Sustainable Energy Markets in Tanzania

Report I: Background

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Abbreviations

BGA	Federation of German Wholesale, Foreign Trade and Services
DfID	Department for International Development (UK)
EWURA	Energy and Water Utilities Regulatory Authority (Tz)
GEF	Global Environment Facility
GST	Geological Survey of Tanzania
IPP	Independent Power Producer
ICF	International Climate Fund
LPG	Liquefied Petroleum Gas
M4P	Markets for the Poor
MEM	Ministry of Energy and Minerals (Tz)
MKUKUTA	Growth and Reduction of Poverty Strategy for Mainland Tanzania
MKUZA	Growth and Poverty Reduction Strategy for Zanzibar
NDF	Nordic Development Fund
PPA	Power Purchase Agreement
PSMP	Power Sector Master Plan
PV	Photovoltaic (generating electricity directly from sunlight)
RE	Renewable Energy
Sida	Swedish Agency for International Cooperation
SIDO	Small Industries Development Organisation (Tz)
SME	Small and Medium size Enterprise
SPD	Small Power Distributor
SPP	Small Power Producer
SPPA	Standardized Power Purchase Agreements
SPPT	Standardized Power Purchase Tariffs
SREP	Scaling-Up Renewable Energy Programming Low Income Countries (part of Climate Investment Funds)
TANESCO	Tanzania National Electric Supply Company
TIC	Tanzania Investment Centre
UNIDO	United Nations Industrial
VETA	Vocational Education and Training Authority
VSPP	Very Small Power Producer
ZEKO	Zanzibar State Fuel and Power Corporation (Tz)

Cover photo: Tanzanian realities; rural, rural village, urban

Contents

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1 Introduction

A summary and the conclusions of this report, including specific project proposals for the respective areas within the scope, is provided in a separate Summary report.

1.1 Background to the study

Energy is a key driver of development in Tanzania, particularly in relation to promoting the growth of small and large scale economic activity in the private sector. Renewable energy is currently growing fast in Tanzania (IEA, 2011) and Tanzanian markets could be supported to benefit from recent improvements in technology associated with falling costs and new business models.

Tanzania has abundant renewable energy resources in terms of hydro, sunlight, wind, waves, geo-thermal sources and bio-mass. Only hydro is currently being exploited in a renewable manner, and there is a great deal of room for improvements in efficiency and sustainability in all areas.

Another assumption underlying this study is that the technology needed to develop these resources is available and that what is constraining development are variables that spring from inadequate marketing systems. There is a widespread lack of knowledge about the potential of renewable energy all along the value chain. A consequence of this is that optimal financial, infrastructural and institutional frameworks to support the development of renewable energy are not in place.

The purpose of this study, then, is to map out the current status of each renewable energy market system in Tanzania, looking at on-going initiatives and potential future demand and supply in order to recommend possible entry points for Sida and DfID over a five year horizon. Mapping the different renewable energy sources includes an analysis of their role in the context of the overall energy sector and development priorities in Tanzania; particularly those which are compatible with M4P (Making Markets Work for the Poor) approaches. Energy efficiency measures are discussed in chapter four. Although these are not always directly related to renewable energy markets, they are important in attaining the goal of sustainable energy for all. Finally, an overview is presented of the systemic issues that need to be addressed to ensure further can market penetration by emerging renewables.

The scope of this study is to provide an overview, analysis and recommendations to Sida and DfID regarding technologies and modalities for supporting the development of renewable energy.

Any study with a limited budget with a scope as wide as this will have limitations. It is not practically possible to evaluate all companies in a sector, or to claim to understand all available tools for funding. The goal has been to identify the market sectors with the most potential and to give examples of how these sectors could become more sustainable.

1.2 Energy in Tanzania

The following section gives an overview of the different forms of energy and energy potential in the country.

Tanzania is a large country[1] with an estimated population of about 44 million. It is endowed with diverse energy sources including biomass, natural gas, hydro, coal, geothermal, solar and wind (WB, 2010), of which the potential of energy from renewable sources is large, but largely untapped. The estimated total energy consumption in Tanzania is more than 22 million tonnes of oil equivalent (TOE), equal to almost one billion gigajoule (GJ) or 0.7 TOE per capita. This represents an increase of roughly one third since 2007.

To date, an overwhelming share (almost 90%) of current energy use is still met by traditional biomass (wood fuels). In the rural areas this means burning natural wood (mostly scrub and prunings) for domestic use. Small rural industry uses larger quantities for processing agricultural products, and charcoal, which predominantly is sold and used in urban areas, is produced. Charcoal is the single largest source of household energy in urban areas and (roughly estimated, assuming primitive kilns) represents 20 % of total energy use. The proportion of households in Dar es Salaam using charcoal has increased and is now above 70%. Approximately half of Tanzania's annual consumption of charcoal takes place in Dar es Salaam, amounting to approximately 500,000 tons for 2009 (WB, 2009).

The remaining share of energy sources are fossil fuels (6.6 percent), gas, (1.5 percent), hydro, (0.6 percent), and coal and peat, 0.2 percent (MEM, 2011). Coal is increasing, with new mines in operation. Consumption in 2010 was over 90 000 metric tons, and this figure is expected to rise substantially. The above regards inputs to the three major energy markets in the country; ***cooking fuels, (grid) electricity*** *and* ***transport fuels***.

Figure 1 below is a pie chart estimate of the main energy sources of the country on an average year. "Charcoal wood" signifies the energy content of wood used for charcoal, typically reaching the (urban) customer as 1/5 or so of the energy content of the input wood.

It is estimated that Tanzania annually imports over 1.8 million tonnes of various refined petroleum products for sale on the local market through port of Dar es Salaam. The continuous high oil prices are a heavy burden for the country. Since liberalization of the (petroleum) fuel market in 2000, companies in the sector have been free to import products in accordance with their requirements; local product prices are determined mainly by the market forces. In contrast to the previous situation, there has been no significant experience of fuel shortages following the liberalization. However, fragmentation of imports caused by the liberalization may be the source of higher costs (lack of economies of scale), including potentially higher average prices of products,

[1] with a surface area of about four times the size of the UK and double that of Sweden.

importation and sales of substandard products (including fuel adulteration by local mixing of kerosene in diesel), and transfer pricing[2].

In Tanzania all of the fossil liquid fuels are imported and 75 percent of these are used by the transport sector. Around 75% of demand for transport fuel is for diesel. The two railways operating in the country are diesel fuelled. Smaller household electricity generators ("gensets") run on petrol and larger (from 10 kW and up) run on diesel.

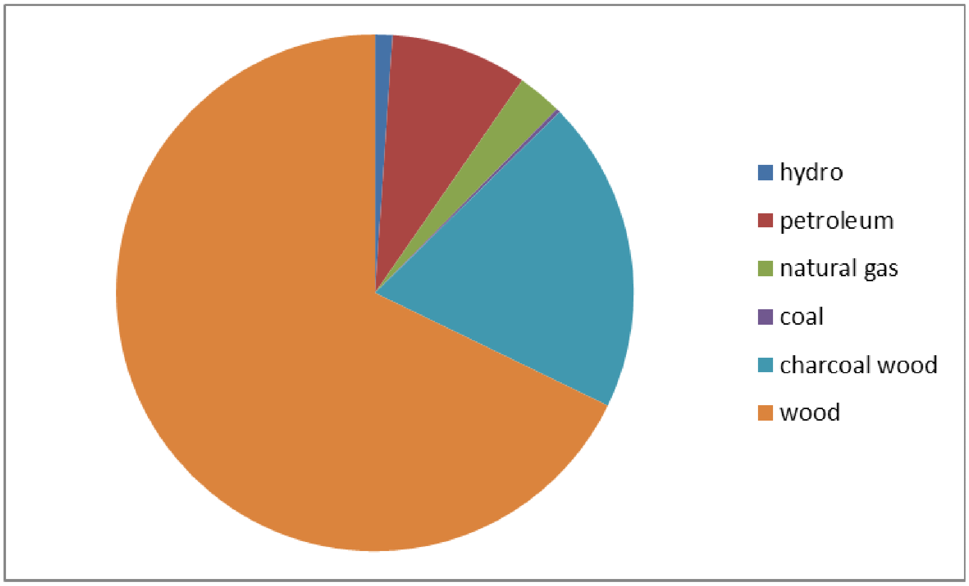

Figure 1. Energy sources in Tanzania (2009/2010, sources: MEM, WB 2009 and others)

While the electricity subsector contributes to less than 2 percent of the total energy consumption, it has a very large impact on the economy. The country's main installed generation capacities are based on hydropower (around 50 percent) and natural gas (around 35 percent), with diesel making up for most of the remainder, and providing most of short-term and emergency capacity. TANESCO also imports a total of 10 MW of electric power for Kagera Region from Uganda while Sumbawanga, Tunduma and Mbozi districts receive about 3 MW from neighbouring Zambia.

Demand for electric power is growing and typically exceeds supply. In the short to medium term generation expansion plan (up to 2016), the majority (59 percent) of the planned generation capacity additions are expected to be based on hydropower, coal and natural gas, but also additional sources such as biomass (combustion), wind and hydropower. Most of the new generation sites for hydro and wind are located in the southern regions of the country (WB, 2010).

[2] Source: EWURA (2007). An example of the effects from policy changes is offered by the re-introduction of a kerosene tax in September 2011, which caused the import of kerosene to drop 70% and conversely caused an similar increase for diesel. The kerosene tax was imposed to curb fuel adulteration, which apart from lower fuel quality also reduced tax revenues around 30 billion TSh per month (source: Tanzania Daily News, October 17, 2011).

The country suffers from low coverage of the electric grid, where around 6 % of its citizens currently have access to grid electricity, and an increasing shortage of electric power production capacity in relation to demand, which roughly grows with the economic growth. The country's main electricity producer TANESCO is in a difficult position since the demand for electricity is high but the ability to pay, especially in the rural areas, is low. Production is frequently subject to political considerations, something which can lead to economic and technical distortions in long term planning and funding. Power generation is further susceptible to changing climatic conditions and the rise in world prices of fossil fuel.

The reliability of electric grid power is low, with frequent brownouts and blackouts. Tanzania suffered drought-related power crises in the 1990's and then in 2006, 2007, 2009 and 2011. In 2011, the national utility company TANESCO had to institute rolling blackouts of up to 12 hours, forcing about 50 factories to close down and lay off their employees.

Emergency power (diesel generators) of a few hundred MW has been installed to deal with the increasing demand, mostly in Dar es Salaam. In March 2011, the International Monetary Fund reduced its forecast for economic growth in Tanzania from 7.2% to 6%, "largely as a result of widespread weather induced power shortages". Power supply is crucial for business and many households. For this reason, many households, shops and industries have to have their own power supply in the shape of primarily diesel driven generators ("gensets"). The investment and operational costs of gensets and fuel is a large burden on the Tanzanian economy.

Tanzania is well endowed with potential for development of a range of sustainable and renewable energy sources; solar power, wind power, wave power, rural biomass, urban waste and others. The use of renewable energy in Tanzania today is limited to large scale hydropower and an emerging market for small scale photovoltaic panels with adjoining systems for domestic and institutional use.

The different forms of renewable energy are further described in section 3.

1.3 Renewable energy

This section gives a definition and a short overview of renewable energy. Energy efficiency is discussed further in section 4.

Renewable energy (RE) is typically defined as energy from renewable non-fossil sources, namely wind, solar, geothermal, ocean (wave) energy, hydropower, biomass, landfill gas, sewage treatment plant gas and biogas. To be renewable, the source must be tapped in a sustainable way, e.g. so that availability is not reduced year by year or that the use entails negative social, environmental or economic impacts. Specifically, energy from biomass is only renewable if the source is from sustainably managed forests, urban source segregated household waste or similar.

The International Energy Agency (IEA 2006a), has identified three generations of renewable energy technologies: (i) First-generation technologies which have already reached maturity, such as hydropower, biomass combustion, and geothermal energy; (ii) Second generation technologies which are undergoing rapid development such as solar energy, wind power, and modern forms of bio-energy; and (iii) Third-generation technologies which are presently in developmental stages such as concentrating solar power, ocean energy, improved geothermal, and integrated bio-energy systems.

These definitions regarding the generations of technological maturity are important in the Tanzanian context as they indicate which technologies may be ready for market development. Mature technologies, namely first generation as defined above, small scale solar and mainstream wind power technology, as opposed to those still under development (second and third generation), are more likely to find both funding and knowledgeable implementing agents in Tanzania. Innovation in terms of mature technologies is likely to be incremental and thus more predictable.

Second generation technologies may, however, be appropriate for long term cooperation, where emerging technology can be adapted to specific uses in Tanzania, involving elements of innovation in international cooperation projects.

It is also important to note that there may be no exact matching between a given form of renewable energy and the supply of coveted energy services as described in section 1.4. For micro-grid applications, a hybrid system with the highest feasible share of renewable sources might then be needed. This is provided by a minimum number of renewable technologies (wind, hydro, geothermal etc.) which together, in the best of cases, can meet demand across the seasons and during all times of the day.

1.4 Fuels and energy based services

This section includes a description of different types of energy services and how they can be supplied.

Energy is useful to consumers since it offers different kinds of services. Today's human life depends on energy services in different forms. Cooking/heating of food is the most common form, and these services can be delivered using a number of different energy sources and supply mechanisms. Poor people need affordable and reliable access to energy services for lighting, cooking, water heating, space heating, cooling, information and communications and, last but not least, for livelihoods.

What is important in relation to renewable energy is that the different coveted services can be delivered in a variety of ways, more or less efficiently and more or less renewably. It is further important to note that the measures to develop markets differ considerably between different services and energy sources.

In a Tanzanian context, services can be divided into six categories, each with different means of supply (Table 1). Each of the fuels and energy categories has intrinsic qualities which in turn shapes the market differently. While power Levels 1, 2, and 3 concern electricity; Level 1 power permits production through several innovative means such as a stand-alone solar PV system, with a panel battery and control system. These services can thus be supplied by a relatively affordable “pack” that is tailored to fit a household or small institution such as a school. This would have large advantages to the consumer in that there is little cost for connecting and that the entire power production unit is local and thus there is no per kWh charge, unless the equipment is made available through lease or other economic arrangements (see e.g. section 2.4.3). Also Level 2 services, with large potential for powering institutions and local industry, can in many cases be supplied from a hybrid system feeding into a micro-grid for e.g. a village.

Transport energy is special in that the energy density of the carrier is much higher compared to e.g. firewood, meaning that few fuels qualify, with diesel (around 75 % of volume in Tanzania) and gasoline totally dominating. All refined fuels are today imported into the country.

Table 1: Energy service types in Tanzania (Source: Renetech)**.**

Label	type	use (services)	energy range	means	renewable energy potential
Level 1 Power	Small (pico)-scale power	lighting, and electricity for phone charging, radio and TV.	10 – 75 Wp	Solar and grid electricity, kerosene (light), candles	total
Heat for cooking	Heat for domestic cooking	preparation of food	< 1500 Wp	LPG, kerosene, grid electricity, natural gas, biomass fuels	very large (e.g. renewable firewood, charcoal, briquettes, ethanol and biogas)
Level 2 Power	Domestic. Agricultural, small business power	air conditioning, refrigeration, vacuum cleaner, dishwasher, water pumps(agri)	150- 5000 Wp	Grid electricity, (local) wind power, solar systems, smaller gensets, absorption (for cooling)	considerable
Level 3 power	Power for heavy industrial production	Industrial machinery and tools, heavy agriculture services	10kW – 1 MW (or more)	Grid electricity, diesel generators, cogeneration	considerable
Industrial heat and cooling	Larger boilers, gensets and driers	heat for drying, industrial processes & generator turbines (cogeneration), (resort) air conditioning	10 kW – 30 MW	renewable or fossil source fuel in boilers, absorption	considerable
Transport power	Internal combustion engine (motive power)	transport	~10 kWh/kg (energy density)	vehicle fuel (such as diesel, gasoline, also LPG, methane/ natural gas)	Low. Renewable fuels (e.g. biodiesel, ethanol) can be blended in

Level 1 power, essentially power for lighting, enables is instrumental for all types of households, rural and urban, high-income and low-income households to sustainably provide light for homes, reading, studying as well as social and productive activities after nightfall. With modern lighting technology such as LED lights, this kind of services would not weigh down a grid. The currently dominating kerosene lighting is costly and causes indoor environment problems. Solar Home Systems can provide rural homes with these level services on a stand-alone basis.

Heat for cooking is necessary for every household, and is thus crucial to provide for urban and rural customers of all shapes and sizes. There are several means to provide cooking energy. In the case of Tanzania, the combination of relatively high electricity prices, low incomes, the availability of wood and limited enforcement of protection measures against the unsustainable harvesting of wood resources, has implied that only the high end of the income scale currently uses electricity to cook, and then only as one solution among many. Because of the energy intensity of cooking, solar solutions are typically not affordable.

Level 2 power, domestic and agriculture power, is relevant for the domestic needs of an emerging middle class (primarily in Dar es Salaam and the regional capitals), it is important for economic growth and makes a number of services such as air conditioning, refrigeration and other domestic appliances available. This level of power can also be important for small business and agriculture, e.g. to pump water for irrigation. The agricultural side is an important factor for value creation and poverty reduction.

Level 3 power, for industrial production, is important for growth, primarily in Dar es Salaam and regional capitals in the high potential areas such as Arusha and Iringa. As the electric grid is not available in the entire country, it is important to identify (new) areas/districts where such power services should be made available to optimize growth, and develop the distribution grid as well as production to serve the designated areas. An example outside the urban areas is the mining districts.

Industrial heat is important for industrial production. Using the example of sugar production from cane, bagasse is currently used in Tanzania's sugar refineries to produce process electricity and heat. There is a potential to optimize this system, and perhaps also adding feedstocks in addition to the available bagasse, to make these units produce surplus electricity as in the case of TPC in Moshi. Another area of utility of Industrial heat is drying as part of food production.

Transport fuel is to date only available in the form of diesel and gasoline. Natural gas could be an additional source. Availability of transport fuel is a condition for development. See section 3.3.3 for renewable options.

1.5 The market

This section provides an introduction to the energy markets in Tanzania, value chains and actors along the chains.

The energy market in Tanzania is under strong development, but its development is hampered by several factors. A lack of enforcement of regulations, a coherent energy strategy with adjoining finance mechanisms and the generally low capacity to pay for energy are among the most important factors that constrain the introduction of new energy production and more long-term cost-efficient fossil energy sources.[3]

Renewables, in combination with development efforts can play an important role. While the hurdle regarding investment, awareness and competence as well as regulatory reform and enforcement is typically higher for renewable energy than for BAU or for staying in a non-renewable regime", the reward in lower running cost, need for finite resources and sustainability of the new solutions may outweigh the initial effort.

For a market to be functional, each actor should be able to act rationally and with access to correct and relevant information about available goods and prices. She or he must have information about the competition and the situation upstream and downstream of the value chain in which the actor operates. Further, the distribution of energy feedstocks and services must be facilitated by infrastructure to prevent that supply cannot meet demand due to high transport and other transaction costs. Transactions should be transparent, i.e. a defined price should be charged for a known and quality assured amount of a good.

What is important to note regarding markets in general is that there are fundamental differences where the "market" appears depending on where in the value chain we find ourselves. As mentioned, the three major energy markets or value chains in Tanzania today are

- electricity (on- and off-grid)
- cooking energy (charcoal, kerosene, LPG) and
- liquid transport fuels (gasoline and diesel)

Diesel and gasoline are also used for back-up power gensets. Off-grid solar energy, which can be offered as a stand-alone Solar Home Systems or battery power in e.g. leasing arrangements, is part of a quickly emerging market. On the other hand there are several drawbacks (if systems are bought) such as limited access to power, higher investment cost and maintenance needs such as renewing the battery every 5-10 years.

To understand market development for renewable energy production and efficient transmission, distribution and consumption, we need to understand where value is created. To be profitable, each link in the chain must be defined and, if needed, regulated. A level playing field for competitors which spurs competition must be sustained. This helps create a market beyond an oligopoly.

What is then a value chain in the case of (renewable) energy? Figure 2 shows the different links (conversion or value creation marked in orange) in the energy value chain. Actors, such as forest owners, can be involved in providing the energy source. Other

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[3] The longer list of barriers to market development is found above in section 2.2.5 "Economics of Climate Change" discussion

types of actors offer equipment for harvesting and processing, distributing or consumption. Another common type is companies that do wholesale, and takes the product (often including transport) from the processing and sell it to the final consumer. Employees or consultants can offer manpower and integrated services for harvesting, processing or doing desk work. There is also a large market for consultancy services for exploration and market planning. The government is an important actor in regulating the practice for each link in the chain.

Figure 2. Value chain for energy provision (Source: Renetech)**.**

To be renewable, each of these (orange) steps must be *sustainable*; not depleting the energy (re-)source and not entailing a net CO_2 deficiency (see section 1.3). Each of the conversion steps usually entails a by product, such as heat, digestate or ash. Some of these may have a value on the market and/or to the ecosystem. For biomass-based chains, it means that by products should be returned to the soil which has generated the basic resource in order to be sustainable. Regarding hydro power, nature takes care of this otherwise cumbersome detail.

Off-grid solar power is special in that for a "Home Solar" integrated domestic system, the entire production chain is installed with the consumer, meaning that there will not (depending on the financing and business model of the agreement between seller and buyer) be a cost per kWh, but only an investment cost and cost to replace broken parts and the system battery each few years. Similar systems where charged batteries are leased or pre-paid for domestic use could reduce the up-front investment cost and make modern energy services available where the ability to pay is low.

The two energy service categories Heat for Cooking and Industry are different from electricity based services in a market perspective, in that e.g. wood and other fuels (for cooking) can be more easily stored than electric power, but not transported around as easily as electricity in a power line. This is the principal reason that the cost of charcoal in Mwanza is around half compared to the cost in Dar es Salaam.

The value chains shown above are a summary for the market in general; the specific access by poor people to different levels in the chain and the role of renewables in the energy mix are discussed in section 3.3.1 of the Summary report (Volume II)

Development of energy services and energy efficiency measures can play a number of roles for development; providing services to those that cannot afford or are not offered the "traditional" energy services, or when traditional non-renewable practices do not continue to work. Off-grid services can improve living conditions, increase efficiency in agriculture and give access to Level 1 and higher services also in areas where the main power grid will not reach in the foreseeable future. Local mini-grids can prepare markets for later connection to future extensions of the main grid.

There are many ways to pave the way for a market for renewable energy:

- *Reducing cost* (by facilitating domestic production, providing tax exemptions and other economic incentives, increasing awareness or accommodating the alternatives in the regulatory framework),

- *Increasing awareness* and availability (again facilitating local production, training-the-trainers initiatives, technology demonstrations, local trade fairs and increasing awareness through campaigns and media).

- *Providing capita for investments*, which in a developing country is a challenge. For development of power production, this can be done by providing (partial) risk guarantees, tariff reform, including feed in tariffs for RE. There is a more detailed discussion of these alternatives in the Summary report.

The "markets" sought are different for each type of energy source and per size of production unit. This could mean that a specific project could be supported where the different development goals coincide with energy demand, much like the Sida/MEM solar project (see Annex 4).

Another way of approaching markets is the "Nexus" approach, the focus of the conference 'Planet under Pressure' in Bonn 2011, in focus also at the Rio+20 Summit 2012 and the recent World Water Week in Stockholm, where the trade-off between the natural resources used for producing the 4 "F's" (food, feed, fuel, and fibre) is the basis for calculating optimization.

Three pillars have been identified for the Nexus; to *sustain ecosystem services*, to *create more with less*, and to *accelerate access, while integrating the poorest*. Here the markets look at more than energy demand, and input costing for natural resources also takes non-energy uses into account. A typical example is to plan for water for irrigation jointly with a hydro dam design.

An urban nexus approach would include integrated planning of infrastructure for water, wastewater and energy. A Nexus approach would additionally include climate considerations, both mitigation and adaptation if needed, into planning (Hoff, 2011). The concept is further discussed in section 3.3.3 in the Summary report. Another type of nexus is that between energy and the metabolism of society, as discussed in the "Symbiocity" concept (see Annex 3), where policies and initiatives can overlap to create sustainable flows of products and wastes in society, e.g. by waste-to-energy technologies like biogas and incineration.

There is a general dichotomy between large-scale and small-scale energy provision. Larger scale energy projects provide needed power for development of welfare and industry, while running the risk of environmental effects near production sites and even displacing local citizens. Small scale production, on the other hand, may provide local energy services and income for the participants, but unless pilot projects are used to pave the way for broader and sustained sector (market) development, there will be no lasting economic, social or environmental benefit.

DfID in 2010 commissioned a study on the Economics of climate change (GCAP, 2011), considering the potential benefits of sustainable energy use, aligned to low carbon growth and the emerging opportunities under the various international mechanisms. The main focus was a technical assessment of the near and medium term potential of Tanzania to invest in more sustainable, lower carbon projects /programmes, which have economic development and growth benefits, as well as conserving the natural resource base. The study found examples of opportunities across all sectors of the economy, if the following challenges are tackled effectively:

- Economic / market challenges (e.g. no finance, poor commercial case)
- Low levels of information / awareness
- Policy / regulatory framework
- Technical problems of use in-country
- Lack of skills / know-how
- Limited institutional capacity

It was noted that there is growing momentum within the private, voluntary and education sectors which are crucial to creating implementation capacity.

There are some emerging positive experiences in the market. Recent studies also show that about 4,000 domestic-size biogas plants have been built in Tanzania over the last two decades, and the market is increasing. This makes Tanzania one of the leading biogas countries in Africa. Biomass for power generation is also available on a small scale. A 2.25 MW wood-fuelled power plant by the Tanganyika Wattle Company (Tanwat) in Iringa, and a few bagasse-fuelled cogeneration plants are working examples of biomass potential for power generation.

The demand for renewable energy will depend also on the supply and price of **non-renewable energy** (- carriers). The different markets (electric power, cooking energy and transport fuel) are dynamic. At the moment, the only renewable cooking fuel would be charcoal from production units developed by e.g. ARTI-energy. Supply of fossil cooking energy has increased considerably in price. A 15 kg cylinder of LPG has gone from around 20 000 Tsh in 2006 to just under 60 000 in 2012.

For grid power, three large coal-fired power plants are under development in the south of Tanzania, where e.g. the Mchuchuma coal mine is to feed a 400 MW generation station, half of which is to be used in a local related iron ore project. This is approximately equal to the total actual power generated in the country, at a price considerably lower price than diesel based "short term" type power production. Using EWURAs principle of setting the tariff in accordance with the avoided cost, this new 400 MW low tariff power production would thus impact the pricing significantly, possibly rendering small hydro plants unprofitable. To further understand the impact on the market, transparency regarding subsidies for fossil source generation, such as tax free import of "emergency" power generation diesel/jet fuel, is important to include into the analysis.

The market for **energy efficiency** requires special attention. There is generally a tradeoff in that higher investment gives higher efficiency, which then makes financing and longer term investment one of the conditions for efficient technology. As an example, a cogeneration plant with a state of the art turbine generator would yield up to double the amount of generated electricity per ton of cellulose fuel compared to a "budget" turbine-generator set. In a Tanzanian context, companies like Tanwat and the sugar mills should be supported - with knowledge and capital - to take an investment decision optimizing the entire regional power balance, not just to sustain the local plant.

2 Stakeholders

A number of stakeholders set the stage for development, both public and private. This chapter looks at the stakeholders involved. For each type of stakeholder, some main issues are listed and organizations active in Tanzania are presented. For each area; donors, commercial companies and other, there is a multitude of stakeholders and those mentioned here are examples.

Sustainable energy markets in Tanzania operate within a complex enabling environment where the Government (and the para-statal TANESCO and its Zanzibar counterpart ZEKO) are major actors regarding power production, while almost 90 % of the annual energy used is from unregulated or under-regulated collection, trade and combustion of biomass.

2.1 Government Institutions, Policies and Incentives

The government of the state of Tanzania is divided in two administrative regions, mainland Tanzania (former Tanganyika) and Zanzibar. The mainland government has the absolute majority of inhabitants (over 40 million), while Zanzibar is a group of islands with around 1.2 million citizens, but around ten times the population density. The division is reflected in the organization of electric power production and distribution, as described below.

Mainland Tanzania has a national strategy for growth and reduction of poverty that set priorities in different sectors of the country, called MKUKUTA[4]. Among the ten priority areas emphasized by the MKUKUTA II, Cluster I /goal 2 "**Reducing income poverty through promoting inclusive, sustainable, and employment-enhancing growth and development"** is the strengthening of the government's and national implementation capacity and scaling up the role and participation of the private sector in priority areas of growth and poverty reduction, both of which are vital for RE development. The national strategy recognises the generation of electricity, utilization of capacity and coverage increase as important operational targets towards poverty reduction, not just for electricity but for other sources of energy too. Targets include:

- Electricity generation increased from 1064MW in 2010 to 2128MW by 2015
- Use of non-hydro renewable for power generation increased from 4% 2010 to 6% in 2015
- total length of transmission and distribution lines doubled by 2015
- Access to electricity increased from 2% in 2010 to 6% in 2010 in rural area; from 14% in 210 to 18% in 2015 at national level, and
- Access to clean and affordable substitute for wood fuel for cooking increased (from 10% in 2010 to 20% in 2015)

Energy has been identified as a cross sectoral driver of growth and essential in creating a good business environment for private sector investment. It is also vital in the implementation of the *Kilimo Kwanza* (Agriculture First) programme. Grid extension is desirable for peri-urban areas and renewable energy for supply to off grid and remote areas. Solar, wind and biofuels are recognised as some of the RE resources to be promoted.

These national goals are translated into respective sectoral policies that are supportive of the development in renewable energies. The National Energy Policy of 2003 is outdated and is currently undergoing a review. Interviews indicate that future policy will support the development of the whole range of renewables; wind power, solar energy, geothermal, bio energy (electricity generation, sustainable wood based fuels, improved cook stoves, solid biofuels production from waste, and liquid biofuel), mini hydro, additional big hydro (dams) and development and maintenance of the distribution line. In the overall Tanzanian energy sector, renewable energy is expected to play an important role in the future due to its relative sustainability, the role it can play in off grid solutions and the abundance of RE resources in the country.

In 2008, Tanzania adopted a very comprehensive Electricity Act, which takes into account many of the international best practices for electricity sector reform and tailors them to the specific ground level realities of the Tanzanian environment. The Act establishes a general framework for the powers of the Ministry of Energy and Minerals (MEM) and the Energy and Water Utilities Regulatory Authority (EWURA). It also

[4] The strategy for Zanzibar with the same goal is named MKUZA.

defines key parameters for EWURA's tariff setting criteria and procedures, EWURA's criteria for awarding provisional and permanent licenses, EWURA's monitoring and enforcement activities, a requirement for ministerial plans and strategies for rural electrification, dispute resolution procedures and a process for determining possible future reorganization of the electricity sector.

Energy efficiency and conservation is also being promoted and the Ministry has an energy efficiency working group that works on labels, standards, course of practice with a focus on electrical equipment and improving the grid system.

In addition, various policy documents, plans and manuals for renewable energies exist. These include:

- Biomass Energy Strategy: being finalized with facilitation by GIZ
- Guidelines for Sustainable Liquid Bio Fuels Development in Tanzania[5]. These have been under development for a number of years (see section 3.3.3). The Biofuel policy is now developed by the Biofuel Task Force.
- Rural Energy Master Plan - under process
- The Energy Master Plan (2009) is now being updated by TANESCO, and should be subject to annual review.
- The Energy Policy (2003): under review.

The **Ministry of Energy and Minerals** frames its strategy and priorities for renewable energy development as part of the overall efforts to achieve economic growth and poverty reduction. It foresees a need for substantial improvements within the energy sector as a whole, both on the demand and supply sides. By means of its agencies, the state owned production/transmission/distribution company TANESCO, the regulator EWURA and the Rural Energy Agency (see below), the ministry manages both non-renewable and renewable resources.

Included among the challenges from the government perspective are:

- investment necessary to meet increasing electricity demand
- domestic power production and cross-border and regional interconnections,
- uncertainties regarding the potential from ongoing exploration,
- creating conditions to enable new and long-term renewable energy production
- how to maintain access to affordable power, including access to modern energy services to the rural population,
- energy efficiency in terms of different types of energy available in Tanzania.

The dependency on wood fuels for cooking continues to be a major challenge.

MEM has established a framework for development of small power projects, ranging from 100 kW to 10 MW and utilizing renewable energy source, intended to supply commercial electricity to the National Grid or isolated grid in Tanzania. The goal is to

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[5] (http://www.mem.go.tz/LIQUID%20BIOFUELS%20eng.pdf).

accelerate electricity access and promote the development and operation of small power projects among investors. The framework includes introduction of Standardized Power Purchase Agreement (SPPA) and Standard Tariff Methodology (with Standardized Power Purchase Tariffs, SPPT), for interconnecting and selling power to the Main grid and Mini-grids in Tanzania, which will be applicable between the developer and the buyer. EWURA is managing these agreements (see below).
The government has not yet set explicit targets for the share of electricity generation from proven renewable energy technologies such as hydro, wind, solar PV, biomass-based cogeneration and geothermal nor has it approved a mechanism of pricing these differently to provide incentives.

MEM has established simplified procedures for investing in solar, wind and micro-hydro projects including a 100% depreciation allowance in the first year of operation, exemption from excise duty and sales tax and concessionary customs duty on the first import of materials used in renewable energy projects.

Other institutions that have important roles to play in the deployment of the RE development and technologies are the Tanzanian Investment Centre (TIC), EWURA, TANESCO, and REA.

Tanzanian Investment Centre (TIC)

The TIC has the role of facilitating all the investment in the different sectors in the country except for mining and petroleum subsectors. All foreign investments costing more than 300 million USD and all local investment costing above 100 million USD need to go through TIC. However, the centre does not provide a rigorous investment guide for RE technologies. At present licensing of energy projects is done by EWURA but promotion of the opportunities is with TIC.

TANESCO: hydropower, transmission, distribution and the emergency plan for thermal generation

TANESCO (Tanzania Electric Supply Company) is a parastatal organization owned by the government of Tanzania. The company operates the grid system on mainland Tanzania, and isolated supply systems in Kagera, Kigoma, Rukwa, Ruvuma, Mtwara and Lindi. Figure 3 shows the main electric grid and some planned expansion. A project example adjoining the backbone project is the recently procured construction of distribution networks in Mwanza and Shinyanga regions including construction of 440 km, 33 kV OH-line, 228km LV-line, substations and connection of over 8,500 customers.

Most of the production plants of TANESCO are hydropower (see section 3.1.2). The company is at present buying production capacity, such as the 18MW gas power plant in Mtwara which was handed over from Wentworth Resources (formerly Artumas) on March of 2012. Power transmission is over 220, 132 and 66 kV networks.

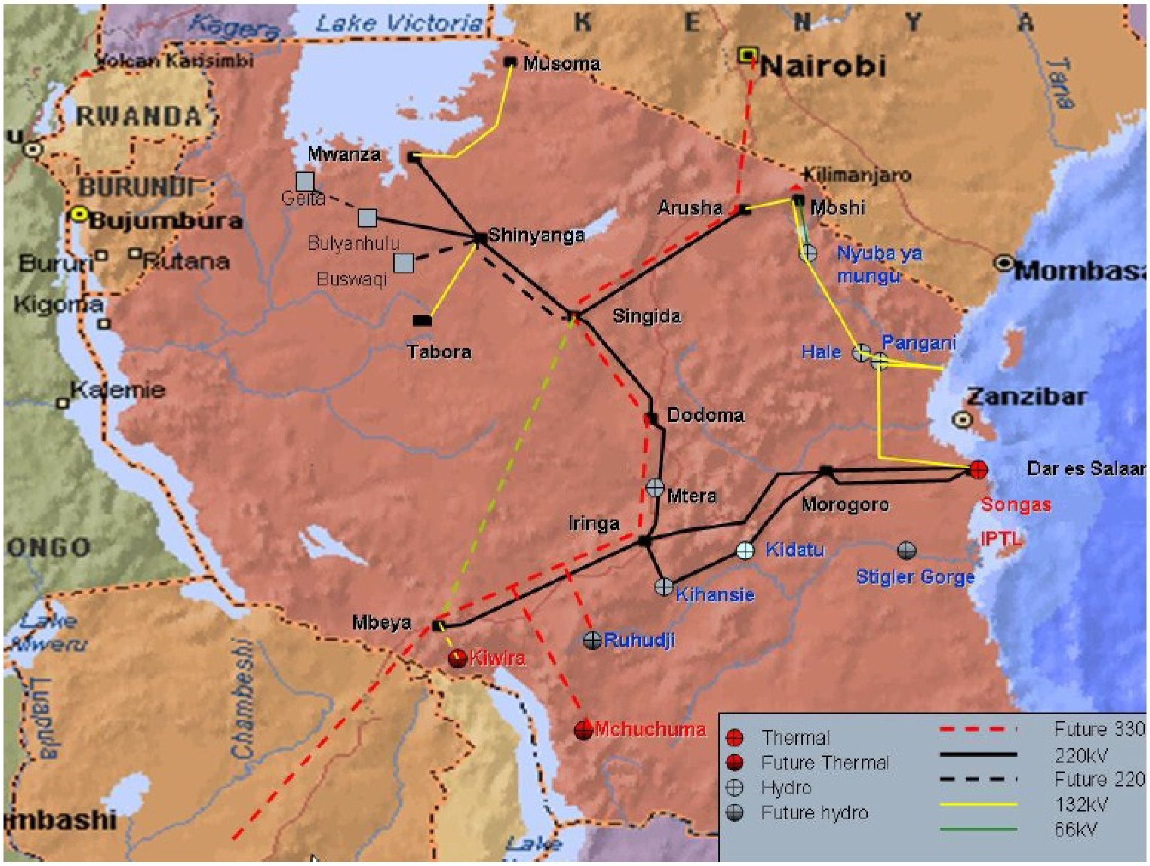

Figure 3. TANESCO transmission network (TIC)

The government has developed an emergency power production ramp-up plan in response to the increased demand for power. (See section 2.4.1 for an overview of emergency power production.) The frequency of emergency power plans has been increasing over the years leading to costly "emergency" type solutions that have benefitted relatively few people (mainly in towns).

The implementation of the last power plan in Tanzania had a budget of 408 million TSh, with 80% of the budget being spent on purchasing fuel for running power generation machines[6]. The need for an emergency plan and short term measures can be assumed to partly depend on inadequate policy for long-term alignment between production and present/predicted demand. TANESCO is in financial trouble since commercial losses are large (see section 4.2) and the cost per kWh of diesel based power costs up to five times more than the company gets paid from its customers. A campaign for increasing revenues has been launched in 2012.

Tanzania is thus allowing other players than TANESCO as power producers and distributors - even if the first projects have experienced a lot of red tape and formal stumbling blocks - and small local utilities are forming based on private initiatives and

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[6] http://www.ippmedia.com.

funding. Even so, for any SPP in excess of a few MW there would in theory be a mutual interest for TANESCO and the SPP to connect physically, to make use of surplus power produced in the private production/grid unit and to support SPPs in the event of a blackout.

ZEKO produces, transmits and distributes power on Zanzibar

Electricity supply in Zanzibar is the sole responsibility of the Zanzibar State Fuel and Power Corp. (ZEKO), a vertically integrated monopoly company. The Government of Zanzibar has jurisdiction over energy policy on the group of islands, and is independent of policy developments on the mainland. There is a considerable degree of installed capacity in off-grid power supply and auto generation (mainly by mining companies), primarily due to TANESCO not having the necessary financial resources to extend the mainland transmission grid in a dependable way.

A project is underway to increase available power in Zanzibar, both through a connection with the mainland and between islands as well as a 100 MW power plant on the Zanzibar Island. Funding is partially from the Millennium Challenge Account (see Annex 4) and Norway.

The Energy and Water Utilities Regulatory Authority negotiates tariffs

The Energy and Water Utilities Regulatory Authority (EWURA) is an autonomous multi-sectoral regulatory authority established by the Energy and Water Utilities Regulatory Authority Act, Cap 414 of Tanzania regulations. It is responsible for technical and economic regulation of the electricity, petroleum, natural gas and water sectors in Tanzania. The following types of actors are defined in the EWURA framework:

> The term “independent power producer” (IPP) covers all types of private electricity producers.
>
> A “distribution network operator” (DNO) is responsible for the operation of a distribution network.
>
> “Small Power Producer” (SPP) means an entity generating electricity using renewable energy, fossil fuels, a cogeneration technology, or some hybrid system combining fuel sources mentioned above and either sells the generated power at wholesale to a DNO or sells at retail directly to end customers or some combination of the two. An SPP may have an installed capacity greater than 10 MW but may only export power outside of its premises not exceeding 10 MW;
>
> “Small Power Distributor” (SPD) means an entity that purchases electricity at wholesale prices from a DNO or some other bulk supplier and resells it at retail prices to end use customers.
>
> “Very Small Power Producer” (VSPP) means an electricity generator with an installed capacity of 100 kW or less that either sells power at wholesale to a DNO or at retail directly to end use customers.

EWURA thus regulates tariffs for all electricity trade[7] in the country. This is done in Power Purchase Agreements (PPAs), including those for Tanesco to sell to final

[7] except for ’eligible customers’. See Electricity Act 23(1)

consumers and SPDs, and other producers to sell to TANESCO, consumers and SPDs. For retail tariffs, TANESCO proposes a tariff and EWURA allows it (or a certain portion). Every year EWURA calculates standardized tariffs for SPPs ranging from 100 kW to 10 MW power generation utilitzing RE sources (see Figure 4). These projects also use a Standardized Power Purchase Agreement (SPPA). . SPPs selling electricity to retail may propose their own tariff, and EWURA has guidelines on approving or disapproving based on the project IRR. VSPP Projects (<100 kW) can also sell to the DNO (TANESCO) at standardized SPP tariffs.

Projects under 1 MW are exempt from EWURA licensing, and the SPP program relies on standardized documents as much as possible to minimize the need for case-by-case negotiation. For licensing and tariff approval, EWURA has proposed to rely to the maximum extent possible on the economic and technical reviews undertaken in electrification grant reviews carried out by the Tanzania Rural Energy Agency (REA) (Greacen et al, 2010). The tariff for SPPs connected to mini-grids is the average of the avoided cost of supply (cost for small-scale diesel generation) and the total incremental cost of mini-grids. For 2012, this is set to 480.50 Tsh per kWh. The SSPAs in coming years would constitute a floor price if they surpass the mini-grid tariff agreed.

This new framework makes it considerably easier to predict the revenues from a new plant, particularly for smaller installations, at the same time as it reduces time for obtaining permits.

Main Grid Connection Tariff

Description		2011 Tariff (TZS/kWh)	2012 Approved Tariff (TZS/kWh)	Percentage Increase
Standardized SPP Tariff		121.13	152.54	26
Seasonally Adjusted SPPT Payable in	Dry Season (August to November)	145.36	183.05	26
	Wet Season (January to July and December)	109.02	137.29	26

SECOND SCHEDULE

Mini Grid Connection Tariff

Description	2011 Tariff (TZS/kWh)	2012 Approved Tariff (TZS/kWh)	Percentage Increase
Standardized SPP Tariff	380.22	480.50	27

Figure 4. 2012 Standardized Small Power Project Tariff for 2012

The Rural Energy Agency supports new small scale renewables

REA (Rural Energy Agency) was established in 2008 under the Ministry of Energy and Minerals to oversee the implementation of electrification projects in rural areas of Mainland Tanzania, using the Rural Energy Fund as provided in the Rural Energy Act, Cap 131. Both REA and the Rural Energy Fund[8] (REF) are governed by the Rural Energy Board (REB), which is made up of 8 delegates from different government agencies and sectors of civil society.

REA promotes rural electrification and power production. Most of the projects implemented with cooperation from MEM are renewable in nature such as the solar PV projects and projects planned on Pico and mini hydro and energy efficiency technologies.

REA has a number of tools, some funded through the TEDAP programme. It can give matching grants of up to 80% for prefeasibility and feasibility studies. Further, it offers a performance grant for each connection to final customers; up to 500USD per connection in rural areas that currently do not have grid access (covers maximum of 80% of the transmission and distribution costs of a project). The agency can help provide loans of up to 70% of the investment cost (85% for projects <3MW) and up to 15 year loan terms with a grace period of 5 years. It also manages competitions for prefeasibility funding and rural lighting.

Vice Presidents Office, Division of Environment, manages CDM credits

The Division of Environment within the Vice President's Office (VPO-DoE) is mandated to oversee and regulate environmental management across government departments and agencies. It prepares and issues environmental regulations and guidelines, in conformity with the National Environment Act (2004). This includes guidelines for undertaking Environmental Impact Assessments (EIAs) as well as broader environmental guidelines and safeguards. In addition, VPO is the Designated National Authority for the Clean Development Mechanism (CDM), the carbon emissions reduction tool for countries without emission reduction targets such as Tanzania. Table 2 shows the present pipeline for projects in Tanzania:

Table 2. CDM project pipeline in Tanzania, August 1 2012 (UNEP)

1	Landfill gas recovery and electricity generation at "Mtoni Dumpsite", Dar Es Salaam, Tanzania	Dar es Salaam	Registered	Landfill gas
2	Mtwara Energy Project	Mtwara & Lindi	At Validation	Fossil fuel switch
3	Reforestation at the Idete Forest Project in the Southern Highlands of Tanzania	Iringa	At Validation	Reforestation

[8] as provided in the Rural Energy Act, Cap 131

4	LUIGA Hydropower Project in Mufindi District, Tanzania	Iringa	At Validation	Hydro
5	Sao Hill Energy Combined Heat and Power (CHP) 15 MWel project, Tanzania	Iringa	At Validation	Biomass energy
6	Replacement of Fossil Fuel by Biomass in a Crude Palm Oil (CPO) Refinery at BIDCO's Dar es Salaam Facility in Tanzania	Dar es Salaam	At Validation	Biomass energy
7	Mwenga Hydro Power Project	Iringa	At Validation	Hydro
8	Nyanza Bottling Company Clean Drinks CDM Project	Mwanza	At Validation	Biomass energy

Most projects are still subject to approval. The only approved project is the Mtoni landfill gas project, which has been stalled after the initial piping phase due to lack of gas. Projects 4-8 in Table 2 are renewable energy projects, so CDM has a large, but yet untapped, potential in Tanzania for projects larger than ~3MW.

There seems to be limited interest at the VPO to approve CDM projects. Carbon revenue can add about 10% of additional revenue for main grid projects, boosting project returns and debt repayment ability, and would be a welcome contribution to the limited profitability of sustainable power production, and VPO should be supported in their approval process.

2.2 Donors and Lenders

This overview concerns the policies of donors, mainly DfID and Sida, regarding Environment and Climate Change, M4P and Energy, and grant oriented funds. It also gives an overview of lenders, capital markets and methods in a Tanzanian context.

2.2.1 Donors

Donors have engaged in a number of projects, including support for wind, mini/micro hydro and reduction of grid losses (energy efficiency) which fall within the scope of this report and which should contribute to improved access to sustainable energy services both for urban and rural customers. It would seem important to maintain an array of initiatives and methods to reach out to the rural, energy starved areas but at the same time see to that the production and distribution of electric power in urban areas is improved.

In listing them, a distinction has been made between projects supporting markets and support to projects concerning larger scale energy production and distribution.

See Annexes 1 and 4 for examples of donor supported projects in the energy sector in Tanzania.

Sida

The most important policy supporting work in the renewable energy sector is that of Environment and Climate Change, 2010-14). For guidance as to how to work in the renewable energy sector, then, the Market Development in Swedish Development Cooperation (Sida, 2011) publication puts the *Business for Development* and *Making Markets work for the Poor* approaches into perspective.

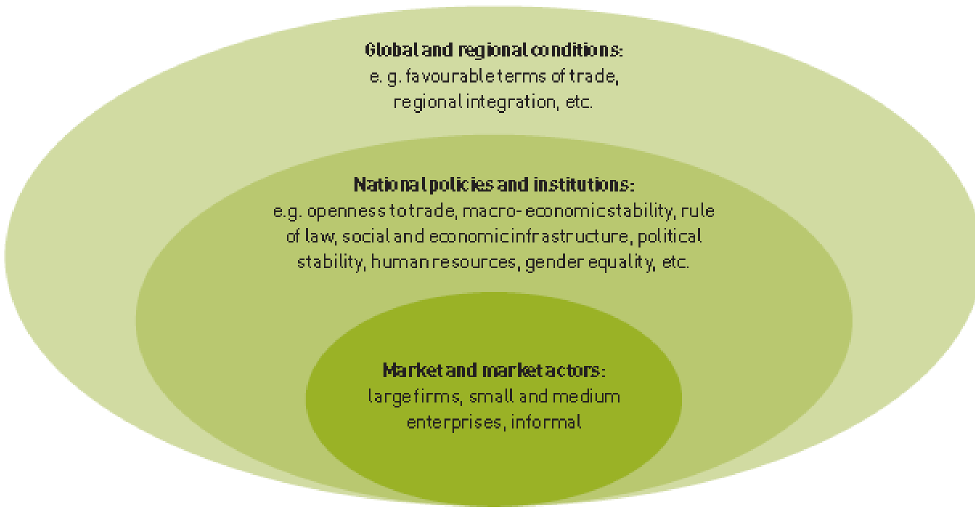

Figure 5. Market Development in Swedish Development Cooperation (Sida, 2011)

Sida and other international experience highlight four principles which form the basic building blocks in the "Making Markets Work Better for the Poor" (M4P) approach:

- *Systemic change*: Finding corrective measures to market systems failures which better serve the needs of poor women and men
- *Sustainability*: Delivering sustainable change by better alignment of key market functions and players with the incentives and capacity to work more effectively
- *Scale*: Leveraging the actions of key market players to bring about lasting and systemic change and achieving impact among the poor at a large scale
- *Facilitation*: Determining a temporary, catalytic role for the development agent that stimulates actions by market players themselves.

Department for International Development (DfID), UK

DfID's current Tanzania Operational Plan 2011–2015 (DfID, 2011b) shows that it will continue to deliver results through support to government of Tanzania budget, with more direct programmes, by working with the government and a range of other partners (civil society organisations and the private sector).

The guiding rationale for DfID is an understanding of what works and which partner or instrument will be most effective in delivering a particular result in Tanzania. Results, transparency and accountability guide all programmes, with a strong focus on demonstrating value for money.

DfID's three strategic objectives in Tanzania are:

1. *Wealth creation:* scale up programmes to increase the incomes of the rural poor, increase access to finance, improve resilience to climate change, reduce the cost of doing business, including trade and transport costs of Tanzanian exports.
2. *Delivering the Millennium Development Goals:* provision of basic services and address key areas where the Government of Tanzania is not able to meet the needs of the poorest and most marginalised, concentrating in areas where we have relative strengths.
3. *Getting Government to work better* and helping Tanzanians hold their Government to account: build a more accountable democratic state that responds to people's needs, and help Tanzanian citizens access and use information on their services, entitlements and rights.

Support in Energy and Climate Change

The UK has established an International Climate Fund to contribute to the delivery of the UK's 2020 international climate change objectives. This represents the UK's contribution to the internationally agreed plan to mobilise of $100 billion of funds per annum for low carbon, climate resilient development[9]. The UK has allocated £2.9 billion of ODA for the period 2011/12 – 2014/15. Case in point, donors may increasingly prefer to use investments such as the ICF as their in-country strategy since it engages a combination of donors and optimizes administration.

Overall, the focus for DFID is very much on delivering measurable impact for poor people, in partnership with government and the private sector. Value for money is always a primary concern. Examples of supported projects are the AECF REACT (see below)

World Bank

WB is present in Tanzania since the 1960s, participating in and organizing projects to develop infrastructure, health, energy, food and other elements of urban and rural development. The Bank manages Trust funds (from e.g. Sida) that have been used in Tanzania for development and analysis.

Projects and initiatives include the TEDAP, studies on the charcoal economy (WB 2010) and support to the Ruhudji Hydropower project as requested by the Tanzanian government (see Annexes 1 and 4).

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[9] The UK also provides support through bilateral programmes and major international climate funds such as the Clean Technology Fund (CTF) and the Scaling-up Renewable Energy Programme (SREP),including a scoping mission to Tanzania in September 2012, with USD 50M under consideration. .

DANIDA and **NORAD** have funded different renewable energy and energy efficiency projects. See Annexes 1 and 4.

In the following, a number of grant oriented funds, some supported by the donors described above, are presented to give examples of recent and ongoing renewable energy funding.

Millennium Challenge

The Millenium Challenge Account, through the Millenium Challenge Corporation, is an agreement between USA and Tanzania that has contributed to a number of development and maintenance activities in Tanzania, such as developing a new undersea cable from the Mainland to Zanzibar, and overseeing a number of efforts to reduce losses in the TANESCO transmission network in Mwanza, Tanga, Dodoma, Morogoro, Mbeya, Iringa and Kigoma, using consultants such as ESB International.

A recent example of a grant is Camco International and Rex Investment Ltd. who were awarded a USD 4.7 million tender issued by REA in March 2012 to distribute and install solar power systems in Kigoma. The project is a large rollout of technology in the country and comprises installation of 208kW of solar capacity PV systems at 45 schools, 10 health centers, 120 dispensaries as well as at several local municipal buildings and businesses. The successful bidders will begin the process of installing the solar panels in May of the same year and are scheduled to be finished by July 2013.

AECF REACT

Africa Enterprise Challenge Fund: Renewable Energy and Adaptation to Climate Technologies (AECF REACT)

The Africa Enterprise Challenge Fund (AECF) is a USD 120m private sector fund, hosted by the Alliance for a Green Revolution in Africa (AGRA). The aim of the AECF is to encourage private sector companies to compete for investment support for their new and innovative business ideas. From June 2008 to Nov 2011, AECF had completed 11 competition rounds, with 87 projects approved in 17 countries. USD 67m of funds are committed with reported matched funding of USD 242m.

In 2010, DfID initiated a climate change funding window in the AECF called the Renewable Energy and Adaptation to Climate Technologies (AECF REACT). Funding allocated by DFID and DANIDA is USD 28M. REACT covers the East Africa Community (EAC) countries, with a specific allocation for Tanzania (from DFID Tanzania) of USD 8M. REACT offers a mix of grants and zero interest loans between USD 0.25M - 1.5M per company. It is therefore targeted at private sector organisations that offer credible, scalable business plans and co-funding in markets where the returns are uncertain.

The overall goal of REACT is to contribute to rural poverty reduction in sub-Saharan Africa. Its purpose is to catalyse private sector investment and innovation in low cost, clean energy and climate change technologies. The first competition for REACT has been completed with contracts currently under negotiation. 21 projects have been approved in the EAC region and total of USD 15m allocated. USD 6m of this has been approved for 9 projects in Tanzania and 2 regional projects with Tanzania components. Summaries of each are shown in Annex 4.

The Tanzania projects include businesses supplying decentralized rural electricity solutions (solar, hydro and biomass) as well as alternative fuels for cooking (biogas and pellets for gasification stoves). Two of the Tanzania projects include micro-finance.

Table 3. REACT Round 1 Tanzania and regional projects under negotiation or contracted

Name	Organization	Country/regional
Portable Grid	EGG-energy	Tanzania
Renewable biomass pellet fuels for gasification cook stoves	Kiwia & Laustsen Limited	Tanzania
Rural Electrification using Biomass Waste	Husk Power Systems	Tanzania
Carbon Management Model for Sustainable Agricultural Growth in Tanzania	Field Masters Ltd	Tanzania
Maluluma Hydro Electric Project	HydroGen Ltd	Tanzania
Rufiji Delta Project	Carbon X Ltd	Tanzania
Decentralized Electricity Generation Using Small Hydroelectric Power Stations	ea-power limited	Tanzania
Financing Access to Solar Energy in Uganda and Tanzania	SolarNow BV	Regional
Mass produced biogas systems for rural households	SimGas BV	Regional
Microfinance Clean Energy Product Lines	microenergy credits	Regional

REACT First Round - Lessons Learned[10]

A September 2011 review of REACT found that the competitive process is working well, particularly in the renewable energy sector. M&E needs to be strengthened and there is a need to address systemic challenges through sharing knowledge. More specifically:

- There are potentially under-represented sectors (such as *traditional fuels and sustainable biomass*) which nevertheless are extremely important to energy supply in the region. This sub-sector dominates the energy sector in Tanzania and in terms of the social, economic and environmental benefits of improvements to cooking fuels supply and stoves. REACT proposals in this sub-sector are reported not to have met criteria in terms of the credibility of business plan and/or the potential for impact at scale. The primary challenge facing market innovation

[10] Source – DFID annual review of REACT (Sept 2011), AECF presentation of (21 Nov 2011), personal communication AECF (Jan 2012)

is thought to be the informal, low cost and unregulated nature of the traditional market preventing entry.

- Expected direct impact of projects is higher than had been anticipated on launch of REACT with much higher projected impact at household/SME level and a leverage ratio of around 5:1.
- REACT could build on linkages with private equity investors and CDC.
- REACT has attracted significant local and international interest: web site registrations: 1102; number of submissions: 348; number of eligible applications: 256; 70 short listed; 33 projects selected for business plan stage; 28 submitted; 21 approved. Half of the successful companies are local, with one joint venture overall.
- Systemic market issues in priority sectors are thought to be important, preventing roll out of solutions at scale (e.g. alternatives and efficiency in fuel wood, charcoal production and cook-stoves). A critical mass of projects that leverage commercial financing are expected to have a risk reduction effect on financial services in the region – already there are a number of projects where financing is coming in as a direct result of the AECF funding.

Overall performance of REACT is judged to be strong, with the potential for projects to influence the business environment. However, whilst REACT participants think that they will generate a lot of experience, this might not make a difference without government support. A top-down and bottom-up approach has been suggested: (i) connecting the main donors in the sector with the AECF and establishing communication channels; (ii) getting companies to exchange ideas on mutual issues and taking action within their circles and networks; and (iii) AGRA (who hosts the AECF) and the AECF itself engaging in business advocacy with AGRA and REACT donors playing a policy and diplomatic role.

Outlook for REACT Round 2

The REACT Round 2 competition closed in December 2011. Funds committed by donors are expected to be allocated in round 2 during the last quarter of 2012.

The REACT window covers adaptation to climate change as well as renewable energy technologies. In the first round, climate adaptation proposals were very limited. This may be due to the lack of awareness in the market about the alignment between core "sector" issues (e.g. agriculture and water) and the opportunity to take innovative adaptive measures.

The second round of REACT has therefore looked to attract more interest on adaptation projects, but is also seeking new renewable energy projects, including more take-up on financing models.

It is still too early to judge but it has been suggested that the current financial allocations for REACT in Tanzania are adequate, given the targeted medium to large scale private sector operators. At the same time, the annual review of REACT suggests that there may be potential for an investment round for SAGCOT under REACT. Round 2 will determine the market opportunity more clearly.

There is still thought to be a gap in the market in terms of support to small scale private sector operators, which fall below the threshold for REACT funding. REACT is collaborating and sharing market information and potential investment opportunities with relevant and capable business support providers such as the Climate Innovation Centre (CIC).

2.2.2 Lenders

An overview is presented with examples of organizations and initiatives involved in lending for energy development projects.

Emerging Africa Infrastructure Fund

EAIF is the first dedicated debt fund for sub-Saharan Africa and has a capital of 600 MUSD. The original sponsor of the fund, established in 2002, is the UK Government through DfID. Since then three other European governments; Sweden, Netherlands, and Switzerland, have joined. Debt is provided from three development finance institutions and two private sector international banks, and used in public/private sector partnership projects. The fund has invested in energy projects in Rwanda and Cape Verde, but not yet in Tanzania.

National banks

A number of national banks can provide debt funding based on available equity. A challenge for rural energy development is that only 5 of 40 banks in Tanzania have a rural presence. A positive example is CRDB, which works with microfinance, SMEs as well as corporate finance from branches across the regions in Tanzania[11].

Funds

There are several examples of funds which provide capital for energy investments. An example is DI Frontier[12], which focus on Sub-Saharan Africa. On the other scale of project size are organizations such as Oiko Credit, which works with microfinance. Upstream of these initiatives are funds such as GEEREF[13] and Global Environment Facility[14].

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[11] Presentation by CRDB at MEEDA symposium, Musoma, May 7 2012.

[12] www.frontier.dk

[13] Global Energy Efficiency and Renewable Energy Fund, www.geeref.com

[14] www.thegef.org

2.3 NGOs

In the following we give a non-exhaustive overview of NGOs working in the area of (renewable) energy. Compared to NGOs in Europe, some of their east African counterparts operate in a manner that is more like a commercial company.

Tanzania Renewable Energy Association

TAREA (Tanzania Renewable Energy Association), formerly known as TASEA (Tanzania Solar Energy Association), was founded in the year 2000. It is a non-profit, non-governmental organization. The objective of the Association is to promote the sustainable development of Renewable Energy. TAREA has been realizing its objectives through training, community awareness raising, policy influence, solar industry and end user protection, energy efficiency, research, volunteer programs, and consultancy services.

TaTEDO

TaTEDO (Tanzania Traditional Energy Development) is a non-profit sharing entity based in Dar es Salaam, Tanzania with activities in ten regions, 27 districts and 127 villages in Tanzania and with more than nineteen years experience actively involved in sustainable energy development projects and programmes in rural areas. TaTEDO uses three main complementary strategic channels to disseminate information about the use of clean energy and sustainable forest management: Firstly, establishing small and medium scale entrepreneurs. Secondly, close collaboration with local government and communities. Thirdly, support to local organisations. To achieve its goals, TaTEDO undertakes the following activities:

- Promote the use of modern energy for productive uses (industrial, agriculture and basic infrastructure etc), consumptive uses(households and communities) and institutional uses (education, health, water etc),
- Implement sustainable energy programmes and projects,
- Provide energy related consultancy services and research,
- Develop networking and partnership with local and international organizations,
- Manage and disseminate energy information to stakeholders,
- Conduct lobbying and advocacy to influence energy related policies, legislations and strategies, and
- Support sustainable energy enterprises.

Arti-Energy

ARTI-Tanzania is active since 2005, and part of the international ARTI network founded in India. Arti-Tz works exclusively with rural energy provision, directly and indirectly by setting up distribution networks for solar home systems and training entrepreneurs for renewable charcoal making. They also do innovative marketing for solar home systems and sell renewable charcoal, produced by ARTI entrepreneurs, at their outlets. Another area in which they are active is biogas, see section 3.3.2 and 2.4.4. The activities can be characterized as non-profit development work with a commercial streak, which is needed to more sustainably spread the word in a large country as large as Tanzania.

The organization has also developed a distributed system for selling/leasing Solar Home Systems based on *mauli kauli*, a Tanzanian praxis for credit based on word of honor, where wholesalers are paid by clients by the end of the month. The goal is to get more families to investment point, and to get income from selling renewable charcoal.

Solar Aid Tanzania
Solar Aid Tanzania is a charity which provides various solar solutions and supports local solar entrepreneurs in rural Tanzania. Solar Aid markets individual solar powered lighting as replacements for kerosene lamps, the dominating source of rural home lighting in Tanzania. In June 2012, over 100 000 lights had been sold. Solar Aid is partly funded by their on-line campaign *Sunny Money*.

2.4 Commercial companies

In the following we give an overview, just as non-exhaustive as the previous section, of private companies working in the area of (renewable) energy. The demand side is discussed in section 2.5 and in the Conclusions report. The aim is to give a flavour for which companies are acting in the area and which commercial space has been explored.

The 1992 National Energy Policy lifted the monopoly by the public utility to allow involvement of the private sector in the electricity industry. This major policy reform enabled Independent Power Producers (IPPs) to operate in the generation segment (see section 2.1).

2.4.1 Non-renewable grid power production and technology

Even though this report focuses on sustainable technologies, the companies providing emergency power and fossil based production are also part of the market. A brief overview follows.

The power supply side of the energy market in Tanzania consists of renewable and non-renewable sources. The news of late is the large offshore gas finds which have spawned investment decisions such as the government announcement on July 21, 2012 that a natural gas pipeline was to be constructed from Mtwara to Dar es Salaam and imply more access to gas in Dar in a little over a year. Coal is also on the rise, going from import to export to power generation. The impact from this on the market for renewables depends on the interest of the government to use the potentially increasing stability in energy provisions to create a more sustainable profile of the production system.

Due to the 2011 drought, and ensuing power shortages, the government through TANESCO has leased a number of emergency power producing units. All of the installed capacity and projects under development to address the power shortages in 2011 are fossil fuel in nature. Before the emergency plan, the country entered into power rationing.

To deal with power shortages the government decided to work with the private sector to both make better use of available capacity and also to buy more capacity. Some of these are Aggreko (has in June 2012 signed a deal with TANESCO to provide 100MW for another 12 months), Independent Power Tanzania Limited – IPTL (100 MW), Dowans (100MW) and Alstom (40MW). The IPTL plant is to be rebuilt to use natural gas instead of Heavy Fuel Oil.

To date installed capacity is the Symbion gas plant 112MW, Aggreko Ubungo 50MW, Aggreko Tegeta 50 MW, Symbion Dodoma 50MW. Some of the country's short term plans include Jacobsen phase one and two, Mwanza and construction of a gas pipe line from Mtwara- Kilwa-Dar es Salaam-Tanga.

Table 4. Projects in pipeline

Project	Capacity	Cost involved	Owners
Jacobsen (gas)	100 MW	USD 124 million	TANESCO
Jacobsen phase II	150 MW	USD 165 million	TANESCO
Mwanza	60 MW	****	TANESCO
Gas pipe line	N/A	****	GoT

Power purchased as part of the emergency plan is considerably more costly than more long-term production, and certainly more expensive per kWh than what TANESCO receives per kWh sold, which is of course not economically sustainable. The inclusion of cheaper, sustainable power production, be it fossile or renewable, is very important to ensure sustained operations.

Songas

The company, owned by the international power company Globeleq, in turn funded by CDC, produces gas and electricity (180 MW) from natural gas findings on Songa Songa Island. The company runs a pipeline to Dar es Salaam. The 100-MW gas-powered Songas plant in Ubungo, went online in August 2004 and was expanded to 180 MW in June 2005. Gas is also sold in limited amounts in Dar es Salaam.

The company wants to expand production and sales and argues that the recent emergency power program that gives precedence to diesel based production rather than production from domestic gas is less sustainable and will result in higher costs. Songas has calculated that the emergency installations cost TANESCO 25-30 US$ per kWh, which is 5-6 times higher than the 6 US$ per kWh that TANESCO pays Songas. This means that for part of its sales TANESCO loses money for each kWh sold, and there is thus a risk for insolvency and reduced available capital for investment and energy purchases[15].

National Development Corporation

NDC is a government owned Development company[16] which develops strategic projects together with predominantly foreign investors. Among current projects under development are Mchuchuma and Ngaka coal-to-electricity projects, in Njoluma and Ruvuma regions, respectively. The projects are (theoretically) planned to produce in total over 1000 MW, some of which will be sold to the grid. The NDC engagement is a result

[15] "Written intervention in support of Application number TR-E-11-012, made by TANESCO on November 9th, 2011", Letter from Songas to EWURA, November 29, 2011

[16] www.ndc.go.tz

of a law passed in 2010, allowing the state to own a stake in major mining projects. The first phase of production is planned to go online in 2014, with additional capacity 2015 and on. NDC also develops a wind energy project in Singida (see section 3.1.5), and geothermal energy (section 3.1.3).

These plans and plants will, if reaching production phase, ease both the capacity problem faced by TANESCO and also reduce the cost for meeting power demand. Given the tariff principle of avoided cost, these large plants could however challenge small hydro producers and other renewable investment.

2.4.2 Renewable grid power and technology

Larger scale project development is an international business area and a number of companies monitor the opportunities in the region. The activity of these companies depends on the conditions for developing, funding and operating e.g. hydro plants and wind farms that feed into the grid. The most common buyer of power is TANESCO, alongside of stakeholders with large demand such as mining companies.

A common feedback from interviews is that there is a perceived, and in case of the Emergency power providers (see previous section) indeed experienced, risk that TANESCO is not reliable in paying for power. This has caused investors to be wary, and power projects to be less bankable.

Aldwych International Ltd

Aldwych International Ltd. is a UK-based IPP company specialised in developing, financing, and operating large infrastructure energy projects in Africa. Aldwych has been leading the development of the Ruhudji Power project since the end of 2006.

The 360 MW Ruhudji Hydro Power project was initially scheduled for completion in 2014 in the PSMP. Construction is expected to take 5 years. A likely date for completion is now 2019. A Government Negotiating Team has been constituted and will begin negotiations with Aldwych International's subsidiary company Ruhudji Power Development Company Limited, (RPDC) to finalize the Project Development Agreement (PDA), the associated 'heads of terms' for an Implementation Agreement and Power Purchase Agreements in Q2 2011/12.

It is intended that the project will be carried out under a Public Private Partnership arrangement, whereby the Government will contribute certain supporting activities, such as improving access roads and providing the land under a lease, in exchange for an equity stake in the project. It is proposed that the project will be carried out under an "open-book" type arrangement and the final level of the least cost tariff will be determined once certain important pieces of work (e.g. hydro and geotechnical risk allocation, completion of detailed technical design, EPC and project financing, etc) are completed. Risk allocation and tariff negotiation will be part of the PPA negotiation, but conclusion of this will be contingent on the Government and their advisors having clear guidance from relevant sector policies that are in need of update or even formulation.

The Government of Tanzania formally requested financial support from the World Bank for both these projects and this request received World Bank management approval in July 2012. The IFC, along with other institutions including the African Development Bank and the European Investment Bank have been following both projects and are studying them with a view to supporting their development and financing.
Both projects are among the near term projects to be implemented under the least cost development plan proposed in the Power Sector Master Plan (PSMP) of 2009.

Since August 2009, the company has also been co-developing the **Wind East Africa** ('Wind EA') wind farm project in Singida (see section 3.1.5) together with local partner Six Telecoms. Wind EA is set up as a special purpose project company and plans to develop 80-100 MW in Southern Tanzania (the Singida project) and subsequently 150 MW in Central and North Eastern Tanzania.

Rift Valley Energy
The company is part of Rift Valley Holdings, including Mufindi tea and coffee factories. The company has a a long history, with the hydro plant located in the southern highlands on the corner of a coffee plantation, The Mufindi tea company, that has operations in the Iringa region, requires stable energy for its operations and took a decision to go into energy production.

While not yet operational, with the plant under construction, the venture is an interesting example of recent development. A plan to build a 4 MW hydro plant[17] with an investment cost of around 10 MUSD including a 120 km power line was approved by the company. Geothermal energy was not considered an option - hydro is low running cost, long term comfort. The company signed a standard PPA with Tanesco. Since the tariff is based on avoided production cost, there is a perceived risk in that tariffs could be reduced if large hydro would come into the area.

The main barrier to reaching the plant build phase has been found not to be technical but financial. No entity has been interested in funding the project, to a large degree depending on the risk of not being paid by Tanesco for energy sold to the grid. Project finance has not been possible asTanesco is not perceived to be an reliable business partner.

The company tried to negotiate with USAID and Sida but could not agree on a financial solution. According to the interviewee, development aid supporting local banks to approach a project finance perspective, such as a guarantee facility, could be important, if not a prerequisite, to get investments going in this area.

[17] The Mwenga hydropower plant is a so called run-of-river type which does not require a large dam and has low diversion to spillway. 7 cubic meters of water per second flows into the turbines after a 350 m drop in a steel pipe. The plant is set in a mountainous area and 150 m of the pipe is underground. The power company itself has less than 10 employees, with a contractor presence of 65 persons at peak construction and 24-25 at present (spring 2012).

The company has received a share of the investment cost as a grant from the EU energy facility. Donors required the project to engage in local energy provisions apart from sustaining production for the tea processing. Apart from supplying internal (Tea factory) needs, and connecting to TANESCO grid, the company has on its own made agreements with 2600 new line connections (domestic) and a few industries in the project area. The project thus includes establishing a utility company for the local customers. 14 villages are in the initial network, while 3 more have written and want connection. The bulk of produced power goes into the 33 kV TANESCO backbone grid.

This is the first scheme which includes production and distribution to individual customers under private ownership that is under construction in Tanzania. The company assumes that the second planned plant, with 100 MW installed capacity, will be easier both regarding planning, construction and funding[18].

Geothermal Power Tanzania Ltd
The company (GPT) was registered 2012 by "Geothermal Power Ltd" (GPL) based in Mauritius, the Tanzanian "National Development Corporation" (NDC) and the Tanzanian mining company "Interstate Mining & Minerals Ltd" (Interstate). GPT has been granted prospecting licenses for geothermal exploration in the Mbeya region, near the Ngozi volcanic area, and Rufiji.

The company is currently investing $5 million in geotechnical, geological and drilling work to establish target areas. The company is contracting a dedicated geothermal drilling rig with a capacity to drill to a depth of 2.5 km and it is expected that the drilling will commence at the end of 2012. Around 10 MW of production capacity is expected initially, at the earliest in 2014[19]. The expected potential to be exploited is around 100 MW.

Sugar cane producers
Sugar cane producing companies have the advantage of producing excellent input fuel for local power production as the sugar is washed out of the cane. The resulting bagasse is used for combustion. The sugar companies **Mtibwa, Kagera, Kilombero** and **TPC** use bagasse for producing electric energy and process heat today, but TPC in Moshi is the only plant that at present produces any amount of electricity to the grid. See also section 3.1.6.

New production capacity is reported to be under development. EcoEnergy, formerly SEKAB Tanzania, has 15MW planned from a power plant run on bagasse as part of a sugar cane plantation and sugar processing plant, and plans to start construction 2013.

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[18] source: Webpage and interview with Mike Gratwicke.

[19] source: the Citizen, May 17, 2012. The company has not responded to further questions on the present development situation.

2.4.3 Renewable off-grid power production and technology

Off-grid is here defined as any production not connected to the main TANESCO grid, and power consumption using technologies that enable solar stand-alone technology or similar. There are numerous providers of small-scale renewable power technology, so those mentioned here are just examples. Some of them focus on selling imported goods, while others are system developers that design, construct and maintain small single-source or hybrid renewable power systems, including systems for villages.

Starting a company to sell, distribute and commission Home Solar Systems, hybrid micro-grid production units or rent out rechargeable battery lamps requires a multitude of skills. The most important barriers are lack of demand due to a limited access to capital, and the difficulty in marketing new solutions to Tanzania's thousands of villages with difficult access and infrastructure such as hotels and other amenities for visitors. Also, a new actor in renewables would have to acquire skills regarding legal documents, local employees, understanding and managing means of funding such as stocks and options, accounting, and other skills.

The two main barriers to market development as expressed by interviewees are the problems of awareness or marketing of available solutions, and the ability to pay for construction of power production (or connection to the grid in relevant cases). Lough (2011) found in a study of energy entrepreneurs, *inter alia* in Mwanza, that without a dedicated effort in supporting energy entrepreneurs to proactively reach out to the market it will be very difficult to enable them to break-even or grow.

Low rural incomes in Tanzania are well documented. At the same time, many households spend thousands of shillings on kerosene for lighting and have been eager to adopt solutions such as those provided by EGG-Energy and other battery and/or solar technologies.

EGG-Energy
EGG-energy is one of the winners in the REACT program (see section 2.2.1), a company dedicated to helping low-income consumers in Sub-Saharan Africa gain access to clean, and affordable energy, focused on portable rechargeable batteries. The company is based in Tanzania but with aspirations to work all over the developing world. The company aims to bridge the gap between household and grid (in most cases not more than 5 km) by renting out power by means of rechargeable batteries. Power is taken from a grid or off-grid power station and charged into portable, rechargeable, and affordable batteries. Each battery is about the size of a brick and lasts about five nights in a typical household. The company started battery charging and swapping operations in Chanika, approx. 40 km south of Dar es Salaam, with distribution stations in neighboring Mvuti, Mbande, Bwama and Msanga. A number of new charging stations, including off-grid, are under development.

Carbon X

The Carbon X Ltd: mandate is to provide conventional 230V AC electricity to isolated rural communities through the use of solar-PV and hybrid mini-grid systems. Carbon X was one of the winners of the Lighting Rural Tanzania Competition 2010, hosted by REA and the World Bank. The funds from this award are currently being used to implement an 11 kWp pilot-scale system in Masurura in the Mara region of Tanzania. It is the first project of its kind in the country and could be an important milestone in renewable rural electrification efforts.

Katani Biogas

An example of a small scale producer is the biogas plant operated by Katani in Hale, using Sisal waste as a substrate. The 300 kW installed capacity has earlier been used to meet company internal demand, but the company is now a SPP and produces power to the grid. Before the new regulations and standardized procedures for SPPs, TANESCO was reluctant to connect Katani because of its limited production. The original biogas plant was developed in part as a UNIDO funded project. The plant is mentioned in the State of the Environment report (VPO, 2008) as an example of beneficial use of crop by-products.

Flexenclosure

Flexenclosure is a supplier of power management systems, founded in 1989 and is based in Sweden, with offices in Nairobi, Kenya, Singapore and Gurgaon, India. Customers include global telecom companies Ericsson, Airtel, MTN and Zain. Regarding renewable energy, the main offer from the company is an intelligent green base station site power management solution for off-grid markets, mainly powered by renewable energy sources (sun and wind) and with an intelligent control system.

Flexenclosure have delivered off-grid base station power in Tanzania, and is also interested in working with off-grid community power.

Community power in Botswana

Flexenclosure is installing a Community Power system as a pilot installation for electricity production in Sekhutlane - a village located in the Southern part of Botswana close to the South African border. The population is 550 people distributed on approximately 100 households. The off-grid electrification unit will supply a mini-grid with 20 connection points using solar and biogas as energy sources. Biogas is mainly produced from cattle manure and the amount of available biogas is expected to generate 50 kWh per day, while up to 240 kWh could be generated if enough manure was available. The resulting power to reach the required 94 kWh per day (according to specification) will be generated by solar.

The Community Power system includes priority functionality which makes it possible to have three groups of users where up to 2 kW will be available for priority group 1 continuously. This could be for powering e.g. a clinic with cold storages. Priority group 2 and 3 users would be disconnected in those cases there would not be enough power available from solar or biogas.

Windpower Technics Tanzania
The entrepreneurial company designs off-grid systems for farms and other customers and has delivered a number of isolated power production units, mostly driven by windpower. At present, a new installation of biogas-based power is under installation.

Zara Solar
Zara Solar is a company that offers different types of imported technologies such as Home Solar Systems, with stores in Mwanza and Dar es Salaam. They offer systems from 15 to 260 Wp and also PV driven refrigeration.

Other
A substantial number of companies provide renewable energy solutions for urban and rural Tanzania and the ones listed above are just examples of active companies. A number of entrepreneurs and companies offering their services in this sector can be found on the TAREA homepage, www.tarea-tz.org. Companies are listed under "Corporate links".

2.4.4 Renewable cooking energy producers and distributors

SimGas Tanzania Ltd is a joint venture between SimGas Netherlands and Simtank of Tanzania. Coincidentally with almost the same partner names, SimGas Tanzania has developed two types of improved biogas systems for the East African market where no concrete is used to build plants. Biogas made from vegetable waste is a substitute for charcoal in urban areas. A system adapted for rural demand is also available. These systems are relatively easy to install (and move and resell, which reduces the investment risk). SimGas Tanzania works with micro-finance partners, such as NMB, to facilitate financing also for low income households.

ARTI (see also section 2.3) entrepreneurs offer a "Compact" biogas system both for urban and rural use. A thesis study suggests that such plants can produce domestic gas and replace the need for wood based fuels, but that installations must be followed up to ensure that operation is continued at each location. Investment cost, around 850 000 TSh, was seen as the greatest barrier (Riuji, L. R., 2009).

Figure 6. Technology developed by ARTI to produce sustainable charcoal.

ARTI also trains entrepreneurs to produce sustainable charcoal from agricultural waste biomass, by collecting waste biomass and processing it in a more efficient kiln as shown in Figure 6. The charcoal dust from the metal kiln is processed into charcoal briquettes.

Others
Other producers and training programs for biogas and briquettes exist in different districts. See for example The Tanzania Domestic Biogas Programme in summarized in Annex 4.

2.4.5 Non-renewable cooking energy producers and distributors

Charcoal producers and distributors
Charcoal production is one of the mainstays of the Tanzanian economy, albeit to a large degree founded on non-sustainable practices (see section 3.3.2 and 4.1.1). A World Bank report (2009) estimates the industry turnover to around 650 million USD (approximately 1 billion TSh) An important element in the transformation towards sustainable energy provisions is actively working with charcoal producers with renewable provisions of biomass and more efficient kilns.

The organization of production is complex. There are formal and informal actors working from the charcoal production, transport, wholesale and onto retail. It is work performed by many, not always full time, and not always in the form of companies. The informal supply chain dominates; it is assumed that only 20% of the charcoal going into Dar es Salaam is supplied formally with government-issued licenses for harvesting wood, and continues to the final customer with paid duties and taxes. A total of around 2 million man years per annum, of which around 5% is in terms of production, is believed to be involved in the supply of charcoal. (WB, 2009).

Development of the sector is discussed in this report regarding renewable production (see 3.3.2), and for energy efficiency in production (see 4.1.1) and distribution (4.2)

Other
In addition to charcoal, other fuels such as kerosene and LPG are available, LPG predominantly in the urban areas. They are attractive based on the comfort of use, while the higher investment and operational cost have led to reduced demand. A network for domestic gas[20] is discussed for Dar es Salaam. While infrastructure cost would be considerably higher than for LPG, this could reduce demand for both charcoal and LPG. Energy sales is a challenging area in Tanzania, and any new power grid is likely to see similar issues as the old (see section 4.2.2). These options are however fossil-based and not further discussed here.

[20] Domestic gas based on methane is typically a mix of air and methane to enhance combustion properties.

2.5 Consumers

This section gives an overview of how energy is used in Tanzania.

As mentioned in section 1.2, the large majority of Tanzanian households have yet to see the advantages of modern energy for cooking and lighting. Demand for energy is to a large extent satisfied by wood fuels. Electric power is available to less than 15 percent of the population, and only a few percent of the rural population have access to power. Where grid electricity is available, a "lifeline tariff" of 11000 TSh per month is offered to low power and low income households for domestic customers using up to 60 kWh per month (or 2 kWh a day) which only suffices for Level 1 and very limited Level 2 energy services.

2.5.1 Rural

This section describes the energy services used (and coveted) by rural domestic and small scale industry consumers.

Rural domestic energy use is to a large extent limited to wood fuel for cooking and kerosene for lighting. Most domestic woodfuel used does not come from forests but from scrub, bush fallow and the pruning of farmland or agroforestry trees. Heating is particularly important in the colder parts of the country (Kilimanjaro, Arusha, Mbeya, Iringa, Sumbawanga and Kagera). Wood is the dominant source of heating energy in rural areas, and wood consumption is significantly higher in these regions, particularly during the coldest months, June and July.

Rural electrification is difficult in that grid power distribution has a large investment cost. The rural community as new consumers of electric power are a difficult target since distances are long, roads are difficult, infrastructure to house visiting energy company representatives are scarce and the ability to pay is low. Apart from thousands of villages and millions of rural households without grid connection, institutions such as schools and nursing homes also lack modern energy. There are over 17 000 non-electrified schools in the country in spite of introductory campaigns for stand-alone systems.

From a market perspective, an issue is that consumer electricity meters are expensive and illicit energy use is common (see also section 4.2.2). TANESCO has introduced prepaid "Luku" meters that can be paid with scratch cards and over cell phone payment systems (e.g. M-Pesa, TIGO-MPESA). These are also the means of payment for private utilities in recent projects.

An important element for setting the agenda for interventions to improve access to energy services is to understand, and to be able to measure, the actual situation for the rural community.

Tanzanian small scale **industry** to a large degree focuses on agriculture, with roughly half of the country turnover related to the sector. Most micro and small scale private manufacturing firms are owned, managed and operated by local indigenous population, which is promising and should be supported. In contrast to domestic use, clearing associated with agriculture and the harvesting of fuelwood for small-scale industries such as brick-making, tea-curing and tobacco-drying can be a significant driver of deforestation .

The government policy- *Kilimo Kwanza* (Agriculture First) is a guide for development in rural areas and beyond. Kilimo Kwanza follows a Value Chain Approach – from agro input to agro production, processing, marketing, and distribution. Apart from cereals, processing of agricultural products, especially vegetables and fruits, is crucial for the contribution to growth and poverty reduction.

A remaining large barrier to rural industrial growth is that Level 2 and 3 electric power, important to sustain processing operations, is rarely available in villages and rural areas. Also, while agricultural production is rural, the demand for these products, expressed as ability to pay, is urban. Transport is neither cheap nor easy given the inferior road infrastructure. In all, this could mean that up to 85% of the small scale industrial potential in the country is immobilized.[21] Rural electrification, including at least Level 2 power services, would greatly enhance the potential for rural agricultural processing, which is fundamental for value creation in the food chain.

Further, rural industry development is not simply a function of offering a connection to Level 2 and/or Level 3 power. Processing techniques must be taught and processing technology must be available and bought into by each agricultural production district. Building power demand is as important as building supply. To build demand and balance supply, at the same time as rural people are informed and involved is an important development task. A proposal to this end can be found in the Summary report.

2.5.2 Urban

This section describes the energy services used by urban consumers: domestic and small-scale industry.

The main energy services in Tanzanian urban households are based on electricity and charcoal. Households also use a variety of petroleum products: kerosene for lighting, cooking, and heating; liquefied petroleum gas (LPG) for cooking and heating; and gasoline and diesel for private vehicles as well as captive power generation. Paying for cooking energy constitutes a fair share of the income of an average family.

Electric energy is available in cities, but the cost per kW hour in relation to average income levels make cooking from electricity too costly also for most urban Tanzanians. It is common in urban households to use a combination of charcoal kerosene and electric stoves. Charcoal may be used to do normal cooking, while electricity or kerosene may be used for lighting. Electricity, LPG or natural gas may be a solution for warming up food. Also, the frequent blackouts mean that reliance on electricity for cooking may not be an option. Around 80% of TANESCOs customers are on a "lifeline" tariff of 11000 TSh per

[21] Interview with SIDO, april 2012

month for up to 60 kWh of consumption. Electricity meters for 1 or 3 phases are either of the "normal" kind with a window for reading and invoicing, or "Luku" prepaid meters that can be paid by vouchers or through e.g. cell phone M-Pesa systems.

The World Bank (2010) concluded in a major study of the charcoal sector in Tanzania that charcoal will be a major urban source of cooking energy for the next 30 to 40 years.

The same report presents different regional rates of urban population growth in Tanzania, reflecting different regional drivers. Growth rates between 1988 and 2002 are highest in Arusha (6.9%), Bukoba (5.2%), Dar es Salaam (4.7%), Tarime (4.5%), Songea (4.4%), Dodoma (4.2%), Mbeya (4.1%), Kigoma (4.1%) and Morogoro (4.1%). While 7,6 million people lived in urban Tanzania in 2002, by 2030, it is estimated that more than 25 million Tanzanians will be living in urban areas (Sarzin and Raich, 2012). The systems to be designed and developed today to supply cooking energy and electricity to cities tomorrow must thus have a capacity to sustainably deliver more than three times the amount of energy.

As to sustainable alternatives for cooking, renewable charcoal seems the most straightforward option. If electric power production was more reliable, renewable, and offered at acceptable prices, this would be another sustainable possibility for urban consumers. In the medium term natural gas, possibly with some renewable biogas injected in time, is another possibility for suitable neighbourhoods. Compared to rural households, urban homes are more captive customers.

In urban areas, Tanzanians operate a variety of micro-enterprises. These include sales of cooked food, cold soft drinks, ice cream, cold beer, home brewed local beer, freshly slaughtered chickens, shop operations, hair and beauty salons, welding, battery charging stations, cloth sewing etc. Energy sources for micro-enterprises are wood, charcoal, electricity and kerosene. Three-stone fires are used to heat water in two hundred-liter open drums. Other appliances which support urban micro-enterprises are sewing machines, refrigerators and hair dryers. Many of these would be attractive options also in rural areas, if only power could be provided. There is a large potential in creating awareness regarding productive uses of energy also in urban areas.

In the urban context it should be remember that, in the future, housing and office buildings will also consume an increasing amount of energy, predominantly for cooling.

2.5.3 Larger scale industry

The agro-processing sub-sector constitutes about 70 per cent of industrial production in Tanzania. This reflects the role of agriculture as the mainstay of the Tanzanian economy. Important sub-sectors are food processing, beverage and tobacco. One important example of energy use is coffee processing. As the country's economy grows and markets expand, a number of products and services will meet sufficient demand for national production to be the most practical option for things that were previously imported. As mentioned, tea-curing and tobacco-drying can be significant agents of deforestation, so both energy sources and efficiency are important issues for sustainability of the sector.

Mining is a subsector that drives development and has large power needs. Mines, especially coal mines, also plan to produce (non-renewable) power as part of their development (see section 2.4.1), so supply and demand to some extent go hand in hand. Tanzanian mining is expected to demand 146 MW of produced power "in the next few years", up from today's 50 MW[22].

Sugar cane plantations and processing plants are an interesting sector in that a plant could be a net producer of energy. This energy production is seasonal, depending on the availability of bagasse, and could balance out the seasonality of hydropower. There is a large potential in supporting power production with funding schemes and tariffs to ensure that new production uses the most efficient generation technology, and that older installations update the technology with similar goals. This industry has a tradition of supplying part of the processing demand with outgrowers, allowing for small-scale farming where rainfall is sufficient.

One of the more interesting potentials for renewable energy, with a highly geographically distributed demand profile, is the telecom sector. Each base station (telephone tower) in the country has to be equipped with backup power, i.e. diesel generators. Also there are over a thousand off-grid base stations in Tanzania which EACH on average consume around 1 500 liters of diesel fuel per month (around 40kW peak, 21 kW average power demand). Technologies exist for reducing diesel demand by over 90% in typical installations. Such hybrid-renewable powered base stations, combining solar, wind, hydro and even biogas based electricity could also be a source of community power for phone charging and up to Level 2 power services. An example of a provider of such technology is found in section 2.4.3. Off-grid base stations with surplus energy can, from a technical standpoint, also serve as community energy providers of Level 1 services and perhaps also Level 2 for selected customers. The design of the base station could be part of a telecom provider program for social responsibility and integrate the success of pay-as-you-go schemes. Such development could also be supported by donors.

3 Renewable energy production in Tanzania

An overview follows of the different types of renewable energy sourced production that are available and how the markets have developed over time. Important to note is that monopoly is also a type of market, and that for village based and telecom, hybrid systems consisting of two or more of the technologies below, maybe in conjunction with diesel genset backup, are viable options. Each section ends with examples of projects in the field.

Power production is everything from a solar panel on a roof of a rural home producing 5 Watts, to the Kidatu Hydropower dam with 200 MW installed power. For this report we separate unbundled projects (typically larger) where energy is sold to the TANESCO grid only, and bundled (typically smaller) projects, where production and distribution to individual customers is combined.

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[22] "Tanzanian gold mines power usage to soar", The Citizen, Dec 12, 2011

A study funded by NORAD (2007) points out a number of means to enhance the growth of “clean” energy in developing countries (not specifically Tanzania), by

- Allocating development aid so as to mobilize public-private partnerships.
- Allocate equity finance so as to mobilize renewable energy projects e.g. by strengthening Norfund
- Better aligning guarantees with local development priorities.
- Scale up support to project preparation, by cost-sharing technical assistance for project preparation and preparatory assistance to relevant ministries and agencies, as well as regional initiatives
- Actively promote engagement by private investors, assisting national authorities in attracting private investment e.g. by maintaining a global project list for possible investment, and co-financing of market studies
- Support rural electrification agencies/funds (REA/REF).
- Rollout innovative rural renewable energy access programs e.g. by using the ‘Sustainable Solar Market Packages’ (SSMP) approach
- Mobilize CDM (Clean Development Mechanism) project finance, e.g. by establishment of a ‘Project Development Facility’; and a ‘Carbon Credit Delivery Guarantee’
- Provide small scale demand-side financing, e.g. by coordinating with, and contributing to, micro-credit facilities
- Coordinate anti-corruption and governance measures.

“All of the above”, possibly with the exclusion of CDM (see the VPO paragraph in section 2.1), could be included in a donor agenda for Tanzania.

A number of donor supported power production projects, both small and large scale, are listed in Annexes 1 and 4.

3.1 Larger scale electric power

For this report, larger power projects are defined as unbundled; solely or mainly aimed at selling power to the TANESCO grid. (A summary of donor supported projects in this area is provided in Annex 4.)

3.1.1 Opportunities and challenges

Larger scale electric power production and transmission is at the core of economic growth, as mentioned in section 1.2. Failure to meet demand and produce stable power for the urban areas directly affects the ability of companies and public institutions to function. Therefore, larger scale sustainable energy provisions are very important in response to the demand in growth of over 7 % annually.

Energy investments in many African countries often include some degree of donor financing; funds may have been channelled to the government for use in supporting and regulating investment or are provided in the form of co-financing of economic and social infrastructure. While involvement in the actual investment process is still limited, there have been widespread calls for donor financing to assist in such areas as technology transfer and adaptation and the analysis of environmental and social impacts (Parola, 2006). Financial resources are of various types: managed funds, private capital, exchange traded funds and a number of others. The type of funding used by investors depends on the type of project. Typically, renewable energy finance for larger projects is done by project finance. The funding of a larger project is typically done by a combination of different types, where FDI plays an important role. Domestic investors can act in consortium with foreign capital.

Financing renewable energy projects in Tanzania is difficult due to high interest rates, short pay back periods and high equity requirements. The creditworthiness of TANESCO has repeatedly been questioned, and it is difficult to negotiate competitive tariffs. Other financing issues include that loans in the sector are given in US$, while services and contracts are both in US$ and TSh, which adds the insecurities of currency fluctuations to an already complicated investment. The sector also requires long tenors, repaid in fifteen years or more, which are difficult to obtain.

EWURA has negotiated non-standard (higher) tariffs on the basis of the avoided cost, often for diesel fuelled generation in different scale. To arrive at a differentiated set of feed-in tariffs (FIT), where the particular characteristics of different types of RE are taken into account, further work is needed. Donors could either help with an additional few cents on top of EWURA tariffs (top-up), or tariffs could be set higher and donors would pay the difference between the standard tariff and what TANESCO would pay out (buy down).

The "market" for larger projects is exposed to political risk, technical risk, financial risk and climate risk, to name a few. Political risk can be creditworthiness and limited ability to give national guarantees

3.1.2 Larger scale hydropower

Larger scale hydropower is here defined as project exceeding around 10MW in production capacity.

On November 14, 1975, Tanzanian president Julius Nyerere inaugurated the underground Kidatu hydropower station and marked the entry of larger scale hydropower in the country. In "wet" years, hydropower supplies up to half of Tanzanian electricity production. The country's hydropower potential capacity is estimated to be more than 4,700 MW, nevertheless, less than 20% has been exploited so far and on average around half of the electric power and the absolute majority of the hydropower is supplied by the 6 large plants in the country.

Table 5. Overview of currently functioning large scale hydropower plants (TANESCO)

Installation	Year commissioned	Installed capacity
Kidatu (Great Ruaha power project, phases I & II)	975/1980	100 + 100 MW
Mtera (Great Ruaha power project, phase III)	1988	80 MW
Kihansi	1999	180MW
Hale Power Station (Pangani "I")	1964	21MW
Nyumba ya Mungo (Pangani "II")	1966	8MW
New Pangani Falls Power Station (Pangani "III")	1994	68MW

Such installations would normally be connected to the national electric grid. As discussed above, large-scale hydropower has historically made important contributions to the electrification of Tanzania. Hydropower installations are typically characterized by a significant initial capital outlay, followed by many years of low cost power generation. The cost over the long term could be brought down to less than 10 cents per kWh. There is still a technically and economically viable potential for new development, although the current focus on more short-term solutions has taken investment focus away from large-scale hydropower.

Geographically, the hydro power potentials of Tanzania are located in the Rift Valley escarpments in the West, Southwest and Northeast regions of Tanzania. The planned large-scale hydropower generation sources include Ruhudji (360MW, see section 2.4.2), Rumakali (220MW), and Stieglers Gorge (2100MW). The latter may have the potential to produce enough electricity to justify investments in extending the national grid, and has been under discussion for decades due to a number of environmental and social issues.

Large-scale hydropower projects have continued to face environmental challenges. The original Malagarasi project could not be done because of the environmental risk of eradicating the habitat of a snail species. It has been relocated to Rumakali, where it is under development with expected production currently planned for 2020. The Stiegler's Gorge site is in a conservation area (Algiers Protocol Heritage International). For the project to continue, Government action will be required at a legislative level. The project is planned to be developed in four phases: Phase I - 2020 (300MW), Phase II - 2022 (600MW), Phase III - 2023 (300MW) and Phase IV - 2025 (900MW). To continue the development of large scale hydropower is thus important, but production should not be expected until the next decade.

There are important environmental considerations that surround investments in hydropower, particularly large scale plants. These considerations become more serious as more sites are developed, leaving fewer sites in natural states in terms of habitats for flora and fauna. Also, those sites already developed can be considered as the "low-hanging fruits" in terms of technical/economic viability; future sites may be not only more environmentally sensitive but less favourable in terms of access (to the grid) and potential. Environmental implications of hydropower development have been the inundation of the land upstream, displacement of people and desiccation of agricultural land downstream and loss of biodiversity (VPO, 2008).

3.1.3 Geothermal power

There is a high potential for geothermal power generation in Tanzania, with temperatures of up to 255°C (dry steam). At least 15 thermal areas with hot spring activity could be justifiable development projects. The total potential geothermal power in 50 identified sites is 650MW. Figure 7 below gives an indication of the location of some identified sites.

The Songwe site in Mbeya region alone has an estimated potential of 100MW of electricity. At issue is that some of the identified sites, such as Lake Natron, are in or near reserves such as Lake Manyara and Ngorongoro. Geothermal exploitation involves changing the flows of underground water, which in some cases have led to draining of nearby lakes. While the potential Tanzania is considerable, it should be kept in mind that estimates are more than an order of magnitude less than in neighbouring Kenya.

To get access to geothermal power for electricity generation could be an important boost towards solving the growth equation of the Tanzanian power system. The execution of the project could be public or private (or combined) exercise. This means that "market development" would be to support fact finding and attracting funds for executing feasibility studies – effectively cost sharing between the public and private sector - in order to make the project bankable. Without sampling and studies that satisfies lenders, no project will take off.

A number of studies have been carried out since the 1950s. The main studies done over the last decades are listed in Table 6 below.

Table 6. Studies conducted 1976-2006 (Mnjokava, 2008)

YEAR	INSTITUTION	STUDY	RESULTS	AREA
1976 - 1979	SWECO through Sida	Reconnaissance exploration	50 hot springs sampled	Lake Natron, Manyara, Utete, Mbeya, Musoma
1983	UNDP funded geothermal mission	Reconnaissance exploration	Mbeya considered a good prospect	South Mbeya
1997 - 2004	First Energy Company Ltd	Reconnaissance Exploration, Power project pre feasibility study	Samples collected and analyzed, good results, (promising site)	Luhoi - Coast region

2004 - 2005	DECON through African Development Bank (ADB)	Rural electrification study Magnetometric, gravity and resistivity surveys	Recommended detailed assessment of Mbeya area.	Lake Natron, Manyara and Mbeya (Songwe, Kasumulo, Mampulo)
2004 - 2005	Regional Consultant for Geothermal in East Africa	Status of geothermal resource development in Tanzania	Recommended further studies on Songwe, Luhoi and Lake Natron	Lake Natron, Songwe river, Luhoi (Coast region)
2006	MEM collaboration with Geological Survey of Tanzania and Federal Institute for Geosciences and Natural Resources (BGR) German	Reconnaissance study on geophysics method of exploration by using Transient Electro Magnetic (TEM) and Vertical Electric Sounding (VES)	One site for detailed assessment identified	Songwe river in Mbeya region

The University of Dar es Salaam[23] has some experts in geothermal energy, in its Geology Department. They have been involved in investigating geothermal sites in Tanzania, including volcano activities on Oldonyo Lengai.

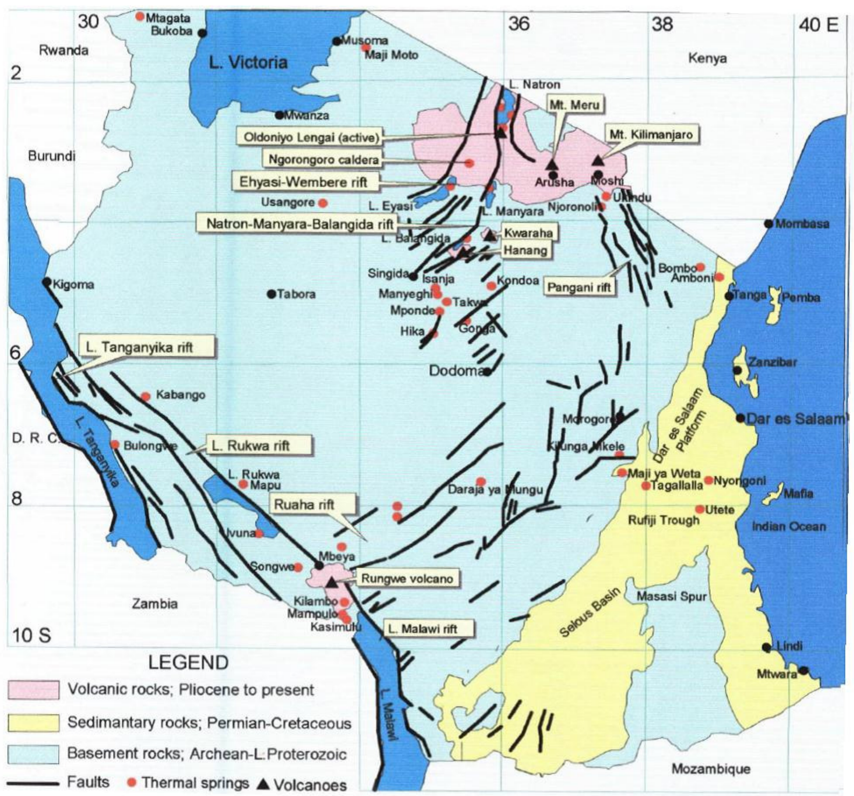

Figure 7. Geothermal sites in Tanzania (Geothermal Survey of Tanzania)

[23] In the current Sida research support to the University of Dar es Salaam, geothermal energy is one of the areas being supported. Currently there is one MSc. student but more are showing interest to join.

There is an ongoing interest to commence production. The Swedish consultancy firm Sweco has outlined a number of studies carried out since 2005, the latest concerning shallow drilling to estimate the power potential (2010-2011). Apart from more theoretical impact studies, deep test drilling and verification of temperatures and flow is needed prior to construction. The build phase for a given site is expected to take around four years. A national committee, consisting of representatives of both public and private organizations, was formed in January of 2012 to develop policy and activities to foster the sector.

Tanzania is a member of the Rift Valley programme - Africa Rift Geothermal (ARGEO). Other member countries are Tanzania, Uganda, Kenya, Ethiopia, Djibouti and Rwanda. . The Steering Committee has two members from Tanzania - MEM (1) and GST (1). A ministerial level meeting will take place during 2012. ARGEO gets funds from GEF/UNEP. A proposal for UNEP to help in development of geothermal resources is being prepared, and SREP are among the instruments available for funding this size investment. TANESCO and the Government are investigating one site in Mbeya. There has not been much interest in geothermal power generation from private investors (MEM, 2011), but there is a company which is has been granted prospecting licenses (see 2.4.2).

Geothermal power in Kenya

Tanzania's neighbor Kenya has a history over 40 years in developing geothermal power in the Rift Valley, which is estimated to have potential of 10,000 megawatts at 14 possible sites. First production started in 1981. Production capacity is currently 129 MW_e, with an additional 400 MW foreseen under the next two decades.

Kenya develops the geothermal potential through the state owned Geothermal Development Company, founded in 2008 to develop, together with the major power company in Kenya, Kenya Electricity Generating Company (KENGEN), and private industry. KENGEN has stated that geothermal power is preferred compared to other alternatives even though the upfront costs are higher, since production is more even and predictable. It should be noted that geothermal contributes around 10% to the country's 1 215 MW installed capacity, compared to 25% of thermal (diesel) generation.

Present development is carried out just 150 km from the border to Tanzania and 170 km from Lake Natron. This means that there will be added production close to Tanzanian needs in the north of the country. This point both to improved grid connections as well as the potential also in Tanzania for geothermal energy production.

Several areas need to be streamlined to enhance the uptake of geothermal energy in Tanzania, such as creating transparent conditions for the private sector to develop projects. Other needed measures include:

- Supportive legislative and regulatory framework for geothermal development
- Structuring off-take agreements for geothermal power and steam
- Establishing a simple process for negotiations and permits for geothermal projects
- Private-Public Partnerships (PPPs) in geothermal development
- Effective Procurement planning and management

3.1.4 Larger scale solar

Larger scale solar is here defined as unbundled projects feeding into the TANESCO grid.

The country's geographical location and available lands make for high potential for solar farms in Tanzania. However, given very high investment costs, in the range of millions USD for a larger scale installation selling directly to the grid, and the difficulty to get premium tariffs from TANESCO for renewable energy, the interest has been low. In other parts of the world, projects such as Desertec[24] in Maghreb have had problems and several large initiatives have disappeared.

For unbundled solar project to be attractive to investors, tariffs must be developed specifically for these projects with the land requirements and connection issues in mind. This sector does not seem to be high priority for support, given many other opportunities in renewables, but should be monitored for profitability as PV panels come down in price and increase in efficiency.

3.1.5 Large-scale wind

Large scale wind power is defined as unbundled projects feeding into the TANESCO grid.

Potential areas for wind areas have been mapped by TANESCO. There are several areas in the country, predominantly along the coast, with attractive wind speeds.

While there at present is no large scale wind energy production in Tanzania, permission was given in 2008 for a 100 MW wind farm to be built, owned, and operated by a private-sector project company, Wind EA (see section 2.4.2). The project cost was estimated to be between US$230-290 million. The wind farm will be constructed along the Rift Valley on a site located east of the town of Singida, in the district and region of Singida[25]. A PPA was handed to the consortium from EWURA late 2011. The first tranche of the project to be realized will be half of the permitted capacity (and cost).

The National Development Corporation, in cooperation with the Power Pool East Africa (see section 3.1.1) is developing another project outside Singida with a final planned capacity of 300 MW. The first phase will see 50 MW installed capacity, and is planned for commissioning in 2013 with the help of a recently approved loan by the Exim Bank of China.

The two projects have been involved in a political wrangle which nearly brought the Wind EA project to bankruptcy.

For this sector to develop according to potential, it is desirable that accurate wind maps be made public, or available, so that projects of different sizes can identify opportunities

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[24] http://www.desertec.org

[25] http://go.worldbank.org/WEERS0AV20

and seek funding. The tariff and PPAs must be attractive and perceived to be stable. Specifically, the connection to the grid must be supported. Given the large hydro production in the country, the capacity of hydropower plants production can be adjusted to balance this relatively uncontrollable source of renewable power for the foreseeable future.

3.1.6 Biomass for Electricity Production

Power production from biomass is common all over the world and holds potential also for Tanzania. A limited number of plants such as sugar producers and sawmills, produce electricity from combustion of biomass as an integral part of their operations. International examples in sustainable forestry include those where thinning or part of the harvest is used for electricity production or urban waste to energy schemes. Biogas is produced sustainably from wastewater and food production waste in many countries.

Sustainable large scale bioenergy can be carried out together with sugar production, with sugar cane bagasse used as fuel for a power generation plant. At present, the Tanzanian sugar industry produces around 290 000 ton sugar per year in around 40 000 hectares of dedicated land, leaving a little less than a million tonnes of bagasse (the remaining fibre as the sugar is washed). The industry uses some of the bagasse for energy purposes. Four plants use bagasse for producing electric energy and process heat, but today only one plant produces electricity for the grid. With old/substandard generation technology, the energy yield is enough for internal use with some surplus, but with steam turbines and more efficient energy management, a larger surplus of up to 50% of production can be sold to the grid. Sagawa et al (2008) have shown that using available bagasse in advanced cogeneration systems could yield 216-859 GWh/year in Tanzania. While such investment has a price tag, it can compensate for most of electricity from fossil-fuelled thermal plants. Given that the harvesting (and combustion) takes place during the dry season, electricity generation from cane processing companies can compensate for a deficit of hydro generated electricity during Tanzania’s dry season.

ICRAF (2009, Figure 8) has shown that the potential for sugar cane production in the country mostly lies in the northwest and in the south.

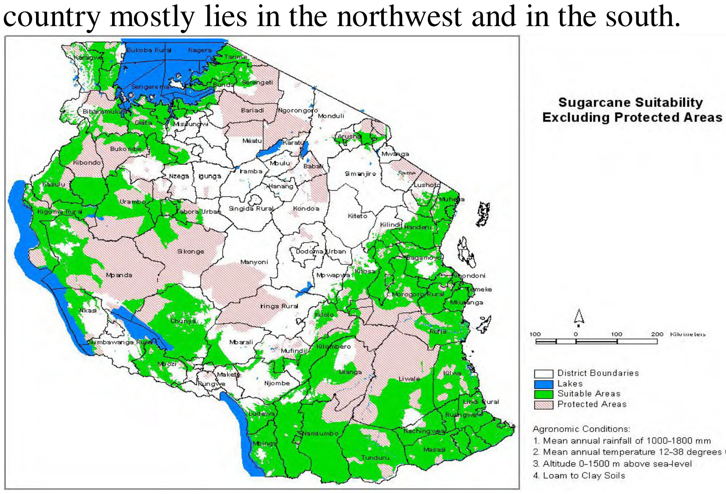

Figure 8. Suitability for sugarcane, excluding protected areas (ICRAF, 2009)

The Tanzania Sugar Board reports that a number of areas are considered for additional production of cane. Five feasibility studies have been done for Ruipa, Ikongo and Mahurunga (see Table 7), and there are also a number of locations identified where a feasibility studies have not been carried out (Table 8).

Table 7. Potential Areas for Cane Growing and Sugar Projects (Tanzania Sugar Board)

Project site	Sugar Production potential (tons)	Irrigation	Feasibility studies
Ruipa I	110,000	Irrigation +Rainfed	Done
Ruipa II	114,000	Irrigation +Rainfed	Done
Ikongo	82,000	Irrigation +Rainfed	Done
Mahurunga	10,000	Irrigation +Rainfed	Done
Total	316,000		

The accumulated need for land for the project sites above corresponds to more than a doubling of the land used today. Assuming that a sugar cane plantation requires 600 – 1800 mm of rainfall per year, any shortage of that would have to be compensated by irrigation. For the lower end of the interval, production methods to reduce the need for water exists and could be a means to make production sustainable also in areas where access to water is more limited.

Table 8. Tentative sugar projects, early stage (Tanzania Sugar Board)

Project site	Region	Proposed Mill Size	Irrigation potential	Feasibility studies
Kisaki	Morogoro	Large scale	Irrigation +Rainfed	Not done
Bagamoyo	Coast	Large scale	Irrigation +Rainfed	Not done
Rufiji	Coast	Large scale	Irrigation + Rainfed	Not done
Kasulu	Kigoma	Small scale	Irrigation + Rainfed	Done
Luiche/ Malagarasi	Kigoma	Large scale	Irrigation + Rainfed	Not done
Pangani	Tanga	Small scale	Irrigation + Rainfed	Not done
Kilosa	Morogoro	Small scale	Irrigation + Rainfed	Not done

Given locations with sufficient water resources, there is thus a large potential to increase both sugar and power production in areas where additional power is needed. Given the seasonality of power production, there are special opportunities to extend the grid to larger bio-power producers such as cane plants. The investment decision with the

different companies should be supported to make sure that investments involving power production are optimized from a regional perspective.
Another area with high potential in Tanzania is electricity from biogas as part of a hybrid system for community (off-grid) generation. Farms with a more than a few dozen heads of cattle or similar, with manure collection, can produce biogas directly for fuel for co-generation. The Tanzania livestock Research Institution manage an institutional farm in Dodoma, Mpwapwa district, with more than one thousand cattle and other livestock species. There is a pronounced interest both with politicians and local researchers to investigate this potential and to demonstrate the potential as a baseline for further investigations and market building.

3.2 Small grid/off-grid electric power

This section concerns development of supply markets for small scale (<10MW) power and power distribution. (A summary of donor supported projects in this area is provided in Annex 4)

3.2.1 Opportunities and challenges

The distribution network in Tanzania currently suffers from large losses and needs to be extended to areas with smaller scale power to serve for the uptake of small-scale power generation. Considering the low proportion of the population that is currently connected to the grid (14%, with only 2.5% in rural areas) and that Tanzania does not produce excess power, all sorts of off-grid renewable power solutions are important for improving sustainable access to clean energy. They are also important as a precursor to developing the national grid.

As mentioned in Section 2.1, TANESCO runs a number of isolated grids fuelled by diesel generation. Apart from this, SPPs are the main new source of rural power outside the transmission corridors which are the responsibility of TANESCO. There are thousands of unconnected villages in the thirty regions of Tanzania, of which a large portion would take an interest in having access to Level 1, 2 and even Level 3 services (see section 1.4). The opportunity is large – 85% of national SME potential may be held back because of lack of power (see section 2.5.1). The challenge lies in connecting supply and demand to create a bankable project, either for a larger, unbundled project, or for a local production unit feeding into an isolated, local "village" or "community" grid.

Funding smaller grid projects may be by means of corporate finance, while off-grid projects could be funded by consumers and microfinance. Off-grid projects are of a size where donors could make a big difference by adding stability – in consortium with domestic investors and any grant or loan scheme. Development Finance institutions can also play a role in engaging in local community development and revolving funds.

Several ongoing projects combine power production and provision of power to individual customers (in villages), so called *bundled* projects, and some of these also connect to the TANESCO grid. Local participation may be an important entry point for creating demand for electricity, especially in isolated grids. Finally, it is easier to motivate local participation if the local villages get access to the power generated. The main barriers to developing the market for rural electrification by means of developing local grids and local production is precisely awareness – villages are difficult to reach, difficult to visit and knowledge about the opportunities from power access is low – and the ability to pay for the investment needed for local power is limited. While paying for energy received may not be a problem according to interviewees, the upfront cost for construction and connection, and even for a feasibility study, is prohibitive. Construction and connection efforts, in turn, are hampered by the lack of demand, since the productive use of power does not come overnight in a remote village.

Interviews have shown that potentially involved stakeholders would take an interest in designing and installing a renewable hybrid village system and mini-grid based on local conditions both regarding choice of energy sources, demand and funding. A project proposal is presented in the Summary report.

Beyond village grids, a number of challenges or issues remain for the development involving both IPPs and TANESCO. Development of a user friendly excel sheet to calculate profitability for new investments, and a user manual for SPCs & SPDs are needed, as is development assistance to the government to apply standards not only to hydropower, but also to cogeneration and other types of renewable energy production. Just as for larger projects, tariffs must be adjusted depending on type of RE.

Another issue is the high *demand charge* – the tariff that TANESCO charges to larger customers for the peak electricity demand they use in a month. The peak demand is typically triggered when an SPP has to draw power to get its plant up and running after a power outage. For every period of 15 minutes per month, TANESCO charges 10 000 TSh per peak kW, meaning that a 500 kW load would entice a cost of 5 Million TSh even if this electricity is only drawn for a few minutes a month. SPPs feel it is unfair to pay these high rates since they need to draw power is the direct result of a power outage on the TANESCO system.

Other points are:

- Developing a simple operation monitoring system for the electric grid which is transparent and forms the basis for improving efficiency and reducing bottlenecks.
- Coordinating of the responsibilities between the new agencies driving development, EWURA and REA, should be enhanced to ensure smooth support to new projects.
- Funding and arranging a credit line that allows the Tanzania Investment Bank to give larger loans to 4-5 commercial banks who in turn can give loans to SPPs, rather than today's 2-3 banks. Loans should be given for 7 years or more.

3.2.2 Off-grid (small scale) solar

Small scale solar is here defined as power systems that do not feed into the national grid, but supply Level 1 (household, see 1.4) power to e.g. 1-2 households, or Level 2 power for microenterprises (e.g. sewing) or agricultural services. This encompasses technologies ranging from individual lights of a few watts up to the solar part (perhaps 2000 Wp and up) of hybrid systems for whole villages or institutions. Off-grid lighting can be offered either as village grids, home solar systems and or battery lamp leasing/rental. Village systems would use solar power connected to a central bank of batteries and a control system (see text box in section 2.4.3), supplying power to a number of households.

A Solar Home system (SHS) is a self-contained domestic solution including the PV panel, batteries and a control system. To directly replace a kerosene lamp, battery lamps that are charged as a service at a central unit are rented out to users. Off-grid telecom base stations, where expensive and inconvenient supply of diesel generator fuel is the problem and hybrid systems involving e.g. solar and wind based power generation could be the solution, is an interesting and growing market.

Tanzania's solar market emerged only in the late 1990s and early 2000s, largely through a spill-over from Kenya and active market development programmes from foreign donors and the Tanzanian government (Ondraczek, 2012). The effect of Kenya was manly seen in Northern regions such as Arusha and Mwanza whereas the rest of Tanzania relied more on imports from South Africa, India, Belgium, etc. One Kenyan company, Sollatek, later set up an office in Dar es Salaam.

The market development programmes took off later, not until 2003-4 in Mwanza and Sida in 2005. The SHS market was very limited up to 2005 and basically only one company focused on rural Tanzania, Umeme Jua, with part help from Dutch Aid. Solar power has a very large potential in Tanzania, with over 90% of the population without connection to the electric grid in rural areas, and good solar radiation. If PV power generation becomes cost-competitive with coal sometime 2012-2014 as quoted in UNEP (2011), demand for off-grid systems could increase even more. This is because in many areas, PV buyers will not have the grid as an option for the coming decade or more. The problem often does not lay in paying for the services, but rather paying for grid connections, or getting the credit to do so.

Support to market development for solar PV technology, which is one of the easiest technologies to understand[26] and implement for the individual consumer, have resulted in significant increases in effective demand in recent years in Tanzania. It is reported that Tanzanian solar market has grown by a factor of fifteen from 100kWp in 2005 baseline study to 1.5MWp in 2009 according to market survey conducted by TAREA. Surveys show that advertisement - mainly through radio and rural road shows -made a difference to local market development, and that dealers that did not make a marketing effort lost

[26] It is mainly the technological systems comprising suppliers, dealers, and electricians that made it possible, not necessarily consumers' deep understanding of the technology. The introduction is application driven.

out in sales.Trained technicians continue to work with installations past initial commissioning, and can make a big difference in the quality of installations, meaning better uptime, better balanced systems and less safety hazards. Seeing a working system was one of the more important drivers for a new customer to purchase a system (Bångens, 2009).

Although there has been a predominant involvement of private sector actors in this development, there are still interesting possibilities for government institutions to pilot and/or support larger scale initial investments through awareness, market building, demonstration projects or village power generation. E.g. smart finding and sensitization on the positive impact of solar lighting on school results could motivate the investment from the point of view of education and development.

A basic installation in a small house would suffice for Level 1 services, e.g. lighting and cell phone charging, as described in Table 1. Imported "Solar packs" suitable for a household, consisting of a small PV cell panel, a battery and a limited number of lamps are now for sale by several distributors. For pumping potable or irrigation water (Level 2 power), 150 Watt or more solar modules with adjoining pumps are mature coupled products and suffices for pumping can irrigate over 1000m². Solar driven water pumps have been installed in Tanzania, showing that there are also other areas where local systems can facilitate development[27]. Solar systems with capacity for more households are also an interesting area, where cost can be reduced by sharing resources.

Two among the many national projects that have been implemented by the Government and stakeholders that has properly documented best practices that could be easily accessible and utilised is the UNEP/MEM Solar PV Mwanza Project (2004-2009), which enhanced technical and marketing capacity of entrepreneurs, and the larger Sida/MEM Solar PV Project. The latter began in 2005 and ended last June 2011. More info on this project can be found in Annex 4 of this report. The MEM/Sida project has shown that to sustain the utility of solar (and other) installations, it is instrumental that each household, entrepreneur or organization see a value, has paid for the equipment and has an understanding of the basic technology. An example of support to institutions is the EU-funded project to schools at the Oldonyo Sambu and Ngarenanyuki wards in Arumeru district, managed by the development finance institution Oiko Credit, where PV panels installed provide power for lighting and computers.

Also more innovative solutions have been demonstrated. *Solvatten*, a solar technology for purifying and pre-heating water, combines water purification and pre-heating without any need for electricity or chemicals in a simple 20 liter unit. There are also companies which replace kerosene lamps by leasing battery powered lamps. EGG energy (see 2.4.3), a company presently supported in the REACT program (see 2.2) , charge their batteries both in grid-fed and off-grid (i.e. initial investment and construction in central solar power units) and offer single-unit domestic lighting at a lower cost than the non-

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[27] http://waterforall.org/stories-from-the-field/116-sunshine-powers-water-pumps-in-tanzania

sustainable kerosene. TAREA has supervised the Generator Zero network[28], a solar project which has replaced 95 rural diesel generators. These and other renewable innovations can reduce several health issues, like air quality, water-borne diseases as well as the need for power, and could be supported in the framework of renewable energy.

Given the economic realities, the size of the country and the low coverage of the national electric grid, small scale power services made available to otherwise disconnected users can prove a boon for the individual in the same way as cell phones have been for connectivity. There is also of course a direct link since solar cell phone charging enables rural cell phone use. Even a small system is an important building block in the improvement of the home environment and development of demand for local grids and main grid connection. The potential to produce components and systems in Tanzania should be studied, as the volume of the potential demand could transfer into a source of employment for the coming decades.

3.2.3 Small hydropower

Small scale hydro is a promising area with the same challenges as other renewables; high initial investments and dependent on steady access to resource (in this case water). Smaller hydro plants (here, less than 10 MW) could be connected to the grid and/or supplying a local grid, for example for a community or an industry. For grid connection, the purchaser of the power is TANESCO, and the finance of the infrastructural investment would be subject to the same challenges that are valid for larger hydro (see 3.1.2). If, however, as is usually the case and the mini-hydro would only be connected to a local grid, the question of how to access financing for the investment, as well as how to price and collect payment for the electricity delivered, become more complicated. Financial feasibility studies for plants connected to the grid would, then, be fairly straightforward while doing a similar study for an off-grid plant would entail considerably more possible variations in the outcome.

TANESCO and others have carried out surveys of potential sites for new hydropower installations on Malagarasi, Muhuwesi, Kikuletwa and other rivers. A list of around 50 sites, of which some have already been surveyed, is available. There has been some investor interest in some of the sites. Most potential sites are in remote rural locations where the national grid does not extend, so many of these sites could see different phases and in the short and medium timeframe be producing for isolated rural electrification projects. REA has also compiled an inventory of potential small hydropower sites. There are 114 potential sites at different levels of assessment (reconnaissance, pre-feasibility and feasibility). The total estimated potential capacity of these sites is 485MW.

An earlier TANESCO study funded by MEM indicated 85 potential sites (see Figure 9) with a potential of 187 MW (GIZ, 2009). Given the discrepancy of the results, it could be

[28] http://www.reeean.com

concluded that the potential is considerable but that a proposed site would have to be assessed individually for viability prior to commitment.

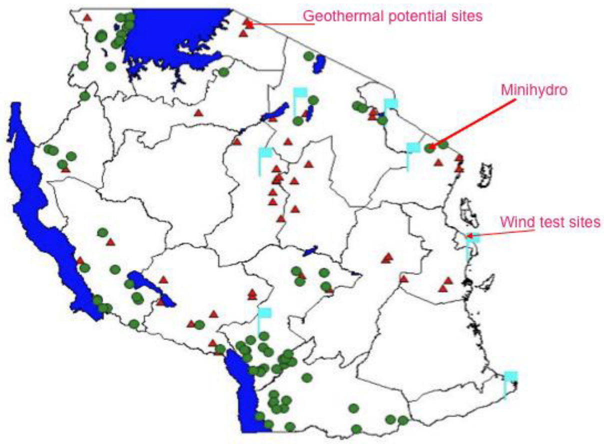

Figure 9. Potential hydropower sites (in green). GTZ, 2009

Those who promote the development of mini-hydro justify their focus on the electrification of rural areas instead of a per se extension of the grid in terms of the relatively low cost this entails for extending power to remote areas. Indeed, many of the discussions of other renewable energy forms have as their main selling argument the "portability" and low cost of these solutions. The advocates of mini-hydro development point out that extension of the grid in and of itself does not lead to any increase in the *production* of energy and it is a very expensive investment.

In addition to purely technical considerations, there are a number of management issues which affect the ability of a mini-hydro power unit to operate efficiently. The most important management issue is the capacity of the organization which supervises energy production. This capacity becomes an increasingly larger issue the longer the supply chain is extended. In other words, the use of the power generated by a mini-hydro in a small local network requires less maintenance capacity than when power is delivered to a larger number of users and/or to the national grid. To reach a scale necessary to address the nationwide problem, however, grids with a minimum load of around 1MW and up should be encouraged, in which case a connection to TANESCO would be beneficial to balance supply and demand.

3.2.4 Small-scale wind

Small-scale wind driven power generation and e.g. pumps can be a significant part of rural energy. Installations would typically be considerably smaller than "small" hydro, but investment and installation costs are smaller for plants of up to a few 100kW, which makes for a more plants and production closer to the user. A number of wind-driven water pumps have been installed for agricultural purposes in Tanzania. AFREPREN (2004), reports on over 100 such windmills being installed by 1996, but with 40% of these not in running order in 2004.

Small-scale wind power units, of around 10-100 kW are on sale in the country, with a potential for pumping water and supplying power. One or more wind turbines can supply energy for a battery based off-grid system, or be part of a hybrid system together with e.g. solar or hydro. The sector sees a lot of activity both from commercial companies and NGOs and is a suitable area for market development in that installed systems have very limited environmental impact, is easy to install and also easy to decommission and sell on if the situation for the user changes.

Off-grid base station hybrid systems, combining wind and solar energy to supply telecommunication stations have been deployed in Tanzania and will be more important as fossil fuel becomes more costly. Such systems can save up to 90% of diesel consumption, more than a cubic meter per base station, and with several thousand off-grid stations in the country, this holds large potential.

Supporting the installation of electricity generation for both domestic and agricultural use, as well as mechanic modern wind-driven pumps may well be worthwhile to create a market for entrepreneurs and funding mechanisms. Awareness and demonstration activities, just as seen in recent projects in the solar area, are also relevant.

3.3 Bio-Energy

Please note that bioenergy for power generation is discussed in section 3.1.6 (A summary of donor supported projects in Bio-Energy is provided in Annex 4)

3.3.1 Opportunities and challenges

As mentioned, an estimated 90 percent of Tanzania's energy needs are today satisfied through the use of wood fuels. It is divided between dried biomass and wood fuels used "as is" in the rural setting and larger, more clearly forest related sources refined to charcoal for the urban areas. This, together with climate related problems and clearing land for agriculture, has led to a depletion of forest resources. Bringing the population growth into the equation means that the forest area per person in Tanzania has declined from 6,3 ha in 1961 to 0,8 ha in 2009[29].

[29] TaTEDO Newsletter, Issue No. 8, January 2011

Forestry Sector in Tanzania

The total forest area of Tanzania is estimated at 38.8 Million Hectares, which is equivalent to 41% of the country's landmass (FAO, 2010b). Out of this total forested area, almost two thirds (around 19 million ha) consists of woodlands on public lands, which lack proper management. About 13 million ha of this total forest area have been gazetted as forest reserves. Around 83,000 ha (0,2 %) of the gazette area is under plantation forestry and about 1.6 million ha (e.g. mangroves) are under water catchment management. The forests offer habitat for wildlife, beekeeping unique natural ecosystems and genetic resources.

However, it is estimated that the sector's contribution to the Gross Domestic Product is between 2.3% and 10% of the country's registered exports. This contribution is generally underestimated because of unrecorded consumption of woodfuels, bee products, catchment and environmental values and other forest products.

While Tanzania has a large potential land bank, many apparently unused areas have multiple and/or seasonal uses involving pastoralists, wildlife migration and gathering. Water resources for agriculture are limited and are shared with industry and urban areas. There is thus reason for caution before repeating the "biofuel boom" period of 2008-2009 (see section 3.3.3 below) and claiming land for producing feedstock for transport fuel, be it for national use or export.

Tanzanian Agriculture

The Tanzanian economy is dependent mainly on agriculture, most of which is at subsistence level. Approximately 90% of the population is engaged, directly or indirectly, in agricultural activities, which provide about 50% of Gross Domestic Product (GDP) and more than 75% of foreign exchange earnings. Agriculture in Tanzania is dominated by smallholder farmers cultivating an average farm sizes of between 0.9 hectares (ha) and 3.0 ha each. About 70% of Tanzania's crop area is rainfed and cultivated by hand hoe, 20% by ox plough and 10% by tractor. Food crop production dominates the agriculture economy. 5.1 million ha. are cultivated annually, of which 85% is under food crops. Livestock is one of the major agricultural activities, with over 90% of the sub-sector belonging to traditional smallholders. The livestock numbers have been increasing steadily in recent decades at roughly the same rate as the human population growth. Women constitute the main part of the agricultural labour force.

Moving to a renewable regime, biomass fuels would have to be produced sustainably for a given purpose, and ideally certified and accounted for a designated use. Agricultural residues, recycled waste etc could be used to extend the base for cooking fuel production. Urban industrial organic waste could be used for biogas production and co-generation. There are mainly two obstacles to more sustainable practices; one is the lack of enforcement of existing regulations, and the other is the ownership of natural resources.

Regarding the latter, much of the land that is owned by the state is not managed by the local communities, even though there are legal provisions for this and examples of successful local management exist. The communities have a long term interest in sustainable management, but are often not benefitting from the extraction of wood resources.

3.3.2 Cooking fuels

This section discusses the development of markets for sustainable cooking fuels. Recommendations for improving the distribution and consumption of charcoal, fall under the category of improving energy efficiency, and as such are described in section 4.1.1. Efficient stoves are discussed in section 4.3.1.

Sustainable fuels for cooking can be renewable (certified and efficiently distributed and used) firewood or charcoal, biogas and ethanol. Also renewable electricity used for cooking falls under this category, but is virtually non-existent in rural Tanzania and is – while rather efficient – at present only used by a few percent of wealthy households in urban Tanzania (Takama et al, 2011) due to high cost and low dependability. Electricity for cooking is therefore not discussed here.

Charcoal is the single largest urban source of household energy. The share of households in Dar es Salaam using charcoal soared from 47 percent to 71 percent between 2001 and 2007. Dar es Salaam accounts for around half (500,000 tons) of Tanzania's annual consumption of charcoal (WB, 2009).

The present sourcing of wood for charcoal making and firewood is not a sustainable or renewable practice (WB, 2009). Deforestation is estimated at 19,4% from 1990-2010 (UNCTAD, 2012) or well over 90 000 ha per annum (some estimates say up to 300 000 ha p a), and there is a large deficit in forestry management, replanting etc. in a country that uses around 1 m^3 wood per capita per year for fuel. It is however a mistake to attribute large scale deforestation only to wood cutting for energy; more important processes are land clearance for new agriculture, grazing and bushfires. Wood and other biomass used for rural domestic energy typically do not come from forests.

The main risk is that non-sustainable charcoal making will further contribute to deforestation. This is not primarily a problem regarding the fuel supply for cooking in rural areas, since other matter such as dry stalks of coconut palm leaves, *Euphorbia* (a cactus-like plant used for fencing) stems and sisal leaves can be used. However, increasing distances for retrieving wood fuels may cause charcoal price hikes, and in time even migrations.

In the case of conventional charcoal and wood fuels, sustainable cultivation of larger trees should be supported. To increase supply, a mix of agricultural wastes, sawdust and short rotation (e.g. one year) forestry could be introduced to respond to demand as supply of renewable feedstocks for production of cooking energy (e.g. carbonization, pelletization and briquetting) would be feasible as supply. These technical and efficiency innovations can be introduced to private companies as well as to communities.

Biogas is another option, which is established in Tanzania and has seen recent market interest. By adding domestic organic waste to an air-tight tank, a family or a group of families can obtain enough gas for cooking and lighting. Several companies and projects seek to make this sustainable alternative available to urban and rural Tanzanians. See section 2.4.4 for descriptions of commercial companies in the area of biogas, and Annex 4 for a description of the Domestic Biogas Programme.

An option discussed for other markets is the use of ethanol for cooking fuel in designated stoves. Given the tradition of sugar cane production in Tanzania, and that Illovo Sugar plans to produce ethanol from available molasses at the Kilombero plant[30], a limited fraction could be used in a project to supply ethanol for cooking. Ethanol could also be produced in considerable quantities from the molasses derived from sugar production. To stimulate demand, a demonstration project[31] involving the whole value chain, or using imported ethanol, could be an important first step towards large scale use of a renewable cooking fuel.

3.3.3 Fuels for transport

There has been considerable debate whether biofuels – vehicle fuels produced from biomass – have a role in Tanzania. In 2006, the National Biofuels Taskforce (NBTF) was established in response to a large number of requests for land and permits for cultivation of feedstocks and production of biofuels, mostly jatropha for biodiesel production and sugar cane for ethanol production. A report from the commission in 2008 placed a moratorium on the production and/or development of biofuel production until a regulatory framework had been developed. In 2008, there were reportedly over 50 contacts and/or proposals regarding biofuels to the Tanzanian government (MEM). At present, only a handful remains. As there is a shortage of sugar in the country, additional cane plantations are less likely to produce biofuels but rather sugar.

The Tanzanian sugar companies regularly produce in excess of 80 000 tonnes of molasses, which could be converted to several million litres of ethanol. The molasses today is either not used or used as animal feed. This potential should be explored. To go into biofuels production in excess of this may prove a challenge. Dedicated liquid biofuels production has not proven The sugar deficit in Tanzania, over 100 000 tons per annum, seems to preclude producing ethanol on any larger scale in the near future. Besides any problems of competing with food production, agro biofuels require large areas of land and sufficient water**.**

Since 2006, the debate has continued regarding the balance between food and fuels (Callé and Johnson, 2010; FAO, 2010a). Biofuel development has also been identified as a contributor to higher cereal prices on world markets (Hoff, 2011). Clearing tropical forests for biodiesel production, and in particular those on peatlands may lead to far

[30] http://www.bloomberg.com/news/2011-07-19/illovo-sugar-plans-to-produce-ethanol-from-molasses-in-tanzania-by-2013.html

[31] Such as the GAIA project www.projectgaia.com

greater carbon emissions than those saved by substituting biofuel for fossil fuel in vehicles and should be avoided. The concept of “marginal” land which is a popular view of where biofuel feedstocks could be grown is one that is hotly debated. Many “unused” or “empty” areas (as seen from the perspective of the investor) are actually areas that may have seasonal or perennial uses, but lack physical infrastructure. Also, as is the case for jatropha, feedstock crops can be grown on marginal lands, but do not yield at rates that are commercially viable unless grown under more favorable conditions. Further, Jatropha has the additional disadvantage of not being conducive to mechanical harvesting. A recent report, examining a biodiesel production plantation in Kisarawe district, claims that about 400,000 hectares of land have been acquired for agrofuel production in Tanzania and describes the consequences, or perhaps rather the aftermath, of three companies acquiring land in different parts of Uganda as little short of a disaster (ActionAid, 2011).

There are however more positive emerging examples of sugar cane ethanol as seen in a recent study of The Addax cane-to-ethanol project in Sierra Leone, where a 14 000 ha plantation involves 2000 farmers. The Addax Bioenergy Farmers Development Program has graduated 1441 farmers since its inception in 2010 (Goldmann, 2012). At present, the Tanzanian government is sourcing a consultant to carry out a Strategic Environment Assessment (SEA), in parallel to carrying out agri-ecological zoning in the different districts, with some support from AfDB. A program was funded by Sida to develop the institutional capacity for a biofuels industry in Tanzania, and awareness programs have been developed as part of this effort.

The other relatively straightforward option is biodiesel production. Also here, a “hype” regarding biodiesel was curbed in Europe in the previous decade and a lot of production capacity was forced to hibernate due to reduced incentives, as studies emerged indicating that additional land cleared and used for biodiesel feedstock production (such as rape seed in temperate climate zones or oil palm or jatropha in the tropics) would contribute to deforestation and yield a “carbon deficit” that would e.g. make it ineligible for CDM credits or climate related support. Recent initiatives in the field have proven unprofitable. While some projects were recently initiated (van Eijck and Romijn, 2008), Tatedo (interview 2012) argues that the biodiesel industry is dormant in Tanzania today and that successful plantations of jatropha do not exist. Other species such as croton tree or moringa may be conducive to more production, but this has not yet been demonstrated.

Small-scale biofuel feedstock production could provide Tanzanian farmers with a cash crop and, if used for local fuel production and provision, increase resilience of the local community. It seems wise to wait for the new regulatory framework and zoning to be in place before supporting biofuel production for development purposes. If domestic sugar production will come to exceed domestic demand in the future, and ethanol for cooking is not found attractive, the discussion of bioethanol production for transport fuel could be renewed.

As to the present market for transport fuels, there are more than 70 oil marketing and trading companies in Tanzania including BP, TOTAL, ORYX, ENGEN, GAPCO, GAPOIL, OILCOM, NATOIL and KOBIL. For the distribution of petroleum product throughout Tanzania, these companies set-up create partnership with private individuals to operate petrol retail stations. The petroleum companies are organized under the Tanzania Association of Oil Marketing Companies (TAOMC).

As natural gas increasingly becomes available, perhaps Tanzania can join other gas producing countries by incentivizing gas driven vehicles. This would entail the advantage of being able to sell domestically produced refined vehicle fuel, as opposed to the imported gasoline and diesel fuels. While a long shot in an African context, larger scale production of biogas could in time be included and increase sustainability in a national or regional gas-as-vehicle-fuel grid.

3.4 Other sources

There are other ways to sustain the need for clean water and hot food. Solar radiation can be converted to hot water with systems like Solar ORC[32]. The heat can also be used for cooling even under off-grid conditions in a process called absorption. The UV portion of the sunrays also serves to purify water which gives an extra benefit from using Solvatten [33] or similar technologies for pre-heating of water for cooking. These technologies should be investigated in a technical and commercial sense for Tanzania, to identify sustainable technologies and combine with fitting business models and incentives.

Wave and tidal power, algae biofuels and other 3rd generation technologies that may show promise to deliver, but have yet to prove their commercial value in a Tanzania context, and investments and projects in these areas, could be left to research in the industrialized world and tapped for potential as the commercial value is proven.

4 Energy Efficiency Potential

Energy efficiency potential can be looked at in terms of production, distribution and consumption and is one of the pillars of the Nexus (see section 1.5). There is great potential, and a potential great reward, for improvement for each of the energy value chains in place in Tanzania.

This chapter thus goes beyond renewable energy. Renewable energy is not *per se*, and especially in the short run, necessarily more economically and technically efficient than non-renewable, just more sustainable. This may be at the heart of the policy dilemma in Tanzania; that if sustainability were an important criterion, then short-term solutions such as diesel powered generators, would be deemed highly "inefficient". Section 1.5 discusses the "nexus" approach where overall natural resources efficiency (with respect

[32] www.stginternational.org

[33] www.solvatten.se

to water, land and other inputs) includes technical and economic efficiency as a criterion, but goes further to quantify the efficiency of natural resource use.

Renewable and non-renewable practices and technologies alike could profit from higher efficiency. The major case in point is the non-sustainable production of firewood and charcoal in Tanzania. A suboptimization case could be made for the inefficiency of biofuel production in situations where the competition over resources such as land and water leads to higher food prices or food shortages.

4.1 Production

This section discusses the main areas for improving efficiency in energy production in Tanzania; the installed hydropower production capacity, and to improve the widespread but inefficient charcoal production processes.

4.1.1 Charcoal

While most national discussions of energy focus around the provision of electricity, the reality in Tanzania is that almost 90% of the energy consumed is made up of solid biofuels or woodfuels. In the rural areas this is in the form of firewood and in the urban areas charcoal is the predominant energy source. One recent report refers to solid biofuels as the "marginalized national energy of the majority in Tanzania"[34].

Studies indicate that the consumption of charcoal in urban areas such as Dar es Salaam is increasing. (Tatedo cited a study where the proportion of households in Dar using charcoal increased from 47% to 71% between 2001 and 2007 and maintains that the consumption continues to increase).

Traditional charcoal production has an efficiency of up to 17%, and thus wastes most of the energetic value of most of wood used for cooking in Dar es Salaam. The advantage of charcoal as a fuel compared to wood or agricultural wastes is the reduced smoke. This can be overcome by methods such as the Uganda kiln or initiatives as the IBEK which improves conversion efficiency to between 20-25%. IBEK is applicable to small-scale production situations.

Many urban consumers use a strategy where charcoal is a part of other energy sources, it is used to do cooking that takes a long time, while electricity or kerosene may be used for lighting and electricity/natural gas may be a solution for warming up food.

Charcoal/woodfuel is the energy source of choice for the great majority and efforts to curtail the use of either through legislation, etc. is bound to be ineffective as long as people do not have an alternative.

[34] Tatedo Newsletter, January 2011

Given the continuing high demand for charcoal in the urban areas, and awaiting its replacement by more environmentally friendly sources of fuel, it is important to improve the energy efficiency of charcoal making. Sustainable charcoal production is discussed in section 4.1.1.

Since charcoal use represents such a substantial part of energy use in Tanzania today, any improvement along the value chain which reduced use of non-renewable material would be a boon to development. Increased efficiency in charcoal making with the present non-cultivated wood as a base would not make charcoal renewable but it would increase availability and possibly reduce price.

Organizations such as Tatedo[35] and ARTI-Tanzania[36] could be part of the solution to instigate/disseminate more sustainable practices in forestry and production and use of other biomass sources.

4.1.2 Hydropower

The large hydropower plants currently supplies around 2,6 GWh per year, where the variance depends on the level of rainfall. Since installation, hydropower technology has not been maintained adequately to international standards. Technical development together with wear and tear make for potential to increase the productivity of the present installations by rehabilitation, such as the Sida sponsored project for Hale.

Siltation of dams is a problem in some areas of Tanzania (especially at the Nyumba ya mungu plant) and the expected capacity of reservoirs can be significantly under what is necessary for optimum power generation. Dredging is an option for old and new dams alike. This relatively cheap and environmentally beneficial potential should be realized and could be a good area for support.

Another option, which has not been examined further in this report, is to see new dams as multi-use reservoirs to increase the total water use efficiency of hydropower compared to dams that solely generate power, in line with the Nexus philosophy discussed in section 1.5. The utility of a power dam also in an agricultural context could affect feasibility calculations and the environmental impact analysis.

The recently announced sustainability assessment (2013-2014) of new and existing hydropower in Tanzania by the World Bank, NDF[37] and DfID, will shed light on the potential in developing the present plants for better performance.

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[35] www.tatedo.org

[36] http://arti-africa.org/

[37] Nordic Development Fund, www.ndf.fi

4.2 Transmission and distribution of electric power

There is a constant deficit of electricity generation in Tanzania and it is often cited as a major impediment to overall economic growth. The private sector ranks poor infrastructure, especially insufficient power supply, as the main constraint to economic growth. Insufficient and unreliable infrastructure services increase input costs, raise transaction costs, and lower productivity.

One of the thrusts of the new poverty reduction strategy (MKUKUTA II and MKUZA II), which covers FY 2011-2015, is to support growth through increased infrastructure spending, especially in transportation, power generation, and irrigation. Unlocking Tanzania's growth potential depends on well designed and implemented public investment programs for energy, transport, and water; and better management of public-private partnerships (PPP) (WB, 2011).

There is also a large hidden cost in the problems stemming from a combination of insufficient generation and distribution problems. Recurrent blackouts and brownouts have forced thousands of store owners and individuals to invest in gensets and diesel purchases.

The energy losses in the transmission and distribution system for electricity in Tanzania are high, at about 24.3%[38], including technical and non-technical losses. EWURA has set up a target for TANESCO to bring down the losses to a level of 15%. As a comparison, an international average for energy losses in well managed distribution systems is around 5-8%.

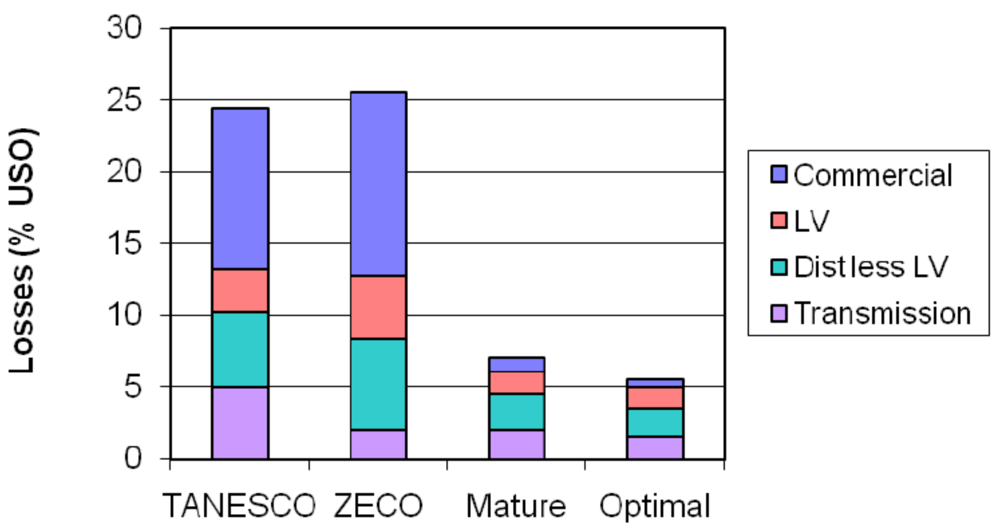


Figure 10. Technical and commercial losses for TANESCO and ZECO, 2010 (Azorom, 2011)

[38] Including transmission (5%), distribution (8.1%), technical (13.1) and commercial (11.2%) losses – (AZOROM, 2011)

Importantly, a large share of the losses are commercial, either electricity "lost" to consumers (not debited), or debited but not paid. During the 2010/2011 budget year, losses in the system were reduced, partially through the introduction of more "prepaid" meters. Smart meters with the larger consumers reduced the losses in this sector from 26% to 21% (MEM, 2011). Prepaid meters are used by private SPDs for off-grid projects.

In mitigating the losses, the Azorom (2011) study does not make much difference regarding the method between the transmission and distribution networks. It is said that the commercial losses can be mitigated faster, while technical losses take more time. Investments of around 79 MUSD (TANESCO) and 5.2 MUSD (ZECO) are needed to reach 6% total technical losses (TANESCO) and get below 20% total system losses (ZECO) by end of 2013. To reach targets for reduction of commercial losses require 7 MUSD per annum (TANESCO) and 500 000 per annum (ZECO) for m – staff, transport, equipment and training.

The conclusion is that there is a large potential to reduce the energy losses in the electricity supply chain in Tanzania. Supporting TANESCO and ZECO in reaching the targets described would keep needed revenue in the companies to invest in additional generation etc. This is a good area for donors which might also reduce the political risk in the government owned companies.

4.2.1 Transmission

Transmission capacity development is important to reduce imbalances between regions, and to connect Tanzania to the surrounding electric power systems. The grid map reveals that the transmission challenges in Tanzania consist of insufficient coverage, and the Azorom study described above also points to losses in the present system. Several projects are underway, funded by the Millennium Challenge Account, TEDAP (see Annex 4) and others.

Recent development in the sector includes the establishment of the East African Power Pool[39], which was founded 2005 and unites 9 countries in the wider region. According to the 2011 master plan of the EAPP, connectors to Kenya and to the planned Rusumo Falls 40-50 MW hydro plant on the Kagera River, on the border to Rwanda, are planned for 2015. Rusumo Falls would be a energy hub uniting Tanzania, Rwanda and Burundi grids, to the benefit of power quality for the three countries.

[39] http://www.eappool.org

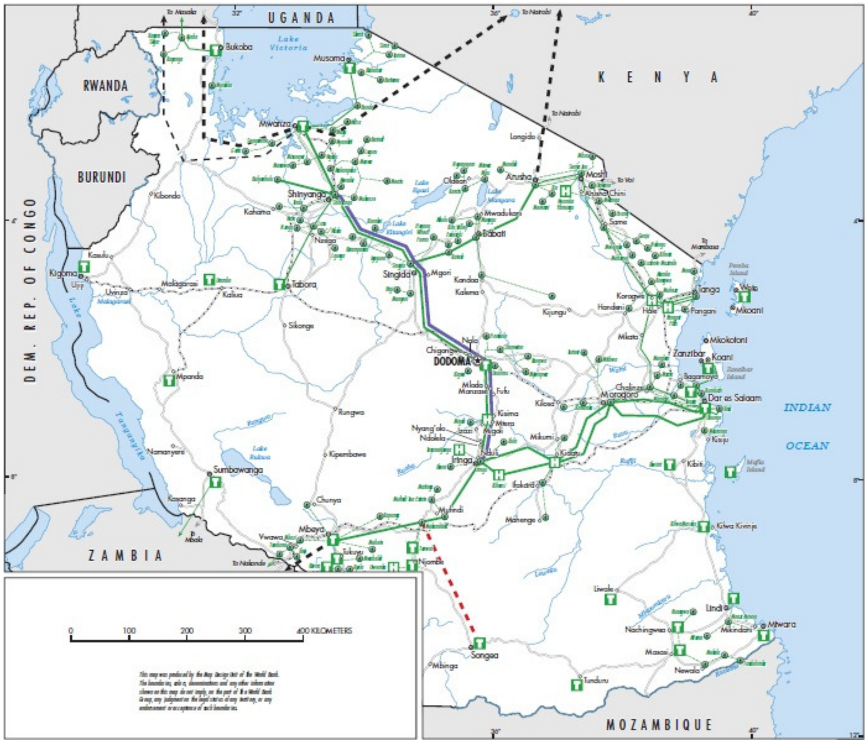
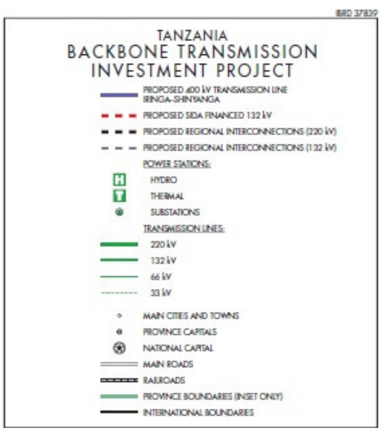


Figure 11. Tanzania transmission and distribution system, showing planned extensions 2010 (WB)



Present projects supported by the World Bank include a new transmission line from Iringa to Dodoma, the first 225 km of the "Backbone" project of 667 km of 400 kV transmission, to strengthen the security of power supply and allow for future interconnectivity between Kenya and Zambia.

Together with the Tanzanian government, Sida is funding a 132kV line to extend the transmission network from Makambako to Songea along with electrification in Songea and surrounding districts.

Figure 12. Legend to Figure 11. (WB)

Power consumption on Zanzibar has been disturbed by a defect and insufficient cable from the mainland. A new 100 MW cable is under construction, with support from the Millennium Challenge Account, and should be operational from the end of 2012. Given growth projections, also this cable would need additional capacity towards the end of the decade. Further, there is not necessarily available capacity on the mainland to meet additional demand from the Islands as TANESCO struggles with growing mainland demand. The EU supports ZECO (the Zanzibar energy company) in their development of island-based renewable energy.

4.2.2 Distribution and sales

Important to note is that additional for-grid renewable power for the most part would be fed into the distribution grid. To accommodate new projects, the grid must thus be extended to connect to new sites, particularly in the south and northwest. An efficient and developed distribution network also facilitates connecting for unbundled projects. A matching study of possible extension of the distribution with local opportunities for e.g. 1-5 MW generation capacity should be carried out.

On behalf of TANESCO, consultancies SWECO and DECON have jointly carried out a study on the needs for improving the distribution network in 24 of the 30 regions in the country. The *Distribution reinforcement plan in TANESCO regions* describes the work divided in a predominantly urban part, Lot 34A[40] and mostly rural Lot 34B[41]. Supporting the implementation of this plan for prioritized areas could offer a structured way to reduce losses.

4.3 Consumption

The discussion on efficiency in consumption is divided on the energy use of households, industry, buildings and transport.

The area of energy efficiency becomes more important as demand grows and requires new investment in power production and infrastructure. Imminent needs include the scoping of a regulatory framework for energy efficiency, including a labelling program, information to domestic and industrial consumers on efficiency and possibly incentives.

4.3.1 Domestic energy use

Domestic energy use, for the purpose of this report, is limited to Level 1 energy services and cooking energy (see section 1.4).

Most rural cooking in Tanzania is done using firewood, while cooking in cities is mostly done using charcoal. To increase efficiency for charcoal and wood fuel stoves would have a large effect on cooking energy use, especially among the most vulnerable in rural areas. The “efficiency” of modern cooking energy also lies in that collecting firewood for a rural home can take up to five hours a day, and is often a task for women and children. Traditional energy is thus often also a reason for inequality and a source for sustained (energy) poverty.

Improved charcoal stoves have been in use with some success for the past 15 years.
Important elements in a move towards increased average energy efficiency of traditional cooking would be to increase the availability of efficient charcoal stoves in urban areas

[40] Comprising Mwanza, Arusha, Kilimanjaro and five regions of Dar es Salaam.

[41] Comprising Morogoro, Dodoma, Tanga, Manyara, Singida, Tabora, Shinyanga, Kigoma, Kagera, Mara, Iringa, Mbeya, Rukwa and Ruvuma

and woodfuel stoves in rural areas. Just as is done regarding programs of this kind under CDM (in other countries), the efficiency of these stoves must be certified, and the continued use of the new stoves in the respective setting must be monitored. The knowledge level of the commercial agents for cook stoves is not always sufficient to sensitize customers (Tatedo) and certification would be important for both fuels and stoves. For efficient stoves to reach the market, financial, technical and market support is likely needed (GVEP, 2009).

To the extent that households use conventional incandescent light bulbs, this would increase energy use several times compared to modern – again, since the upfront cost for low-energy lamps ("energy savers") are higher, some kind of cost model for allowing low income but grid connected households to reduce their consumption and monthly cost by buying low-energy lamps would reduce overall both overall power demand and cost for the poor. However, it is essential that any replacement program would encompass some kind of product certification, since low-quality lamps may swamp the market and give a reverse effect.

4.3.2 Efficient buildings

Buildings consume a large portion of power in East Africa: 56% on average (1,413 MW out of a total 2,524 MW). The urbanisation rate in the region is currently at around 4.7% growth annually (UNEP, 2012). As the Tanzanian economy grows, more and more buildings will take place in her cities. Depending on choice of technology and maintenance of the operational building, energy use in these new buildings can range from 0 to 500 kWh/m^2 per year. This is the subject of a recent study by TANESCO[42]. It is essential that fast growing cities will not be filled with buildings in the high end of this wide spectrum, in the face of power shortages and constrained power distribution.

A UNEP (2012) workshop estimates that approximately 30% of energy consumption can be saved through proper building design, using proper building orientation, building materials and construction technologies. Another 20% of energy consumption can be saved through efficient lighting, cooling, heating and other appliances. Modern solar heat adsorption technologies for cooling could be employed for new buildings and resorts. Between 10 to 20% of energy consumption can be saved through good housekeeping and behavioural change. An example is the installation of solar water heaters in new construction, and the replacement of old water heaters with solar powered heaters.

Regarding efficient housing, the main means to achieve improvements are awareness, incentives, access to pertinent technologies and competence and, not the least, certified and relevant measurements. To be able to measure energy use, and have access to comparative benchmark figures, for a selected sample of typical buildings and industrial installations could, in view of UNEP results above, lead to great energy savings. First steps for Tanzania and its major cities e.g. Dar es Salaam, Arusha, Mwanza and Dodoma.

[42] The report from the study on building efficiency, commissioned by TANESCO in 2011, has not been made available as input to this present study.

Working with initiatives like ESMAP:s Energy Efficient Cities Initiative (EECI) is another route.

4.3.3 Industrial energy efficiency

As outlined in section 2.5.3, much of present industry and even more of the future potential, in Tanzania is related to agriculture. Improved efficiency in processing would enhance the sector growth potential. Other sections are mining and construction.

Energy savings in most industries can be achieved through improved combustion efficiency in boilers and furnaces; steam and condensate management, and increasing efficiency in the use of electric power for e.g. cooling and efficient utilization of electricity in pumps and motors in quarries and mines. Another example is recovering energy from cement production to reduce overall energy use. Drawing from interviews conducted at COSTECH, one of the main areas for improving efficiency in food related processing would be to make improved drying technologies available to Tanzanian industry. There are different technologies, and also room for some innovation to reduce the time compared to sun-drying of fish, coffee or other foodstuffs.
Little more specific information on the potential of improving drying technologies have been found in interviews, and could be an area for more studies and interventions.

An area which deserves attention and support is design of plant and the adjoining investment decision for industrial equipment with Tanzanian industry, e.g. for biomass combustion turbines. While any company deciding on new technology would optimize its investment for corporate purposes, a larger installation also could be part of supply to the grid or community power planning rather than as a stand-alone unit, and reduce costs for both parties. Implications could be a more efficient system, e.g. by investing in a combined cycle gas turbine rather than a simpler turbine, and reduce the need for other power production, or for the company to invest in a (more expensive) biomass boiler rather than a gas fired unit, reducing pressure on the gas supply. This would be an example of using the Nexus (see section 1.5) approach.

4.3.4 Transport

Apart from playing a role in transporting energy, as in the case for charcoal (see section 3.3.1), transport is an important consumer of energy. The potential to improve the energy efficiency of the Tanzanian transport system[43] is large and lies mainly in three areas; improved road and rail infrastructure, development of public transport (PT) capacity and more efficient private and PT vehicles. A main element of improvement in all three areas would be increased and improved governance (regulation and enforcement).

The upside of further reform would be considerably reduced energy use (and cost) per person-km, and ton-km of travel. This in turn would enable a better functioning market

[43] defined as all roads, rail, vehicles, vessels and the respective road, rail and waterways networks, governed by one or more regulatory framework(s). In this report, airfreight is not included.

both for energy and for other goods, in line with the rationale for the ongoing DfID-sponsored Transport Policy Support Programme. With better roads and public transport[44], the roads become less congested and travel time is reduced and has less queuing. It is argued that inferior road quality is one of the main limiting factors for enabling a well-working market for energy. It is however also probable that better roads would have a so-called rebound effect of more traveling, with both highly desired but also unwanted effects in turn. A less desired effect in this regard may for instance be that charcoal could be transported larger distances, meaning that also more distant areas would be attractive for (illicit) charcoal making.

As more roads reach acceptable quality and width to allow for safe traffic both for car/truck transport and bicycles, an increase of the latter could absorb a lot more of the transport demand both in and out of cities. Unless road accidents are unacceptably high, Non-motorized transport is sustainable, and even fed by renewable energy.

As to the efficiency of the rolling stock, international experience shows that an operational and enforced car inspection system which includes an emission check reduces fuel consumption as well as greenhouse gas and local emissions.

[44] As an example, it would seem that the potential for ferry commuting services should be exploited or at least defined. The planned public transport system developments for Dar es Salaam are encouraging.

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Annex 1

Power production projects with Donor support (Funding approx 77% of total project cost). Source: Embassy of Sweden, Dar es Salaam, 2012

§	Project Name	Financial Scheme	Fin. Am.Tsh (mil.)	Other Co-fin.		GoT Fin. Amount (TshM.)	Total Project Cost (Tsh M.)	Status
				Yes/ No	Fin. Amount (Tsh M.)			
AfDB	Electricity V	Mix	69 900	No	0		69 900	impl.
EU	Up-Scaling Access to integrated modern energy services for poverty reduction	Grant	4 578	Yes	1 930	0	6 508	impl.
EU	Mwenga 3 MW Hydro Power	Grant	7 200	Yes	7 200	0	15 400	impl.
EU	Integrated Rural Electricity Planning in Tanzania	Grant	1 510	Yes		500	2 010	impl.
EU	Yovi Hydro Power Project	Grant	4 777	Yes	3 472	0	8 249	impl.
EU	Upgrade of Mawengi micro hydro plant	Grant	2 890	Yes	780	0	3 670	impl.
EU	Cluster Solar PV Project	Grant	1 900	Yes	400	0	2 300	impl.
EU	Upgrade of Ikondo micro hydro plant	Grant	2 832	Yes	700		3 532	impl.
EU	Introducing a new concept for affordable biogas system	Grant	2 400	Yes	600		3 000	impl.
JICA	Backbone Transmission Investment Project	Credit	105 840	Yes	625 940	46 235	778 015	impl.
JICA	Project for Reinforcement of Distribution Facilities in Kilimanjaro Region	Grant	45 622	No	0	3 923	49 545	impl.
JICA	Project fro Reinforcement of Power Distribution in Zanzibar Island	Grant	53 863	No	0	3 063	56 926	impl.
JICA	Project for Capacity Development of Efficient Distribution and Transimission Systems	Grant	4 724	No	0	0	4 724	impl.
Korea EDCF	Arusha-Kilimajaro Transmission Line Project (A part of TEDAP)	Credit	36 625	No	0	0	36 625	impl.
MCC	Distribution Systems and Rehabilitation	Grant	189 000	No	0	6,2	189 006	impl.
MCC	Zanzibar Interconnector	Grant	101 700	No	0	0	101 700	impl.
MCC	Malagarasi Hydropower and Kigoma Distribution	Grant	17 250	No	0	0	17 250	impl.
SIDA	Rural Energy Fund Support		49 035	No	0	0	0	impl.
SIDA	Capacity Development to REA		6 763		0	0	0	impl.
SIDA	WB TF Electricity Access		7 246		0	0	0	impl.
SIDA	Ruhuji & Kakono Hydro		2 657		0	0	0	impl.

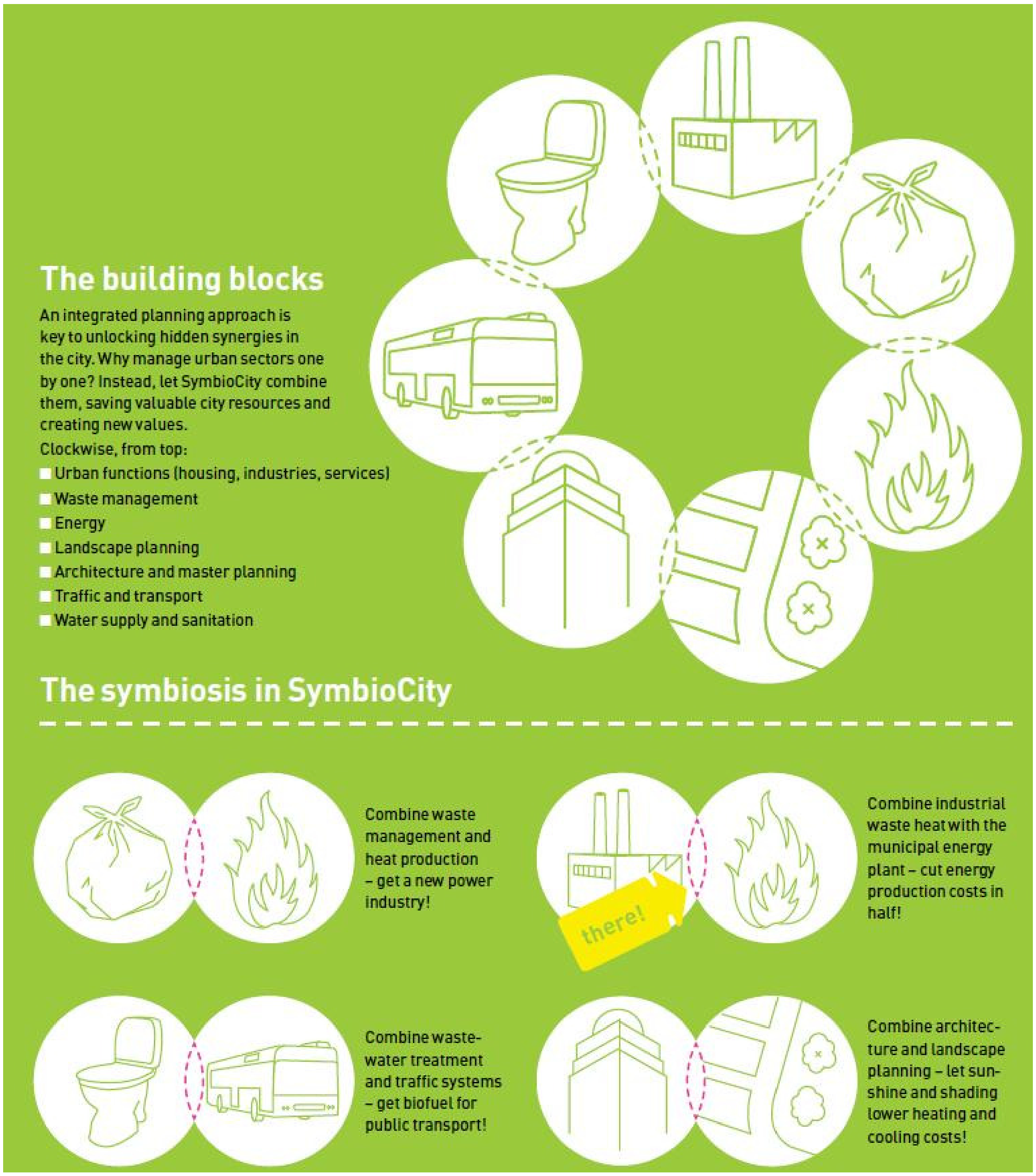
SIDA	Strengthening Policy,Legal, Regulatory and Institutional Framework to the Development of a Sustainable Biofuels Industry		3 140		0	0	0	impl.
SIDA	Makambako-Songea 132 kV Transmission Line	Mix	120 000	No	0	0	120 000	impl.
WB	Tanzania Energy Development and Access Project (TEDAP).	Credit	249 000	No	0	0	249 000	impl.
WB	Backbone Transmission Investment Project	Credit	225 000	Yes	625 940	46 235	-	impl.
SIDA	Backbone, New Iringa - Shinyanga Transimission Line Project - Rural Electification		0		0	0	0	disc.
SIDA	Capacity Development on CDM		2 416		0	0		disc.
SIDA	Capacity Dev MEM		0	No	0	0	0	disc.
WB	Energy Sector Capacity Assistance Project	Credit	43 200	Yes	[USD 7mil TBC]	TBC	[USD35mil TBC]	disc.
WB	Singida Wind IPP		160 000	Yes	TBC	TBC	[USD300 mil TBC]	disc.
WB	Ruhudji HPP	Mix	480 000	Yes	TBC	TBC	[USD800mil TBC]	disc.
AfDB	Iringa- Shinyanga Transmission Line (Backbone transmission investment project)	Credit	92 171	Yes	625 940	46 235	764 346	ready
Korea EDCF	Backbone Transmission Investment Project	Credit	53 352	Yes	625 940	46 235	725 527	ready
SIDA	Hale HPP Rehabilitation	Mix	38 400	No	0	0	384 000	ready
Netherl.	Electrifying Rural Tanzania	Mix	11 457	Yes	0	11 457	22 915	concept
SIDA	Rural Electrification in Ukerewe		7 247		0	0	0	compl.
SIDA	Development of PV Market in Rural Areas		6 522		0	0	0	compl.
Norway	Support to the Energy Sector	Grant	60 457				60 457	concept
Finland	Improving the electric power supply reliability in the city of Dar es Salaam	Credit	50 000	No		3 000		impl

Annex 2: Grants awarded by the Rural Energy Fund in 2010/11

S/N	Project name	Region	Amount (TZs)
1	Installation of 10kw wind power turbine at Wama Nakayama girls secondary school	Coast	45,500,000.00
2	Installation of solar PV charging centers for two secondary schools	Kigoma	39,870,000.00
3	Pre - feasibility study of twelve small hydropower sites in Muheza and Lushoto districts in Tanga region	Tanga	41,730,000.00
4	Installation of 5.25kw solar pv backup system at wama Nakayama girls secondary school at Nyamisati village	Coast	46,035,159.00
5	Distribution of 1200 portable solar lighting systems in musoma	Mara	26,480,000.00
6	Installation of solar pv systems for kabagwe and titye secondary schools in Kasulu	Kigoma	68,860,000.00
7	Installation of solar pv systems at mkamba health centre, Mbezi Msufuni and panzuo Kibuyuni in Mkuranga district	Coast	39,427,080.00
8	Construction of three biogas plants in Kwimba	Mwanza	68,184,250.00
9	Installation of solar pv systems in Mtanza Msona villages in Rufiji district	Coast	13,309,000.00
10	Supply and installation of solar pv systems for Kidaru health center and Urughu secondary school in Iramba district	Singida	43,031,880.00
11	Construction of biogas digester to word islamic propagation and humanitarian services (wipahs) in Kibaha district	Coast	80,110,000.00
	Total		**512,537,369.00**

Annex 3

Symbiocity elements – waste to energy and energy efficiency



Annex 4 – Renewable Energy Projects with Donor Support

1. Large scale electrical power

Green Africa Power (GAP)

Green Africa Power is a project supported by DFID to stimulate private sector investment in large-scale renewable energy generation. The proposed business case for GAP calls for a maximum donor commitment of USD 306m, resulting in a total capacity of 1469MW installed and /or under construction by end of GAP's investment phase (2020). GAP is organized by the Private Infrastructure Development Group (PIDG) and funded by DFID and Norad.

GAP aims to overcome a number of constraints and obstacles to private sector investment in renewable energy generation in SSA. GAP would create an alternative market for CERs and facilitate the monetisation of such CERs which will lead to the completion of renewable independent power projects (IPPs) that would likely otherwise not be implemented.

Also proposed under GAP is the issuance of guarantees to address credit problems and conditional investment on a "patient capital" basis. GAP stemmed from a request from DFID to The Private Infrastructure Development Group Trust to suggest ways in which existing or new PIDG facilities could address the issue and set up systematic interventions to drive forward renewable IPPs in SSA. In response, a concept was formulated to support renewable IPPs which would, in the absence of the intervention, not be constructed.

Phase 1, completed in 2010, was to assemble a pipeline of potential actual example transactions. The objective was to find developers whose projects were facing difficulty because of one or more of the market failures, which would be willing to explore with GAP the possibility of finding a workable transaction structure involving GAP, to drive it forward.

The recycling of donor funds into new projects is proposed, with improvement in the leverage ratio from 11.7 times in 2020 to 19.0 times by 2025 which is reported to be line with other PIDG funded initiatives (Trinity International LLP 2011).

The EcoEnergy Bagamoyo Project in Tanzania is one of the GAP "pipeline" projects, with four other projects in Burkino Faso, Kenya, Rwanda and Senegal. The five pipeline projects are in the range 10MW to 300MW of installed capacity.

Tanzania Energy Development and Access Extension Project (TEDAP)

The TEDAP project, co-funded by the World Bank and the Global Environmental Facility, is intended to increase the electricity access in rural and peri-urban areas of the country. The original agreement was for 105 MUSD (WB) plus 6,5 MUSD (GEF). The project is operational since April 2008, originally until June 2012 but is now extended to March 2015.

It consists of three components:

- to support urgent generation and distribution investments by TANESCO (80% of the budget)
- to develop, test and demonstrate new rural electrification approaches
- to provide sectorial technical assistance

A number of activities and subprojects have been launched. The project has supported the newly established Rural Energy Agency to provide pre-investment support to local renewable/rural energy developers. As a result, a number of rural renewable energy projects have been initiated by the local private sector.

2. Small grid/off-grid electric power

Sida/MEM project

The Sida/MEM Solar PV Project (see also section 3.2.2), which began in 2005, ended in June 2011. The Project was a collaborative effort between the Tanzanian and Swedish governments, the Ministry of Energy and Minerals and the Swedish International Development Agency. It has been implemented by Camco Advisory Services.

> *"The long-term development objective of the project is to improve living standards and community development in rural areas by providing access to modern energy services through an increased access to and demand for PV technology. "* (MEM, 2002).

The Sida/MEM Solar PV Project has achieved notable success. Among its successes is its contribution to the growth in the Tanzanian solar market, which has increased by a factor of fifteen since 2005 (from 100kWp to 1.5MW in 2009) (Camco, 2011).

Equipment prices are still higher in Tanzania than in Kenya, suggesting that a market never really took off in Tanzania despite of the project efforts. Financing was also more difficult than was expected. It proved difficult for the project managers to just facilitate the project without being a part of a new and growing market themselves.

The project had as a goal to improve the market for solar power. One problem was that solar lamps had been handed out for free by earlier donors and ruined the market. Another problem is the low level of training with the retailers of solar equipment. Another major issue was that the general business climate is not conducive for creating a market – information on competing system is scarce, travel to distant areas. Further, many imported "kits" were of inferior quality and has scared the customers off. The project held workshops and meetings, allowing vendors and customers to meet and enhancing competition. By focusing not on distributing systems – equipment donated in earlier projects had not been used properly for various reasons – but on supporting the creation of a more transparent market with more competent actors, the project has likely contributed to improving market conditions in Tanzania. 183 technicians were trained. The project also supported the creation and development of TAREA (see section 2.3).

The Energy and Environment Partnership (EEP)[46]

EEP is a DfID funded £27.6m programme partnering with SADC and EAC over 4 years commencing in 2011/12. It is implemented through delegated cooperation with Finland Aid, involving SADC, the EAC Secretariat and implementing agent DBSA. There are 8 country level representatives: (Botswana, Kenya, Mozambique, Namibia, South Africa, Swaziland, Tanzania and Zambia)

EEP provides co-funding for pilots to increase clean energy access to poor households, and co-funding for feasibility and pre-feasibility studies to leverage private sector investment.

The aim of EEP aim is "Greater access to clean energy services achieved through the fast tracking of renewable energy project demonstration and deployment, including through technological learning, donor co-ordination and private sector investment."

Outputs are set in terms of: Carbon reductions achieved; greater demonstration and deployment of new technologies, particularly renewable energy; Increased and more efficient energy access for the rural and urban poor; Private sector finance attracted or levered; and Welfare benefits due to improved employment creation opportunities.

Eligible EEP activities in the 4th call for proposals of Dec 2011 (EEP 20110) are

- pre-feasibility study,
- feasibility study,
- pilot project,
- demonstration projects, and
- up-scaling of existing pilot or demonstration project.

The maximum EEP funding per project is EUR 200,000 over 3 years with minimum 50% co-funding. Applicants may be public, private, non-governmental, profit or non-profit. Only individuals and central government entities are ineligible.

Climate Innovation Center (CIC)

DANIDA, DFID and the World Bank are supporting the launch of a Climate Innovation Center (CIC) in Kenya, to launch in 2012. The Kenya CIC will provide a country-driven approach to climate change. The CIC has an objective of becoming the focal point of innovative commercial development of profitable climate-related business in Kenya and potentially East Africa.

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[46] details from DFID EEP Business Plan dated Aug 2011.

A grant award has been made through the World Bank to an implementing consortium to support CIC Launch (year 1 and 2) and Scale-Up (year 3 to 5). In addition to the Kenya-focused activities described below, the CIC will also be eligible for additional funding (approximately USD 1.3m) to design and implement a network in East Africa to support climate innovation activities on a regional basis. Core CIC services include:

- *Advisory Services* - Business training and specialized technical training, access to a technical assistance fund.
- *Proof of Concept Financing* - proof of concept grants (USD 25,000 – 100,000) to promising SMEs or researchers, liaison for SMEs to a related risk capital Fund and facilitate other sources of financing.
- *Enabling Ecosystem* – help develop policies that support clean technology adoption, coordinate and broker technology transfer and joint collaborative R&D, and international networking, raise the visibility of the CIC, innovators, and climate technology generally.
- Access to Information - market information, access to technology information for entrepreneurs, access to a database of financial information.
- *Access to Facilities* - support rapid technology design, adaption, proto-typing, testing and manufacture.

Additionally, the CIC will be linked to a related risk capital Fund that will invest in selected SMEs that may obtain services from the CIC.

Developing Energy Enterprises Programme

The Developing Energy Enterprises Project East Africa (DEEP EA) is a five year initiative established in 2008 to provide support for the development of a sustainable and widespread industry of micro and small energy enterprises in Kenya, Uganda and Tanzania. The need for the programme springs from constraints and challenges faced by energy entrepreneurs; especially the lack of business and technical capacity and inadequate access to finance. DEEP EA supports the development of energy enterprises formed by, and for, rural and peri-urban entrepreneurs by assisting them with the identification of viable energy market opportunities, technology options, and service structures to generate revenue and sustain business. Entrepreneurs can also get assistance in developing business plans and access the necessary financing.(www.gvepinternational.org)

Modern Energy Services for Sustainable Development and Poverty Reduction in Tanzania

The program in total ran 2007-2010 in 8 regions, supported by Norad, EU and HIVOS.

Norad supported the NGO Tanzania Traditional Energy Development (TaTEDO)s program 'Integrated Modern Energy Services for Sustainable Development and Poverty Reduction' with 10 million NOK for three years (2008-2010). The goal of the program was to contribute to sustainable development and poverty reduction by enhancing access to sustainable modern energy technologies and services for consumptive and productive needs in households, Small and Medium Enterprizes (SMEs) and social service centers in eight regions.

Lighting Africa

A World Bank Group initiative which supports the private sector to develop, accelerate, and sustain the market for modern off-grid lighting technologies which are tailored to the needs of African consumers. The initiative has had considerable success in Tanzania and contributed to domestic lighting in rural areas.

African Rural Energy Enterprise Development

AREED was initiated in 2000 by UNEP in view of the lack of funding opportunities and sustainability regarding rural access to modern energy services. The project offered financial and business support to SMEs in Tanzania, Zambia, Ghana, Senegal and Mali. TaTEDO was the Tanzanian representative. The project provided loans for replacement of fossil fuels, helped create an SME (SEECO) and did show that empowering SMEs could be an important complement to the project driven approach in achieving technical change in the sector. Challenges included the

3. Bio Energy

Strengthening Regulatory Framework

In 2008, Sida and Norad approved funding of approx 4 MUSD to MEM for the strengthening of the regulatory framework for the establishment of a biofuels industry in Tanzania, in response to a request from the Ministry of Finance. At the time, the country had received over 50 proposals for biofuels production projects all over the country as part of a global rush, partly due to rising oil prices.

Originating from a request from the Tanzanian government for support to update its energy policy (2003), Sida is also supporting the ongoing review of the policy.

Policy Innovation Systems for Clean Energy Security (PISCES)

Policy Innovation Systems for Clean Energy Security (PISCES) is a five year (2008-2012) initiative funded by the U.K's Department for International Development (DFID). PISCES is working in partnership in Kenya, India, Sri Lanka and Tanzania to provide policy makers with information and approaches that they can apply to unlock the potential of bioenergy to improve energy access and livelihoods in poor communities.

The purpose of PISCES is to develop new knowledge and policies promoting energy access and livelihoods through bioenergy. This new knowledge will also contribute to global debate on whether and how humanity should find more of our energy from bioenergy sources, and how that pathway might affect the poor and the environment.
A range of research has been conducted on water, food and energy security, focussing on the pivotal issue of bioenergy in increasing energy access and the security of livelihoods for the poor in Africa and Asia. Publications are available at http://www.pisces.or.ke/resources/publications.

The University of Dar es salaam (UDSM) is the PISCES group leading the technology research theme. The theme focuses on analyses, development and testing new and existing technologies, including plants, processes, appliances and practices, to provide policy-makers with improved information to analyse bioenergy pathways and outcomes. An emphasis has been on development of biofuel and bioenergy appliances which are easily accessible to rural communities.

Key activities and impacts in Tanzania have been:

- Modified biofuels technology for stationary engines in collaboration with Tanzania Petroleum Development Corporation (TPDC).
- Alternative non-edible indigenous biofuel crops have been identified including propagation studies.
- Gasifier stoves technologies have been developed. Jatropha seed gasifier stoves have been successfully field tested in Singida and Shinyanga region. Rice husk gasifier stove have been tested in Morogoro.
- Tests on new bioenergy appliances have indicated a reduction of fuelwood use and a significant impact on health through reduced smoke production.

Tanzania Domestic Biogas Programme

In biogas, Tanzania Domestic Biogas Programme (TDBP) is a national programme previously initiated by CAMARTEC in Arusha 1975, part of the 6-nation Africa Biogas Partnership Programme. 2000 urban and 610 rural (larger) digesters have been produced. A 6 m^3 unit, made of bricks, costs 700 000 Tsh, some of which can be paid in kind by the user by collecting stones or bricks. Artisans are trained, with the goal that they continue working after the program to increase supply. The goal is to include 12000 households by 2013. The program is not supported by the government, but has received funding from various sources since its inception.

Annex 5 Signed SSPA Contracts and LoI regarding RE

	SPP NAME	TECH.	Inst CAP. (MW)	LOCATION	LOI NO. (Site Ref. Numbers)	SPPA SIGNED	COD
1	TANWAT - Njombe	Biomass	1,5	Grid connec.	Biomass/SPP/2009/01	17.09.2009	15.06.2010
2	TPC - Moshi	Biomass	9	Grid connec.	Biomass/SPP/2009/02	06.10.2009	13.09.2010
3	Mwenga - Mufindi	Hydro	3	Grid connec.	Hydro/SPP/2010/03	19.01.2010	31.07.2012
4	Ngombeni - Mafia Island	Biomass	1,5	Off Grid	Biomass/SPP/2010/04	19.01.2010	31.12.2012
5	Sao Hill - Mufindi	Biomass	6	Grid connec.	Biomass/SPP/2010/05	26.02.2010	June. 2014

	SPP NAME	TECHNOLOGY	Sell CAP. MAX (MW)	LOI DATE	LOI NO. (Site Ref. Numbers)
1	Mapembasi - Njombe	Hydro		25.06.2010	Hydro/SPP/2010/07
2	AHEPO - Mbinga	Hydro	1	22.09.2010	Hydro/SPP/2010/08
3	EA-Power - Tukuyu	Hydro	10	07.02.2011	Hydro/SPP/2011/09
4	St. Agnes - Songea	Hydro	7,5	05.07.2011	Hydro/SPP/2011/10
5	Kikuletwa II Kilimanjaro	Hydro	7	28.10.2011	Hydro/SPP/2011/12
6	KMRI - Tunduru	Biomass	0,45	28.10.2011	Biomass/SPP/2011/13
7	Darakuta Mini Hydro	Hydro	0,88	10.01.2012	Hydro/SPP/2012/14
8	Mofajus - Mpanda	Hydro	1,2	27.04.2012	REC/MIL/03/2012
9	Symbion-KMRI-Kigoma	Biomass	5	15.05.2012	Biomass/SPP/2012/17
	TOTAL CAPACITY		**54,03**		