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THE DEVELOPMENT OF WIND FARMS

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The Eastern Cape in South Africa has been identified as having ideal characteristics for the development of wind farming, and thus the industry has grown in this area. Wind energy has been identified as a tool to create jobs; as the demand for electricity increases and renewable energy sources become a necessity, the South African Government has provided targets and incentives to attract investors into the industry. This study investigates why wind farms attract public resistance. It also investigates if wind energy is expensive compared to other sources of energy in South Africa and the Eastern Cape. A descriptive survey was conducted with two associations related to the study. Essential findings include: The largest impact that wind farm developments have on the environment is their visual pollution. Wind-generated energy provides the best return on investment and the second-best capital cost per megawatt in comparison with other sources of energy. In the Eastern Cape, wind as a resource is consistent enough to realise a financial return, and could be used to a large extent in terms of provision of power to the national grid.

Keywords: Power generation, Public participation, Renewable energy, Wind energy, Wind farm developments.

1 INTRODUCTION

The Eastern Cape is "ideal" for wind farms because the wind patterns in this area have huge potential for energy generation (Hollands 2013). Thomé (2013a) concurs, adding that the Eastern Cape is set to become the leading wind and renewable energy hub if the Department of Energy were to meet their target of 3,725mW of renewable energy by 2016. This target is part of the Renewable Energy Independent Power Producer Procurement (REIPPP) process.

Over the past few years there has been growth in wind energy developments in South Africa. The popularity of this source of power will have huge consequences in some form for everyone in the Eastern Cape if not nationwide—whether the wind turbines are a sight on the horizon, a job is created for somebody in the vicinity, or the power supply to the grid is supplemented by these wind farms. Let us consider why wind farms encounter public resistance, and then discuss whether wind energy is expensive compared to other power sources in South Africa.

2 LITERATURE REVIEW

2.1 Visual Impact of Wind Farms and Turbines

Wind turbines are very large structures, and have been argued to be more noticeable than stationary structures due to the rotation of the blades (Molnarova *et al.* 2012). Other studies have reached the opposite conclusion – when turbine blades rotated there was less of a negative visual effect, possibly because people had less of a negative perception when the structure was at work (Bishop and Miller 2007). Wind farm developers need to take into account the residents closest to the turbines. Wind turbines could encounter less resistance if the following factors are considered in the planning stages (Gipe 1995): a minimum number of turbines; the sight from popular observation points; avoidance of land that is perceived to be of scenic value, particularly on the coast; location in areas of lower scenic value; visual uniformity; and density of turbines.

The most important aspect to the public when siting a wind farm is that the quality of the landscape is respected (Molnarova *et al.* 2012).

2.2 Perceived Wind-Generated Noise

The sound that is generated by wind turbines (Janssen and Vos 2011) is described as different to any ordinary sound, due to environmental sources at even lower levels that would normally annoy people. Bakker *et al.* (2012) found that "Among respondents that benefited economically from wind turbines, the proportion of people who were annoyed by the noise was significantly lower, as if wind turbine sound was differently valued by them compared to non-benefiting respondents." This also confirms that the more participation the public has in these developments, the more likely they are to be a success from a public relations point of view. It was also discovered that sounds are more acceptable when there is a more positive association with the source, as opposed to having a negative attitude towards them.

2.3 Public Involvement in Development Planning

As noted above, effective community participation in the developing of wind farms is vital if they are to be a success. Engaging the public in the planning stages and inviting key stakeholders to contribute valuable local understanding will enhance the design quality of the scheme, reduce the perceived threat posed to a community, and increase the anticipation of benefits from the wind farm (Breukers and Wolsink 2007).

2.4 Capital Cost Per kW for Wind and Alternate Sources of Renewable Energy

The capital cost is the amount of money initially spent on a project to get it to a point where the operation can start to make money. For wind energy, this would include the land and the infrastructure. The cost of electricity is made up of a few components of which the capital cost is one (Chandler 2009): fuel, CO_2 emissions, operating and maintenance, and capital – including planning and site work.

Ackerman (2005) states that a general comparison of electricity production costs is difficult, particularly in different countries due to availability of resources and differing tax incentives. Wind energy, for example, is generally only feasible within a certain distance of the coast. Wind speeds and strengths at different locations also differ.

Therefore, each situation needs to be carefully considered when identifying which source of renewable energy to implement.

According to Saayman (2013), currently wind power costs half that of solar power per mW. The current trend is to use the synergies between various technologies to produce more efficient systems, combining wind, solar, biomass, or ocean-generated power.

2.5 Wind Energy Consistency

Wind can be an inconsistent resource. When it does not blow there can be no wind energy generated. This will need to be supplied from an alternate source, generally a fossil-fueled generator, referred to as a backup. The generation of power can vary between zero and maximum unpredictably, although prediction tools for winds are increasing in technological accuracy, meaning a backup supply can be planned (Etherington 2009). Fluctuations at a site are inevitable, and the planning and forecasting is important.

2.6 Feasibility of Wind Farms

In the past ten years, according to McCubbin and Sovacool (2013), investment in wind energy has increased by a factor of seven. According to Wang and Sun (2012), there are a number of important advantages to wind energy, making it one of the leading industries in the global electricity market. Advanced technologies have increased the efficiency and reduced the cost of wind generation plants. Wind farms are arguably the best method of power generation in remote areas, and wind turbines require minimal floor space, enabling the surrounding land to be used in other ways.

3 RESEARCH

3.1 Research Method and Sample Strata

A quantitative study using a self-administered questionnaire was conducted in South Africa's Eastern Cape Province. The sample strata included wind farm developers, wind energy stakeholders, and renewable energy consultants that are members of the South African Wind Energy Association (SAWEA) and the Southern African Association for Energy Efficiency (SAEE). 21 of 59 members of SAWEA, and 10 of 28 members of SAEE responded – response rates of 36.6% and 35.7% respectively, and overall 36.2%.

3.2 Findings

Table 1 indicates the extent of public resistance towards wind farm developments, in terms of percentage responses to a scale of 1 (minor) to 5 (major), with an MS between 1.00 and 5.00. Given that the MS of 2.24 is $> 1.80 \leq 2.60$, the public can be seen to resist wind farm developments between a minor-to-near-minor / near-minor extent.

Table 1. Extent of public resistance towards wind farm developments.

Response (%)						
Unsure	**Minor……...Major**					**MS**
	1	**2**	**3**	**4**	**5**	
6.5	29.1	32.3	16.1	12.9	3.2	2.24

Table 2 presents the frequency that respondents expressed objections regarding the development of wind farms in terms of a scale of 1 (never) to 7 (daily), with a MS between 1.00 and 7.00. Given that the MS of 2.30 is $> 1.86 \leq 2.72$, the frequency can be seenas between annually-to-biannually / biannually. This finding underscores the minor resistance to the development of wind farms apparent in Table 1.

Table 2. Frequency of public objections to the developments of wind farms.

Response (%)								
Unsure	**Never**	**Annually**	**Biannually**	**Monthly**	**Fort-nightly**	**Weekly**	**Daily**	**MS**
29.0	32.3	16.1	6.5	16.1	0.0	0.0	0.0	2.30

Respondents were also required to indicate the frequency which factors were cited in terms of objections to the development of wind farms, relative to a scale of 1 (never) to 5 (always). Based upon the percentage responses to the scale, MSs between 1.00 and 5.00 were computed. Given that the MS for "location of the wind farms" (3.43) is $> 3.40 \leq 4.20$, the frequency this is cited is between sometimes-to-often / often. The MS of "noise levels due to wind turbines" (2.62) is $> 2.60 \leq 3.40$, and therefore the frequency is between rarely-to-sometimes / sometimes. The MSs for "type of noise made by wind turbines" (2.39), "number of wind turbines" (2.38), density of wind turbines (2.29), and "size of wind turbines" (2.21) are $> 1.80 \leq 2.60$, and therefore the frequency is between never-to-rarely / rarely.

Table 3 indicates respondents' degree of concurrence with the statement "The public base their opinions on uniformed perceptions" in terms of percentage responses to a scale of 1 (strongly disagree) to 5 (strongly agree), and a MS between 1.00 and 5.00. The MS of 3.87 ($> 3.40 \leq 4.20$) indicates that the concurrence is between neutral-to-agree / agree.

Table 3. Extent to which the public base their opinions on uninformed perceptions.

Response (%)					
Strongly disagree	**Disagree**	**Neutral**	**Agree**	**Strongly agree**	**MS**
0.0	12.9	12.9	48.4	25.8	3.87

Respondents were required to indicate the perceived return on investment for seven energy sources on a scale of 1 (very poor) to 5 (very good). Wind power was ranked first with a MS of 3.59, followed closely by hydropower (3.56). Therefore, according to respondents, wind and hydropower provide the best return on investment.

Respondents were also required to indicate the perceived capital cost per megawatt for seven energy sources on a scale of 1 (very inexpensive) to 5 (very expensive). Wind power was ranked sixth with a MS of 3.00, which indicates it is perceived to be between inexpensive-to-average / average.

Respondents were requested to indicate the length of time they thought it would take to realize a financial return from a wind farm development. It is notable that 47.8% of the respondents indicated that a wind farm would realise a financial return in 10 years. In fact, the mean number of years a wind farm would take to realize a return is 8.54 years.

Table 4 indicates the perceived extent to which wind energy could be used as a source of energy in South Africa, in terms of percentage responses between a scale of 1 (minor) to 5 (major), and an MS between 1.00 and 5.00. The MS of 3.74 ($> 3.40 \leq 4.20$) indicates that the perceived extent is between neutral / near-major extent.

Table 4. Extent to which wind energy could be used as a source of energy in South Africa in terms of provision of power.

Response (%)						
Unsure	**Minor……...Major**					**MS**
	1	**2**	**3**	**4**	**5**	
0.0	6.5	9.7	19.4	32.3	32.3	3.74

Respondents were asked to indicate the extent to which there should be more sensitivity towards the public when developing wind farms. 61.3% indicated that there is adequate sensitivity, 25.8% that there should be more sensitivity, and only 12.9% said there should not be.

4 CONCLUSIONS

As surveyed, the public offers little resistance towards wind farm developments, and public objections can be described as infrequent. Based upon the frequency factors cited in terms of objections to the development of wind farms, it can be concluded that their location is critical, and developers must be conscious and mindful. Furthermore, it can be concluded that perceptions exist with respect to the noise generated by wind turbines.

This and the other findings lead to the conclusion that the public is uninformed, which amplifies the need for consultation and information dissemination among stakeholders to increase their knowledge and understanding. Another conclusion is that wind power is perceived to generate a return on investment, and to have the lowest capital cost per megawatt among various sources of energy. Furthermore, wind energy is positively viewed as a source of energy in South Africa in terms of provision of power.

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