RETHINKING FEED-IN TARIFFS AND PRIORITY DISPATCH FOR RENEWABLES

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Abstract

Within the German System of feed-in tariffs for renewable electricity supply (RES) producers of renewable electricity also have the privilege of priority dispatch. Depending on the design of the tariff this is either a physical priority dispatch ("guaranteed grid access") or a financial priority ("bonus payments"). In either case suppliers of renewable energy sources are inclined to deliver energy even when the cost of production exceeds the market price, i.e. the electricity's value. We suggest to remove the priority dispatch and to modify the design of feed-in tariffs in such a way that RES suppliers receive a payment for their potential supply in cases where the price of electricity drops below their marginal costs. Thereby, renewable electricity producers will suffer no drawbacks but social welfare increases.

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1. Introduction

Promoting the use of renewable energy sources (RES) is a central goal of the European Union, which was recently corroborated in directive 2009/28/EC. RES can be supported with either price- or quantity-based policies.[2] Feed-in tariffs, a price-based policy, are the most commonly used support schemes[3] and are also considered to be "the most efficient and effective support schemes for promoting renewable electricity"[4]. The fundamental characteristic of feed-in tariffs is a guaranteed price for the production of electricity that covers the long-term marginal costs of RES.[5] Such a support scheme has led to a massive development of RES in Germany and several other countries.[6] In this paper we do not challenge the general efficiency or effectiveness of feed-in tariffs but we show a shortcoming of such support schemes that comes along with the linkage of the tariff and the "priority feed-in", which implies that the tariffs are paid for the actual production of electricity. Once the price for electricity drops below the short-term marginal costs of RES it is not socially optimal to produce electricity from RES. Thinking about solar- and wind power plants this may not be of importance in times of positive prices for electricity. However, whenever negative prices occur this is of particular relevance. Any institutional or financial priority feed-in of electricity from RES leads to a loss of welfare. Thus, we argue for a modification of the design of feed-in tariffs without endangering the expansion of RES. For this purpose, the remainder of this paper is as follows. Chapter 2 briefly outlines the need for potentially unlimited negative prices. In chapter 3 we assess the loss of welfare of the current German RES support scheme with a comparative-static analysis. In chapter 4 we develop a simple modification of the design of feed-in tariffs with the constraint that renewable electricity producers will suffer no drawbacks but social welfare increases. Chapter 5 concludes.

2. Negative Prices and short term intertemporal marginal costs

A price indicates scarcity and brings supply and demand to equilibrium. With electricity, there are two peculiarities: Peak loading and non-storability. The former leads to the need for different technologies: base- and peakload power plants. If demand were constant, a single (the cheapest) technology would suffice. Baseload power plants have high fixed costs and low variable costs and they are exceptionally inflexible. In an intertemporal context an inflexible power plant does not want to change its workload as this causes additional fuel costs, attrition and, most importantly, a loss of benefit. Whenever an inflexible plant is shut down, it needs several hours to get back to its full workload. When prices are high in these hours, it may have been advantageous to not shut the plant down at all. These opportunity costs must be kept in mind. In brief we call them "short term intertemporal marginal costs of production". These are negative for certain kinds of power plants (Ockenfels/Grimm/Zoettl 2008).

Non-storability implies that supply must be equal to demand at all times. When there is a situation with very low demand (for only a short time), then power plants with negative intertemporal

[2] For a survey of different support schemes see IEA 2008.
[3] See REN212009, p.18.
[4] See European Commission 2008, p.3.
[5] For a detailed review of several Feed-in tariff schemes see Couture/Gagnon 2010, pp.955-965.
[6] See Butler/Neuhoff 2008, p. 1859 or Sawin 2004, p. 8.

marginal costs want to pay for not shutting down. So there may be situations with negative prices even without the integration of RES. The bottom line is that negative prices are not a phenomenon only linked to the expansion of RES supply.[7]

3. The inefficiency of the priority dispatch

Feed-in tariffs typically include a fixed tariff paid for actually produced electricity as well as a guaranteed grid access that we will denote "priority dispatch". In terms of the priority dispatch, renewable electricity sources (RES) are drawn prior to conventional sources. Suppliers of RES are paid a fixed feed-in tariff. The feed-in tariff is supposed to cover the long-term marginal costs, which means capital costs are included. Capital costs have no influence on the short-term power plant dispatch and are excluded from the following considerations. We will focus on short term intertemporal marginal costs. In the case of RES like wind energy or photovoltaic, these costs hardly differ from short term static marginal costs due to very low costs of output adaption. However, in the case of biomass power plants, they can very well differ from the static marginal costs. Hence the term "short term intertemporal marginal costs" will shortly be addressed with "marginal costs". Using a framework of comparative-statics we show that a welfare loss is incurred if priority dispatch for a uniform technology of renewable electricity generation is granted.

Case 1: Price above marginal costs

Assume that all external costs and benefits are internalized. The supply function of the conventional suppliers is linearly increasing. The uniform RES-technology has constant marginal costs c_{RES}. Demand is completely inelastic up to the prohibitive price. The price is p_0, with $p_0 > c_{RES}$. In this case the supply of renewable electricity is economic. In other words the RES-technology could produce in a market without priority dispatch. In the long term p_0 will not suffice to cover fixed costs. Hence a tariff is paid which lies well above market prices.

In this case however the priority dispatch does not change the logic of the power plant dispatch according to marginal costs along the merit order. This implies that under these circumstances the RES feed-in does not cause allocative inefficiencies and thus does not cause welfare losses. Because of the feed-in tariff there is, however, a redistribution of economic rents from consumers to RES-suppliers. This is politically intended and socially accepted.

Case 2a: Price below marginal costs and fixed feed-in tariff

[7] Consequently, from an economic point of view it should become clear that a price floor for electricity (which is widely discussed at present) cannot be an efficient way to cope with too much RES supply as the price works as a scarcity indicator even when it becomes negative: Inflexible power plants need the signal of negative prices to shut down. With a price floor, allocation of supply would be done by e.g. "pro rata"-allocation which implies strong welfare losses, see Viehmann/Sämisch 2009.

Now assume that due to, say, low demand the market price lies below RES' marginal costs. RES would not produce in this case. This is shown in figure 1.

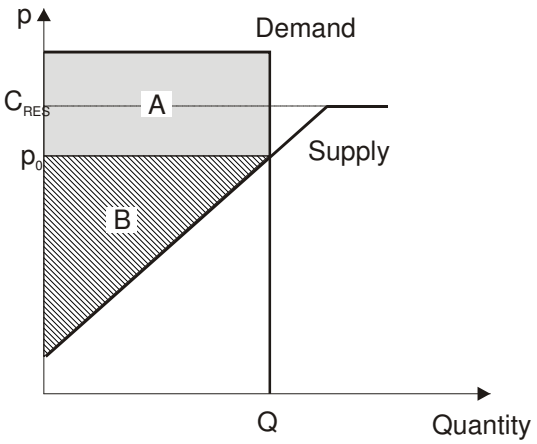

Figure 1: Market result without priority feed-in.

The market price is p_0. The consumers' surplus is represented by area A. Area B shows the producers' surplus. Now assume that the priority feed-in drives the RES suppliers to produce. The new dispatch and the allocation and distribution effects are shown in figure 2.

By means of the priority dispatch the RES supply is privileged in comparison to conventional supply and the conventional supply is pushed to the right (figure 2a),[8] while the demand function does not change. We now have an expanded supply and unchanged demand, so a part of the conventional supply is pushed out of the market. These suppliers lose their economic surplus, represented by area C in figure 2b. This is a welfare loss, resulting from the crowding out of economic supply. Hence the priority dispatch leads to allocative inefficiency. In addition, marginal costs of the RES technology c_{RES} lie above the value of electricity, which is p_0. Now as electricity is produced at a higher price than its economic value, resources are spoiled. Thus we have an additional welfare loss, represented by area D. The overall welfare loss, which is shown by areas C and D, originates from the fact that due to the priority dispatch an (in this particular situation) inefficient technology is pushed into the market.

Beside these allocative effects there accrue distributional effects: Because of the expanded supply price falls from p_0 to p_1.[9] This implies that consumers have a surplus, represented by areas E and F in figure 2b. Area E was a producers' surplus beforehand – due to the decreased price there is a redistribution in favor of the consumers. RES-producers would lose areas D and F as their marginal costs lie above the market price. Now let us assume that they get a fixed feed-in tariff covering exactly their marginal costs and that the tariff is paid by the consumers. In this case, the consumers will lose areas D and F. Altogether, the new consumers surplus is A + E + F – F – D = **A + E – D**.

Whether the consumers are winners or losers of the priority feed-in depends on the difference on c_{RES} and p_0 and on the quantity of produced RES-electricity. When the feed-in tariff lies above the marginal cost of RES production there is an additional redistribution from consumers to RES

[8] By using a comparative-static framework like we do not all arising effects can be incorporated. Of course the priority feed-in changes the market rules and thus the calculus of the suppliers. In the long run the supply function will change which may alter the identified effects. See Nicolosi/Fürsch 2009. Insofar an additional analysis to explain the reaction of the suppliers seems appropriate.

[9] This effect is often addressed with „merit order-effect of RES". Economic implications of this effect are e.g. covered by Sensfuß/Ragwitz/Genoese 2008.

producers. The conventional producers' surplus is **B – C – E**. The conventional producers are unambiguously the losers of the priority feed-in as they are partly pushed out of the market and suffer the decreased market price.

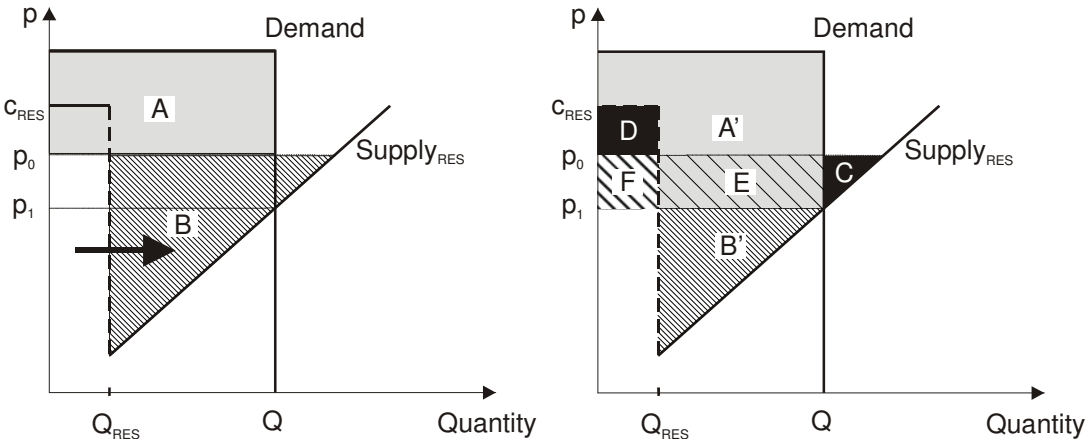

Figure 2: The changed result with priority feed-in.

Case 2b: Price below marginal costs and bonus payment

A widely discussed alternative to the fixed feed-in tariff in combination with priority dispatch is a model of direct marketing of RES in combination with a bonus payment.

In Germany, direct marketing has been introduced with § 17 EEG. As the revenues from the electricity market may not cover long term marginal costs, this possibility however is scarcely used.[10] A model widely discussed to promote direct marketing is the "bonus model" suggested by Sensfuß/Ragwitz 2009. When a RES-supplier chooses direct marketing he gets a bonus payment for each unit of produced and sold electricity. The bonus consists of a variable market premium as well as a fixed premium. We are skeptical about the fact that the bonus payment is coupled with the physical production and sale of electricity. This implies incentives which are similar to the incentives in the case of the priority dispatch: As RES-suppliers only receive a bonus payment when they actually produce electricity, they are inclined to produce already at the point where the market price is equal to (or higher than) their marginal costs reduced by the bonus payment, i.e. they are inclined to produce electricity at market prices below their marginal cost of production which, again, leads to welfare losses. These are shown in figure 3.

[10] See BDEW 2009 for data concerning direct marketing in 2009.

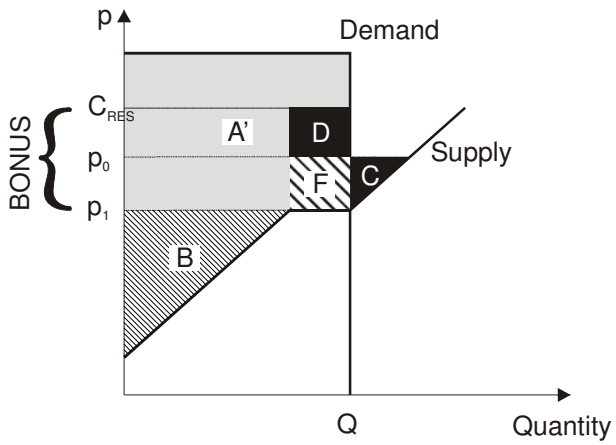

Figure 3: Bonus payment

The figure is similar to figure 2, albeit it shows the bonus payment and not the fixed feed-in tariff. By means of the bonus payment the RES-suppliers can produce profitably. Market price drops to p_1, leading once more to a crowding out of conventional suppliers. A welfare loss accrues which is identical to the loss in the case of a fixed feed-in tariff, shown by area C. Also, a loss represented by area D accrues which is due to RES' high marginal cost of production. ($c_{EE} > p_0$). We can think of situations in which the market price is at a level where RES production is not profitable even with a given bonus payment. In this case RES suppliers will not supply electricity and no welfare loss accrues.

The bonus payment comes without physical priority dispatch, but it establishes a kind of "financial priority" with similar effects on the merit order and accordingly similar welfare losses. A market price driven dispatch of RES is not achieved.

Case 3: The example of wind energy supply

We now apply the framework developed to wind energy. The economic mechanisms are the same as in case 2. The only difference is that we now assume marginal costs of production that are equal to zero and that the (fixed) feed-in tariff lies considerably above these marginal costs. Figure 4 shows this case.

Let´s assume a situation in which a low level of demand and the marginal cost situation of conventional plant lead to a market price p_0 below zero. Wind energy cannot supply profitably in this situation. By means of the priority dispatch (or by a sufficiently high bonus payment) the wind energy suppliers are still inclined to produce electricity. By crowding out conventional suppliers we have again a welfare loss shown by area C. Because the price p_0 lies above marginal costs of production we also have a welfare loss shown by area D. As the market price falls to p_1, consumers gain a surplus represented by areas D, E and F. Conventional suppliers lose areas C and E. Their surplus is finally B' only.

When the feed-in tariff is V, wind energy suppliers capture part of the consumers' surplus. This corresponds to areas D, G and F. The aggregate effect is again unknown as it depends on the supplied quantity of wind energy and on the tariff. Without feed in tariffs and priority dispatch, wind energy

producers would not supply electricity when market prices fall below zero and no welfare loss would accrue.

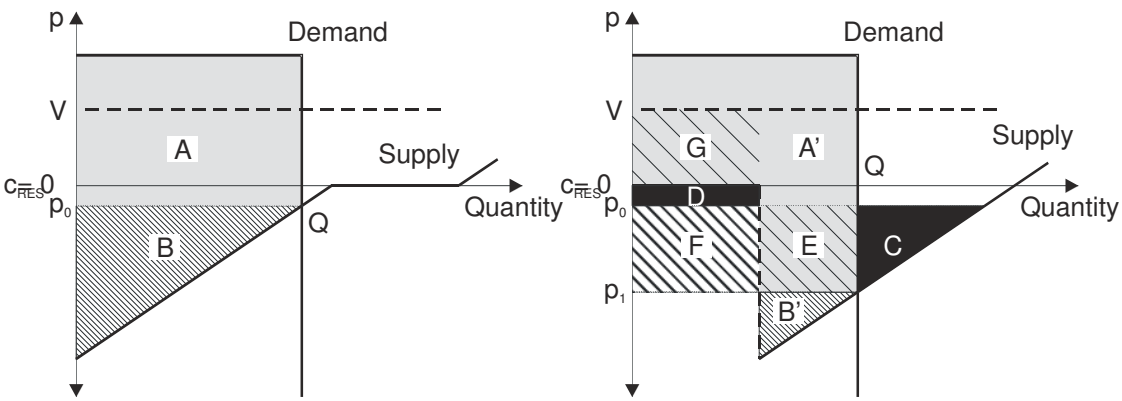

Figure 4: The case of wind energy

What about external effects?

So far the analysis does not take account of external effects. We will now show that external effects legitimate the promotion of RES, but not priority dispatch for RES.[11]

From a political perspective the promotion of RES shall lead to learning effects and thus to technological advantages: RES shall become competitive over time. In addition a domestic industry shall be established. Learning effects are achieved by research activities as well by site construction. (Junginger/Faaij/Turkenberg 2005). The actual supply of electricity however does not lead to learning effects. Consequently, to achieve technological advantages the promotion to build and operate capacities should be established. But there is no benefit in maximizing the utilization of these capacities with regard to the learning curve.

A different case concerns the emission of carbon dioxide. RES production leads to reduced emissions of carbon dioxide by substituting conventional electricity supply. Consequently, positive external effects are gained with each produced unit of RES electricity. However, since 2005 there is the European emissions trading system (EU ETS) which internalizes the external effects of carbon dioxide.[12]

Thereby the comparative disadvantage of RES production is reduced. When RES' marginal costs of production are above the market price for electricity including the price for carbon dioxide emissions,

[11] Whether a promotion of actually produced RES electricity makes sense at all is not our concern. See for a discussion e.g. Klessmann/Nabe/Burges 2008 and Lienert/Wissen 2006.
[12] See Janssen/Ströbele/Wobben 2007.

electricity production by conventional sources should be preferred. Thus priority dispatch does not imply a benefit for the climate.[13]

From a resource political view RES imply a higher level of security of supply by reducing the dependency of imports. The social utility originates from the option to use RES when supply is scarce and thus from the installed capacity. The bottom line is that the construction of capacity should be promoted and not the actual supply. The priority dispatch does not lead to additional benefits.

4. Political implications

The question is what kind of support scheme provides the right incentives for RES suppliers. We have shown that by abandoning the priority dispatch welfare gains are achieved. Without this priority in general two cases are possible:

1. Market price is above marginal costs of RES production. In this case, RES suppliers will produce electricity and be paid the feed-in tariff for their **actual production**. There will be no welfare loss but there will be a redistribution of wealth in favor of the RES suppliers.
2. Market price is below marginal costs of RES production. In this case, RES suppliers should not produce. In order not to change their investment decisions they would have to be paid for their losses, i.e. they should receive the feed-in tariff for their **potential production**, albeit reduced by their marginal costs of production. The deduction is necessary as otherwise RES suppliers with positive costs of production (e.g. biomass) would have an incentive NOT to produce in order to receive the complete tariff AND save their production costs. By not producing and paying for the potential production welfare losses are avoided, but the payment to RES suppliers remains unchanged to the case of priority dispatch.

For the accomplishment of our suggestions the marginal (intertemporal) costs of production of all technologies have to be known by the entity selling the RES production. In the case of biomass power plants the development of such a benchmark could be somewhat more complicated. In the case of solar power plants and wind energy the investigation should be easy.[14] The selling entity will then place the bids for the forecasted RES production on the basis of the marginal costs-benchmark in the spot market and has to make sure that production is switched off in case the market clears at a lower price. This means that a given RES supplier will not produce electricity when the spot price lies below her specific marginal cost benchmark. Thus welfare losses are avoided.

However, to achieve these efficiency gains investments are required as not all RES technologies can currently be monitored and adjusted in their output. Such investments however will make RES production “smarter” which might even be a prerequisite in order to increase the share of RES in line with political objectives.

[13] When RES promotion and emissions trading are not coordinated by adapting the emissions cap, the priority feed-in does even constrain the efficiency of climate policy. Without an adaption of the cap the priority feed-in leads to reduced emissions prices leading to comparative advantages for those power plants with the highest emissions. See Böhringer/Rosendahl 2009, Kemfert/Diekmann 2009 and Kemfert/Traber 2009.

[14] One could assume them to be very close to zero.

5. Summary

We have shown that the price for electricity is an essential scarcity indicator, no matter if positive or negative. The reason why negative prices are observed more and more often is the growth of renewable energy sources which enjoy the benefits of a feed in tariff.. However, the priority feed-in implies that RES suppliers are paid for their actual electricity generation, thereby causing them to supply independent from the price of electricity. This situation leads to welfare losses. Paying a bonus to cover fixed costs –as is the case in the model proposed by Sesfuß/Ragwitz- does not eliminate the welfare losses as long as payment is tied to actual production.

The losses could be avoided by abandoning the priority dispatch and paying the RES suppliers for their potential supply in cases where the price, or value, of electricity drops below their marginal costs. The payment has to be reduced by the suppliers' marginal costs of production which are avoided when no electricity is actually produced. This design would lead to significant welfare gains and could pave the way for widespread direct marketing. Future research should be directed to define the details of such a model to promote renewable energy sources in a more efficient way, tailored to be in line with competitive and open markets.

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