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MONETARY ESTIMATES OF SOCIAL AND ENVIRONMENTAL COSTS AND BENEFITS IN THE WIND ENERGY SECTOR

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Abstract

Monetary estimating the social and environmental costs and benefits of energy is a key to the development of truly green projects that would allow first of all presentation of economic, social and environmental benefits and costs to the stakeholders so that they would form a scientific opinion about what really happens in green economy. Through this study we tried to present and monetary estimate a series of social and environmental costs and benefits of wind energy given the challenges which mankind is facing on a global scale and even locally. The results of this article are in fact the conclusion that these estimates are subjective and could not be regarded as reliable. Also was revealed that the use of wind resources for power production compared to lignite could be better if we take into account the social and environmental dimension.

Keyword: externalities, green economy, monetary estimate, social and environmental dimension, wind energy sector.

JEL Classification: G23, O13, Q42, Q56

I. Introduction

Monetary estimating the social and environmental costs and benefits in the field of energy is a present topic that raises many questions about the use of natural resources

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and the current consumption mode of the population. However, there was still no model to monetary estimate the social and environmental impacts, that to be widely accepted internationally, due to the complexity of the social and environmental dimension. Looking at the history, among the issues that led to the various wars and economic and energy crisis has always included the lack or the limit of natural resources which were absolutely necessary for the survival of human society. As a result of this, the world has created a series of strategies and policies (UNEP, 2011; EEA, 2013 Council of the European Union, 2006) to reduce the limited natural resources and to promote the use of renewable natural resources, including also wind energy resource. Thus, by promoting green economy is intended to consider also the social and environmental dimensions, without which the economic dimension would not be viable in a very long time horizon, reason for which national and international regulations require achievement of socio-environmental impact assessment for the development and implementation of investment projects (Dey, 2006).

We believe that the topic chosen corresponds to current concerns and to the current context of diminishing fossil fuels and encouraging the use of renewable energy resources. Thus, by creating wind farms, the wind energy it could be capitalized, but to determine the viability of these investments compared to those using fossil fuels is essential to monetary valuation of social and environmental costs and benefits of these parks and their integration into the final economic reports. However, the importance of this assessment is given by the fact that these goods should be able to be traded on the market (Ioan, Bran et al.,2009) and that stakeholders be able to realize how important it is the socio-ecological dimensions.

The basic question that started this study was "which are ways used in practice for assessing socio-environmental impacts of wind energy?" while the pursued objectives were: to determine socio-environmental impacts that may occur as a result of implementing a wind farm and to present the ways of impacts' monetary estimate. Of course, this study has limitations in the sense that were presented only certain social and environmental costs and benefits given by the operation of a wind farm, the well known ones, and the estimated ways have shown a subjective nature.

II. Literature Review

There are various studies showing various models and methods for estimating the social and environmental impacts in different fields of economy (Friedrich and

Volume **2**/2014 ISSN 2344-102X
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Bickel,2001; Moran and Sherrington,2007; Lee, Chen, et al. 2009), but currently there is no method which to be widely accepted and implemented worldwide. Monetary estimating the social and environmental impacts conducted in one country may differ from that carried out in another country, which basically means that for now these evaluations are just indicative and subjective. However, there are specialists (Navrud and Pruckner, 1997), among which we count, who raise the issue of whether these methods for estimating social and environmental impacts are effective and really reflects the total economic value of the costs and benefits caused (including social and environmental externalities). Now it is considered that in fact it could not be calculated the total economic value because it may take into account only a part of moral values (Söderholm and Sundqvist, 2003) and also are not aware of all the possible implications. So, arose the concerns to build a modern theory of value, by this being redefined the concept of value which now includes appreciation of ecosystems (Ioan, Bran et al.,2009).

Externalities arising from the production or consumption of energy are divided according to the action of impact in two major categories, namely externalities arising from gas emissions affecting locally/regionally and externalities arising from emissions gases that affect globally that are involved in climate change (Owen, 2006).

The monetary estimation of social and environmental costs and benefits is achieved by using one of the following assessment methods: willingness to pay, willingness to accept, contingent valuation method (Haab and McConnell, 2002). Also, the subjective nature of this assessment has enabled the creation of methodologies to estimate the social and environmental costs and benefits. Thus, to monetary estimate the social benefits, can be used interaction patterns between the availability of wind energy, the existing demand and the dispatch conventional generator (Kennedy, 2005) and to calculate the impact of pollution emissions of greenhouse gases should be considered the achievement of a link between the renewable resources, technology characteristics and location characteristic of the wind farm area (Owen, 2006).

Therefore, to take decisions in achieving energy investment projects is carried out various analyzes on the evaluation of socio-environmental impacts such as cost-benefit analysis, multi-criteria analysis, data modeling, risk analysis, vulnerability analysis, lifecycle costing (Ness, Urbel-Piirsalu et al., 2007).

III. III.Methodology

This study was conducted based on information provided by the CASES project created by the European Commission, which aims to determine the total cost (cost of external and internal) of Energy from the various renewable and conventional sources and to inform all stakeholders about it. (European Commission, 2008). Also for converting lei-euro was used currency exchange rate of 1 leu = 4,367 euro since 17.04.2013. To assess the loss of agricultural production through the removal of agricultural land have been used a methodology based on profit (Negrei, 2013). We relied on data from specialist of EPC environmental consultancy, to which were applied interviews regarding the wind farms.

IV. IV.Results

Given the complexity of social and ecological implications, we would present in this study only the most obvious and known socio-environmental costs and benefits. These impacts are felt as costs or benefits to society and ecosystems.

The main socio-environmental benefits are:

- Creating new jobs by engaging in new green sectors and supplement income of farmers on whose lands are placed the wind farms.
- Reduction of CO2 and other greenhouse gas emissions, benefit that contributes to diminishing the intensification of climate change.
- Decrease in the reduction of stocks of fossil fuels by using renewable, which means that conventional energy stocks will exist over a period much longer of time, which will also cause a smoother transition to a green society, a society that does not use fossil fuels.
- Increasing energy security as a result of ensuring energy from domestic resources of each country which will lead to lower energy dependence on countries that have vast oil and gas stocks.
- Energy saving due to the construction of technologies that provides their energy consumption from their own production.

The main socio-ecologic costs are:

- Losses of agricultural production through removal from use of agricultural land.
- The impacts of shading effects and shadow flicker on the local community.

Volume 2/2014 ISSN 2344-102X
Issue (1)/ February 2014 ISSN-L 2344-102X

- Impact of noise pollution due to the exploitation of machines and equipment used to build the park and the effect of noise on the local community as a result of the operation of the turbines.
- Impact on biodiversity (especially the birds).
- Air pollution emissions due to building technologies needed for the wind farm, the operation of machines and equipment necessary for the construction and as a result the operation of the wind farm.

Regarding revenue estimate granted to locals whose plot is located on the park, we can say that in order to receive land on which will be built the turbines platforms and access roads, the park investors will have to sign a contract for full details on the right to use and usufruct of land owned by the local population where it will be located the park. After reaching an agreement on these details, the administration of the wind farm will have to ensure a certain lease payment for land owners and to compensate the farmers for the removal from the circuit of agricultural land and thus for loss of income. According to the ,, Guide to cost-benefit analysis of investment projects" carried out by the European Commission (European Commission, 2008), the additional social income generated by creating new income can be determined by using a lower cost than the amount paid, to emphasize that the current income is greater than the opportunity cost. So if we take into account the payment of compensation to farmers and subsidy per hectare per year paid to a farmer, the total social income will be:

n locals * (payment compensation to farmers - x% * subsidy per hectare) (1)

where n = number of locals and x% = percentage of the total area of the farmer occupied by turbine.

Also, when we want to monetary estimate the impact of increased household income by creating m permanent jobs for a wind farm in general, as regard to the security services of the park, we can use the following calculation:

n locals * 12 months * salary gross lei/year / 4.367 lei/euro. And in this case the comparison applies to the opportunity cost of the work supported by the European Commission.

To determine a monetary estimation of CO_2 air pollution it is considered that in reality also the wind farms pollute, even if it is stated that a wind power plant emits no pollutants. These wind farms pollute especially phase of technology construction needed for the park, which usually is not taken into account in the economic analyzes of projects, so that even in this case was not considered. Therefore, it emits 0.0044 kg CO_2/kWh

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during actual construction of the wind farm, 0.0051 kg CO2/kWh during operation processes and 0.00024 CO2/kWh when disassembling the plant, with a total of 0.0098 kg CO2/kWh.

The total economic value of these emissions in the period 2010-2019 is:

10.54 Euro2000/tons * 0.0098 kg / kWh * Q (production) wind / year. (2)

With regard to the determination to reduce CO2 emissions and their monetary estimation will initially make a comparison between the amount of CO2 produced by fossil fuel based technology and one based on wind power. The total CO2 emissions produced by a wind farm were 0.0098 kg/kWh compared to 0.91731804167 kg/kWh produced by plants using lignite (Mayer-Spohn and Blesl, 2007). We chose the comparison with coal because 60% of electricity is produced from coal in Romania (Petrescu, 2011). Also, CO2 emissions are monetary assessed (Markandya, Bigano, et al., 2011) at 10.54 euro2000 /tons (for the period 2010-2019 using the annual updating of emission). Thus, for a given wind farm, monetary estimation of the reduction in CO2 emissions (2010-2019) is:

10.54 Euro2000/tons * (0.91731804167 kg/kWh - 0.0098 kg/kWh) * Q wind/year. (3)

In the equation (3) the elements relating to technology must be added, which affects the amount of emissions released into the air. To predict a longer period of time, which allows it CASES project, I noticed that for the period 2020-2029, the cost of CO2 is 13.67 euro2000/tons and for the period 2030-2039 it is considered to be 15.21 euro2000/tons. These costs are replaced in equation (3), plus technological elements to determine the monetary estimate of the reduction in CO2 emissions in the respective periods.

Another category of cost that should be considered is the loss of agricultural production through agricultural land removal from use. To estimate these losses is intended to calculate two indicators: overall average production per hectare and gross weight per hectare (Negrei, 2013). You must first be established that the area of land to be taken out of service. First, it must be established which area of land will be taken out of service. Thus, for a better understanding of the methodology, we assume that for the construction of the park will be removed from service 360 ha of agricultural land. We also assume that the park is located on approx. 180 ha Jorăşti and 180 ha Vârlezi, two commune in Galaţi County, and that calculations were made based on the area planted with major crops in 1999. Assuming that, on these lands removed from circuit, is grown the crop presented in the table below, then the overall average yield per hectare ($\bar{Q}$) and total profit per hectare (Pr) should be calculated according to the following formula: $\bar{Q} = \sum_{i=1}^{n} \bar{q}_i * \%$ and Profit = Income (V) - Expenses (Ch) => RPr = V/Ch-1.

The overall average yield per hectare it will be of: $\bar{Q}$ = 2575*49.36%+2288*26.08%+1161*24.56% =
= 1271.02+596.71+285.14 = 2152,87 kg/ha.

Table 1 - Indicators - main crops set aside (during construction)

No. crt.	Crop	Surface (ha)	% crop from total surface	Yield (kg/ha)	Profit rate (Guţu,2006) (%)	Price (lei/kg)
1	Porumb boabe	177,7	49,36	2575	21	1
2	Grâu şi secară	93,9	26,08	2288	20	1,1
3	Floarea-soarelui	88,4	24,56	1161	19	2
	TOTAL	360	100	-	-	-

Source: Developed by authors, 2013

Grain maize: RPr = 0.21 => Ch=V/1.21 => Ch=2575/1.21= 2128.09 lei/ha
V=2575*1=2575 lei/ha
Prp= 2575 – 2128,09 = 446,91 lei/ha
Wheat and rye: RPr = 0.20 => Ch=V/1.2 => Ch=2516.8 /1.2= 2097.33lei/ha
V=2288*1.1= 2516.8 lei/ha
Prgs= 2516.80 – 2097.33 = 419.47 lei/ha
Sunflower: RPr = 0.19 => Ch=V/1.19 => Ch=2322/1.19= 1951.26 lei/ha
V=1161*2= 2322 lei/ha
Prfs=2322– 1951.26 = 370.74 lei/ha
Total profit per hectare: Pr = Prp+Prgs+Prfs= 446.91 + 419.47 + 370.74 = 1237.12 lei/ha.

Thus, during the construction of the park (1 year) there will be a monetary loss of 1237.12 lei/ha * 360ha/4,367 = 101983.79 euro.

This study also shows how to assess the impacts of noise and shadow effects, namely making a noise modeling (performed at a certain wind speed specific to the location of the park, speed over which the sound does not increase) and achieve shading modeling. This can be achieved in reality with WindPRO program (modules Environment: Decibel and Environment: Shadow), afterwards to be able to determinate the impact of park on population's health in the area. The results of the modeling of noise during the night (worst case scenario) can show whether there is or not a negative impact on the population in terms of sound. The negative impact is defined in the Romanian legislation (Order 536/1997) and, if the sound exceeds the limit of 40 dB at night, then it must be among the monetary estimated socio-ecological cost. In what concerns the modeling the effect of shading which must be done on the worst case scenario (all days in a year are sunny and bright and the turbine operates non-stop), this is not governed by Romanian law to limit the effect, therefore will be compared with the German regulations (information obtained from EPC Environmental Consulting), which recommends a maximum limit of 30 hours/year of shading. Also, must be taken into account intermittent shading effect (shadow flicker) which affects population health by inducing stress (risk of 40%), sleep disturbance (100% risk) and even has the potential to induce photosensitive seizures (low risk). Although in Romania there are no regulations on this subject, it should nevertheless be taken into account the regulations existing in other countries (Society for wind vigilance,2013). In order to monetary estimate these social costs it could be used two indicators: transport expenses to and back from medical services and price of medicines required due to adverse effects occurred because of the shadowing implications. Returning to the problem exposed in the introduction, it is really enough? We believe not, but taking into account those two indicators would be a step forward for Romania in the consideration of socio-environmental costs.

V. Conclusion

Through this study we have seen the involvement of Romanian and foreign researchers in the development of methods and methodologies for monetary estimating social and environmental costs and benefits in various fields, but also that there is no universally accepted method worldwide and even national level, which still means a deficiency in this area, because comparability between certain projects estimated differently is meaningless.

We also identified the main social and environmental costs and benefits of wind energy, which must be taken into account when considering the viability of a project and determine its impact on welfare.

Through this study we have analyzed several ways to monetary estimate social and environmental costs and benefits of wind energy, by presenting concrete examples and real practice. Thus, we conclude that estimating the socio-ecological dimension is very important to demonstrate the importance of a long-term project.

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