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Intermodal transport of windmills

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Abstract

Special goods can be difficult to handle due to fragility, weight or size and therefore require special treatment when transported. Windmills are examples of special goods with challenges both with respect to high weight and large size. At least in Europe, the focus on green energy entails rapid development of windmill projects where components needing special handling is transported over great distances. This paper studies the transport of windmills from Continental Europe to Norway where challenges are related to the long-transport distance, low road standard and rough climate. Different transport strategies are presented and discussed in relation to a theoretical model aiming to minimize the generalized transport costs. It is argued that unimodal transport by truck is not practically possible due to many insuperable barriers. Therefore, two types of intermodal transport are suggested of which the benefits of reduced handling at terminals are weighted against lower capacity utilization at the water based long-haul distance. Despite being part of a political strategy aimed at developing green energy, the companies transporting windmills are rarely imposed any environmental requirements by the shipper.

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Keywords: Generalized transport costs; handling costs; intermodal transport; ship; truck; windmill

1. Introduction

Wind is a source for renewable energy that has received considerable attention the last decades. Wind power can to some degree contribute to the production of energy and many countries have access to wind that can be utilized for such purposes by wind mills (e.g. Aman et al., 2013). The global windmill industry, dominated by the markets in Europe, North America and Asia, grew by about 29% in 2008 and exceeded 120 GW by the end of the year (Saidur et al., 2011). In Europe, this rapid growth could be a consequence of the target of increasing the proportion of

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renewable energy to 20% in 2020 (European Commission, 2008). During the last decade, wind mills have been constructed also at sea (offshore) where the wind resource is more abundant and of better quality (van der Tempel, 2006).

It is the goal of the transport policy within the European Union to establish a sustainable transport system (European Commission, 2009) and the successful promotion of intermodal transport has been identified as the most critical action in order to achieve this (Tsamboulas et al., 2007). Thus, intermodal transport is promoted through policies that are addressed at all political levels (Macharis et al., 2011). To make intermodal transport a preferred alternative to road haulage, generalized transport costs would have to be equal or lower (Hanssen et al., 2012), thus the extra costs due to pre- and post-haulage (PPH) as well as transshipments at the intermodal terminals must be offset by the lower costs of the long-haul transport (Bärthel and Woxenius, 2004).

Transport of windmill components from production to assembly site can be challenging due to large scale and high weight. Windmills are made up of large sections, and transports can be 50 meters long and 5 meters wide. Hence, this is classified as special goods with challenges that often can be met only by special preparing of infrastructure. The parts of the transport chain carried out by road must meet national rules and restrictions. This implies for example that bridges must have sufficient carrying capacity which can require that they are closed down while special transport is in progress. Additionally, for such oversized transports, it can also be required that police and/or public road authorities are present at transport by road. To our knowledge there are few studies focusing on the economic consequences of the challenges related to transport of windmills.

The aim of the paper is twofold. First, the challenges and considerations for a typical transport of windmills are discussed based on interviews with representatives for two companies providing such transport services. Second, a specific case involving transport of oversized windmill parts from the production site in Europe to the assembly site in Norway is presented. Two transport solutions derived from this case is related to a theoretical model of intermodal transport in order to discuss under which conditions each of the alternatives should be chosen.

The paper is structured as follows: Section 2 presents a theoretical framework where generalized transport costs are applied to explain the conditions for making intermodal transport preferred to unimodal solutions. Then in Section 3 the case of transport of windmill components from northern Europe to the middle part of Norway is presented and analyzed in relation to the theoretical model in Section 4. Finally, conclusions and implications are given in Section 5.

2. The Model

The optimal transport solution will depend on the objectives to be maximized. For a shipper this is usually to some degree related to minimizing the generalized transport costs. The choice of transport solution can be studied by the use of generalized costs comprising all cost related to the transport (Button, 2010). For shippers aiming to minimize total costs an intermodal transport solution is preferred to unimodal transport if this gives lower generalized transport costs (Hanssen et al., 2012). In line with the model presented by Hanssen et al. (2012), let us assume that a shipment needs to be transported over a given distance measured in km and denoted by D. An unimodal alternative using road transport only with generalized costs, G_t, is defined in (1) where subscript t indicates truck. In (1) the distance independent part of generalized costs is represented by ρ_{0t}. The distance dependent element is defined by ρ_{1t} comprising both price and time costs per kilometer.

$$G_t = \rho_{0t} + \rho_{1t} D \tag{1}$$

The shipment can alternatively first be transported by truck (pre-haulage) to the distance D_1, then by water (could as well be rail) for the long-haul distance $(D_2 - D_1)$ and, finally, by truck (post-haulage) to the final destination, $\widehat{D}$ (D-hat). Terminal handling costs from truck to water at D_1 and back to truck at D_2 are symmetric and defined by H. Note that these handling costs comprise both pecuniary costs and time costs. The generalized transport costs for this intermodal transport solution using truck and water, G_{Int}, is defined in (2) where subscript w indicates transport by water. Moreover, in (2) the pre- and post-haulage costs are adjusted by the factor $\varphi \geq 1$ taking into account that generalized transport costs are higher per kilometer due to low speed compared to that of long-haul transport.

$$G_{Int} = (\rho_{0t} + \varphi\rho_{1t} D_1) + \left(H + \rho_{1w}(D_2 - D_1)\right) + (H + \varphi\rho_{1t}(\widehat{D} - D_2)) \tag{2}$$