"Project Formulation Survey" under the Governmental Commission on the Projects for ODA Overseas Economic Cooperation in FY2013

Summary Report

Republic of Kenya

Study on Providing Power to Un-electrified Villages through Utilizing Small Wind Turbines and Base Transceiver Stations in Kenya

March, 2014

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The content of this report is a summary of the project formulation survey, which was commissioned by the Ministry of Foreign Affairs of Japan in the FY 2013 and is carried out by the consortium of Zephyr Corporation and Pacific Consultants Co., Ltd. It does not represent the official view of the Ministry of Foreign Affairs.

Introduction

The "Study on Providing Power to Un-electrified Villages through Utilizing Small Wind Turbines and Base Transceiver Stations in Kenya" was carried out by the study team formed by Zephyr Corporation and Pacific Consultants Co., Ltd. from September 2013 to February 2014. The main objective of the study was to examine the feasibility of utilizing Zephyr's small wind turbines and base transceiver stations (BTSs) of the mobile network operators to enhance electricity access in rural Republic of Kenya (hereinafter Kenya) through an official development assistance (ODA) project.

I. Description of the current situation and development needs of the development issues in the surveyed country

The electrification rate in Kenya was mere 18 % in 2010 and 34 million people lacked access to power. In the rural area this figure is down to 5 % which is comparably lower than the Sub-Sahara African average of 13 %. Many people are forced to use kerosene for lighting and travel long distances to charge their cell phones.

To the contrary, the penetration rate of cell phones is increasing dramatically in Kenya. Cell phones have become a necessity for even the people living in very remote locations. Not only for use in talking and texting, they are becoming more and more utilized for money remittance and gathering information on agricultural produce prices for instance. There was a 15.6 % increase in the penetration rate over the past year and the figure stood at 74 % in 2012. Along with the growth in the number of mobile users, more and more new BTSs are being established, many of which are in un-electrified areas as well.

There is scope to improve the access to power of the rural population in Kenya by installing Zephyr's small wind turbines onto the antenna towers of these BTSs. The current study examines the feasibility of implementing a public-private partnership project which will provide power to the BTSs and rural population at the same time in the currently un-electrified areas of Kenya utilizing Japanese ODA.

II. Possible applicability of the SME's products and technologies, and prospects for future business development

Zephyr Corporation was established in June 1997. Since 2006, it has been manufacturing and marketing the ultra-light weight small wind turbine the "Airdolphin." In 2012, Zephyr enhanced its product lineup by entering into partnership with the top British small wind turbine manufacturer and adding the "Zephyr9000." Through technical development on hybrid-standalone power supply system utilizing small wind turbines and other energy sources, Zephyr is aiming to become the top global company in the provision of small renewable energy solutions.

Zephyr is planning to pursue two business possibilities in response to the results of the current study. First, it will promote the sales of its small wind turbines to the mobile network operators and their subsidiaries which own the BTSs. In Kenya, power supply to BTSs normally falls under the responsibility of the integrators. In many cases, it is the integrators which promote new products to the BTS owners. For this reason, Zephyr will appoint integrators which service the BTSs as its local distributor. Zephyr is also considering of adding local companies which deal with renewable energy products and familiar in wind power as its installer or distributor.

Second, Zephyr will continue to explore the feasibility of a RESCO (Renewable Energy Service Company) business which will provide stable power supply at an affordable price to BTSs and the surrounding population. In RESCO business, small wind turbines, hybrid-standalone power supply technology and BTS antenna towers will be utilized for power generation. The customers will consist of mobile network operators which are heavy and stable users of power and the rural population who

have limited capability to pay. This combination is expected to enhance the sustainability of the RESCO business and allow affordable power pricing for the rural population.

So far, the Ministry of Energy and Petroleum of Kenya has welcomed the RESCO business concept. Several Kenyan companies which have potentials of becoming partners for the RESCO business have been identified. The largest network operator in Kenya, Safaricom has agreed that Zephyr and a local integrator which maintains Safaricom's BTSs to conduct a product trial.

Efforts will be concentrated on making sure that the product trial succeeds and obtaining the confidence of Safaricom towards Zephyr's small wind turbines. Once the small turbines are accepted by Safaricom, Zephyr will make efforts to penetrate into the Kenyan BTS market. It will then enter other east African countries with its local partners.

Efforts to realize the RESCO business will be accelerated once the BTS business takes off. In order to realize the RESCO business, several hurdles need to be cleared. They are: 1) establishment of feasible methods to provide power to the local population; 2) establishment of business partners; 3) development of a business plan; and 4) securing of finance and establishment of RESCO.

III. Verification of adaptability of the SME's products and technologies to the surveyed country (Demonstration and pilot survey)

Meetings with relevant companies and organizations, a seminar and trials were conducted during the study to introduce and to verify the applicability of Zephyr's small wind turbines and its business proposal.

In the meetings, many expressed interests in Zephyr's products and particularly valued the fact that the Airdolphin was so light that it can be fitted onto existing antenna towers. At least five companies showed an interest in distributing Zephyr's products. Some have suggested that the small wind turbines may not only be used for BTSs but can also serve as a backup power supply and be used for operating pumps to draw ground water.

As for the RESCO business concept, the Ministry of Energy and Petroleum provided a favorable feedback and asked the study team to realize such idea. However, some have suggested that if the RESCO was to provide power through a micro-gird, the cost implications and regulations may render the business economically unfeasible. There was a company exploring the feasibility of rural electrification by a standalone renewable energy system and micro-grid but there seemed to be nothing more than pilot projects towards this end. Safaricom seemed to be indifferent to the RESCO business concept judging from the words of one of its managers who stated that Safaricom is only interested in securing power for its BTSs and will not allow the use of land or antenna tower it owns for providing power to the rural population. Although this cannot be taken as the official stance of Safaricom, overcoming such indifferences is critical to realizing the RESCO business.

Forty organizations were invited to the seminar titled "Small Wind Turbines for Base Transceiver Stations and Rural Electrification" which introduced Zephyr's products and business ideas. Only 21 people participated despite 37 had promised that they would be present. Nevertheless the representatives from the 14 organizations which participated including the Energy Regulatory Commission, Kenya Power and Airtel Africa actively engaged in the event asking questions on the performance and price of Zephyr's products, Zephyr's business structure in Africa, JICA "Private Sector Investment Finance" and the recently started "Joint Crediting Mechanism" between Japan and Kenya.

The trials for Zephyr's products were conducted in Mombasa and Naivasha. The applicability of the products to the anticipated project and business in Kenya was assessed on the following grounds:

- Understanding of the products and technologies;

- Designing of systems using the products;
- Installation of the products;
- Operation and maintenance of the products; and
- Usefulness of the products.

The trial in Mombasa was conducted at a Safaricom owned BTS site. The BTS is connected to the grid but experiences frequent power outages. The two Airdolphins installed was expected to act as a backup power supply. This means that the turbines can only generate power when the voltage of the batteries which provide power to the BTS falls below a certain threshold. The trial at this site does not allow the demonstration of the basic performance of the small wind turbines which is normally done by measuring and comparing the wind speed and power generation.

The trial in Naivasha was conducted at a farm in an un-electrified area. An Airdolphin was added to an existing power supply system consisting of a diesel generator set, solar PV modules and a battery bank. The aim of the trial here was to demonstrate the performance of the small wind turbine in an environment which is not affected by grid power. Wind and generation data will be obtained to objectively demonstrate the performance of the Airdolphin.

At Mombasa, the trial started in 15 December 2013. During the 36-day trial, 6.6 kWh was generated by each Airdolphin installed. The average wind speed was 3.1 m/s. The generation performance of the two Airdolphins proved to be normal. However, because the wind speed was low during this trial period, the full potential of the small wind turbines was not realized. The fact that the BTS is connected to the grid also affected the power generation by the small wind turbines.

The start of the trial at Naivasha was delayed by a month because of the long delay in customs clearance of the inverter. The trial started on 11 January 2014. The power generated by the Airdolphin during the ten-day trial period was 2.7 kWh. The average wind speed was 2.1 m/s. The small wind turbine was performing to specifications but because the wind speed was not reaching the cut-in speed of 2.5 m/s during most of the trial period, again the full potential of the small wind turbine was not realized.

From Zephyr's past experiences, it is known that a trial period of at least three months is required for a mobile network operator to decide on the introduction of a new product. In the current study, because of the low wind speeds to date, it has not been possible to demonstrate the full potential of the small wind turbines. It is not possible to demand Safaricom to adopt Zephyr's products at this stage. The trials will be continued to obtain further data.

Taking into consideration the results of the trials, the feasibility of the RESCO business model was examined as shown in Figure 1. The model site is assumed to consist of a BTS and 20 rural households. Assuming an average wind speed of 5 m/s and four Airdolphins installed, the available power would be 8.4 kWh/day. If the power was sold to the BTS (i.e., the network operator) and rural households at 2 USD/kWh and 1 USD/kWh respectively, the annual sales amount to 5,621 USD. The return on investment is approximately five years as the initial start-up cost which includes the product, transport and installation costs is estimated to be 27,520 USD. Under this model, an average household is assumed to consume 70 Wh/day. The average power cost to the household will be 2.1 USD per month, which is lower than the current budget spent on lighting by many un-electrified rural households.

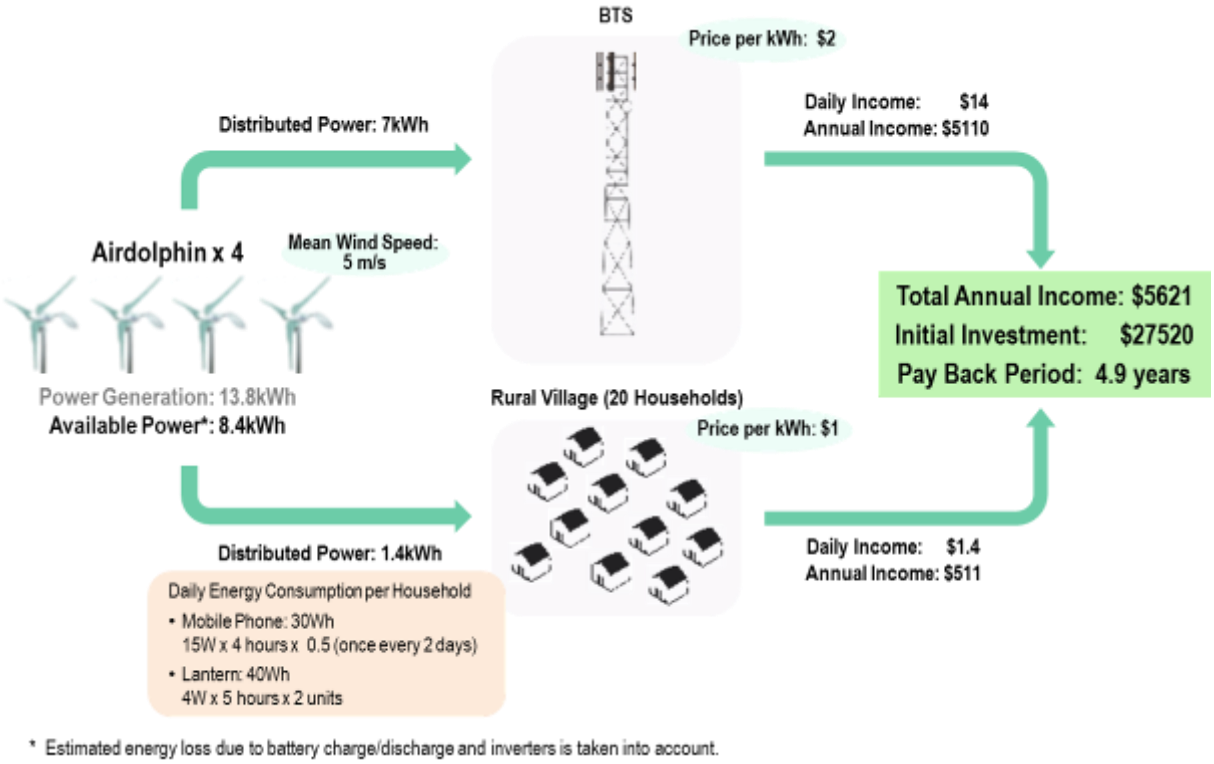

Figure 1: Feasibility simulation of RESCO model

IV. Expected development impact and effect on business development of the proposing SME in the surveyed country through proposed ODA projects

Airdolphin is light and compact. It can be installed at BTS sites scattered in remote locations. Unlike diesel generators, refueling and regular maintenance are not required and there is no risk of fuel theft. Unlike solar PV modules, the Airdolphin can be mounted high on a tower and is less likely to be stolen. The integrator maintaining the BTSs in the un-electrified northern border area believes that the Airdolphin will solve many of the problems it is facing.

The RESCO business concept was welcomed by the Ministry of Energy and Petroleum and others have also shown interests. Power needs in rural Kenya is becoming more and more prominent partly because of initiatives such as the Laptop Project promoted by the Kenyan Government. However, as explained earlier, connecting households by a micro-grid poses a big challenge.

In rural areas, water supply is also a problem. One of the companies visited was supplying its own wind turbines to water supply projects. Zephyr's small wind turbines may also have a role in such projects as well.

In the RESCO business, by utilizing the revenue stream from the power sales to the BTSs, the surrounding un-electrified rural population will have access to affordable and stable lighting and power. BTSs will also benefit from the lower energy and related costs. In Kenya, BTSs are rapidly increasing and according to the recent report published by the GSM Association, there are 596 BTSs which can potentially be a site for the RESCO business. Assuming that the population within the vicinity of a BTS is 20 households consisting of 120 people, 70 thousand people can be provided with power on a business basis.

According to a JICA report, an average rural household consumes four to five liters of kerosene every month for lighting. By implementing the RESCO business, the rural population can reduce the costs and have access to brighter and safer lighting. In addition, it will become easier for them to use cell

phones, radios, televisions and other electronic devices. The livelihood of the rural population is expected to be enhanced.

According to the analysis made by Zephyr based on a GSM Association report, by 2015, there will be 17 thousand BTS sites suitable for small wind turbine installation worldwide due to the rapid penetration of cell phones into off-grid areas. It is expected that many of the off-grid BTS sites will employ renewable energy means to reduce the operation costs. For Zephyr, gaining access to such a promising market through the implementation of an ODA project will greatly boost its sales and business development. If the RESCO business materializes, Zephyr will move from simply being a manufacturer of small wind turbines to an energy solution provider. This in turn will lead to achieving its corporate vision.

V. Proposals for formulating ODA projects

As stated earlier, Zephyr is planning to promote the sales of its small wind turbines as a BTS power source on a business basis and is also considering to develop the RESCO business which will provide power to BTSs and their surrounding population. For the latter project, the use of ODA is being considered.

In the current study, as a first step towards realizing the RESCO business, the trials on the small wind turbines were started. It is hoped that the trials will succeed and the confidence of the relevant parties towards the small wind turbines will be gained. After the trials, Zephyr is considering implementation of a pilot project on the RESCO business using the "Pilot Survey for Disseminating SME's Technologies" managed by JICA. However, if this JICA scheme was to be employed, the counterpart organization must be a public entity and BTS sites, which are basically private properties, cannot be used. Based on the advice of the Ministry of Energy and Petroleum, the use of antenna towers owned by the police and other public institutions is being considered as an alternative to the BTS towers.

A pilot project which will utilize an antenna tower belonging to a public institution and provide power to the rural population in an un-electrified area for two years starting from 2014 is being considered. In order to utilize the Pilot Survey for Disseminating SME's Technologies, use of antenna tower sites belonging to public institutions such as the police, Kenya Broadcasting Corporation and government outposts will be considered with the help of the Ministry of Energy and Petroleum.

Once the pilot project starts to produce positive results and the RESCO business is deemed to be economically viable, the use of the Private Sector Investment Finance will be considered. Zephyr and its local partners will then establish a joint venture company to be supported by the finance scheme and start a business which will provide power to BTSs and the surrounding population using Zephyr's small wind turbines. By utilizing the mobile network infrastructure which now covers 90 % of the total population of Kenya, the business will contribute to the elimination of areas without access to power. The utilization of the fund for achieving "Leapfrog Development" to be established by the Ministry of Environment Japan in Fiscal Year 2014 will also be considered.

Attachment: Outline of the survey