SOCIO-ECONOMIC IMPACT OF WIND TURBINES IMPLEMENTATION

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Abstract
Energy is the life blood of our society. The well-being of our people, industry and economy depends on safe, secure, sustainable and affordable energy. The energy challenge is thus one of the greatest tests which Europe has to face. Renewable energy continued to grow in 2014 against the backdrop of increasing global energy consumption, particularly in developing countries, and a dramatic decline in oil prices during the second half of the year.
Wind power is increasingly being used worldwide as an important contribution to renewable energy. This study outlines an overview of the main aspects related to economic and social importance of wind turbines implementation. This study results inventories the main advantages and oportunities that can results by implementing wind turbines.

Keywords: *wind turbines, socio-economic impact, market analysis, socio-economic benefits*

JEL codes: *M41, M48*

1. Introduction

In recent years, worldwide, an increasing interest in developing and implementing energy conversion systems based on renewable energy sources (RES) is shown. The expansion of their use plays an important role in achieving the goals of sustainable development policies that relate to energy security, reduction of the environmental impact by restricting the use of fossil fuels and thus mitigation of climate change. The access to modern energy services is a prerequisite for economic development and the right to energy means that they must be reliable, affordable and evenly distributed in order to eliminate the disparities between urban and rural areas.

The amount of energy from renewable sources continued to increase in 2014 due to higher worldwide energy consumption, particularly in developing countries, despite the dramatic drop in oil prices in the second half. Despite the increase in energy consumption for the first time in four decades, global **carbon emissions** related to energy consumption **remained stable in 2014**, while the global economy grew.

In the context of the need of RES capitalization and of increasing economic competitiveness and **development of knowledge-based economy**, it is necessary to adopt new paradigms according to which the increase of energy efficiency is based on a large-scale development and decentralized systems integration, systems of small power for producing electricity.

Electricity production, under the current centralized paradigm, is mainly linked to large generation facilities and then shipped through the transmission and distribution grids to the end consumers. Due to its higher level of integration, this type of energy supply system is vulnerable to disturbances, but apart this there are several issues reducing its attractiveness (EUREC, 2009). In the context of overcoming centralized energy supply systems disadvantages and taking into account the request for energy efficient and reliable energy production/supply systems one viable solution is to complement or even replace the existing paradigm with distributed generation where the electricity is produced next to its point of use.

Technical improvements are also adding to this trend. Moreover, by producing a wide range of new, innovative products and services, and by continuing to reduce costs to make new and existing technologies cost competitive, the renewable energy industry is essential to the advancement of the objectives of "Sustainable Energy for All".

2. Current situation at national and international level

European Council Directive 28/2009 on renewable energy, implemented by Member States in December 2010, sets ambitious targets in respect to the percentage of electricity produced using renewable energy sources (RES), namely, a 20% share by 2020 and their percentage up to 10% in the transport sector. The 27 EU member states are obliged by the

Directive to notify a National Action Plan for Renewable Energy Sources (NAPRES) based on a model provided by the European Commission. The European Union could achieve the overall objective for 2020 only by means of ambitious and coherent national action plans.

Current systems for electricity production correspond to a centralized conception and are based on high power electrical plants. Their power is usually higher to the local consumption, which implies the need for a system of transmission and distribution of electricity. Given the high level of integration, this type of power supply system is vulnerable to perturbations, but also unattractive, in some respects, for renewable energy (EUREC, 2009).

The amount of renewable electricity that is harnessed from the wind is growing rapidly. However, in order to be taken advantage of this resource, turbines should be installed in open sites and on sufficiently tall towers. Coastal locations and flat rural areas without significant vegetation, obstacles or buildings, offer the most laminar wind flow. Contrarily, urban areas are places of poor wind resources and are usually extremely turbulent. Thus, up to now wind systems installed on roofs do not produce satisfactory electric energy, they have short life spans and they are considered as uneconomical choices for investments.

Due to the above, photovoltaics (PVs) are prioritised for residential renewable electricity options. However, a PV installation that could generate a sufficient amount of energy for residential needs needs significant space and this is a considerable drawback that concludes to the localization of the solar utilization in rural areas on rooftops and on ground mounted installations. Another point that restricts the solar source exploitation in rural areas is also the aesthetic issue. Thus, since a wind system is uneconomical and problematic in the installation and the solar system needs large space and has aesthetic cost, the renewable energy sources (RES) has almost been abandoned in urban areas.

3. Socio-economic impact of wind turibines implementation

Most times, it is almost impossible to outline a clear distinction between social and economic, since these two components of human existence are intercorelated. Any attempt to define these two concepts leads to creating a blurry image on every subject under review.

We admit that wind power, as a renewable energy source, plays an important role for achieving goal of the transition to post-fossil carbon societies. Despite significant environmental benefits associated with wind power, its social impact should not be overlooked.

The rapid urbanization has created a massive energy demand whereas the negative environmental impacts associated with conventional energy sources are well recognized. As a result, the development of renewable energy has become an agenda for many countries over the world. The government has released a number of policies and strategic plans to promote the development of renewable energy resources. These include: National Strategy for Sustainable Development in Romania Horizons 2013-2020-2030 and European Union climate and energy package 20-20-20. Other strategic plans include: Romanian National Strategy for Climate Change 2013 – 2020, Romanian National Strategy for Research, Development and Innovation 2014 – 2020, Romanian Nord-West Region Development Plan for 2014-2020, and Romanian National Strategy for Competitiveness 2014 - 2020.

There are diverse renewable energy resources. Wind power is one of the renewable energies, which have been applied in various conditions due advantages such as it being in-exhaustible, less environmental pollution, and is freely accessible, and reduces the costs of balancing services (Li et al., 2013; Shaahid et al., 2013). There are both benefits and costs associated with renewable energy development. The most widely recognized benefits of renewable energies are the environmental benefits, such as reducing the consumption of conventional fossil fuel and associated carbon emissions (Hooper and Austen, 2013). The high initial costs are commonly cited as a drawback of renewable energy, which inhibits its development (Khare et al., 2013; Yuan et al., 2013).

There is an increasing interest in quantifying the impact on regional economies of such deployment, especially in those peripheral regions with low growth rates and traditional declined sectors.

Besides PV and biomass facilities, barely considered investment options for households to generate electricity are small wind turbines (SWT). SWT are characterized by a small installed capacity (typically around 1-10 kW) as well as a hub height of up to around 30 m, and can either be free-standing or roof-mounted. Roofmounted SWT in particular could be an investment option for private households in urban areas.

The market for SWT is still small, but growing steadily. The German Federal SWT Association (Bundesverband Kleinwindanlagen, BVKW) expects an increase in the number of installed SWT of up to 700,000 units in Germany by 2020 (Frey, 2009). In comparison, the number of installed SWT in the UK is expected to increase to about 600,000 units in the same period of time. The World Wind Energy Association (WWEA) published the first worldwide market

study of SWT in 2012. China was identified as the country with the largest number of SWT (450,000 units), followed by the United States with around 140,000 units. Most of these SWT are not gridconnected but running in off-grid (island) systems, particularly in rural areas of China, where SWT have been used for local electricity generation or water pumps since the early 1980s. According to the WWEA study (2012), there were around 520,000 units installed in 2009 worldwide, a number which grew in 2010 by 26% to about 650,000. An increased importance of SWT is also expected for developing countries in the context of rural electrification projects (Rolland, 2013).

3.1 Influences on the main social indicators

The social factor is positively influenced by the installation and functioning of wind turbines. This is due to the fact that energy is one of the main elements that ensure a comfortable life, and in this case it is produced cheaper and cleaner.

Social indicators aim to analyze the changes that the implementation of innovative solutions proposed by the project on population migration, on increasing the qualification of the local population, on request of public services such as health, education, public cleaning etc brings. We can also talk about changes in the mentioned social indicators to the extent that at national level an industry in the wind energy is developping. Thus, in this direction the following countries can be cited: Spain, Germany and recently Greece, countries that created over 150,000 new jobs by developing this unconventional energy sector of wind potential. Developing an industry in the field of wind potential it is obvious that most social indicators will increase. Thus, depending on the degree of development of the area, a densification of the population, an increase in the qualifications of the staff employed in the field, an overall increase in degree of employment of population can be seen. As a consequence of wind industry development, all other social sectors will increase. Wind turbine installation technology involves both simple and complex operations which require high qualifications. These operations require significant human resources. Considering the social indicators' impact we can say that:

- During installation there is a demand for labor force, which becomes a significant social indicator when the number of installed turbines is large enough;
- The development of this sector of the renewable energy industry determines significant changes in the analyzed social indicators;
- An important social impact in conjunction with the economic one results from the fact that Europe imports 50% of the energy needed and if no alternative solution are to be found until 2030, energy imports will increase to 75%. This is one of the reasons why wind potential alternative should not be rejected.
- Another important social impact refers to reducing the production costs and hence the sales costs of electricity. European and worldwide local communities where local production of electricity from wind potential has meant reducing electricity prices up to 50% compared to national existing rates are known.

The race for clean energy across the world is very important and winners of this race will have many benefits, both political and economical in the years ahead. The renewable energy can contribute to the electrification of rural areas in many developing countries and not only. In many rural areas, the renewable energy is the cheaper option to meet the needs of communities compared to power supply traditional solutions.

Creating new jobs

Creating new jobs by building wind power plants is related to their manufacture and installation and also to some infrastructure work required by installation. Thus, in Germany, the development of the energy sector has lately enabled the creation of 130,000 new jobs, this country having the most developed network of wind power plants worldwide, with an installed capacity of 18,000 MW by now. In Romania, national programs for the use of renewable energies are just starting out and although it can be said that there is a significant wind potential at national level, the installed output is only 1.4 MW. On a scale of values involving both efficiency of generating new jobs and the skills of personnel working in the field, the use of technology for producing electricity from wind potential can be noted with 8. It is worth mentioning that in this sector, 80% of highly qualified staff is involved, considering the technology used for the construction of systems.

Impact on population's health

Air pollution and water pollution generated by the production of electricity or heat from coal and natural gas is linked to respiratory problems, neurological damage, heart attacks and cancer. The replacement of fossil fuels with the renewable energy can reduce premature mortality, and total healthcare costs, too (Machol&Rizk, 2013). In addition,

wind power and solar energy does not essentially require water for the production process and therefore does not pollute water resources, not calling into competition with agriculture, water supply or other important needs of drinking water. In contrast, fossil fuels can have significant negative impacts on water resources.

Health indicators aim to analyze the changes brought by investors on the health of the population and the environment. Construction, installation and operation of wind turbines has no negative impact on those environmental factors that can lead to population's illness. The main enviromental factors would not be significantly affected (soil, water and air). The only parameters that could be discussed are noise, vibration and stroboscope phenomenon generated by the interleaving of turbine blades with sunlight at certain times of the day. It is estimated that the population is not affected by these parameters.

The innovation impact on the environment

According to aggregated data of the **International Panel on Climate Change** (IPPC, 2011), the life cycles of GHG emissions associated with renewable sources, including manufacturing, installation, operation and maintenance, and the dismantling or decommissioning of energy sources **are minimal**.

Compared to natural gas, which emit between 0.3 and 0.9 kg carbon dioxide equivalent per kilowatt-hour (CO2e/kWh) and coal that emits between 0.6 and 1.6 kg CO2e/kWh, wind systems emit only between 0.009 to 0018 kg CO2e/kWh, photovoltaic systems 0.03-0.09, geothermal ones 0.04 - 0.09, and hydro between 0.04 and 0.22 kg in CO2e/kWh. Also, a study of US Department of Energy's - National Renewable Energy Laboratory has examined the feasibility and the environmental impacts associated with the **generation of 80%** of the country's electricity by 2050 from renewable sources and found that global emissions, at national level, of greenhouse gas (**GHG**) from electricity generation could be **reduced by about 81%**.

Simultaneously, the *Partnership for Smart Cities and Communities* advocates for the development and implementation of technologies and smart urban services that open great prospects in terms of solving large urban agglomerations.

In Romania, a number of programs and policies that advocate for the use of energy from renewable sources for the development and implementation of new sustainable technologies focused on energy efficiency and significant contribution to mitigating climate change, pollution and noise levels were initiated. Among these policies we can notice the *Smart National Strategy for smart smart cities in Romania*, *the National Climate Change Strategy 2013 - 2020 and the National Strategy for Sustainable Development of Romania, Horizons 2013-2020-2030.*

3.2 Economic impact of wind turbines implementation

In a research conducted in Germany, Grieser et al (2015) underline that from the perspective of large-scale investors, mature renewable energy technologies, such as on- and off-shore wind power, solar power plants, hydro power and biomass plants are the most important investment options. Due to the feed-in tariffs provided by the EEG (2012) support scheme and the associated feed-in guarantee for the generated electricity, these technologies are often attractive and low-risk long-term investments. But also small investors, such as private households, can play an important role in national energy transition.

Today there are about 250 companies in 26 countries manufacturing small wind turbines. More than a third of these, and the largest, are based in the U.S., but the U.K. and the Netherlands are also home to other big manufacturers. The global market for small wind technologies is forecasted to more than double on a business-as-usual scenario between 2010 and 2015, reaching USD 634 million. The installed capacity could increase threefold in the same period. Much of this growth will take place in developing and emerging markets.

Small wind costs and financing

Prices of SMWT depend on the type of the turbine and its size. The costs of a small wind turbine vary as much as from EUR 2,500 to EUR 7,500 per kilowatt installed. For example, a complete SMWT battery charging system of 5kW (turbine, pole, and electronics) will cost around EUR 8,000 to EUR 12,000 (uninstalled). Adding batteries and a standalone inverter, as well as the installation cost, would include another 20-40% in the overall costs. It is important to make the cost calculations and breakdown before starting a project in order to determine electricity prices compared to alternatives, such as diesel or kerosene.

The costs also vary significantly in different parts of the world, based on production expenses. For example, a similar turbine could cost about USD 3,000 in the U.S., USD 1,500 in China and more than USD 5,000 in Taiwan.

With prices comprised between 15 and 35 USD cents per kWh over the lifetime of the system, small wind is, in these conditions, cheaper than small scale PV, and even cheaper than some small scale hydro solutions. In remote rural areas,

it is common to find very high diesel prices (integrating the cost of the diesel itself, as well as of the transportation) and an inefficient genset that generates a kWh at a cost between EUR 1-3.

Table 1 - Status of renewable technologies, characteristics and costs

Technology	Typical Characteristics	Typical Energy Costs (U.S. cents/kWh)
Micro-hydro	Plant capacity: 1-100 kW	7-30
Biomass gasifier	Size: 20-5,000 kW	8-12
Small wind turbine	Turbine size: 3-100 kW	15-25
Household wind turbine	Turbine size: 0.1-3 kW	15-35
Solar home system	System size: 20-100 watts	40-60

Source: REN21, 2010

If these costs can seem relatively high compared to other off-grid renewable energy technologies, limiting this comparison to investment costs would be a mistake. SMWT do not fall under the same investment category as other small scale alternative energy technologies, such as standalone PV systems, and usually do not meet the same type of needs. However, when it comes to costs over the lifetime of a project, the comparison starts looking different and often more to the advantage of the small wind turbines. Under favourable conditions, small and medium wind generation prices are significantly lower than those of conventional energy sources (diesel, kerosene, etc.) and can be even lower than the price of some other renewable alternatives (see Table 1).

In Europe or other mature markets, private clients pay cash for their SMWT or use credit schemes. In contrast, many 'development' projects in remote areas of developing countries are often at least partly financed by an external organisation due to the high initial investment required. But even in these developing and emerging economies, it is possible to find SMWT paid in cash, largely for projects built by private stakeholders such as mobile phone operators for telecom towers, which require a substantial amount of power. In these cases, if the natural conditions are favourable and wind measurements have been carried out correctly, it is not rare to have a high return on investment, with full cost recovery only after a couple of years. At the same time, the payback period can vary greatly depending on factors such as the technology chosen, location, available financing options and other incentives.

Besides a grant oriented/supported approach, a well-designed small wind or hybrid project could also be profitable and sustainable without any subsidy. In this case, however, access to capital through loans or other types of financial instruments is compulsory, along with a long term off-take agreement (with a private user, the local utility or a community) to help the project developers to support their investment.

Economic benefits and opportunities

Many people may minimize the importance of renewable energy sources just by looking at the definition of this concept. They would not hesitate to ask themselves why it is necessary to pass to sources such as sunlight, wind or rain. The way in which these issues are perceived does not create the impression that they are very safe energy sources. This is one reason why the following question can be asked: what are the real **advantages and benefits** of wind power, as well as major opportunities that can be exploited?

Among the **main advantages** we can include:

- Cost competitiveness and quick cost break-even in favourable natural conditions.
- Easy to integrate in (existing) mini-grids fed with diesel. Hybrid wind-diesel systems provide higher quality, lower costs, and are a more reliable and sustainable solution than diesel-only systems.
- Allow, in combination with such applications as solar to develop a 'whole-year-round' solution.
- The perfect solution not only to generate enough power for feeding and developing small businesses, but also to increase the synergies with growing sectors.

Real opportunities of wind energy sources could be represented by:

- Develop knowledge of this technology. Education and training are the key to everything.
- Encourage local communities and small businesses to use alternative sources of energy. This will increase the reliability of their electricity supply and decrease their electricity bills.
- Feasibility studies and assessment of wind speed data are missing. This type of study is an easy way to discover new business opportunities and favourable locations.
- Integrate, impose and control quality standards and certifications for every new installation. This will ensure the installation of products that will generate reliable electricity over a longer time span.
- Encourage the development of joint ventures and partnership agreements with expert companies. This will ensure proper installation, operation and maintenance AND will generate local employment.

In general, when considering jobs created by the wind energy sector, it is useful to make a distinction between pre-connection and post-connection jobs. Post-connection jobs are typically ongoing and include operation and maintenance (O&M) while pre-connection jobs are more variable in nature and include project development, onsite labour, manufacturing, wholesale, and distribution. For example, the USA reported an impressive number of new jobs created in this sector. Thus, in 2011, the wind industry employed about 75,000 people in a variety of capacities, including manufacturing, project development, turbines' construction and installation, operations and maintenance, transportation and logistics, financial, legal and consulting services. Other technologies of renewable energy had even hired more workers. In 2011, the solar industry employed approximately 100,000 people on part-time or full-time, in areas like installation, manufacturing and sales; hydropower industry employed approximately 250,000 people in 2009; and in 2010, the geothermal industry employed 5,200 people.

4. Conclusions

By producing a wide range of new, innovative products and services, and by continuing to reduce costs to make new and existing technologies cost competitive, the renewable energy industry is essential to the advancement of the objectives of Sustainable Energy for All. In this context, the present proposal answers to the challenges coming from both the European and national renewables implementation policies and from SWT industry by the development of affordable (low-cost) and reliable SWT technologies.

The race for clean energy across the world is very important and winners of this race will have many benefits, both political and economical in the years ahead. The renewable energy can contribute to the electrification of rural areas in many developing countries and not only. In many rural areas, the renewable energy is the cheaper option to meet the needs of communities compared to power supply traditional solutions.

That type of innovation is the perfect solution not only to generate enough power for feeding and developing small businesses, but also to increase the synergies with growing sectors.

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