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Investitionskosten erneuerbarer Energietechnologien in Zeiten volatiler Rohstoffpreise

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Motivation

Increasing penetrations of renewable energy sources (RES) require both effective and efficient support schemes in order to keep additional consumer expenditures at a moderate level. A necessary precondition for the design of efficient RES support options is a precise forecast tool of future investment costs of RES technologies. Recent market observations have shown that not only technological learning influences RES technology costs but much more also volatile raw material prices hold a significant impact. Hence, this paper discusses the multi-factor learning curve approach for incorporation of, among others, steel price impacts on wind energy technologies, in particular wind onshore, into energy models. However, the historic development of wind energy technology prices can not only be described by the impact of volatile steel prices, as other parameters as market structure or market power influence the investment costs strongly, as well. Thus, it is the aim of this paper, to point out the impact of energy price related impacts of commodity production prices on RES technology costs based on empirical observations and applied to future scenarios. Additionally, the same assessment is carried out for investment costs of Photovoltaics and the impact of related silicon costs.

Methodology / practical implementation approach

In order to ensure consistency to EU scenarios, raw energy prices refer to the European Commission published forecast scenarios until 2030, whereas wholesale energy prices as well as relevant commodity prices are calculated endogenously. Hence, dynamic investment cost changes of RES technologies based on raw energy and material prices, are derived from this endogenously calculated commodity costs[1] based on the exogenous crude oil, natural gas and coal prices. In the case of onshore wind energy, a relation between the developments of coal respectively coke prices to the steel price has been derived using a regression approach based on empirical observations combined with scientific future expectations[2] [1]. Furthermore, the impact of the steel price on onshore wind investment costs is considered in a multi factor learning curve approach [2].

In this context, the multi factor learning curve has been implemented with only two factors, the impact of a certain raw material price as well as technological learning based on cumulative production. Depending on the specific energy technology the most important materials (i.e. steel price) are considered in the model, according to Eq(1).

[1] The expression commodity costs is used, since they are calculated by only considering the commodity production cost but no market power or other parameters determining the commodity price

[2] The currently high share of steam coal and coking coal in the steel-making process might decline over time according to a shift of the process (from BOF to EAF). Respectively the impact of increasing steel prices declines with higher coal and coke prices [8].

$$c(x_t) = c(x_0) \cdot \left(\frac{x_t}{x_0} \right)^{-b} \cdot \left(\frac{CP_0}{CP_t} \right)^{LCP} \qquad \text{Eq(1)}$$

In Eq(1) the product of the first two terms represents a certain cost reduction based on technological learning with each doubling of cumulative installations ($xt/x0$) and the last term indicates the positive or negative impact (LCP) of raw material prices on RES technology costs, depending on the raw material price $\left(\frac{CPo}{CPt}\right)$. In order to determine the impact factor (LCP) of steel prices on the wind onshore investment costs, a regression model was established and adjusted according to historic observations. Hence, the outcomes only reflect the impact of the steel price, but do not necessarily meet the real historic investment costs due to facts as strategic pricing, mentioned above. Consequently, the impact factor (LCP) holds a negative sign in every moment.

Results

Combining the two regressions and applying the two factor learning curve formula Eq(1), delivers estimates of the future development of – in this case – wind investment costs. Figure 1 below depicts the result of the future development only based on technological learning on the other hand and on the other hand considering the identified impact of the steel price. With respect to historic observations, calculated wind investment costs do not totally match with real observation but show the same trend in significant magnitude. Again, it has to be noticed, that this approach does not aim to simulate the past, but solely allows forecast tools to incorporate the steel price influence. In this case study, the effect of technological learning is almost compensated by the high steel price level. Hence, adjusting the technological learning rate by the effect of volatile steel price, the seven percent assumed learning rate (LR=7%), only equals the common technological learning approach at a learning rate of 3.3%.

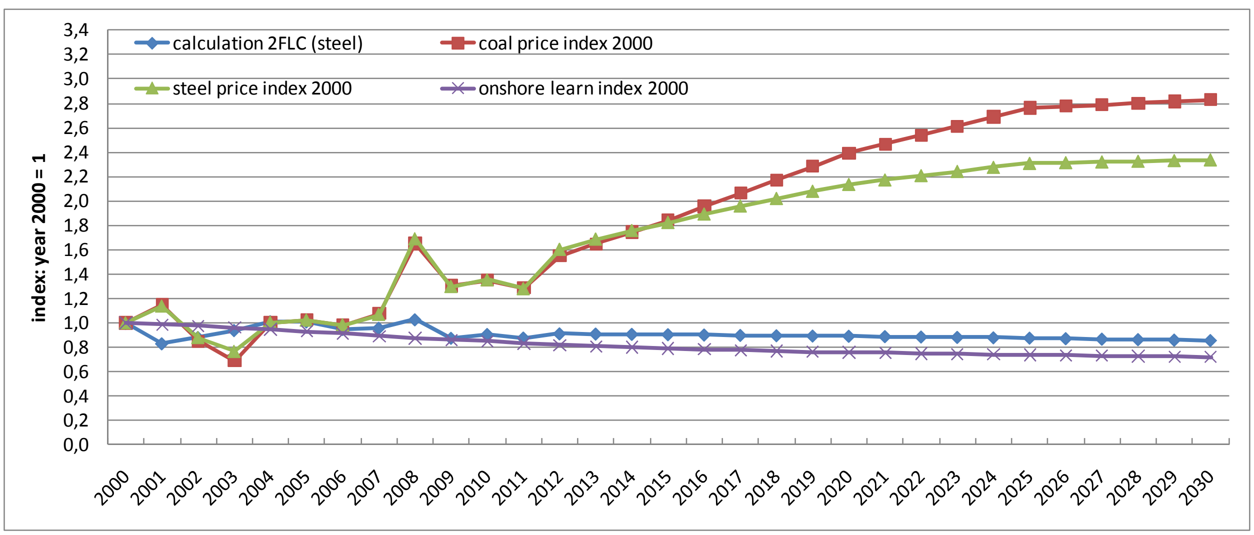

Figure 1 Indexes of coal and steel price (endogenous calculation) development for the period 2000-2030 and corresponding development of wind onshore investment costs, at technological learning (LR=7%) only, and with steel price consideration

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