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IMPRESSUM

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Advanced Mechanisms for the Promotion of Renewable Energy - Models for the Future Evolution of the German Renewable Energy Act

Ole Langniß[a], Jochen Diekmann[b], Ulrike Lehr[c]

Abstract. The German Renewable Energy Act (EEG) has been very successful in promoting the deployment of wind power plants and other renewable energy power generating technologies in Germany. The increasing share of EEG-power in the generation portfolio, increasing amounts of fluctuating power generation, and the growing European integration of power markets governed by competition calls for a re-design of the EEG. This article identifies increasingly important problems and describes three different options to amend the EEG without jeopardising the fast deployment of renewable energy technologies. In the “Retailer Model”, it becomes the responsibility of the end-use retailers to adapt the EEG power to the actual demand of their respective customers. The “Market Mediator Model” is the primary choice when new market players are regarded as crucial for the better integration of renewable energy and enhanced competition. The “Optional Bonus Model” relies more on functioning markets.

Keywords: Regulation, Renewable Energy, Promotion, Policy Design, Feed-In Tariff, Minimum Price Standards

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Introduction

The German Renewable Energy Act, as well as its precursor the Feed-In Law, has been proven to be one of the most effective and efficient policies to promote renewable energy-sourced electricity (Mendonça 2007). The success can be measured in new installations, generating capacity, as well as investment and employment numbers. In addition to Germany, eighteen other countries in the European Union use a feed-in tariff system similar to the EEG. Feed-in tariffs have been appreciated as the most effective means to promote renewable energy (EU 2005). Six EU countries are using a quota system— in theory guaranteeing for a certain quantity of RES-E, but not generally resulting in a price based on different technological maturity of various renewable energy technologies. Quota systems have promoted only the cheapest RES technologies, whereas Germany's feed-in tariff system has proven to promote a broader spectrum of renewable energy technologies (Mendonça 2007). The lessons learnt are that governments have to be ready to adjust the market framework to meet the challenges of rapidly evolving energy markets and to meet collective goals such as energy security, climate change and a sustainable energy system.

The EEG is facing new design challenges as renewable energy shares continue to increase as a part of total power supply. Incentives should be provided to adapt the RE power generation better to meet the actual power demand. Also, it is critical that the EEG is synchronised with the European Emission Trading Scheme. And, it is an on-going challenge to keep the costs to power customers as low as possible. Therefore, the technical and commercial integration of RES-E need to be strengthened. This needs to be achieved without endangering the fast pace of renewable energy growth needed to cope with the challenges of climate change.

We summarise the performance of the German promotion policy. The structure of the German EEG with an emphasis on pricing mechanism and burden allocation will be described in chapter 3, followed by an analysis of the challenges the EEG is facing (chapter 4). In chapter 5, three alternative models for evolutionary advancements to improve the EEG in order to achieve better integration of renewable energies are discussed. A comparative assessment concludes this paper.

Performance of the German Promotion Policy

Since the implementation of the EEG in 2000, RES-E has doubled from 37 TWh in 2000 to 74 TWh in 2006. RES-E contributed 12 % of the total gross electricity consumption in Germany, almost achieving the targets set for 2010. In 2006, 51.5 TWh were remunerated under the EEG. Photovoltaic and wind power have displayed especially dynamic growth. Germany now has more installed wind power capacity than any other country worldwide and claims at least half of the world market in photovoltaics. Due to the EEG, wind power has surpassed hydro power as the main renewable source for power generation in Germany, comprising 42 % of all RES-E (BMU 2007a).

The specific remuneration averaged over all technologies and all vintages was 0.10875 €/kWh (VdN 2008) which is approximately double the current market price. Total RES-E remuneration in 2006, which reached €5.6 billion, was four times as high as in 2001 (VdN 2008). This remuneration reflects the total costs of which approximately €3.3 billion are additional costs, net of market value (BMU 2007a). The additional burden from the EEG accounts for only €0.007 per kilowatt-hour (kWh) consumed which translates into 3.7% of the average household power price of €0.194 / kWh. This means that a three-person household typical for Germany with a power requirement of 3500 kWh per year has to pay approximately €2 per month for an increasing share of renewable energy.

In 2006, almost half of the total remuneration under the EEG was paid for wind power generation. Photovoltaics received 20% of the total amount of remuneration in 2006, up from a share of only 2% in 2000. Despite the increased share in remuneration, photovoltaic installations accounted for only 4.3% of remunerated electricity. The difference is due to the higher tariff for photovoltaics (€0.53/kWh in 2006) compared to wind power (€0.09/kWh). By 2013 it is estimated that renewable electricity in Germany will receive €12.6 billion in annual remuneration payments through the EEG (VdN 2007).

Approximately 50 million tonnes of CO_2 -equivalents, 6% of Germany's total CO_2-emissions, were avoided through EEG installations in 2006. It has been argued that the EEG has not led and will not lead to additional CO_2 mitigation when the interaction with the European Emission Trading Scheme (ETS) is considered (Beirat 2004, Frondel et al. 2008). However, if the CO_2 -equivalent reductions made possible through the EEG are anticipated in the National Allocation Plans by lowering the amount of total emission allowances (ETS cap), accordingly, this no longer holds true. Germany's two National Allocation Plans have not explicitly considered greenhouse gas mitigation made possible through the EEG. The European Commission has however countered Germany's proposed ETS emissions cap with a substantially reduced cap anticipating a number of factors including the reductions from the EEG. There is increasing consensus that an Emission Trading Scheme is not alone sufficient to trigger the necessary shift towards a more sustainable energy supply (Mitchell 2007, Stern 2006). Carbon pricing, even though central and necessary to address climate change, needs to be supplemented by direct governmental intervention for technology choice and market support (Stern, 2006). This principle is reflected in the target setting of the European Council in 2007 and the climate change package of the European Commission of January 2008 (European Commission 2008).

Also the overall economic impact of the German promotion policy is remarkable: In total, €11.6 billion were invested in RES installations in 2006 and €11.3 billion of turnover was due to operating RES-plants in the power, heat and fuel sector (BMU 2007a). Of the total investment in RES-plants, 63%, or €7.3 billion, is attributed to investment in and operation of hydro, wind and photovoltaic power plants. Jobs in the manufacturing and operation of RES power plants in these three technology areas in 2006 climbed to 110,000—an increase of 20,000 over 2004 numbers (Kratzat et al. 2007).

Basic Structure of the German Renewable Energy Sources Act (EEG)

The Renewable Energy Act (EEG) is the central instrument to promote electricity from renewable energy sources (RES-E) in Germany. It was established in 2000 and has been amended twice (2004 and 2006). The EEG is a feed-in tariff system (minimum price standard) that obliges distribution network operators (DNO) to connect RES driven power plants, to purchase RES-E and to pay a fixed remuneration (Cent per kWh) to the plant operator. The level of remuneration is cost oriented, differentiated by technology, plant capacity and other characteristics. This remuneration is fixed for 20 years for most technologies, providing investors some security in terms of planning and recouping associated costs. The level of remuneration decreases for new power plants every year (according to a vintage approach) with a technology specific degression rate to reflect technological progress and cost reductions due to learning effects. Since the degression rate is set in advance it guides plant manufactures on the expectation on cost reductions. In this respect the EEG resembles an incentive regulation of the RPI-X type (Littlechild 1983) which has been often hailed for the strong incentives it provides for efficiency in regulated markets. In summary, the remuneration follows the following generic scheme.

$$p_{tvi} = p_{Ti} \cdot (1 - d_i)^{v-T} + k_i \quad (1)$$

with

p: Specific remuneration per kilowatt-hour
t: Actual year of remuneration
T: Base year when the EEG was established
v: Year of start of operation (vintage)
i: Technology category, e.g. photovoltaic

k: Additional premiums for innovative technologies such as energy crops or combined heat and power

d: Degression rate

The EEG mandates a priority access for renewable power to the grid and thereby overcomes a critical hurdle in getting renewable energy from generator to consumer. With access, the operator of a RES power plant (RES operator) delivers electricity to the distribution network operator, who then passes it to the transmission system operator (TSO), who, in turn, then pass it on to retailers (Figure 1).

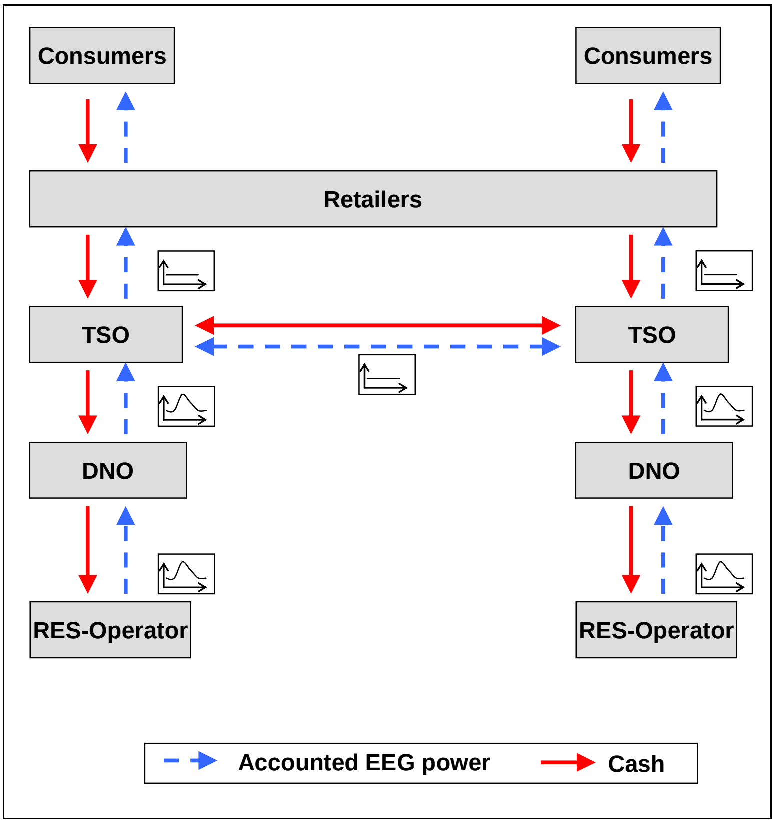

Figure 1: Balancing mechanism in the current German Renewable Energy Act (EEG) exemplified for two different transmission grids (Langniß et al. 2007)

In practise, the actual transfer of RES-E from the power generator to the consumer, as well as the payment from the consumer to the power generator, is more complicated. There are two basic issues that complicate these transfers:

1. Fluctuating sources (wind, solar energy) account for nearly half of the power attributed to the EEG. The power supply therefore needs to be matched to the power demand and a mechanism is needed to allow cost recovery for this service.
2. The German transmission grid is separated into four regions and each one is run by a different operator. This requires a specific balancing mechanism between TSOs to ensure that the amount of RES-E remunerated annually according to the EEG, as well as the resulting burdens, are equally distributed according to the electricity consumption in all four transmission grids.

The EEG requires an immediate transfer of the RES-E to electricity retailers. According to the grid-operators, this has not been feasible in practise, since the actual power output of many renewable energy installations is not known in real-time and therefore can not be balanced with real-time demand. This is particularly the case with small power plants like photovoltaic-installations where the output is registered only one to four times a year. For this reason the Association of German Network Operators has established specific rules to compensate for the lack of real-time data (VDN-VDEW 2005). According to these rules the sum of total EEG power generation is predicted monthly. The TSOs then transform the actual fluctuating power generation into a band of constant power, which equals the predicted generation, and transfer that constant power to the electricity retailers. This is known as vertical balancing of electricity. The TSOs have to provide the constant power based on the monthly predictions and need to purchase or deliver additional power for this purpose. Deviations from the predictions are considered in establishing future monthly forecasts.

Vertical balancing of electricity has been criticized by electricity retailers. Their first point is that transforming the fluctuating power into constant power not only creates additional costs, but also does not match the real power demand patterns. Moreover, retailers face uncertainty and risk because the final calculation of the transformation of fluctuating power to constant power is only made a year and a half after the data from small generators becomes available.
In order to ensure the same share of EEG power and the same average remuneration paid for EEG power on all transmission grids, the TSOs must exchange electricity and money based on monthly predictions. This is called the horizontal balancing. Wind power is the exception as it is immediately, i.e. in real-time, transferred between the TSOs; thus, predictions are not applied for the horizontal balancing of wind power generation (and there is less risk involved for electricity retailers).

The EEG provides different degrees of freedom to the different actors involved in the system. Plant operators and network operators may, by mutual agreement, deviate from priority access according to Para 4.1 of the EEG. This is done in particular cases to avoid overstress on the electricity grids but is not used as a systematic strategy for matching generation to demand because of the lack of incentives. Operators of renewable energy installations are allowed to market RES-E outside of the EEG framework. For the most part, this has not been economically advantageous as the EEG remuneration is higher than the average prices on the power exchange. However, at certain times of the year, prices on the power exchange might be higher than the remuneration; on these occasions, direct marketing becomes an attractive and competitive option. Looking at the example of wind power in 2007, the hourly average spot market price of electricity was higher than the remuneration paid to wind power plants of the 2007 vintage for 485 hours in 2007 (EEX 2008). In practise, the rules of the power market are not prepared for the marketing of small and/or fluctuating amounts of electricity and direct marketing of renewable power has been reportedly rather limited. However, direct marketing has however gained more interest and several commercial initiatives are offering bundled generation from different renewable energy sources as a marketable product (BMU 2007b).

Distribution network operators may also market RES-E purchased from generators directly instead of transferring it to the TSO. A final point is that the TSOs may deviate from the rules of the horizontal balancing since these have been only stipulated by mutual agreement and not by law. However, network operators have only limited economic interest in optimizing the integration if the network regulation authority allows them to transfer any appropriate costs to customers. Thus there may be no interest in seeking for a more efficient integration of RES-E.

Requirements for Adaptation

Irrespective of the need for continued increase of renewable energy in the power supply it is clear that more competition is needed in the German and European power markets (Kemfert, Diekmann 2006). It is often suggested that Germany's future support mechanisms should allow for more market-integration of power from renewable energies (VDEW 2005, Kohlmann 2005). A concurrent expectation is that more market-integration leads to more competition and thus lowers overall costs for the support of renewable energies and that the balancing mechanism could be simplified with related costs decreasing. However, such expectations rely on competitive power markets which can be encountered so far neither in Germany nor in Europe as a whole. For example, only four companies own 85% of the German power generation capacity; furthermore, the two largest companies own 60% of the capacity (Hirschhausen et al. 2007). This is clearly indicative of a market structure with only limited competition (Kemfert 2007, Kemfert, Traber 2008).

It is essential that the regulation of electricity grids becomes operational in Germany. Appropriate incentives within the grid regulation are needed to further promote the deployment of renewable energies. Additionally, Germany is rapidly moving beyond a point where discussions pertaining to renewable energy sources' "impact" on and renewable energy technologies' abilities to adapt to transmission and distribution infrastructure are out-dated. Grid infrastructure is, and must be, continually updated, adapted and finally, built specifically for an energy mix that includes increasing shares of RES and corresponding technologies.

The call for a better integration of renewable energies is to be seen under two different aspects:

1. Enhancing the *physical* or *technical* integration of renewable energy generation into the power supply system. Key is generation and distribution of renewable energy which needs to match, as much as possible, the actual demand. At the same time, it is important to avoid overstressing existing power grids. Currently, the EEG does not provide any incentive to generators, grid-operators or power suppliers in this respect.
2. Enhancing the *commercial* integration of renewable energy into the power market. Who should market the renewable power? Who should purchase it? And on what contractual terms? Since the present framework of the EEG provides generators of renewable power with an implicit standard power purchase contract (Langniß 2002, 2003, Finon und Perez 2004), they have no incentive to address these issues.

The physical and technical integration of RES-E mainly has to do with when and how much power is to be fed-in to the grids on the short-term. These questions are becoming more important as renewable energy generation's share in the power mix continues to increase. To accommodate renewable energies appropriately and to minimise overall costs, these questions should not be addressed solely to power generators but also to grid operators and power suppliers because an optimisation of the entire supply system is needed. Such optimisation needs to reflect the targets for the deployment of renewable energies. The German government targets a share of renewable energy electricity supply by 2010 of 25% - 30 % by 2020. This minimum target presents a milestone on a path to a more sustainable, future energy supply based primarily on renewable energies. Exceeding this target must be rewarded rather than treated as a failure of policy.

All energy sources have particular characteristics. Oil, for example, is a resource that requires millions of years to form and a large undertaking to find, extract, transport, refine and distribute. It also is located in specific regions, etc. Renewable energy sources have specific characteristics as well that must be considered as the EEG goes forward and the foundation for a sustainable energy system is laid. With renewable energy, consideration has to be given to the fluctuation over time of some variable sources like wind power. Additionally, spatial distribution needs to be considered for an optimal technical integration of renewable energy generation. In the case of Germany, appropriate sites with good resources are rather limited when compared to the shares of future power demand renewable energies are expected to cover. The wind resources differ widely locally as well as regionally. Therefore, higher grid integration costs, i.e. through regional concentration of wind power plants, may be acceptable if a higher power yield leads to lower generation costs. Biomass and geothermal resources are often also highly regional specific in Germany. Considering the ambitious targets for deployment, all resources need to be exploited. The siting of renewable energy installations follows, and will continue to follow, patterns other than those followed for conventional power plants. It is clear, that the power grid needs to be strengthened and enhanced to meet the challenges of the future energy supply. This is an essential departure from choosing renewable energy installations to be sited based on existing grid conditions. In this respect, it becomes more important for the planning of conventional power plants to consider up front, in design and siting, the growing share of distributed and partly intermittent renewable energy generation.

The commercial integration of renewable energies into the energy market has short-term and long-term elements. The energy markets in Germany and Europe function on several time-scales. For example, power purchases can be governed via the spot market as well as via long-term contracts stretching over the whole life-time of the power plant in the extreme case. Thus, short-term decisions on the generation as well as long-term decisions on the investment in capacity are concerned. Stable prices and long-term certainty serve as counterbalances, allowing for market development, uptake and deployment. The support mechanism supporting commercial integration needs to provide sufficient certainty to investors in the long-term—to make sure investments happen and that additional risk premiums, in the short-term, are minimized.

Policies can have the commercial integration of renewable energies as an objective in itself, i.e. markets should ultimately govern renewable energies, and the promotion should be as market-based as possible. However, the imperfect market conditions in the energy markets, specifically the lack of competition in the marketplace, and other market failures must be recognized. Additionally, policies with explicit market goals have not necessarily led to thriving markets. For example, countries that have relied on the market, rather than policies, to pick technology winners have seen only the cheapest renewable energy sources and technologies, in most cases onshore wind, developed (Mitchell 2008). Furthermore, domestic manufacturing has often succumbed to international businesses. Germany's EEG, on the other hand, explicitly differentiates and supports a range of renewable energy technologies and sources. It also is particularly targeted to encourage domestic manufacturing. Finally, it has been noted for encouraging more competition and costing less than alternative policies, such as the UK's Renewables Obligation (Toke 2007). Along these lines, adapting the EEG to encourage commercial integration should encourage more competition and result in operators of renewable energy plants being prepared and capable to market their generation independently, or through third parties, to the power markets. To make this happen, operators need to supplement their extensive technical experience with commercial know-how. Alternatively, the commercial integration aspects can be regarded as a means to promote a better technical integration of renewable energies – if the RES-E is technically integrated and optimally adapted to power demand then operators will maximise prices.

Analysis of Alternative Models for Balancing and Marketing

This section describes three alternative models for evolutionary advancements to amend the EEG in order to achieve better integration of renewable energies. It is thereby essential that the successful elements of the EEG are maintained i.e. sufficient investment into renewable energies triggered by providing and maintaining sufficient investment certainty. It is also important that the financial cost to electricity consumers is not unduly high; an increase of the burden is only acceptable if there is also an additional economical or environmental benefit. Key to achieving better integration of renewable energies into the power grid is the transfer of responsibilities for that integration.

From the three different models discussed, the *Retailer Model* creates the smallest change in the support mechanism. In the Retailer Model, end-use retailers receive the renewable energy generation directly. It becomes the responsibility of the retailers to adapt the EEG power to the actual demand of their respective customers. In the *Market Mediator Model*, one or several independent market mediators such as energy brokers are responsible for the integration and marketing of the renewable energy power. Finally, the *Optional Bonus Model* transfers the entire responsibility for marketing of power to the renewable energy power generators. In the following sections, we analyse design elements of these models and evaluate their pros and cons in terms of achieving a better integration of renewable energy generation.

Retailer Model and Optional Retailer Model

This model shifts responsibility for the integration of renewable energies from the transmission system operator (TSO) to retailers. Retailers would purchase supported RES electricity according to the profile of the total electricity from renewable energies fed into the grid according to the EEG (see Figure 2). Retailers would be directly confronted with, and responsible for integrating, the varying generation of the EEG plants. In this model retailers would no longer receive the constant, transformed band of power and would need to match the power to the actual demand of their customers. Competitive advantage is an incentive in this model forcing retailers to match the power demand in a manner as efficient as possible. The success of this competitive model should reduce costs and also lead to lower prices for consumers—and ultimately reduce the cost paid by end-users for the EEG. It is likely that large retailers, with large capacity, could and would organise the integration themselves and smaller retailers, with no or only limited capacities, would rely on third parties offering balancing and integration services.

This model would provide greater incentives for an efficient integration of renewable energies than the present EEG. The direct relationship between retailers and consumers would allow for efficient demand adjustment to the EEG power supply. Consumers would potentially benefit from decreasing costs. The balancing mechanism would be simplified because it would be based on actual EEG power rather than on a constant band of transformed power. Many retailers would rely on the market to balance the generation with the supply, contributing to liquidity of the market and strengthening competition. Most importantly, all advantages of the present EEG would be maintained. In particular, the system would continue to ensure that all final consumers would receive the same share of EEG power and bear equal shares of the financial costs. That being said, the model does not stimulate any integration efforts on the part of power plant operators or on the part of grid operators. The tasks of the retailers would get more complex; potentially, this could become a barrier for new markets entrants.

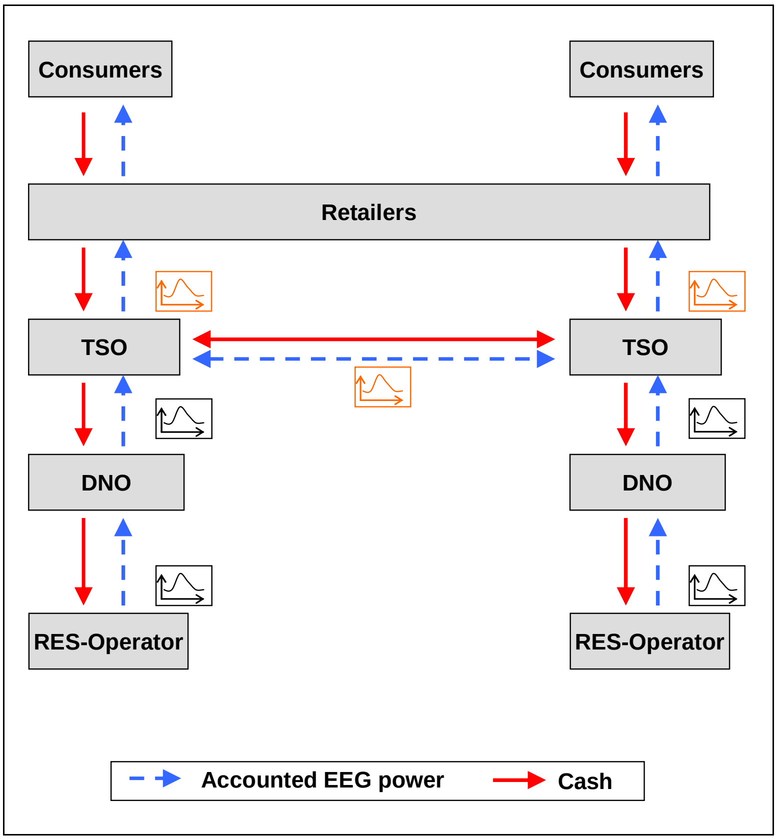

Figure 2: Balancing mechanism in the Retailer Model (Langniß et al. 2007)

To allow for more flexibility in this regard, the task of balancing the EEG power could be offered as an option once a year. In this Retailer Option Model, individual retailers could remain in the present EEG balancing mechanism if they do not feel ready to integrate themselves varying EEG power into their portfolio. Retailers would then have the option, once a year, to choose which of the two models they would prefer. The pros and cons of a Retailer Option Model are similar to the pure Retailer Model; however, in effect, often weaker due to the current EEG still operating in parallel.

Market Mediator Model

Central to this model are one or several market mediators responsible for the efficient integration and marketing of the renewable energy power. Distribution network operators (DNO) would still be obliged to purchase renewable power from plant operators and remunerate according to the EEG. The DNO would then immediately transfer the electricity to a market mediator and would receive any remuneration paid to plant operators from him (Figure 3). The market mediator would seek to maximize the benefits of marketing the power. For example, this could mean creating products for the balancing of the power or to be bought on the day-ahead spot market. Additionally, market mediators could also enter into bilateral contracts with conventional generators or retailers. Another option would be to supply power directly to end-users—particularly beneficial would be power consumers that are able to adjust electricity demand to the fluctuating power supply from renewable energy sources. Compared to the present situation, all of these options would enhance liquidity of the power markets.

Considering the current market structure and price levels, earnings from green power marketing would not be sufficient to cover all of the costs of remuneration. Thus, market mediators would need to receive an "add-up" in form of a premium. To finance the extra costs of renewable generation, final power consumers would pay an add-up on the grid charges to the transmission system operator (TSO). The add-up would then be transferred to the market mediators. The result would be that the differential costs would be incorporated in the balancing mechanism. Furthermore, the market value, as well as the power itself, would no longer be subject to the balancing mechanism. Retailers would not have to purchase the transformed, constant bands of power any longer.

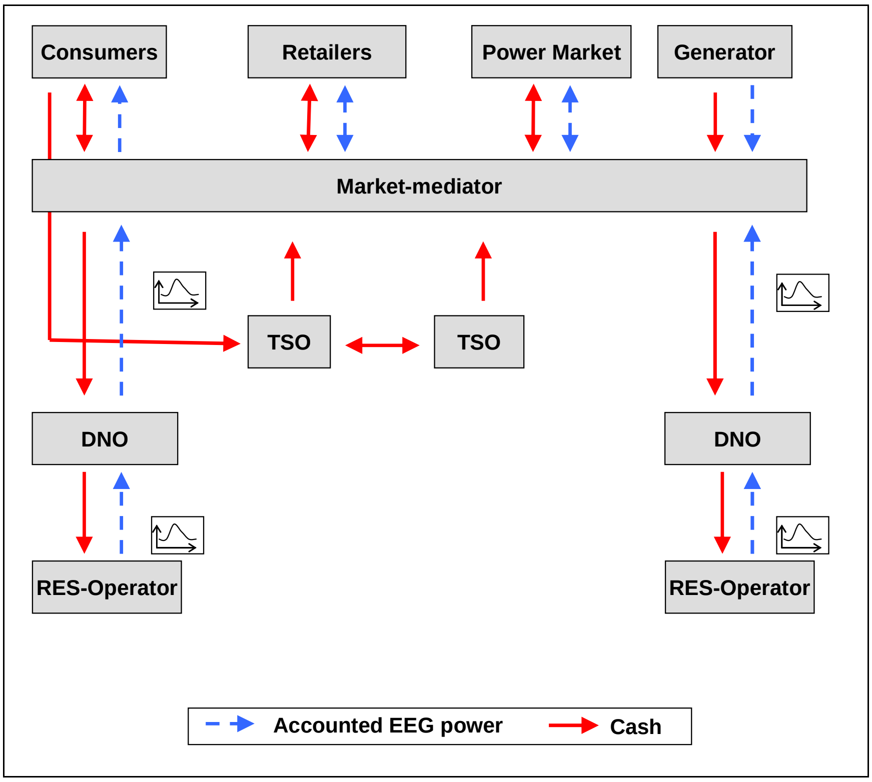

Figure 3: Balancing mechanism in the Market Mediator Model (Langniß et al. 2007)

It is crucial that the market mediators act on a commercial basis i.e. as profit-seekers, so that a strong incentive is provided to market and integrate renewable power by the most economically efficient means possible. Market mediators therefore need to be allowed to profit from the efficient integration. At the same time, power consumers should also benefit through lower costs. To achieve these goals the task of the mediator should be open to tender on a regular basis. In an auction, the bidder with the lowest demand for specific add-up payment-per-purchased kilowatt hour of EEG-power would win the contract. The contract would incorporate the purchase of all power from a specified set of EEG generation plants at prices fixed by the EEG. This would give the market mediator the opportunity to cooperate with the EEG plant operators e.g. to adapt power generation to market demands and thereby increasing the value of the output. The contracts would extend over a fixed period. If necessary, in order to reflect changing prices on the general power market, the fixed add-up payments could be supplemented by a price adjustment clause. With such a price adjustment clause, the add-ups would decrease as general power prices increased.

It is reasonable to divide the sum of EEG power generation into several tracks which would be given to different market mediators. This would allow for benchmarking. For instance, all power plants of a certain region, or all power plants of a certain technology, could be bundled together. On the other hand, tracks of individual technologies, for example wind power, even thought they would allow for specialisation of market mediators, would not have the same overall benefits as portfolios of different technologies would—in that mixed technology portfolios provide for an easier balancing of the EEG generation. Newly added capacity could be offered for tender regularly, every six months. In order to encourage market mediators to enter multiple trades and to invest in the long-term, e.g. communication infrastructure and storage technologies that allow for improved physical integration of EEG power, the market mediator contracts should extend over a period of several years. It is also for this reason, to exploit integration efforts tied to plant operators that the power purchased by individual market mediators originates from specified plants and is not tendered as a certain amount from anonymous producers.

The task of market mediator could be taken over by power brokers. However, actors having their own power capacities, be it conventional or renewable, have the advantage because they can more easily create and market successful products out of the EEG power. The market mediator role might be of particular interest to foreign electricity companies looking for entrance in the German market. Combined efforts from operators of EEG plants are good candidates for this task as well.

The market mediator model provides incentives for an efficient integration of EEG power throughout the whole value-added chain from the individual power producer to the final power consumer. Market mediators as profit-seekers will try to adjust power generation and power demand to each other in the most efficient way. By opening the function of market mediators up to regular bidding, market mediators are forced to share the benefits of efficient integration with final power consumers. With new, potentially independent market mediators entering into the power market, competition in the energy markets will increase. This model would continue to provide the same amount of investment certainty to RES-power plant operators as the present EEG, because the district network operators will remain the unique counterpart to the plant operators providing them with the legally stipulated payments. The design of the auction process is both critical and challenging. Therefore, stepwise, or incremental, introduction of this model is reasonable. This could easily be achieved by only auctioning parts of the entire EEG generation portfolio in the beginning. At a later point, the market mediator scheme could govern the entire portfolio of EEG plants. Such a framework could also incorporate currently remunerated EEG plants, so that in the end the market mediator model would entirely replace the current EEG regime.

Optional Bonus Model

Incentives to plant operators of EEG power plants to better integrate their power production are key in the bonus model. In a pure bonus model, only payments of fixed bonuses to plant operators are stipulated by law. The bonuses are differentiated by technology and decrease every year for new vintages of power plants. It is left entirely to the plant operators to market their power generation on the market and achieve income beyond that from the bonus. In contrast to the present EEG, grid operators are not obliged to purchase EEG power. The part of the operators' income represented by the bonuses is not subject to any price risk and is thus as certain and predictable as the entire remuneration in the present EEG. The income from marketing the power would be subject to the usual price and quantity risks. As described earlier, there is only limited competition in the German power market, making it particular challenging for independent power producers to market their output under reasonable and fair conditions. To reflect the lack of fair conditions in power markets and to reduce investment risks it is reasonable to give plant operators an option between the fixed remuneration according to the EEG and the bonus. This proposal is similar to the current Spanish promotion scheme. In such an optional bonus model, once a year, plant operators could choose whether they prefer to market their power output on their own or whether they prefer to supply the power generation to the grid operators and receive the fixed remuneration. The operator's income would remain the same as described in equation (1) as long as the operator does not choose the bonus option. In the case that he chooses the bonus option, his income follows the generic form of equation (2).

$$p_{tvi} = e_{ti} + b_{Ti} \cdot (1 - d_i)^{v-T} + k_i \qquad (2)$$

with

p: Specific income per kilowatt-hour

t: Actual year of remuneration

e: Market price of self-marketed power *b: Bonus*

T: Base year the EEG

v: Year of start of operation (vintage)

i: Technology category, e.g. photovoltaic

k: Additional premiums, e.g. for innovative technologies, energy crop, combined heat and power

d: Degression rate

Most of the power plants benefiting from the EEG are operated by independent power producers (BMU 2007b). Independent power producers have no direct access to final consumers and thus rely much more on spot markets than the incumbent power producers. However, the prices at the spot markets have seen wide variations putting independent power producers at undue risk in a pure bonus model. The flexibility of annually opting for the bonus scheme may be supplemented with more short-term adjustment to shield against undue price risks. One way to achieve this is to allow plant operators to choose to opt-in more than once a year. However, this may lead to cherry-picking. We therefore propose to dampen the price risks of power sale. For this purpose, the bonus should be adapted whenever monthly average prices at the power markets fall outside of a price corridor. When average power prices fall below the bottom price in the corridor, the bonus would be increased by the difference of the actual average power price and the lower margin of the price corridor. At the other end, profits of plant operators would be limited by decreasing the bonus every time the average market price is higher than the price corridor. End-users would benefit from the dampening effects, because such a scheme avoids windfall profit in the case of tremendously increasing electricity market prices (as in 2005/2006).[d] It is proposed to set a range +/- Δ (of e.g. 2ct/kWh) around the originally anticipated market price (e_a) to create the price corridor (e_a-Δ , e_a+Δ). Equation (2) for the specific income would be altered as follows

$$p_{tvi} = e_{ti} + b_{Ti} \cdot (1 - d_i)^{v-T} + k_i + c \qquad (3)$$

[d] Alternatively to such price corridor arrangements one could offer a default minimum price—a price floor. In the case that no offers come in above the minimum price, those power plant operators who have opted for the bonus would have the choice the sell the power at the minimum set price. The minimum price would be set in a way that the sum of the minimum price and the bonus remains below the EEG remuneration. The minimum price could be tied to the average monthly power market price and thus be recalculated every month. This would connect the minimum price more closely to markets. To guarantee that power plant operators attempt to market the power themselves, the bonus for the generation of the entire year could be reduced by, for example, 0.5 ct/kWh once a power plant operator has opted for the minimum price.

with

$$c = 0\,, \qquad \text{if } (e_a - \Delta) \le e_t \le (e_a + \Delta) \quad (4a)$$

$$c = e_a - \Delta - e_t\,, \qquad \text{if } e_t < (e_a - \Delta) \quad (4b)$$

$$c = e_a + \Delta - e_t\,, \qquad \text{if } e_t > (e_a + \Delta) \quad (4c)$$

with

c: market price corrector

e_a: *in advance anticipated price of electricity on general power markets*

e_t: *actual market price*

The Optional Bonus Model would provide strong incentives to plant operators to adjust their power supply to power demand. They could invest in storage facilities or hybrid power plant concepts to allow for a well-managed supply or provide additional peak power. Power plant operators would gain experiences in marketing their power themselves and at the same time restrict the risks arising from such independent marketing. This model is the only one from the three discussed which provides direct incentives to plant operators for achieving better commercial integration. To encourage plant operators to opt for self-marketing, there needs to be a sufficient gap between the fixed remuneration and the bonus option. The expected sum of bonus and income from the power sale needs to be higher on average than the feed-in tariff to reflect the risks. Higher total payments to plant operators' results in a trade-off as the grid-integration costs, which are presently borne by the grid-operators, are reduced.

The bonus model places the emphasis on the value of the power produced whereas the present feed-in tariff sets the tariffs according to the costs of individual technologies. Considering the increasing call for more market integration, establishing an optional bonus, which still provides sufficient investment certainty, would be an important step in the right direction. However, any mechanism coupling the income of renewable energy plant operators to market prices runs the risk that renewable energy power plant operators will exceed their costs substantially (due to increasing prices for conventional power). The Spanish experience after the introduction of the optional bonus system between 2005 and 2006 confirms this. It is therefore crucial that regular short-term and mid-term review mechanisms are in place allowing for adaptation of the payment rules when necessary.

Conclusions

The German Renewable Energy Sources Act has proven to be a very successful instrument to promote renewable electricity. Such sectoral and technology specific promotion policy is needed to supplement overall greenhouse gas policies like the European Emission Trading Scheme if we are to make the fundamental shift to a sustainable energy system.

However, the need for better technical and economical integration of the renewable power into the electricity supply system also calls for a discussion of conceptual shifts. Such conceptual shifts should provide incentives for better integration by all actors along the entire value added chain, including: the power plant operator, the grid operators, the electricity suppliers, and the final consumers. This would allow for more efficient integration and result in lower costs to final consumers. With special emphasis on the economic efficiency of the institutional setting of the support mechanism we discuss three possible models: The "Retailer Model", the "Market Mediator Model", and the "Optional Bonus Model".

The Retailer Model represents the smallest change when compared to the existing EEG. The responsibility of adjusting the fluctuating renewable power supply to consumption patterns is given to electricity utilities supplying final consumers. In the Market Mediator Model third parties ("Mediators") are commissioned with this task. In the Bonus Option Model this task is given to the operators of the renewable energy plants on a voluntary basis. Of the three models discussed, only the Bonus Option Model alters the income structure and the risks of power plant operators; the other two alternatives focus on where and how the RES electricity enters into the market.

The three models differ as to who receives incentives along the value-added chain. The Retailer Model focuses on the electricity retailer with some scope for involving final consumers into better integration efforts. However, power generators do not receive any incentives to adapt generation to demand. In contrast, incentives would be given (indirectly) to power generators in the Market Mediator Model as well as to all parties along the value-added chain—allowing the largest scope for improvement. At the same time, competition in the energy markets would be improved. That being said, designing and establishing the Market Mediator

Model involves substantial institutional risks. Plant operators would receive direct incentives for adapting their power output to electricity demand in the Bonus Model. It is unclear if the gains in efficiency evoked through such a system are sufficient enough to cover the extra costs emanating from increased investor risk from uncertain income streams. The Bonus Model is particularly feasible as a supplement to the existing EEG, allowing plant operators to switch voluntarily to the Bonus Option[e]. Table 1 summarises the characteristics of the different models in comparison to the existing EEG.

Table 1: Comparison of different models to amend the current EEG

	Current scheme (EEG)	**(Optional) Retailer Model**	**Market Mediator Model**	**Optional Bonus Model**
Financial balancing	DNO and TSO full costs	DNO and TSO full costs	DNO and TSO, additional costs	DNO and TSO; with bonus only additional costs
Physical balancing horizontal	between TSO via bands	between TSO in real-time profile	not needed	not needed as far as bonus option chosen
Physical balancing vertical	DNO to TSO; TSO to Retailers via bands	Optional retailers in real-time profile otherwise: DNO to TSO; TSO to Retailers via bands	plant operator to mediator in real-time profile	not needed as far as bonus option chosen
Priority connection	yes	yes	yes	yes
Priority dispatch	yes	yes	yes	no, as far as bonus option chosen
Technological differentiation	yes	yes	yes	yes
Degression of tariffs	yes	yes	yes	yes
Incentives to plant operators	no	no	yes, indirect	yes, as far as bonus option chosen
Incentives to network operators	no	no	yes, indirect	yes, indirect, as far as bonus option chosen
Incentives to electricity suppliers (utilities)	no	yes, as far as retailer use option	yes, indirect	yes, indirect, as far as bonus option chosen
Incentives to electricity consumers	no	yes, indirectly through retailer	yes, indirect	yes, indirect, as far as bonus option chosen

DNO: Distribution Network Operator. TSO: Transmission System Operator.

[e] An intermediary step towards this scheme could be a premium addition to the legal remuneration for those

In the Optional Bonus Model plant operators take over price risks they have to bear neither in the Retailer Model nor the Market Mediator Model. This might be problematic as investments in renewable energy technologies are still inherently risky, often also incorporating large up-front investments. Moreover, plant operators might not be ready to take over these responsibilities. Against this background, the Bonus Option Model should be considered as a supplement rather than a substitute to the existing price regulation; possibly only applied to the most mature renewable energy technologies. On the medium to long-term however, it is inevitable that renewable energy sources will need to compete with each other as well as with other energy carriers on the market. It is therefore needed that plant operators prepare to take over more responsibilities than in the current EEG.

The Optional Bonus Model and the Market Mediator Model are both promising evolutions of the present promotion system. Whereas the Market Mediator Model maintains the priority access of RES and enhances integration by new players - the market mediators - the Optional Bonus Model relies on the price signals of the existing power market. If with stronger framework regulation, more competitive markets and fair conditions for RES-E are created, then the Bonus Model is the primary choice. If the lack of competition in the power markets is viewed as a sticky institutional problem, then the Market Mediator Model should be preferred, and new actors are appropriate to establish renewable electricity and thereby enhancing competition in the marketplace.

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operators adapting their power generation to a predefined demand curve.

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