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Entrepreneurship based on intermodal transport for the installation of a wind turbine in isolated regime

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Abstract

The complex activities for the implementation of renewable energy projects (RES) need a well-documented entrepreneurial plan to find qualified suppliers for the development of RES projects. The activities of the chain links in RES projects, respectively, the transport of heavy components, require a collaborative logistics system to be continually monitored. The requirements stringency imposed for the implementation of wind energy projects inevitably implies infrastructure, implementation and logistical constraints. Special parts of the wind turbine can be difficult to handle due to their fragility, weight or size and therefore it requires special treatment when transported. This work, based on the Analytic Hierarchy Process (AHP) method, respectively through a decision model provides an entrepreneurial plan for the intermodal transport needed to assembly a wind turbine in isolated regime, where there are challenges related to the high transport distance, low road standard and rough climate.

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Keywords: entrepreneurship, intermodal transport, wind energy, AHP

1. Introduction

The use of renewable energy resources is one of the major issues on the agenda of the European Union (EU). Given that talks about the dramatic fall in fossil fuel prices are still under debate, the benefits of developing renewable energy have already proven to be a very good solution to the real global energy issue. [1] In addition to global energy debates about the growing needs of world's population with conventional energy sources, the implications of continuing dependence on fossil fuels are considered to be particularly important for climate

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change.[2] In this sense, representing a viable solution to the effects caused by climate change, promoting projects from conventional energy sources, namely wind energy projects are among the main promoters of green energy due to its superior characteristics in abundance. In the wind industry, the introduction of new composite materials technologies has made wind turbine installations to have a rapid increase in manufacturing of large components. Due to the maturation of wind turbine technology and the proliferation of government policies, plans have been created to support the development of such projects. The development of the renewable energy sector tends to maximize the benefits of nature, moreover, wind project developers are aware of long-term benefits and are proposing major investments in developing countries. [3]

Throughout the development of the renewable energy sector, differences in the performance of different types of wind energy entrepreneurs were analyzed. The interdependence between the different systemic conditions - technical, economic, institutional and social conditions - was also examined, with an emphasis on the relative importance of institutional and social settings for market development. Systemic conditions and interdependencies influence the behavior of wind energy entrepreneurs. [4] Entrepreneurs in this complex area have to face exceptional situations in particular in choosing optimal transport routes for heavy components and beyond. Choosing quality suppliers is an important process for implementing RES projects. In their turn, suppliers are submitted to much more complex activities in order to provide special materials for the production of wind energy components. They have to provide the necessary quality raw materials and have to deal with difficult decision situations, in order to respect the technical commitments in accomplishing the specific parts to each type of RES project. The requirements stringency imposed for the implementation of wind energy projects inevitably implies infrastructure, implementation and logistical constraints.

After the energy sector, transport is the most important producer of carbon dioxide (CO2). Unlike the energy sector, energy consumption and greenhouse gas emissions in the transport sector are still rising in many industrialized countries. The problem is even more severe in developing countries, where enormous growth is needed to reach the industrialized world, as experience shows that economic growth is strongly correlated with increasing transport volumes. The purpose of transport policy within the European Union is to establish a sustainable transport system in every industry [5] and the successful promotion of intermodal transport has been identified as the most critical action to achieve this demand. [6] Thus, intermodal transport is promoted through policies that address all political levels. [7] In order for intermodal transport to be a preferred alternative to road transport, generalized transport costs should be equal or lower [8], thus additional costs due to pre-transport and post-transport as well as transshipment at intermodal terminals must be offset by lower costs of long-distance transport. [9]

2. The importance of using intermodal transport for renewable energy projects

In today's technological context, decision-making for the implementation of renewable energy projects is a challenge both for specialist's teams in the research, development and implementation of RES projects, as well as for the choice of the partner suppliers, which need to face stringent technical requirements imposed by the project documentation. The rapid increase in global demand, in recent years, for the production of large components and heavy toner in wind industry has led to many collaboration challenges between chain links in decision-making. The activities of the logistics chain links in wind industry namely the transport of heavy components, need a collaborative logistics system that must be constantly monitored. Special parts of the wind turbine can be difficult to handle due to their fragility, weight or size and therefore it is required special treatment when transported. Transporting the wind turbine components from production to the assembly site can be a challenge due to their sizes and weights. Wind turbines consist of large sections and their transports on special platforms can reach 50 meters long and 5 meters wide. This is, therefore, classified as special assets oversized vehicles with challenges that can often only be met by special infrastructure training. The chain parts of the road transport must comply with national rules and restrictions. This implies that bridges must have sufficient transport capacity, which may require their closure while special transport is in progress. In addition, for such oversized transport, police and / or public authorities may be required to be present on road transport. [10]

Consistent with arguments presented above, this paper focuses on the challenges of transporting the oversized components of a wind turbine from the place of production to the assembly site.

3. The case study

This paper is based on the researchers conducted for a RES exploitation project in isolated regime carried out by a team composed by a key representative of a company directly interested in the research topic and the authors. Within this project, the research team identified through a long debate and a multi-criterion decision an efficient and economical way of choosing a wind turbine power and an optimal transport route for the installation of a wind turbine in an isolated region. These decisions required different project activities that involved research, development and implementation, correlated with some disciplines that included a wide range of specialists. The complex combination of knowledge by specialist teams generates some difficult decision, in most cases, due to the technical parameters imposed by the isolated regime. (Fig.1)

Thus, within the RES project, in isolated regime, the following activities were analyzed:

• Studying topographical characteristics of the assembly place.
• Selection of specialized suppliers of components in the RES field.
• Selection of transport routes for large components.
• Verification of the transport land, which may present non-conformities, not being built for the traffic of large-scale machines.
• Strengthening and expanding rural roads.
• Use of special equipment for land clearance, transport of construction materials, foundation and concrete for tower lifting.
• The construction and operation of a wind power plant.
• Components design of the wind power plant (mechanical structure, turbine, blades, electric generators, converters, driving and supervision structures)
• Location of the tower and the rotor and the placement of the warning signs.
• Construction of connection and transmission lines to the electrical network.
• Identify the optimal cost for the connection voltage.
• Electrical installation and earthing in rough terrain.
• The modality for disconnection the turbine when a network fault occurs.
• Ensuring access to wind installations and decommissioning requirements.

This paper presents three power types of wind turbines with different characteristics that are technically appropriate to achieve the economic objective for RES projects in isolated regime.

Type 1 -low-power wind turbines: less than 12m blades diameter rated power of less than 1.0 MW and turbine pillar 7 m height. Hub and all three blades are assembled at the farm site. Remaining sub-assemblies (lower tower and transition piece, lower and upper tower sections, upper tower and nacelle) are done at the farm site. Two tower sections and the nacelle are transported separately. (Fig.2)

Type 2- medium power wind turbines: less than 45m blades diameter rated power between 1.0 MW and 2.0 MW turbine pillar 9 m height. Two tower sections are assembled at the farm site, also the nacelle and hub are assembled together all the remaining components are transported separately to farm site. During installation, first the tower is assembled to the transition piece, then the nacelle and hub sub-assembly is attached to the tower, finally three blades are lifted and assembled to the hub.

Type 3 -high power wind turbines: 46m blades diameter exceeding rated power over 2 .0 MW-2.5 MW turbine pillar 12 m height. The nacelle and hub are assembled together at the farm site all the other components are transported to the farm site separately. During installation, first the lower tower is assembled to the transition piece, then two tower sections, after that the nacelle and hub sub-assembly is attached to the upper tower; finally, three blades are bolted to the hub one by one.

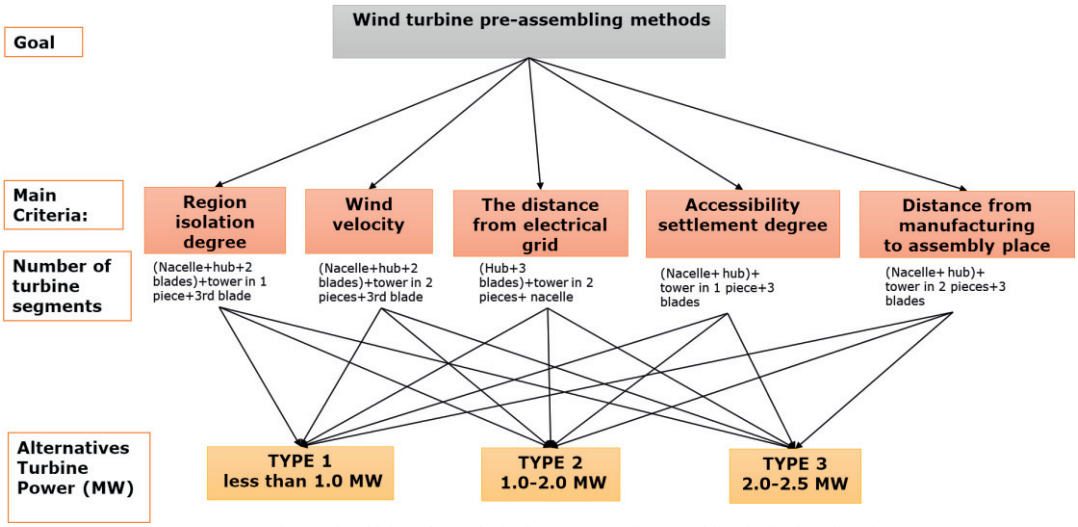

Fig. 1 Identifying the technical parameters imposed by the isolated regime.

The solution provided by the AHP algorithm has indicate that Type 1 provide a framework for detecting the optimal alternative, much more offer a solution to avoid high costs by choosing the right pre-assembly method and obtaining a minimum transport cost for installing the wind turbine under special conditions. The use of the AHP algorithm offers both advantages and disadvantages, since defining it by its elements can determine which combination is appropriate for developing an economical wind turbine installation plan in isolated regions.

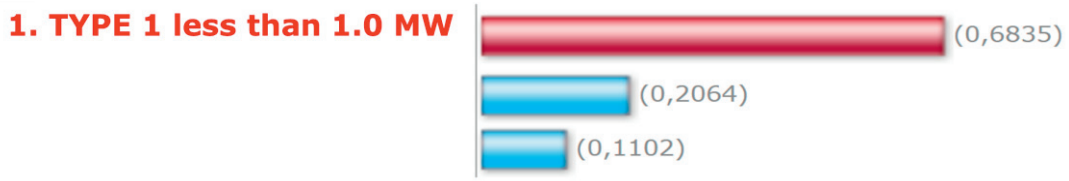

Fig. 2 Detecting the optimal alternative through the AHP algorithm

Also, in order to achieve the economic objective, finding a transport route is a complex decision-making problem, involving multiple and sometimes conflicting criteria and objectives. In addition to turbine production costs, the cost of energy is significantly affected by heavy tonnage transport operations. (Fig. 3) [1] In this respect, the transport of large components for RES project in isolated regime involves different barriers. The challenges and considerations for such a particular transport are discussed on the basis of interviews with representatives of two companies providing these type of transport services.

Some relevant examples are presented below:
-The steep terrain chosen for the installation of the wind farm and extreme weather conditions create real impediment for the teams responsible for transporting the reinforcement in the installation site. For the supporting pillar construction, it is necessary to construct and transport the foundation reinforcements so as not to allow the infiltration of water into the cable connections.
-The installation of the wind power plant at the top of a hill requires the right choice of transport route for the delivery of large parts without incurring additional costs to the project.
- A potential risk of such projects is the deterioration of the quality of rural roads designed for low traffic or light vehicles. Existing rural roads need to be rebuilt or strengthened to support the weight of oversize equipment.

For example: The nacelle assumes an enclosure containing the electrical and mechanical components, namely the

gearbox, the brake, the speed and direction monitor, the tilting mechanism and the generator. Nacelles have a light fiberglass shell and can easily be damaged. Thus, choosing the best route (national and special train) eliminates the risk of damage to the auxiliary components. The analysis carried out shows a high weight ***0,6591*** for the choice of the optimal transport route, respectively the national road and the special train (Table 1)

Table 1. Comparison of the studied transport solutions.

Type 1 less than 1.0 MW NACELLE	**BY ROAD**	**BY TRAIN**	**BY ROAD AND TRAIN**
Total costs	Highest	Middle	Lowest
Time use	Highest	Middle	Lowest
Probability for damage	Highest	Middle	Lowest
Environmental impact	Highest	Middle	Middle
WEIGHTS	**0,1602**	**0,1808**	**0,6591**

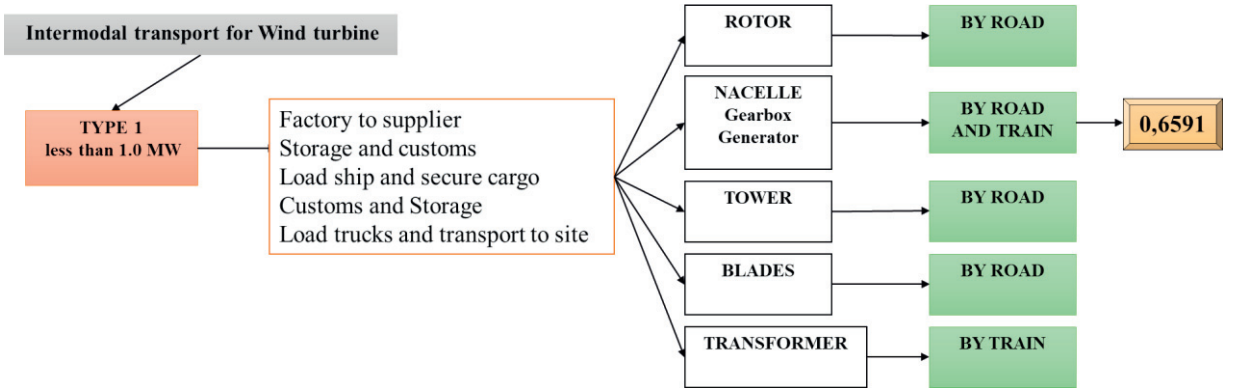

Fig. 3 Intermodal transport for RES project in isolated regime

In this case, transport contracts are usually awarded after competitive bidding rounds involving more than one transport company. Transport companies need to invest considerable resources in preparing price estimates. They need to review the transport route and develop infrastructure conditions. This includes special train facilities, upload and download, availability and road network properties. Since so many things are at stake, there is always a running attempt before the actual transport starts. There is a tendency for manufacturers to leave more parts of transport to external companies. Thus, transport companies assume responsibility and coordinate the necessary components to be transported when is needed. The fact that most transport companies do not have all the necessary equipment for such specialized transports denotes the involvement of several companies that need to interact in the transport chain. Naturally, the transport properties vary depending on location and infrastructure for the manufacturer and location,

4. Conclusions

This paper provides solutions for the use of intermodal transport for projects from renewable energy sources. This paper focuses on the challenges of transporting oversized components from the production site to the assembly site with special conditions. Two questions are specifically addressed in this paper. First, there are three types of wind turbines with different characteristics that are technically appropriate to achieve the economic objective for

RES projects in isolated regime and are recommended by using the AHP algorithm the transport solution that would be the most efficient for the case in question. Secondly, there is a description of the typical transport of wind components, focusing on the specific challenges of this type of specialized transport.
The information on the transport of oversized components should be developed to carry out a risk assessment and to establish appropriate terms and conditions of coverage.

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