Partnership for Growth: Energy Efficiency in Tanzania – Green Buildings

FINAL REPORT

*Prepared under the **Energy Efficiency for Clean Development Program***

Leader Award

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1. INTRODUCTION

This report summarizes findings from activity completed under "Partnership for Growth – Energy Efficiency in Tanzania," a project under ICF's current Leader with Associates cooperative agreement with the U.S. Agency for International Development (USAID) entitled "Energy Efficiency for Clean Development Program" (EECDP), No. AID-OAA-L-11-00003-00. Along with objectives to address energy-saving opportunities through capacity building among utility staff and key electricity customers (under Work Stream 1), the project also set out to explore how a green building initiative could address energy efficiency opportunities related to the boom in civil construction taking place in Dar es Salaam (Work Stream 2).

The findings are intended to further inform efforts by the utilities (TANESCO and ZECO), private-sector stakeholders, the Government of Tanzania, USAID, additional international donor agencies, and other entities working to improve energy efficiency in Tanzania.

1.1 BACKGROUND

Tanzania is undergoing a boom in civil construction as economic growth accelerates in Dar es Salaam, the largest city in Tanzania, and across the island of Zanzibar, with its large tourism business. These are the country's main economic and social centers and are attracting new construction projects focused on office buildings, hotels, and residential apartment buildings. The new buildings are typically designed with central climate control rather than with the passive ventilation and distributed air conditioning systems that are traditional in low-rise construction. As more new buildings become operational, they will drive a massive increase in electricity load with an increasingly steep peak load profile, which the current Tanzanian power system is ill-equipped to handle with existing and planned generation. In addition, they will tax an already-overloaded transmission and distribution system.

Many countries have embraced green buildings as a strategy to control increasing energy demand. The global green building movement has a multitude of drivers, not the least of which is improved energy performance through energy efficiency and design strategies. Green buildings also have broad appeal for their integration of passive and technical solutions to achieve comfortable and healthy indoor environments. There are four primary green building rating systems which are operational in multiple countries:

1. Building Research Establishment's Environmental Assessment Method (**BREEAM**) claims the oldest and largest program with more than 500,000 registered certificates since its inception in 1993.
2. The US Green Building Council's Leadership in Energy and Environmental Design (**LEED**) program was established in 1998 and is primarily focused on US residential buildings.
3. The **Green Star Rating System** was originally designed in Australia based on experiences from LEED and BREEAM, and has been adapted for South Africa and most recently Ghana.
4. **Estidama Pearls** was established in 2009 to address particular issues related to green buildings in the Persian Gulf region.

These green building rating systems generally address similar building features such as energy and water consumption, landscapes, indoor environmental quality, materials, and building management practices. The Green Star Rating System, which is well-established in South Africa, has created rating tools for offices, public and education buildings, retail centres, multi-unit residential buildings, and interior retrofit projects. The program claims to yield 25-50 percent lower operating costs, increased property values, higher return on assets, reduced liability and risk, increased comfort, and reduced emissions. The rating system is primarily based on the following characteristics: (1) management, (2) indoor environmental quality, (3) energy, (4) transport, (5) water, (6) materials, (7) land use & ecology, (8) emissions, and (9) innovation.

In this context, a green building initiative, if successfully implemented and incorporated by the private sector, could have profound and long-lasting benefits for the Tanzanian power system and economy. While a long-term effort is required to produce measurable impacts on energy use and peak load, it is nonetheless an important element of the country's electric load growth management strategy over time. Therefore, ICF considers a green building initiative to be an element of a larger demand-side management (DSM) effort, with the understanding that it will take more time to result in significant levels of energy savings than some of the other DSM elements.

1.2 Approach

For this green building activity, ICF conducted (1) an energy savings potential assessment that incorporated the energy analytics needed to quantify the long-term demand-side management (DSM) potential of a green buildings initiative, and (2) a market assessment to establish a basic understanding of the market and institutional factors that would affect the design and implementation of such a scheme.

Energy Savings Potential Assessment

Activity 1 - Conduct Energy Analyses of Design Measures – Using data from Work Stream 1, task 4, which examined savings associated with physical characteristics and energy feature characteristics of buildings, ICF characterized and simulated a series of green building design strategies, including:

- Energy-efficient technologies such as cooling equipment, water heating equipment, lighting, cooking, and fans/pumps;
- Basic architectural features such as orientation, fenestration/shading, and thermal mass;
- Adaptive comfort strategies that include varying assumptions about temperature settings in building HVAC (heating, cooling, and air-conditioning) control systems, and related measures that can minimize energy demands on a daily and annual basis; and
- Renewable energy including photovoltaic, wind, and solar thermal technologies.

The resulting simulations included estimating technical potential energy savings for applying a set of improved green building strategies to buildings in Tanzania.

Market Assessment

Activity 2 – Analyze Municipal Construction Policies, Practices, and Infrastructure – To provide guidance in Tanzania's urban areas on green building, ICF conducted an assessment of policies related to construction, including zoning restrictions, material requirements, codes, and earthquake/natural

disaster requirements. These types of requirements are necessary to provide a foundation for specific policies on green building. Similarly, ICF assessed other existing practices regarding building design and construction to inform a strategy to introduce green building widely into the market including infrastructure for building construction, such as the inspection and permitting processes, professional certification, and training that exists for construction.

Activity 3 – Identify and Conduct Outreach to Stakeholder Groups. ICF identified stakeholders active in green building and/or with related activity and interests. Outreach was conducted with local organizations active in this area, including the main university and primary real estate developers in Dar es Salaam. Information on available green building benchmarking tools, guidance, and networking opportunities in the region was assessed along with the current interests, activities, and potential roles of stakeholder groups. Particular attention was paid to seeking out partnering opportunities that would leverage progress made by other funders and organizations. For background on potential regional partners, ICF also communicated with implementers of the Green Star South Africa rating system.

1.3 Report Overview and Organization

This report summarizes the findings of both an energy savings potential assessment (***Section 3***) and a market assessment (***Section 4***), and concludes with a proposed set of near-term recommendations for expanding green building activity in Tanzania (***Section 5***). Due to the current strain on the power grid and expectations for continued economic growth, the analysis of "green building" potential focuses primarily on opportunities for energy efficiency and the resulting energy savings. For green buildings, in general, energy efficiency measures are critical to balancing additional construction costs that may be incurred when incorporating materials and technology that support an overall goal of environmental impact reduction. At the same time, the recommendations do not assume an ideal process or required starting point to achieve progress on green buildings; instead, they utilize the assessment findings to inform reasonable next steps that build on current activity, interest, and market realities in Tanzania.

2. ENERGY SAVINGS POTENTIAL ASSESSMENT

ICF characterized and simulated a series of green building design strategies appropriate for Tanzania, using data generated under Work Stream 1 of this project which identified opportunities for demand-side management. The energy opportunity analysis focused on building performance improvement related to energy consumption, which is typically more readily verified and inspected compared to other green building criteria (e.g., product/material sustainability). Savings associated with physical characteristics and energy feature characteristics of buildings were examined, including:

- Energy-efficient technologies such as cooling equipment, water heating equipment, lighting, cooking, and fans/pumps;
- Basic architectural features such as orientation, fenestration/shading, and thermal mass;
- Adaptive comfort strategies that include varying assumptions about temperature settings in building HVAC (heating, cooling, and air-conditioning) control systems, and related measures that can minimize energy demands on a daily and annual basis; and

- Renewable energy, including photovoltaic, wind, and solar thermal technologies.

2.1 Energy Savings Opportunity Analysis

Building Characteristics and Efficiency Levels

In general, green building design and construction strategies can be more effective for commercial buildings than residential or industrial buildings. Commercial buildings are typically managed by entities with sufficient institutional capacity to create and maintain green building measures. Additionally, energy processes do not compete with the property manager's core business interests, as could be the case with industrial facilities. Based on ICF ground observations, six commercial building types were believed to yield the highest energy savings opportunities:

- Medium-size Office Building
- Outpatient Medical Facility
- Small Restaurant
- Secondary School
- Small Hotel
- Retail Outlet/ Strip Mall

These building types were used to estimate the potential for energy savings impacts of green building design measures in Tanzania. As a first step, the baseline (current practice) and proposed "green building" levels for building energy efficiency features were identified for the selected building types. These are summarized in the tables below: Table 1 (Medium Office); Table 2 (Outpatient Medical Facility); Table 3 (Small Restaurant); Table 4 (Secondary School); Table 5 (Small Hotel); and Table 6 (Retail Outlet/Strip Mall).

Table 1 - MEDIUM OFFICE: *Baseline and Green Building Levels for Energy Efficiency Features*

Feature Category	Energy Efficiency Feature	Baseline Level	Green Building Level
Building Envelope	Air Infiltration (ACH)	0.75	0.2
	Roof R-Value	1.76	2.79
	Above grade wall R-value	0.77	1.42
	Foundation R-Value	0.54	0.54
	Fenestration SHGC	0.54	0.25
HVAC	Cooling Efficiency (COP)	3.11-3.38 COP	3.23-3.38 COP

Water Heaters	Water Heater Thermal Efficiency	80%	80%
Lighting	Lighting Power Density (W/m^2)	16.9	10.8

Table 2 - OUTPATIENT MEDICAL FACILITY: ***Baseline and Green Building Levels for Energy Efficiency Features***

Feature Category	Energy Efficiency Feature	Baseline Level	Green Building Level
Building Envelope	Air Infiltration (ACH)	0.93	0.28
	Roof R-Value	1.76	2.79
	Above grade wall R-value	0.77	1.42
	Foundation R-Value	0.61	0.61
	Fenestration SHGC	0.54	0.25
HVAC	Cooling Efficiency (COP)	3.01	3.13
Water Heaters	Water Heater Thermal Efficiency	80%	80%
Lighting	Lighting Power Density (W/m^2)	18.9	13.5

Table 3 - SMALL RESTAURANT: ***Baseline and Green Building Levels for Energy Efficiency Features***

Feature Category	Energy Efficiency Feature	Baseline Level	Green Building Level
Building Envelope	Air Infiltration (ACH)	2.41	0.64
	Roof R-Value	1.76	5.18
	Above grade wall R-value	0.77	1.98
	Foundation R-Value	0.32	0.32

	Fenestration SHGC	0.54	0.25
HVAC	Cooling Efficiency (COP)	3.3-3.67	3.5-3.67
Water Heaters	Water Heater Thermal Efficiency	80%	80%
Lighting	Lighting Power Density (W/m^2)	16.05	17.8

Table 4 - SECONDARY SCHOOL: ***Baseline and Green Building Levels for Energy Efficiency Features***

Feature Category	Energy Efficiency Feature	Baseline Level	Green Building Level
Building Envelope	Air Infiltration (ACH)	0.6	0.16
	Roof R-Value	1.76	2.79
	Above grade wall R-value	0.77	1.42
	Foundation R-Value	0.54	0.54
	Fenestration SHGC	0.54	0.25
HVAC	Cooling Efficiency (COP)	3.13-3.5	3.5
Water Heaters	Water Heater Thermal Efficiency	80%	80%
Lighting	Lighting Power Density (W/m^2)	15.4	12.4

Table 5 - SMALL HOTEL: ***Baseline and Green Building Levels for Energy Efficiency Features***

Feature Category	Energy Efficiency Feature	Baseline Level	Green Building Level
Building Envelope	Air Infiltration (ACH)	0.95	0.25
	Roof R-Value	1.76	2.79

	Above grade wall R-value	5,84	1.42
	Foundation R-Value	0.54	0.54
	Fenestration SHGC	0.54	0.25
HVAC	Cooling Efficiency (COP)	3.2-3.4	3.67-3.8
Water Heaters	Water Heater Thermal Efficiency	80%	80%
Lighting	Lighting Power Density (W/m^2)	16.1	10.4

Table 6 - RETAIL OUTLET/"STRIP MALL": *Baseline and Green Building Levels for Energy Efficiency Features*

Feature Category	Energy Efficiency Feature	Baseline Level	Green Building Level
Building Envelope	Air Infiltration (ACH)	1.23	0.33
	Roof R-Value	1.76	2.79
	Above grade wall R-value	0.77	1.42
	Foundation R-Value	0.32	0.32
	Fenestration SHGC	0.54	0.25
HVAC	Cooling Efficiency (COP)	3.23-3.5	3.3-3.67
Water Heaters	Water Heater Thermal Efficiency	N/A	N/A
Lighting	Lighting Power Density (W/m^2)	38.5	17.5

Renewable Energy

Building technologies that utilize renewable energy to reduce the energy required from the electric grid are a significant part of the green building energy profile. While these technologies can increase the cost of construction, this is often paid back in the near-term through energy savings (from renewable technology as well as from other energy-saving building features). Solar hot water heaters and photovoltaic technology, as described below, were assessed as cost-effective opportunities and incorporated into the "full code upgrade" scenario for analyzing buildings in Tanzania. The elements of this scenario are further described in the following section (*3.2 Beacon Commercial Analysis*). The associated energy cost savings for these renewable technologies are tabulated in Table 7.

Solar Hot Water Heaters

Solar hot water heaters capture thermal energy from solar radiation to heat water in order to meet the building's hot water demand. Using ICF's building reference models for each building type and ICF expertise, it is expected that 10 percent of each building type's rooftop can be utilized for solar water heaters. At an average solar irradiation of 2100 W/m^2 per year in Tanzania, and a conservative energy solar irradiation to hot water energy conversion rate of 40 percent, every building is expected to meet its entire hot water requirements using solar hot water heaters.

Photovoltaic (PV)

PV technology converts photons from light, particularly the sun, into electricity using the photovoltaic process. Similar to solar hot water heaters, it is assumed that 10 percent of each building type's rooftop can be utilized for PV technology. However, commercial PV technologies can be expected to convert roughly 10 percent of solar irradiation into useful electricity. While advanced technologies can help achieve efficiencies as high as 25 percent, they are often expensive and not accessible in many markets.

Table 7 - Energy cost savings potential for renewable energy technology with energy cost of TZS 205 per kWh

Building Type	Estimated Annual Electricity Demand (MWh)	Full Code Upgrade Annual Hot Water Demand (kWh)	Assumed Utilizable Roof Space for Solar Energy Technologies (m^2)	Annual Energy Cost Savings Potential for Solar Water Heaters	Annual Energy Cost Savings Potential for PV
Medium Office	830	5,636	166	TZS 1,155,403	TZS 7,149,443
Outpatient Medical Facility	1,588	7,033	137	TZS 1,441,833	TZS 5,912,013
Small Restaurant	231	13,606	26	TZS 2,789,139	TZS 1,114,392
Secondary School	3,924	63,556	1,190	TZS 13,028,889	TZS 51,238,110

Small Hotel	764	61,547	100	TZS 12,617,181	TZS 4,319,637
Retail Outlet/Strip Mall	395	-	209	TZS 0	TZS 8,998,828

2.2 BEACON COMMERCIAL ANALYSIS

Using ICF's Beacon™ Commercial software[1], the following improvements in energy consumption were simulated for each of the following criteria:

- **Full green building code upgrade** assumes a package of features to be implemented together under a code or standard that include: air sealing; loading dock weatherseals, where applicable; vestibules; roof insulation; above grade wall insulation; floor insulation; fenestration solar heat gain coefficient (SHGC) improvement; door insulation; duct sealing; efficient fan power; efficient cooling equipment; efficient water heating; and efficient lighting.
- Efficient cooling equipment
- Efficient lighting
- Efficient water heating
- Efficient windows
- Orientation of building

These criteria were selected for separate simulation in order to isolate unique effects from interactive effects between different components of a building. For example, more efficient cooking equipment could reduce cooling requirements and would falsely claim larger savings for efficient cooling equipment. The results are presented below in Figure 1.

[1] See Appendix for detailed explanation of tool.

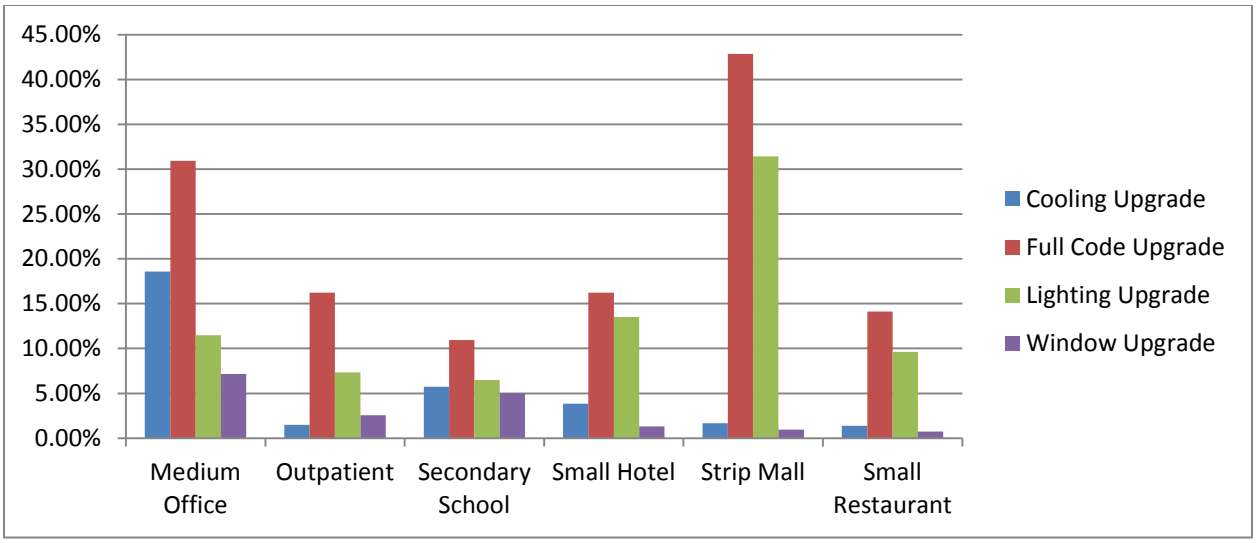

Figure 1 – Utility bill % savings for different proposed energy-related green building measures

Full green building code implementation as defined in this section can yield between 11 and 43 percent energy reduction. With a T2 tariff class energy rate (commercial – low voltage supply) of roughly 205 TZS per kWh, this equals to TZS 22,550 to TZS 92,250 per 1000 kWh of baseline energy consumption per year. A deeper analysis of end-use consumption before and after implementation of the code requirements, presented in Figure 2, reveals that interior equipment are a primary source of consumption and could yield significant operation cost reduction opportunities for tenants and property managers. Interior equipment upgrades were not included in this model due to limited understanding of available appliances in the Tanzanian market.

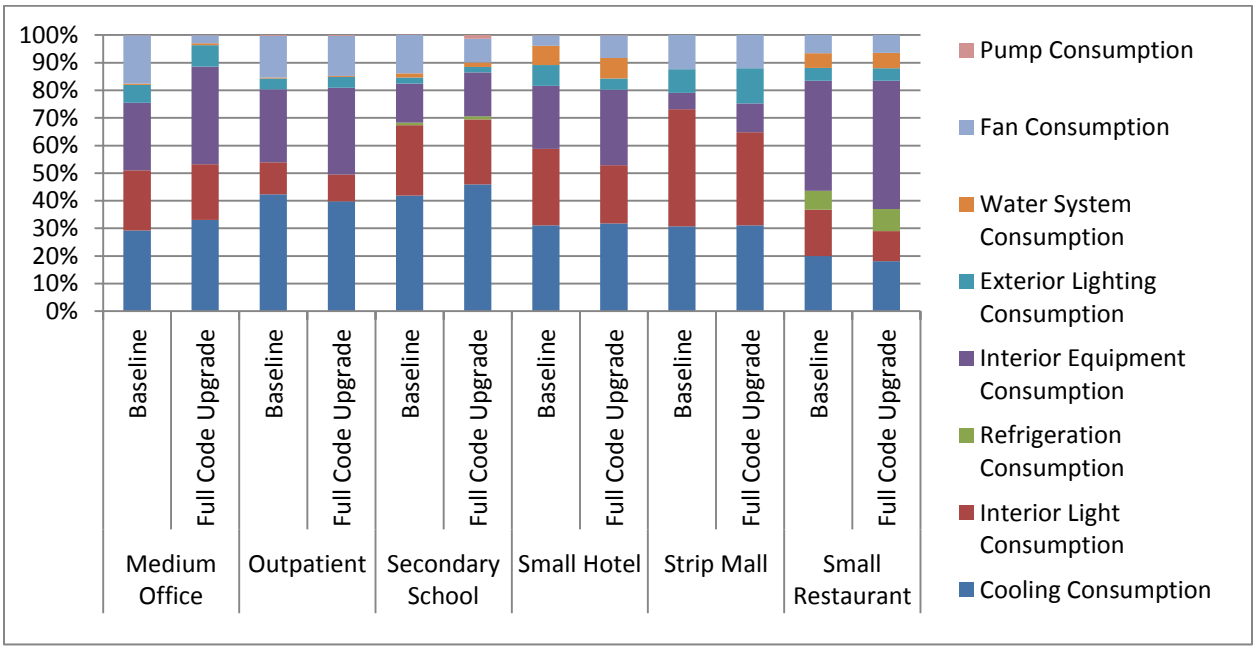

Figure 2 – End-use energy consumption for different building types.

2.3 RELATED ENVIRONMENTAL IMPACT POTENTIAL

Green building initiatives are fundamentally about climate and the greenhouse gas (GHG) emissions related to the construction and operation of buildings. The significant impact of buildings on the environment is prompting countries across the world to take action to build green as a mitigation strategy. Emissions increased globally by 70 percent between 1970 and 2004.[2] For a country like Tanzania, where economic growth is expected to attract businesses and industry, and lead to new expansion in cities, a green building initiative provides an important growth strategy to manage increased demands on resources and infrastructure. Populations are growing in cities worldwide – according to the Rockefeller Foundation, 75 percent of the world's population is expected to live in cities by 2050. So as the US supports expanded sources for power generation through its "Power Africa" initiative, efforts to support smart use of that power is a sustainable parallel strategy.

3. MARKET ASSESSMENT

The starting point for any effort to promote green buildings in Tanzania is the current state of the market. This includes guiding commitments to environmental regulation, standards and codes, construction laws, and general value associated with energy efficiency and the environment. Just as important is the current group of stakeholders, their interest and ability to support a green building initiative, and their barriers and challenges. Conducting this type of broad market assessment identifies gaps and opportunities, and points to next steps.

3.1 POLICY

A green building initiative will initially be most relevant in Tanzania's urban areas. ICF identified and analyzed the mixture of policies related to construction in effect, including zoning restrictions, material requirements, codes, and earthquake/natural disaster requirements, to provide a foundation for specific policies on green building. These baselines, created around existing building design and construction practices, inform a strategy to introduce green building widely into the market. Infrastructure for building construction, including the inspection and permitting processes, professional certification, and training that exist for construction, in general, was also analyzed for its potential to build support for green building practices.

Environmental Commitments and Regulation

Tanzania's environmental commitments and policies are primarily concerned with the conservation of forests and wildlife through the following frameworks:

- ***The National Environmental Policy 1997*** is focused on the need for formulating environmental legislation and sector-specific legislation as an essential component of environmental management in Tanzania. The policy is intended to involve local communities as part of the formulation process.

[2] United Nations (UN) Intergovernmental Panel for Climate Change (IPCC) Fourth Assessment Report (AR4)

- ***The Convention on Biological Diversity,*** ratified on 8 March, 1996, focuses on the conservation and sustainable use of biological diversity through the use of legal instruments.

- ***The Convention for the Protection, Management and Development of the Marine and Coastal Environment of the Eastern African Region and Related Protocols,*** ratified on 1 March, 1996 are focused on conducting assessments, preparing legislation, and building institutional capacity for the protection of marine life.

- ***The United Nations Convention to Combat Desertification*** ratified April, 1997 is focused on combatting desertification and mitigating the effects of drought through state institutions and international cooperation.

- ***The United Nations Framework Convention on Climate Change*** ratified in April, 1996 is focused on efforts to mitigate and adapt global temperature increases due to anthropogenic activities.

- ***The Vienna Convention on the Protection of Ozone Layer and Montreal Protocol on Substances that Deplete the Ozone Layer*** acceded on 7 April, 1993 and 16 April, 1993, respectively. This convention is intended to limit the production and sale of chemicals deemed hazardous for the ozone layer.

- ***United Nations program for Reducing Emissions from Deforestation and Forest Degradation*** (REDD+) is an international program designed to reverse deforestation caused by agricultural expansion, conversion to pastureland, destructive logging, and fires. Tanzania's environmental commitments in this framework do not account for the introduction of green buildings.

These frameworks do not provide clear mandates or authorities to create tangible instruments for the installation of green buildings in the country. However, the promotion of green buildings can help achieve national commitments to reduce GHG emissions.

Codes and standards

Green buildings are rarely driven by mandates; however, strong building codes ensure a common level of practice in regard to health, safety, and energy performance, which provides a necessary foundation on which to build practices seeking higher performance. Tanzania's codes and standards require further development if they are to effectively support a green building rating system. ICF's analysis evaluated codes involving buildings and appliances, and reached the following conclusions:

1. Action can be taken by national and municipal government agencies, including the Ministry of Works, the Tanzanian Buildings Agency, the directorate of Dar-es-Salaam, and the Tanzania Standards Bureau, to fulfill the quality assurance needs of green building construction and regulation.
2. There is limited capacity to enforce regulations and standards.

3. Due to the lack of regulation, the best tools for introducing green building standards, energy-efficient technologies, and other best practices appear to be public recognition, education, and financial incentives.

The Tanzanian Ministry of Works (MOW) enacted the *2003 Construction Industry Policy*, which was intended to create an efficient, dynamic, and competitive construction industry for buildings, roads, mining, and other permanent structures. Within the MOW, The Tanzanian Building Agency (TBA) is the only identified regulatory body that is focused on building construction quality. However, TBA's focus is on government buildings and it is not concerned with the construction industry at large.

Tanzania's largest city, Dar es Salaam, has no building codes, which contributes to poor and unsafe construction practices. However, in response to a deadly building collapse in 2013, the directorate of Dar es Salaam instituted more stringent inspection policies during site visits before and after building construction. Our search for building codes in other municipal authorities across the country did not find any other cities with codes in effect.

The Tanzanian Bureau of Standards (TBS) was established under the Ministry of Industry and Trade in 1975 and designed to strengthen institutional infrastructure for commerce and industry. TBS has *working committees* that focus on electrical equipment, machineries, construction material, food, chemicals, textiles, and environmental management. However, we did not find any existing or draft standards that explicitly deal with features related to green buildings, such as thermal properties of construction material or energy consumption ratings.

3.2 STAKEHOLDERS

A successful initiative to promote green buildings must have market-based support, ideally from a combination of key government agencies, commercial real estate interests, technical practitioners, and educators. While securing the involvement of all of these stakeholders is not necessary at the outset, eventually they will all find value in building green and play a role in transforming the market. Standards are typically voluntarily and as such, they need to be developed around an accepted definition of "green" that fits the local building context and the goals of potential adopters and implementers. In addition to helping craft an agreed-upon standard, a diverse set of stakeholders is needed to support the parallel initiatives required for success. These include technical training, improvements to design and construction oversight, development and implementation of health, safety and energy efficiency codes, and voluntary energy efficiency programs and incentives.

A significant boost to this project was the launch of a green building council in Tanzania prior to the stakeholder assessment task. Since it is critical that any recommendations for further progress on green building work in concert with existing efforts, the project turned to focus on the new Tanzania Green Building Council (GBC), its current members, outreach activities, goals, and needs. Understanding the kind of support needed by key stakeholders to contribute to the green building movement became the center point around which the recommendations were developed. ICF conducted outreach to local and regional organizations active in this area. Information on available green building benchmarking tools, guidance, and networking opportunities in the region were assessed, along with the current interests, activities, and potential roles of stakeholder groups. ICF sought out partnering opportunities that leverage progress made by other funders and organizations.

The Tanzania Green Building Council (GBC):

The GBC was launched by the Association of Consulting Engineers Tanzania (ACET), which plans to continue to organize and host meetings for the GBC, at least in the foreseeable future. However, the GBC is envisioned by the chairman as an open forum for stakeholders and not intended to be owned by ACET or any one organization or stakeholder group. The first stakeholder meeting was held in Dar es Salaam on 31 January 2014. Initial support has been expressed at the national government ministry-level (e.g. Ministry of Industry and Trade/Tanzania Bureau of Standards), by major real estate developers and from the main university.

The GBC faces some significant marketplace challenges in moving forward as a sustainable organization, which include the lack of a national building energy code, university curriculum, and council membership documents (memorandum of understanding, partnership agreements, etc.). The GBC has identified three main areas where support is needed:

- The GBC recognizes that a national building energy code is critical to establishing a uniform minimum level of efficiency in the market. This was discussed at a recent meeting of the National Construction Council. The Tanzania Bureau of Standards (TBS), established under the Ministry of Industry and Trade, is in the early stages of developing a building policy and code and has invited GBC to work with them. To support this effort, GBC is looking for assistance in bringing together international manufacturers to participate on standards developments for efficient and green building materials.
- The Engineers Registration Board (ERB) provides training for its members (both architects and engineers). Ideally, the GBC wants to provide requirements for green certification, as well as a syllabus for training courses. The GBC would like assistance in developing training for delivery through ERB, design and engineering firms, and the university.
- To succeed, the GBC understands that it needs to establish itself as a stable and sustainable organization. This will require developing a strategic plan, a business plan, a process for management and operations, and a governance structure. GBC is looking for assistance in preparing the needed documentation to set up necessary structures and partnerships/membership.

Public Service Pensions Fund (PSPF):

PSPF is a major real estate investor in Tanzania and constructs office (multi-use) buildings and residential apartments for medium and low-income populations. In this capacity, they are interested in the opportunity provided by green buildings to reduce energy operating costs and increase the marketing appeal of their properties for potential buyers and renters. For new construction, PSPF hires a consultant for the design and a separate engineering contractor for the construction, and observes that both are typically unaware of green building approaches and need training on specific technology, as well as on the overall concept. They report a widespread assumption that building green is expensive and there is not a clear understanding of the related energy cost savings and environmental impacts.

PSPF was represented at the initial meeting of GBC stakeholders and plans to continue their involvement. In addition to new construction, they are also very interested in what can be done in the buildings that PSPF already operates. Providing guidance on green actions for existing buildings may be

a strategy for the GBC to quickly engage key development partners while a new construction standard is under development. To sustain their support of the GBC, PSPF is looking for the following support:

- Assistance on developing educational materials to build internal support for green building within PSPF. Specifically, information on costs and benefits would be helpful, even though cost is not a main barrier as long as the payback is well understood.
- Educational material for buyers and renters of their buildings that focused on the benefits of green design and technology.

Watumishi Housing Company Limited:

Watumishi Housing is a real estate developer and fund management company. They currently manage a consortium to implement the *Tanzania Public Servant Housing Scheme* – a project to build 5,000 low-income houses (duplexes and single family homes) within five years under a government program to provide civil servants with lost-cost housing (or soft loans to construct their own). Other institutions involved in the program include the National Social Security Fund (NSSF), PPF Pensions Fund, PSPF, Local Authority Pensions Fund (LAPF), Government Employees Pensions Fund (GEPF), National Housing Corporation (NHC), and the National Health Insurance Fund (NHIF). Ten banks are also participating: National Microfinance Bank (NMB), CRDB Bank, National Bank of Commerce (NBC), Bank of Africa (BoA), Azania Bank, Exim Bank, Banc ABC, NIC Bank, DCB Bank and KCB. Despite lacking detailed information on the technology and design involved in constructing a green building, Watumishi is very supportive of the green building concept, the potential for saving energy and money, and the perceived social benefits associated with these types of buildings. Watumishi is looking forward to participating with the GBC, especially with this large housing project underway, and is seeking the following support:

- Information on how to make housing green, in terms of design and technology.
- Assistance in setting up requirements for contractors to consider green technology and design in their proposals.

Tanzania Electric Supply Company Ltd. (TANESCO):

TANESCO is the primary utility in Tanzania – generating, transmitting, distributing, and selling the majority of electricity on the mainland and selling bulk power to the Zanzibar Electricity Corporation (ZECO). As a major stakeholder in Tanzania regarding energy, TANESCO is very willing to work with the GBC on green buildings to improve efficiency. In discussions with staff, they view the lack of product standards as a primary obstacle for green building. Any product or material can be imported and put into the market, often resulting in the availability of sub-quality equipment and materials. Without standards, not only can consumers not differentiate between products based on their performance, but any success in presenting new efficient products into the market is likely to quickly result in a flood of cheap imitations. This is a problem that currently affects TANESCO's planning to promote energy efficiency. Another important area of concern is the lack of a legal framework for building energy codes. TANESCO is interested in receiving support in the following areas:

- Communications and marketing support to roll out information to their customers on energy efficiency. They already have the savings calculations for different technical solutions but need to better understand the market, and assess strategies for targeting and reaching important populations.

- Guidance on how to communicate about energy efficiency in the green building context –how to promote energy efficiency activities as important for green buildings.

School of Architecture and Design (SADE), Ardhi University:

SADE is very interested in doing their part to promote green buildings in the market – the university has a directive to train, consult, and conduct research, and views green building activities as a pursuit which will significantly contribute to these goals. Ardhi University encompasses six related areas of study – (1) environmental science and technology (SEST), (2) real estate (SRES), geospatial science and technology (SGST), (4) construction economics and management (SCEM), (5) urban and regional planning (SURP), and (6) architecture and design (SADE). While sustainability and green building principles are taught in the existing curriculum, they are offered as an elective. There is potential and interest to identify and integrate environmental concepts and related projects across all areas of study to improve core curriculum. Students are already extremely interested in energy and the environment and almost all final research dissertations include some aspect of sustainability.

Despite great interest, there are significant challenges. These include the lack of access to software to teach energy modeling to architecture students. An emphasis on promoting research for both students and lecturers is needed to support professors who also need to build their expertise in related subject matter areas. Scholarships are another significant issue – energy and the environment are not seen as critical issues for Tanzania, which is targeted by most international donors with support on power generation/ development, agriculture, and health. SADE believes that the students need more opportunities to study abroad and undertake needed research. Specific requests for assistance to support growth of a green building market in Tanzania include:

- Developing curriculum and student opportunities, including developing connections to other universities and identifying models for green programs that could be created.
- Understanding how they can participate and support the GBC and its goals, as well as pursue its own activities to strengthen the green building market.

4. RECOMMENDATIONS TO PROMOTE GREEN BUILDINGS

This section summarizes key findings and recommended follow-on activities developed from the research and in-person interviews undertaken through this project to understand the current opportunity for green buildings. Tanzania presents a market environment with well-positioned and ready stakeholders, but which needs to address significant information, technical, and policy barriers if green buildings are to be successful in reducing energy use and GHG emissions. In general, the recommendations target the following objectives:

- Provide strategic support to the Tanzania Green Building Council (GBC), TANESCO, and Ardhi University to build their capacity for promoting green buildings in Tanzania.
- Build capacity at TANESCO (and ZECO) to develop and implement effective marketing campaigns to promote energy efficiency activities and build general public awareness on issues of building energy use and environmental impact.

4.1 KEY FINDINGS

Green buildings offer significant energy savings potential for Tanzania.

- A green building standard which includes both design and technology features (as modeled in this study) has the potential to produce energy bill savings ranging from over 10 percent to over 40 percent across six major building types.
- A Tanzania-specific green building standard could be developed based on successful regional models, such as Green Points S.A., and phased-in with early focus on retail outlets and office buildings, as the highest savings opportunities, and then move to encompass outpatient medical facilities, small hotels, restaurants, and secondary schools.
- Space cooling and lighting, individually, offer significant savings and could be pursued as near-term strategies in new construction while a comprehensive green building standard for Tanzania is developed for long-term use.
- Similarly, solar water heating could be promoted in the near term to satisfy a building's entire demand for hot water.

Existing regulations and policies do not support energy-efficient or green buildings.

- The Tanzanian government has committed to a suite of international environmental agreements that are significant in their recognition of the need for related action; however, they do not specifically address energy consumption or related GHG reductions.
- The lack of regulation and limited enforcement capacity for building construction creates a gap both in the technical guidance and quality assurance infrastructure needed to support green building construction.
- Due to lack of regulation, the best tools for introducing green building standards, energy-efficient technologies, and practices appear to be public recognition, education, and financial incentives.

A number of stakeholders are already engaged and ready to take action, but need significant support.

- The newly launched GBC not only needs support to develop technical capacity, but also financial and organizational support to ensure its viability.
- Many of the stakeholders are well positioned to transform the market for green buildings but need to receive support which addresses their own priorities; this may include areas of focus that differ from the largest energy savings opportunities (e.g. existing buildings and duplex housing).

- The utilities can play a significant near-term role in building market awareness around energy efficiency and promoting good practice.

4.2 FOLLOW-UP RECOMMENDATIONS

In general, the recommendations to USAID for activities to advance a green building initiative in Tanzania focus on collaboration with three major stakeholders to reach the broader community and leverage critical opportunities for energy savings.

Tanzania Green Building Council (GBC):

- **Organization-building Assistance:** To facilitate the establishment of the GBC as a stable and sustainable organization, USAID could provide support to develop necessary organizational structures and documentation, including a strategic plan, a business plan, a process for management and operations, and a governance structure. USAID could also support the GBC in identifying additional stakeholders critical to their mission.
- **Technical Capacity Development:** USAID could support the GBC in facilitating the development of technical expertise among its members regarding green buildings, including:
    - Green certification and training through the Engineers Registration Board (ERB) for its members (both architects and engineers) through activities such as developing requirements for certification and a syllabus for training courses;
    - Standards for efficient and green building materials in Tanzania by providing assistance to bring together international manufacturers to participate in a stakeholder development process;
    - Definition of Tanzania-specific standards for green commercial and residential buildings that is responsive to the climate and market;
    - Guidance on energy management practices for existing buildings; and
    - Requirements for engaging contractors and architects on green building projects.
- **Communications Assistance:** USAID could support the GBC in working with its members to develop messaging and educational materials to support green buildings, including:
    - Technical assistance to help communicate the energy efficiency concept to the general public, public and private sectors;
    - Materials on costs and benefits to develop internal support within member organizations/companies; and
    - Materials for buyers, renters, and property managers of residential and commercial buildings that focus on the benefits of green design and technology.

TANESCO*:

- **Communications Assistance:** USAID could work with TANESCO staff to develop a communications strategy for energy efficiency programs (leveraging program opportunities identified through Work Stream 1 of this project). This should include working sessions which train and support staff on:
    - Assessing and segmenting the market,
    - Branding programs and identifying key messages, and
    - Developing cost-effective activities to achieve program goals.
- **Marketing Guidance:** USAID could provide guidance to TANESCO staff on how to market energy efficiency in the green building context – focusing on energy efficiency as an important element for green buildings.
- **Technical Capacity Development:** USAID could assist TANESCO in working with other stakeholders, including the Tanzanian Bureau of Standards (TBS), to develop and promote energy standards for buildings.

**Parallel assistance can be pursued with ZECO to address energy efficiency in Zanzibar.*

Ardhi University:

- **Strategic Support:** USAID could support the university in developing a strategy across their six programs to establish a leadership position on green building issues in Tanzania which leverages their strength in training, research, and consulting.
- **Technical and Organizational Capacity Development:** USAID could work with university staff to build capacity on developing curriculum and student opportunities, including developing connections to other universities and identifying models for green programs that could be created.

APPENDIX A BEACON™ - BUILDING ENERGY ANALYSIS CONSOLE OVERVIEW

Beacon Overview

The Building Energy Analysis Console, Beacon™, is ICF's proprietary software program for simulating energy consumption within buildings. The tool utilizes a streamlined proprietary interface coupled with publicly-available state-of-the-art simulation engines to facilitate efficient, robust analysis that is reflective of variations in building type, architectural characteristics, energy efficiency features, operating profiles, and weather conditions. Beacon has been designed to efficiently manage the process of configuring, executing and processing data from many buildings with ease. Coupled with the ICF building energy expertise, Beacon provides powerful insights into the consumption of resources by buildings and ways that consumption can be optimally reduced.

Key Characteristics of Beacon

Beacon utilizes sophisticated simulation engines that leverage highly detailed building definitions to produce hourly estimates of resource consumption on a per-building basis.

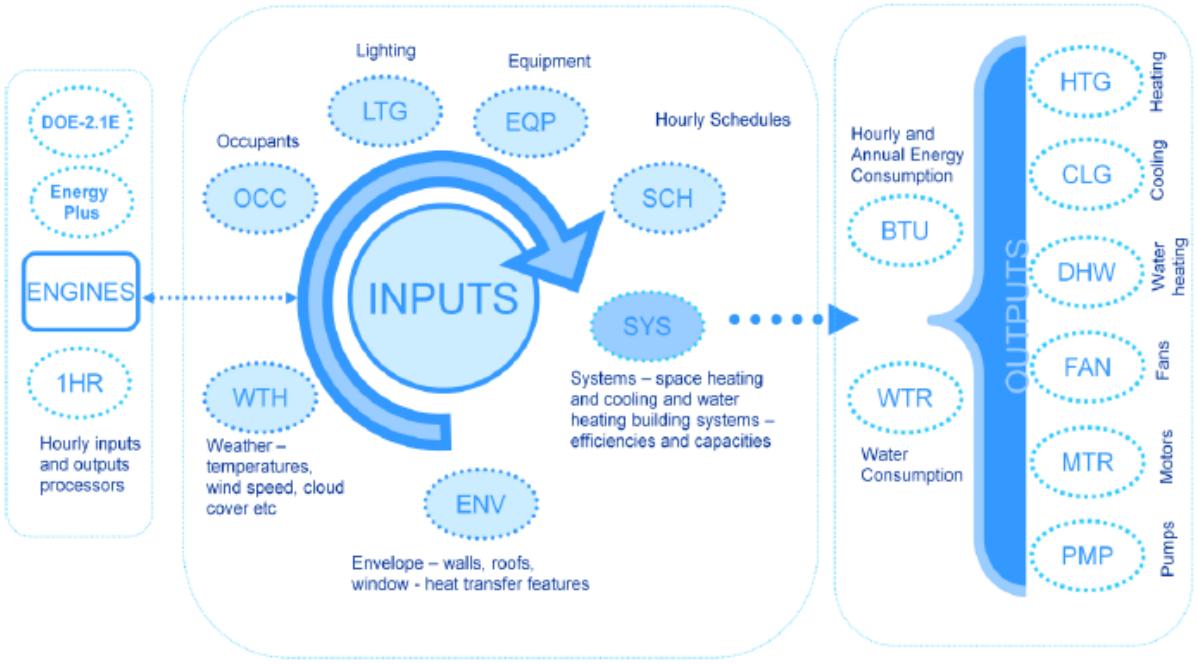

Figure 3 – Infographic of Beacon software capabilities

In addition, Beacon has an integrated database of standard characteristics such as schedules and lighting and appliance efficiencies. The number of buildings simulated can be tailored to the needs of the project and may range from one building up to millions of buildings. Therefore, ICF has the ability to create highly detailed project-specific datasets. These data can be packaged in versatile ways to meet client needs, encompassing variations in:

- Time-steps: hourly, day-type, seasonal, annual;

- Building-levels: single building, building sector, geographic region; and
- Resource metrics: energy, demand, emissions.

This detailed yet efficient capability provides unparalleled resolution to make informed programmatic and policy decisions.

Rigorous Analytics

Beacon's combination of simplified interface and sophisticated simulation engines enable highly rigorous analytics. Because Beacon allows ICF to quickly create many permutations of buildings, diverse data sources can be used to create a unique set of building configurations for each project. For example, a set of building configurations can be defined using building surveys of construction practices, historical consumption data, state and national energy policies, and/or state building codes. To estimate resource savings potential, multiple mitigation measures can be modeled, both traditional and emerging, including options for energy efficiency, demand reduction, and load-shifting. Documenting input and mitigation measure assumptions and using publicly-available simulation engines allows ICF to create detailed, transparent, defensible, and reproducible analyses which are not confined by previous studies of technologies and building energy performance.

The Engines behind Beacon

Beacon utilizes two engines at the backend, DOE2.1E, also known as DOE-2, and EnergyPlus.

- **DOE-2** is a widely used and accepted building energy analysis program that calculates the hourly energy use and energy cost of a commercial or residential building given information about the building's construction, operation, utility rate schedule, heating, ventilating, and air-conditioning (HVAC) equipment, and climate. DOE-2 utilizes hundreds of subroutines designed to solve specific building-design problems and performs an hourly simulation of the building to generate energy consumption and utility bills estimates. Originally developed by the US Department of Energy starting in the 1970s, DOE-2 has been the industry standard for many decades.
- **EnergyPlus** is the next-generation building simulation software program that has been developed by merging DOE-2 with Building Loads Analysis and System Thermodynamics (BLAST). It is similar to DOE-2 in function, but with the thermodynamics subroutines stemming from the BLAST program. BLAST was originally developed by the U.S. Department of Defense starting in the 1970s. EnergyPlus takes the best features of DOE-2 and BLAST and unites them in a single program. EnergyPlus also offers new analysis tools for the more recent and emerging building technologies.

Diverse Applications

Beacon has been applied to a diverse set of applications, including:

- For over 15 years, ICF has provided full service support to the EPA's ENERGY STAR New Homes program. This has included the simulation of thousands of residential building configurations using Beacon to help assess the impact and design of policy decisions on emissions reductions.
- For Owens Corning, ICF developed the Building Energy Solutions Calculator, a software based tool which assists builders in determining how to comply with the new home energy efficiency tax credits in the 2005 Energy Policy Act. The tool has a simple web based interface based on a

version of the Beacon interface with client specific modifications, and the robust DOE-2 hourly simulation program as its backend engine. It offers two unique features, a tiered approach and a cost optimization algorithm. The tiered approach allows users to enter as little as three pieces of information in the first level and a more complete description of current builder practices in the third level. The cost optimization algorithm assesses hundreds of thousands of energy efficiency upgrades for a particular combination of architectural characteristics and locations and selects a combination of upgrades which result in the most cost effective way of achieving the required 50% savings in heating and cooling energy compared to the 2004 IECC.

- ICF has developed Predictive Savings Tools for use with the ENERGY STAR Homes and AC Distributor Market Transformation Programs in Texas and Massachusetts. These tools have been developed since 2001 and allow the user to estimate peak demand and annual energy savings of homes submitted to the program using limited information such as the size of the home and the Home Energy Rating System (HERS) rating. These tools have been used to satisfy Public Utility Commissions audit process for estimating program energy and demand savings in Texas. The database behind these tools contains results from millions of pre-simulated building configurations using Beacon.

- ICF estimated technical DSM savings potential within the United States over a twenty-five year planning horizon to support the Greenhouse Gas Reduction Accord of the Midwestern Governors Association to establish an emissions-trading initiative within its member states. The analysis was completed at the state-level for Midwestern member states and at a census/sub-census level for the remainder of the continental United States. It encompassed both the residential and commercial building sectors and both new and existing construction. Tasks included developing a baseline scenario that was representative of existing consumption and a business-as-usual forecast in future years using Beacon characterizing dozens of energy-efficient technologies for their cost, energy, and demand impacts also using Beacon; and estimating annual market penetration over the planning horizon utilizing another ICF proprietary tool called Energy Efficiency Potential Model or EEPM .

- ICF developed marginal abatement curves of energy efficiency options for the residential and commercial building sectors for the whole of New Zealand. This process included an assessment of greenhouse gas emissions attributable to these sectors using UNFCCC National Inventory Reports and supplemental research papers; energy simulations using Beacon for New Zealand-specific building characteristics, weather conditions, and building technologies to accurately characterize the existing building stock and the upgrade options available; and the estimation of incremental costs and market acceptance of these mitigation measures. The resulting marginal abatement curves were combined with additional multi-sector marginal abatement curves to assist the Ministry with prioritization of its efforts to reduce GHG emissions.