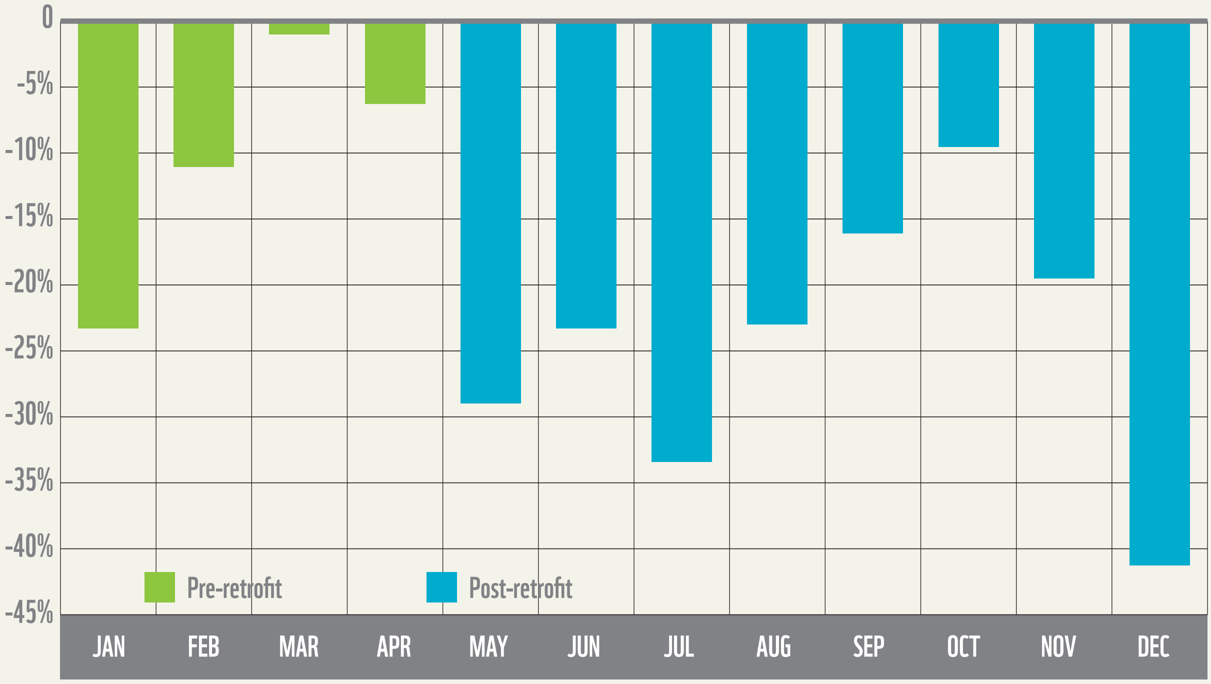
Water usage

Water consumption has decreased an average of 25.5% year-on-year post retrofit, falling from an average total of 6.4 kL to 4.8 kL per unit per month[13]. A smaller reduction in water consumption was also observed in the pre-retrofit months (January–April), of 11.4% year on year. It is unclear what could have caused this change other than tenant behaviour. A similar decrease in electricity consumption was noted for January to March, year on year, in 2016 compared to 2015.

There is a good degree of consistency in the findings, suggesting that the retrofit has been successful in terms of reducing overall water consumption. Accounting for the potential effects of suppressed demand skewing the results, there's still an overall reduction of 14%.[14]

Further, it should be noted that occupancy levels of the different blocks seems to have no appreciable effect on the percentage of water saved. However, there are variations in the savings. The Silverboom block reduced water consumption the most, by 41%. Meanwhile, Eikehuis, Chestnut and Keurboom reduced consumption by far less: approximately 14%.

Figure 8: Changes in water consumption, 2016 vs 2015 (% kL y-o-y)



SOURCE: OWN ANALYSIS BASED ON MUNICIPAL UTILITY BILLS

13 2015 and 2016, May to December, year on year.
14 Subtracting the effect of decreased water use in January–April 2016 compared to the same period in 2015, and calculating the additional savings in excess of this reduction.

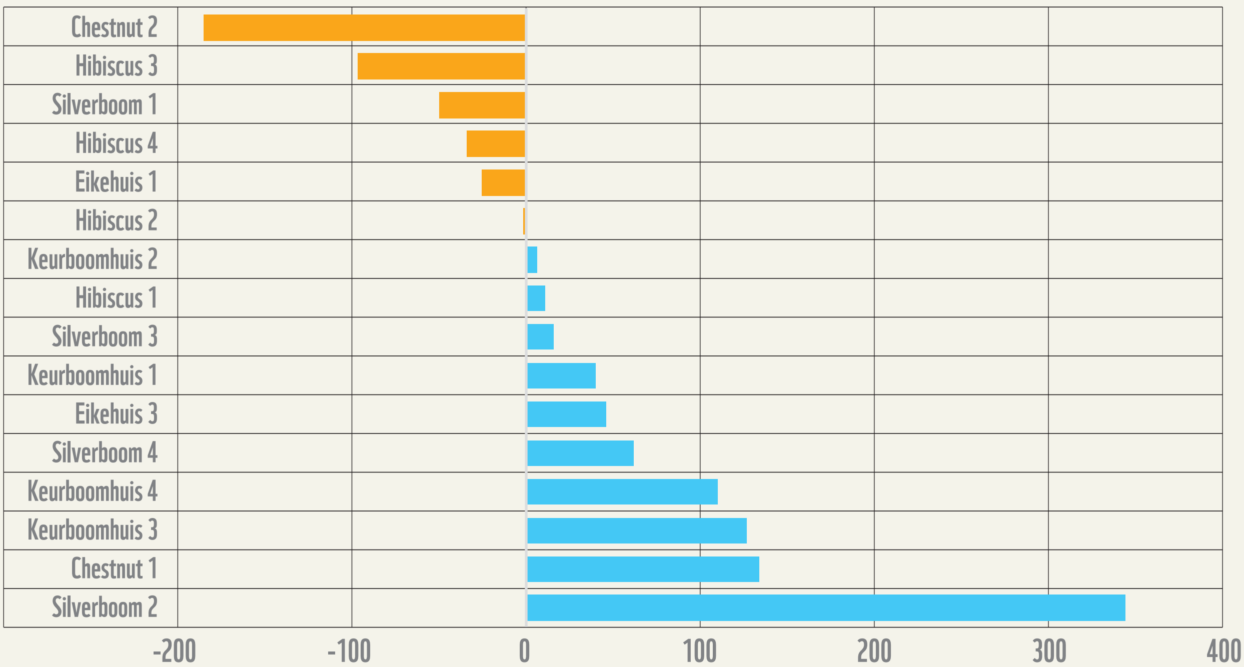
Retrofit impact

Tenant

On average, tenant financial position has improved since the retrofit took place. Estimated electricity expenditure has dropped in both absolute and relative terms, containing increases in the total cost of occupancy (which includes not just rental but associated accommodation costs such as utilities for own account). In absolute nominal terms, **monthly electricity expenditure fell by an average 12.2% year-on-year in Q4 2016, from R254 to R223**. In real terms (i.e. once inflation is allowed for), the saving approaches 17%. While the saving appears marginal, it is a valuable finding since Boom Flats rentals increased substantially over the period; any savings in utilities would have improved tenant ability to service rental obligations. Of course, this is a very small sample so conclusions remain tentative.

There is a high degree of variability in these savings, however. In certain instances, tenant expenditure on electricity remains above 2015 levels. Households at Chestnut 2 and Hibiscus 3 are spending substantially more on electricity than they did in 2015 (R97–185), while those at Silverboom 2, Chestnut 1, and Keurboomhuis 3 and 4 are each saving more than R100 per month.

Figure 9: Average monthly savings per unit, Q4 2016 (Rand, year-on-year comparison)

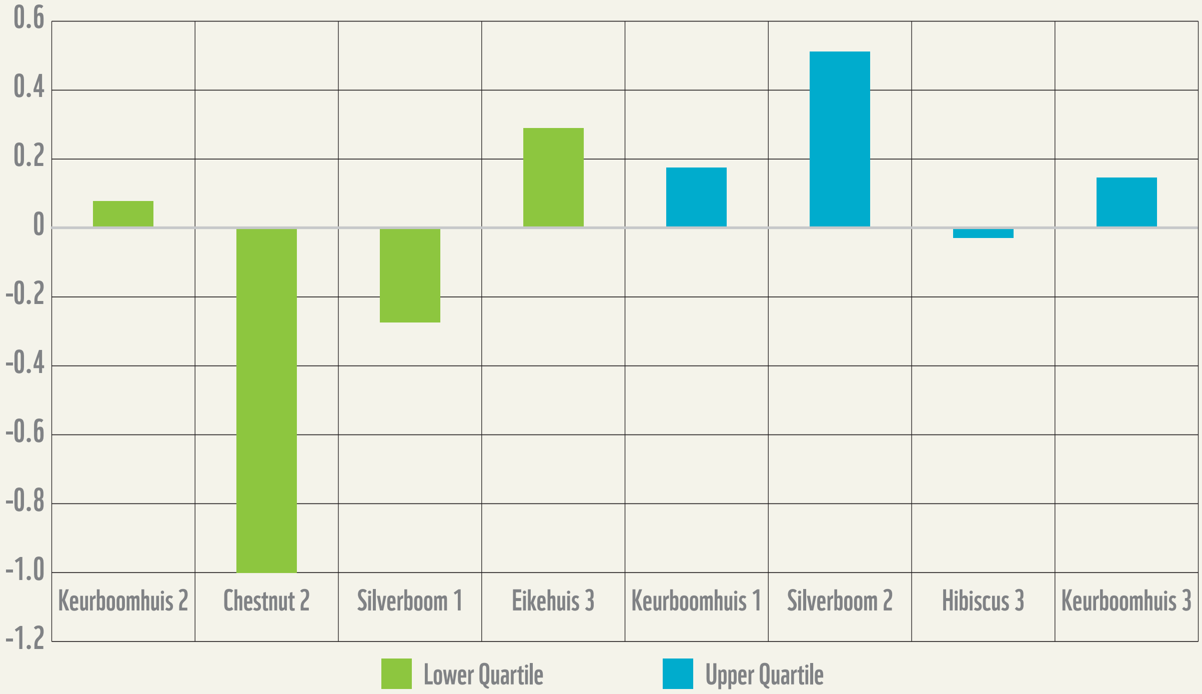


SOURCE: OWN ANALYSIS USING SEMS DATA

In certain cases, failure to realise savings appears to be due to higher or fluctuating occupancy. Chestnut 2 and Hibiscus 3 are occupied by single parents whose children and other relatives or friends visit from time to time. It may be that occupancy had permanently changed within these units between Q4 2015 and Q4 2016, or else that guests had arrived for a period of time. However, Hibiscus 4 is occupied by a pensioner couple, while the tenant at Eikehuis 1 is a single adult, so changes in occupancy do not fully explain the increase in electricity expenditure.

To better understand individual household patterns of response to the retrofit, **units were ranked from lowest to highest baseline expenditure on electricity**, in Q4 2015. The rand value of decrease/increase in electricity expenditure in Q4 2016 was then compared with these levels, and converted into percentages to control for different starting points. It can be seen that tenants in the lowest expenditure quartile are more likely to increase spend after the retrofit, while tenants in the highest quartile tend to save.

Figure 10: Average monthly savings per unit Q4 2016, lowest and uppermost quartiles (%, year-on-year comparison)



SOURCE: OWN ANALYSIS USING SEMS DATA.
NOTE: NEGATIVE VALUES IN THE %RAND AXIS REPRESENT TENANTS WHO ARE SPENDING MORE IN Q4 2016 THAN Q4 2015.

There is some tentative evidence of suppressed demand associated with energy poverty, with electricity savings being lower than anticipated and failing to realise at all in some units. The lowest quartile of consumers of electricity in 2015 actually spent 67% more money on average in Q4 2016 than in 2015. Meanwhile, the upper quartile saved 25%. This is an indication that the most energy poor households benefitted less (or in some cases not at all) from the retrofit in terms of financial savings. This may be the result of a few things: the rebound effect, where tenants are aiming to recover the efficiency through increased use; continued misunderstanding of how best to employ the energy saving measures; or of changes in occupancy – though there is little evidence of major occupancy changes. It should be noted that there is no indication that tenant status as employed or pensioner has any correlation to realized savings, although the pre-retrofit tenant data on employment status is incomplete (data available for 16 of the 20 units).

If tenants are indeed highly constrained and have high levels of unmet demand for electricity, then the retrofit is resulting in an improvement in quality of life, for example through enabling more showers or baths, enabling children to read and do homework at night, etc. The evidence for this claim is consumption remaining at a level which is 20% higher than anticipated in December 2016[15], despite having declined consistently since September 2016. It is difficult to be more conclusive since there are several conflating variables at work:

- Varying levels of tenant understanding of operation of efficient technologies, especially solar water heaters
- Varying manual operation of geyser and solar water heater back-up elements to control hot water supply
- Varying hot water fraction due to solar panel orientation, climatic conditions, etc.

In general, it is more difficult to quantitatively assess to what degree the tenant's quality of life has improved as a result of the retrofit. Interviews conducted with select tenants and green stewards suggest that the greatest perceived non-financial gain has been the cosmetic appeal of newly painted and tiled areas.

15 Projected levels of consumption are calculated by applying a 30% saving to 2015 consumption levels (75% saving in electric geyser element operation, which accounts for approximately 40% baseline electricity consumption).

MICRO EVIDENCE
TENANT INTERVIEWS

To supplement the quantitative data collected from meters and utility bills, interviews were conducted with households to gauge perceptions of the retrofit as well as the impact of the retrofit on quality of life and tenant behaviour.

Prior to undergoing the retrofit, the units were reported to be in varying condition. Some tenants were very happy with their homes, whilst others complained about inadequate maintenance, damp and mould, or window and door sealing which detracted from their experience at Boom Flats. When asked about priorities for improvement, the majority of tenants noted general maintenance (repainting, damp proofing, etc) and security upgrades. However, tenants indicated that they would not be able to cover any associated costs, implying Communicare would need to carry the additional expense.

Usage of electricity was rather limited and took place during the evening; most tenants cooked once a day (using a stove, gas, microwave or hot plate), usually to prepare supper, bathed after supper (usually only every few days), and watched some TV. Lighting at night was generally provided by CFLs. One of the household members was often responsible for manually controlling the electric geyser element, switching it on daily during the afternoon to have hot water after 6pm. During the daytime, the main appliances used were the fridge and kettle, the latter particularly frequently the pensioners who stayed at home during the day. Laundry was done weekly, using washing machines and irons. Patterns of consumption did not vary much between summer and winter, with few tenants making regular use of fans or heaters.

Overall, tenant reaction to the retrofit was mixed. Regarding positive impacts, general maintenance upgrades including painting and tiling were appreciated. Several tenants also appreciated the installation of showers, particularly older tenants which struggled to get in and out of baths. A few tenants noted the benefit of an electricity saving, usually in the order of approximately R100 (consistent with meter data calculations). Negative perceptions of the retrofit included poor workmanship, a poorly managed installation process, and an ongoing overriding concern with security (which had not been included in the retrofit process but nonetheless continued to negatively impact quality of life).

While there was a significant effort from WWF to educate and engage with tenants, there seems to be a lingering lack of tenant understanding with regard to the use of retrofit technologies. Additionally, tenant dissatisfaction with other issues at the site have somewhat diluted the overall impact and response to the initiative.

Landlord

Similarly to the average tenant experience, the landlord has also benefitted financially. In December 2015, water cost Communicare approximately R21 per day, compared with just R1 per day in 2016: a drop of 95%. The reason for the dramatic change is the subsidised 'free' allowance covered almost all consumption by late 2016. This is important considering that water tariffs increased by more than 20% over the period to discourage unnecessary water usage during the prolonged drought period. Additionally, daily sewerage costs at Boom Flats decreased from R5 to R4 (sanitation is a function of water usage). Over the course of a month, this suggests that Communicare is saving in excess of R600 in utility costs as a result of the retrofit. This excludes any maintenance saving associated with long-life lamps, replacement of geysers with solar water heaters, and so on. These are expected to be considerable.

Municipality

The key short term financial benefit to the City of Cape Town (CoCT) of social housing retrofits is a reduction in electricity subsidy in the high demand winter season. The Megaflex Municipal tariff imposes a time-of-use linked charge of between R2.50 and R2.86 per kilowatt hour for supply to municipalities during peak hours from June to August from 6–9am and 5–7pm. As redistributor, CoCT can make a substantial loss on sale of electricity during this time, charging as little as R0.97/kWh for consumption at any time of day, all year-round on Lifeline tariffs for indigent households (all figures are ex VAT). This implicit subsidy may create a significant fiscal drain for CoCT with growth in low income households due to in-migration from rural areas.

Whilst there is not yet reliable case study data on the impact of the retrofit during the peak winter months, it is estimated that the size of the electricity subsidy saving would be in the region of R621 000–R929 000 per month if all similar households occupied similar units and received similar retrofits, resulting in an annual expenditure reduction by the CoCT of R1.9m–2.8m[16]. For context, this saving approaches 0.01% of the City's 2016/17 budget of R41bn. However, it should be noted that the drop in subsidy would be offset to some degree by lower electricity savings during times when the Lifeline tariffs exceed the Megaflex Municipal tariff and so generate surplus for the CoCT.

Another longer term financial benefit is a reduction in the need for new water purification and storage infrastructure. An average annual saving of 821 megalitres water could potentially be saved through retrofitting housing for all Cape Town households of similar income levels, if results are to be extrapolated. This is approximately equivalent to water consumption for the entire population of Cape Town for one day. Additionally, such water saving measures could also be applied to upmarket homes, where the impact would be much greater in absolute terms. This is critically important in the Cape Town region, which has seen depleting water reserves due to extended drought. Current emergency alternatives range from short

16 This is based on a 10–15% winter peak hour (6–9am and 5–7pm) electricity saving realising across all 42 743 households in Cape Town with income of R4 801–9 600pm (Statistics South Africa, 2017), assuming that all of these households have similar electricity consumption to the tenants at Boom Flats.

term small scale initiatives including waste water treatment, which will reportedly cost the City in excess of R300m over the next three years, to a 450 megalitre-per-day desalination plant with a price tag in excess of R16bn (Phakathi, 2017).

National / International

In the medium term, retrofits which shift load out of peak times can assist Eskom in managing its peaker plant requirement. Extrapolating the results from the Boom Flats to other households of similar socioeconomic status in Cape Town reveals that peak demand for the group may rise to over 240 MW during winter evenings. Reducing evening peak by 40-50% amongst these homes may consequently eliminate the need for one of the 148 MW generating units at the Ankerlig open cycle gas turbine in Atlantis. Electricity produced by these plants is also not only costly, as a result of diesel combustion, but also extremely carbon-intensive.

In this instance, it is difficult to estimate with any certainty the reduction in GHG emissions, given multiple factors at work which are currently dampening the anticipated reduction in electricity consumption.

LEARNINGS AND CONCLUSION

Both tenants (on average) and the landlord Communicare have saved as a result of the energy and water retrofit undertaken at Boom Flats. While the degree of cost reduction is limited as a result of subsidised municipal 'free allowances' of water and electricity, the extremely limited disposable incomes of social housing tenants and ongoing steep increases in the price of water in Cape Town, underscore the importance of initiatives of this kind. For an average tenant household, the retrofit will deliver a monthly financial saving in the region of R50 (including VAT) during the 2017 winter months, if the 16% electricity consumption reduction observed in the last month of 2016 is sustained. Savings should be even higher amongst households with high baseline consumption, which have tended to reap the greatest benefits of the retrofit in this case.

However, it appears that additional savings potential could be realised. Anecdotally[17], tenants are confused about how best to take advantage of the retrofit, particularly the efficient water heating systems Despite awareness-raising measures conducted with tenants, the switch from manually operated electric geysers to more sophisticated systems with pre-set back-up element timers which offer less reliable outcomes (from a 'free' water heating perspective) has left tenants unsure of the financial benefits of resource efficiency. It is also possible that energy poor tenants are compensating to a degree by increasing usage, for example of hot water, effectively sacrificing financial savings to enhance quality of life. Continuing upskilling efforts and promoting correct usage through the efforts of 'green stewards' may assist in realising additional savings.

The broader benefits to South African fiscal sustainability – and thus the taxpayer base – could become substantial. Far more material savings may accrue to various spheres of government and Eskom in future, in the form of limited municipal subsidies, avoided capital costs associated with adding regional potable water facilities, and national electricity generation capacity (especially expensive peaker supply). By way of example, the CoCT is able to reduce municipal electricity subsidies during peak winter hours by an estimated R1.9m–2.8m through efficiencies realised amongst the social housing tenant target market. Finally, this study shows that the CoCT's water conservation goals can be supported through improving water efficiency near the base of the pyramid. For all of these reasons, it is worthwhile considering a small fiscal incentive to landlords serving lower income populations, which may otherwise find it financially infeasible to undertake retrofits.

17 Conversations with Tenants at Green Stewards Meetings

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WWF EVALUATION OF AN ENERGY AND WATER EFFICIENCY RETROFIT PROJECT IN SOCIAL HOUSING

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