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SUSTAINABLE RURAL ELECTRIFICATION

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Related Sustainable Development Goals

Goal 07	Ensure access to affordable, reliable, sustainable, and modern energy for all
Goal 08	Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all
Goal 12	Ensure sustainable consumption and production patterns
Goal 13	Take urgent action to combat climate change and its impacts

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Introduction

It is estimated that 85 percent of the 1.2 billion people in the world living without access to electricity reside in rural areas, which is attributable to the marginalization of the poor as well as their long distance from established electrical grids[1]. In order to address this lack of access to electricity and to prevent a growing dependence on fossil fuel, researchers have argued for the use of small-scale renewable energy production[2]. This brief will focus on Sub-Saharan Africa (SSA) as a region in great need of rural electrification since it only has 14.2% rural electrification, which makes it the most energy poor rural area in the world[2].

By the year 2012, of the USD 41 billion, which is annually needed in the power sector in Africa in order to achieve universal energy access by 2030, the continent invested approximately USD 11.6 billion[3]. This brief will focus on analyzing finance mechanisms that can contribute to fill this substantial gap. It will also concentrate on solar-powered electrification systems that are one of the most common small-scale electrification system types of the region. In fact, solar energy in particular is a great opportunity for pro-poor energy access in Africa because it is naturally ubiquitous, accessible in large quantities, progressively low cost, non-vulnerable to supply or price fluctuation (contrarily to fossil fuel), and compatible with the global consensus to increase low-carbon energy generation[4].

This brief's main objective was to inventory innovative and efficient mechanisms for financing rural populations access to sustainable energy -specifically photovoltaic systems (PV)- and to identify critical indicators for evaluating their efficiency. For this purpose, case studies and models of finance mechanisms were analyzed and assessed by weighting their weaknesses and strengths, and assessing their feasibility and adaptability within remote areas in SSA in order to the three best-fitting finance mechanisms determined by our metrics analysis.

Sector-Specific Issues

Mostly, non-urbanized lowly populated, rural areas with a lower educated and poor population represent a big challenge in the expansion of electrification through renewable energy. The three main problems for financing renewable energy infrastructure and the provision of services are: level-playing field for all types of energy, easy market, and political and regulatory investment risk[3]. From these main three barriers there are some ramifications that also hamper the development of PV in rural areas. Those barriers can be financial, technological, and cultural. Financial hurdles to rural electrification are ascribed to: 1) a lack

of appropriate end-user financing mechanisms, 2) a difficulty for local businesses to access working capitals and credits at low cost, 3) a lack of relevant mechanisms and organizations to convey finance towards end-users (small enterprises and consumers), and 4) an investment uncertainty (Risk of non-payment by end-users and small enterprises. Technologically, rural regions are expensive to electrify because they are far from the grid ending in general on the outskirts of cities.

Finance Mechanisms

Utilizing quantitative and qualitative information gleaned from a review of case studies and peer-reviewed research papers on rural electrification, finance mechanisms for rural electrification were evaluated based on criteria that assess the mechanisms' ability to overcome sector-specific barriers. Nine criteria were derived from the sector-specific barriers and ranked in order of importance for success (Table 1). The criteria rankings were used to apply a weight to each mechanism, from 1.3 to 0.6. Then the finance mechanisms were rated according to each criterion from 1 to 10 (please see explanations for the ratings in Appendix 1). The finance mechanisms rankings were weighted according to the criteria rankings, resulting in weighted total points for each finance mechanism. The results of this point's assessment are shown in figure 1. Total points were the highest for Pay-as-you-Go, Fee-for-Service, and NGOs (i.e., donations). In order to illustrate the workings of these three finance mechanisms, we selected case studies, which are detailed in the following section.

1) *Financial sustainability*
2) *Reliance on government financing or policy support*
3) *Ease of initial implementation*
4) *Ability to mitigate risk*
5) *Scope of reach*
6) *Cost to consumers*
7) *Reliance on business or administrative supports*
8) *Breadth of applicability across countries and contexts*
9) *Ease of use with solar PV technologies.*

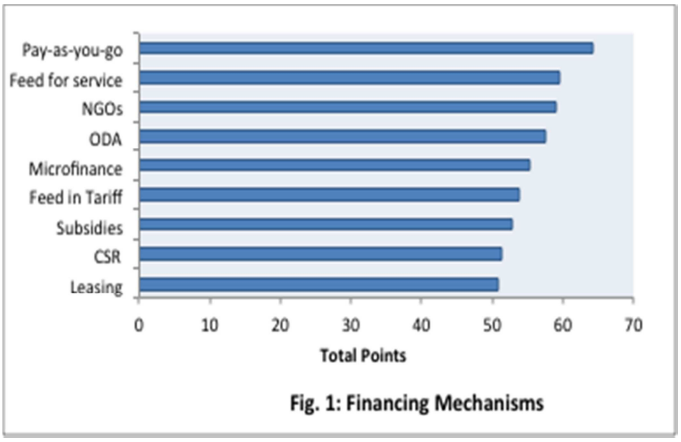

Fig. 1: Financing Mechanisms

Table 1: Criteria of Finance Mechanisms Evaluation

Case Studies that illustrate the top three mechanisms

Pay-as-you-Go (PAYG)

The small scale enterprises and end users finances constitute the key finance chasm for rural electrification; in fact, the high cost of working and start-up capital for those enterprises make their products and services less affordable for rural populations. The pay as you go model, a mobile-enabled payments method, has proven to be a good tool to remove those barriers. Indeed, it enables to decrease the working and start-up capital for investors, and allows flexibility in end-users payments[5]. Not only does this payment method allow consumers to split their monthly bills into smaller and more affordable installments payable at any time, but also it decreases the uncertainty for investors by an ongoing payment[6,7]. The situation of SSA, where less than 37% of the population has access to electricity but where the mobile network covers more than 74% of the population[8], represents a great opportunity for this innovation[5]. Thus, new innovating models of PAYG have been created, for example, M-Kopa, Mobisol, Azuri Technologies, and Fenix International[5,6,7,9]. More than 82 million people in Kenya, Tanzania, and Uganda, and about 59 million only in Nigeria, West Africa could have access to energy through the mobile enabled energy service.

In Kenya, South Sudan, Zimbabwe, Tanzania, Rwanda, and South Africa, Azuri technology uses the indigo

scratch cards system for electricity payment of 20,000 customers. Customers pay US$10 for installing a home lighting system and then a scratch card of about US$1.50 per week enabling them to have electricity. Consumers can pay off their unit and upgrade for the Escalator, which is a more powerful model.

Fee-for-Service

A common finance mechanism used across Africa is the fee-for-service utility model. This follows the finance model of a leasing arrangement, wherein the company—in this case the Energy Services Companies (ESCOs)—supplies the PV equipment (which remains the property of the company) and also provides the service and maintenance[3]. "The initial investment for these solar home systems remains unaffordable for the majority of the end users living in rural areas of developing countries[9]. Some experts argue that these models can provide greater affordability to rural households because large capital purchases are not necessary[10]. "People don't take care of things that they get for free[10]", especially when there is no information on how to manage the solar equipment. On the other hand, by the fact that the ESCOs provide end-users with information and feedback allows them taking more care of the equipment. Thus, the equipment lasts longer, which makes it more profitable for the ESCOs[9].

In countries like South Africa, Morocco, Argentina, Kiribati, and Zambia, governments have opted to take partial responsibility for funding the infrastructure development and supply a subsidy. "The PV solar equipment needs to be subsidized because the purchasing power of inhabitants remains low and there are no local financial institutions ready to offer loans to small rural companies, subsidies must cover 50-70% of the capital cost"[11]. But the state alone cannot manage to be responsible for the whole process, so some of them rely on public-private partnerships (PPP). The South African and Zambian governments are involved in the financing of solar photovoltaic equipment that private business (the fee-for-service schemes) needs to supply its energy services in rural areas. In these successful PPP cases, the Zambian government bought equipment with donated money and lent them to the Energy Services Companies (ESCOs), which in turn must pay this money back in 20 years [11].Some of the successful cases of fee-for-service mechanisms have demonstrated that it depends on the stability and commitment of the government for financial support through appropriate budgetary allocations[3]. But although the main financing comes from the government, the fee-for-service model gives opportunities for an entrepreneurial approach.

Non-Governmental Organizations

Non-Governmental Organizations (NGOs) can work as a valuable mechanism to provide PV solar services to rural communities in SSA. At local level they can serve as intermediaries between donors or equipment/service providers and the community, but they can also break the top-down structural barriers and fill the intermediate level between the national, local and political[12]. The main services that NGOs provide in PV solar services are those of purchasing, guidance, support and advising on the benefits of solar technology and the correct use of the system/service[13]. In Africa, NGOs tend to operate on a more commercial model than government-run programs and encourage the use of global funds to support sustainable development projects[14]. "Experience shows that some traditional NGOs have operated successfully as Market facilitation organizations by adopting a greater private-sector orientation" [10]. These relationships can also be viewed as a PPP.

An example of an effective NGO is the Traditional Energy Development (TaTEDO) of Tanzania. TaTEDO promotes and establishes small- and medium-scale entrepreneurs and works closely with governments and communities to develop partnerships and consultancy services in the green energy sector [15]. TaTEDO has experienced that the lack of management (besides traditional thinking and gender) is one of the

major constraints. "The solution lies in securing good management through income by generating productive use of electricity" [12]. The downside of NGOs is that the projects work when the NGOs are on site before, during, and after the implementation; but the projects fail when they leave the local communities without the empowerment and pertinent preparation needed for continuing administrating the electrification programs[16].

Opportunities and Risks

No one mechanism to finance rural electrification via solar in Africa is truly the best across all criteria. Governments must therefore take into account their own rural electrification, environmental and development goals and solvency capacities to support the finance mechanism that will satisfy these goals. "The most powerful incentive mechanism for renewable energy deployment in developing countries was the establishment of clear national targets for renewable energy" [17]. Thus, financing for solar electrification--and presumably all sustainable development financing-- does not occur in a vacuum, but instead requires the coordination of public and private forces. In many of the successful cases, more than one finance mechanisms were implemented and incorporated into a singular program, wherein the government and private entities work together to create socially as well as financially profitable outcomes. Lessons drawn from cases such as the PAYG show that those countries can use business structures that are already in place to achieve sustainable development goals. The role of the government in this example is to create a conducive environment for such solutions to growth exemption on solar products, or reduce import taxes [18]. Instead of financing development sectors for sustainability in a piecemeal manner, a more holistic view can be taken in order to accomplish several development goals with one program.

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Appendix 1: Research methodology

Table 1. Explanation of Criteria Ranking Scale

Criteria	Explanations
Financial Sustainability	10: the finance mechanism always maintains solvency 7: the finance mechanism usually maintains solvency 5: the finance mechanism sometimes maintains solvency 3: the finance mechanism often leads to insolvency 1: the finance mechanism always leads to insolvency
Reliance on Govt Financing/Policy	10: the finance mechanism requires no government financial or policy support whatsoever 7: the finance mechanism relies on one fairly difficult-to-maintain policy and/or some government funding 5: the finance mechanism relies on one fairly difficult-to-maintain policy and/or some government funding 3: the finance mechanism relies on a moderate number and/or somewhat politically difficult to maintain policies and/or financing 1: the finance mechanism relies on many and/or politically very difficult-to-maintain policies and/or financing
Ease of Implementation	10: implementation is practically automatic; all infrastructure is already existing 7: much existing infrastructure and/or required infrastructure is not extensive, time-consuming or costly to establish 5: some existing infrastructure and/or required infrastructure is somewhat extensive, time-consuming and

Criteria	Explanations
	costly to establish 3: little existing infrastructure and/or required infrastructure is fairly extensive, time-consuming and costly to establish 1: no existing infrastructure and required infrastructure is extensive, time-consuming and costly to establish
Mitigates Risk	10: completely removes all financial, technological, and political risk 7: removes most financial, technological, and political risk 5: removes some financial, technological, and political risk 3: removes little financial, technological, and political risk 1: removes no financial, technological, and political risk
Scope of Reach	10: reaches all of the target population 7: reaches much of the target population 5: reaches some of the target population 3: reaches a very low percentage of the target population 1: reaches almost none of the target population
Cost to Consumer	10: energy provided is practically free to consumers 7: consumers spend a relatively low percentage of their monthly household budget on energy 5: consumers spend an expected percentage of their monthly household budget on energy 3:consumers spend a fairly high percentage of their monthly household budgets on energy, not cutting into other necessities such as food or health care 1: consumers spend a high percentage of their monthly household budgets on energy, cutting into other necessities such as food or health care
Reliance on Business/Admin Support	10: the finance mechanism requires no, or almost no, financial institution/business and administrative support 7: the finance mechanism requires limited financial institution/business and administrative support 5: the finance mechanism requires some financial institution/business and administrative support 3: the finance mechanism requires much financial institution/business and administrative support 1: the finance mechanism requires continued and intensive financial institution/business support and/or continued and intensive administrative support
Breadth of Applicability	10: the finance mechanism can be applied in any country and in any context 7: the finance mechanism can be applied in most countries and in most contexts 5: the finance mechanism can be applied in some countries and in some contexts 3: the finance mechanism cannot be applied in many countries and contexts; the mechanism may require specific circumstances to function properly 1: the finance mechanism cannot be applied in most countries and contexts; the mechanism requires very specific circumstances to function
Ease of use with solar PV/Longevity	10: systems are always high quality and well-maintained; financing and program type are ideal for use with solar PV 7: systems tend to be of higher quality and are well-maintained; financing and program type are generally suitable for use with solar PV 5: systems may be cheaply made and ill-maintained; financing and program type may be suitable for use with solar PV 3: systems tend to be cheaply made and ill-maintained; financing and program type not very suitable for use with solar PV 1: systems tend to be cheaply made and ill-maintained; financing and program type not at all suitable for use with solar PV

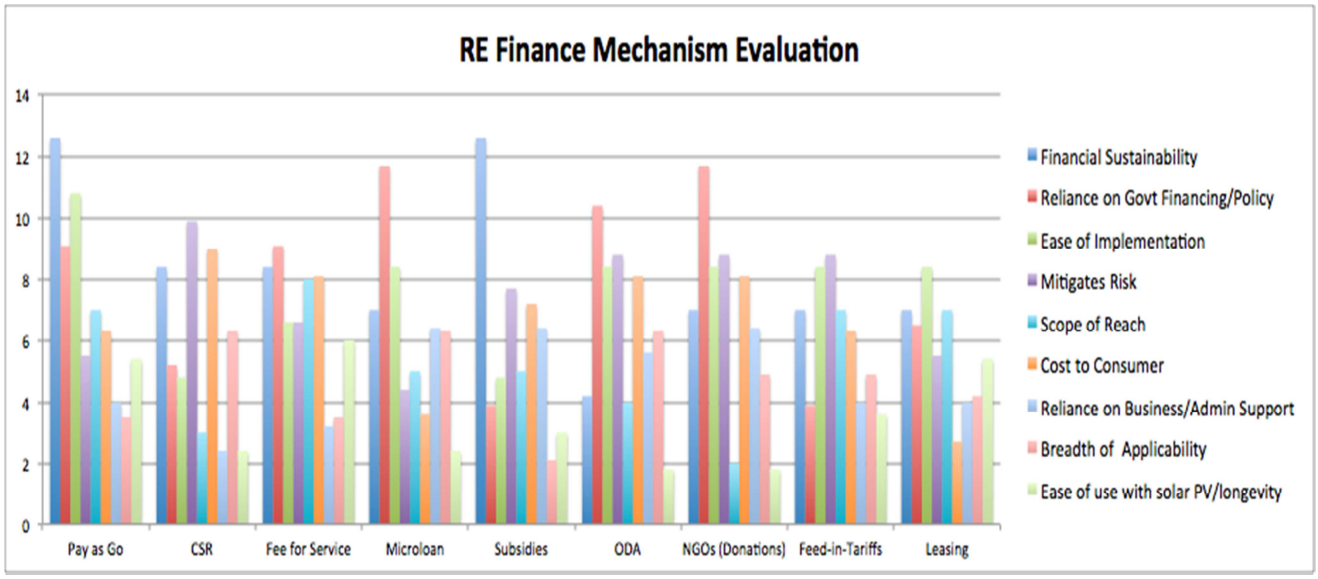

Figure 2: Financing Mechanisms Evaluation

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