**Group decision and wind energy: the stakeholder’s consensus**

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**Juliana Botelho**  
Federal University of Rio de Janeiro  
Cidade Universitária – Rio de Janeiro, Brazil

**Carlos Eduardo Durange de Carvalho Infante**  
Federal University of Rio de Janeiro  
Cidade Universitária – Rio de Janeiro, Brazil

**Rogerio Valle**  
Federal University of Rio de Janeiro  
Cidade Universitária – Rio de Janeiro, Brazil

**Abstract**

The growing share of renewable energies in the global energy mix is primarily grounded in a set of likely positive externalities that they are able to generate, such as: employment generation, expanding access to energy and reducing emissions of GHG. In this scenario wind power has emerged, with an average annual market growth of around 10%, in late 2012, reached 281.1 GW of installed capacity (GWEC, 2013). Yet the construction of wind farms has shown many side effects, among them are: visual and shadow flicker effects, noise emission and the land occupation and usage. These impacts foster resilience of local communities to build these farms in their surroundings, cluttering project implementation. So it becomes important to evaluate such projects, from a methodology for group decision, in which are analyzed fully all impacts and decisions to be taken by stakeholders. This possibly minimizes the rejection of same and generate greater acceptance. From this approach, this paper aims to establish a prospective scenario possible social consensus to be achieved in the implementation of such projects, using the method of multicriteria decision support, from the theory of group decision.

**Keywords**  
Wind Energy; Group decision; Multicriteria method

**1. Introduction**

Renewables underpinned the growth of many nations for a long period. However, from the fifteenth century, mass deforestation, for use of wood as a primary source, started a new route of production and trade. The exponential growth of consumption and utilization of oil led to a dependence of nations and disputes increasingly fierce, the access to the same, high levels of pollution and GHG (Greenhouse Gas) emissions. All this movement has created new opportunities for the country, making it a route investment for multinational companies active in the wind industry.

The processes of negotiation and group decision are very complex human activities. Negotiation is a process of joint decision making.

From this discussion, this article aims to analyze the main impacts to the local community, with the use and operation of wind farms, and ultimately, build a step-by-step decision-making in complex situations involving multiple decision makers.
2. Wind Energy Context

Renewables underpinned the growth of many nations for a long period. However, from the fifteenth century, mass deforestation, for use of wood as a primary source, started a new route of production and trade. The drastic reduction of reserves and this led to a change in the energy regime, which was based on an easy to process and transform as well, when compared to the new, coal. The shortage of it contributed to rising prices of this commodity encouraging the search for new sources and by the early twentieth century the oil was used in large scale (RIFKIN, 2003). The exponential growth of consumption and utilization of oil led to a dependence of nations and disputes increasingly fierce, the access to the same, high levels of pollution and GHG emissions. The oil shocks showed the fragility in which were being grounded energy pillars of nations. This has encouraged the search for new methods of production and exploitation of resources. Moreover, the sustainability agenda begins to enter the political and business landscape (RIFKIN, 2003; ELKINGTON, 2012). This scenario has encouraged the search for alternative energy route, thus favoring the growth of renewables.

Europe was the first continent to invest huge amounts of money and build a consistent legislative framework with the renewable energy market. Moreover, contributed to the promotion of these sources around the world, little by little, opening space to promote their viability mainly through government incentives (WWEA, 2012).

It is estimated that the world's gross wind power potential is of the order of 500,000 TWh/year, which means more than 30 times current worldwide consumption of electricity. This potential, at least 10 % is technically usable, which corresponds to about four times the current global electricity consumption (GWEC, 2013). There is the prospect that the sector receives 269.8 GW of new wind turbines in a period of only five years (WWEA, 2012).

According to the statistics presented by GWEC (2013) the wind market remains booming in different world regions, with an average annual market growth of around 10 % and 19% increase in cumulative capacity. In late 2012, the global installed capacity increased by 44,184 MW totaling approximately 281.1 GW (EUROBSERVER, 2013).

Countries which have made greater increases in their installed capacity in the year 2012 were: China, United States, Germany, India, United Kingdom, Italy, Spain, Brazil, Canada and Romania. The first three nations (China, United States and Germany) together accounted for over 64 % of the movement of the market in period of this study (GWEC, 2013).

In the scenario presented Brazil stands out for having, in 2012, occupied the seventh position in the ranking of countries that have made increases in their installed capacity, accounting for 2.4% of the total. This demonstrates the government’s commitment to expand its renewable sources as well as providing the complementarity of national headquarters, in particular regarding the seasonality of water potential in drought periods and technological impediments that permeate oil exploration (MME, 2013).

The growth of wind power in the national matrix was achieved primarily from incentive programs; including the PROINFA has greater relevance to the Brazilian context. The program was designed as feed-in and initially included 54 wind farms, which would total 1.4 GW (MME, 2013).

Another important mechanism to aggregate the national wind power matrix, are the auction sale of electricity. In 2009, the Reserve Energy Auction, exclusive to wind, there were 71 contracted projects totaling approximately 1,805.7 MW to be installed by July 2012. The starting price was R$ 189.00 / MWh, but reached the final value of R$ 148.39 / MWh. In 2010, two auctions Alternative Sources contractors that resulted in 70 plants and approximately 2,047.8 MW at an average price of R$ 130.86 / MWh occurred. In 2011 , wind energy began its participation in the auctions in conjunction with traditional sources and auctions mode A-5, totaling 117 projects with 2,905 MW contracted at an average price of R $ 101.48 / MWh. In 2013, the SPC plans to perform three new auctions. The first occurred in Agosto/2013, in the A-5, has hired 1,505 MW at a price of R $ 110.51 / MWh in 66 enterprises (MME, 2013).

The monitoring of this expansion has required high investments. Since 2010, the wind industry has received, on average, U.S. $ 9 billion a year and this has provided, approximate growth of 2 GW per year, reaching the end of the decade with an installed capacity of 10,000 MW and participation up 7 % in the electric matrix (ABEEÓLICA, 2012).

In Brazil the production of electricity from wind power reached 2,705 GWh in 2011. This represents an increase of 24.3 % over the previous year, when it reached 2,177 GWh (MME, 2013). In the same year the installed capacity for wind power generation in the country increased by 53.7 % and the national 498 MW wind farm grew, reaching 1,426 MW (ANEEL, 2012).

All this movement has created new opportunities for the country, making it route investments for multinational companies active in the wind industry. The arrival of new entrants to the scenario of wind supply chain has provided the development of local industry that moves an average of three billion dollars per year and employs twelve thousand workers, only to manufacture wind turbines. There is still expected generation until 2020, two hundred
eighty thousand jobs directly and indirectly in this segment (ABEEÓLICA, 2012), considering that from 2005 to 2010, according to the ILO (2011), there was a 27% increase in number of jobs in this sector.

The absence of adequate social analysis is the main source for embargoes wind projects, so it is important to develop tools for the strategic management of the same.

3. Group Decision

The processes of negotiation and group decision are very complex human activities. Negotiation is a process of joint decision making. It is the direct or tacit communication between individuals who are trying to establish an agreement for mutual benefit (YOUNG, 1991).

Jiménez and Polasek (2003) show, in this context, three different situations: group decision, negotiated decision and systematic decision. In the first case, all individuals looking for a common goal. Then, each individual solves the problem independently, and areas of agreement and disagreement between the different positions are found. Finally, in the third case, each individual acts independently, but all positions are met according to the principle of tolerance. Importantly, the type of group decision addressed in this paper does not involve negotiation.

According Jelassi et al. (1990), the group decision is usually understood as the reduction of different individual preferences in a given set for a single collective preference.

Problems involving different decision-makers. An important feature of group decision is that all individuals involved belong to the same organization. They may represent different departments of a company, or different countries in an international organization, or simply different partners involved in a project. They may differ in the perception of the problem and have different interests, but they are all responsible for the welfare of the organization and share the responsibility for decision implemented.

When a decision situation involves multiple actors, each with different values, the final decision is usually the result of an interaction between these individual preferences. However, this interaction is not free of conflict that can be caused by many factors such as different ethical or ideological beliefs, different specific objectives or different roles within the organization (ROY, 1996).

In this context, although the set of alternatives and criteria are identical for all makers, evaluations can be quite different according to the preference functions and weights distributed individually. This depends strongly on the specific interest of the decision makers, who should consider larger weights to the criteria that represent their concern on the problem, be they technical, financial, social or environmental.

At the end of this stage, all makers have a good personal view of the problem and the values obtained in net flows represent the preferences of each decision-maker, the largest corresponding value the best alternative for that decision maker. Thus, the rankings of each are collected and arranged in a comprehensive evaluation matrix. So, is initiated to a new multicriteria problem with the same alternatives, considering as criteria decision makers.

Local communities will be the focal being treated in this article considering that the processes that involve the construction, installation, maintenance and decommissioning of these are perceived by them as point sources of impacts. These impacts can be seen in Table 1, as mentioned Ferreira and Vieira (2013).

The difficulty of decision-making is in dealing with the need to satisfy the constraints, goals, objectives and conflicting criteria, this being the main search field Multicriteria Decision Aiding (AMD). Takeda (2001) states, that the complex decision problems involve conflicting criteria, with inaccurate ratings of alternatives on criteria, creating uncertainties and indeterminacies.

<table>
<thead>
<tr>
<th>Impacts</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Landscape and visual impact</td>
<td>morphological changes in the region, movement of heavy machinery, large number of waste generated by construction, dispossession and displacement of families, etc.;</td>
</tr>
<tr>
<td>Shadow flicker impact</td>
<td>moving shadows from interaction of sunlight and rotating blades from wind turbines; reflection of sun rays from blades</td>
</tr>
<tr>
<td>Noise emission impact</td>
<td>sounds emitted by wind turbines when they are in operation; health side effects such as sleep disturbances, during the construction of the park explosives for excavation generating high noise levels are used, the noise emitted by means of transport carrying equipment and personnel to the region;</td>
</tr>
<tr>
<td>Land occupation and usage impact</td>
<td>permanent occupation of areas; exposure of land to erosive agents, soil contamination by oils and similar products</td>
</tr>
<tr>
<td>Socio-economic impact</td>
<td>intensification of traffic, worsening the quality of existing infrastructure, reducing the tourism potential of the region and the local jobs and income generated by them</td>
</tr>
<tr>
<td>Air quality and carbon footprint impact</td>
<td>emission of pollutants such as CO2 and NOx, evaluation of non-GHG emissions over the entire life of the park</td>
</tr>
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4. Multicriteria Analysis

According Simos (1990), the first publications cataloged the multicriteria decision aid dating from the late 60's of last century. Multicriteria decision aid is called, by French school, Multicriteria Analysis, and by American School, Methods of Multicriteria Decision Aid (MCDA – Multiple Criteria Decision-Aid) or Multicriteria Decision Making (MCDM - Multiple Criteria Decision Making) (VINCKE, 1992).

Roy (1985) states that European school differs from American school regarding the use and definitions of multicriteria methods. The second one focuses its efforts in the discovery and description of the decision maker, and build on theorems, corollaries, axioms and concepts in the search for "optimal solution". Already the European side quest to find the "best compromise solution", which means that in the case of multiple criteria, it is impossible to think of the optimal solution.

Outranking methods are not adapted to the uncertainty with uncertain and imprecise data, as explained below:

• Criteria indeterminate, since the method of evaluation criteria are arbitrarily selected among several possible definitions;
• Criteria uncertain, because the measured values refer only to a point in time and some values vary in the long run. For example: the “employability” of projects depends on the economic situation. “Investments in facilities” may not be evenly distributed throughout the time.

In applications for studying the sustainability, often the performance indicators are used as criteria (AFGAN & CARVALHO, 2008; ROUSSAT ET AL., 2009; BOGGIA & CORTINA, 2010; CASTELLINI ET AL., 2012; INFANTE ET AL., 2013).

5. Results and Discussion

Forth in Table 1, where the impacts are set inherent to the installation and operation of wind farms, we realized that with the use of the methodology in a group decision, coupled with the multi-criteria evaluation, consensus can be reached.

The quantification of the solutions, their ordination, or the generation of new set of possible solutions is attributes using advanced methods. They can be used at any time, immediately after the construction of the criteria, the reformulation of the goals, or the relaxation of the preferences and analysis of the consequences.

The Figure 1 presents the proposed methodology for treatment of conflicts arising from the use and operation of wind farms. In the first instance, the multiple decision makers conflict with the surrounding society, which are directly impacted by the actions of the enterprise. The method of group decision subsequently is used, and supported by multicriteria decision support methods. With the integrated use of these two methodologies, we arrive at a consensus, whose purpose is to enable a final decision and convergent, under indirect and direct impacts to society.

![Figure 1: Proposed to minimize impacts](image-url)
The trading group, then you need:
- Preference information set of actors, or as defined as possible;
- Definitions of the problems involved;
- Group of alternatives to be evaluated; and
- Decision criteria, weights assigned to these criteria, or range of weights.
Thus, the use of a support system trading is possible only if it recognized the existence of one or multiple problems (common to both) and stakeholders become aware of the need to use a system that allows the collectivization of decision.

6. Conclusion
The development of wind power has expanded the number of parks built and therefore it impacts generated by them. In this scenario the local communities are directly affected and so have offered resistance to increasing deployment of wind sites in its surroundings. This paper aims to construct a model of trading in a group able to assist decision makers in solving complex problems pertaining to this context in order to obtain the necessary consensus for final decision making.

It is intended in future work with the proposal presented in Brazilian wind farms located in the Northeast region, given that the largest number of wind farms in the country.

References


