Economics of the use of renewable energies under the influence of variable markets

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1 Introduction

Renewable energies sources are un-doubtful the most environment friendly and sustainable energy sources. Therefore, they are strongly supported by the society and politics. However, their economics is under big discussion. Since "economics" is widely defined, one has to focus on a special aspect.

In this context it is important to take the view of one of the stakeholders. Stakeholders on business level are e.g. users or owners, investors, manufacturers or grid owners. Each of the stakeholders has a different view. On macroeconomic level stakeholders are e.g. politics, utility companies and private or business users.

On business level, renewable energies achieve in many cases positive economic impact for the individual stakeholder because of the legal regulations of the Renewable Energy Act (Erneuerbare-Energien-Gesetz, EEG) [19]. However, the macroeconomic impact for the user is strongly disputed. This aspect is discussed here.

2 Costs and benefits of the EEG

For this purpose, costs and benefits of the EEG related renewable energies are compared, based on the approach in [1]. Since a complete data set of the individual aspects is available only for 2006, the comparison is done for this year. The results are presented in Figure 1 and are discussed in the following. Costs and benefits are shown by bars representing minimal and maximal values as well as "best-guess" values, which seem to be most plausible.

2.1 Cost

The allowances due to the feed-in tariff according to the EEG are un-doubtful costs. They account for 3.3 Bill. € in 2006 [1]. Similar values are listed in [11] and [19].

To compensate for the unsteady generation of renewable energy sources, control power is necessary. In [1] the costs are listed with a maximum of 122 Mio. €/year (incl. 35 Mio. €/year additional fuel consumption), while in [18] they account for 600 Mio. €/year.

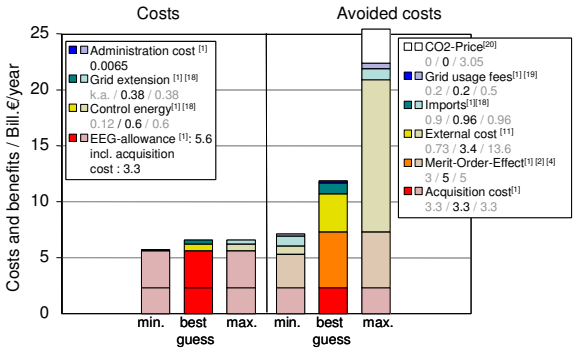

Figure 1: Cost and benefits of EEG related renewable energies.

Since renewable energies are generated in a geographic different distribution at certain points in time, it is necessary to extend the distribution grids, especially on highest voltage level. In [1] and [18] this task is listed with 4 Bill. € in total for the coming years. Since up to now (in 2006) no significant extension has been done, this amount is not considered in [1]. In [18], this amount is depreciated over 25 years leading to yearly cost of 375 Mio. €/year.

As additional costs, administration costs are estimated to 6.5 Mio. €/year [1].

In total, the costs of the feed-in tariff dominate the costs. Control power and power grid extension contribute much less, and the administration cost are negligible.

2.2 Benefits

Here, benefits from an economic point of view are avoided costs. This includes especially the acquisition costs. These are costs, which would appear, if the needed energy had to be purchased from conventional energy sources, because it was not generated from renewable energy sources. According to the EEG these costs may be subtracted from the allowances and the remaining differential cost may be charged to the users. The acquisition cost are usually related to an average price at the European Energy Exchange (EEX) in Leipzig, e.g. to the index Phelix Base [13]. This accounts for 44 €/MWh in 2006 [1][11][13][18], resulting in savings of 3.3 Bill. €/year for the whole generated renewable energy.

The increased offer of electrical energy further leads to a decreasing whole sale power price at the spot market of the stock exchange, which relates to the whole trading volume of electrical energy and not only to renewable energies. This "Merit Order Effect" will be discussed below in detail. It leads to savings of 3…5 Bill. €/year [4], as also cited in [1] and [18]. In [2] the effect is calculated with 4.98 Bill. €/year.

A further benefit of the use of renewable energy sources is the avoidance of external costs due to reduced emissions, especially related to the climate change and to the health of the population. The well-known "Stern-Report" [12] expresses the costs of the climate change as a reduction of the future consumption per head by 5% to 20%. In [11] the avoided external cost are related to marginal costs of the emissions. According to the findings, the external cost are dominated by the climate change, which economical consequences can be foreseen only with a large uncertainty. However, 70 €/tCO2 are commonly accepted as "best guess", with a bandwidth ranging from 15 to 280 €/tCO2. This results in total avoided external costs between 0.73 and 13.6 Bill. €/year with a "best guess" of 3.4 Bill. €/year.

In addition, import of fossil fuels is avoided with a value of 961 Mio. €/year [1] or rounded 900 Mio. €/year [18], which is considered as benefit of renewable energy sources.

Due to the de-centralized generation of renewable energies savings of the grid usage fees of 205 Mio. €/year [1] or 504.7 Mio. €/year [19] can be realized.

The substitution of energy from fossil fuels leads to reduced CO2 emissions. Due to the larger offer of emission rights their price will drop down. According to [20] this effect accounts for cost reductions of 3.05 Bill. €/year. However, this is critically questioned in [3], since the market of the CO2 emission rights is very volatile and dependent on many other factors.

In total, it is obvious that even with conservative assumptions the economic effect due to renewable energy sources is positive for the end users.

3 Merit-Order-Effect

To derive the price at the EEX spot market [16], the offered amounts of electricity are sorted according to their offered price (Merit-Order) (see Figure 2 for a fixed fictive point in time). This offer price usually corresponds to the marginal variable cost of the electricity generation. All offers, which exceed the current need are not considered. The offer, which

is just considered, determines the price for all other considered offers. The difference to the offered price is the contribution margin, which covers fixed costs and revenues.

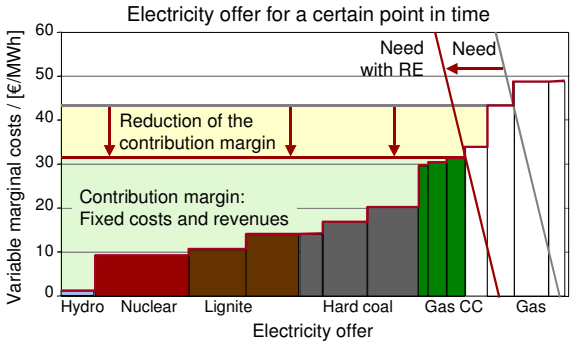

Figure 2: Price reduction at the EEX spot market due to renewable energy sources (fictive curve with usage of data in [3]).

Usually, renewable energy sources have negligible marginal variable costs and furthermore their purchase is mandatory (according to EEG). This is equivalent to a reduced need. This leads to high price offers being not considered anymore, such that the final price reduces. As illustrated in Figure 2, the contribution margin of *all* contributors decreases.

This effect is meanwhile verified by simulations [2][3] and empirical investigations [6] and is acknowledged by an expert commission [4] of the BMU (Bundesministeriums für Umwelt, Naturschutz und Reaktorsicherheit). Especially solar power has a considerable effect, as shown recently [7], because it substitutes conventional electricity especially at times of large need during noon.

While the Merit Order Effect is commonly acknowledged as short-term effect, the long-term effects are under critical discussion [4][8][9][10]. It is argued that without renewable energy sources the composition of the power plants would develop differently. According to the Peak-Load-Pricing (PLP) Model [14], the same prices would develop as with renewable energy sources, such that the Merit Order Effect would equal zero [8]. An empirical simulation even resulted in a slight reduced price with a matched power plant composition [8]. According to [9] a sufficient number of conventional power plants is conserved or put out of service in the last years, which could compensate for the renewable energy sources.

However, these models require an ideal market. But especially the renewable energy sources as additional free stakeholder initiate dynamics in the sense of a free market.

In addition, the whole list of benefits has to be taken into account for the evaluation of the long-term effect. This relates especially to the rising costs of fossil fuels, which do not only increase the avoided acquisition costs, but will influence the price structure of the Merit Order. The expected higher oil and gas prices will increase the price gradient in the sensitive range of the Merit Order and thus also the Merit-Order-Effect.

Therefore it can be assumed as conclusion that renewable energy sources will also have long-term economical benefits for the users.

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