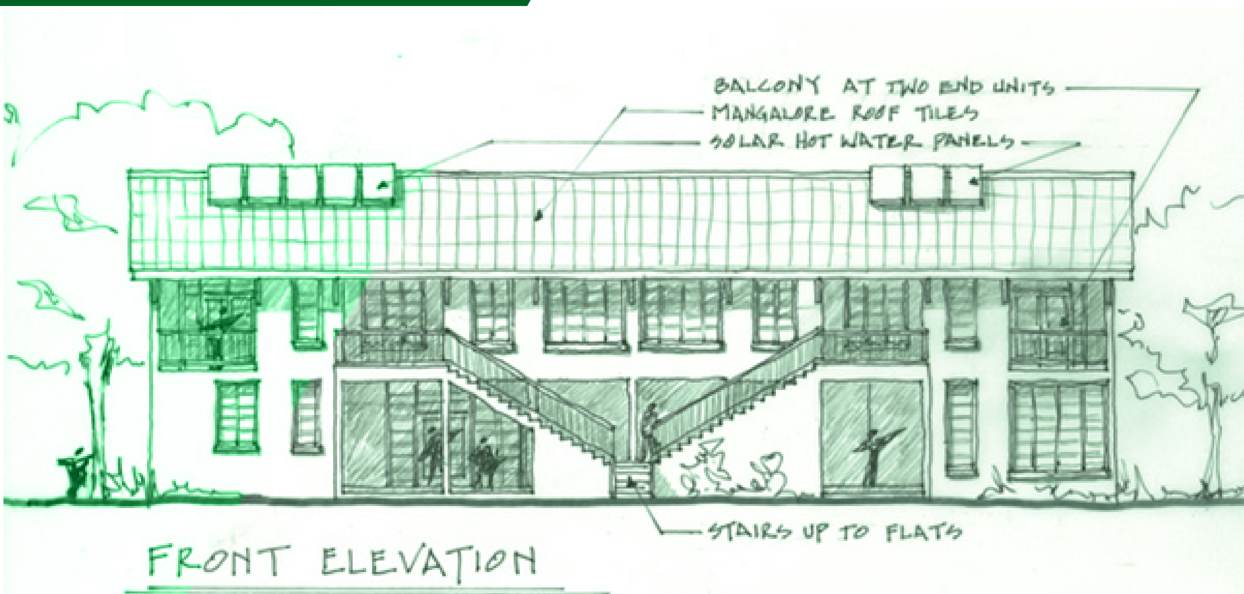
GREEN FINANCE MODELS:

ASSESSING FINANCE PRODUCT CAPACITY TO LOWER BARRIERS TO GREEN BUILDING IN EAST AFRICA



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OVERVIEW

The document was prepared as a companion piece to the Sustainable Building Finance: a practical guide to project financing in East Africa under the UN-Habitat Energy Efficiency in Buildings in East Africa (EEBEA) initiative. The intent is to test a number of the finance mechanisms/strategies described in the Sustainable Building Finance Guide for their applicability to East Africa, and assess their ability to overcome barriers to delivering green/energy efficient buildings and local low-carbon energy networks[1].

In early 2017, requests were issued to several property developers (parastatal and private) in the four main EEBEA target countries for use of planned or recently completed projects as base information for green finance product modelling. Project details and data points were sought on building typologies, design details, site layouts/large-area master plans, construction specifications, and construction cost details. Due primarily to commercial confidentiality concerns, the requested information was not secured. In lieu of this, building/project data points were collated from a number of publicly available sources of planned or proposed, in construction, or completed projects in the region. Data on construction costs, design/specification details, energy use and energy costs/expenditure was pulled from these resources where the information was stated. For this, citations are provided in the model descriptions and results in the following pages. Otherwise, the models rely on assumptions from:

- the project designs/images;
- energy cost information from national utility regulators;
- construction cost data points as described in Chapter 6 of the EEBEA Sustainable Building Finance guide;
- energy consumption data points from the UN-Habitat - Assessment of Energy and Resource Consumption in Buildings in East Africa report; and
- reference materials such as the IRENA Solar PV in Africa: Costs and Markets (2016).

Models were developed for each of the primary EEBEA target countries: Kenya, Rwanda, Tanzania, and Uganda. The results are generally applicable from one country to the next, though caution should be exercised where energy consumption rates or retail energy costs differ significantly. Moreover, given the sensitivity between affordability and benefits of green design/construction and interest rates, differences of one or two percentage points could make a material impact. Again, the transferability of results should be treated with caution where there are significant interest rate and tenor variances between countries[2]. As with any high-level modelling exercise, the results are meant to be illustrative and should be subject to further refinement with the availability of more detailed and greater number of data inputs.

1 *Refer to Chapters 4 and 5 of the EEBEA Sustainable Building Finance Guide.*

2 *Research undertaken for the EEBEA initiative suggests fairly minor differences in lending terms (interest rates, tenors, loan to value ratios) in the four countries. Note that the effect of interest rate capping presently in place in Kenya has probably pushed the interest rate 'floor' further from the norm than in other countries.*

01 HOMEBUYER GREEN MORTGAGE FINANCE: LOAN TO VALUE RATIO

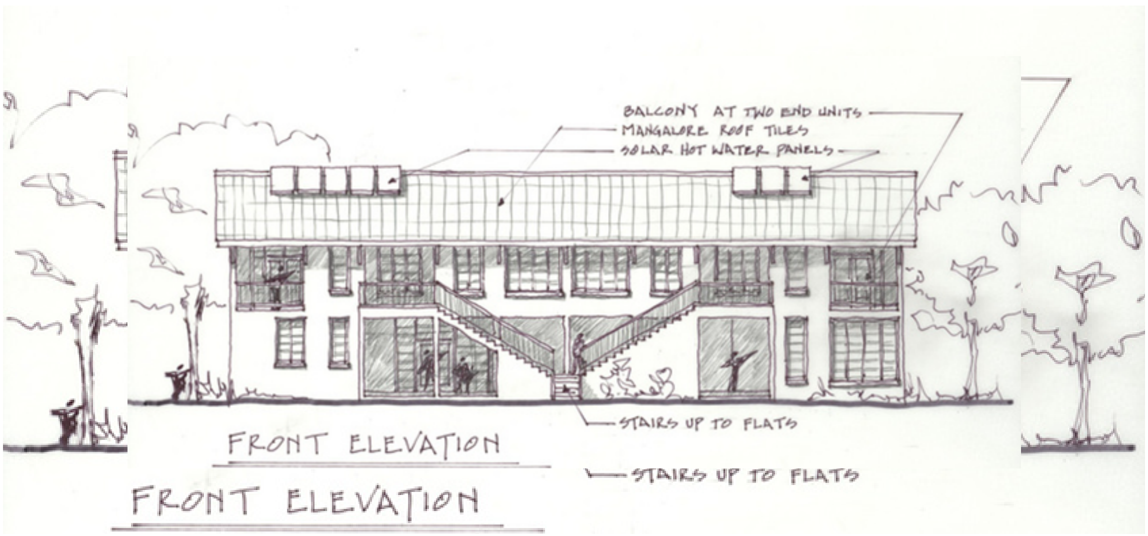
DODOMA, TANZANIA

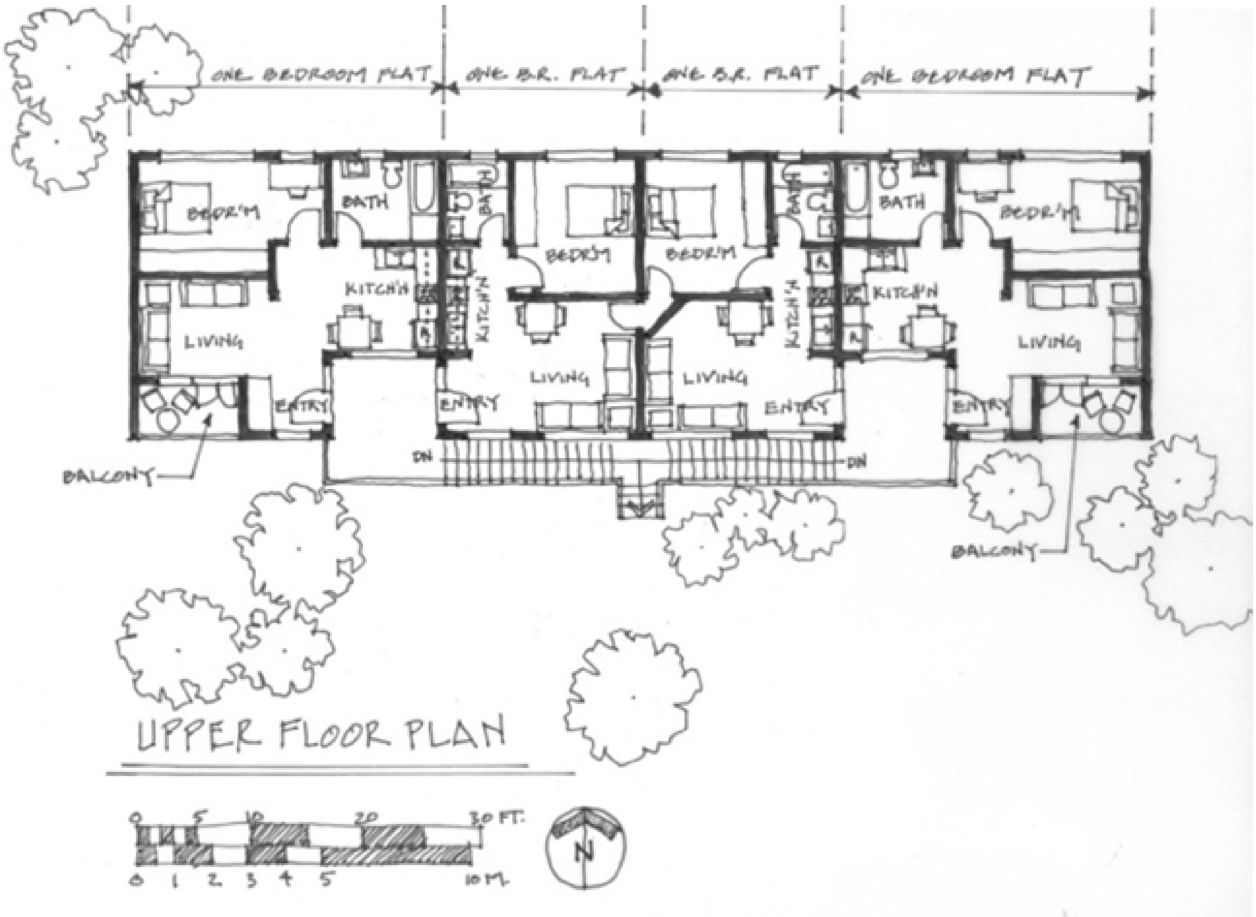
Key messages

- Banks need to make only small loan to value ratio adjustments for equity constrained buyers to accommodate higher capital costs/sales prices for green homes.
- Relatively low energy costs and usage rates may require small interest rate reductions to make energy efficiency investment affordable.

OVERVIEW

As-built plans for a four-unit residential flat complex in Dodoma, Tanzania were used to test the cost-effectiveness of energy efficiency design against prevailing mortgage finance terms. The four upper floor units, situated above a ground floor meeting and communal space at the Dodoma Christian Medical Center, are long-term guest apartments for visiting medical staff. For the model, it was assumed that the units were commercially-built flats for individual sale. The units are good examples of integrating passive design principles (long north/south orientation, cross-ventilation, roof overhang) to increase natural daylight and decrease unwanted solar heat gain (see renderings and photos below). Efficient light fittings, ceiling fans, and solar hot water heating systems were specified in the construction.





Source: *Peter Ozolins – Peter Ozolins Architecture and International Development (http://peterozolinsarchitect.com/index.php); PhD in Environmental Design & Planning Dissertation: "Assessing Sustainability in Developing Country Contexts: The Applicability of Green Building Rating Systems to Building Design and Construction in Madagascar and Tanzania" (https://theses.lib.vt.edu/theses/available/etd-05062010-150249/)*

SCENARIO

A comparison was made between an assumed standard and green/energy efficiency construction specification. The capital cost for the green unit was higher, based on the addition of a solar hot water heating system and improved building fabric. Other energy efficiency benefits result from the building's passive design attributes which are cost-neutral. The intent was to test, from the home-buyers' perspective, if the higher mortgage payments were cost-effective and delivered additional financial value, taking into account the relatively low energy usage, energy costs, and high mortgage interest rates. From the lender's perspective, the model provides guidance on changes to standard loan to value ratios and prevailing interest rates required to maintain affordability. All figures are adjusted from local currency to US$.

Data points and assumptions

- Unit sale price based on US$550 and US$571 per m^2 (standard and green construction), i.e., a 4% increase in capex.
- Base case mortgage terms of 80/20% loan to value ratio; 16% interest rate; 20 year tenor.
- Retail electric rates of US$0.12 per kWh consistent with present tariffs in Tanzania, escalating at a steady 3.5% rate for the 20 year life of the mortgage.
- Annual electricity consumption (kWh per m^2) of 16 and 9 for the standard and green units, respectively.

Results

The model shows that the loan to value ratio only changes slightly where the amount of the equity contribution (in dollars) remains equal to accommodate the higher borrowing needed for the green property. However, the value of the energy savings alone is insufficient to offset the higher mortgage costs. Therefore, a reduction in the mortgage rate is required to make the green investment cost-effective. A reduction from 16% to 15.25% makes the investment net positive over the life of the loan; a slightly lower rate of 15% significantly increases the financial value.

The model shows the sensitivity to interest rates and electricity costs. At prevailing interest rates, not all energy efficiency/green design features will be cost effective without at least a small interest rate reduction. Note that electricity costs in Tanzania are comparatively low for the region. As such, achieving a net benefit from the energy efficiency improvements in other countries may be achieved at a mortgage rate closer to the standard (e.g., 15.5% or 15.75%).

	16% (standard)	16% (green)	15.25% (green)	15% (green)
Unit sales price	US$ 30,800	US$ 32,000	US$ 32,000	US$ 32,000
Mortgage amount (principal)	US$ 24,640	US$ 25,840	US$ 25,840	US$ 25,840
Loan to value ratio	20%	19.3%	19.3%	19.3%
Annual mortgage cost	US$ 4,114	US$ 4,314	US$ 4,140	US$ 4,083
Annual electricity cost (yr 1)	US$ 107.5	US$ 60.5	US$ 60.5	US$ 60.5
Annual electricity cost (yr 20)	US$ 206.7	US$ 116.3	US$ 116.3	US$ 116.3
Net benefit (yr 1)		(US$ 153)	US$ 21	US$ 78
Net benefit (20 yr cumulative)		(US$ 2,670)	US$ 810	US$ 1,950

02 CONCESSIONAL PROJECT FINANCE FOR GREEN RESIDENTIAL CONSTRUCTION

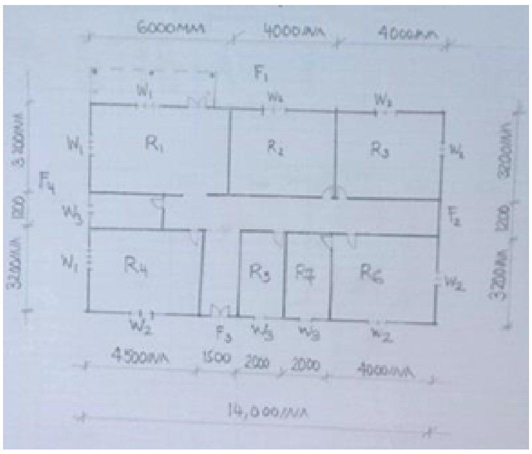
DAR ES SALAAM, TANZANIA

Key messages

- Significant interest rate concessions for project finance may be required to equalise the sales/unit price between green units and standard units, depending on the percentage increase in green housing capital cost.
- Concessions are viable finance tools in the near-term until the value of green buildings in tested in the market and developers can secure a 'green premium' and justify higher unit costs.

OVERVIEW

A number of energy audits were performed on existing buildings in Tanzania, Kenya, and Uganda as part of the Energy Efficiency in Buildings in East Africa initiative. This included a comparison of actual energy usage with predicted energy usage based on best practices in green design and construction for the relevant climatic zone. The images below are for a single-family residence in Dar es Salaam (hot and humid climatic zone), constructed in 2007. The home measures 135m². In the EEBEA energy audit report, a comparison was made between actual energy use and predicted use based on prescribed design improvements.



SCENARIO

Using the energy audit and modelling as a guide, a comparison was created between the construction costs for the existing home and a 'green' version if both were built today. The goal is to determine the interest rate concession needed on the construction finance so as to equalise the production and end-sales price of the standard (as audited) and green (as modelled) home. As consumers do not presently value green homes above standard designs, developers will likely require lower cost finance in order to bring green homes to market. Based on the building energy audit, the following improvements are recommended to bring the home toward an ideal energy consumption figure:

- external shading devices
- ventilated roof
- double glazing
- internal insulation of walls and roof
- solar water heating
- LED lighting
- High efficiency fans and air conditioning

It is estimated that the energy consumption could be less than half of the current consumption - from 38.9 to 17.5kwh/m^2 per annum - if designed to best practice standards. All figures are adjusted from local currency to US$.

Data points and assumptions

- The construction costs variations are clustered in three cost estimating categories (Roof; External walls, windows and doors; Heating, ventilation and cooling) which comprise roughly 33-40% of the construction budget.
- The greatest cost differentials between the existing home and green variation are in glazing, shading devices, insulation, and solar water heating.
- Construction costs (excluding land, fees, contingency, and developer's profit) are US$500 and US$540 per m^2 for the standard and green units, respectively.
- End sale price to buyer includes all development costs, i.e., including construction finance, professional fees, and developer's profit.
- Construction finance is based on a two year loan with twice-yearly principal and interest payments, with the land counted as a partial equity contribution.

Results

The modelling shows that a significant interest rate concession is required to accommodate the green premium (circa 7% of total development costs).

At present retail electricity rates in Tanzania, the energy costs savings to the occupant should amount to US$345 per annum. Ideally buyers would be willing to pay a modest premium for the green home, given the extra income available (lower utility costs) from their homeownership choice (i.e., use the efficiency savings to repay the larger consumer mortgage). Until this is the case, compiling evidence on energy savings can help lessen the barriers faced by developers to produce green housing units. As the market matures and there is more information available on the energy savings between average homes and best practice homes, the value of green homes should be recognised by buyers and the need for such a concession rate reduced.

Development cost figures	Standard	Green
Development cost per m^2	US$ 765	US$ 820
Total development cost	US$ 103,275	US$ 110,700
Developer equity contribution (20%)	US$ 20,655	US$ 22,140
Construction debt (loan principal)	US$ 82,620	US$ 88,560
Project finance interest rate	**17.5%**	**10.0%**
Total payment (principal and interest), 2 years	US$ 101,450	US$ 99,900
Unit price with developer's profit (20%)	US$146, 525	US$ 146,448

03 ENERGY ASSET FINANCE FOR SITE-WIDE SOLAR PV

KIGALI, RWANDA

Key messages

- Solar systems for large master plans can generate positive rates of return for energy asset developers/owners.
- Returns are marginal at 15% cost of capital, but show attractive investment opportunities at low commercial rates (12%) and particularly at concessional interest rates (7%).
- Property owners/occupiers can benefit from securing electricity costs at or below retail rates. Leasing roof areas to energy asset owners generates a small income stream.

OVERVIEW

A concept master plan for a new urban neighbourhood was prepared by a team from the University of Arkansas Community Design Center (US) and Peter Rich Architects (S. Africa). It offers a design typology and area layout vision (mixed uses, economic and social spaces, transit connections) for neighbourhoods transitioning from informal to formal settlements. The plan is based on a six hectare area comprised of individual one hectare development zones of different character and uses. The images below show the whole area and a representative one hectare zone.

Source: *University of Arkansas Community Design Center - Building Neighborhoods that Build Social and Economic Prosperity. http://uacdc.uark.edu/work/building-neighborhoods-that-build-social-and-economic-prosperity*

SCENARIO

An indicative model was created for integrating rooftop photovoltaics (PV) across the site. The model is based on a one hectare development area (above image, right). It is meant to test the potential investment returns for a developer/owner of a site-wide solar electric network. Positive returns should indicate that the energy assets could be separately developed and financed from the underlying property development, thus leveraging energy project development expertise that sits outside most property development organisations. For the model, the energy output from all the rooftops is aggregated and sold to occupiers in lieu of purchasing electricity from the local retail supplier. The site remains grid connected and will rely on grid electricity to supplement the output from the solar panels. It assumes a 20 year power purchase agreement (PPA) between the energy asset owner (the separate entity, though potentially the property developer) and the individual building occupants.

Data points and assumptions

- The electricity generated from the on-site solar system is sold at US$0.15 per kWh, which is generally equivalent to retail residential electricity tariffs in Rwanda. A 3% yearly price escalation is built into the model.
- Energy system development costs of US$2.25 per watt.
- Estimates were made on the building cover across the one hectare site (2/3rds), and roof area suitable for PV (50%). This yields a 515kW system in aggregate per hectare.
- Electricity output is based on an average of 5.7 kWh of electricity generated per m² of PV area. Total output is phased in over 3 years to account for the build-out time of the development area. A degradation of energy output of 0.5% per annum is assumed for the 20 year life of the PPA contract.
- Costs borne by the developer/owner of the PV system for operating expenses (maintenance, component replacement) and for leasing roof area are included in the model.

Results

The model generates internal rate of return (IRR) figures for an energy asset developer for the displayed one hectare zone. (Total investment could be six times the below figures if solar is incorporated over the whole of the neighbourhood development). Different investment scenarios were tested:

- an indicative 'standard' and 'low' commercial finance, i.e. a 15% standard and 12% low interest rate, 75/25% debt to equity ratio, and 15-year tenor; and
- concessional finance at a 7% interest rate, 70/30% debt to equity ratio, and 10-year tenor[3].

The cumulative 20 year net income from energy sales is the profit to residents after debt repayments. The 15% debt is effectively un-economic for project developers. The cash flow does not become net positive until year 11 and the return too small to interest equity investors. Thus the 12% or lower rate finance is needed. In reality, there is little or no commercial bank debt for solar at the above terms (interest rate, tenor) presently available for projects of this scale. The model shows the value of concessional rates to activate the market.

3 *The concessional rate is based on terms offered by commercial banks in the region via the L'Agence Française de Développement (AFD) SUNREF programme. See https://www.sunref.org/afriquedelest/en/ for more details.*

	15% interest rate	12% interest rate	7% interest rate
Equity	US$ 289,688	US$ 289,688	US$ 347,625
Debt	US$ 869,063	US$ 869,063	US$ 811,125
Cumulative 20 year net income	US$ 336,795	US$ 648,735	US 1,338,102
Internal rate of return (IRR)	**3%**	**7%**	**12%**

04 RESIDENTIAL SOLAR PV WITH ENERGY NET METERING

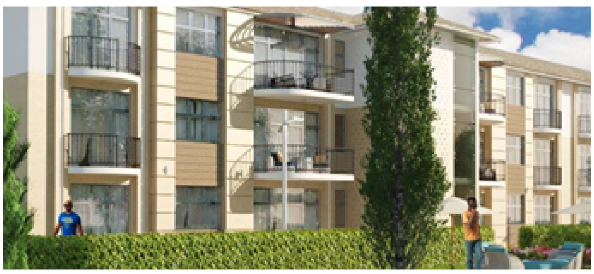
KAMPALA, UGANDA

Key messages

- Solar energy can be integrated to new buildings and financed as part of the home mortgage.
- To be cost-effective, green finance should be available to either reduce the homeowner cost (retail mortgage) or the development cost (project finance). Of the two, a small reduction on the retail mortgage rate has a much greater impact.
- Improving the energy efficiency of the residential unit maximises the economic value of the PV array where net metering is available.

OVERVIEW

The Uganda National Social Security Fund (NSSF) is presently developing an upper-income residential development in the Kampala suburb of Mbuya. A 40-unit complex of 3-bedroom apartments has been tendered and is under construction. The images show the scale and typology of the buildings planned. Note that publicly available information does not indicate solar energy is being incorporated. Thus the scheme is being utilised for modelling purposes only. The intent is to test the cost-effectiveness of PV generally as a means to lower homeowner's annual expenditures (mortgage plus utilities), and whether it is more advantageous to reduce finance rates for construction or the end-mortgage.



Source: *NSSF Uganda - https://www.youtube.com/watch?v=y1uh771hnTk ; https://www.facebook.com/notes/nssf-uganda/mbuya-housing-project-what-you-need-to-know/1181468408538953/; and The Observer (Kampala): http://allafrica.com/stories/201606090633.html.*

SCENARIO

The model incorporates solar PV on the roof of each residential block, scaled to the total floor area for the scheme and the building typology. From this, a prospective yearly electrical energy output from solar was derived. This was then matched against the indicative energy consumption for the forty residential units, assuming best practice in low-energy design for the climatic zone[4]. On this basis, there is a yearly net excess (on-site generation over on-site consumption) allowing for the on-site generation to be net-metered and generate income over a 20-year economic life of the solar array. The model assumes that the capital cost of the solar panels is added to the construction budget and financed as part of the short-term construction debt for the project. For the developer to generate its return, a pro-rata portion per individual residential unit of the solar system is added to the sales price of the unit. The pro-rata energy output for the system is similarly assigned to each unit. The model assesses the value of the solar energy to the homebuyer based on the time period in which the income from the net-metered energy exceeds the added cost to the homeowner's mortgage to incorporate solar, and the cumulative value.

Data points and assumptions

- One-third of the roof area is suitable for PV panels. The resulting system size is 108 kW.
- Annual energy generation is based on 1,570 kWh per kW of installed capacity.
- Capex for the PV system is US$2,500 per kW. This is added to the project development costs (US$625 per m^2 of floor area without solar)[5]. The capex is 100% financed through commercial construction debt[6].
- The cost of the solar is added to the base residential unit sales costs, which is US$1,120 per m^2 (without solar)[7].
- The retail electricity rate paid by homeowners for their consumption is assumed as US$0.19 per kWh, based on present tariffs in Uganda. A yearly 3.0% escalation rate in retail electric has been added. Excess energy production, i.e., solar production above energy consumption, is net-metered (returned as income) at the same retail electricity rate.
- Yearly homeowner carrying costs are mortgage plus electricity costs, minus net energy export revenue.

Three cost/benefit scenarios were tested:

1. The cost of the PV, as added to the building cost, is financed at standard project finance rates (16% interest, two-year tenor), and the buyer takes out a standard mortgage for the home purchase inclusive of PV (18% interest, 20-year tenor).
2. PV is added to the building cost at concessional project finance rates applied to 100% of the PV capex only (8% interest, two-year tenor), and the unit is purchased by the homeowner at standard mortgage rates (18% interest, 20-year tenor)
3. The cost of the PV, as added to the building cost, is financed at standard project finance rates (16% interest, two-year tenor), and the buyer takes out a 'green' preferential interest rate mortgage (17% interest, 20-year tenor).

- The base case against which the cost/benefit assessment is compared against is a residential unit without solar financed at standard mortgage rates (18% interest, 20-year tenor).
- Mortgage finance is based on an 80% loan to value ratio.

Results

- The model shows the timeframe in which a residential unit with solar energy creates lower annual carrying costs for the owner (mortgage plus electricity consumption, minus net metering income) compared to a standard non-solar unit, and the cumulative value over the 20-year mortgage loan. Benefit comparisons are based on the ways in which the solar is financed (standard and concessional construction debt; standard and preferential rate green mortgage).

4 *Based on the UN-Habitat report, as prepared under the EEBEA initiative, "Assessment of Energy and Resource Consumption in Buildings in East Africa: A Case Study of Sample Buildings, Benchmarking and Evaluation of Energy Saving Potentials."*

5 *http://allafrica.com/stories/201606090633.html*

6 *This is effectively a mezzanine or second mortgage added to the primary construction finance package.*

7 *http://allafrica.com/stories/201606090633.html*

	Standard unit	Solar unit, standard project finance	Solar unit, concessional project finance*	Solar unit, green mortgage**
Unit cost (sales price)	US$ 179,062	US$ 187,017	US$ 186,410	US$ 187,017
Debt (mortgage principal)	US$ 143,250	US$ 149,613	US$ 149,128	US$ 149,613
Mortgage terms	18%, 20 years	18%, 20 years	18%, 20 years	**17%, 20 years**
Annual carrying costs yr. 1	US$ 26,986	US$ 27,356	US$ 27,266	**US$ 25,982**
Year solar is cash-positive	-	Year 17	Year 14	**Year 1**
Cumulative costs	US$ 542,853	US$ 545,811	US$ 544,011	US$ 518,331
Cumulative benefit	-	(US$ 2,959)	(US$ 1,159)	**US$ 24,521**

* 8% interest rate on solar capex only; all other construction debt (i.e., the standard unit development package) is priced at 16%.

** Standard project development costs (16% construction finance).

All units with solar create decreasing carrying costs over time due to their steady mortgage expense but increasing value of the net-exported energy. Thus the units eventually become cash positive, even though they begin with higher mortgage principals. However, the results show that it is only in offering a small reduction in the retail mortgage rate (from 18% to 17%) that a cumulative net value is created for the homeowner. This reduction makes solar cash-positive from Year 1 compared to the non-solar unit. A reduction from 18% to 16% makes the cumulative value even more pronounced, totalling US$51,641 over the life of the 20-year mortgage. Note that the value will vary if the unit uses more or less energy, impacting solar output available for net-metering income. Thus prioritising energy efficiency in building design is critical.

05 GREEN MORTGAGE FINANCE FOR LOWER INCOME HOUSING: DEBT TO INCOME RATIO

KENYA

Key messages

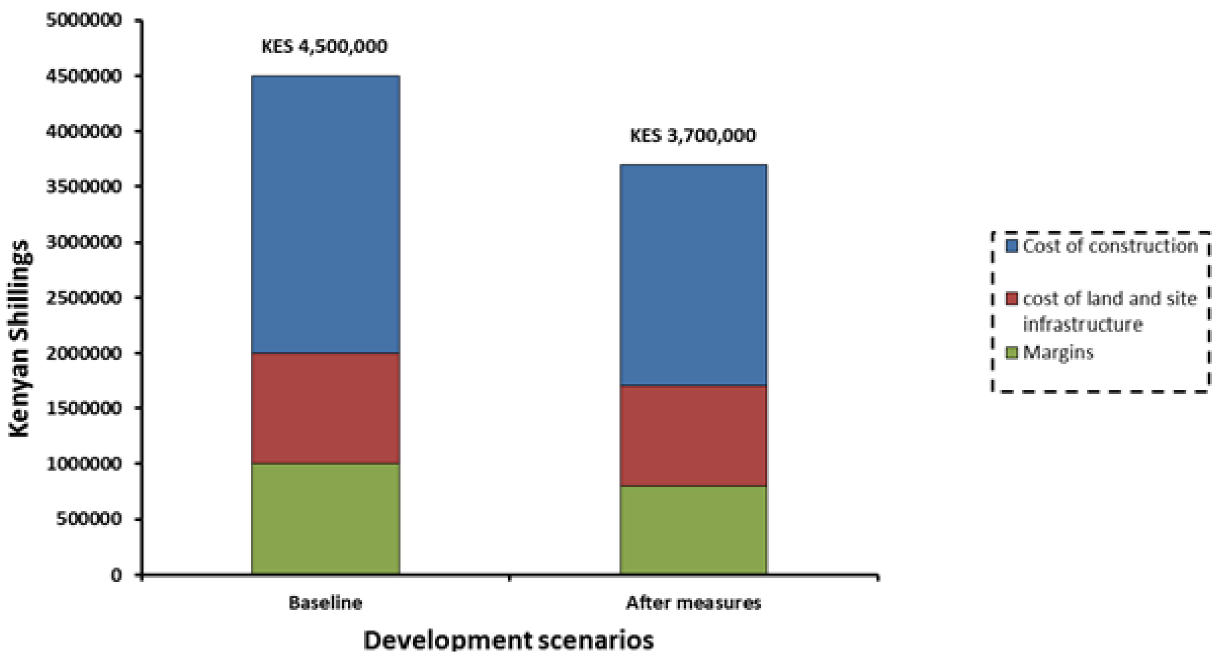
- Green mortgages can help address the significant housing affordability challenges and need to greatly expand the availability of low-cost housing.
- Construction cost reductions resulting from green building techniques should be coupled with low-interest rate and high debt to income ratio home mortgage loans.

OVERVIEW

The World Bank published a study in mid-2012 investigating how residential building practices at the low end of the Kenyan housing market could be changed to improve affordability while reducing the climate change impacts from the construction sector[8].

Compared to common practices, it found that significant material, water, and energy use savings were possible through improved design/engineering specifications, material substitution, passive design measures, and water saving devices. Importantly, these could actually lower the cost of construction, primarily through specification and material changes. The graph below shows the possible modelled development cost reduction. The images on the next page are examples of typical design/construction for housing in Nairobi.

8 *Kalra, R and Bonner, R. Addressing Climate Change with Low-Cost Green Housing. World Bank, Washington, May 2012. http://siteresources.worldbank.org/FINANCIALSECTOR/Resources/Low_Cost_Green_Housing_Final_Report.pdf*



Sources: *Kalra, and Bonner (2012) (top images); Hydraform (http://www.hydraform.com/) (lower images)*

The bottom images highlight an alternative material to conventional stone and block walling that the authors cite as having significant cost saving potential – stabilised soil blocks called Hydraform which are common in Sub-Saharan Africa but less so in Kenya (Hydraform machine, bottom left, and example of Hydraform block building in Nairobi).

A similar investigation in Ethiopia to assess cost reduction potential in lower-income housing compared conventional hollow concrete block (HCB) construction to stabilised soil blocks (Hydraform / HF) produced a modelled cost savings of 30%[9]. This is summarised in the table on page 13.

9 *Woundimagegnehu, Tameru (ND). Affordable Houses for Middle and Low Income Group in Ethiopia. Ministry of Works and Urban Development, Federal Democratic Republic of Ethiopia. Retrieved 26 April 2017 from http://www.humanitarianlibrary.org/resource/affordable-houses-middle-and-low-income-group-ethiopia-0#comments*

No	US$ is equivalent to 12.88 Ethiopian Birr	Conventional construction of HCB wall & reinforced concrete structure elements	Load bearing hyraform (HF) wall with new construction system	Cost comparison of HF against HCB in %
A SUB-STRUCTURE				
1. Excavation & earthwork	BIrr	6,521.55	5,663.79	-13.15
2. Concrete work	"	32,107.28	8,707.79	-72.88
3. Masonry work	"	12,271.03	7,553.24	-35.45
SUB-TOTAL	"	50,899.86	21,924.82	-56.93
B SUPER STRUCTURE				
1. Concrete work	"	66,027.56	35,658.37	-45.99
2. Block work	"	30,250.09	34,910.80	15.41
3. Roofing	"	14,296.57	14,296.57	0.00
4. Carpentry	"	11,728.57	11,728.57	0.00
5. Joinery	"	7,155.00	7,155.00	0.00
6. Metal work	"	10,645.40	10,645.40	0.00
7. Finishing	"	63,077.12	31,535.28	-50.01
8. Glazing	"	1,862.06	1,862.06	0.00
9. Painting	"	12,077.22	12,077.22	0.00
10. Electrical installation	"	9,163.00	9,163.00	0.00
11. Sanitary installation	"	8,610.00	8,610.00	0.00
SUB-TOTAL B	"	235,742.59	178,827.06	-24.14
TOTAL A+ B	"	285,792.45	199,567.09	-30.17

Cost comparison between new construction material technique of HF and conventional HCB construction system. Calculated based on the model design and price index at time of publishing.

SCENARIO

Using the construction cost figures and average lower-income earning and household expenditure figures from the World Bank report, a model was developed to assess the affordability gap (difference between incomes and housing costs), and the contribution that green mortgages can make to closing this affordability gap. A range of interest rate, loan to value, and debt to income ratios were tested for their impact on borrower ability to repay. The debt to income measure is the data point of most significance, assuming that the predicted household energy savings from the green construction serves as 'income' to repay the housing debt.

Data points and assumptions

- Green unit sales price, based on improved design/material/specification measures, of KSh. 3,700,000 (compared to KShs. 4,500,000 for the standard dwelling).
- Average monthly income of the target buyer is KShs. 60,000.
- Average monthly utility cost paid by the target buyer is KShs. 6,000 (standard housing).
- Standard interest rates are consistent with present rates in Kenya due to interest-rate capping as mandated by the Kenyan government.
- All figures are based on data from the 2012 World Bank study and have not been updated to present day values. It is assumed that the ratios between housing costs, utility costs, and household income for the lower-income market in Nairobi hold similar to present day conditions.

Results

The modelling shows that even with the lower cost of construction for the green home (KShs. 3,700.000), affordability is a significant challenge. It is unlikely that banks can find a significantly sized pool of qualified buyers at conventional lending terms, e.g. debt to income ratios of 35% and below. It is only at ratios between 40% and 50%, and with mortgage interest rate reductions, that incomes match the cost of the mortgage loan.

The cells in yellow designate loan products/terms where the debt to income ratio is between 45% and 50%. The green cell shows a ratio below 45%. All figures are based on the average monthly income cited above. If the lender treats predicted energy savings as income, i.e., the reduced energy payments made by owners monthly is credited in the debt to income calculation, the 12%, 25 year loan with red text is only below 50% (figure in parenthesis) based on a utility cost reduction of 50% compared to a standard home. (All other debt to income percentages shown are absent any factoring of utility savings.)

The model demonstrates that to effectively serve the lower end of the housing market, construction cost savings need to be coupled with long-tenor and low-interest rate loans.

Given the additional 'income' from the prospective energy savings of the green unit compared to conventional construction (that is, expected energy reductions between 20% and 50%), there is some room for lenders to relax debt to income ratios. Research from the United States has also shown that occupiers of green homes are less likely to default on their mortgages, thus further reducing lender risk.

	90% LTV (KES/month)	Debt to income ratio	80% LTV (KES/month)	Debt to income ratio
Standard rates and tenor				
15.5% 10yr	54,749		44,226	
15.5% 20 yr	45,084		36,420	
15.5% 25 yr	43,948		35,501	
Green interest rate reduction				
12% 10 yr	47,776		42,467	
12% 20 yr	36,666		32,592	
12% 25 yr	35,072		31,175	**52% (49%)**
Deep Green interest rate reduction				
10% 10 yr	44,006		36,116	
10% 20 yr	32,135		28,565	**45%**
10% 25 yr	30,260	48%	26,898	**43%**

All figures are KES per month. Blank cells in the debt to income ratio mean that the ratio exceeds 50%.

The project **"Promoting Energy Efficiency in Buildings in East Africa"** is an initiative of UN-Habitat in collaboration with the United Nations Environment Programme (UNEP), the Global Environment Facility (GEF) and the governments of Kenya, Uganda, Tanzania, Rwanda and Burundi.

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