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THE FEASIBILITY OF USING WIND ENERGY FOR RURAL POPULATIONS LACKING ELECTRIC POWER IN BRAZIL

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RESUMO: In the wake of current global image involving environmental impacts, the use of wind power has had a remarkable growth in recent years as a technique for generating electricity. In fact, it is a source featuring strong dissemination of technology which provides decrease in costs and a greater access to low-income electricity. PROINFA (Incentive Program for Alternative Energy Sources) promotes a greater diffusion of new technologies for power generation, in particular wind-produced. Due to such a scenario on the exploitation of such energy source, current analysis discusses strategies for the development of domestic wind technology and the implications for electricity-lacking rural areas. Analysis shows a similar behavior between rural populations lacking electricity and the amount of potential energy available in the region. It is expected that this assay will contribute towards the establishment of public policies for wind-energy parks on rural farms in the North and Northeast regions of Brazil.

KEYWORDS: electricity, Brazilian northeast Region, alternative energy sources.

ANÁLISE DA VIABILIDADE DA UTILIZAÇÃO DA ENERGIA EÓLICA PELA POPULAÇÃO RURAL SEM ACESSO À ENERGIA ELÉTRICA NO BRASIL

RESUMO: Diante da atual imagem mundial, relacionado aos impactos ambientais, a utilização da energia eólica tem crescido muito nos últimos anos como forma de geradora de energia elétrica, já que trata de uma fonte com forte disseminação de tecnologia, o que proporciona não só uma diminuição dos custos que a utilizam, mas também um maior acesso da população de baixa renda à eletricidade. O PROINFA (Programa de Incentivo às Fontes de Alternativas de Energia Elétrica), por exemplo, promove uma maior difusão de novas tecnologias para a geração de energia elétrica, destacando-se principalmente a eólica. Diante do cenário de prospecção do uso desta fonte de energia, o presente estudo visa relacionar as estratégias para o desenvolvimento da tecnologia eólica nacional e as implicações em regiões rurais sem acesso à energia elétrica. Na análise do estudo, foi possível mostrar um comportamento semelhante entre a quantidade da população rural sem acesso a energia elétrica e a quantidade do potencial energético disponível por região, o que contribui para criação de possíveis políticas públicas visando a implementação de parques eólicos voltados ao meio rural das regiões Norte e Nordeste sejam efetivadas.

PALAVRAS-CHAVE: eletricidade, região Nordeste, fontes alternativas de energia.

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1 INTRODUCTION

Wind power is the kinetic energy produced by air movement (wind) that may be employed for humanity´s well-being and ends. The use of wind power may be initially observed in water pumping and grain grinding systems (GABRIEL FILHO, 2011). The use of wind power worldwide as a means to generate electricity has grown exponentially during the last decades due to the dissemination of technology, machine improvements, growing investment costs and especially the search for clean energy sources with low environmental impact (DUTRA, 2001)

Within the course of the 20th century, wind power has been the object of extensive research to introduce great energy sources (wind farms) triggered by progress in electrical network systems.

According to Holtmeyer et al. (2013), studies on electricity in rural regions should be meticulously studied due to geographical conditions and distances from production centers. Economical feasibility is especially required. Southern Asia, with only 37% of the population benefitted with electricity in many almost unreachable regions, has invested in solar energy (PALIT, 2013). Similar investments have been also provided in Nigeria (SHAABAN & PETINRIN 2014).

Although Brazil has an immense hydroelectric power sources, the administration followed world trends for the employment of wind power. According to the Global Wind Energy Council - GWEC (PULLEN, 2011), the US and Germany are at present the countries using such energy, followed by China, Spain. India, Italy, France, UK, Portugal and Brazil.

The first projects on solar and wind power were implemented in the northeastern and northern regions of Brazil where lack of electricity supply is critical. Several projects involving the installation of photovoltaic and wind systems were introduced for the decentralized generation of electric energy in several isolated communities which had not been benefitted with conventional electricity (AMARANTE et al., 2001).

Small and isolated systems were constructed either by batteries or by gravitation energy to store water pumped into high placed reservoirs for later use. Some isolated systems do not require storage. This is the case of irrigation in which all pumped water is directly employed. Approximately almost all the area of a wind farm may be used for other ends such as cattle-raising and agriculture,

Incentive programs for alternative sources in electric energy, particularly PROINFA, try to increase renewable energy sources within the Brazilian energy environment. The program brings forth the autonomous independent producers' as agents of enterprises based on eolic sources, small hydroelectric plants and biomass.

Gabriel Filho et al. (2008, 2010) has dealt with applications of wind power in Agricultural Engineering, whereas Jorge et al. (1990) studied the population of Pinus elliottii in the application of alternative energy on farms.

Current investigation discusses strategies for the development of Brazilian wind power technology and its implications in rural areas lacking conventional electrical energy.

2 MATERIALS AND METHODS

Current analysis was developed by secondary data collection and theoretical research in the literature. Population data by the Brazilian Institute of Geography and Statistics (IBGE) were collected, coupled to information on the potential of wind power in Brazil and its different regions to verify whether conventional electricity access could be replaced by wind-produced energy.

2.1 Regulating energy situation

Brazilian Law 10,438, published on the 26th April 2002, is a historical landmark for the national electric program since it deals with the diversification of its generation matrix. The act established PROINFA and thus promoted the diffusion of new electric generation technologies, including electricity produced by wind power. In fact, it forwards two strategies for the production of renewable energy sources, or rather, national aims and the use of procedures for its initial phase which makes possible a fast introduction of the best technological and energy source arrangements on the market.

The amplification of the national technical and scientific basis may be undertaken by systems based on renewable energy with original projects that foreground the Brazilian historical trajectory within the expansion of the supply of clean energy.

The employment of renewable energy is already working in Brazil even within the context of the so-called modern technologies (Table 1).

Table 1: *Contribution of each renewable source for the generation of electricity in Brazil, compared to traditional ones (TOLMASQUIM, 2003).*

Sources	Installed capacity
Big hydroelectric plants	66218
Gas thermoelectric plants	6361
Petrol thermoelectric plants	5652
Coal thermoelectric plants	1461
Nuclear plants	2007
Wind-powered plants	22
Small hydroelectric plants	2027
Biomass	2410
Total	85068

More than 300,000 homes in Brazil lack any type of electric energy, of which 230,000 lie in rural areas. They are provided neither by the local electric distribution network nor by autonomous electric generation through small diesel- or photovoltaic-run generators.

According to IBGE (2011), 33.28% (approximately 77000) of rural homes in the northern region of Brazil do not have any type of electric energy. In the northeastern region 47.29% of homes in the rural area (approximately 110000 homes) lack electricity, whilst in the central-western region the amount reaches 6.71% (approximately 15000 homes). In the southeastern and in the southern regions 8.83% (approximately 20000 homes) and 3.89% (approximately 9000 homes) of homes lack electric power.

2.2 Wind Power availability

Brazil is one of the biggest countries with great clean energy-producing capacity. According to the International Energy Agency (IEA), Brazil is the biggest electricity producer from clean and renewable sources, such as hydroelectric, biomass and wind power plants. In fact, 85.9% of electricity supplied in Brazil comes from such energy matrixes (PULLEN, 2011).

The employment of wind power in Brazil is increasingly on the rise since the country´s size and the territorial position favor the exploitation of this type of energy. The extensive Brazilian coastline provides the coastal states with high wind interference and triggers the implantation of turbines in many regions.

3 RESULTS AND DISCUSSION

The lack of electric energy in rural areas may be partially solved by the installation of wind-powered turbines or aerogenerators for small-sized appliances. As Figure 1 shows, approximately 15% of rural homes in Brazil do not have electric energy, contrastingly to the situation in town homes (IBGE, 2011).

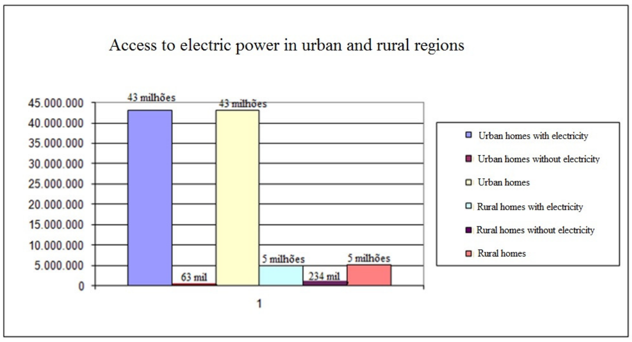

Figure 1: *Electric power in urban and rural areas.*

The above data are extremely critical in the northern and northeastern regions of Brazil, as Figures 2 and 3 show, and demonstrate high consumption disparities that occur between the country´s different regions.

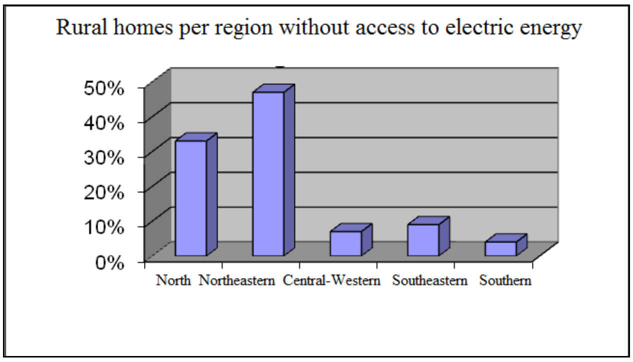

Figure 2: *Rural homes per region without any electric power (IBGE, 2011).*

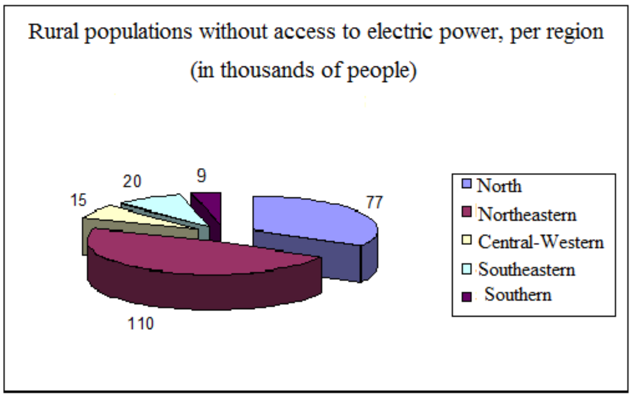

Figure 3: *Rural homes without any access to electric power, per region – in thousands of homes (IBGE, 2011).*

The rural northeastern region of Brazil has five times less the electric energy than the southeastern and southern regions, although it has the highest percentage in rural homes in the country. Political, geographical and economical reasons better explain the fact that a great number of people living in the rural areas are still without the benefits of electric power.

Brazil has technical conditions to provide electric energy to the above-mentioned population. Research centers´ scientific production, with its variegated and original solutions to the problem, is extensive and comprehensive. In fact, the northeastern region with its great concentration of rural homes has a crucial lack of resources when compared to those in other regions of Brazil. On the other hand, the great wind power potential of the region may change significantly the situation.

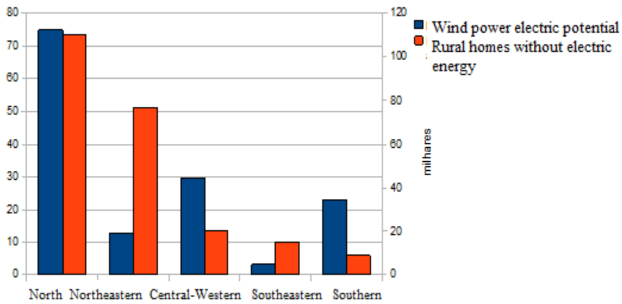

***Figure 4:** Wind-based electric potential and rural homes without electric energy per region.*

***Table 2:** Co-relationship of wind power potential and rural homes without electric energy per region, provided by research in IBGE (2011) and CRESESB (2011) databases.*

Region in Brazil	Wind power potential (gW)	Rural homes without electric energy (in thousands)
North	12.8	77
Northeast	75	110
Central-west	3.1	15
Southeast	29.7	20
South	22.8	9
Co-relationship	**0.69**	

Figure 4 shows a similar behavior between the quantity of rural populations without electric energy and the amount of potential energy available per region.

Table 2 demonstrates Pearson´s coefficient of co-relationship of the phenomenon (0.69), or rather, a reasonable behavior co-relationship. It highlights current research´s contribution towards public policies to implement wind power farms for the rural regions of the northern and northeastern regions.

It is expected that, within the context of PROINFA, the ´independent autonomous producers´ undertake wind-power application in less favored regions through conventional and rich transmission networks (and also rural regions) in clean and renewable energy sources. The above reflects the northern and northeastern regions following results of current analysis (Figure 4 and Table 2).

4 CONCLUSIONS

In the wake of economical issues, it may be verified that there is a direct relationship between the lack of electricity and the population´s income, characterizing a condition of suppressed demands. Electricity consumption by some families is not extant due to low family income which, in its turn, is based on the lack of electric energy. In fact, it is rather difficult to aggregate value to extractive or artisanal agricultural products. Regions such as the northeastern part of Brazil harbor the highest indexes of rural homes without electric energy. The above favors the introduction of renewable energy sources such as wind power-based ones since regional conditions are highly favorable for such renewable type of energy.

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