



Adaptation of Feed-in Tariff for remote mini-grids: Tanzania as an illustrative case



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ABSTRACT

Following the successful Feed-in Tariffs (FiTs) system worldwide, few countries have implemented FiTs explicitly tailored for off-grid or mini-grid systems. This study takes an integrated approach to examine the feasibility of an off-grid Feed-in Tariff (off-FiT) for existing and new remote mini-grids in Tanzania, using a combination of geographical analysis, technical, economic and institutional assessments. Based on detailed modelling of two community off-grid cases, (i) PV-diesel and (ii) mini-hydro, we identify least-cost rural electrification options that make solar and mini-hydro energy competitive with diesel generators and potential effect of the support scheme on rural electrification plans. In the first case, we illustrate where the off-FiT complements diesel generation of an existing mini-grid (PV-diesel). In the second case (mini-hydro), we illustrate conditions where the off-FiT policy brings mini-hydro generation to non-electrified communities and sells renewable electricity directly to new customers.

Currently, Tanzania has Standardized Power Purchase (SPP) rates, which target generators connected to the national grid and distribution systems of mini-grids or isolated grids. We found for the off-FiT tariff the total amount needed to support the same number of customers by solar and hydro-mini grids versus diesel would be of 31.5 million US\$, or a premium of 0.11 US\$/kWh to the present current SPPs tariff of 0.24 US\$/kWh for PV. We also found that a technology specific FiT tariff would be most suitable to attract national and international investors by providing a rate of return that compensates the risk of the investment. The overall support is comparable to the 36 million US\$ that the government currently subsidizes and allocates to diesel mini-grids in country, and this shows the potential for a long-term renewable energy strategy for mini-grid areas.

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1. Introduction: Feed-in Tariffs for renewable energy in Africa

There is a growing interest in promoting renewable energy development in Sub-Saharan African countries as a way of providing a more independent energy pathway that transitions from dependence on external resources. Renewable energy generation in Sub-Saharan Africa can offer off-grid electrification in rural areas where national grids are non-existent [1,2]. Renewable energy can also play a role in decarbonizing national electricity supply and diversifying the energy mix. Renewables can provide revenue for household and community level energy technologies to make a contribution to national generation and expand energy access. In Tanzania only about 14% of the population has access to electricity, with only 3% in the rural areas [3]. There is a wide array of technologies and possible technical solutions that provide electricity services to rural consumers. These solutions range from an individual system to power a single house, to a mini-grid that can electrify a whole village. Effective policy mechanisms for renewable energy promotion are needed to develop and expand renewables in a Sub-Saharan African context [4]. This study focuses on the application of renewable energy to mini-grids limited to systems above 10 kW and up to a few MW [5].

1.1. Generic FiT

Traditional Feed-in Tariffs (FiTs) have been one of the most successful support mechanisms to increase the deployment of renewables in national electricity grids and its application is rapidly spreading [6]. Because renewable energy technologies' costs have reached around grid parity, many developed countries have adjusted their FiT rates. Globally, there are more than 80 countries where such traditional FiTs are in use [7]. Feed-in Tariffs policy encourages the introduction of renewable energy through fixed electricity payments per kWh produced by renewable resources (most commonly solar, wind, geothermal and small hydro), which is "fed into" the grid [6]. A typical Feed-in Tariff often differentiates the rates by technology category. Within the traditional FiT model, payments are usually covered by re-distributing costs amongst all electricity end-users.

1.2. FiT in Africa

In this last decade, traditional FiTs have gained increasing attention as a renewable energy policy mechanism especially for developing countries [8–11]. Competitiveness in developed countries allows for reduced FiTs, however, in developing countries as the users pay lower prices, the FiT mechanism can alleviate the price difference. Several African countries have already introduced the FiT policy (such as Algeria, Kenya, Mauritius, Rwanda, South

Africa, Tanzania, and Uganda) and many proposals are underway, either developing their FiT or planning: Botswana, Egypt, Ethiopia, Ghana, Namibia, and Nigeria [12]. However, the different context of applying FiT programs in African environments demands additional analysis. Power sector reforms have been under way for many years, and the new systems are built on shifting regulatory institutions and goals. Access and affordability are paramount concerns, adding complexity to tariff design. Energy governance and finance are connected to international institutions and development aid, so tariff changes face constraints, but at the same time, some additional potential opportunities for allocating financing [13].

1.3. Feed-in Tariff for promoting rural electrification: a viable option?

In many African countries, the utilization of various renewable energy sources represents the least-cost option for rural electrification [1,14]. Traditionally the promotion of renewable energy technologies in rural areas has been supported by international donations or governments subsidizing the initial capital investment of generation technologies. Unfortunately, this has not been adequate for improving the access to modern energy in Tanzania, or Sub-Saharan Africa in general [15], and the traditional government policies based on the extension of electricity grid have achieved a limited success in increasing access to electricity [16]. Policy makers should not therefore assume that a Feed-in Tariff policy for off-grid areas will incur significant additional costs over conventional technologies [11,17]. To ensure sustainability of systems, a FiT scheme for off-grid areas focuses on the cost of producing electricity, i.e. delivery of the service during the whole project lifetime (15–20 years), rather than just the delivery of the physical components of the project. By this, we can ensure that the funds will be available not only to commence a project, but to maintain its operation.

1.4. Aim

Tanzania is a particularly relevant case for examining the off-FiT scheme in Sub-Saharan Africa because of its broad institutional efforts to support renewable energy. Our study examines the feasibility of an explicitly tailored FiT that can support rural electrification in Tanzania where the existing regulatory and institutional context might need minor modifications. The so-called off-grid Feed-in Tariffs (off-FiT) is a variation of the FiT scheme for isolated areas and mini-grids that are not directly connected to the main national grid. Specifically, Tanzania has Standardized Power Purchase (SPP) rates, which are explicitly aimed at distribution systems in mini-grids or isolated grids. In the Tanzanian context, funds to support rural energy (the Rural Energy FundREF) including

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