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Impact of renewables on electricity markets – Do support schemes matter?

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HIGHLIGHTS

- Renewable support schemes matter regarding the impact on electricity markets.
- Market-oriented support schemes reduce the impact on electricity markets.
- More flexible electricity systems reduce the need for market participation.
- Sliding premiums combine market integration with a productive risk allocation.

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ABSTRACT

Rising renewable shares influence electricity markets in several ways: among others, average market prices are reduced and price volatility increases. Therefore, the "missing money problem" in energy-only electricity markets is more likely to occur in systems with high renewable shares. Nevertheless, renewables are supported in many countries due to their expected benefits. The kind of support instrument can however influence the degree to which renewables influence the market. While fixed feed-in tariffs lead to higher market impacts, more market-oriented support schemes such as market premiums, quota systems and capacity-based payments decrease the extent to which markets are affected. This paper analyzes the market impacts of different support schemes. For this purpose, a new module is added to an existing bottom-up simulation model of the electricity market. In addition, different degrees of flexibility in the electricity system are considered. A case study for Germany is used to derive policy recommendations regarding the choice of support scheme.

1. Introduction

In many countries, liberalized electricity markets are organized as energy-only markets i.e. electricity generators receive revenues for selling electricity but not for providing capacities[1]. In an energy-only market, market imperfections and inadequate regulation can lead to investments below optimal level (the "missing money problem"). Issues include limited demand side flexibility, inadequate spot prices during scarcity events due to regulatory price limits, investment risks due to volatile prices and coordination failures (see among others Cramton and Ockenfels, 2012; Edenhofer et al., 2013).

While an increase of renewables does not per se lead to a failure of energy-only electricity markets, the increase of renewable shares especially of variable renewable aggravates these market failures in at least two ways according to Edenhofer et al. (2013). First, variable renewables increase price volatility and thus investors might be discouraged or require higher risk premiums. Second, higher renewable shares lead to lower average prices and thus make investments less attractive or push existing plants out of the market (compare among others Rubin and Babcock, 2013; Cutler et al., 2011; Klinge Jacobsen and Zvingilaite, 2010; Winkler 2012). As a consequence reserve margins shrink and scarcity events occur more often. As optimal scarcity pricing is not likely due to regulatory price limits the "missing money problem" is therefore more probable in electricity systems with high shares of renewable electricity. In addition, the income of renewables

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[1] In most markets, the bigger energy-only segment is complemented by a much smaller balancing market segment where generators are also paid fr providing capacity in order to compensate short term deviations of demand and supply. Due to the limited size of the balancing market this does however not change the general assessment of energy-only markets provided here.

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declines at rising shares if other factors are kept constant (Hirth 2013).

Nevertheless, renewables are supported in many countries due to their expected beneficial effects such as emission reduction or employment creation (Groba and Breitschopf, 2013). A variety of support schemes is employed for increasing electricity generation from renewables (Ragwitz and Steinhilber, 2014). These differ regarding the degree to which plant operators are affected by market prices. On one end of the spectrum feed-in tariffs incentivize generation regardless of market developments. On the other end capacity based mechanisms allow for undistorted market participation and quota schemes oblige plant operators to participate in both the regular electricity market and a certificates market where the value of green electricity is determined. Under feed-in premium schemes, renewable electricity is sold on the electricity market and investors receive an additional payment per produced electricity unit.

Based on these developments the question becomes relevant in how far more market-oriented support schemes mitigate the described influence of renewables on electricity markets. This paper uses a model-based approach to address this question. Electricity systems with different degrees of flexibility are included as flexible systems facilitate the integration of renewables (Palchak and Denholm, 2014).

The remainder of this paper is structured as follows. Section 2 describes the different support schemes and the respective rules for participation of renewable electricity generators in electricity markets. Section 3 gives a more detailed overview of the impacts of renewables on electricity markets. The methodology is described in Section 4. Section 5 presents and discusses case study results for Germany. Section 6 concludes.

2. Participation of renewable plant operators in electricity markets under different renewable support schemes

The behavior of renewables in electricity markets is determined by the kind of support they receive. The support scheme influences both the trading behavior and the plant design by the degree to which plants are dependent on price developments and thus demand conditions on regular electricity markets (Jägemann 2014; Battle and Baroso, 2011). In many countries, renewable generators are shielded from market price as market participation of renewables also implies higher risks for plant operators, which usually increases capital costs and thus support expenditures (Gawel and Purkus, 2013; Kitzing 2014; Klessmann et al., 2008).

Table 1 provides an overview of support systems with the corresponding income structure of plant operators, main benefits and drawbacks as well as the degree of market participation regarding long term investment decisions and short term generation adaption (Klobasa et al., 2013). In all cases the actual reaction to market signals also depends on the income share that can be generated from the market. If e.g. a capacity payment covers all costs, the incentive for plant operators to adapt generation to market conditions remains low.

On one end of the spectrum, fixed feed-in tariffs consist of a fixed tariff that is paid to the plant operators for each unit of electricity they produce regardless of the demand situation of the electricity system. Thus, neither investment decisions nor short term generation patterns are adapted to the demand situation. Under the different feed-in premium options, plant operators receive a premium on top of the electricity market price. They sell their electricity on the market and are therefore incentivized to react to market signals. While under the sliding premium and the premium with cap and floor the long term development of electricity market prices is of low importance for plant operators, it is

Table 1
Overview of renewable support schemes.

Support scheme	Feed-in tariff	Sliding feed-in premium	Feed-in premium with cap and floor	Fixed feed-in premium	Quota-based support scheme	Capacity-based support scheme
Income	Constant payment per unit of electricity generated	Electricity price plus premium adapting to the market price, relatively constant total income	Electricity price plus premium, total income between cap and floor price	Electricity price plus fixed premium	Electricity price plus certificate price	Electricity price plus generation independent capacity premium
Advantages	Low risk for plant operators and low capital costs	Low risk for plant operators and low capital costs, reaction to short term market signals	Low risk for plant operators and low capital costs, reaction to short term market signals	Expected reaction to long term and short term price signals	Competitive determination of support	Expected reaction to long term and short term price signals, undistorted market participation
Drawbacks	Risk of over or under compensation, no reaction to electricity demand	Limited reaction to market signals, relatively high complexity might increase capital costs	Limited reaction to market signals, relatively high complexity might increase capital costs	High risk for plant operators unless fixed premium covers big share of income which might lead to over compensation	High risk for plant operators due to double marketing on electricity and certificate markets	High risk for perverse incentives regarding plant design
Reaction to long term market signals	None	Very limited	Limited (depending on spread between cap and floor)	Yes	Yes	Yes
Reaction to short term market signals	No direct marketing	Support payments (or certificate prices) as opportunity costs for generation reduction				Undistorted market participation