Sustainable Energy Markets in Tanzania

Report II: Analysis and conclusions

David Bauner
Melinda Sundell
Jacqueline Senyagawa
Jeremy Doyle

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Cover photo: hot springs in Maji Moto, Mara region, possible to develop for geothermal electricity production

Executive summary

This report investigates the role for donors in supporting the development of markets for renewable energy and energy efficiency in Tanzania. A **Background report** precedes this analysis.

The method used is a combination of interviews with stakeholders in Tanzania during two missions in January and May of 2012 together with literature studies. Relevant stakeholders, e.g. organizations supplying renewable energy products and services to Tanzania have also been interviewed.

Tanzania's population is around 44 million and it is a country that is endowed with diverse energy resources including biomass, natural gas, hydro, coal, geothermal, solar and wind. The potential of energy from renewable sources is substantial, 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.

Almost 90% of current energy use is met by traditional biomass: wood fuels. For domestic use in rural areas, this means burning natural wood (mostly scrub and prunings). Smaller rural industries use large quantities of biomass for processing agricultural products, and charcoal is produced to be sold in urban areas. Charcoal is the single largest source of urban household energy with 20 % of total energy use. The proportion of households in Dar es Salaam using charcoal has increased to over 70%. Half of Tanzania's charcoal is used in this city - approximately 500,000 tons in 2009.

The remaining share of energy sources are fossil fuels (6%), gas (1.5%), hydro (0.6%), and coal and peat (0.2%). 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.

While the electricity subsector contributes to less than 2% 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%) and natural gas (around 35%), with diesel making up for most of the remainder, and providing most of short-term and emergency capacity.

The work carried out for this report shows that sustainable energy is a promising area for donor support at present. This is because there is a large potential for economic growth and poverty reduction, a growing awareness of the need for reform, a large potential for domestic energy production, an explicit and growing demand for energy and relevant, active stakeholders.

Donors play an extremely important role in the energy sector of Tanzania. They support the development of energy policy and contribute to making bankable projects more visible by engaging in project consortia. They also contribute to on-going processes, such as the extension of the connector to Zanzibar, helping start-up companies find a market and supporting the establishment of suitable tariffs for small power producers. Most new infrastructure and power projects are donor funded in various ways.

The energy system can be roughly divided into five areas from a sustainability perspective.

1. Large scale power production and transmission,
2. Small scale power production and distribution,
3. Energy for cooking,
4. Transport fuels, and
5. Energy efficiency improvements on 1-4 above

Looking across these various sustainable energy areas, this report proposes 18 specific actions for donors within 6 different categories as follows:

4.1 Institutional development	4.1.1	Regulatory reform and incentives for renewable power production
	4.1.2	Developing the financial sector
4.2 Developing small scale power demand, electrification and off-grid solutions	4.2.1	Building demand, charting supply
	4.2.2	Training for entrepreneurs
	4.2.3	Bridging the Power gap
	4.2.4	Improving power distribution
	4.2.5	Demonstration project for electricity production from biogas
4.3 Large scale renewable power and transmission	4.3.1	Increasing dependability and efficiency of existing hydropower
	4.3.2	Complementary support to developing renewables
	4.3.3	Support to developing geothermal energy
	4.3.4	Developing a market for urban waste-to-energy
4.4 Sustainable bioenergy for cooking	4.4.1	Certification of cooking fuel
	4.4.2	Fiscal support to the governing of forestry/land resources and the charcoal trade
	4.4.3	Demonstrating a value chain for ethanol for urban cooking
4.5 Energy efficient industry and buildings	4.5.1	Industrial efficiency study
	4.5.2	Developing demand for energy efficient buildings
4.6 Sustainable and energy efficient transport	4.6.1	Methane as a transport fuel in Tanzania
	4.6.2	Benchmark study of energy efficiency in transport

Development of more sustainable forestry and biomass provision, efficient industry and buildings, and finding an appropriate role for solar, wind, hydro and geothermal energies in Tanzania should be primary overall targets for support.

Content

References are listed at the end of the Background report.

1 Introduction

This Summary report (Report II) condenses a Background report (Report I) on the development of Sustainable Energy Markets in Tanzania, including the areas of Renewable energy and Energy Efficiency. The analysis leads to recommendations on areas, topics and methods for support of the sector.

Please refer to the Background report for references.

2 Summary and analysis of the Background report

2.1 Background

Developing markets for renewable and efficient energy services in Tanzania is a great challenge. Progress will enable access to these services by Tanzanian consumers; domestic users, industry and institutions. Most of the energy sources in Tanzania today are not sustainable, and a successful transition to more sustainable pathways for cooking energy, transport fuels and electricity faces numerous obstacles.

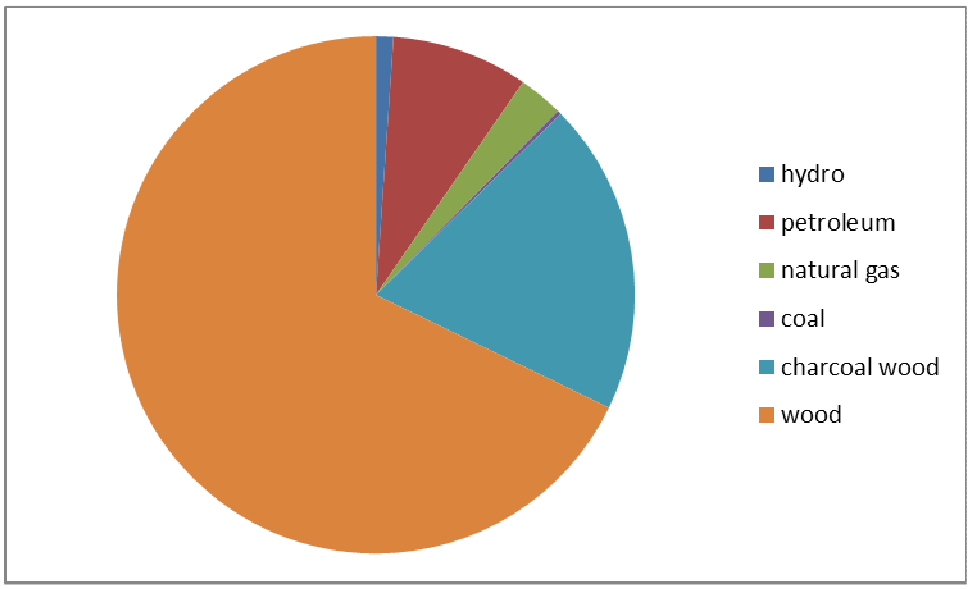

Figure 1. Energy sources in Tanzania (2009/2010, sources: MEM, WB 2009 and others)

The Background report defines six levels of energy services:

- **Level 1 power** is that obtainable from home solar systems and individual leased battery lamps: LED lighting, cell phone charging, radio and an efficient TV.
- **Cooking heat** is the value chain (fuel and stoves) that provides the heat for domestic and institutional cooking.

- **Level 2 power** can be used for agricultural services such as pumps, but also refrigeration and a number of micro-enterprises
- **Level 3 power** is higher electric power levels needed by industries such as mining and larger scale agri-processing.
- **Industrial heat and cooling** is needed for industrial processing and refrigeration , cogeneration boilers and e.g. district heating and cooling systems
- **Transport energy** is fuel for road vehicles and locomotives

Each of these services can be supplied with a range of sustainable energy sources, but the markets differ and are thus discussed individually below. Important to note is that Level 1 power and Cooking heat are basically indispensable for every household in the country, and should be the first to be supported for reducing both economic and energy poverty in rural areas.

2.2 Renewable energy is developing, "markets" are slower

Renewable energy is developing in Tanzania, along with both medium and short term fossil based power projects. Renewable energy under development includes both small and large hydro, medium size biomass and large scale wind projects. While there have been several projects regarding knowledge building in the areas of renewable energy technologies and energy efficiency, market development needs a long term perspective, but the short term view typically dominates. The experience of the industrialized world is that developing sustainable energy markets takes decades.

The Background Report describes the energy situation in Tanzania as depending on non-sustainable biomass, large scale hydropower and thermal power generation (from gas, diesel and heavy fuel oil). There are markets in Tanzania for cooking energy, grid electricity and transport fuels. All these are growing and suffer from lack of sustainable sources, high transaction and distribution costs and incomplete regulation and enforcement. Creating an enabling environment for markets for off-grid power and cooking energy might be the easier in Tanzania since they are not as exposed to political risks due to the smaller scale.

Regardless of the need for short term power, it is instrumental for developing and even maintaining the country's access to modern energy that efficient and effective renewable solutions are given a prominent role also in the short and mid-term. Short term "emergency" power costs five times or more per kWh than larger renewable or larger natural gas based production, implying that TANESCO loses money for each kWh sold. This is not a way to develop a business, regardless of the source of financing.

Even if a project or method is successful and its utility to the participants is "proven" in audit and follow-up activities, both technically and commercially, there may still be obstacles for the technology, method or policy to be adopted in a larger scale. Ensuing commercial development stemming from the different program results have been seen mostly regarding solar and biogas plant development. Several interviewees highlight the

difficulty of moving from pilot level to commercial introduction. Here, an understanding of the conditions for behavioural change is important. Credit lines, demonstration projects and guidance to help new entrants are a means for implementation.

While larger scale projects can be dealt with on a project-by-project basis, supply of power and energy related services to most of the thousands of villages in rural Tanzania can only be done by companies acting in a market. It is thus a prerequisite for the government to negotiate transparently and with attractive incentive packages for the larger projects, and create and implement policy that attracts a multitude of private actors for off-grid solutions.

Market support for small scale renewable power

This section summarizes the findings on electrification: demand for power, distribution, small scale grid and off-grid production.

The normal way for markets to develop is demand driven, with supply coming as a response. This is particularly true for areas where multi-tier investment and longer term agreements are needed to make projects commercially viable. For grid power the dynamics are different, but the basic balance between development cost and an ability and willingness to pay for services must nevertheless prevail. This is one of the reasons the development of the grid in Tanzania has been so slow. An important element in market building would thus be to enhance demand. The creation of local grids, developed in cooperation with villages and regional industry, is a way to build demand. Another means is to provide individual lights and off-grid Level 1 services.

Many of the market related projects and policies mentioned in the Background report are new and have not as of yet had any larger impact on the market. Tanzania has a large potential for rural development, and market imperfections can be rectified by certification schemes (requirements for PPAs) and more transparent information about the technology and promoting actors who supply that technology. Small RE systems can make significant contributions to building demand and improving living conditions.

Work to accommodate new SPPs has come a long way. EWURA has negotiated non-standard (higher) tariffs on the basis of the avoided cost, often for diesel fuelled generation in different scales, and SPPAs are established for small hydro. To arrive at a differentiated set of feed-in tariffs (FIT), where the particular characteristics of other types of RE are taken into account, further work is needed. To help TANESCO accommodate more sustainable but also more costly RE, 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). Depending of the magnitude, this type of support could be a more or less substantial on-going operational cost to the donor.

A more general issue is to make knowledge of the new opportunities available to both customers and developers. To develop a renewable energy village grid, for example, technical staff needs to meet with the village leaders to chisel out an agreement, establish

a project and design the system, find funding, find contractors, develop the production and grid and, not least, make provisions for sustainable operations both regarding service and revenue. The thousands of villages in Tanzania thus present a significant logistical challenge, given that many of the villages may not be optimal in size and ability to pay in regards to the available renewable sources such as a nearby river suitable for micro hydro etc. Thus, a more active approach than just offering a standard tariff is needed to create off-grid production in remote locations.

Looking at consumers, the primary drivers of unsustainable behaviour are the perceptions, usually highly justified in terms of historical market behaviour, of unreliable supplies and unpredictable and volatile price changes. Consumers are pursuing a suboptimal consumption strategy in order to reduce risk. Price regulation is a clumsy instrument, but perhaps direct sources of price information via, for example, the mobile phone network, would assure consumers of accurate information and might encourage more competition among suppliers. Increased transparency can be an important factor in reducing the perception of risk by the consumer and encouraging more optimal (and sustainable) behaviour.

There is a large supply (technology and entrepreneurs) and demand (thousands of unconnected villages) in Tanzania in this area, so projects which manage to bridge supply and demand and help create a market can have a huge upside in reducing the need for fossil, harmful and unsustainable heat and power.

The electric power distribution network is likely to be the long term solution for large parts of the country in need of development and a very suitable area for support. The structure of such support is facilitated by a recent study by SWECO and DECON, allowing for donors to select regions for support (see section 4.2.2 of the Background report).

For **small scale power** provisions, this means solar and battery lights, home solar systems and hybrid systems for agricultural services and community power. In this context, capacity building, awareness and policy support would aim at supporting markets through informing about an already existing potential by making resources available to e.g. NGOs such as ARTI and TaTEDO for further extending the offer to areas of the country where the potential of a given technology or energy service has not yet been realized. More dissemination, and maybe complementary studies and research on business models can engage local entrepreneurs and banks to be willing to invest in the minigrids as a rural solution, with the ultimate goal of turning small hydro power and predominantly hydro based hybrid systems into viable business.

Supporting larger scale renewable power and transmission

This section summarizes the findings on larger "unbundled" electricity generation and transmission.

The electric power sector has been for many decades a monopoly market belonging to the government. As the system moves from utilities to multiple actors in competitive markets,

the changes represent a normal restructuring of the energy system towards a higher level of flexibility and efficiency. The system evolves from centralized to decentralized generation/fuel production. Renewables and local grids take the system from transmission and distribution grids to "smart" grids. Technological convergence is evolving, and thus new legal frameworks are needed. Specifically, new institutional requirements are shaping the work of EWURA to accommodate private and public actors in the same system, and go from sectorial segmentation to synergy in generation and uses. This creates new cost structures, which require innovative business models.

Larger hydropower plants are under development, but will not be operational during the current decade. The recent natural gas finds will reduce the cost for power and create a political challenge: can the government and donor community work to use the more stable situation from short and mid-term natural gas-based power production to free more resources for developing additional larger scale RE power production, as well as off-grid and rural expansion? Or will the increase in gas-based production mean the demise for renewables?

On a larger scale, if tariffs for renewables are set lower than actual production costs, or if the risk of TANESCO not paying remains a barrier for project finance, availability of capital will not help. It is important to directly address this risk to investors by working with the government and TANESCO to increase economic stability and predictability.

The transmission network is under development with two major projects underway, and connection with surrounding nations under discussion through the East African Power Pool. While there are large challenges to extend the main network across the country further, efficient transmission is needed to bring down the energy losses and improve system stability.Given the size of renewable power production, it is perhaps advisable to focus on developing the distribution network and off-grid and isolated grid power to build demand in anticipation of more articulated demand.

Areas for support include the continued support to institutions for defining just and transparent rules for market actors to engage in developing renewable energy production and distribution to off-grid consumers. Specifically, conditions for supporting the development of a "transparent pipeline " of projects already "taken" and those that the government and donor community would like to see developed would help new actors.

Supporting sustainable and efficient cooking

This section summarizes the findings on sustainable cooking energy and efficient stoves.

The demand for cooking energy is predicted to increase threefold (Sarzin and Raich, 2012) in urban Tanzania from 2002 to 2030, but the high price and low dependability of electricity will help maintain the demand for charcoal beyond that time. To reduce pressure on forestry, it is therefore important to allow alternatives into the marketplace.

The Pisces project (see section 3.3.3 of the Background report) has brought much needed insight into the volatile area of bioenergy to the participating countries. More studies and

demonstration projects are needed to further understand specifically the impact on a commercial market.

Ethanol for cooking has been tried on a limited scale but did not reach success because of fuel prices and slow burning stoves. Still, it is a clean alternative which could reduce the need for charcoal in urban Tanzania. Development of more energy efficient stoves is needed here. Since demonstration is instrumental for market uptake, the creation of a sustainable value chain from production, distribution and sales of both fuel and efficient stoves in a few suitable regions could be a first step for fostering a new market. Ethanol for cooking, produced from molasses from national sugar production or from cassava, could be an important renewable alternative for urban Tanzania.

CDM is designed to enhance adoption of carbon practices such as efficient stoves. CDM has hitherto been slow in Tanzania. Supporting projects in the CDM pipeline to be approved would be important in its own right to entice the development of new projects, if the carbon price improves.

Supporting sustainable and efficient transport

This section summarizes the findings on renewable transport fuels and efficient use of energy in the transport sector.

Transport is the most challenging area for renewables. Since Tanzania has experienced a rather unproductive biofuel boom, there is no outlook for any larger volumes of biofuels to replace the pervasive diesel (around 75%) and gasoline (25%) in Tanzania anytime soon. While it is essential to foster an understanding on how to provide sustainable transport in the longer term, the biofuel boom is over and export of fuels to Europe is geographically challenged compared to West African producers.

An important area of immediate concern is energy efficiency. It can be assumed that an efficient transport system can considerably reduce today's energy use per passenger-km and tonne-km in Tanzania compared to today's situation, and considerably reduce travel time and cost. In a country where ability to pay is limited, any improvement would be a great benefit to economic development. Examples include supporting the ongoing development of both a city train system as well as a Bus Rapid Transport System in Dar es Salaam. Donors could engage in the development of functioning bike lanes and the uptake of bicycling in the topographically suitable Dar and other cities. Modern ferries could also be useful for reducing time and energy use in coastal cities.

A more efficient transport system would also be a prerequisite for efficient markets in the distribution phase (excluding electricity) for renewable fuels and sustainable practices; in that market development today is greatly hampered by inferior rural road infrastructure.

Given that this has not been a focus of the study, and that the issues in transport efficiency are focused on Dar es Salaam, only a scoping study is recommended for support.

Energy efficient industry and buildings

This section summarizes the findings on the potential of energy use efficiency in buildings and industry.

Buildings and industry are among the largest consumers of electric power in Tanzania. In East Africa as a whole, buildings consume 56% of the produced energy while the population is growing with over 7 % per year (UNEP, 2012), thus many more buildings will be erected. There is an interest to pursue means to reduce losses, and the area of energy efficiency for buildings has recently been studied by TANESCO.

A market for more efficient solutions for buildings and industrial production (drying, electric machinery etc) could arise once customers would be able to measure and compare the energy use and the economic and environmental effect of more efficient systems. Indicators for industrial installations per sector, and building types and their energy use, should be developed as a base for investigation of current average and best practice in Tanzania. The start for the industrial sector would be a charting exercise to understand the potential and look at financing mechanisms. Regarding buildings, there is a need to make potential savings more visible through labelling of equipment and types of construction, establishing certification of qualified contractors and performing benchmark demonstrations.

2.3 Overcoming systemic challenges

This section lists renewable energy related challenges and suggests options to move ahead.

The development of renewable power generation in Africa has been slow and the reaction to power shortages in Tanzania has been to increase dependency on non-renewable (fossil) fuel sources rather than move away from it. The bulk of investments are still focused on developing power production from non-renewable technologies.

The same principle can be said to apply to basic energy services. Since non-renewable wood fuel sources and informal charcoal making dominate the production system, (due to lack of enforcement of existing legislation to prohibit this), renewable wood fuel production and more efficient, higher investment fuel production is held back.

Systemic imperfections are general features of the failure of both governments and commercial actors to develop a functioning market for renewable power. As an example, sustainable and renewable solutions for power generation typically require new know-how and higher investment than non-renewable systems. “Emergency” power generation systems using diesel are standard units where the providers have decades of experiences of the time and cost for production and commissioning, and the risk is left with the sales process. Renewable technologies, while sometimes offering lower cost per kWh than fossil systems, are typically more site specific and thus cannot be offered and developed as easily at a fixed cost prior to carrying out a thorough feasibility study for just that location.

In addition to the uncertainties surrounding future energy costs, each type of renewable energy has a set of typical risks and environmental issues which normally require comprehensive (i.e. money and time consuming) social and environmental impact studies which in turn may question the viability of the project and be a reason for political debate.

The inherent complexity in renewable energy investments, then, is the major systemic challenge to further developments in this sector. This complexity takes a variety of forms (site specificity, new technology, higher costs and higher risks) and is felt by governments and investors alike in the short run. The benefits of renewable energy are uncertain in the short run and *likely* to be highly positive in the long run, which is not a tempting scenario for either the government or the investor.

However, in the discussion of barriers to overcoming this major systemic challenge highlighted below, this inherent complexity is taken as a given, and it is assumed that the long term benefits will outweigh short term costs and risks.

There are systemic barriers, then, which affect the development of renewable energy in any context. In the specific context of Tanzania there are a number of systemic barriers which must be dealt with in any efforts to promote development in the sector. A recent workshop held in Dar es Salaam identified *stakeholders*[1] *perceptions* of key barriers impeding the promotion of renewable energy in Tanzania. These included:

- *low awareness and understanding of energy by key stakeholders,*
- *inadequate financial resources,*
- *lack of clear strategy and legal framework for energy policy implementation and enforcement,*
- *inadequate local institutional framework,*
- *low participation of private sector,*
- *low investments,*
- *inadequate capacity, etc.*

Drawing on this and further evidence, the following nine challenges are seen as especially critical for the development of sustainable energy in Tanzania:

Challenge 1: Perceptions of Energy by Key Stakeholders

There is a tendency to equate energy with electricity, both among consumers and within government and the private sector in Tanzania. Donor focus has naturally tended to follow government priorities. Even renewable energy has often been appraised in terms of its ability to produce electricity for the national grid, not a surprising development given the long history of hydroelectric power in Tanzania.

[1] Stakeholders came from academic, government and NGO institutions present at the 39th meeting of the COSTECH R&D Advisory Committee on Industry and Energy, held in June 2011. Significantly there is no representation from the private, commercial sector.

On the contrary, non-renewable biomass today meets more than 90% of basic energy needs in the country. If the trend continues and resources are permitted to deplete beyond repair, millions of people may be forced to resort to obtaining their energy inputs from the remaining forested areas. This, in turn, will either force migration and/or result in higher transport costs.

The rapidly increasing popularity of solar pv "packs" for lighting and battery charging in the rural areas is indicative of just how important the off-grid and small scale solutions are to an important consumer segment in the Tanzanian market.

Challenge 2: The Institutional Wrangle in Tanzania

Not only are perceptions of energy often limited to electricity coming from the national grid, but there is also a wide-spread perception in Tanzania that a central, government authority such as TANESCO should be the major provider of energy services. Whether or not this is ideologically desirable is a moot point, there is not currently a realistic possibility that this can be the case for the foreseeable future.

Given the financial and institutional weaknesses of TANESCO, it is currently unable even to live up to the regulatory, maintenance and supervision expectations placed on it. While these weaknesses should certainly be addressed, it is important that there be a wider understanding on the part of government and the general population of the needs and requirements of the private sector, particularly, then independent power producers (IPPs). Many, but not all, of these requirements have to do with project finance, and are discussed below.

Challenge 3: Financial Constraints

A recent analysis[2] points to the incongruence between the economic viability of an IPP, which typically requires large investments which require a long period to mature, and the scarce availability of long term loans (to add to already significant long term debt) in countries such as Tanzania. Long term debt is required to allow for the gradual increase of the retail tariff and the ability to deliver debt service coverage ratios that are reasonable to project finance lenders and economic returns which are sufficient to justify the risks involved. DFIs (Development Finance Institutions) or multilaterals such as IFC, African Development Bank, EAIF, European Investment Bank, FMO, DEG, Proparco, BIO, IDC and others have, until recently, been the only "club" of possible debt funders for long term debt in SSA. Recently commercial lenders, particularly those from South Africa, including Standard Bank, Nedbank, Rand Merchant Bank and ABSA have all made encouraging moves into participating again in these projects in SSA. Commercial lenders, however, continue to require fully commercial offtakers, sovereign guarantees or

[2] Trinity et al (2011);

full political risk insurance coverage, each of which has either time or cost consequences (or both).

Availability of equity

Unless a developer of an IPP has the balance sheet itself to undertake the full equity financing required for a project there will be a requirement to find further equity to meet the equity component of the financial plan. Although certain of the DFIs noted above also provide equity (and/or mezzanine debt) there remains a lack of equity financing that is available pre-financial close. This lack of funding is exacerbated by the fact that those equity investors who will take these risks expect return on investment which the PPA tariff cannot deliver for on any renewable source.

Even a DFI though would typically need to ensure that the tariff due under the terms of the PPA can be absorbed by the offtaker and the electricity sector in general. In the context of a renewable IPP, tariffs are typically higher. The resulting need for an increased retail electricity tariff for end users in comparison with cheaper coal/fuel based tariffs is often embroiled in politics and is commonly only partially implemented and, sometimes, deferred indefinitely.

Challenge 4: Improving the clarity of strategies and legal frameworks for energy policy implementation

Given the government's need to maintain control and insight, it is important that this is spelled out clearly in policies, directives and laws so that the private sector actors feel confident that they know the "rules of the game" and that they can predict the conditions for the development of their investment. A number of studies[3] point to the generally risky investment environment in SSA and, while it can be argued in some cases that the environment is perceived as more risky than it actually is, it is still true that a large number of planned investment projects never come to financial close. To what extent an uncertain legal/policy environment is responsible for this is unclear, but there are many planned investments in renewable energy never coming to fruition in Tanzania.

Tanzania does have a legal and regulatory environment which seeks to support and regulate private sector involvement in infrastructure projects, and also addresses directly the possibility of investing in renewable energy. The National Investment Promotion Policy (1996) mentions both national and foreign investment in renewable energy, but refers primarily to hydropower and biomass resources in terms of forestry and agriculture residues. The more recent (2003) National Energy Policy states that the government will assist the introduction of appropriate renewable energy development through financial, legal and administrative institutions, and by establishing norms, codes of practice, guidelines and standards for renewable energy.

[3] Trinity et al (2011), Johnson et al (2012)

The National Energy Policy is currently being reviewed and updated, and there is a National Liquid Biofuels Task Force and a Wind Power Task Force. However, in spite of these efforts, investors still report facing a complicated array of bureaucratic requirements, long waiting times and a lack of transparency. Development in the renewable energy field has been very rapid, and this is perhaps not unusual, but if Tanzania is serious about encouraging investment in this field, there will have to be some substantial improvements.

Challenge 5: Tariffs as Economic Incentives

Related to the inability to attract private investment for renewable energy from the private sector, is the lack of clarity in pricing policies for electric tariffs. While this addresses a relatively small area of energy use at the moment, it can be argued that electricity generation has a disproportionately large impact on economic growth in relation to its role in power consumption in Tanzania.

A tariff system implemented by EWURA that will effectively be used to incentivize RE investment requires that there are levels tariffs attractive to IPPs which can be negotiated with utilities/Governments as being one of the significant constraints to successful implementation. Hydropower tariffs remain significantly lower than what is usually required for developers to take on the risks of development for renewable energy. Tariffs for other types of RE have not yet been defined. This has led to the focus on non-renewable solutions to growing demand for power. For off-grid or local grids, investment is hampered since supply and demand must be matched locally at every instant. While the tariff in effect can be higher; surplus energy cannot be sold which means producing to potential is not economically viable. To manage this, off-grid production should aim at a mix of private and industrial clients, where the latter can absorb more power to match production.

CDM has not been a viable alternative for financing renewable energy initiatives in Tanzania. To date, only one application has passed through the approval process at the Division of Environment/Office of the Vice President (land fill gas from the Mtoni landfill), but this is only partially operational. This in addition to the fact that it is expensive and time-consuming (estimates are two years for processing at a cost of €100,000) to register the project with CDM itself.

Challenge 6: How to encourage Developers

IPP developers with risk capital and capability are currently few and far between. The GAP analysis points to the existence of AES Corporation (back in the market after a number of years of not being involved in Africa), Globeleq, Aldwych International, Contour Global, IPS, Sithe Global, Africa Finance Corporation, Infraco, Ormat, Copperbelt Energy Corporation and a few smaller developers.
The GAP analysis concludes that save for a few larger hydro deals and the geothermal projects in Kenya, there have not been many renewable IPPs undertaken successfully in SSA at all. A development team needs to be able to pull together all of the land, consents,

equipment supply, civil works, offtake contracts, political risks and then arrange a debt and equity financing structure. In many jurisdictions in SSA the creditworthiness of the offtaker is poor and not considered sufficient by project finance lenders and the tariff itself is, particularly in respect of more expensive renewable technologies, not sufficient to cater for the then anticipated debt and equity returns, particularly when these are anticipated to reflect all of these risks and all of the required time and skills required to undertake such a process.

Creditworthiness of offtakers is a highly relevant problem to the case of Tanzania. The host utility offtaker (TANESCO in the case of Tanzania) should not simply accept the right level of risks pursuant to the terms of the PPA, but should also have the means available to actually assume such risks in practice. Unfortunately, this is often not the case. It is certainly true that DFIs have, over the last few years, not considered fully whether the counterparty to the PPA can in fact fully assume the liability to pay the termination compensation sums which could possibly be due on default. This lack of liquidity though within an offtaker such as TANESCO is one of the reasons why commercial banks have been so scarce in financing such IPPs, as the requirement to fund for a long tenor (which is necessary to make the project economic), combined with the sometimes clear lack of the offtaker's balance sheet ability to meet its liabilities makes it naturally hard for any credit committee of a commercial bank to accept the resultant risk / reward package.

Challenge 7: Reducing Political Risk

Even if an IPP has a PPA that is acceptable to equity and lender investors, there remains a political risk associated with the potential acts (or omissions) of Government. This hinders the ability for that PPA to be properly performed. The resulting PPA will have little relevance as lenders and equity investors will normally require that either the enabling legislative environment is sufficient to cater for these concerns, or more commonly it is required that the host Government enters into a specific agreement with the project company (and often the lenders directly as well) to the obligations of the host Government and what the consequences are if the Government fails to perform. In the context of a renewable IPP, where it is often the host Government which has the capacity to manage applicable carbon credits which may accrue from such a project, it is particularly important to ensure that there is an understanding of the baseline involved in the project, the economics involved with the carbon credits and how the credits will be applied.

Challenge 8: Improving markets for equipment and technology

There is usually a general availability in equipment and applicable technology in the international market. Very little equipment is produced locally in Tanzania, although in some cases this is probably more through lack of awareness than financial/technical inability to produce. For renewable energy, however, the market is still emerging and there has historically been little demand.

There is, however, again a need for such providers to accept the typical norms of project financing. One of the key risks which lenders will not expect the project company to take is that of achieving commercial operations by a date certain at a fixed cost. This risk would typically be assumed by an EPC contractor whereby all construction requirements are taken by one entity. If this is not the case, lenders would require further support within the project company itself (imposing further equity risk on the sponsors). In respect of renewable technologies there are a number of typical risks. For wind there is often a divide between turbine supply and the foundations required for the turbine installation; in hydro, where ground condition risk and hydrology risk are often large and are expensive risks to be assumed by a contractor; in geothermal projects where the risk of the steam field reservoir and its extraction is significant; in solar, where the technologies are still untested at a large scale; there is a significant package of risks needed to be addressed by equipment and technology suppliers and/or otherwise also dealt with by the project company and its sponsors.

Challenge 9: Managing competition with fossil sources

Tanzania is a growing country with a large deficit in power production. This implies that non-renewable means of electricity generation, if cost competitive to renewables, are likely to be needed, coveted and bankable for the foreseeable future. This results in a competition between the two sources, and political infighting as well as and lobbying from the non-renewable side is possible.

A principle when negotiating tariffs should be that renewable sources should have a premium based on long-term price projections and sustainability. The size of this premium depends on type of RE. While the emergency program is important for maintaining the provision of energy based services directly and indirectly to domestic clients, industry and public institutions, spending large amounts of cash on buying fuel that could be used for supporting sustainable energy production and involving national industry means that fewer funds are available for reducing losses and building sustainable production capacity. A plan to reduce the subsidies to fossil power (diesel fuel tax alleviation) should be established.

3 Renewable energy market support

3.1 Introduction

Chapter 2 in the background report discusses the different stakeholders in the energy market in Tanzania. Chapter 3 describes more in detail the market trends (supply and demand), investment requirements, enabling infrastructure and potential contribution to energy access for different renewable energy sources.

While attention is given to some renewable energy sources which hold a great deal of future promise, it should be kept in mind that biomass based fuels and energy services will continue to form the base of supply for the majority of Tanzanians, and efforts to increase sustainability of supply of these resources will be instrumental to provisions of basic services in the coming decades. A lack of low cost cooking energy will very quickly cause severe problems in rural and urban areas alike. Development of more sustainable forestry and biomass provision should thus be the primary target of support for renewable energy in Tanzania, at least in the short run, however promising the other sources may be for the future.

First, we are operating under a number of assumptions:

- Access to sustainable energy is desirable for long term economic growth
- Governments and parastatals do not and will not have the capacity to develop energy sources. The private sector must be heavily involved
- Governments play a crucial role in regulating and providing incentives to energy development and must have the capacity to do so if the private sector is to be engaged
- Resource-poor and low income segments of the society will probably need support in order to gain access to modern energy

The criteria that Sida and DFID may wish to apply to making their own priorities, then, include:

- The relative sustainability of the energy source, especially in terms of its environmental impacts and competition with other resource uses
- The ability of poorer segments of society to access energy delivery by source or technology
- The ability of Tanzanian government institutions to provide the necessary guidance and incentives for the development of these sources

The six high priority areas for cooperation identified by the Team were made in terms of *functions* which must be supported in order to see the growth of renewable energy delivery in Tanzania and were not analyzed by energy source, as such. They are also linked closely to the systemic barriers identified above. When appropriate, however,

mention is made of a specific energy source or technology in order to make the recommendations more understandable.

A recent stakeholder meeting[4] discussed the importance of promoting renewable energy in the country in order to reduce dependence on imported energy and facilitate sustainable supply of solid biofuels and its substitutes. These are also the main justifications for donor support to renewable energy development in Tanzania.

Within the context of general development priorities on the part of the government of Tanzania, DFID and Sida and the current situation in energy markets in Tanzania, the Team has come up with a list of six prioritized areas for future cooperation. It was not deemed necessary to further prioritize among these six; but there are a number of criteria which could be used to further filter these priorities.

The identified areas for cooperation, which are discussed in more detail in the sections below, include:

- Private Sector sensitization, awareness and training, including creation/strengthening of trade organisations, demand assessment, business plan, marketing and budgeting
- Urban or industrial wastes to energy and/or fertilizer
- Adaptive research in available technologies
- Support legal and institutional framework for helping the private sector to succeed.
- Credit/Finance mechanisms to promote renewables and reduce costs to the small scale consumer
- Making bioenergy more sustainable throughout the value chain, including land tenure, local sustainable forestry, market regulation and pricing etc

In a market context then, each actor must act more transparent, and the market must be characterized by stable rules and credible institutions.

3.2 Modalities of Support

Developing markets for renewable energy implies enhancing demand, strengthening supply and fostering an enabling environment. Donors have a great challenge in supporting the government and private companies and other stakeholders to ensure universal access to affordable sustainable energy by 2030, as well as seek to double the rate of improvement in energy efficiency and the share of renewable energy in the global energy mix, as stated in the UN High Level report, paragraphs 14 & 20[5].

[4] Reference to Costech Meeting, DSM June 2011

[5] United Nations Secretary-General's High-Level Panel on Global Sustainability, Resilient people, resilient planet: A future worth choosing. 30 January 2012

Methods differ depending on the type of market. For larger scale projects, it could imply working directly with the dozen or so projects that are running at any given time. Divided across the donor community, this is reasonable and could have important advantages such as an understanding of the need for ancillary support. Regarding small scale projects, the number of market actors can run into the thousands and it is more effective to work with the development of policy and enforcement.

Regarding energy efficiency (buildings, industry, transport, electric grid), it is more of a challenge to create markets. Here, certifying and labelling products, supporting the development of accepted measurement methods for efficiency and engaging in developing the means for more efficient transport such as bike lanes (reduced energy use per km, less congestion, with fewer traffic accidents as a bonus) and infrastructure development for public transport can be more areas for intervention.

There are a number of ways that donors could support the development of renewable energy markets in Tanzania. The UN High Level Report on Vision for Sustainable Development[6] highlighted the need for markets and entrepreneurship to be prime drivers of decision-making and economic change given the scale of the investments, innovation, technological development and employment creation required for sustainable development and poverty eradication.

To support policy development, "resident" consultancy or "think-tank" type activities can be funded directly or through e.g. WB trust funds, working with specific issues, or capacity building projects e.g. for department staff.

Financing can be done in a number of ways, with differing goals - loan guarantees, environmental loan, sector support, bilateral/multilateral cooperation, private sector support, NGO support, leveraging other investment etc.

Through competitions or for projects dealing with prioritized issues, direct project support is another option. Supporting e.g. off-grid system development and lease is one example.

3.2.1 Capacity building and policy support

The government's ability to enforce the present energy policy is limited. Increasing resources and tools to monitor forestry and agriculture and enforce forestry policy on

[6] United Nations Secretary-General's High-Level Panel on Global Sustainability, Resilient people, resilient planet: A future worth choosing. 30 January 2012

district levels would be important measures to reduce illicit charcoal and other unsustainable practices.

For **larger scale power** projects, support for institutional reform on a national and regional level to create a level playing field for commercial actors is needed. Tariffs and incentive levels needs to be constantly trimmed to entice competition without draining the capital of TANESCO.

To build demand, capacity building is needed also when it comes to consumers. This implies easily accessible information on energy alternatives, perhaps even integrated into school curricula.

3.2.2 Project and venture funding

One of the key drivers in market growth is access to finance. Interest rates in Tanzania are high and local banks have a low tolerance for renewable energy projects. To develop access to capital – directly or by mitigating risks perceived by other financial partners – is very important.

Apart from direct support to projects, donors could develop tools which would make it possible to leverage any other support engaged in projects, such as community banks, guarantees and Advance Market Commitments (AMC).

Donors can use the Nexus approach to ensure co-benefits and joint financing of energy projects, also that energy development in the biomass sector is not done at the expense of food security or the sustainable development of water resources. This is an important project filter, besides the usual feasibility and ESIA studies. Competitions could be a modality for support.

3.3 Rationale for support

To prioritize between measures for improving renewable energy markets in Tanzania, a number of issues must be balanced. Some of these are macroeconomics, poverty, governance, environment and social issues.

3.3.1 Wealth creation – poverty reduction

The most central rationale for engaging in development of renewable energy markets in Tanzania is to reduce poverty and improve the livelihood for Tanzanians, both rural and urban. The rural population, being geographically sparse and far away from the national grid connections, would benefit in particular from the development of renewables.

3.3.2 Government accountability

Given limited resources in the country to support the development of sustainable energy services, such services are not practically available to most Tanzanians. Before renewable

energy and efficient building practices become the less costly options for entrepreneurs and consumers, the development and marketing of sustainable energy products and services will be severely constrained.
In various sectors of the Tanzanian economy; agriculture, forestry, industrial production and urban construction, regulation is not effectively enforced. How to achieve higher, uniform productivity and a well functioning market for renewable power will be an important challenge for the future.

Even with policies in place, supporting the development of renewable energy markets may be difficult. Ministries do not have resources to properly staff and equip forestry monitoring and other energy related activities. This would be an important area for support.

3.3.3 Environment

There is a large environmental potential in supporting "good" market development in Tanzania. Some areas where aid interventions could make a difference for the environment are renewable and sustainable power production, which reduces both local pollution and CO_2 emissions and reduces the need for costly emergency power production. Sustainable charcoal production would reduce deforestation and in itself increase energy efficiency, both of which reduce the burden on non-renewable wood resources.

The Nexus approach

One aspect of energy is the links to the availability of water and food. This is the "Nexus" approach, coined for the conference 'Planet under Pressure' in Bonn 2011, 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. A Nexus approach highlights the interdependence and trade-offs between several variables. This approach can be a useful analytical tool to analyze and quantify the tradeoffs that Tanzanian policy-makers are faced with in terms of promoting the development of renewable energy sources in the future. Since energy relates to short of all activities in society, there are likely further elements of interdependence (nexus) beyond food and water. Three guiding principles were highlighted in a recent study analyzing the Water, Energy and Food Security Nexus[7] :

Investing to sustain ecosystem services
Provisioning ecosystem services, as they are defined in the analysis include some of the most important products in Tanzania: food, feed, biofuels, wood (fuel) and fibre. With the exception of biofuels, these products already supply Tanzanians with their basic livelihoods. Developing renewable energy sources may lead to pressures on existing ecosystem services and the possibilities of negative externalities such as reduced bio-

[7] (Hoff, 2011):

diversity. Tourism in Tanzania ranks as the second highest foreign exchange earner after agriculture (Tanzania Invest); ecosystems and biodiversity are serious sources of incomes, not just resources with a theoretical long term value.
Tanzania has a very rich biodiversity and is host to one of the world's biodiversity hotspots. This biodiversity has important economic, technological and social implications. For example, well-functioning ecosystems and biodiversity, on which tourism depends, are therefore serious sources of incomes, not just resources with a theoretical long term value.

Specifically for Tanzania, which its present deforestation rate at between 90 000 and 300 000 ha per annum, there is a clear risk that not only wood supplies and related services will be scarce, there is also a risk of ecosystem breakdown, a loss of resilience, if the system come under too much stress from overharvesting.

Creating more with less
Productivity is defined in the report as the output – such as kilograms of biomass, kilocalories of food or kilowatts of electricity – per unit of water consumed, or land or energy utilized. This measure of productivity has not been used in the documentation that the Team could find for Tanzania, and would be highly useful for quantifying the tradeoffs between different development opportunities in the renewable energy field.

Water productivity in biomass production depends on various factors such as vegetation (feedstock in the case of biofuel production), climate, and land and water management practices and land degradation status. The potential for increasing the productivity of water and land is particularly high in sub-Saharan Africa and south Asia.

The Green Economy focuses on increased overall resource use *efficiency*. Generally, spatial aspects are considered to be key towards improving overall resource use efficiency and are usually discussed under such headings as "landscape planning" or "landscape configuration".

Depending on where in the landscape each measure is implemented, efficiency and also negative externalities across the different natural resources may play out differently, e.g. biofuels in marginal areas do not compete with food production (but on the contrary can rehabilitate land), afforestation should be avoided especially in water scarce areas, and reservoirs in steep valleys (and cooler regions) have lower evaporative losses than shallow reservoirs with large surfaces. That spatial aspect is also important for outscaling and upscaling of local solutions.

If interventions and investments which increase water or land productivity are designed with the nexus in mind, they do not negatively affect energy productivity (and greenhouse gas emissions), or vice versa, but can instead increase overall resource use efficiency.

Energy efficient electric power, bioenergy, industry, buildings are important areas for intervention included in section 0 below.

Accelerating access, integrating the poorest
"There is considerable overlap between the 1.1 billion poor people without adequate access to water, the (close to) 1 billion who are undernourished, and the 1.5 billion who are without access to electricity"

"Access to clean, affordable and reliable energy (and eventually the development of integrated energy systems through productive electricity and modern fuels) is crucial to the fight against poverty, while secure (rights-based) access to resources also leads to more sustainable use of natural capital. Hence investment and innovation that accelerate equitable access and benefits for the poor can have high rates of return in terms of development and environmental sustainability."

Regarding rural development, a nexus approach to energy access can play a pivotal role in creating markets for the poor.

Climate adaptation technologies

Potential climate change impacts in Tanzania can take many forms, from coral loss in Zanzibar, to coastal erosion, to declining lake productivity, to a higher malaria challenge, to loss of plant and animal biodiversity. The current climate variability in the form of extreme events such as droughts and floods, already leads to major economic costs in Tanzania, with the economic cost of regularly occurring individual annual events in excess of 1 percent of GDP. Such trends are likely to continue, with Tanzania particularly vulnerable due to its high level of dependence on natural resources. As mentioned earlier, biomass provides 90 percent of the primary energy supply, and Tanzania's forested ecosystems are subject to climate-related stresses. Further, over 90 percent of agriculture is rainfed, and climate change is likely to affect precipitation and runoff. Malaria is spreading to higher altitudes as temperatures warm. Models indicate that climate change could have net economic costs equivalent to a further 1 to 2 percent of GDP/year by 2030, and Tanzania's capacity to adapt is limited[8].

Persistent poverty, governance challenges, low access to capital, and ecosystem degradation all stand in the way of an effective climate change response. The country's limited water storage capacity, for example, could hamper efforts to adapt to changes in precipitation and water supplies[9].

[8] World Bank, 2011

[9] Ibid.

Agri-business/Energy

Potential for improving energy-use efficiency and benefit sharing in food production:

According to the FAO[10] there are three main routes for the food system to become 'energy smart': more efficient energy use; energy substitution (i.e. more renewables); and improved access to sustainable forms of energy. Opportunities for greater efficiency in food production include cutting fertilizer overuse, more precise application of fertilizer, and green agriculture and agro-ecological alternatives such as intercropping, nitrogen fixing, and use of compost and other re-cycling of residues. Improvements in rainfed agriculture can reduce the need for irrigation and the associated additional energy input.

Energy recovery from wastewater can reduce the energy demand in the treatment plant or even allow an export of excess energy to the power grid. Technologies include methane production in anaerobic digestion and electricity production through microbial fuel cells. In Germany (and other places) there are initial examples of energy self-sufficient wastewater treatment plants.

The table below indicates the cost of investment and operations per type of power supply.

Table 1. Production cost for different energy types

Type of energy	Investment cost USD/kW	Operating cost USD/kWh	Source
Co-generation bioenergy	140 – 850	0,04 (9%-20% of IC)	IRENA, 2012a
Wind power (20-30% cap f)	1 300 - 1 450[11]	0.013 to 0.025 (EU)	IRENA, 2012b
Large hydro	1050-7650 (2400)	0,03 to 0,04	IRENA, 2012c, IEA (2006b)
Small hydro	1300 – 8000	0,02 to 0,06	IRENA, 2012c, IEA (2006b)
Geothermal	1150 and up	0,015 to 0,025 (USA)	IEA (2006b)
Fossil thermal	810	0,06 to 0,45 (Tz)	Interviews
Landfill gas	1 917 – 2 436	low	IRENA, 2012a

10 FAO (2011) Energy-Smart Food for People and Climate: Issue Paper

[11] Value representing experience from China and India

4 Suggested interventions

The following table (Table 2) lists a number of specific actions that would support the development of sustainable (energy efficient and renewable) energy markets in Tanzania. A description of each suggested intervention is listed per area in the following.

Table 2. Overview of proposals per energy type and target service

Energy →	Hydro		Solar		Wind		Geo-	Bio-	Energy
Area ↓	Small	Large	Small	Large	Small	Large	thermal	mass	efficiency
Institutional development	**4.1.1**, **4.1.2, 4.3.4**								**4.5.1, 4.5.2, 4.6.2.**
Off-grid / RE[12]	**4.2.1, 4.2.2, 4.2.3**		**4.2.1, 4.2.2, 4.2.3**		**4.2.1, 4.2.2, 4.2.3**			**4.2.1, 4.2.2, 4.2.3, 4.2.5**	**4.2.4**
Grid / RE		**4.3.1, 4.3.2**		**4.3.2**		**4.3.2**	**4.3.3**	**4.3.4**	**4.3.1**
Cooking								**4.4.1, 4.4.2, 4.4.3 4.4.4**	**4.4.1, 4.4.2, 4.4.3**
Industry/ Buildings			**4.5.2**						**4.5.1, 4.5.2**
Transport								**4.6.1**	**4.6.2**

4.1 Institutional development

4.1.1 Regulatory reform and incentives for renewable power production

As the market develops, and hurdles for new actors along the value chains of the various energy sources-to-services become noticeable, there is a strong role for donors to support the elimination of those hurdles. For market actors to engage at any scale, there must be guarantees that there is a level playing field with stable conditions, and that tariffs permit profits for developers. This could be continuing support in developing frameworks for renewable energy regulation, developing methods for calculating feed-in tariffs also for solar, wind and geothermal, continuing financial support (e.g. planning support and investment grants, probably through REA for smaller projects) and other approaches to improve institutional governance.

Key intervention elements needed now include:

[12] Renewable Energy

1. Development of a user-friendly Excel based model and accompanying users' manual for evaluating the financial viability of SPPs and SPD

2. Assistance in developing in developing general tariff setting and grid integration standards for larger (i.e., non-SPP) renewable energy and cogeneration projects and applying the standards to one proposed project that applies for license and tariff approval by EWURA

3. Development of tariff setting standards for the provision of "back-up" and partial requirements power supplies for SPPs and SPDs

4. Development of a simple by effective monitoring system for operational SPPs and SPDs who have received tariff approvals and licenses from EWURA

5. Initial scoping study on a possible regulatory framework to promote different forms of energy efficiency

A budget can be set and then assigned to projects developed in cooperation with the government.

4.1.2 Developing the financial sector

The donor role would be to support public institutions in regulating the use of capital, informing public and private entities on and working with banks to help them mitigate risks and enable lending to renewable energy projects. Developing microfinance schemes and community bank initiatives could be other means of supporting e.g. the development of local grids.

4.2 Supporting the development of small scale power demand, electrification and off-grid solutions

Small scale power is defined as supply of power to off-grid and micro-grid systems; typically with (much) less than 10MW installed power. Also, where the SPP has a focus on local electrification, but chooses to connect to TANESCO for selling surplus energy and increasing grid redundancy, it serves the purpose of this report to call it small scale power.

Off-grid power is here defined as regarding community power /village supplying Level 1 and 2 power, standalone systems that provide a home or small institution with Level 1 power, or leased battery lamps or similar that provides Level 1 services to a home.

Two issues dominate the slow development of small scale power, limited awareness of available solutions and a limited ability to pay. A third issue is the organization of effective and efficient operations and maintenance.

4.2.1 Building demand, charting supply

As a stand-alone precursor to the Bridging project, market actors – including consumers - would be helped by better understanding the conditions for building rural mini-grids and offering stand-alone solutions. Entrepreneurs would conversely be helped by knowing where there is demand and possible energy sources across the vast nation.

The project would consist of choosing a number of districts per annum where selected entrepreneurs or system providers can present their products and services to local villages, in combination with researchers carrying out a pre-feasibility study of e.g. the available mini-hydro and biogas opportunities, much to the tune of the distribution grid study discussed in section 4.2.2 of the Background report.

Services offered by entrepreneurs could be the whole range of renewable off-grid solutions: leased rechargeable battery lamps/cell phone chargers, Home Solar systems, agricultural hybrid systems, institutional solar for schools and hospitals, micro-hydro technology, micro-grid control systems, community systems based on off-grid telecom base stations and others. Financing alternatives could also be presented.

This Building Demand project could inform the "Bridging" project, giving villages the opportunity to express their interest in participating. It would also be an opportunity for entrepreneurs to present themselves to a number of villages and hopefully gain the confidence of some consumers.

If found suitable, the project could also include demonstration projects and invitation to new entrepreneurs for producing sustainable cooking fuels as presented in 2.4.4 in the Background report.

4.2.2 Training of entrepreneurs

While the need for a greater involvement on the part of the private sector in renewable energy (IPPs and inputs and services delivery entrepreneurs) is seen clearly by outside observers, this idea may be less widely accepted in Tanzania than is supposed. (see Barrier 2 above)

A number of suggestions have been made for training potential entrepreneurs in the Tanzanian market. Basic training in accounting and business management are carried out by a number of organizations, but some thought here has to be given to the particular characteristics of entrepreneurial groups in Tanzania and the historical separation (and at times even hostility) between the state actors, including parastatals, and the private sector.

More in general, SIDO, VETA and other organizations could help develop training and capacitation programs for technicians and manufacturers in the area of renewable energy solutions. Important areas include where competitiveness depends on industrial ability to keep uptime and deliver specialized technology.

Efforts should also be directed to connect research and practitioners. Much of the energy technology research carried out by academic institutions in Tanzania has little to do with market developments. Development of business models, and organization of operation and maintenance are important issues. Researchers and research results should be used more directly to empower market actors and enrich competitiveness.

Progress has already been made here in terms of strengthening private sector involvement in the solar PV market; perhaps the logical next candidates would be wind power and mini-hydro. Here, experiences from the PV market development should be considered.

4.2.3 Bridging the Power gap

Tanzania's villages lack power. This hampers education, economic development, health, and other elements of modern society. It is found in interviews that for a village to pursue the development of a local grid is as large a step as for an entrepreneur to spend a few days in a remote village to propose the same to the village chief and expect to get an order. Having said that, there is a large and articulated interest on both sides to achieve this, but insecurity of the outcome is too high with the parties and the surrounding situation.

A project which "marries" a village with a designer, develops the agreed solution and then assigns a "micro-utility" or Small Power Distributor (SPD) to own and manage the grid and sell services to clients in the village at a price similar to normal tariffs, supported by one or more donors, could be a means to roll out a number of mini-grids in distant regions and develop demand. In addition to the advantages of domestic access to Level 1 services, the access to Level 2 power could entice commercial development and entrepreneurship such as agricultural processing and micro-entrepreneurs as discussed in section 2.5.2 of the Background report.

The project could consist of the following elements:

- Qualification of entrepreneurs/system designers
- Qualification of technology and suppliers (if applicable)
- Qualification of villages and districts
- Announcing a competition for both parties to define their needs and interests, resulting in a number of mutual acceptances by a defined district/area, an assigned system designer/developer and the donor to build and operate a system.
- Agreement on the terms
- Construction of systems
- Commissioning of the system and handing over to a SPD
- Operational/commercial phase

Criteria and location of suitable areas for developing local grids have been proposed by GVEP and Vivid economics (2010) and examples are shown in Figure 2 below. This is of course not an exhaustive list.

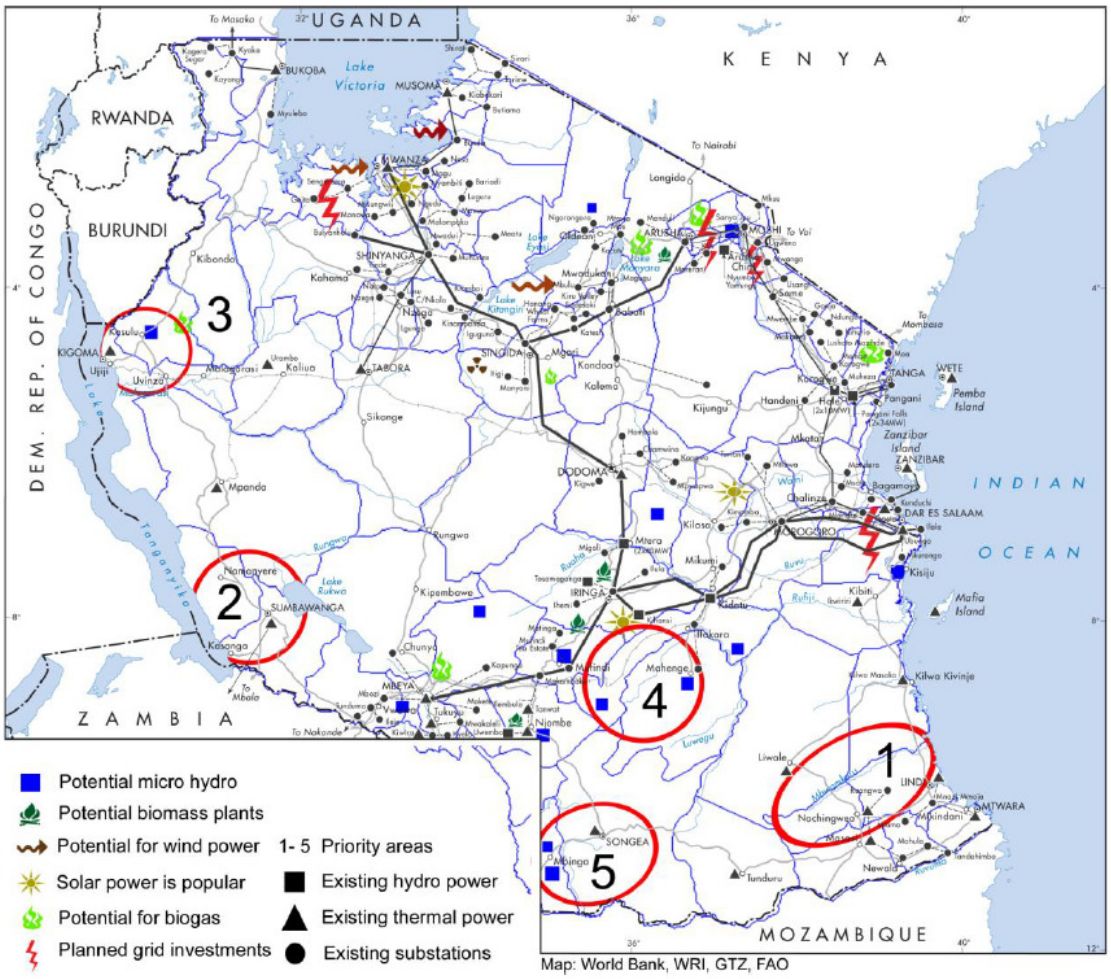

Figure 2. Possible areas for off-grid development (GVEP/Vivid Economics,2010).

To reach a a scale necessary to address the nationwide electrification deficiency, 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.

The funding of each mini-grid is of course a challenge in itself. The project would make use of the grants offered by REA. A number of solutions such as donor support, community banks, Advanced Market Commitments (AMCs), *mauli kauli* (see section 2.3 in the Background report) and other means should be investigated and developed as part of the project. A combination of the above is likely a sustainable option.

4.2.4 Support for sustainable power distribution

Most of the losses for TANESCO and ZECO are losses in the distribution and commercial losses. To come to terms with these issues, Azorom (2011) have proposed an increased focus on Revenue Protection, the establishment of annual reviews of loss

performance, acquisition of new Network analysis software, improved planning and a number of technical issues.

A plan for the reinforcement of the distribution grid is presented in two reports covering most of the connected regions in Tanzania[13]. Supporting this development is a relatively low hanging fruit which will improve both revenues and efficiency. The distribution grid is also important for the development of rural electricity, as connection to the TANESCO grid is important to allow for project developers to leave room for local demand in sizing the off-grid project. The project would thus have two components:

- Improving revenues and efficiency of the distribution network
- Extending and adapting the grid for small-scale energy production.

4.2.5 Demonstration project for electricity production from biogas

Biogas has a great potential for cooking energy, but in larger scale also holds potential for electricity production. The Tanzania Livestock Research Institute manages an institutional farm in Dodoma, Mpwapwa district, with more than one thousand cattle and other livestock species. Biogas from manure can be demonstrated as a resource and form the base for more awareness around Tanzania's huge waste-to-energy potential, and demonstrating the fertilizer value in the Dodoma region in the same way as the biogas-from-sisal power plant has done in Hale, Tanga region.

4.3 Large scale renewable power and transmission

Two issues have been shown hampering the development of large scale projects; the risk of TANESCO not paying for power, and the political risk of not acting on a level playing field as developers. This is addressed in the proposed intervention 4.1.1.

A secondary goal is to reduce the transmission losses of TANESCO. There are several projects underway for transmission improvement in Tanzania at the moment which are relevant since this is a very important area for power quality and load balancing Further initiatives could be co-financed by the donors with AfDB, WB, KfW and environmental loans could potentially be used. Multi-donor projects such as this deserve continued attention, but this is not discussed further here.

4.3.1 Increasing dependability and efficiency of existing hydropower

Using the results of the recently announced sustainability assessment (2013-2014) of new and existing hydropower in Tanzania by the World Bank, NDF[14] and DfID, low hanging fruits found early on in the study could be addressed and corrected, including turbine renewal, improved SCADA systems etc and dredging of silted dams.

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[13] The "*Distribution reinforcement plan in TANESCO regions*" by SWECO and DECON describes the work divided in a predominantly urban part, Lot 34A and mostly rural Lot 34B.

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

4.3.2 Complementary support to developing renewables

Energy provisions do not exist in a vacuum, but interact with e.g. food and water systems. Using a Nexus approach (see section 3.3.3), opportunities to enhance the design and use of new renewable energy, different types of training, infrastructure and equipment can be developed and provided as a complement to contributing to the direct investment.

An important area is to mitigate potentially negative impacts in terms of access to water and issues in health, education and road infrastructure in the communities where projects are developed. Here the aid agencies can facilitate complementary infrastructural development in the local community. While the new power project can act as a substantial local stimulus, involvement of an aid organization can provide support in terms of improving the social and community environment and participation.

With this in mind, a fund can be set up with the ability to support ancillary projects as renewable energy projects commence.

4.3.3 Support to developing geothermal energy

Recent studies have confirmed a potential for geothermal, especially in the Mbeya region. Maintaining transparency to include commercial actors, donors could reduce the main barrier to entry by supporting drilling to better define the technical potential of geothermal sites for commercial actors to subsequently step in. Such test drilling could be funded by a consortium, requiring transparent allocation of concessions after dividing the found potential areas into blocks as is done for mining and other natural resources.

Another, somewhat contradictory option is to develop a specific national authority for geothermal energy development, as has been done in Kenya. Tanzanian NDC does act in this capacity today.

4.3.4 Developing a market for urban waste-to-energy

A tonne of waste could yield up to 3MWh in electricity and heat[15]. Realizing the energy potential of even a very small fraction of the 3000 tonnes of municipal waste generated in Dar es Salaam each day would mean a turnaround in the sustainability of the city, both regarding its energy balance and the business model of waste collection. A scoping study, followed by licensing or developing a PPP around the opportunity could help both planned and unplanned settlements in the city. Related potential lies in wastewater management.

[15] Heat in larger quantities could then be transformed to cooling, e.g. for district cooling schemes.

4.4 Sustainable bioenergy for cooking

Biomass based fuels and energy services will continue to form the base of supply for the majority of Tanzanians, and efforts to increase sustainability of supply of these resources will be instrumental to provisions of basic services in the coming decades. A lack of low cost cooking energy in urban areas has already caused severe problems and will continue to do so if decisive measures are not taken.

4.4.1 Certification of cooking fuel

Sustainable forestry and sustainable charcoal making are areas not traditionally viewed as "energy sector" in terms of government or donor planning, despite dominating the national energy mix. Development of more sustainable forestry and biomass provision should be the primary target of support for renewable energy in Tanzania, at least in the short run, however promising the other sources may be for the future.

The charcoal ban in 2006 showed that there is little use of prohibition of a good unless there are alternatives. A longer term, inclusive process is needed that develops towards a fuels market that identifies, labels and supports national and NGO-based certification schemes for sustainable charcoal and other renewable and efficient fuel types. Finding better ways to make charcoal, and sustainable alternatives to charcoal, is key for a more sustainable Tanzania. A project with this focus could thus bridge good forestry practices and sustainable energy provisions.

4.4.2 Fiscal support to the governing of forest resources and the charcoal trade

Apart from offering more sustainable fuels, working with the upstream supply chain to reduce illicit charcoal making and moving profits from wholesalers towards more sustainable production could reduce the impact on forestry and agriculture of charcoal production. Increasing resources for policy implementation and monitoring can lead to reforms where both environmental responsibilities AND charcoal revenues are distributed more equally between national, district and village governments.

Certification of stoves

The support of testing and labelling of stoves for woody biomass, charcoal, biogas and ethanol respectively would reduce risks for health and safety. Organizations such as TaTEDO have been developing innovations in this area for a long time, and especially for entrepreneurs supplying the urban markets, an efficiency/health/safety labelling scheme could help foster sound products. Certification could also include ensuring a healthy model for the evacuation of smoke for indoor cooking.

4.4.3 Demonstrating a value chain for ethanol for urban cooking

Contrary to earlier research, a recent study carried out by SEI[16]shows that understanding the preferences of the consumer is the key to achieve change and adoption, not using programmes of giving improved stoves for free or forcing the use of improved stoves on the consumer.
This is very relevant to the earlier unsuccessful efforts to introduce ethanol as a fuel in Tanzania which have failed largely because of lack of understanding the demand side.

By demonstrating the entire value chain, potentially using a fraction of the new national ethanol production from sugar cane molasses, through efficient stoves and efficient distribution and use, and using the results to form policy, an important clean, renewable and safe alternative to charcoal can be introduced to urban Tanzania.

4.5 Energy efficient industry and buildings

Buildings and industry use most of the electric power in Tanzania today. To reduce the energy consumption of these large consumer groups is essential to allow for economic growth.

4.5.1 Industrial efficiency study

In Tanzania, much industrial activity and future potential is related to agriculture (See 2.5.3 in the Background report). Improved efficiency in processing would enhance the sector growth potential. Other sectors that involve large scale use of energy are mining and construction, including cement plants, where there may be large potential to achieve mainly private sector efficiency improvements.

An in-depth study to identify which specific areas deserve more attention in reducing power requirements and even contributing to power production is likely to result in attractive options for donor support. The study should seek co-sponsors and partners with organizations as TANESCO, large energy users and industrial associations.

4.5.2 Developing demand for energy efficient buildings

The basis for a "market" for energy efficient buildings is transparency – benchmarking the present situation and understanding the alternatives - something which is lacking today. Understanding monthly power charges for commercial tenants, understanding long term effects from choosing building materials and choosing design are important elements of this market development.

Energy efficiency labelling of equipment and development of accepted indicators are a means to achieve greater awareness and lead to real reduction in energy demand. The potential of regulation and incentives should be assessed. The potential for district

[16] Takama (2011)

cooling systems in larger commercial districts of the big cities should be investigated from the point of view of improved overall efficiency.

4.6 Sustainable and energy efficient transport

It is difficult to see any short term changes regarding the provision of transport fuels in Tanzania, and given the outlook for availability and cost, renewable alternatives would be very slow in uptake without heavy subsidies. Proposed interventions are here thus limited to efforts in light of the increasing supply of natural gas (and biogas) in Tanzania and efforts to increase the understanding of present and potential energy efficiency.

4.6.1 Methane as a transport fuel in Tanzania

In some countries around the world, methane (natural gas and upgraded biogas) enjoys an increasing market share. For certain sectors, this could be an interesting option in Tanzania to reduce emissions, reduce CO2 and soot emissions and to reduce the import of fossil fuels. Presence of methane fuelling stations and natural gas vehicles would also provide an alternative to the existing diesel/gasoline market and in the long term permit the development of production of renewable vehicle fuel from biogas.

4.6.2 Benchmark study of energy efficiency in transport

To understand the potential for different options in the area of increasing energy efficiency in transport, and specifically for making different options available in the market transparent as to their efficiency per person-km and tonne-km, a study can be carried out outlining the different elements of road, rail and waterborne transport in Tanzania. Fuels (regulation, certification), private, public and goods transport should be included, as well as the transport infrastructure. Present average values and best practice should be investigated, and recommendations for improvement should conclude the study.

5 Other research and studies

Adaptive research can be designed to interact with skills and entrepreneurial training; indeed this would not only make the upscaling of technologies more successful but would also provide valuable feedback to researchers.

Analyses of what is needed to scale up the adoption of renewable energy technologies often point to the need for certification procedures and standards in order to enhance credibility and performance of these technologies. This is currently being done in the area of solar PV technology and is an important function for the adaptive research institutions. Researchers should be able to develop standards and procedures for systems design and integration into a variety of offtake scenarios such as the national grid, off-grid and other existing infrastructure. For Tanzania, off-grid solutions will continue to be very important for the rural population for some time to come.

Another important function is to tie efforts to increase the level of awareness regarding energy technology options to those doing the adaptive research. Outreach programmes proposed in the previous section need credible background knowledge, including

information specially designed for specific target groups such as policy-makers, investors and the general public. An adaptive research institution could be tasked with developing relevant background material.

In Tanzania, academic research in energy-related (and other) fields is seldom related to the needs of market actors. It would be important to explore non-academic alternatives to host research efforts, perhaps with connection to the academic institution, in order to make adaptive energy research more responsive to the market, such as the R & D unit of a large corporation. This could for example be done by supporting a market related committee in COSTECH.

Research projects should be developed to support the initiatives described in the previous section.