Technical Assistance to the Rural Energy Agency of Tanzania

Final Report

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Acronyms and abbreviations

AECF	Africa Enterprise Challenge Fund
AfDB	African Development Bank
ASD	African Solar Designs, Ltd.
BoP	Base/Bottom of the Pyramid
CAA	Communications and Accessories, International
CAPEX	Capital Expenditure
DFID	Department for International Development
DIV	Development Innovation Fund
ECA	Economic Consulting Associates
EEP	Energy & Environment Partnership
EnDev	Energizing Development
EWURA	Energy and Water Utilities Regulatory Authority
GMG	Green Mini-Grids
IFC	International Finance Corporation
kWp	Kilowatt peak
kWh	Kilowatt-hour
LCOE	Levelised Cost of Electricity
MEM	Ministry of Energy and Minerals
O&M	Operation and Maintenance
OTC	Over the Counter
OPEX	Operational Expenditure
PAYG	Pay-as-you-Go
PPA	Power Purchase Agreement
RBF	Result Based Financing
REA	Rural Energy Agency
REACT	Renewable Energy Adaption to Climate Technologies
SEFA	Sustainable Energy Fund for Africa (AfDB)
SHS	Solar Home Systems
SSMD	Sustainable Solar Marketing Development Project
SSMP	Sustainable Solar Market Packages
TA	Technical Assistance
TAF	Technical Assistance Facility (Energy Africa)
TEDAP	Tanzania Energy Development and Access Expansion Project
UNF	United Nations Foundation
USAID	United States Agency for International Development
USD	United States Dollar
W	Watt
Wh	Watt-hour

Report Summary

Background. The Rural Energy Agency's Sustainable Solar Market Packages (SSMP) is an on-going Government of Tanzania programme. It promotes the off-grid sector and advances distributed solar for public institutions and households in rural areas of Tanzania. SSMP was conceived to help build commercial markets for off-grid solar by a) bundling regional procurements into commercial packages that are bid out on a competitive basis; b) to introduce innovative subsidies to develop and improve affordability of the private Solar Home System (SHS) market; and c) to introduce a stronger focus on after-sales services and continued marketing. In its second phase, SSMP is now being implemented in 8 districts.

Energy Africa is a UK initiative to accelerate the expansion of the household solar market in Africa, helping achieve universal energy access in the continent by 2030. The core of the Energy Africa initiative is about removing policy and regulatory barriers to market expansion, and to foster better co-ordination among donor support to the sector as a whole.

REA requested DFID and SIDA financial support to expand the performance grant portion of the SSMP 2 programme. DFID commissioned this assignment to review assumptions and likely impacts of the performance grant provided under SSMP 2 given the changes in the solar market, and to assess how much REA could save with alternative or modified approaches.

DFID hired African Solar Designs, Ltd. (ASD) and Economic Consulting Associates (ECA) through the Energy Africa Technical Assistance Facility (TAF) as the TA Providers to support REA through a high level economic analysis of SSMP 2. This analysis will be used to inform and provide recommendations for future approaches that offer value for money and give support to the sector that reflects the ongoing evolution in solar markets.

To achieve the assignment's objectives, the consultant used several approaches to gather the needed information. These included desk-based research (especially of SSMP background documents), direct engagement with key stakeholders during a week-long visit to Dar es Salaam and analysis of the SSMP experiences - as well as the experiences of other market-building solar initiatives (including commercial Pay as You Go (PAYG) development and Results Based Financing (RBF)).

In order to better assess the value for money of the SSMP programme, economic modelling and analysis was conducted to directly compare SSMP performance grants for SHS against RBF experiences (also on-going in Tanzania) and to compare procurement verse service-oriented electricity delivery approaches.

SSMP 1 and 2. Both Phases of the SSMP have not lived up to expectations. SSMP Phase 1 took a long time to reach fruition. As per a 2014 SSMP1 Evaluation, in the period immediately following installation of a number of public facility systems, serious technical deficiencies were observed including including failed batteries, faulty components and poor after-service from contracted companies. As well, development of private sales was assed as *"disappointing, having installed less than 250 SHS of the 8,000-minimum target*".

SSMP 2, currently in its 3rd year of implementation, was intended to be an up-scale of SSMP 1, covering eight districts (Biharamoulo, Bukombe, Sikonge, Chato, Kasulu, Kibondo, Tunduru and Namtumbo). It is being implemented over a five-year period from 2014 – 2019. The first three years have focused on the installation of hardware for both public and private

sectors with the remaining two years focusing on maintenance and after sales services. The work targets 71,000 private SHS, 1,939 public systems and 2,275 street lights. Installation has been awarded to two companies and the project is now being executed.

Lessons learnt from SSMP, RBF and other solar market development programmes.

- **There have been high failure rates of institutional systems under SSMP 1 and 2 programmes.** This is also the case for other institutional PV equipment supply by procurement initiatives.
- **Current after-service arrangements do not work well.** Off-grid solar systems in public facilities fail not because of the technology, but because of after-service arrangements, end user management of energy and spare parts supply.
- **SHS distribution and institutional PV supply are different businesses.** In general, integrators and installers of large off-grid systems do not have the skills or interest in setting up distribution sales networks for household solar products. SSMP has not attracted long-term players to the supply of SHS products.
- **There is little monitoring of installed systems.** Despite the extremely high investment in systems, there is little regular reporting about institutional system performance.
- **SSMP is not meeting its SHS sales targets.** Over both SSMP 1 and 2, less than 15% of the overall SHS targets have been met and long-term sales networks are not being set up. In spite of this, the SHS market has expanded extremely rapidly in Tanzania due to other private sector initiatives, though not uniformly throuout the country. These developments have overtaken the original intention of SSMP.
- **Finance or PAYG is needed for SHS sales to Base of Pyramid (BoP) customers**. Cash-based subsidies have less to offer rural poor than PAYG finance that offers them lower cost models to acquire systems. Consumer financing offered directly by solar equipment providers themselves has proven to be the most effective credit delivery tool.
- **The SSMP performance grant needs to be revised**. The existing SSMP performance grant system for SHS should be revised in future to directly address the affordability issue and provide a real incentive for participating companies. Increasing the performance grant has not, thus far, significantly increased SHS product sales.
- **RBF is showing success in building sustainable markets.** With the RBF incentive model, SHS importers and retailers are incentivised based on market sales. It is an efficient approach of developing the supply chain and increasing the uptake of SHS, provided pre-financing is available to local solar companies. RBF also encourages business innovation and it encourages long term presence in the market.
- **"Lighting Africa Quality Verified Product" standards have been valuable as a tool to benchmark equipment quality across the market.** Though the quality benchmark has in no way reduced the prevalence of low-cost substandard products in the market, it has promoted the credibility of off-grid products and confidence among consumers in using the solar products. It has also enabled programmes providing performance grants to qualify products.

Economic analysis. A comparison has been made of SHS and institutional cost models. The SHS comparison assessed the existing SSMP performance grants vis-à-vis the RBF model in use in the Lake Victoria Region of Tanzania. The institutional comparison assessed the existing procurement model against a proposed service model. The key takeaways from this economic modelling and analysis are below.

*Household solar systems***.** RBF incentives provide a far greater and sustained impact than cash performance grants.

- SSMP grants have a much lower impact in terms of overall numbers of systems sold per dollar of grant provided.
- In the long term, SSMP performance grants are expensive for households. This is because, as managed, SSMP monopoly grants do not encourage price competition and systems often sell for more than similar RBF-supported systems even with the significant subsidy.
- The SSMP scheme fails to create local competition that will encourage innovation, customer service, community involvement and capacity building in the target districts.
- A disadvantage for RBF is that the supplier is supposed to cover the full up-front cost and cover the financing costs before the subsidy is paid out. It is also relatively expensive to implement and verify sales (though performance grants also have verification costs).

Institutional systems. Procurement models are more expensive than service models in the long term.

- For institutional systems, while the full maintenance scenario lowers the Levelized Cost of Electricity (LCOE) by about 50%, it is only about 10% higher than the low maintenance scenario over the period of five years.
- Failure to link payment to performance makes contractors less keen on systems Operations and Maintenance (O&M) which lowers operational sustainability of the system.

Recommendations. Three potential ways forward may improve SSMP performance or re-design. These recommendations suggest replacing standard procurement contracts and simple performance grants with models that are more results-oriented and likely to deliver a better value for money to REA, SIDA and DFID.

- **Replace the performance grants for private solar home systems with a results based financing system.** An RBF approach a) ensures that distribution channels are set up and maintained; b) provides a more robust verification system; and c) encourages a more competitive approach with larger numbers of players.
- **Use a service-driven micro-grid approach instead of a procurement approach to supply solar power in institutions.** A new approach would a) provide site-wide 240 AC power which is readily connectable to TANESCO power when the grid arrives; and b) ensure that delivered power is paid for as an on-going service (as opposed to delivered equipment) and c) ensure that O&M is included as an on-going part of the service.
- **Test new approaches as part of a competitive, locally-driven rehabilitation exercise.** This would a) repair poorly functioning systems in pre-identified districts; b) build local capacity to manage systems - especially at the local government level; and c) encourage involvement and responsibility of local government and communities in the rehabilitation and management of systems.

In addition to exploring the above three recommendations, we recommend that follow up activities provide two levels of implementation support. First, a tendering and delivery approach (as currently managed by REA) provides the equipment and the base line service arrangements. Second, a regional local support initiative should be developed which provides local districts with the resources to directly follow-up, support and monitor the after-service activities of contracted SSMP agents. This second activity would take over from the REA-managed activities and enable local districts to build skills in the management of off-grid electrification.

SECTION 1
Introduction

1.1 Background

The Rural Energy Agency (REA) of Tanzania is an autonomous body founded in 2007 under the Ministry of Energy and Minerals (MEM) of the United Republic of Tanzania. Its main role is to promote and facilitate improved access to modern energy services in rural areas of Mainland Tanzania.

Energy Africa is a UK initiative to accelerate the expansion of the household solar market in Africa, helping bring universal energy access by 2030. The core focus of the Energy Africa initiative is about removing policy and regulatory barriers to market expansion, and better co-ordinate donor support to the sector as a whole.

DFID supports a range of energy access activities in Tanzania including the Africa Enterprise Challenge Fund (AECF) Renewable Energy and Adaption to Climate Technologies (REACT), the Energy & Environment Partnership (EEP) programme, the Green Mini-Grids (GMG) programme currently being implemented by REA, and the Energizing Development (EnDev) Tanzania programme for Results-Based Financing (RBF) in Lake and Central Zones.

REA's Sustainable Solar Market Packages (SSMP) constitute the Government of Tanzania's ongoing programme to advance distributed solar (for public institutions and households) in rural areas of Tanzania and promote the off-grid sector.

- SSMP1 (Package 1) bundled the procurement of government-funded PV installations for public facilities with requirements for commercial sale of solar home systems (SHS) to households. The package was awarded to one company through competitive bidding. The contract for the first package (SSMP1) was signed in January 2010 with a private company. SSMP 1 had a household target of about 8,000.
- SSMP2 (Package 2) consisted of 8 lots with a total household target of about 70,000, which aims to provide electricity through stand-alone solar systems in 8 districts of Tunduru, Namtumbo, Bukombe, Sikonge, Kasulu, Kibondo, Chato and Bihara. This was awarded in 2014: 2 lots were awarded to a local company and 6 lots to a joint venture of 2 Chinese companies.

An evaluation of SSMP1 commissioned by the World Bank in 2014 identified challenges and alternative possible future directions for REA support towards the off-grid solar market. For example, new business models have emerged in Tanzania and other African countries (e.g. fee for service, rent-to-own, or Pay-As-You-Go models). The successes of these can be attributed to the availability of new, compact, highly efficient solar pico systems and appliances, and the increasing availability of mobile phone financial transactions (mobile money). This ongoing market evolution and cost reduction has implications for the incentive programmes offered by REA, and SSMP in particular. Moreover, it brings into question the overall original concept of bundling solar home systems and public procurements as envisioned by the creators of SSMP.

REA has specifically requested DFID and SIDA support to expand the performance grant portion of the SSMP 2 programme. DFID commissioned this assignment to review assumptions and likely impacts of the performance grant provided under SSMP2 given the

changes in the solar market, and to assess how much REA could save (or how many more households or regions could be reached) with alternative or modified approaches.

DFID hired African Solar Designs, Ltd. (ASD) and Economic Consulting Associates (ECA) through the Energy Africa Technical Assistance Facility (TAF) as the TA Providers to support REA through a high level economic analysis of SSMP 2. This analysis will be used to inform and provide recommendations for future approaches that offer value for money and to give support to the sector that reflects the ongoing evolution in solar markets.

1.2 Objectives of the Assignment

Under this assignment, the Technical Assistant Providers (TA Provider), African Solar Designs, Ltd. (ASD) and Economic Consulting Associates (ECA), are required to meet the following objectives:

- Review the Rural Energy Agency's (REA) proposal for DFID and SIDA to support the Sustainable Solar Market Package 2 (SSMP2) programme and provide recommendations on how REA could achieve its desired results at a lower cost. The outcome will be more rapid expansion in the Tanzanian off-grid solar market, through more efficient and effective deployment of public funds.

- As per the Inception Report, the following activities were completed:
  - **Literature review** of all documentation related to SSMP and relevant information on the off-grid solar sector in Tanzania;
  - **Consultation** with key partners in the Tanzanian government, notably REA, but also the Ministry of Energy and Minerals (MEM) and the Energy and Water Utilities Regulatory Authority (EWURA), key off-grid solar providers including those implementing SSMP2, and key international development agencies working in this sector (notably SNV, International Finance Corporation (IFC) and World Bank);
  - **Analysis** of the main technical conditions and economic assumptions of SSMP, its funding needs, effectiveness and economic efficiency in the context of the evolving off-grid solar market in Tanzania (including energy service levels, product prices, availability of consumer credit and the targeting of SSMP). This should draw on progress, results and lessons from the EnDev Results-Based Financing (RBF) for solar programmes to avoid duplication of effort; and
  - **Synthesis** to produce clear conclusions and recommendations to guide REA and its partners.

1.3 Project Approach

ASD was contracted to undertake the following tasks as provided in the TOR (see Annex 1):

1. Inception report and background document review
2. Completion of consultation and literature review
3. Submission of the draft report
4. Presentation and discussion of outputs with REA, DFID and SIDA
5. Submission of the final report

1.3.1 Methodology

To achieve the assignment's key objectives, the consultant used a number of approaches to gather the needed information. These approaches included:

- A thorough desk based research of technical data, business models, government policies, regulations, development agencies programs and other background documents. These documents included but were not limited to:
  - SSMP 1 and SSMP 2 documents
  - EWURA statistical data and energy regulations

    - MEM energy policies and strategies
    - SNV programme documents
    - Other documents (See Annex 4)
- Direct engagement with key stakeholders through in-person meetings, phone and skype calls and emails. These engagements involved contextual settings and key informant interviews. Mark Hankins, the lead TA provider, met with representatives from the following public and private institutions in Dar and over skype.
    - Ministry of Energy and Minerals
    - Rural Energy Agency
    - International Finance Corporation (IFC)
    - Energy and Water Utilities Regulatory Authority
    - SNV
    - DFID
    - IIED
    - IMED
    - Energy4Impact
    - World Bank
    - Tatedo
    - USAID

  A full list of stakeholders can be found in Annex 3.

1.4 The Tanzanian Off-grid Solar Market

Tanzania has the third most active off-grid market in Africa (Kenya being the first and Ethiopia being the second)[1]. Solar markets have been growing by more than 10% annually in the last decade. This can be attributed to strong economic growth leading to demand in un-electrified rural areas, government policies, support from donor and development agencies, new innovative business models, technological advancement and availability of affordable financing options for consumers especially those at the BoP. The grid is also expanding rapidly through government-led initiatives but solar products are duly recognized as part of rural electrification strategies.

Growth in the agriculture sector is also playing a key role in increasing rural spending power. Solar companies such as Mobisol, Off-grid Electric and others are beginning to overcome some of the major barriers such as the lack of sales and installation infrastructure in rural areas. Moreover, national and NGO projects are stimulating demand for large institutional systems.

Solar equipment such as PV modules, batteries, inverters, charge regulators and appliances are widely available and accessible in Tanzania. The value chain has reached many rural areas where there is strong demand for solar products.

However, challenges are still faced by off-grid solar PV companies, especially those targeting rural households. In particular, in the very competitive commercial environment, some of the companies offering Pay-As-You-Go (PAYG) solutions have had trouble scaling up their operations and transitioning from solar equipment suppliers to rural credit providers[2]. The cash-based over-the-counter market is still the most important segment of the household PV market, and the difficulty of ensuring that consumers get quality products and services continues to be a challenge for over-the-counter players.

[1] Lighting Africa, Off-Grid Solar Market Trends Report, 2016

[2] "Scaling up" operations in rural areas requires large cash outlays to finance consumer purchases and leaves companies at risk, especially during droughts, political crisis or when competition reduces margins.

1.4.1 Organisational players in the Tanzanian off-grid market

The off-grid market development in Tanzania benefits from a number of key stakeholders who are involved, in one way or another, through policies, regulation strategies, financing and technical assistance. Below is a brief description of such institutions and organizations working in the Tanzanian off-grid market:

- **Ministry of Energy and Minerals (MEM**) is the government's policy-making body which is tasked with implementing energy-related policies (including SE4All) to facilitate the development of small power producers and renewable energy technologies. Renewable energy plans and strategies are embedded in specific energy programmes (e.g. SE4All).
- **Rural Energy Agency (REA)** is concerned with the development of off-grid projects and the administration and awarding of rural electrification subsidies and grants. Projects seeking to supply power to under-electrified communities in rural areas deal directly with REA. REA was set up to address the special requirements of rural consumers through programmatic grant and subsidy support from multi-development agencies and philanthropic foundations. REA has played a key role in implementing solar-related programs at the rural level including the Lighting Rural Tanzania Programme, SSMP 1 and 2, etc.
- **Energy and Water Utilities Regulatory Authority (EWURA)** is a government-owned parastatal that is responsible for negotiations and approval of Power Purchase Agreements (PPAs). The body also sets the electricity tariffs (including the feed-in-tariff) in Tanzania.
- **Development partners.** International multi-lateral organizations have played a critical role in promoting development of solar products in Tanzania. Some of the major organisations include:
    - The **World Bank** was actively involved in the REA Sustainable Solar Market Packages (SSMP). It also supported the Lighting Rural Tanzania Programme that was being implemented by REA. The WB continues to provide support to inform technical assistance and funding to different government departments and agencies, including REA's work in off-grid under Tanzania Rural Electrification Expansion Project. However, it opted not to support the second phase of SSMP.
    - The **International Finance Corporation (IFC)** is actively involved in energy access in Tanzania through Lighting Tanzania (which offers market development services to the household market) and through its support to mini-grid developments. The Lighting Tanzania Program, a joint initiative of the World Bank/IFC is supporting the development of the off-grid market through the application of the Lighting Global Quality Standards. The programme also includes initiatives in consumer education, business intelligence, and business and supply chain development. IFC is also implementing a Green Mini Grid (GMG) support programme under SREP.
    - The UK's **Department for International Development (DFID)** is supporting the Energizing Development Tanzania for Results Based Financing (RBF) for solar home systems through SNV Tanzania. Other energy access programs implemented by DFID in Tanzania include the AECF Renewable Energy and Adaptation to Climate Technologies (REACT) challenge fund, the Energy & Environment Partnership (EEP) and the Green Mini-grids (GMG) programme.
    - **United States Agency for International Development (USAID)** has a number of programs, all part of the broader Power Africa initiative, including the Off-grid Challenge Fund and the Development Innovation Venture (DIV).

- **SIDA** is a major supporter of the Tanzania energy sector. It is working with DFID in the implementation of the Green Mini-Grids programme with REA. The agency is also involved in PFAN Initiative on Clean Energy Financing (SPICEF) and Demo Environment Funding facility.
- The **African Development Bank** (AfDB) through the Sustainable Energy Fund for Africa (SEFA) is implementing a number of energy access programmes in Tanzania with specific considerations of mini-grids and solar off-grid products. The fund is channelled through AfDB by the governments of Denmark, the UK, the US and Italy.
- **United Nations Foundation (UNF)** worked with African Solar Designs, Ltd. to understand the energy needs with regards to health care services provided to women and children. From the recommendations provided, UNF is implementing stand-alone and micro-grid systems in different health facilities in Uganda. It is anticipated that they will develop activities in Tanzania in the near future.
- **United Nations Development Programme (UNDP)** is working with the Ministry of Energy and Minerals to develop and implement a new programme to achieve Tanzania's Sustainable Energy for All (SE4All) targets. This support has included development of an SE4All Action Agenda and an Investment Prospectus in 2016.

- **Non-Governmental Organisations.** NGO-led off-grid programmes are being implemented across the country with support from the government and the donor community.
  - **SNV** is implementing an RBF programme supported by DFID.
  - **Hivos** is focused on biogas digesters for households in rural Tanzania. They are also working with the International Institute for Environment and Development (IIED) in the Energy Change Lab Tanzania, with a focus on developing entrepreneurial capacity for off-grid renewable energy solutions in rural Tanzania and creating opportunities for livelihoods from the electricity provided. The programme is being supported by Charles Stewart Mott Foundation from Netherlands.
  - **Energy4Impact** is engaged in mini-grid business development working with IFC under SREP, particularly in the development of productive use applications as anchor customers in mini-grids.
  - The **Tanzania Traditional Energy Development Organisation (TaTEDO)** has been an active player in off-grid biomass and small-scale electrification projects throughout Tanzania for many years.

- **Private Companies** are actively involved in solar off-grid market in manufacturing, importing and distributing off-grid solar products in rural communities. Many companies have adopted innovative business models and financing schemes to provide power to the BoP consumer segment.

- **Consultants/Research Institutions** offer knowledge services to support off-grid market policies and regulations. Active organisations in this space include International Institute for Environment and Development (IIED), Eco Associates Limited and the Institute of Management and Entrepreneurship Development.

SECTION 2

Off-Grid Energy Access in Tanzania

Tanzania has a population of about 53.5 million[3]. A 2016 REA report[4] indicates that 16.9% of Tanzania's rural population has access to electricity (compared to 65.3% of urban households). As a share of the total number of installations, solar power systems represent 24.7% by all households with electric power, with of majority of SHS installations located in rural areas[5]. The Government of Tanzania and donor partners have taken steps to further stimulate the development of solar markets in off-grid regions.

This section provides a background to the development of household and institutional solar market sectors. Section 2.1 discusses institutional markets and Section 2.2 discusses household systems.

2.1 Institutional Solar Systems

Institutional use of solar energy began in the 1980's and earlier. Even when the cost of solar equipment was extremely high, remote telecom sites found that solar could more reliably power expensive equipment at lower costs than diesel generators. Remote signalling equipment and security systems also began to adopt solar PV in many rural parts of East Africa.

In the late 80's and 90's, governments and donor partners began to use solar to power institutions in remote areas. Schools, clinics, police posts, research centres, border posts and ranger posts in game reserves built a growing market for solar even before solar home systems became common.

With falling costs and improving technology, the use of solar increased in public institutions, often with the support of multilateral donor partners. The World Health Organisation supported the development of solar powered vaccine fridges for the cold chain in the '80's and 90's. In this period, solar fridges became relatively common in rural clinics. Shortly afterward, the World Bank and governments began to support off-grid electrification with procurement-based purchase of solar systems in loan investments. NGOs and relief agencies also became important customers of solar companies, as they bought solar systems for the remote areas where they work. Solar pumps also became a small but important part of rural water supply.

Procurements of solar for institutions were an extremely important part of early solar PV markets. However, institutional use of solar suffered from problems with after-service. As explained in the sections below, the new technology did not have infrastructure in place to service or provide spare parts for equipment. Batteries failed and could not be replaced by local authorities. End-users did not know how to manage the limited output of solar PV systems.

[3] ODI, Accelerating Access to Electricity in Africa with off-grid Solar, 2016
[4] Energy Access Situation Report, 2016, Tanzania Mainland (REA, http://rea.go.tz/Resources/E-Library/tabid/132/Default.aspx)
[5] http://rea.go.tz/Resources/E-Library/tabid/132/Default.aspx

Programmes like the Sustainable Solar Market Packages (see Section 2.3 below) were introduced by the World Bank largely to overcome the early Operations and Maintenance (O&M), servicing and spare part issues that rural end-users and buyers of institutional solar systems faced.

2.2 Solar Home Systems and Pico Solar Systems

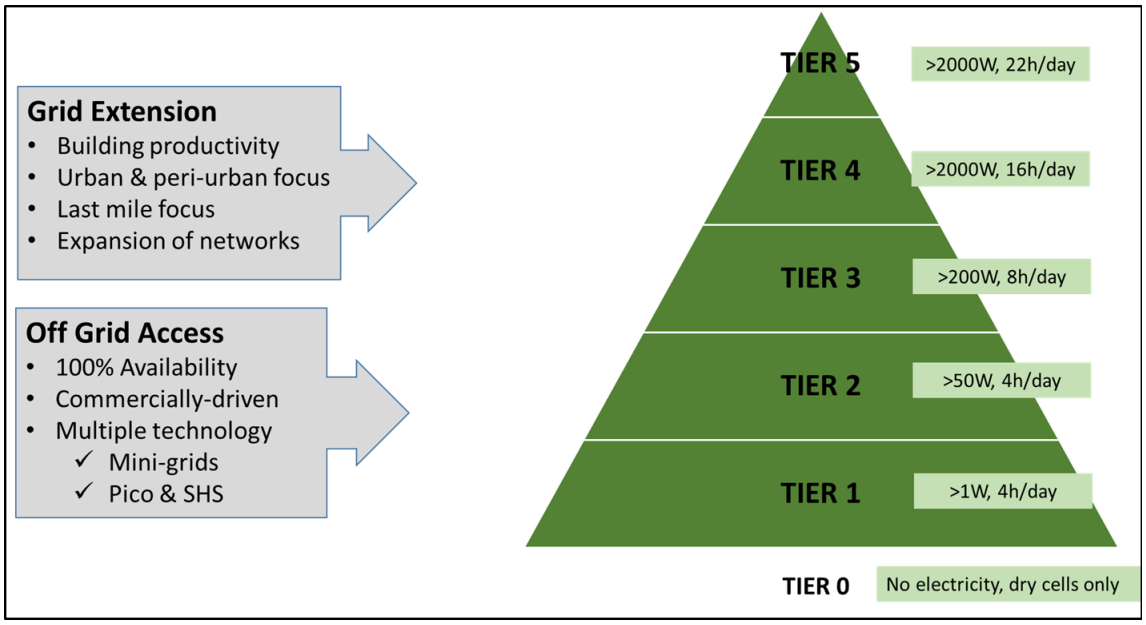
Since the 1990s, off-grid solar products have been transforming entry-level electricity access for millions in sub-Saharan Africa. The Tanzanian market is one of the strongest in the region. It has closely followed the rapid development of the Kenya solar market. Pioneer efforts by local companies (and by the SIDA MEM Solar PV Market project in 2002-2005) built supply chains throughout the country.

2.2.1 Market Evolution

The growth of solar markets in East Africa can be broken into four stages as shown below. These stages are useful as their transitions led to price changes and increases in competition in rural markets. As explained below, SSMP was designed at the end of the second stage and did not anticipate the rapid market developments that took place afterwards.

- **Stage 1: Pioneer stage (1985-95).** Early efforts to design off-grid PV systems were stimulated by wealthy customer demand for television and lighting. Pioneer entrepreneurs quickly understood the technology and wider potential for off-grid solar home systems, especially in cash crop areas.
- **Stage 2: Development of Demand and Distribution Chains (1995-2005).** Market-based distribution systems evolved as competing importers built supply chains and sourced products. The private sector drove sales of PV systems for private consumers and institutions. Consumer awareness (and hence demand) increased rapidly.
- **Stage 3: Focused Product and Market Development (2005-2010).** Development of lower cost pico-systems was made possible by inexpensive solar modules, lithium ion batteries and high-efficiency LED lights - and a better understanding of the market. IFC's Lighting Africa created a platform for pico-solar companies to grow their markets.
- **Stage 4: Introduction of Data-Driven Business Models (2010-present).** Mobile money and cell phone technology enabled companies to introduce financed PAYG systems. This opened up a large market segment and simultaneously attracted social entrepreneurs and significant investment into the off-grid sector.

Figure 1: Tiers of Consumer Energy Needs and Best Energy Solution



2.2.2 Main Drivers of Market Development in Tanzania

Rural off-grid demographics, expanding telecommunications network coverage, and the prevalence of mobile money has provided fertile ground for the most recent stages of market growth. Start-ups such as Mobisol, Off-Grid Electric, Ensol and others have invested in distribution, quality, marketing and, mostly, in consumer finance. Historically, demand has been driven by a number of factors.

- **Off-grid electricity appetite.** Solar products provide entry level power to Tier 1 and Tier 2 consumers (as shown in Figure 1). Pico and SHS products found a large niche in the Tanzanian market because rural communities have a strong demand for lighting, mobile phones, and television and radio --- and off-grid solar is an easy way to power these services in homes and small businesses. Though many consumers would prefer grid power, there are significant limitations to the geographical and economic spread of Tanesco to all areas.
- **Innovative business models have emerged rapidly in the last 10 years**. Private sector players incorporate mobile money and cellular data changing the way people pay for and use solar. These updated micro-credit options provide consumers with modular approaches to pay for power or system components when they can afford it. MKOPA, Off-grid Electric, Mobisol and Azuri Technologies, just to name a few, have taken keen interest in the Tanzanian market which can be credited to the PAYG business model. Distribution models have also been advanced by a number of cash based solar companies who are now using community based models, and in some cases gender specific models targeting certain demographic profiles.
- **Technological innovations.** Lower cost and higher quality products have become available. Efficient LEDs, low cost PV modules, lithium ion batteries and integrated circuit controls have redefined the market. That most pico-solar products offer mobile phone charging capacity makes products that much more appealing for end users.
- **Mobile money.** The technology was first implemented in Kenya but spread rapidly to other countries in East Africa. In 2016, Tanzania recently overtook Kenya as the leading place for mobile money with over 45% of the adult population using mobile money[6] and 47% of GDP transferred using the system[7]. Tanzanian rural

[6] http://www.tanzaniainvest.com/mobile-money
[7] http://allafrica.com/stories/201704170135.html

communities have leveraged the technology to pay for solar products through the PAYG model.

- **Government policies.** The Government of Tanzania has been supportive of the off-grid solar markets. It recognises small-scale solar PV as part of a 'package' of solutions for electrifying off-grid and under-electrified consumers. The government prospectus highlights the potential of electrifying households through SHS for those that are 10km away from the national grid. However, off-grid markets have, at times, experienced shifting regulations such as the un-expected removal and re-imposition of VAT and duties on solar products.
- **Development agencies / Donor support.** This has been provided mainly through two approaches; technical assistance in the form of setting up quality standards, capacity building and market campaigns; funding through grants, equity, concessional loans, guarantees and combination of equity and loans. In Tanzania, the SIDA-MEM Solar project in the early '00 played an instrumental role in promoting solar and in connecting solar importers with retailers in each of 42 districts in the country.
- **Increasing market awareness.** Growing awareness of solar has dramatically changed consumer perceptions and increased their willingness to pay for products.

2.2.3 Business and Financing Models

Efforts have been made by consumer players, donors and government to make entry level PV systems available to the BoP consumer segments. This is done through initiatives that address obstacles around micro-credit access and high cost of product sales in remote rural areas. Furthermore, other programs are being carried out to distribute quality solar products under the Lighting Africa program. A number of models have emerged to serve the off-grid SHS and pico-solar market.

Over-the-counter (OTC) model

Cash-based sales by solar integrators and general retailers is by far the most prominent solar distribution model in Tanzania. OTC sales are well over 70% of the market volume and have been growing for over a decade.

- **Integrators** focus on larger systems and SHS. Their target market includes NGOs, professional clients, project-based work and upmarket consumers. They maintain stocks of modules, batteries, inverters or other components (i.e. lanterns) which they sell over-the-counter. However, their core business is participating in tenders or professional jobs for larger clients. Some integrators sell to distributors since there is a well-developed downstream market for equipment.
- **General retailers** sell household PV components as part of a wider product range that is focused on consumer electronics and/or household appliances. They sell solar alongside mobile phones, laptops, televisions, electric appliances, and light bulbs. Generalist retailers are the major drivers for small-scale and pico solar PV, moving thousands of units per month. Product quality varies greatly. Products range from high quality Lighting Africa-approved kits to lower quality short lived kits (the majority). They do not tend to offer credit and they do not tend to provide after-service support for their products (including warranties). Very few offer operations and maintenance services.

Pay-As-You-Go and Energy-As-a-Service

- **Pay-As-You-Go (PAYG)** business models were introduced in rural markets to sell solar products to households closer to the BoP, see Figure 1 above). PAYG solar business models enable low-income groups to make small payments towards acquiring solar systems and electrical devices that would ordinarily be out of their reach. In Tanzania, the birth and development of PAYG model began over 10 years ago. It was brought about by (1) availability of international investments, (2) mobile

technologies, (3) lower costs, (4) improved quality of solar products, and (5) increasing awareness of and willingness to pay for solar.

More than half of PAYG companies in Tanzania offer Rent-to-Own transactions where the end users ultimately own the assets after completing all monthly payment instalments. Companies using this model include M-KOPA (in Kenya), and Mobisol. The consumer is first required to make a deposit or down payment then pay off the remaining outstanding balance over time through a prepaid deal. Off-Grid Electric rebranded as Zola in 2016 with a rent-to-own model[8].

- A related business model made possible by advancements in digital finance is **Energy-as-a-Service.** Used by companies including Lumos in Nigeria[9], it requires customers to pay an ongoing usage fee to the energy company in exchange for prepaid days or weeks of usage without the option of ultimately owning the solar product. This model removes most of the financing and technology risk from end-customers as compared to a Rent-to-Own model. Companies deploying Energy-as-a-Service are typically focused on maximizing concentration of subscribers in targeted geographic regions. They spend a relatively low amount of time and resources assessing payment risks before approving a new customer. However, consumers in Tanzania have displayed a preference for rent-to-own models.

2.3 Improving Off-grid Solar Markets

This section provides background on several programmes which were designed to improve the overall performance of off-grid products in Tanzania. These strategic initiatives were designed to increase rural energy access and the participation of the private sector in the market. This section provides a historical account of these initiatives and information about their viability and effectiveness.

- Lighting Africa/Lighting Tanzania (Section 2.3.1)
- Sustainable Solar Market Package (SSMP) initiative (2.3.2)
- Result Based Financing (RBF) (2.3.3)

2.3.1 Lighting Africa and Lighting Tanzania

Lighting Africa was set up to increase energy access and help build solar household markets in Africa in 2006.

> *"The joint IFC-World Bank Lighting Africa programme has set itself the ambitious and important target of enabling more than 250 million people across sub-Saharan Africa currently living without electricity to gain access to clean, affordable, quality-verified off-grid lighting and energy products by 2030."*

The approach of Lighting Africa Tanzania (and in Africa) is to develop the commercial market for quality-verified solar products among households in rural communities. Lighting Africa works in 11 African countries on a) market intelligence, b) quality assurance, c) access to finance, d) consumer education, and e) business development support. The Tanzania programme has included a policy environment assessment in 2010 and market research in 2013 (which is still on-going). These studies provided insights into consumer behaviour, supply chain channels, the policy framework, and informed the design of the program.

The following activities have taken place in Tanzania since 2016:

[8] They had previously provided an energy-as-a-service model. See http://allafrica.com/stories/201608020755.html
[9] http://www.lumos-global.com/about/

- Tanzania Bureau of Standards adopted Lighting Africa Quality Assurance standards and set up a testing lab for solar products in the country. This has required every solar product manufactured, imported and distributed in the market to meet certain minimum standards.
- IFC Lighting Africa programme provides access to financing to off-grid companies that are selling quality verified solar products.
- It leverages technical assistance and financing from donors and development agencies to distributors, retailers and NGOs active in the solar sector.
- Consumer education is being carried out to sensitise the public about solar PV and to promote good quality solar products that meet international standards.
- An updated business development & market intelligence IPSOS report is due in August-September 2017.
- IFC is working with government agencies including the Tanzania Bureau of Standards and MEM to develop a checklist of products that have met the quality standards.

Lighting Africa now works closely with the Global Off-Grid Lighting Association (GOGLA). Solar initiatives in Tanzania can make use of the programme's list of approved products, its checklist for solar projects and the important linkages it has built in the country.

See https://www.lightingafrica.org/country/tanzania/ for more information about Lighting Africa in Tanzania.

2.3.2 Sustainable Solar Market Package

Sustainable Solar Marketing Development Project (SSMD) was initiated in 2008 as part of the efforts from the Government of Tanzania to increase access to modern energy through off-grid approaches. Under the concept, a successful private sector company would receive a contract to install and maintain several lots of institutional systems and would receive performance grants to supply a targeted number of solar home systems **in a specific region**.

The project framework includes a contracting mechanism that provides for the supply, installation and O&M of institutional and household PV systems in a defined geographic area. Based on a World Bank project of the same name in the Philippines, SSMP is broken down into two components:

i. Sustainable Solar Market Packages (SSMP) for remote dispersed population consisting of bundled **public institution systems** in schools, clinics, police posts, street lights, etc.
ii. A commercial solar PV programme aimed at developing **solar home systems (SHS)** market.

REA's SSMP has been implemented in two phases, SSMP1 and SSMP 2.

Sustainable Solar Market Package I

In 2007, the Government of Tanzania received credit financing for the SSMP1 from the World Bank under the Tanzania Energy Development and Access Expansion Project (TEDAP)[10]. REA led the bidding process calling for procuring, installing, commissioning, providing maintenance services and spares, and conducting training of end users and off-takers for public facility PVs and streetlights in eight districts in Tanzania.

[10] REA, Invitation for bids (IFB) Tanzania Energy Development and Access Expansion Project (TEDAP), 2008

The length of the SSMP1 contract was set for 5 years. SSMP1 drew from global best practice lessons and sought to overcome transaction costs associated with doing business in remote areas, using the following key features[11]:

- Bundling of wards/villages into commercial packages that are bid out on a competitive basis. Each SSMP package contains standard bid designs for community facilities (village halls, health facilities, schools, public light, water pumping).
- Innovative subsidies to develop the private market and to buy down the capital cost and improve affordability for solar home systems.
- Strong focus on after-sales services and continued marketing (including contractual obligations and performance securities).

The first SSMP1 contract was signed in January 2010 with the German company Communications and Accessories, International (CAA)[12]. The project was initiated in the Rukwa region, Sumbawanga District. The project was designed to benefit 80 villages with electricity services to 400 public facilities including schools, dormitories, dispensaries, health clinics, police posts, and street lighting. As well, the company was to supply a targeted 8,000 private households (and other private customers) and receive performance grants for each installed system[13].

As per the Rural Energy Act of 2005, REA is not allowed to engage in operation and maintenance of systems. REA finances the procurement and installation of systems. The contract awarded to CAA included an additional 6-year after service maintenance contract that defines in detail maintenance intervals, number of visits, types of procedures to be carried out and spares to be kept on site.

After the contract period with the supplier is over, operation and maintenance of installed systems in public institutions is the responsibility of the district council. Though in principle local authorities are supposed to cover O&M costs and to replace failed batteries, the exact financial responsibilities of the local authority are not defined.

Unfortunately, actual development of the programme was very slow. As per TEDAP's SSMP1 Evaluation in 2014, nearly four years later, the public facilities were largely completed but with technical deficiencies. The private sales side was noted to be *"disappointing, having installed less than 250 SHS of the 8,000-minimum target*"[14]. See Section 3.1.1 for a further discussion of the issues identified.

Sustainable Solar Market Package II

SSMP 2 is an up-scale of SSMP 1[15]. SSMP 2 targets provision of solar PV systems to public institutions in 452 off-grid villages. As with SSMP 1, it bundles together coverage of public institutions and provision of electricity to household SHSs.

The project covers eight districts: Biharamoulo, Bukombe, Sikonge, Chato, Kasulu, Kibondo, Tunduru and Namtumbo. Like SSMP1, SSMP2 is being implemented over a five-year period from 2014 – 2019. The first three years will focus on the installation of hardware for both public and private sectors with the remaining two years focusing on maintenance and after

[11] GIZ, Target Market Analysis – Tanzania's Solar Energy Market, 2009
[12] TEDAP's Sustainable Solar Market Package (SSMP) Approach: An Evaluation of the Experience with SSMP1 and Suggestions Going Forward, 2014
[13] AHK, Target Market Study Tanzania – Solar PV & Wind Power, 2013
[14] TEDAP's Sustainable Solar Market Package (SSMP) Approach: An Evaluation of the Experience with SSMP1 and Suggestions Going Forward, 2014
[15] Significantly, the World Bank declined to finance SSMP 2.

sales services[16]. The work targets 71,000 private SHS, 1,939 public systems and 2,275 street lights. Installation was awarded to two companies.

- SINOTEC Co. Ltd was awarded six lots: Tunduru, Namtumbo, Sikonge, Kasulu, Kibondo and Chato.
- Rex Investment Ltd. was awarded two lots: Bukombe and Biharamulo.

Since SSMP1, the market has changed and grown significantly. With these changes in mind and learning from SSMP1, SSMP2 was designed to accommodate developments in the solar market. In addition, the Government raised the level of the performance grants per watt to US$ 5.0/Wp for systems over 5Wp in size. This is a major change from SSMP1 where the performance grant provided was US$2.5/Wp for SHS up to 30 Wp and US$1.5/Wp up to 100 Wp. The idea behind the raise was that households in rural areas are scattered and hard to reach, and that a larger performance grant was required to stimulate the market.

Table 1 below shows the system size and specifications required for SSMP 2 institutional solar systems.

Table 1: SSMP 2 Institution System Size and Specifications

Syst. No.	Item	Description	Design Load incl. load growth (Wh/day)	Min. PV Array (Wp)	Min. Battery (Ah@C_{20} x@V)	Max. battery (DoD)	Battery fuse (A)	Min. Charge Controller (A)	Min. Inverter (W)
1	E-Admin	School Administration	1,200	340	255*24v	70%	60	18	1000
2	E-Class-LED	Classroom	1,280	340	264*24v	70%	33	19	535
3	E-Lab-LED	Schoolroom	1,570	430	330*24v	70%	63	23	1000
4	E-Lantern	Schools laboratory	1,100	300	200*12v	70%	33	33	NA
5	E-Dorm/ H- Ward	School lantern and desk light charging	680	222	170*24v	70%	26	12	400
6	H-HC	Health Centre	2,390	650	500*24v	70%	96	35	1,500
7	H-Disp	Dispensary	890	266	200*24v	70%	63	14	1,000
8	H-VAC	Vaccine refrigerator	1,000	280	290*24v	85%	15	15	NA
9	H-OT-LED	Hospital operating theatre	1,230	340	258*24v	70%	41	18	680
10	PP-LED	Police Post	795	219	167*24v	70%	13	12	200
11	SL-LED	Street light	104	33	56*12v	60%	4	4	NA
12	SHS-M	Staff residential	730	200	280*12v	80%	50	22	40

(Source: REA, 2017)

As was the case with SSMP 1, ownership of installed systems in SSMP2 was transferred by REA to the relevant district councils and the public institutions. This transfer of system ownership necessarily involved transfer of operation and maintenance responsibilities after the private O&M contracts were complete.

Unfortunately, the progress seen with SSMP2 echoes that of SSMP1; progress has been slow. Progress has yet to reach 50% of the targets for the public systems and, despite the increased performance grants, results are even more disappointing for private household systems. An analysis of the specific issues is discussed in Section 3.1.1.

[16] REX, REA Project, Tanzania – Africa Energy Forum Presentation, 2016

2.3.3 Results Based Financing

Overview

Results Based Financing (RBF) was introduced to the solar sector in Tanzania under EnDev, with support from DFID. RBF was specifically designed to address previous market failures --- and in particular the tendency of donors to support "good ideas" rather than "concrete results"[17]. The RBF initiative answers a need for new financing schemes that encourage new clean energy business solutions and that rewards outputs.

The RBF model awards achievement of outputs as opposed to activities conducted. In the RBF model, the finance institution conditions its payment to a service provider on desired outcomes. All risks are therefore removed from the financial partner and placed on the service provider.

This is beneficial to the service provider as they are given the freedom to attain results in an achievable manner. This symbiotic relationship ensures that targets of the finance institution are met without extra hurdles on the service provider. It also ensures that the finance institution is not risking their funds for something promised but rather rewarding something delivered.

The RBF model provides three main benefits[18]:

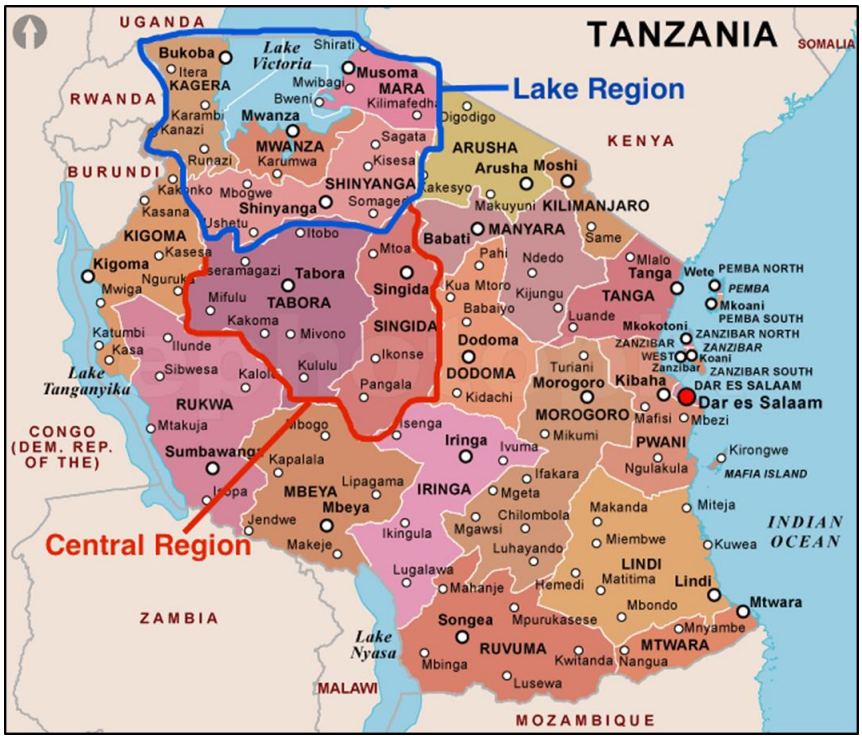
1. **There is a better value for money for donors, implementers and consumers.** When funding is linked to quantifiable results, the risk of funding failed concept ideas is significantly reduced and, more importantly, equivalent amounts of money generate higher and sustained results.
2. **Allows providers to develop their own business models and adjust them as necessary**. Reimbursing results rather than receipts gives service providers flexibility with how they attain those results.
3. **Incentivises diversified service models that are often better than previous models**. With less restrictions on the process, the RBF model is more attractive to service providers, therefore increasing the number of potential business models from companies.

SNV's RBF model in the Energy Sector in Tanzania

The RBF Fund is financed through the Energizing Development (EnDev) initiative and SNV is among the first organizations worldwide to pilot RBF. In Tanzania, SNV has introduced RBF schemes for both household biogas and PV sectors. Tanzania Investment Bank (TIB) was selected to host the RBF Fund.

[17] SNV, How Results Based Financing is Spurring Solar Market Development in Tanzania
[18] Instiglio, What is Results-Based Financing, 2017

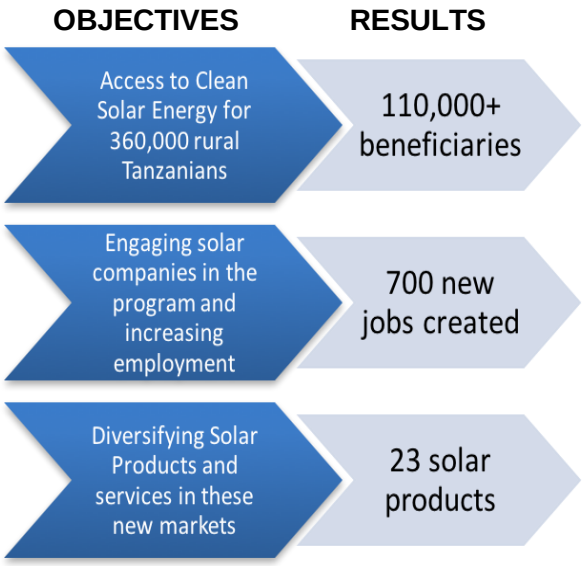
Figure 2: RBF Geographic Focus Areas



The solar project has created an RBF Fund of €1 million that serves to assist the private sector in developing the market for pico-solar products in defined rural areas. The Fund covers Tanzania's Lake Zones (Kagera, Geita, Mwanza, Shinyanga, Simiyu and Mara) and Central Zones (Tabora, Singida and Dodoma) (see Figure 2).

RBF is specifically set up to assist suppliers and retailers-agents of pico-solar technologies to build investments in solar distribution chains. It rewards private sector players with incremental sale and performance incentives based on actual sales[19]. SNV has three stated objectives and corresponding results for this RBF Fund as shown below:

Figure 3: SNV Objectives and Results for RBF Tanzania by mid-2017[20]



[19] SNV, RBF Fund – Operational Guideline, 2017
[20] Numbers from RBF documents and interviews with RBF staff in Dar es Salaam.

The RBF model rewards units sold to (or subscribed to) by rural consumers in Lake and Central Zones of Tanzania.

- All units sold must be approved and verified pico-solar products; only Lighting Africa approved products are considered.
- The value of the RBF incentive per pico-solar product is based on brightness (lumens) and duration (runtime per solar day of charge) of light that the product is capable of providing according to the product specification sheet as publicly available on the Lighting Africa website[21]. The resulting 'lumen-hours per solar day' of the pico-solar product is quantified as a number of 'energy service units'. Thereafter, a monetary value (Euro cents) is applied to each qualifying energy service unit.
- In using the Lighting Africa standards, the minimum energy service unit threshold is set at 100 lumen-hours per solar day, meaning 24 lumen light output, 4 hour run time/day solar charge[22].
- The energy service units available for composing the RBF Product Incentives per product are therefore based on the actual energy service units of the product less the minimum energy service units.

The value of the RBF Fund for Product Incentives is €2 million. The Fund opened as of May 1st 2014 and will be closed on May 31st 2018 (or when the full RBF Fund €2 million is depleted). The applications received for the Fund pass through the advisory group of the TIB, REA, and World Bank – IFC Lighting Africa. This advisory group reviews actual RBF Fund usage in the private sector biannually. There are three rounds for the supplier applications to participate. Table 2 depicts the period of each round, the number of suppliers accepted and the shared value per round.

Table 2: RBF Rounds 1-3 Supplier Values (extracted from SNV, RBF Fund – Operational Guideline, 2017

RBF Share Thresholds (Euro)	Share Value per Round	No. Suppliers per Round (max)	Initial Share Value per Supplier (min)
RBF Round 1 (2014)	600,000	5	120,000
RBF Round 2 (2015)	400,000	5	80,000
RBF Round 3 (2017)	200,000	5	40,000

As designed, the RBF model intends to stimulate better market practices by participants because it does not impose restrictions on the activities of private sector actors. As long as results are achieved, businesses will see a return on their investments and the finance institutions will have spurred tangible development goals. Once they meet a maximum sales target, performance grants are capped and no more subsidy is available.

[21] SNV, RBF Fund – Operational Guideline, 2017
[22] SNV, RBF Fund – Operational Guideline, 2017

SECTION 3
Analysis of Preliminary Findings

This section presents analyses of programmes and experiences relevant to the study request.

- Section 3.1 presents an analysis of both phases of the SSMP
- Section 3.2 summarizes Tanzanian-based programmes that have installed institutional systems
- Section 3.3 presents the findings of the UNF study of 450 publicly installed solar health centres in Tanzania, Uganda, Ghana and Malawi
- Section 3.4 presents an analysis of the Results Based Financing program
- Section 3.5 presents a summary analysis of Lighting Africa

3.1 SSMP Institution Solar Program

Relevant details of the Sustainable Solar Market Packages (SSMP) design and targets are introduced in section 2.1 above. This section provides the outcomes and analyses of the two phases of the programme.

3.1.1 SSMP 1 Performance Overview

A study was commissioned by the World Bank in 2014[23], nearly four years into the project, to evaluate SSMP 1. It identified numerous technical and maintenance challenges that caused the programme to under-perform. The evaluation found that although the project had installed solar PV system in almost all the 400 public institutions that had been earmarked, a majority of them had either completely failed or were not working to full capacity 4 years after the project completion.

Technical deficiencies in the programme included:

- Failed batteries that needed replacement
- Faulty or failing systems and components (PV modules, DC CFL bulbs, streetlights, switches, etc.)
- Missing or undelivered supplies
- Poor response to callout for repair
- Inadequate maintenance services

As well, the contracted supplier failed to stimulate sales of solar home systems. Less than 10% of the targeted goals were met for SHS sales, even with the performance grants. A major contributing factor to this was the contractor's lack of experience in marketing SHS and its lack of investment in sales and distribution networks. CAA organized its own marketing operations for solar home systems rather than cooperating with local dealers.

A more critical factor may have been the unaffordability to consumers of cash-based sales of solar home systems. Even with performance grants, the cost of the cheapest 20 Wp SHS, for example, could end up costing a total of US$350 or more after installation[24]. Since the

[23] TEDAP's Sustainable Solar Market Package (SSMP) Approach: An Evaluation of the Experience with SSMP1 and Suggestions Going Forward, 2014
[24] TEDAP's Sustainable Solar Market Package (SSMP) Approach: An Evaluation of the Experience with SSMP1 and Suggestions Going Forward, 2014

41,000 households in the target region[25] are mostly engaged in subsistence agriculture (earning an average income of US$33 per month)[26] they were unable to afford solar PV systems on a cash basis. Thus, the SHS options provided by CAA (and the project design) were unrealistic for local consumers from the beginning.

3.1.2 SSMP 2 Performance Overview

To assess the progress of the SSMP 2 programme, REA contracted two groups to evaluate the work carried out in the 8 contract regions.

- Tanzania Electrical, Mechanical and Electronics Services Agency (TEMESA) was hired in November 2015 to conduct verification of Solar PV Installations for SSMP 2 in six lots under SINOTEC: Sikonge, Chato, Kibondo, Kasulu, Mantumbo, and Tunduru.
- Arusha Technical College – Production and Consulting Bureau (ATC-PCB) was contracted for the verification of the other two slots under Rex: Bukombe and Biharamulo.

The aim of this quarterly review was to determine if the contractor had met the requirements including quality standards and technical specifications for the approval of the contractor's payment.

The table below shows the details of the implementation status as of June 8th 2017, 3 years into the project (it is based on the evaluations and REA reports):

Table 3: Project Implementation Status (as of June 2017)[27]

		Lot 1 Bukombe	Lot 2 Sikonge	Lot 3 Chato	Lot 4 Biharamulo	Lot 5 Kasulu	Lot 6 Kibondo	Lot 7 Tunduru	Lot 8 Namtumbo
Public Systems	Scope	194	198	114	148	350	506	209	220
	Status	11	198	83	11	173	312	11	11
	% Progress	5.6%	100%	72.8%	7.4%	49.4%	61.7%	5.3%	5%
	% Overall Progress	38.4%							
Private Systems	Scope	6,600	3,900	3,500	5,600	20,500	13,800	10,600	6,500
	Status	307	3,300	820	229	2,600	3,000	1,200	1,000
	% Progress	4.7%	84.6%	23.4%	4.1%	12.7%	21.7%	11.3%	15.4%
	% Overall Progress	22.2%							
Street Lights	Scope	260	185	140	250	460	365	410	205
	Status	1	185	140	1	135	1	1	1
	% Progress	0.4%	100%	100%	0.4%	29.3%	0.3%	0.2%	0.5%
	% Overall Progress	28.9%							

[25] It is notable that the region chosen for the pilot SSMP programme was one of the lowest income parts of the country.
[26] TEDAP's Sustainable Solar Market Package (SSMP) Approach: An Evaluation of the Experience with SSMP1 and Suggestions Going Forward, 2014
[27] Taken from REA Sustainable Solar Market Package (SSMP2) – Brief Report and Status of the Project

The evaluation activities found that SSMP 2 progress has also been slow. In particular, the evaluations identified the following issues in their field work:

- Battery failure has occurred in a number of facilities. In some others batteries have been stolen.
- Solar equipment has been vandalised.
- Solar modules have been damaged in some sites.
- A number of solar systems are found to be only partially functional (functioning for only few hours per day).
- System sizing is inconsistent. In some facilities systems are overdesigned and in others they are under designed.
- Workmanship in some of the facilities is below standard (e.g. conduits are laid without using proper jointing accessories and not properly aligned with the wall).
- Solar arrays are often poorly oriented or shaded.
- Systems are often overloaded and overuse by consumers.

TEMSEA notes that *"some system repairs need immediate attention otherwise they will be a wasted investment"*[28].

Site verification images from the TEMSEA report are shown in Figure 5 below.

Figure 4: TEMSEA Verification of six districts covered under SSMP 2

A school laboratory room with excessive light fittings

Conduits crossing from one building to another without a supporting wire.

Conduits running direct on floor without being concealed or protected against mechanical damage.

SSMP 2 is now in its third year of implementation. During planning phases, it was anticipated that by 2017, the installation of hardware for all public and private sectors would be complete. It was also anticipated that the remaining two years would focus on maintenance and after sales services.

Since a) less than half the work is complete, b) what is complete does not follow quality standards, and c) there is a need for a number of systems to be redone or repaired, the original plan does not seem to have a realistic timeline.

3.1.3 Overall assessment

Institutional systems installed through both SSMP 1 and 2 face numerous challenges that have led to system failures. Consequently, the project is not meeting its objectives of providing electricity to off-grid public institutions for socioeconomic development. Some of these deficiencies can be attributed to the shortcomings in original project design, as discussed below.

[28] TEMSEA, First Quarter Verification and Performance Review Report, 2017

1. Operation and maintenance plan

As mentioned above, the Rural Energy Act of 2015 does not allow REA to directly carry out operation and maintenance (O&M) of systems. After installation by REA-contracted agents, O&M tasks are delegated to local authorities (district council) and the public institutions that own the systems.

- The handover of equipment is made without full understanding of how district councils and public institutions will maintain the systems. Note that local authorities often do not have enough allocated funds for O&M and particularly for battery replacement. Often it is left unclear who is in charge of the O&M of the systems and thus no entity takes the initiative for system repair.
- In addition, local authorities lack the technical capacity to carry out proper operation and maintenance. In some cases, district councils and public institutions perceive the systems to be the property of REA and therefore have no commitment to carry out O&M.
- Communication and reporting about system status is also an issue. Despite that fact that low-cost technology is available to do the job, no monitoring equipment or reporting procedures are put in place to enable REA or local government authorities to ascertain the operational status of equipment.

The lack of a clear O&M plans is a main cause of system failure. The most common component failure is the battery, which typically requires replacement after two to four years. The local authority and institutions are unable to cover the cost of battery replacement (or even to specify the type of batteries needed). In the case of a system breakdown where repairs are required, there is unlikely to be a technical person to troubleshoot the problem and carry out the repair. In many cases, budgets for system repairs are not available.

2. System management

For institutional solar PV systems to function properly, they need to be properly managed. Over use of loads needs to be avoided and operation schedules need to be adhered to. However, system management is left to the institutional staff with little or no technical knowledge on the limitations of the systems and how to optimise their performance.

- Poor system management leads to overuse and overloading of the system, draining of the battery and poor performance of the solar system. Short battery life can be directly attributed to mis-use of PV systems.
- For example, during the verification of solar PV installations for SSMP 2, it was common to find solar systems that were overloaded. This is especially prevalent in staff houses where single module PV systems do not provide enough energy for household electricity demand.
- Many systems were found to be used longer than the stipulated time per day.

3. Local technical capacity

Since O&M work is the responsibility of local governments and the institution itself, there is need for trained and qualified local technicians to carry out these activities. However, public institutions lack skilled personnel to maintain the systems and to conduct minor repairs when needed. Local authorities do not have budgets to deploy off-grid solar technicians.

4. System monitoring

Lack of system monitoring is another contributor to large-scale failure of the institution system. The SSMP project aims to instal hundreds of institutional solar systems. When systems are not properly monitored for their performance, REA and local governments, have no data on system performance status or, when failures do occur, the causes of failure.

Most of the time, minor performance issues of off-grid systems could be easily addressed if information was available. However, systems are located in remote off-grid areas where accessibility makes visits, physical monitoring and troubleshooting difficult.

Modern remote monitoring technology can be used to assess system performance in real time. Through remote system monitoring, systems can be easily tracked and --- when they are not functioning due to minor technical issues --- they can be diagnosed remotely and repairs can be actioned accordingly.

5. Private SHS sales vs public procurements
SSMP 1 and 2 both bundled together procurement of solar PV installations for public institutions with commercial sale of SHSs. The bundling was originally developed to encourage more efficient locally-focused delivery practices by supply companies by offering them both procurement and sales opportunities. This intended outcome has not, in fact, occurred and is a significant design flaw of the SSMP plan.

In fact, in both phases, the contracted companies have been unable to meet the SSMP sales targets for SHS supply despite relatively generous cash subsidies provided. Moreover, in both projects, long-term distribution agents for supply of the SHS products have not been set up. In both SSMP 1 and SSMP 2, once the procurement phase was complete, the contractors did not maintain sales of support agents for SHS products.

In practice, the design, installation and maintenance of institutional PV systems for public facilities requires companies with very different set of skills and financing requirements than PV SHS vendors or service providers. In the past 5 years, PAYG companies have emerged in the Tanzanian market that are quite efficient at addressing household energy needs --- these companies are rarely involved in supply of institutional systems.

A cursory examination of the SNV RBF service providers shows that most companies operating in the household pico, SHS and PAYG market are not focused on institutional PV procurement markets (see below). As well, players in procurement markets are not usually active in household PV markets.

3.2 Other Institutional Solar Programs in Tanzania

A number of non-REA programmes in Tanzania provide solar PV systems to public institutions. Most of these programmes use the procurement model of installation service approach, whereby private companies sell, install and maintain systems in off-grid areas.

The list below details some of the programs currently in place:

- **The Clinton Foundation through The Clinton Health Access Initiative (CHAI)** is providing solar electricity to off-grid health facilities for refrigeration of vaccines and medicines, lighting for childbirth and other medical procedures, recordkeeping with computers, and other electricity needs. It is a collaboration of the government and private sector with an aim to improve access to high quality health care for people though solar electricity provision to health facilities. Facilities covered under this programme include four rural health centers in the Masasi District of Tanzania: in Chiwale, Mangaka, Michiga and Nanyumbu; and additional a dispensary at Mauguruin.
- **USAID Tunajali Programme** is a programme that provides comprehensive and sustainable clinical and community HIV/AIDS services to People Living with HIV/AIDS (PLHIVs). As part of its mission, the programme has been providing solar systems to health facilities in rural area of Tanzania. Phase 1 of the programme (Tunajali 1) installed solar power systems in 42 rural health facilities between January - April 2011 at a cost of Tshs 2.7 billion.
- **World Vision Tanzania** is involved in a number of programmes that provides solar systems to public facilities. Among these, it is involved in installing solar powered

water pumps for communities in rural off-grid areas of Tanzania as part of its mission to provide clean water to millions of people in sub-Saharan Africa using solar-powered water pumps.

- **The International Rescue Committee (IRC) Tanzania** has been installing solar PV systems in refugee camps in Tanzania. It is being done in collaboration with United Nations High Commissioner for Refugees (UNHCR), the Ministry of Home Affairs Tanzania and other relevant partners.
- **The Mailman School of Public Health at Columbia University** has been carrying out installation of solar PV systems in its AIDS clinics.
- **Tanzania National Park (TANAPA)** has been installing solar systems in national parks across the country for some time. Tenders for installations in eight sites were floated in May 2016.
- **UNDP Tanzania through Capacity Development in The Energy Sector and Extractive Industries (CADESE)** project is supporting NGOs and other groups in providing solar systems to schools. One of the beneficiaries is a local NGO called the Africa Partnership on Climate Change Coalition (APCCC) that has installed solar power to staff quarters and classrooms at off-grid schools in Bukoba District on the western shore of Lake Victoria. The CADESA project is also providing solar powered water pumps to off-grid communities.

This study does not have the resources to assess the performance of the systems put in place under the above programmes. However, it is important to understand that the overall procurement-driven approach to installation of off-grid solar in rural institutions is a large business in Tanzania and other countries.

As explained above, and as further elaborated in the next section, a large portion of the off-grid institutional systems installed with Government and donor funds fail within five years because of a lack of operation and maintenance support and because of a lack of funds for battery replacement.

3.3 UNF Study in Tanzania Malawi, Uganda and Ghana

In 2015, United Nations Foundation (UNF) commissioned an energy need assessment study on off-grid health facilities in Malawi, Uganda and Ghana. The study was led by African Solar Designs (ASD), working together with in-country coordinators from the three countries and covered a total of 210 health facilities. The study involved an assessment of the electrification status of the health facilities followed by energy audits and solar PV system design for the selected dispensaries, clinics, health centres and other small tier rural health facilities. In 2016, the same study was extended to Tanzania. In collaboration with the Ministry of Health and BRN, it audited an additional energy systems in 53 rural off-grid health facilities located in areas around Lake Victoria.

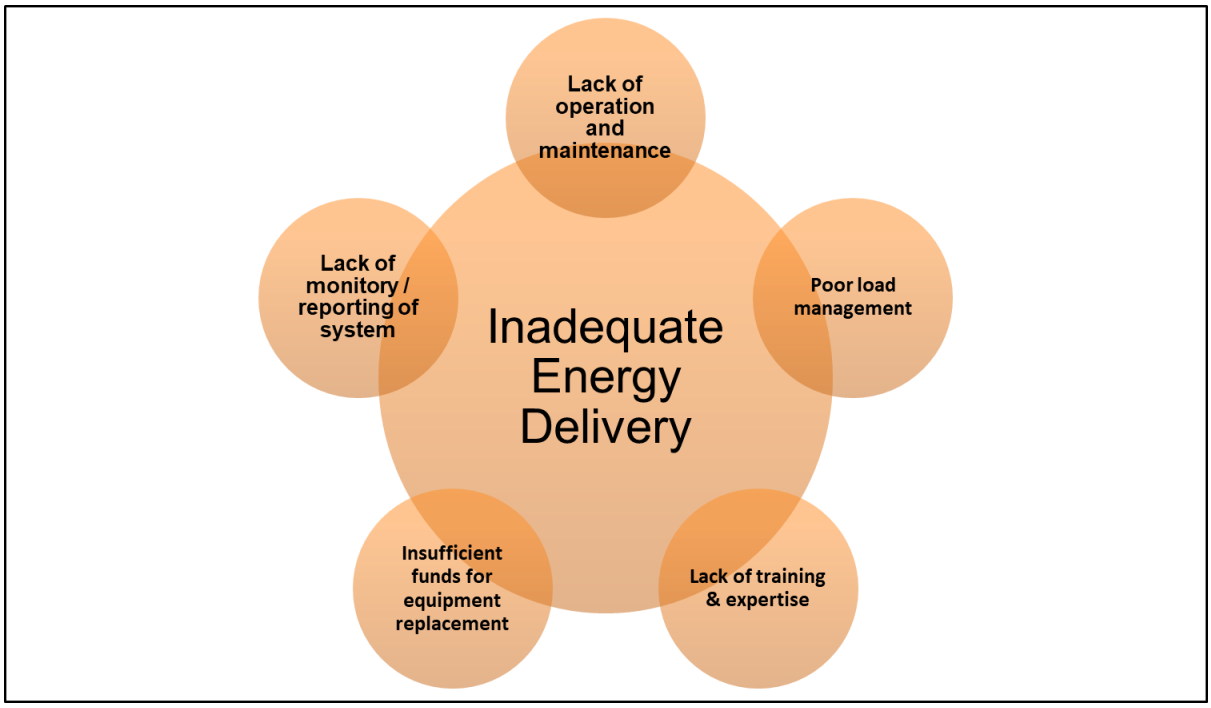
The combined results of the study closely resemble the evaluation results of the SSMP work. In the 4 countries, ASD found the following:

i. Solar PV installations for the off-grid health facilities is **procurement driven**. There are multiple non-government actors who have been supplying off-grid electricity systems to health facilities for years through this model. These programmes run by donors, NGOs and different Government ministries often have little coordination or long-term planning.

ii. More than 50% solar systems at health facilities are either **not working or are working inadequately**. The main reason for system failure or poor performance is:
    a. Lack of operation and maintenance plan;
    b. Poor load management;
    c. Lack of site training or expertise;

d. Insufficient funds for equipment replacement (especially batteries that are the main cause of system failure).
e. Lack of monitoring or reporting of system status after handover.

Figure 5: Inadequacies Observed in Facilities



iii. There was **little or no after service offered** on the systems by the companies contracted to do installations.
iv. In most health facilities, the **installations had been done poorly**, which in turn affect the functionality of the system. It was also common to find health facilities with more than one system (sometimes up to five) that have been provided by different donors or government programmes.
v. The failure of solar systems has given solar technology a **bad reputation** among Government planners.

The findings from this study are broadly similar to the experience of many programmes providing solar PV to public institutions in sub-Saharan Africa[29]. After installation of solar systems, equipment fails within a short period of time because of strategic weaknesses in the post-installation planning for the equipment and its operation. The UNF study identifies major weaknesses of the procurement model that are employed by governments and NGOs in providing solar systems to health facilities.

[29] The same issues have been identified in a Kenyan school electrification programme carried out by the Rural Electrification Authority.

3.4 Lighting Africa and Lighting Tanzania

In line with the Lighting Africa programme, Lighting Africa –Tanzania's overall goal is to contribute to the development of commercial market for quality-verified solar lanterns and SHS. It started its activities in 2016, after conducting a policy environment assessment in 2010 and a market research in 2013. Programme activities revolve around quality assurance, consumer education, market intelligence, business and supply chain development, and access to finance (as discussed above).

Much of the work is ongoing. Nevertheless, the programme has made some important achievements that are already positively impacting the solar lighting and SHS market in Tanzania. Some of the programme's milestones and achievements so far are as follows:

- The programme has been working with the Tanzania Bureau of Standards (TBS) to integrate the Lighting Global Quality Standards into their regulatory framework. The standards have already been adopted by TBS and implementation began in June 2017. Certification of products will be increased to systems of up to 350W. Although there are many companies already dealing with Lighting Global Quality Verified products, adoption of these quality standards into the national regulatory framework is expected to streamline the market by helping remove substandard products mainly sold over the counter.

- At Tanzania Bureau of Standards (TBS), a laboratory was set up with IFC assistance to assess the performance of locally-procured PV products.

- The programme has been conducting market research as part of its market intelligence activities. In addition to the one first study conducted in 2013, IPSOS Tanzania is currently conducting a market intelligent and business development study with a report expected in August or September this year. Availability of market data and information is seen as key in attracting investment and facilitating innovation.

- The programme is conducting consumer education in Tanzania to increase awareness of solar lighting and other solar energy systems. An assessment conducted in 2010, when the programme was beginning, showed a low awareness level on the uses and benefits of off-grid lighting and energy products, especially among those at the BoP. Increasing the levels of awareness will be key in growing the market share and attracting investments.

- The programme has been working with financial institutions and facilities to ease access to financing of off-grid solar companies, particularly local companies. Access to financing has been cited as a major barrier to expansion and scale-up of off-grid businesses selling solar lighting products.

3.5 Result Based Financing

Result Based Financing mechanisms for SHS were launched in 2014 in Tanzania's Lake Region (refer to section 2 for details on RBF's instalment in Tanzania).

As a result of the first two rounds after 2014, the following results were achieved:

- 10 companies participated and 8 are still active. They include Mobisol, Off Grid Electric, GCS/Greenlight Planet, Ensol, Simulsolar, Lotus Africa/Azuri, Sollatek, Ongeza. SunnyMoney/SolarAid wound up its Tanzania offices during the project.
- Two of the companies (Mobisol, Off Grid Electric) achieved the maximum possible incentive cap (Euro 550k).
- All companies secured pre-financing from other sources before starting sales through investment or loans. Some use RBF to leverage loans.
- The programme Incentivized 38,000 unit sales of Lighting Africa-approved products ranging from pico to 200W in size. 70-80% of the systems were over 10Wp.
- 25-30% of the systems were used for productive income-earning activity.
- In round 1 and 2, PAYG took up 65% of sales (6 of 8 firms used PAYG) and cash sales took up 35%.
- Market demand is moving towards larger systems.

The project count does not include 18,000 to 24,000 systems that were sold by companies over their caps or urban systems sold (this adds an additional 15%).

In the 3rd round at least 15 additional companies will be participating. The project will add mentoring services as part of its portfolio of support services.

The RBF programme has directly trained more than 50 people and created new work opportunities for far more. It has realised steadily increasing sales of quality pico-solar products – providing the benefits of clean and affordable lighting to rural Tanzanians. As a result, more than €1.4 million in grant support has been successfully deployed to the private sector with very significant increases in product sales.

From the above, it can be seen that the RBF model is effective, sustainable and attractive to private sector solar companies and is proving to be a powerful tool for supporting the private sector in building sales and energy access. The project has been universally recognized by the private sector and development partners as a global example for best practices in solar market development[30]. It has demonstrated that better business models are more important than product innovation.

The model is however facing a number of challenges.

- **Pre-financing of companies.** First, there are issues with pre-financing for the companies that qualified for the program. Locally, there are limited pre-financing mechanisms especially from MFIs and other financial institutions. Available pre-financing mechanisms are not attractive to the international players. More importantly, if local players can't access pre-financing in-country to develop markets, they may be at a disadvantage in RBF schemes, especially if international players have greater access to grant funding.
- **Information collection.** Another challenge is a lack of information coherence. PAYG companies rely mostly on local agents who use informal names and language making it difficult to collect data and monitor efficiently the business model.

[30] SNV, Study - Pico-Solar for All

- **Cost of monitoring.** Accurately following up and verifying sales of 12,000 units in remote areas is an expensive task that consumes a large part of the budget. Monitoring checks include:
  - Claims by sellers are required.
  - Paper checks on transactions are required.
  - Phone checks to customers and consumers (50% of agents, 10% of consumers).
  - On-site verifications by local NGOs and/or consultants are needed to examine and verify product samples. This requires some customer audits (5% of total) as well as agent audits (25%).

  Agreed internal benchmarks on participating companies reduce the inspection tasks. In short, once companies have passed a certain number of inspections they are seen to be compliance and require lower monitoring levels.

3.6 Key Takeaways

Below is a list of lessons learned from SSMP, RBF and other solar market development programs that can enhance future programs.

SSMP 1 & 2 and Procurement Based Installation of Institutional Systems

- **High failure rates of institutional systems.** A large portion of remotely installed institutional PV systems fail within the first 5 years. The experience of SSMP 1 and 2 installations is similar to that of institutional PV equipment supply by procurement in other parts of Africa. High failure rates lead to reduced confidence in solar.
- **Current after-service arrangements do not work.** Off-grid solar systems in public facilities fail not because of the technology but because of after-service arrangements, end user management of energy and spare parts supply.
- **SHS distribution and institutional PV supply are different businesses.** In general, integrators and installers of large off-grid systems do not have the skills or interest in setting up distribution sales networks for household solar products. Unlike RBF, SSMP has not attracted long-term players to supply SHS products. Two players can partner in a project, however. Evidence from the Philippines shows that, successful SSMP developers partner with vendors to meet SHS distribution targets.
- **There is little monitoring of installed systems.** Despite the extremely high investment in systems, there is little regular reporting about system performance. Technology is available that can provide on-line up to date information about systems.

Development of Solar Home Systems and Pico Systems Market

- **SSMP support for SHS should be redesigned or removed from the programme.** The solar home system market has expanded extremely rapidly in Tanzania, often in ways that were not anticipated at the time of the SSMP design. This expansion has to do with improvements in technology, lowered prices, new business models and the introduction of PAYG finance. These changes have overtaken the original intention of SSMP, which was partially to stimulate the SHS market.
- **Finance or PAYG is needed for SHS sales to BoP**. Cash-based models do not appeal to the rural poor. Sustainable finance is likely to result in more long term impact than higher performance grants.
- **Consumer financing offered directly by solar equipment** providers themselves has proven to be the most effective credit delivery tool.
- **Need for revised SSMP performance grant**. The existing SSMP performance grant system for SHS should be revised in future projects to directly address the affordability issue and provide a real incentive for participating companies. Increasing the performance grant has not, thus far significantly increased, SHS product sales.

- **RBF is showing success in building sustainable markets.** With the RBF incentive model, SHS importers and retailers are incentivized based on the sales they make in the market. It is an efficient approach of developing the supply chain and increasing the uptake of SHS, provided pre-financing is available to local solar companies. RBF also encourages business innovation and it encourages long term presence in the market.
- **"Lighting Africa Quality Verified Product"** standards have been valuable as a tool to benchmark equipment quality across the market. Though the quality benchmark has in not yet reduced the prevalence of low-cost substandard products in the market, it has promoted the credibility of off-grid products and confidence among consumers in using the solar products. It has also enabled programs providing performance grants to qualify products.

SECTION 4

Economic Modelling and Analysis

This section presents economic modelling and analysis conducted by ECA and ASD to compare the SSMP performance grant with the recommended Results-Based-Financing model. The SSMP model includes private households and institutions (schools, clinics, street lighting, etc.). As per the above sections, the analysis separately compares SHS household and institutional systems.

4.1 Households

4.1.1 SSMP method

The method used to disburse the SSMP 2 subsidy is a simple $5/Wp payment on all systems, up to 100Wp in size. The systems offered by the contractor are sized from 20Wp to 100Wp with retail prices (excluding installation) ranging from $200 - $900. The highest possible subsidy is therefore $500 for a 100Wp system.

4.1.2 RFB method

The Results-Based-Financing method does not measure the subsidy based on their capacity (in watt peak) but rather on the effective output of the systems, i.e. lumen-hours. The suppliers are therefore encouraged to sell more energy efficient equipment. The RBF subsidy decreases annually according to a predetermined schedule. In addition, the total subsidy available to a single household is capped at $34 (EUR30) and includes a minimum of 100 lumen-hours a day which will not be covered by the subsidy.

4.1.3 Comparing the two methods

The different incentives created through the two models, SSMP and RBF, encourage different types of solar energy systems, which makes a direct comparison difficult. The SSMP model incentivises larger PV modules with less focus on providing lighting. The RBF encourages more efficient systems with smaller and cheaper PV modules where the main emphasis is placed on providing lighting for longer periods. For this analysis the issue was resolved by comparing the products based on their technical specifications and output (lighting potential and ability to charge a mobile phone or small appliances).

Three categories were created for the comparison: Light with charging, Multi-room kits, and solar home systems. These categories roughly represent Tier 1 and Tier 2 service levels presented in Section 2. For each category a representative module size (corresponding to SSMP) and a representative product (Lighting Africa licensed products corresponding to RBF) were chosen.

The RBF incentive calculations focus on the lighting output of the licensed systems. However, since the RBF solar systems are market-driven, almost all licensed units have the possibility to charge mobile phones allowing the user to prioritise the method of electricity consumption. Most of the systems also include the capacity to power small appliances. Due to recent technical advances these systems often manage to deliver equivalent or higher capacity for much lower rated solar PV modules.

The corresponding technical specifications and module sizes for the solar products are presented in Table 4.

Table 4: Technical specifications and module sizes for SSMP and RBF schemes[31]

Category	Hours of light [lumen-hours]	SSMP[32]		RBF[33]	
		Solar PV module [Wp]	Hours of light [lumen-hours]	Solar PV module [Wp]	Hours of light [lumen-hours]
Light with charging	700-900	20	750	5	900
Multi-room kits	1,800-2,500	50	1,800	50	2,400
Solar home systems	4,800-5,000	100	1,800	100	4,800

In order to compare the two methods, a hypothetical scenario was constructed where 10,000 private households were to be electrified. The households would choose one of the three categories in the following ratio:

- Light with charging – 25%
- Multi-room kits – 30%
- Solar home systems – 45%

This coincides well with findings from EnDev's 2016 Progress Report[34] which shows that 80% of SPS/SHS customers chose a Tier 2 level of service with the rest opting for smaller systems or single lights.

4.1.4 Results for private household comparison

Using the hypothetical scenario described in the previous section the two models were compared and their results presented in the table below.

Table 5: Results from comparison of RBF and SSMP incentives schemes

	Number of units	Capacity [Wp]	Subsidy - SSMP (total/per unit) [USD]	Subsidy - RBF (total/per unit) [USD]
Light with charging	2,500	5	$62,500 / $25	$45,600 / $18
Multi-room kit	3,000	50	$750,000 / $250	$102,600 / $34
Solar home system	4,500	100	$2,250,000 / $500	$153,900 / $34
Total	**10,000**		**$3,062,500**	**$302,100**

[31] The comparison is for illustration purposes and not critical to the quantitative analysis of the two schemes. The analysis focuses on the incentives provided by each scheme for a similar product (in terms of output and capacity).
[32] Source: TEDAP (2014)
[33] The figures represent a typical product licensed by Lighting Africa with similar capacity for powering appliances as the SSMP technical specifications.
[34] Source: Table B.2 - http://endev.info/images/a/a1/EnDev_Annual_Planning_2016_short_version.pdf

Using the same ration in systems sold, the total number of household's service for a fixed amount was calculated. For USD1,000,000 each scheme could service:

- **SSMP II:** 3,265 total equivalent units
- **RBF**: 33,102 total equivalent units

4.1.4 Analysis

The comparison of the two models shows a number of key differences:

- The cost and number of households serviced varies by an order of magnitude. This can partly be attributed to the efficiency of the solar systems each incentive mechanism is encouraging.
- The SSMP method of calculating the subsidy encourages systems that are not optimized for providing lighting. In addition, the SSMP incentive calculation do not take into account the substantial advances in design, manufacturing and business models that have happened over the last few years. As an example, the $500 subsidy available for a 100Wp system under the SSMP 2 would cover the full retail price for an equivalent Lighting Africa Solar Home Module[35].
- The RBF scheme rewards output (lumen-hours) over input (Wp) which SSMP prioritizes.
- Another major difference between the two incentive mechanisms is the cap on subsidy for RBF funding. The difference is most apparent when it comes to the larger SHS modules (50-100Wp) where the incentive payments can reach $34 and $500 under the RBF and SSMP 2 mechanisms, respectively (Table 55). Data from EnDev[36] shows that customer appetite is the highest for larger systems, which increases the difference between the two mechanisms even further.

Qualitative analysis

Despite offering substantially lower subsidies for each system sold, the RBF mechanism does not seem to be affected by lower sales due to affordability of the end user. On the contrary, the cheaper, more efficient and better optimized systems sold by the companies participating in the RBF scheme have been surpassing sales under the more subsidised SSMP 2 scheme[37]. The innovative business models developed by the RBF suppliers have also helped with making SHS affordable to the end-user. Table 6 shows a simple comparison for typical retail prices for both subsidy schemes. A caveat to keep in mind is that retail prices corresponding to SSMP correspond to typical retail prices from the SSMP 1 and are the retail prices from 2013. However, this does not change the fact that SSMP's incentive mechanism focusses on input rather than output and does therefore not provide the proper incentive for innovation in design and product range.

No subsidy digression mechanism is included in the SSMP. When that is compared to the RBF scheme where the cap and quantity are reduced following a published schedule it shows that SSMP does not encourage the suppliers to reduce cost, investigate cheaper and more efficient systems, and innovate with different business models.

[35] RBF Fund: Operational Guideline May, 2107
[36] EnDev 2014 report
[37] Based on SSMP 2 status reports from June 2017 and RBF assessment report from April 2016 (Melnyk, 2016)

Table 6: Overview of typical retail prices for modules from SSMP 1 and RBF schemes

	Light with charging	Multi-room kit	SHS
SSMP			
SSMP 1 retail prices (with installation)[38]	$350-400	$600-700	$1,000-1,100
SSMP subsidy	$100	$250	$500
End user price	$250-300	$350-450	$500-600
RBF			
Typical Lighting Africa supplier retail price (with installation)	$40	$114	$570
RBF subsidy	$18	$34 (capped)	$34 (capped)
End user price	$22	$80	$536

Table 6 shows that in most cases the customer ends up paying more for a product that has similar output in terms of lighting and appliance powering potential. In addition, the SSMP scheme does not reward innovative business models and the potential for capacity building at a local level is much lower than under the RBF scheme. By procuring out large areas, the SSMP scheme creates monopolies where the supplier is not subject to competition and does therefore not need to innovate or develop good relationships with locals. On the other hand, under the RBF scheme, the suppliers have to compete for their customers by building relationships with local people and offer different business models which increase their customers' affordability to pay.

The RBF has some disadvantages over the SSMP scheme as the suppliers required to come up with the up-front cost for the solar systems and cover the financing costs while receipts have been processed with RBF and the subsidy paid out.

4.2 Institutional systems

For this part of the analysis a series of hypothetical institutional systems were designed and different procurement systems compared. Under the procurement approach modelled, a significant portion of the payment will be offered through 5-year service contracts and linked to performance (delivered electricity). This approach encourages continuous maintenance of the systems and incentivises sustainable practices.

Two implementation scenarios of a micro-grid approach were modelled with the main aim of analysing total life-cycle costs of the systems based on the level of maintenance and service. The two implementation scenarios are listed below:

- Full maintenance – 60% of total CAPEX would be paid as "investment fee" with the remaining 40% paid out through a 5-year service contract along with incurred O&M
- Low maintenance – 100% of CAPEX will be paid out as "investment fee" O&M to be the responsibility of contractor

The analysis builds on the micro-grids as they are presented in Section 5.2. Each micro-grid is to supply a hypothetical area consisting of a mix of school houses, clinics, street lights and staff houses. Further details are provided in Table 7.

[38] Data represents a SSMP I contractor, CAA. Source: Terrado (2014)

It must be noted that this is a very rough analysis aimed at illustrating the importance of incentivising good O&M practices while procuring institutional solar PV systems. The impact on local economies through capacity building and job creation will also be discussed later in the section.

In order to compare the different implementation scenarios a hypothetical customer profile for a procured area was constructed. The area consists of 150 micro-grids each powering a small town with 4 Schools, 1 Clinic, 50 Street lights and 15 Staff houses. The consumption profile of each individual micro-grid is presented in Table 7.

Table 7: Consumption for the hypothetical micro-grid

Customer	Daily consumption [Wh]	Average load [Wp]	Daily consumption [hrs/day]
Schools	4,800	600	8
Clinics	3,500	350	10
Street lights	8,000	2,000	4
Staff houses[39]	3,000	750	4
Total	**19,300**	**3,700**	

4..2.1 Capital Expenditure (CAPEX)

The CAPEX for providing a single system with the level of service outlined in Table 7 was calculated using typical costs and sizing assumptions[40], and resulted in:

- CAPEX for a single system – USD21,187
- CAPEX for the entire procured area – USD3,177,975

This translates into an average cost of about **$4,500/kWp**

4.2.1 Operational Expenditure (OPEX)

The largest recurring cost for operating a solar PV is the scheduled replacement of batteries. For the analysis it was assumed that replacement costs would not decrease over time and remain the same as when the grid was originally constructed.

O&M costs (excluding battery replacement) was assumed to be: 2% of CAPEX for the Full-maintenance scenario; and 0% for Low-maintenance scenario.

The decreased maintenance cost between scenarios was assumed to have a negative impact on the system by accelerated degradation of batteries and lower output[41].

[39] The consumption for staff houses does includes only the consumption of a few lights and an appliance for 4 hours each day at 50W load. The micro-grid operator could, at its own discretion, supply additional power and charge the end-users directly.

[40] Batteries were sized for 50% Depth of Discharge (DoD) and 1 day of autonomy and 7-year lifespan; Solar PV modules sized according to 4 hours of peak capacity (including losses); Coincidence factor for overlapping peak load was 70%; Costs included internal wiring for customers; Aggregated battery and PV module cost was about 45% of total CAPEX.

[41] The negative impact of a lack of maintenance and a higher depth of discharge is widely understood. Sources supporting the assumption include IRENA (2015).

Table 8: Annual battery degradation and OPEX for the hypothetical micro-grids

Customer	Full maintenance	Low maintenance
Annual degradation [pp]	0%	10%
Battery replacement	Every 7 years	Never
Total OPEX [USD] (Not discounted)	2,660,790	0

4.2.3 Levelised cost of energy (LCOE)

By using the assumed system degradation and the cost of OPEX and CAPEX, a high-level LCOE was calculated. The future generation, battery replacement and O&M was discounted using a discount factor of 10%. The calculation does not account for different implementation models as presented later in the section and is only representative of lifecycle costs under different levels of maintenance. The result is presented in Table 9.

Table 9: Levelised cost of energy for different scenarios

	Full maintenance	Low maintenance
LCOE [USD/kWh]	1.7	3.3

While this analysis does not substitute a thorough feasibility study for installing Solar PV powered micro-grids, it does highlight the importance of investing in proper maintenance of the equipment and batteries. In our analysis, proper maintenance includes making sure that average depth of discharge for the batteries does not fall below levels that would be considered sustainable for the assumed 7-year lifetime of batteries.

4.2.4 Payment schedule under different implementation models

Using the same cost figures and levels of maintenance, the payment schedule for a fund or agency managing the procurement process was modelled. The model followed the assumptions laid out in Section 4.2 and calculates the undiscounted payments to the installation and service agent. An overview of the payment schedule is presented in Table 10. The calculations assume that the remaining funds are paid for delivered electricity and a failure to deliver leaves the operator missing out on funds.

Table 10: Payment schedule under three incentive implementation models

	Payment to installation and service agent [USD]						
	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Total
Full maintenance	1,906,785	317,798	317,798	317,798	317,798	317,798	3,495,773
Low maintenance	3,177,975	-	-	-	-	-	3,177,975

While the scenarios do not include a maintenance contract like the SSMP approach, the low maintenance is the most similar scenario to the actual results from SSMP 1. The maintenance contracts did not manage to incentivise local capacity building to a sustainable level and local authorities do not have the necessary technical or financial capacity to sustainably maintain the systems. The full maintenance scenario provides a very strong incentive for the systems to be properly maintained and operated since such a large part of the funds is linked to the delivered quantity of electricity (around 45%).

4.2.5 Analysis

The model shows that the total cost of the full maintenance scenario is only about 10% higher (the O&M costs for these 5 years). The lack of performance linked payments allow the contractor to build the grid without delivering the proper O&M for the systems to be operated sustainably. As we see in Table 9, LCOE under the full maintenance scenario is substantially lower than the low maintenance scenario, further underlining the importance of ensuring proper maintenance despite higher costs.

An important variable that needs to be considered is the sustainability of the system and the impact on local communities. By linking payments to the successful delivery of electricity, positive incentives are created for the operator to maintain the system properly and the long-term sustainability of the system ensured.

- The full maintenance scenario would also have much higher positive impact on local communities as it would require local people to be employed to maintain and repair the system.
- The positive impact on local communities would not be as large under the low maintenance scenario as they assume much less maintenance will be performed.
- In addition, the full maintenance scenario assumes that consumption will be controlled in a sustainable manner to decrease battery degradation. In practice, this would require capacity building at the community level to ensure that all users are aware and understand the benefit from treating the batteries in a sustainable manner.

4.2 Key Takeaways

The following are the key takeaways from this economic modelling and analysis.

Households

- The SSMP performance grant is expensive for households. In most cases households end up paying more than the retail price of a product with the same output in terms of lighting and appliance powering potential.
- The SSMP scheme fails to create competition that will encourage innovation, customer service, community involvement and capacity building for the local people.
- A disadvantage of RBF is that the supplier is supposed to cover the full up-front cost and cover the financing costs before the subsidy is paid out.

Institutional systems

- For the institutional system, while the full maintenance scenario lowers the LCOE by about 50%, it is only about 10% higher than the low maintenance scenario over the period of five years.
- Failure to link payment to performance leads to contractors not keen on systems O&M, which lowers operational sustainability of the system.

SECTION 5

Conclusions and Recommendations

In Section 5, three potential ways forward are presented that may improve the SSMP programme performance. They replace standard procurement contracts and simple performance grants with models that are more results-oriented and likely to deliver better value for money to REA, SIDA and DFID.

As elaborated below, three recommendations are made to improve the SSMP programme:

- **Replace the performance grants for private solar home systems with a results based financing system.** The RBF approach a) ensures that distribution channels are set up; b) provides a more robust verification system; and c) encourages a more competitive approach.
- **Use a service-driven micro-grid approach instead of a procurement approach to supply solar power in institutions.** A new approach would a) provide site-wide 240 AC power which is readily connectable to TANESCO power when the grid arrives; and b) ensure that delivered power is paid for as an on-going service (as opposed to delivered equipment).
- **Test new approaches as part of a competitive locally-driven rehabilitation exercise.** The exercise a) would repair poorly functioning systems in pre-identified districts; b) build local capacity to manage systems ---- especially at the local government level; and c) encourage involvement and responsibility of local government and communities in the rehabilitation and management of systems.

It is proposed that these improved SSMP 3 business models be presented and discussed with REA, SIDA and DFID. Note that full development of any and all of the concepts will require further work separate from this assignment.

In addition to exploring the above three recommendations, we recommend that follow up activities provide two levels of implementation support. First, a tendering and delivery approach (as currently managed by REA) provides the equipment and the base line service arrangements. Secondly, a regional local support initiative should be developed which provides local districts with the resources to directly follow-up, support and monitor the after-service activities of contracted SSMP agents. This second activity would take over from the REA-managed activities and enable local districts to build skills in the management of off-grid electrification.

5.1 Result Based Financing for SHS

It is clear from the above analysis that RBF incentives have stimulated far more development in the SHS and pico-system market than the SSMP programme. As well, the RBF work has resulted in long-term investment in supply chains as opposed to one-off procurements. Further, we note that it would go against good development principles to have two market support programmes competing against each other in the same country (particularly if both are funded by one donor – i.e. DFID) --- adoption of a single market support system is necessary.

It is recommended that the performance-based payments for SHS be replaced with an RBF approach for private household system delivery. The new approach would:

- Separate SHS performance grants from institutional power system supply. Vendors would not be required to respond to both private SHS supply and institutional bids unless desired. They would be free to partner with suppliers of institutional systems and vice versa.
- Follow (and build on) the general parameters of the SNV-managed programme currently underway in the Lake and Central regions.
- Encourage competition among several players in each lot. Monopoly awards do not encourage development of the overall market and should be avoided except where they make sense in a particular case.
- Use the monitoring, capacity building and verified after-payment approach that has been built up by the SNV programme.
- Encourage strong partnerships between procurement suppliers and existing household PV system providers.

We note that there would be little need to design a new RBF programme. The main elements of the programme are already in place and could be easily repurposed for the needs of REA. It is possible that REA could out-source some of the RBF programme elements to the existing managers of RBF who already have ample experience managing the programme.

5.2 Privately-Run Micro-Grids at Institutions as Service Contracts

Evaluations of SSMP 1 and 2 clearly show that institutional systems are likely to fail a few years after installation. Evaluations of other procurement-based off-grid institutional solar system programmes have come to broadly similar conclusions as the ones raised here.

Simply put, the long-term after-service requirements of off-grid solar systems are not being met.

- First, procurement companies are averse to developing local presence to maintain systems in the long term.
- Second, there is limited on-site capacity to manage and maintain the systems within the institutions, local government or in the community, and there is limited finance to cover the costs of service and spares.
- Third, the handover of systems to local authorities and local institutions does not clearly assign financial responsibilities for after-service and especially battery replacement of solar systems.
- Fourth, the SSMP programme did not include adequate reporting of system performance in its design; the programme did not anticipate improvements in monitoring technology that can provide real-time information to system planners and managers.
- Finally, individual installation of a number of stand-alone systems in the same compound --- especially staff quarters --- carries a high risk of failure because of a lack of accountability and system management capacity among the individual system users.

Fortunately, there are successful models for reliably meeting off-grid power institutional needs in East Africa in other sectors. First among these is the telecom sector. Operators successfully manage tens of thousands of base stations based on performance contracts with private entities that pay for delivered power and penalise down-time. These contracts are private sector-led and based on outputs. They also use state-of-the-art technologies for remote monitoring of the systems and for servicing and troubleshooting.

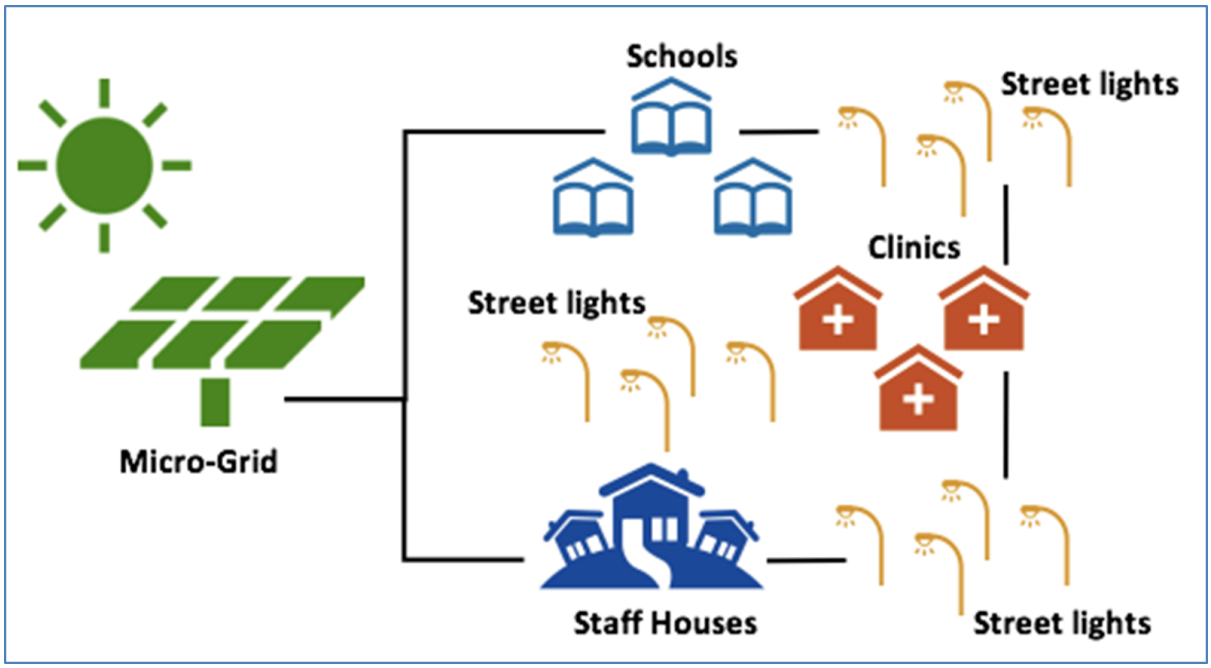
We believe that this type of service model would a) be better suited for long term off-grid power supply in institutions, and b) better prepare remote sites for eventual connection to the Tanesco power grid.

It is recommended that REA, SIDA and DFID trial a micro-grid paid-service approach for the institution-wide supply of power to health centres, schools, police posts and building clusters.

This approach would be implemented as follows:

1. Contractors would supply equipment as part of a site-wide installation that is at a standard 240 AC voltage.
2. All buildings would be connected to a single micro-grid and there would be one connection point (which would eventually be the Tanesco entry point to the site).
3. The contractor would set up a solar micro-grid generation system in an agreed site (preferably on the premise) and would install a single power system sized to power the entire site. If necessary, generators or other renewable equipment could be used to back up the solar-battery system but this investment would be entirely at the discretion of the contractor.
4. The contract costs would be covered with two payment mechanisms:
    a. The contractor would be paid an agreed “investment fee” which would cover most of the capital outlay for the power system. This would be paid for as part of normal REA disbursements.
    b. Over an agreed period (i.e. 5 years), they would be paid a “monthly power delivery fee” based on verified reports and satisfaction from the institutional customer. This fee would come from a fund managed by the local government.
5. The contractor would be responsible for management of loads within the site. They would ensure that the site loads stay within agreed parameters and, based on mutual agreements, they would be able to increase the system size (and their payment) if loads increased.
6. The contractor would be responsible for the operation, maintenance, servicing and management of the power systems. They would also be responsible for supply of spares including batteries.
7. Staff quarters in institutions would receive a basic allotment of electricity to cover lights and mobile phone charging. If staff required more electricity, the contractor would be able to provide them with more power based on an additional fee. This approach would get staff used managing power use and to paying for power over and above “life-line” levels.
8. A monitoring system would provide regular reports to local government and REA officials. This would enable them to track systems, manage necessary service with the contractors and prepare global energy access reports.
9. Contractors would be free to engage in the following activities completely separate from the institutional installation:
    a. Sales of solar home systems as part of the performance grant programme (see above)
    b. Development of local mini-grid systems assuming that they have the necessary licenses, environmental approvals, local permissions, etc.

Figure 6: Micro-Grid Paid-Service Approach



An important issue in the development of a "public institutions mini/micro-grid concept" is how the development of such a programme would interact with established GMG programmes (i.e. such as those funded by REA, SIDA and DFID). The brief points below provide some key ideas in how green mini-grids and institutional micro-grids could synergistically work together rather than compete with each other.

- First, because the sites start as self-contained closed regions (i.e. within the border of a school or clinic), they would not be considered "green mini-grids". Though they would technically be implemented as mini-grids, they would legally be stand-alone entities.
- Should the winning operating entity be interested in expanding the mini-grid beyond the boundaries of the institution, it would have to be granted some type of license or approval which would give it the right to develop a full mini-grid in the village outside of the institution.
- The institutional mini-grid approach would be of interest to companies already operating as green mini-grid developers. If the model was adopted, it would open up a range of new opportunities for such companies and greatly enhance their opportunities.
- Of course, when seeking grants to support their development, such companies would have to be clear about "double-dipping" for support to develop their mini-grids and, at the same time, Government and donor programmes would have to clearly delineate where one programme ends and another begins.

5.3 Rehabilitation of Failed Systems

A number of stakeholders mentioned the prevalence of non-functional systems. This also came out during the UNF and SSMP evaluation studies. It is clear that there are many locations with systems that are broken down and do not serve the institution or community anymore. The stakeholders from NGOs, donors and the private sector suggested that there is an opportunity to use a new SSMP programme to address failed systems and the causes of these failures.

It is recommended that a new phase of SSMP be targeted at rehabilitating failed systems and building local capacities to address system failures. The rehabilitation initiative to rehabilitate and fix failed systems would include the following components:

- A rehabilitation initiative would be primarily designed to build local after-service infrastructure and would work to overcome technical, financial and administrative short-comings of SSMP at local levels.
- Local governments would be invited to participate in the rehabilitation as part of a competitive exercise. Districts that made the best case for participation in the programme would be selected. They would ideally demonstrate a) need (broken/failed systems), b) willingness to cooperate with the initiative, and c) capacity to manage the programme in the long-term.
- The rehabilitation initiative would include a significant component of training and capacity building. It would seek to build a long-term strategy to manage remote solar systems, develop local private sector skills, create sustainable cash flows to cover the costs of systems, and work with existing vocational facilities.
- Any rehabilitation programme would be coordinated to work with private contractors working in the SHS supply sector and institutional power supply.

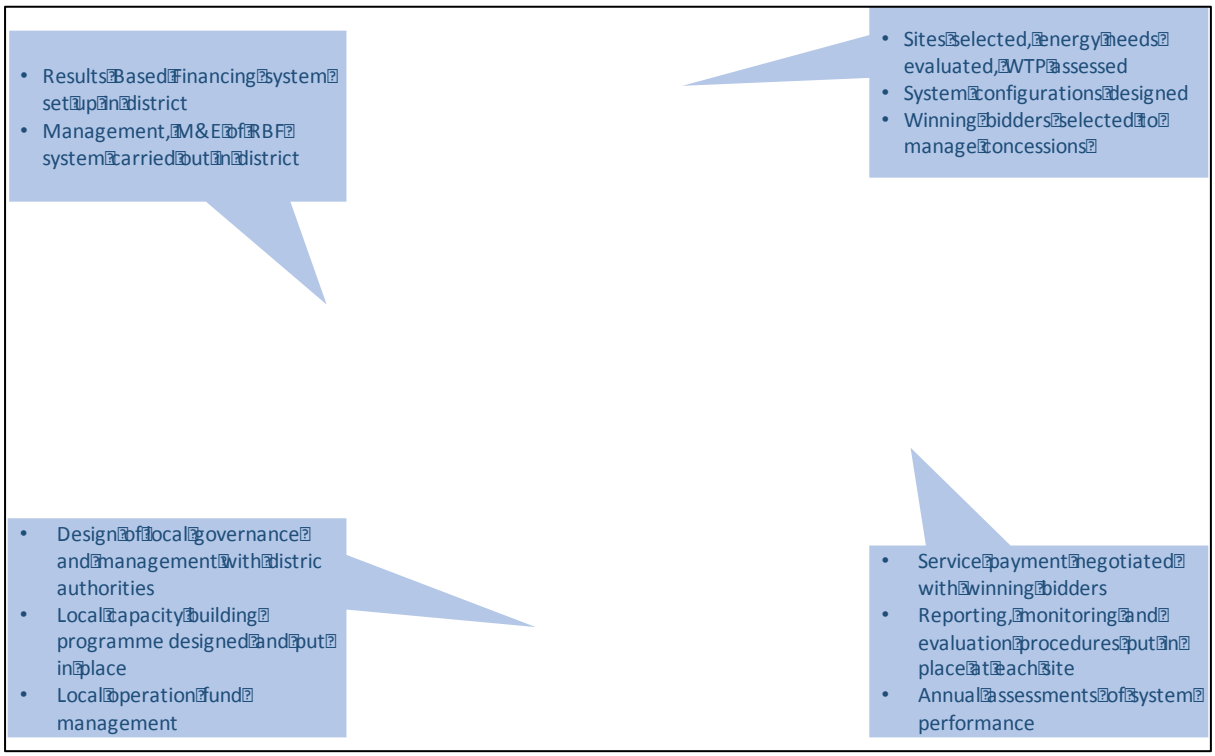
5.4 Next Steps

This section outlines the next steps for the implementation of the above study results. It recognises that, in order to implement the recommendations, significant changes would have to be made to the existing SSMP modalities. Because the on-going SSMP 2 work has already prepared terms of references, selected contractors and negotiated outputs, it would not be easy for DFID support, which has its own requirements, to be provided under SSMP. A redesigned SSMP programme would likely have to be developed in order for DFID to provide its support within a REA SSMP window.

Below, critical steps are outlined that would be required for the development of a refined SMMP program. First, a general agreement between REA and DFID on the overall scope of the project. Secondly, a full redesign of the SSMP programme (or launch of a completely new one) which incorporates the desired elements of the programme. This would necessarily include locally-based implementation and after-service elements of the programme.

Figure 7 below provides a summary of a programme. It would ideally be managed by REA with strategic inputs from service providers.

Figure 7: Next Steps: Elements of a Redesigned SMMP Programme



5.4.1 REA and DFID/SIDA Agreement on SSMP Redesign Parameters

Before moving forward with implementation, REA and DFID would have to agree on the basic tenets of a redesigned SSMP programme. Overall, agreement on whether to move forward with a programme would require common understanding of the following:

- Scope, boundaries and overall aims of the project
- Budget
- Time frame
- Geographical focus of project
- Management considerations (agency responsibilities, degree of capacity building requiring, need for out-sourcing of tasks, etc.)

5.4.2 Redesign of SSMP

A re-configured SSMP would be re-designed to address the short-comings identified above. A discrete activity would:

1. Prepare a time-bound project that is under REA overall management but outsources specific project elements that are not available within REA.
2. Decide on target districts.

A) Stand-Alone (SHS) Performance Grant Arrangements

As indicated above, we recommend that the REA wholly incorporate elements of the RBF programme into a SHS promoting component. The programme would be based on the successful market-building, local involvement and sales-based strategies of RBF. As needed, it could be adapted according to the specific needs of each district.

B) Design and Procurement of Institutional GMG Systems

This part of the project would be broadly similar to the previous activities for SSMP 1 and 2. The principle difference is that, instead of designing a number of stand-alone systems, the design would plan for integrated mini/micro-grid systems at each school, clinic, police post or cluster of buildings. Wherever possible individual buildings and clusters of buildings would be wired into a micro-grid which would be powered by a single power source at 240VAC.

The following process would be followed:

1. Sites would be selected and audited. At selected sites, energy needs would be evaluated and ATP and WTP would be assessed. If old PV systems are at the site, a plan for their removal would be put in place.
2. System configurations would be designed based on the needs of the included institutions. Base load projections would be provided to bidders based on these configurations.
3. Short-listed bidders would be encouraged to visit sites so that they can make their own system designs and so that they can also assess community power needs (which they might want to supply separately as part of their mini-grid system).
4. Winning bidders would be selected to manage concessions based on responsive proposals that include a) initial installation payments for sites and b) a service payment plan over a defined period.

C) Design of Service Contacts and Mini-grid Payment Arrangements

This part of the re-designed SSMP would replace procurement-based aspects of institutional equipment supply with service-oriented aspects of electricity delivery elements. As mentioned, clients (schools, clinics, public offices, staff houses) would be clustered into micro-grids and payments would be made based on a) kWh's of electricity provided and b) service reliability.

It is anticipated that, unlike the REA SSMP arrangements, payments to contractor/service providers would be broken into two components. The first component (which would cover major installation costs) would be paid by REA upon installation of the system according to agreed specifications and standards. The second components would be monthly payments from district sources based on demonstration that electricity had been provided according to defined service terms[42]. Mini-grids would supply institutional clients as "anchor loads" but would be able to flexibly supply power to other clients (households, businesses, etc.) based on extension of the mini-grid.

- Service payments would be negotiated with winning bidders based on standard contracts.
- Reporting, monitoring and evaluation procedures put in place in each district with monthly reports from the contractors to the REA, district offices and project management.
- Annual assessments of system performance would be provided as part of the monitoring work.

[42] Note that initial district payments would likely be managed by a project-based contractor before being handed over to districts following demonstration of the project success.

D) Local Capacity Building Arrangements

As mentioned above, a key part of this initiative would be to rehabilitating failed systems and building local capacities to address system failures. Companies that set up local mini-grids would be required to staff local mini-grids to ensure their operations. However, in addition to the use of companies with local staff is the development district-based capacity to manage, monitor and eventually finance the running of energy systems.

Therefore, the project, which would ideally select districts that desire to have systems rehabilitated, would work closely with districts to:

- Design local governance and management with district authorities.
- Build local capacity at the government, private sector and civil society level.
- Set up a district-based operation fund which would pay bills for institutional power over the life of the project.
- Finally, the project would utilize old equipment (modules, inverters, mounts, etc) to support local vocational training centres where local technicians, O&M staff and others can learn about solar technology.

Annex 1 Terms of Reference

TERMS OF REFERENCE (ToR): TECHNICAL ASSISTANCE TO SUPPORT THE RURAL ENERGY AGENCY (REA) OF TANZANIA

Background

1. The Rural Energy Agency (REA) of Tanzania is an autonomous body under the Ministry of Energy and Minerals (MEM) of the United Republic of Tanzania. It became operational in 2007 and its main role is to promote and facilitate improved access to modern energy services in rural areas of Mainland Tanzania.

2. Energy Africa is a UK (DFID-initiated) initiative to accelerate the expansion of the household solar market in Africa, helping bring universal energy access in the continent forward from 2080 to 2030. The core focus of the Energy Africa initiative is about removing policy and regulatory barriers to market expansion, and better co-ordinating donor support to the sector as a whole.

3. DFID supports a range of energy access activities in Tanzania including the AECF Renewable Energy and Adaption to Climate Technologies (REACT) Challenge Fund, the Energy & Environment Partnership programme (EEP), the Green Mini-Grids programme implemented by REA, and the Energizing Development (EnDev) Tanzania programme for Results-Based Financing (RBF) in Lake and Central Zones.

4. The REA's Sustainable Solar Market Packages (SSMP) constitute the Government of Tanzania's ongoing programme to advance distributed solar (for public institutions and households) in rural areas of Tanzania and promote the off-grid sector.

   - SSMP1 (Package 1) bundled the procurement of government funded PV installations for public facilities with requirements for commercial sale of solar home systems (SHS) to households. The package was awarded to one company through competitive bidding. The contract for the first package (SSMP1) was signed in January 2010 with a private company. SSMP 1 had a household target of about 8,000.
   - SSMP2 (Package 2) consisted of 8 lots with a total household target of about 70,000, which aims to provide electricity through stand-alone solar systems in 8 districts of Tunduru, Namtumbo, Bukombe, Sikonge, Kasulu, Kibondo, Chato and Bihara. This was awarded in 2014: 2 lots were awarded to a local company and 6 lots to a joint venture of 2 Chinese companies.

5. An evaluation of SSMP1 commissioned by the World Bank in 2014 identified challenges and alternative possible future directions for REA support towards the off-grid solar market. For example, some new business models, subsequently highlighted in SSMP2, have emerged in Tanzania and other African countries (e.g. fee for service, rent-to-own, or Pay-As-You-Go models). The successes of these may be attributed to: i) availability of new, compact, highly efficient solar pico systems (SPS) and appliances, and ii) the increasing availability of mobile phone financial transactions (mobile money). Companies are seemingly managing their costs and offering affordable prices to customers. This ongoing market evolution and cost reduction has implications for the incentive programmes offered by REA, and SSMP in particular.

6. DFID would like to review assumptions and likely impacts of the subsidy provided under SSMP2, given the changes in costs of solar available in the market up to 2017, and assess how much the REA could save (or how many more households or regions they could reach) with alternative or modified approaches.

7. DFID is therefore commissioning a reputable and independent consultancy firm/individual/consortium ("TA Provider") to support REA through a high level economic analysis of SSMP 2 in the current market conditions. This will be used to inform and provide recommendations for future approaches and support to the sector that reflect the ongoing evolution in the market and offer good value for money.

Project Objective, Outcome and Outputs

8. The objective of the proposed consultancy is to review REA's proposal for DFID and SIDA to support the Sustainable Solar Market Package 2 (SSMP2) programme and provide recommendations on how REA could achieve its desired results at a lower cost.

9. The outcome will be more rapid expansion in the Tanzanian off-grid solar market, through more efficient and effective deployment of public funds.

10. The proposed activities are:
    - Literature review – of all documentation related to SSMP and the latest information on the off-grid solar sector in Tanzania;
    - Consultation – with key partners in the Tanzanian government (notably REA, but possibly also MEM and the Energy and Water Utilities Regulatory Authority (EWURA)), key off-grid solar providers including those implementing SSMP2, and key international development agencies working in this sector (notably SNV, International Finance Corporation (IFC) and World Bank);
    - Analysis – of the main technical conditions and economic assumptions of SSMP, its funding needs, effectiveness and economic efficiency in the context of the evolving off-grid solar market in Tanzania (including energy service levels, product prices, availability of consumer credit and the targeting of SSMP) – this should draw on progress, results and lessons from the EnDev Results-Based Financing (RBF) for solar programmes to avoid duplication of effort; and
    - Synthesis – to produce clear conclusions and recommendations to guide REA and its partners.

11. The results for the study will be discussed with and presented to REA, DFID and SIDA.

12. The outputs of the work will be*:
    - An inception report detailing the approach to the assignment;
    - A draft report; and
    - A final report comprising maximum 20 pages plus annexes, and a Power Point presentation summarising the results of the work.

Cooperation Partners

13. To ensure the project builds on already produced results and complements activities of other organisations, the project will be implemented in cooperation with partner organisations:
    - GIZ / SNV will be asked to support the consultants by sharing information and providing relevant evidence;
    - International development partners that are active in the Tanzanian off-grid energy sector including SIDA, DFID, IFC, World Bank, and the African Development Bank; and
    - GOGLA members (https://www.gogla.org/members/current-members/) will be asked to provide country level information.

Timeframe

14. The time table for the delivery of the services is provided below:

Week 1	Inception report
Week 4	Completion of consultation and literature review
Week 5	Submission of draft report
Week 6	Presentation and discussion of outputs with REA, DFID and SIDA
Week 8	Submission of final report

DFID Coordination

15. The TA Provider will be contracted and work jointly with the Energy Africa Compacts TA Facility Supplier. Both the TA Provider and the TA Facility Supplier will be providing services under the CEIL PEAKS Contract which is managed by DFID Africa Regional Department's (ARD) Programme Manager. The draft and final deliverables will be reviewed and approved by the DFID regional adviser from ARD responsible for the TA Facility Supplier contract, in addition to DFID Tanzania.

16. The DFID Tanzania office will be the client for the project (alongside REA and SIDA) and will act as coordinator with all project partners and stakeholders.

Budget

17. The TA Provider is expected to provide the services outlined in these terms of reference within 20 consultant days at the appropriate rates as negotiated under the CEIL PEAKS Contract. The TA Provider will consider appointing locally based consultants for both national and international inputs.

18. Travel to Tanzania is required if not locally based and the expenses relating to two country visits of one consultant may be charged to this assignment. The TA Provider must follow DFID policy on travel and expenses and make their own travel and transport arrangements.

19. The budget for the work of the TA Facility Supplier in relation to coordination, contracting, project management and quality assurance is covered under a separate contract.

Required Expertise

20. The TA Provider should have qualifications and relevant experience in the following areas:

- Energy policies, regulations and institutional arrangements, particularly household and off-grid solar in sub-Saharan Africa;
- Off-grid energy programme evaluation and design;
- Energy sector economic analysis, particularly for the off-grid sector;
- Investment consulting, particularly in nascent industries and businesses in developing country contexts; and
- Work with donor agencies, African energy agencies (preferably Rural Energy Agencies) and the off-grid private sector.

Contract Management

21. The TA Provider will be contracted by and report to the TA Facility Supplier.

Responding to the ToR

22. In responding to these terms of reference, interested consultants should:
    - Provide CVs of proposed expert(s) and covering letter outlining their experience and ability to provide the TA services required. If more than one expert is proposed, a breakdown of the activities and number of days assigned to each team member should also be provided;
    - State their availability for conducting the TA services; and
    - Provide a budget for the in country visit and travel expenses in accordance with DFID's travel policy.

Duty of Care

23. The TA Provider is responsible for the safety and well-being of their Personnel and Third Parties affected by their activities under this Contract, including appropriate security arrangements. They will also be responsible for the provision of suitable security arrangements for their domestic and business property. The TA Provider is responsible for ensuring appropriate safety and security briefings for all of their Personnel working under this Contract and ensuring that their Personnel register and receive briefing as outlined above. Travel advice is also available on the FCO website and the TA Provider must ensure they (and their Personnel) are up to date with the latest position. In case of a situation where new security information, which is not in the public domain or would not be easily obtained by the TA Provider, is made known to DFID, a named person from the contracted organisation should be responsible for being in contact with the HTSPE Ltd and IMC Worldwide Joint Venture to ensure information updates are obtained. There should be a process of regular updates so that information can be passed on (if necessary). This named individual should be responsible for monitoring the situation in conjunction with the HTSPE Ltd and IMC Worldwide Joint Venture.

24. The TA Provider is responsible for ensuring that appropriate arrangements, processes and procedures are in place for their Personnel, taking into account the environment they will be working in and the level of risk involved in delivery of the Contract (such as working in dangerous, fragile and hostile environments etc.). The TA Provider must ensure their Personnel receive the required level of training and safety in the field training prior to deployment.

25. Tenderers must develop their Tender on the basis of being fully responsible for Duty of Care in line with the details provided above and the initial risk assessment matrix prepared by DFID (see Annex 2 to this Terms of Reference) or any other information

provided by the HTSPE Ltd and IMC Worldwide Joint Venture with this ToR. They must confirm in their Tender that:

- They fully accept responsibility for Security and Duty of Care.
- They understand the potential risks and have the knowledge and experience to develop an effective risk plan.
- They have the capability to manage their Duty of Care responsibilities throughout the life of the contract.
- They will give responsibility to a named person in their organisation to liaise with the HTSPE Ltd and IMC Worldwide Joint Venture and work with the HTSPE Ltd and IMC Worldwide Joint Venture to monitor the security context for the evaluation

26. If you are unwilling or unable to accept responsibility for Security and Duty of Care as detailed above, your Tender will be viewed as non-compliant and excluded from further evaluation by the HTSPE Ltd and IMC Worldwide Joint Venture.

27. Acceptance of responsibility must be supported with evidence of capability (no more than 3 A4 pages) and the HTSPE Ltd and IMC Worldwide Joint Venture reserves the right to clarify any aspect of this evidence. In providing evidence Tenderers should consider and answer yes or no (with supporting evidence) to the following questions:

- Have you completed an initial assessment of potential risks that demonstrates your knowledge and understanding, and are you satisfied that you understand the risk management implications (not solely relying on information provided by the HTSPE Ltd and IMC Worldwide Joint Venture)?
- Have you prepared an outline plan that you consider appropriate to manage these risks at this stage (or will you do so if you are awarded the contract) and are you confident/comfortable that you can implement this effectively?
- Have you ensured or will you ensure that your staff are appropriately trained (including specialist training where required) before they are deployed and will you ensure that on-going training is provided where necessary?
- Have you an appropriate mechanism in place to monitor risk on a live / on-going basis (or will you put one in place if you are awarded the contract)?
- Have you ensured or will you ensure that your staff are provided with and have access to suitable equipment and will you ensure that this is reviewed and provided on an on-going basis?
- Have you appropriate systems in place to manage an emergency / incident if one arises?

Annex 2 Minutes of the Project Kick-Off Conference Call & Stakeholders

Attendees

Jeremy Doyle - Technical Assistance Facility
Leanne Jones – DFID Tanzania
Mark Hankins – ASD Lead Consultant
Rafael Diezmos – ASD Support Staff to Mark Hankins
Federico Hinrichs – ECA
Almar Banja – ECA

Context

1. LJ: Relatively weak government leadership on off-grid energy
2. DFID entry point is the large Green Mini Grids (GMG) project with SIDA. £30m DFID contribution, with a £5.3m allocation for SHS. DFID commitment to this element is uncertain.
3. Change in president in Oct 2016 has led to movement on energy (industrialisation) but the focus is strongly on-grid — electrify all remaining 7700 unconnected villages. Target before elections 1M SHS by 2018. After elections, not mentioned any more. But, growing market for SHS in Tz, without government leadership
4. In the EA Plan of Action (Jan 2017), there was a specific action on scale up through SSMP engagement. SSMP has been running for a few years, request from REA for DFID to fill a funding gap (SSMP 2 and 3). Request has been pending for a few months – response needed (hence the TA). TA is to assess VFM and take account of the market today, working with SIDA and REA mainly.
5. DFID also supports SNV/EnDev RBF – DFID centrally managed programme. (lake zone and now central zone). Avoid competing programmes – need complementarity.
6. Ideal world – build on what is happening already. See if possible to show that there will be better results if we adjust the SSMP model: move from procurement to competitive
7. SSMP II awarded- 8 lots
8. Richard Hosier has the background on SSMP II. WB declined to support SSMP II

TOR comments/discussion

9. MH: since SSMP 1 the market has changed and grown. PAYG systems, multiple suppliers, investable market. Companies now split between mini-grid/institutional solar and SHS markets.
10. Useful data now out on costs in Kenya.
11. Team will engage with SIDA, USAID, AFDB, WB, REA, SNV, GOGLA, Mobisol, etc to get available info. Move to analysis (ECA), then review SSMP approach making recommendations.
12. GMG programme is well-designed on paper
13. Implementation is harder
14. Good value for money programme that REA could implement without too much extra work
15. Suggest instruments

Next steps

16. LJ to share SSMP 2 status report with consultants asap.
17. First deliverable Inception Report due 30 May.
18. MH in Dar 5-9 June. Then 26-29 June to present results (dates to be confirmed (LJ))

Annex 3 **Stakeholders Consulted**

Name & Designation	Organization	Contact Details
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Annex 4 List of References

No	Title	Author	Publisher	Year
1	Accelerating Access to Electricity in Africa with off-grid Solar	Overseas Development Institute (ODI)	Overseas Development Institute (ODI)	2016
2	Invitation for bids (IFB) Tanzania Energy Development and Access Expansion Project (TEDAP)	Rural Energy Agency (REA)	The United Republic of Tanzania	2008
3	Target Market Analysis – Tanzania's Solar Energy Market	Integrated Energy Solutions (IES); Mark Hankins, Anjali Saini, Paul Kirai	GIZ	2009
4	Sustainable Solar Market Package (SSMP) Approach: An Evaluation of the Experience with SSMP1 and Suggestions Going Forward	Ernesto N. Terrado	TEDAP	2014
5	Target Market Study Tanzania – Solar PV & Wind Power	Delegation of German Industry and Commerce in Kenya	AHK	2013
6	REA Project, Tanzania – Africa Energy Forum Presentation	Francis Kibhisa	Rex Energy (Tanzania)	2016
7	First Quarter Verification and Performance Review Report	Tanzania Electrical, Mechanical and Electronics Services Agency (TEMSEA)	TEMSEA	2017
8	How Results Based Financing is Spurring Solar Market Development in Tanzania	SNV	SNV	2017
9	Results Based Financing (RBF) for Rural Market Development for Pico-Solar	SNV	SNV	2017
10	Study - Pico-Solar for All	SNV	SNV	2017
11	What is Results-Based Financing	INSTIGLIO	INSTIGLIO	2017
12	Lighting Africa	Off-Grid Solar Market Trends Report	Bloomberg New Energy Finance and Lighting Global	2016