UNDERPINNING FACTORS FOR THE DEVELOPMENT OF A COMMERCIALIZATON STRATEGY FOR SMALL WIND SYTEMS IN KENYA

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Abstract
Kenya experiences an average wind speed of 3-4m/s which could provide excellent opportunity for wind energy. However, the cost of acquisition is proving to be inhibiting as demonstrated by the slow uptake of the technology given the massive potential the country holds. This paper aims to provide an understanding of small wind energy sector with regarding to the current status of the under pinning issues for informing the development of a commercialization strategy for unlocking the market potential of small wind turbine systems (SWTs). The objectives are to conduct technology and stakeholders mapping of small wind turbines and to determine the pricing model for SWT for different materials. The research has utilized social and scientific methods of data collection. This includes stakeholder mapping and participatory market mapping exercise which lays an understanding of the underlying issues in the market. A willingness-to-pay analysis shows that users are keen on observing value for money for different SWTs sizes and rotor materials. Price modeling as a tool helps in determining the optimal cost per kWh. Inadequate marketing strategies and low efficient SWS are some of the factors affecting the growth of local manufacturers in addition to lack of economies of scale. The paper present the current technology status, with regard to current types/models of wind turbines sold in Kenya their component costs and capacities. It further provides the market players, market gaps and unitized optimal pricing for small wind turbines.

Key words: Commercialization strategy, small wind systems, decentralized energy, Market analysis, price modelling, life cycle energy analysis

1.0 Introduction

As Kenya aspires to become energy secure, the role of decentralized energy systems has huge potential in meeting immediate needs for isolated institutions, businesses and households. Only 6% of the rural population has access to grid electricity. The high connection costs and low incomes among the underserved population accelerate low access to energy despite the government efforts under the rural electrification. The cost of rural electrification has been estimated to be between US¢ 30 to US¢ 40 per kWh, compared with an amortized life-cycle cost of US$ 1 to US$ 2 per kWh for solar and battery operated systems (Kiplagat and Wang, 2011). According to the World Bank (1995), only 10 to 50% of the economic cost of REPs is recovered from the users; thus these programs have to be heavily subsidized by urban industrial users or by the government.

According to the recently released Global Tracking Framework report (World Bank 2013) under the Sustainable Energy for All Initiative to measure levels of energy, development of market for locally manufactured small energy technologies was noted to be one of the indicators to attain energy security and exploitation of renewable energy sources. The Government of Kenya Wind Resource Assessment report (Kenya Wind Atlas) shows an a average wind speeds of 4 - 5 m/s that could provide excellent opportunity for enhancing access to modern energy sources in rural areas using renewable energy sources. However, the cost of acquisition is proving to be inhibiting as demonstrated by the slow uptake of the technology given the massive potential the country holds. The current price for a 0.4 KW wind turbine made of cast aluminum and carbon fiber is between Kshs 76,000 and Kshs 110,000 and 1KW costs Ksh 450,000.

The Kenya national energy policy objective is to ensure adequate secure, affordable, sustainable and reliable supply of energy to meet national and county development needs, while protecting and conserving the environment. The policy also aims to prioritize and promote the development of local technologies in energy development and delivery. However this aspect is yet to be fully realized and some of the hindering factors include low adoption of renewable energy technologies despite the huge potential the country have. The low adoption is accelerated by the high cost of imported turbines. Currently, there exist small scale pico-wind turbine manufactures, though efficiency is noted to be pretty low, these systems haven't really penetrated the market (IEET Small Wind workshop proceedings, 2013). The existence of these manufacturers is rarely known by potential users in addition the pricing of these turbines is no clear and consistent.

To facilitate uptake of these technologies, development of efficient low-cost wind turbines stands to be a major determinant coupled with a strong strategy to promote commercialization on these technologies. The Institute for Energy and Environment Technology (IEET), in collaboration with Japan International Cooperation Agency has embarked on an initiative to develop an affordable wind turbine that can be locally manufactured and be used to enable access to modern energy services in rural areas. This paper focuses on small wind turbine market and explores a commercialization strategy for promoting the uptake of locally manufactured small wind turbines.

2.0 Problem Statement

Through the wind sector is not relatively new, its growth in the country is at a low pace as compared to the developing countries (SREP, May 2013). Lack of market analysis has always hampered the uptake of product development (Goldsmith, 2005) as demonstrated by inadequate market understanding with regard to stakeholder mapping, technology mapping and promotional strategies. High product cost can lead to market stagnation further impend the uptake of the technology. Currently, there exist small scale pico-wind turbine manufactures, though efficiency is noted to be pretty low, these systems haven't really penetrated the market. The existence of these manufacturers is rarely known by potential users. In addition, the pricing of these turbines is not and consistent.

2.1 General Objective

To evaluate the underpinning factors for the development of a viable strategy for commercialization of low-cost small wind turbines in Kenya

2.2 Specific Objectives

(i) To conduct a technology mapping of small wind turbines specifically on current types/models of wind turbines (local and imported) sold in Kenya
(ii) To conduct a stakeholder mapping in the SWT sector using a Participatory Mapping Analysis approach.
(iii) To determine the pricing model for SWT for different materials include the user willingness to pay

2.3 Methodology

The research utilized both social science and scientific methods to achieve the objectives. To identify the stakeholders in the small wind sector, a Participatory Market Mapping approach was utilized. This model clearly depicts the sector enabling environment, the market actors and their linkages and the support services available (Practical Action, 2012). A core market analysis was conducted to show the relationships in the small wind sector and pinpoint market problems. A descriptive method was also utilized which combined observation and correlation. The study combines both quantitative and qualitative approaches. The descriptive survey design was used to establish the existing SWT models, component costs, stakeholder's opinions and pricing of different turbine materials.

3.0 Results

3.1 Stakeholders Mapping

A stakeholders mapping was done through a Participatory Market Mapping approach. The small wind sector in Kenya has a number of players. Table 1 is a summary of the sector enabling environment, support services and the market actors and a description of their linkages.

Table 1: Participatory Market Map of a small wind turbine

Enabling environment	Market deepening, Regulation from ERC, Policy on SWT; credit financing, Awareness, Quality and standards
Markets Actors	Retailers(Telecommunications companies, Safari lodges, government); NGOs; Turbine dealers; Kenyan wind turbine manufacturers, raw material suppliers, importers
Support services	Availability of credit, Kenya Revenue Authority, Manufacturing Capital, Insurance, legal and Regulatory framework, Power companies, Local government permits, labour ,Marketers, Clearing and Forwarding agents

3.2 Technology Mapping

Technology mapping was done through consultation with turbine manufactures, importers, installers, users and promoters. Table 2 is summary of turbine models sold/manufactured in Kenya by different market actors.

	Table 2: List of current wind turbine models in the Kenyan Market				
	Dealer / Manufacturer	MODEL	BLADE DIAMETER	NOMINAL POWER (W)	PRICE (KShs)
1	RIWIK	AIRFLOW 350	1.8 m	350	135,000
		AIRFLOW 800	3.0 m	800	189,000
		AIRFLOW 1000	4.2 m	1,000	262,000
2	WindGen EA	Twiga Turbine	1.6 m	200	56,000
		Simba Spinner	2.1 m	400	99,000
		Rhino Rotor	3.1 m	1,000	149,000
3	Craftskills EA	Craftskills EA Turbine		150	33,500
		Craftskills EA Turbine		300	53,500
		Craftskills EA Turbine		700	103,500
		Craftskills EA Turbine		1,200	138,700
		Craftskills EA Turbine		1,800	170,100
		Craftskills EA Turbine		2,500	215,500
		Craftskills EA Turbine		3,000	238,000
		Craftskills EA Turbine		6,000	292,000
		Craftskills EA Turbine		9,000	565,000
		Craftskills EA Turbine		12,000	960,000
4	Kenital solar	Wind Turbine		400	165,000
		Wind Turbine		900	354,000
		Wind Turbine		1,000	375,000
		Wind Turbine		1,300	435,000
5	Davis & Shirtliff	TY 400	1.8 m	400	95,000
		TY 600	1.8 m	600	105,000
		TY 1000	2.8 m	1,000	190,000
6	Chloride Exide	Air Breeze-Marine		200	120,000
		Air Breeze-Land		200	98,000
		Air X-Marine		400	114,000
		Air X-Land		400	98,000
		Whisper-Land		100-900	334,000
		Whisper-Marine		100-900	334,000
		Whisper-Land		200-1000	366,000
7	Powerpoint Systems EA	Taifu		400	76,000
		Taifu		600	86000
		Taifu		1000	124000
		Air Breeze-Marine		200	120,000
		Air Breeze-Land		200	98,000
		Air X-Marine		400	114,000
		Air X-Land		400	98,000
		Whisper-Land		100-900	334,000
		Whisper-Marine		100-900	334,000
		Whisper-Land		200-1000	366,000

Source (Author)

3.3 Weight and Cost

The weight and cost of the turbine is the key to making wind energy competitive with other power sources, because research programs have significantly improved the efficiency of the rotor and maximized the energy capture of the machine (Dunnett et al., 2001). The real opportunity today is through better, low cost materials and though high volume production, while ensuring the reliability is maintained (DOE, May 2011). The typical weight and cost of the primary turbine components today are shown below in Table 3. In addition there are foundations and conventional ground-mounted systems, including transformers, switching and other power equipment.

Table 3: Turbine component weight and cost

Component	% of Machine Weight	% of Machine Cost
Rotor	10-14	20-30
Gearbox	5-15	10-15
Weight on Top of Tower	35-50	N/A
Generator systems	2-6	5-15
Nacelle and machinery, less	25-40	25
Tower	30-65	10-25

Source (US, DOE-1997)

3.4 Materials for Making a Turbine

Small Wind turbines come in many sizes and configurations and are built from wide range of materials. In simple terms, a wind turbine consists of a **rotor** that has wing shaped blades attached to a hub; a nacelle that houses a drivetrain consisting of a gearbox, connecting shafts, support bearings, the generator, plus other machinery; a tower; and ground-mounted electrical equipment (American Wind Energy Association, 2001).

The wing shaped blades on the rotor actually harvest the energy in the wind stream. The rotor converts the kinetic energy in the wind to rotational energy transmitted through the drivetrain to the generator. Generated electricity can be connected directly to the load or feed to the utility grid.

Rotor	
Hub	Steel, Aluminium
Blades	Steel; Glass Reinforced Plastic; Wood Epoxy; Carbon Filament Reinforced Plastic
Nacelle:	
Gear Box:	Steel; Aluminium; copper
Generator:	Permanent Magnetic Materials; steel; copper
Frame, Machinery and shell	Steel; Aluminium; Copper; Glass reinforced Plastic

Majority of the small wind turbine importers, have little confidence with the locally made turbines. The main reason is that the technology have not being tried for long. It's much safer to import rather than take chances with a cheaper locally made turbine- after all the client have to pay for all the costs. Rarely will a dealer stock a wind turbine like in the case of solar panels; they normally make procurement orders when a client expresses interest. The four local manufactures in the country are confident with their products despite facing the competition from the dealers who import turbines form China, USA, Canada and Netherlands(Vanheule,2012). The local manufcatures have been improving their products with time to have a competitive edge in the market.

4.0 Discussion

As the population increases the energy demand is also on the rise. Decentralized energy systems are continuing to play a major role in powering homes, institutions and businesses away from the grid or acting as backup systems during outages. In a research conducted by Mutimba in 2005, the installed capacity was estimated at 80-100 small wind turbines (total of 50kW) and a total of 750kW large wind turbines and 300-350 windmills.

The world small wind turbine market remains highly competitive. According to World Wind Energy Association (WWEA) report shows that more than 330 manufacturers offer wind turbines up to 100 kW. The top five countries by number of small turbine manufacturers are the United States, China, Germany, Canada and the U.K. With the exceptions of Germany and Canada, there are correlations between supportive federal policies and the level of domestic manufacturing (AWEA 2001). The WWEA predicts the worldwide small wind market will increase from 95 MW in 2011 to 700 MW in 2020, or approximately 25 percent per year.

According to Goldsmith 2005, generally a commercial model looks in to 3 different aspects i.e., the technical, marketing and the business aspects. In any given business its success will be majorly determined by how the technical aspects of a product or a service is serving the client's needs and the other bits depends on how the entrepreneur is able to reach out to the right people and market the product.

Among the small wind turbine stakeholders , the study revealed a disconnect in terms of operation such that though the 4 manufactures know each other they don't consult one another as they are business competitors. The Ministry of Energy which should lead institution haven't really given much focus on the small wind systems sub- sector though the government is supporting the wind campaigns over the past 5 years. On the technical aspects, it was observed that the capacity is still low and training is required in the small wind sector. In Kenya, there are no specific engineers purely trained to handle wind sector.

On the market and promotional aspects, both local manufactures and dealers admitted that they don't have a specific proactive strategy to market wind energy. In most instances the clients walk in to the premised or make phone enquires after which the dealer will now help the client in designing. All the dealers have placed the wind technology information on their website. For the fabricators, they lack any display product due to the cost involved in the manufacturing. The businesses consider only institutions as the only target clients ignoring the households who also have potential.

5.0 Conclusion

The results of this study have shown that the small wind sector is still lagging behind despite the huge potential the country has. There is huge preference of imported wind turbines that are believed to the efficient. However the cost of acquisition has proved to be high hence discouraging potential users. Inadequate marketing strategies have proved to be one of the underpinning factors to the uptake of the technology. A disconnect of stakeholders and market actors is also contributing to the widening gap in wind technology knowledge. With economies of scale and improved product technology, the small wind turbine sector can flourish as well as lower the cost of production. Increasing awareness of potential users can further increase the market segmentation and enhance technology uptake.

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