EFFECTS OF INCREASING WIND ENERGY SHARE IN THE GERMAN ELECTRICITY SECTOR ON THE EUROPEAN STEEL MARKET

Shivenes Shammugam, Fraunhofer Institute for Solar Energy Systems ISE, Tel: +49 761 4588 2119, E-mail: shivenes.shammugam@ise.fraunhofer.de
Estelle Gervais, Fraunhofer Institute for Solar Energy Systems ISE, Tel: +49 761 4588 2119, E-mail: estelle.gervais@ise.fraunhofer.de
Andreas Rathgeber, Institute for Materials Resource Management (MRM), University of Augsburg, Tel: +49 821 598 3040, E-mail: andreas.rathgeber@mrm.uni-augsburg.de
Thomas Schlegl, Fraunhofer Institute for Solar Energy Systems ISE, Tel: +49 761 4588 5473, E-mail: thomas.schlegl@ise.fraunhofer.de

Overview

The Renewable Energy Sources Act was formed in Germany in order to grant priority to renewable energy sources and to facilitate a sustainable development of energy supply. Several studies have been published to prove the technical viability of a future energy system with high share of renewable energy. They share the common fact that wind energy will have the largest share in the German electricity production. In the field of economics, studies show that additional demand of a commodity will generally lead to higher resource prices [1]. In some cases, an increase in demand of a single considerably large industrial consumer can lead to the higher commodity prices [2]. With Germany being the leading actor of renewable energy systems in Europe, the economic effects of the increase in demand due to the deployment of renewable energies cannot be neglected.

The main contribution of this paper is the approach to combine <u>raw material demand analysis</u> of an energy technology and <u>econometric methods</u> in order to analyze the effects of an increasing share of renewable energies on the raw material price. This approach is exemplarily applied to analyze the effects of growing wind turbine deployment in Germany with respect to raw steel. The aim of the paper is therefore twofold. Firstly to estimate the total steel demand to fulfill the development of the German wind energy sector based on existing energy scenarios. Secondly, a general framework of an interdisciplinary approach of combining the material demand with an economic analysis is presented. The evolution and the interdependencies between prices, demand and production of steel as well as several other fundamental micro- and macroeconomic factors is investigated.

Methods

In order to determine the material composition of wind turbines, life cycle analysis (LCA) from manufacturers and published studies as well as manufacturers' sheets are used as the basis to obtain data. The market shares for different types of drive train concepts and components are derived based on current market conditions and manufacturers' portfolio. Since the deployment of wind energy is subject to significant uncertainties, two different scenarios are defined in order to describe and consider the scope of possible developments of the wind energy sector in Germany. Using an upscaling approach, the mass of future wind turbines are estimated. The lifespan of the turbines are modelled via a Weibull distribution in order to estimate the amount of turbines to be repowered more precisely. The annual steel demand until 2050 is then calculated based on the installed capacity provided by existing energy scenarios, such as [3].

The influence of the increase in demand on the steel price is investigated via a vector autoregressive analysis (VAR) and impulse response function (IRF). We have selected 4 microeconomic variables to be included in the VAR model, namely the steel price as well as the apparent consumption, production and export of iron ore of Germany. Despite the availability of several steel-specific data such as import and export of iron ore, pig iron and scrap, they were discarded, with the exception of export of iron ore, upon conducting a preliminary Wald test, where no significant influence on the steel price could be identified. Further macroeconomic factors such as the GDP, CPI and yields on debt securities outstanding of Germany as well as the WTI oil price are applied to complement the results and to control for macroeconomic influence [4]. The Augmented-Dickey-Füller (ADF) test and Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test is conducted to test for the presence of a unit-root in the time series. In case of a unit-root, the log returns of the time series are calculated. The maximum lag length of the variables in the VAR model is determined by the Akaike and Bayesian information criteria. A stable and invertible VAR-model is then set up. In order to investigate the impacts of growing demand in the future on the steel price, the Monte Carlo method is employed to calculate the IRF as mentioned in [5].

Results

The steel demand increases gradually in all scenarios, whereby the demand in 2050 alone may vary between 2,000 and 5,900 kt. Depending on the market development, the cumulative steel demand resulting from the deployment of wind turbines in Germany from 2012 to 2050 lies between 50,000 and 116,000 kt.

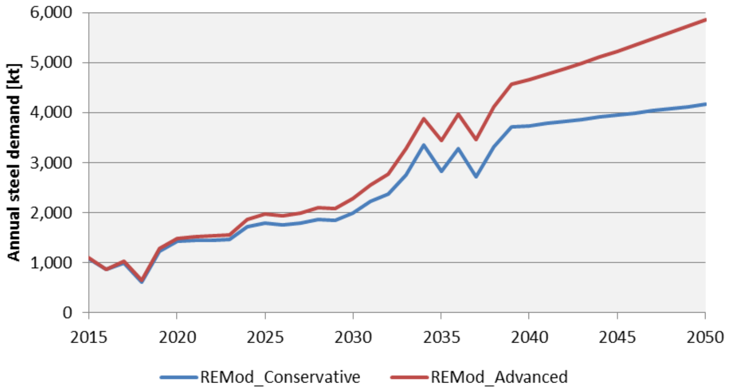

Figure 1: Total steel demand in the wind energy sector in Germany according to a selected scenario

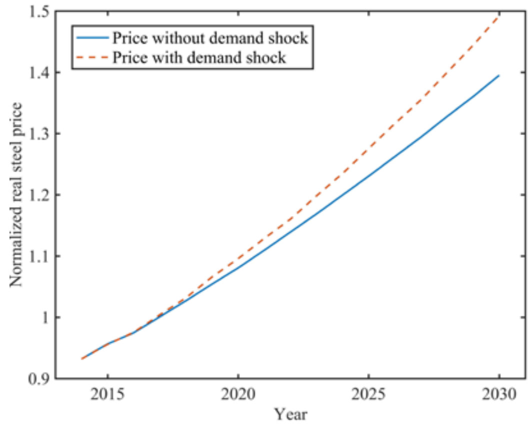

Figure 2: Effects of a demand shock according to the REMod-Advanced scenario on the steel price

In order to investigate the effects of the increasing demand due to the wind turbines on the price, two cases are analyzed. Firstly, the natural growth of the steel price is modelled as no demand shock was induced in the IRF model. In the next case, the additional annual steel demand based on the REMod-Advanced scenario is modeled as annual shocks to the steel demand. Both results are shown in figure 2.

The steel price in the first case has an average growth rate of 2.4 % p.a. until 2030. In the second case, the growth rate of steel price increases minimally to 2.8 %. On one hand, this is owed to the fact that the steel production in Germany is not affected by the demand shock. In our model, we found that the compound annual growth rate (CAGR) of steel production will remain at 0.1 % until 2030 in both cases. On the other hand, the increase in total steel demand in Germany will be much greater rate than the additional demand due to wind turbine deployment. The induced demand shocks are absorbed by the model, thus limiting the impact on the price.

Conclusions

The results show that the steel demand due to the deployment of wind turbines increases gradually until 2050. With respect to the current steel production level in Germany, a bottleneck in the steel supply is therefore not foreseeable. Results from the IRF show that additional demand from the wind energy sector is minimal compared to the overall increase of total steel demand in Germany. The annual growth of production and export of steel remains on average unchanged. The real steel price is expected to rise 2.4 % per year on average, with the additional steel demand from the wind sector contributing to a further 0.4 % increment on average. It can therefore be concluded that the increase in steel demand due to wind energy deployment in Germany only have a minimal impact on the European steel price.

Overall, we showed that the approaches presented in this paper can be applied to combine raw material demand analysis and econometrics to determine economic impacts of growing material demand from any energy technology. Further works are required to determine the total material demand of different technologies within an energy system to analyze its economic impacts as a whole on the material prices and other fundamental economic factors. In addition, the proposed VAR model has to be further enhanced by testing and expanding it to accommodate more relevant fundamental variables and to model the economic impacts more precisely.

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