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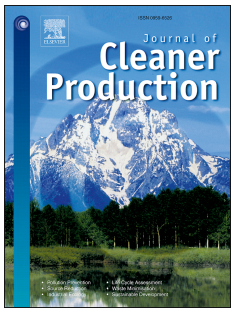

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A two-stage performance assessment of utility-scale wind farms in Texas using data envelopment analysis and Tobit models

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Abstract. Wind power becomes one of the most promising energy sources in the electricity generation sector in Texas over the past decade by declining levelized cost of wind energy. However, recent studies show that the wind farms in Texas are relatively less productive. Hence, this study aims to find out reasons of inefficiencies by constructing a two-stage performance assessment of wind farms in Texas. In the first stage of analysis, comprehensive input- and output-oriented Data Envelopment Analysis (DEA) models are applied to evaluate productive efficiencies of the 95 large utility-scale wind farms by using pre-determined three input and two output variables. The sensitivity analysis is provided for the robustness of the DEA models with different combinations of input and output variables of the original model. The slack analysis and projection data are obtained for inefficient wind farms to find out optimal input-output variables. Tobit regression models are conducted for the second stage of the analysis to investigate the reasons of inefficiencies. DEA results indicate that half of the wind farms were operated efficiently in Texas during 2016. 13 wind farms were performed at the most productive scale size, ten wind farms should reduce their operational size to improve production efficiency, and 72 wind farms have the notable potential to increase their production efficiency by expanding operational sizes with modern wind turbine technologies. The sensitivity analysis shows the importance of each input-output variables. Tobit regression models indicate that elevation of the site, rotor diameter, hub height, and brand of the turbine have significant contributions to the relative efficiency scores of the wind farms, and the age of turbine has a negative impact on the productive efficiency of the wind farms.

Keywords: Data Envelopment Analysis (DEA), Productive Efficiency, Renewable Energy, Tobit Regression Model, Wind Energy, Texas.

1. INTRODUCTION

Wind power is one of the most critical renewable and sustainable energy sources in the United States. It has gained enormous interest in the electricity generation sector starting with the millennium, especially during the second decade. According to the U.S. Department of Energy, in 2000, the wind power capacity was only 2,539 megawatts (MW), it was about 9,147 MW in 2005, and it increased to 40,267 MW by the end of 2010. The cumulative installed wind power

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