CHAPTER 10

COST EFFECTIVENESS ANALYSIS OF LOW INCOME HOUSING

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The CEA model (in excel) is available on the CD attached to the inside cover of this manual

"While the environmental and human health benefits of green building have been widely recognized, this comprehensive (US) report confirms that minimal increases in upfront costs of 0-2% to support green design will result in life cycle savings of 20% of total construction costs – more than ten times the initial investment. In other words, an initial upfront investment of up to $100,000 to incorporate green building features into a $5 million project would result in a savings of $1 million in today's dollars over the life of the building."

Aileen Adams commenting on "The Costs and Financial Benefits of Green Buildings," a report to California's Sustainable Building Task Force, October 2003.

INTRODUCTION

There is now an emerging global consensus that unsustainable resource use (global warming, breakdown of eco-system services, depletion of key renewable and non-renewable resources) will threaten the existence of large numbers of human and non-human species. These threats have been well documented in several major international reports, including inter alia the impact of human-induced global warming (Intergovernmental

Panel on Climate Change. 2007), the breakdown of the eco-system services that humans and other living species depend on (United Nations. 2005), the depletion of oil reserves (International Energy Agency. 2008), the ecological threats to food supplies (Watson et al., 2008), the threat of water scarcity (Gleick. 2006; United Nations Development Programme. 2006), and the negative impacts on the poor of the global crisis of unsustainability (United Nations Development Programme. 2007). The result is a global consensus that the continuation of unsustainable modes of development will need to be replaced by what the Johannesburg Plan of Implementation adopted at the World Summit on Sustainable Development (WSSD) in 2002 defined as "sustainable consumption and production". This broad framework has led to a focus on cities because it is generally assumed that the construction and operation of the built environment is responsible for approximately 50% of all CO_2 emissions. There is a growing consensus that cities have to play a leading role in the transition to a more sustainable socioecological regime (United Nations. 2006).

Significantly, recent empirical research commissioned by the United Nations Environment Programme (UNEP) has identified three priority challenges, namely transport, food supplies and the construction of buildings/ urban infrastructure, which together account for more than 60 percent of total energy and materials used by the global economy. This brings into focus the technical aspects of the design and construction of buildings. More sustainable use of resources means reducing CO_2 emissions, using less primary material resources and reducing unproductive waste outputs. Sustainable living is made possible when the built environment is configured to achieve these objectives.

There is, however, a common – and sometimes offensive – opinion that sustainable built environments will remain the preserve of the affluent and/or developed economies, while minimum standard conventional housing provision remains the only affordable option for the poor. This common assumption is based on hard facts about what it costs to construct the physical structure of the house and related infrastructure, but it ignores the cost of operating the house over its entire life-cycle. This is highly problematic in light of the fact that life-cycle operating costs are projected to rise faster than inflation due to declining supply of key input resources.

The objective of this research was to demonstrate that a life-cycle approach rather than the more traditional once-off capital cost approach generates results that demonstrate that sustainable living is more affordable for both the household and the tax base of the city. This has been achieved by collecting data and information on life-cycle costs of both minimum standard conventional housing provision (hereafter referred to as the "current approach") as well as a package of "sustainable living" applications. Conclusions were reached by measuring and comparing 30-year life-cycle cost effectiveness of the two alternatives. The results are expressed as net present values, using a discount rate of 9%.

According to Wrisberg, there are several "life-cycle" methodologies that are in use in the world today that have emerged in response to the global demand for "tools" to determine the material and energy content of particular production and consumption processes, as well as environmental impacts (Wrisberg et al. 2002).

A "life cycle" approach is necessary because it has become imperative to take into account the full capital and operational costs of a given production or consumption process over the life cycle of the process. Without this kind of analysis it will not be possible at the design stage to determine which process will contribute most towards achieving a more sustainable socioecological regime; or alternatively, which one will do the least damage.

However, a wide range of life-cycle methodologies have emerged for different purposes. These included the following: Life Cycle Assessment, Material Input per Unit of Service (MIPS), Environmental Risk Assessment (ERA), Material Flow Accounting (MFA), Cumulative Energy Requirements Analysis (CERA), Environmental Input-Output Analysis (env.IOA), analytical tools for eco-design, Life Cycle Costing (LCC), Total Cost Accounting (TCA), Cost-Benefit Analysis (CBA) and Cost Effectiveness Analysis (CEA). It is not possible to describe and analyse these different methodologies here.

Suffice it to say that a CEA approach has been adopted because this makes it possible to compare the "conventional approach" to housing delivery to a "sustainable living" alternative across the life-cycle. The essence of this approach, according to Wrisberg, et al (2002), is that it does not quantify benefits like CBA, even though they regard it as a derivative of CBA. Citing a report by RPA (1998) entitled Economic Evaluation of Environmental Policies and Legislation, Final Report for DG III of the European Commission, Contract Number: ETD/97/501287, Wrisberg, et al (2002) states that CEA aims at determining the least cost option of attaining a predefined target after the fundamental decision process has been finalised. CBA, by contrast, is used to assess viability of an investment by quantifying the future realisation of costs and benefits, generally through discounted cash-flow analysis. An investment is viable if the present value of all benefits exceeds the present value of all costs. The net present value (NPV) should therefore indicate a positive return.

The following sections will cover, first a definition and description of housing, including the current approach and sustainable living alternatives; second a description of what was included in the measurement and how the measurement was executed; third the actual measurement of data collected on the current approach; fourth the actual measurement of data on the package of sustainable living applications; and fifth an interpretation of the results and formulation of recommendations.

DEFINING HOUSING AND SUSTAINABLE LIVING APPLICATIONS

The intention here is not to recoup on housing literature through the ages, but it is of relevance to firstly refer to John Turner's 1972 benchmark work where housing is defined as both a noun and a verb (quoted in Spence, Wells & Dudley. 1993). When considered as a verb, the focus is not on the physical structure of the house, but on the processes of how people came to be housed and how those people continue to sustain their existence in and from such a house. Bourne (1981) defines housing as a 'flow of services' with inputs, a matching process and outputs.

On the outputs side, shelter is only one such output and is supplemented by equity, satisfaction and status, environment, access, services and social relations, all of which have a bearing on sustainable living. This agrees with Turner's laws of housing, which emphasize that housing is not what it is, but what it does in the lives of people (Spence et al. 1993). Even though such conceptualisations of housing find many practical manifestations in various systems taking care of the livelihoods of the poor in South Africa, they are not taken to the logical conclusion of one integrated cost effectiveness framework for evaluating housing delivery in its entire life-cycle.

When turning to the sustainable living construct – or sustainable development to make it a delivery construct – it is once again not the intention to reflect on the growing volumes of literature, but as with the brief return to seminal housing definitions, the watershed Brundtland Report (World Commission on Environment and Development. 1987) and its definition invoking the needs of future generations counterbalanced by the as yet unmet current needs of a large proportion of the world's population is of relevance. The three mutually reinforcing and critical aims of sustainable development conceptualised in the Brundtland Report, namely improvement of human well-being, more equitable distribution of resource use benefits across and within societies and development that ensure ecological integrity over intergenerational timescales (see Sneddon, Howarth & Norgaard. 2006) serves as reality check when reflecting on how to improve the livelihoods of literally millions of South Africans.

It is an undeniable fact that South Africa's total ecological footprint is already between 15 and 20 percent higher than its total biocapacity (World Wildlife Foundation. 2006) and that the many current power outages and water restrictions clearly signal that it is impossible to keep on expanding business as usual as the current approach to housing delivery is doing. The National Framework for Sustainable Development that was adopted by the South African Government in June 2008 (by Cabinet resolution) explicitly stated that South African cities and housing construction must adopt sustainable resource use guidelines.

The National Department of Housing is responsible for housing delivery. Since 1994 it has adopted and implemented two quite different housing policies. The first was articulated in the 1998 White Paper on Housing which essentially provided for a capital subsidy to drive housing delivery for poor households. Because this subsidy included the land cost, the urban poor that received houses landed up on the outskirts of the urban system far from places of work and connected via expensive transport systems. Since 2004 the Department of Housing has implemented a new housing policy known as Breaking New Ground.

This policy recognises the need to provide for a range of interventions aimed at creating integrated human settlements rather than marginalised ghettoes. Significantly, the current approach does not ignore sustainable development – at least not in policy and strategy development. Since the promulgation of the Housing Act, 1997 (RSA, Act 107 of 1997), housing policy development has increasingly emphasised the importance of sustainable livelihoods. Such conditions were defined in the Act and subsequently further clarified with policies and strategies and also given content with new funding arrangements.

The Comprehensive Housing Plan for the Development of Integrated Sustainable Human Settlements (otherwise known as Breaking New Ground) as announced by the Minister of Housing, Dr Lindiwe Sisulu, in September 2004 (RSA, National Department of Housing. 2004) provides for not only the development of low-cost housing, medium-density accommodation and rental housing, but also the promotion of the residential property market through stronger partnerships with the private sector; social infrastructure; and amenities to promote the achievement of a non-racial, integrated society. Since late 2008, the Minister and her Department have emphasized the need to include "sustainability". This current approach entails making available a top structure subsidy of R43 506 (2008/09 amount) that must provide as a minimum a $40m^2$ gross area, 2 bedrooms, separate bathroom with toilet, shower and hand basin, a combined kitchen/living area, "Ready Board" electricity supply and adhere to NHBRC technical specifications (Provincial Government of the Western Cape (PGWC), Department of Local Government and Housing, 2007). These technical specifications are quite comprehensive, but nevertheless distinguish between Level 1 and Level 2 User

Performance parameters, with Level 1 "intended for houses, where for reasons of access to initial capital a user is able to tolerate more frequent maintenance cycles, limited penetration of water to the interiors, discernable deflections, minor levels of cracking etc." (RSA, National Department of Housing. 2003: 38). Even though the specifications also prescribe a design working life of 30 years for structural systems and non-accessible components and 15 years for repairable or replaceable components, the existence of a Level 1 illustrates that it remains a tendency to shift as many costs as possible later into the life cycle of the asset. This invariably means lightening the financial burden for tax-funded housing providers, but increasing the burden for tax-funded infrastructure operators and self-funded households.

The sustainable living applications package for the sake of this research project moves from the premise that the initial tax funded provision should be substantially increased in order to reduce tax funded and self-funded life-cycle operating costs, but simultaneously achieve better total life-cycle cost effectiveness. Although the emphasis is therefore on cost-effectiveness measurement (as explained in the next section), the sustainable living package selected for this comparison requires a much higher initial investment in order to introduce qualities indispensible for social, socio-economic and ecological sustainability. The sustainable living package as measured in this research is derived from the Kosovo Project design concept and estimates (ARG Design, 2008 and Kahts & Sparks, 2008) as well as research results of a Lynedoch Eco Village project as captured by Dowling (2007).

The package has the following features:

- Medium density development, i.e. 158 units per ha compared to the approximately 70 units per ha of typical "current approach" projects in order to reduce land cost per unit and give more households better access to opportunities and facilities, thereby serving the densification strategies of the City;
- Civil services infrastructure that is already more cost effective due to higher density development;
- A neighbourhood-level sanitation system consisting of neighbourhood sewage treatment plant and re-use of water, nutrients and potentially methane;
- Medium density housing structures of two to three storeys providing design opportunity for better sense of space and security;
- Better quality units, consisting of User Performance Level 2 specifications (RSA, National Department of Housing. 2003) and higher levels of finishes and fittings, ventilation, insulation with specific ecological design features with regards to orientation of units, roof and structural shielding and window sizes to maximise solar penetration in winter and shade in summer, and including thermal mass for passive heating and cooling (R3 449 per m^2 used in estimates compared to the R1 088 per m^2 used in the current approach);
- Solar water heating, with higher density allowing sharing of components between units; and
- Landscaping as ecological design feature, i.e. to use plants to provide shade in summer.

It is acknowledged that the specific package as set out here may be supplemented by further elements such as solid waste separation and recycling and rain water harvesting, the above were selected for their relative ease of application and the measurability of their life-cycle operating costs.

MEASURING LIFE-CYCLE COST EFFECTIVENESS

In this section, cost effectiveness analysis, the use of a spreadsheet template for measuring cost effectiveness analysis, the types of cost items and various sources contributing to the financing of life-cycle costs are described.

Cost effectiveness analysis

Cost effectiveness analysis is a technique for investment appraisal prescribed in the South African National Treasury directives. The "Medium Term Expenditure Framework Treasury Guidelines: Preparing Budget Proposals for the 2007 MTEF" (RSA, National Treasury. 2006), expresses the following intention:
"It is the intention of the National Treasury to progressively require more detailed analyses as funding requests are becoming larger compared to available resources. Under these circumstances it is appropriate to prioritise requests which can demonstrate the largest benefits to our country."

Since the 2007 MTEF, all new infrastructure projects or programmes require some form of appraisal to demonstrate advanced planning. Such appraisal may include needs analyses, options analyses, cost-benefit analyses, lifecycle costs and affordability analyses. Cost-effectiveness analysis (CEA) was specifically identified by National Treasury as a tool that can help to ensure efficient use of investment resources in sectors where it is difficult to value benefits in monetary terms. They specifically identified CEA as useful for the selection of alternative projects with the same objective (quantified in physical terms), and it is most commonly used in the evaluation of social projects – e.g. in the health or education sectors (RSA, National Treasury. 2006). It is therefore a logical deduction to use CEA for measuring the long term cost of housing sustainability.

A critical factor is the selection of a discount rate to convert future money into present value in order to compare costs and benefits spread unevenly over time. The higher the discount rate, the smaller the weight of future costs in the NPV. Seeing that the majority of costs in a capital investment are incurred early in the life-cycle and benefits are accrued over the longer term, it is advisable to use a higher discount rate in order to rather have a pessimistic view on future benefits. Another factor influencing the choice of a discount rate is the economic situation of the particular source. Winkler, Spalding-Fecher, Tyani and Matibe (2002) for example used the social discount rate (then 8 percent) for tax-funded investment, but a consumer discount rate of 30% for investment by poor households in their cost benefit analysis of energy efficiency in urban low-cost housing. The authors argued that poor households do not have money to invest upfront, forcing them to rely on very punitive sources of capital.

In cost effectiveness analysis, benefits or returns are not quantified. The costs incurred over a period of time for two or more alternatives serving the same purpose are discounted to a NPV and the alternative with the lowest NPV therefore represents the most cost effective investment. It stands to reason that conservatively future costs should be weighed heavier in the NPV, meaning a lower discount rate.

Similarly, future costs for poor households with their lower than inflation increase in revenue should be weighed conservatively more than present costs by means of the use of a lower than social discount rate. However, for the sake of simplicity and because we may be accused of deliberately favouring the sustainable living alternative with its higher capital and lower life-cycle operating costs, we used the 2007 National Treasury prescribed 9% social discount rate for all sources.

The spreadsheet template used

The spreadsheet template designed for measuring the NPVs of different alternatives require as input the identified capital expenditure and operating expenditure cost items, each with its base year (2008) amount, identification of its source, the year in which the expenditure starts, the year in which the expenditure ends and the price escalation expected for that item. Further input required is the discount rate per source and the identity of each source. Different discount rates to different sources could therefore be assigned, should further debate about discount rates be considered necessary in future.

Finally, the life-cycle duration must be entered. The template can therefore test NPVs for different periods of time, up to 40 years. The values depicted at the end of this report represent NPVs for different periods, ranging from five to 40 years. We went beyond 30 years even though the technical specifications for the current approach calls for a design working life of 30 years for structural systems and non-accessible components and 15 years for repairable or replaceable components in order to indicate the widening gap between the current and sustainable living packages. The latter arguably has a design life of much longer than 30 years.

Types of cost items and cost item sources

Cost items for the two alternatives were firstly divided into capital expenditure items incurred in the base year and operating expenditure items incurred from year one. Capital expenditure items had two sources: Source 1, the City or Municipality, providing funding for infrastructure and city-wide bulk services, plant and installations; and Source 2, the Department of Housing Subsidy Quantum funding the current approach to the set minimum standards.

For the sustainable living alternative, the package set out in the previous section would require a bigger allocation per house. Operating cost items had two sources, namely Source 1, operating and maintaining infrastructure and funding indirect service costs and Source 3, the household, paying consumption tariffs and maintaining the house. These costs items are set out in Tables 1 and 2 in the following sections.

LIFE-CYCLE COST MEASUREMENT OF THE CURRENT APPROACH

The main sources of data and information on the capital and operating cost items relating to the current approach were extracted or derived from the "Neighbourhood Baseline Report" (Lagus. 2007) commissioned by the Sustainability Institute; Circular Minute No. 5 of 2007, "Adjustment of the housing subsidy quantum and the introduction of the new 40 square metre quality house: 01 April 2007" (PGWC, Department of Local Government and Housing. 2007); the 2008/09 subsidy quantum updates (PGWC, Department of Local Government and Housing. 2008); "Design and Construction of Houses. Project Linked Greenfield Subsidy Project Developments. Generic SpecificationGFSH-11" (National Department of Housing. 2003); "Assessment of Housing Products" (NHBRC. 2005) and presentation notes from a September 2008 Social Housing Foundation/ShiFT workshop, "Design for efficient maintenance" (Pienaar. 2008). In addition, actual costing of various recent or planned projects in the Western Cape was used as explained below. All prices are per unit. Table 1 provides a list of cost items for the current approach. 2008 prices are used.

Table 1: Current approach costing

Capex Item	Amount
Land	10 050
Civil services infrastructure	25 855
Electrical infrastructure	9 600
Top structure 40m²	43 506
Opex Item	**Amount**
Household water and sanitation	362
Household electricity	1 020
Household other energy	850
Household maintenance	1 305
City water and sanitation	492
City electricity	293

The capital cost items measured included land, civil services infrastructure, electrical infrastructure and top structure. The price used for land was the actual price of a recent Mitchells Plain project. The other prices with the exception of top structure were derived from Lagus (2007) and escalated by 20% for base-year amounts. The reason for this high mark-up is to acknowledge the real capital expenditure for infrastructure improvement by the city in the coming years as reported by Lagus. Even the 20% escalation may be too conservative if the required long-term massive city-wide investments in especially water infrastructure (the

Berg River Dam was recently completed at a cost of R1.4bn) and electrical infrastructure are to be realised. As for top structure, the 2008/09 subsidy quantum update amount of R43 506 was used. For this amount, a minimum 40m^2 gross area, 2 bedrooms, separate bathroom with toilet, shower and hand basin, a combined kitchen/living area, "Ready Board" electricity supply and adherence to NHBRC technical specifications is expected (Department of Local Government and Housing. 2007). The housing subsidy quantum also contains information and a cost breakdown of a serviced stand totalling a 2008 amount of R17 847, which is lower than the amount used as derived from the Lagus Report, but the latter was used, because it is based on prices from actual projects and includes bulk services contributions. All capital cost items were entered in the template as if incurred in Year 0, i.e. a one year capital project taking place during 2008.

Operating cost items included in the analysis were household expenditure on water and sanitation, electricity, other energy and maintenance. With the exception of maintenance, costs were derived from the 2007 Lagus Report and escalated to 2008 prices as with capital costs. Maintenance was priced as 3% of current top structure cost. This however, may be too low, taking into consideration the Level 1 User Performance Parameters, acknowledged to require "more frequent maintenance cycles" and remedial work caused by "limited penetration of water to the interiors, discernable deflections, minor levels of cracking etc." (National Department of Housing. 2003: 38). Life-cycle price escalations used for operating cost items were 15% for water and sanitation, 16% for electricity and 9% for maintenance, keeping in mind ever increasing resource and space shortages over the next 30 years.

Capex items not included, but arguably indispensable to occur somewhere during the life-cycle, are top structure upgrading, including full electricity distribution in the unit.

LIFE-CYCLE COST MEASUREMENT OF SUSTAINABLE LIVING ALTERNATIVE

Data and information for this section came from the same sources as mentioned in the previous section, but in addition, design and cost estimate information of the Kosovo Project design concept and estimates (ARG Design. 2008; Kahts & Sparks. 2008) as well as research results of a Lynedoch Eco Village project as captured by Dowling (2007) were used to inform costs.

Capital cost items included are land utilised at Kosovo density; civil services infrastructure utilised at Kosovo density and with neighbourhood level water and sanitation system; city-wide water and sewage; electrical infrastructure; city-wide solid waste; top structure Kosovo density, User Performance Level 2, ecological design features; full electrical distribution; solar water heating and landscaping as ecological design feature. Items at 2008 prices were included in the sustainable living alternative and are shown in Table 2. All capital cost items were entered in the template as if incurred in Year 0, i.e. a one year capital project taking place during 2008.

Table 2: Sustainable living costing

Capex Item	Amount
Land medium density	4 430
Civil services infrastructure, including neighbourhood water and sanitation system	17 227
Electrical infrastructure, reduced capacity and network distances	7 680
Top structure 46m², medium density, User Performance Level 2, ecological design	158 654
Solar water heating, components shared between units	5 000
Solar water heating replacement in Year 20	5 000
Landscaping as ecological design feature	640
Opex Item	**Amount**
Household water and sanitation	181
Household electricity	510
Household other energy	425
Household maintenance	1 305
City water and sanitation	123
City electricity	147

The assumptions and cost estimates of each of these items require further clarification:

a. **Land, medium density use:**

A land price per unit of R4 430 compared to the R10 050 of the current approach was derived from the Kosovo Project costing.

b. **Civil services infrastructure, medium density, neighbourhood water and sanitation system:**

The price of R17 227 was derived by using the current approach amount, and then splitting the amount into two, assigning R13 864 to water and sanitation and R11 715 to roads and storm water, using the Department of Local Government and Housing (2008) figures to guide the split. The R11 715 roads and storm water portion was multiplied by 70 and divided by 258 to adjust it for medium density compared to the current single unit per stand approach. The water and sanitation amount was then replaced by the per unit cost of the neighbourhood water and sanitation system, using adjusted (2008) prices of the Lynedoch Eco Village Project.

c. **Electrical infrastructure reduced capacity due to smaller demand and shorter per unit cable distances due to higher density development:**

20 percent reduction in neighbourhood electrical infrastructure compared to current approach.

d. **Top structure medium density, 46m², User Performance Level 2, ecological design features:**

This item provides for the most significant cost increase compared to the current approach. The estimated cost of R158 654 per unit is derived from Kosovo estimates.

e. **Solar water heating:**

Provided at R5 000 per unit, but because of the high density, units may be able to share components, bringing about savings. Solar water heaters have an estimated life span of 20 years and provision is made for a replacement after 20 years.

f. **Landscaping as ecological design feature:**

Trees and shrubs serve to provide further thermal control and are included as R640 per unit, based on Kosovo estimates.

Operating items are the same as with the current approach, but the objective of this project was to measure cost effectiveness, with the expectation that the higher initial investment would result in substantive life-cycle savings. Price escalations were kept similar to that of the current approach package.

Costs were derived as follows:

g. Household water and sanitation, 50% saving on current approach;

h. Household electricity, 50% saving on current approach from solar water heating and ecological design;

i. Household other energy: According to Lagus (2007), paraffin and gas is used primarily for space heating and to a limited extent, cooking. User Performance Level 2 and ecological design features will reduce the need for space heating substantively, R425 allowed.

j. Household maintenance: Same amount allowed as for current approach even though the higher quality of structure and finishes will require less maintenance.

k. City water and sanitation: No sewerage and 50% less water: R123 per unit allowed.

l. City electricity: 50% saving on current approach, assuming cost allocation based on consumption.

Tables 1 and 2 and the explanations of how the various expenditure items were priced to 2008 amounts must not be seen as financial reports but simply as means of input for the spreadsheet template used to measure life-cycle cost effectiveness. The results from the cost effectiveness analysis using the above expenditure items and prices will be discussed and interpreted in the next section.

INTERPRETATION OF RESULTS

The objective of this research project was to compare life-cycle cost effectiveness of housing as currently provided with a package of sustainable living alternatives by using as far as possible costing of recent, ongoing and planned projects in the Cape Town area. This was done to determine if the common belief that sustainable housing alternatives are too expensive when compared to the current approach is valid. This section concludes on the achievement of the research objective by summarising and interpreting the results of the cost effectiveness analysis using the data as explained in the previous two sections. Table 3 and Graph 1 provide a summary and illustration of the results. They reveal that the common belief is a false perception created by the illusion of not looking beyond start-up costs. By way of interpretation of the results, the amounts in the table are explained in the following subsections.

a. **Capital expenditure**

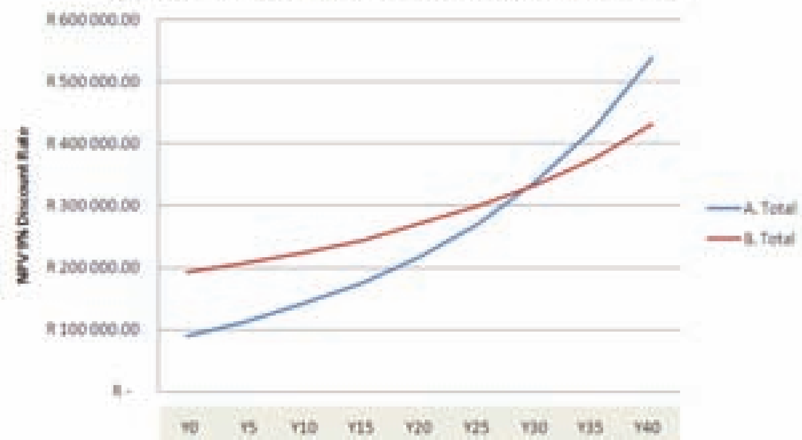
   The sustainable living package used for the purpose of this analysis requires R104 620 (117 percent) more than what is currently invested. However, in user performance level, finishes and fittings, it is a superior product not only designed to promote ecological and economic sustainability through less resource consumption and life-cycle operating costs, but also to promote social sustainability through living and community space design.

b. **Life-cycle cost effectiveness**

   The sustainable living package has, measured in NPV at a 9 percent discount rate, a R4 666 (1,4 percent) lower life-cycle cost over the prescribed 30 year technical design working life, with the added benefit that structural elements will last far beyond 30 years.

Table 3: Comparing Cost Effectiveness									
	A. Current Approach				B. Sustainable Living				C. Difference
Source:	1. CoCT	2. DoH	3. Household	A. Total	1. CoCT	2. DoH	3. Household	B. Total	A. - B.
CAPEX (Y0)	R 45 505.00	R 43 506.00	R -	R 89 011.00	R 29 977.00	R 163 654.00	R -	R 193 631.00	R -104 620.00
NPV (Y0 to Y5)	R 50 175.00	R 43 506.00	R 19 078.00	R 112 759.00	R 31 591.00	R 163 654.00	R 12 801.00	R 208 046.00	R -95 287.00
NPV (Y0 to Y10)	R 56 382.00	R 43 506.00	R 41 063.00	R 140 951.00	R 33 752.00	R 163 654.00	R 27 056.00	R 224 462.00	R -83 511.00
NPV (Y0 to Y15)	R 64 637.00	R 43 506.00	R 66 980.00	R 175 123.00	R 36 647.00	R 163 654.00	R 43 277.00	R 243 578.00	R -68 455.00
NPV (Y0 to Y20)	R 75 618.00	R 43 506.00	R 98 214.00	R 217 338.00	R 40 527.00	R 163 654.00	R 67 157.00	R 271 338.00	R -54 000.00
NPV (Y0 to Y25)	R 90 234.00	R 43 506.00	R 136 643.00	R 270 383.00	R 45 730.00	R 163 654.00	R 89 634.00	R 299 018.00	R -28 635.00
NPV (Y0 to Y30)	R 109 697.00	R 43 506.00	R 184 806.00	R 338 009.00	R 52 711.00	R 163 654.00	R 116 978.00	R 333 343.00	R 4 666.00
NPV (Y0 to Y35)	R 135 626.00	R 43 506.00	R 246 149.00	R 425 281.00	R 62 080.00	R 163 654.00	R 150 912.00	R 376 646.00	R 48 635.00
NPV (Y0 to Y40)	R 170 185.00	R 43 506.00	R 325 337.00	R 539 028.00	R 74 661.00	R 163 654.00	R 193 768.00	R 432 083.00	R 106 945.00

Graph 1: Total Cost Effectiveness Comparison



c. **Investment by the City:**

Investment not including the initial top structure cost is already lower from the first year of the life-cycle and by the end of the design working life; the sustainable living package has life-cycle cost effectiveness 52 percent better than the current approach. Apart from cost effectiveness, scarcity of urban space and the rapidly increasing scarcity of water and raw material for non-renewable energy are making dramatic densification and reduced extraction of water and energy from nature inevitable. It must be emphasised that the sustainable living package does not demand less resource consumption than the current, but cuts down on adding new water and non-renewable energy by means of recycling and use of renewable sources. The capacity of current city-wide installations and plants such as dams, purification plants, reservoirs, sewerage plants and electricity plants is stretched to their maximum already and not even the intended massive investment in new infrastructure will alleviate the problem anymore.

d. **Investment by the household:**

The most important source pays less right from the start, ending the 30-year design working life period with 37 percent better cost effectiveness than the current approach. This amount does not even include savings due to improved access to opportunities for more people resulting from higher density living or reduced health related costs due to better living conditions.

As was explained in Section 3 of this report, benefits are not quantified when using CEA. However, benefits that may result from a particular alternative, but are of such a nature that they are not directly quantifiable in terms of the unit of analysis, should still be identified and considered.

BENEFITS NOT QUANTIFIED

The benefits from a sustainable living application - apart from cost effectiveness - that deserve some explanation include creation of assets for the poor, improved access to opportunities, improved quality of life and more opportunities for utilising the large potential of renewable energy.

- The establishment of quality neighbourhoods are indispensible for realising the intended economic value of residential property. According to Blakely and Bradshaw (2002) a quality environment and strong community capacity multiply natural advantages for local economic development.
- It is not possible in this exercise and on this level of analysis to quantify and compare costs of travelling and potential lower costs of travelling of higher density developments with better access to opportunities, but it is worthwhile to refer to various research projects in this regard. According to Khan (2009, also quoting Behrens & Wilkinson. 2003; Dewar. 1995; CSIR. 1997), there is no economic justification for locating low income settlements far away from employment opportunities and higher order commercial and social facilities. For households, exorbitant travel costs weigh heavily on time and expenditure that could be deployed towards improving nutrition, health, education, incomes and dwellings. For the state, for example, the annual bus subsidy in Cape Town accumulated over five years, is equivalent to the housing subsidy, and over twenty years, it would be the equivalent of four subsidies. It is argued that if the number of South African subsidised bus commuters travelling longer than an hour were to be relocated closer to work, the yearly saving would be around R118.6 million. If central location enabled a switch to walking or other unsubsidised modes of transport, recouping the capital investment would be considerably less than twenty eight years.
- Even though quality of life indicators are used widely, it is not possible to correlate it directly with quality of living environment. However, better ventilated and insulated space as proposed by the sustainable living package will undoubtedly provide health benefits.
- South Africa's potential for utilising renewable energy and job creation through renewable energy is far from utilised as is alluded to in the White Paper on Renewable Energy (RSA, Department of Minerals and Energy. 2003). The sustainable living package does not exhaust the potential for further new innovations and technologies. Photovoltaic wind and solar generation is rapidly becoming cost effectiveness, especially with neighbourhood-level systems. This should enable energy self-sufficiency in the near future and further improve life-cycle cost efficiency even though it will further increase initial capital outlay.

CONCLUSION

We have two sets of recommendations, namely more research and short term policy adjustments:

The data captured in this report is Cape Town based. Undoubtedly, data from all urban centres and most rural areas will yield similar results, but for the sake of enhancing the validity of findings, research should be expanded to other areas and specific aspects such as the real cost of maintenance or the loss where maintenance is neglected. Empirical data on health conditions caused by inadequate insulation and either top-structure compromises must also be collected in order to enhance knowledge and further inform policy decisions. In addition, on the housing and urban development policy side, it is recommended that drastic steps to enable sustainable living housing provision should be taken immediately. The technical specifications should include all the sustainable living features and more as compulsory elements to housing provision, just as the current subsidy quantum has certain minimum design criteria. This should apply to all housing provision, even for small projects of limited numbers of housing. The initial increased demands for capital outlay should not even have to lead to a slowdown in housing provision, because of immediate savings in city-wide infrastructure costs.

These steps represent a substantive investment in the future. If there can be consensus in the car industry that massive investment to reducing the carbon footprint is nonnegotiable, then the policy and practice steps proposed here must be considered equally nonnegotiable in the face of the social, economic and ecological challenges in South Africa.