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Implicit Premiums in Renewable-Energy Support Schemes

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Abstract

This paper determines the implicit premiums included in support schemes for renewable energy in a number of European countries. These premiums depend on the design of the support schemes. These schemes vary from feed-in-tariffs, sliding feed-in-premium systems, quota systems and netting of electricity production by prosumers. We find that the UK quota system has delivered the most renewable energy per unit of premium, while the German system has been the most generous. In 2014, the average premium for renewable energy was about 70 euro/MWh in the UK, while in Germany the average premium was about 150 euro/MWh. The main factor behind these differences is to what extent the schemes give specific treatment to the different generation techniques. The more general a scheme is, the lower the premiums for renewable energy.

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1. Introduction

In 2020 all member states of the European Union have to fulfilled the national targets set by the European Commission with regard to renewable energy production in their energy mix (EU, 2009). On average, the EU Member States have to produce 20% of the energy consumed by renewable-production sources. Although the implications of this policy on the total amount of carbon-dioxide emitted can be questioned, the costs of realising these targets also depend on how the renewable energy is stimulated. The ultimate objective of designing a scheme is to give incentives to producers to reduce the costs without providing them with too much rents (see e.g. Haas et al. 2011; Schmalensee, 2012; Marcantonini and Ellerman, 2015). A number of alternative options exists that can be used to increase the share of renewables, directly or indirectly.

In this paper in which we assess a number of support schemes, we look in particular at the premiums that are paid to the producers of renewable energy and the distribution of risks and rents among the various stakeholders. In particular we study the designs that have been implemented in Germany, the Netherlands and the United Kingdom over the past decade. To a lesser extent, we also discuss the experiences in the combined market of Sweden and Norway. For all these countries we calculate the premiums per MWh or renewable electricity for the period 2002-2014, as far as the required data were available.

In Germany the four TSO's publish extensive information about the yearly production of - and remuneration paid to – producers of renewable electricity. This information is differentiated by sources of production as well as the scheme under which the producer is rewarded through a subsidy. Using these data, the total annual remuneration to specific sources can be derived. By subtracting the average electricity price the source has received for the FiT-producers, the premium for each source is calculated. The premium for the FiP is calculated as the remuneration per produced MWh.

In the Netherlands the total remuneration given to renewable energy sources can be split by technology, the year of disposal and the year of production. This data enables us, for instance, to calculate the total remuneration in 2014 of solar producers that applied for a subsidy in 2010 as well as producers that applied for a subsidy in earlier years. The calculations are differentiated to the source of production, the year of production and the scheme under which the subsidy was provided.

The subsidy-effectiveness in the U.K. is derived in a slightly different way, as the U.K. does not have a subsidy scheme, but a quota scheme, the so-called Renewable Obligation scheme. Before 2009, the U.K. allocated for each technology the same amount of certificates, enabling us to calculate the 'value of having a certificate' during the period of 2006-2014.[3] The premium paid is therefore equal to the value of having a certificate. After 2009 some renewable sources started to receive more and other less than one certificate per MWh, which is called banding.

The structure of this paper is as follows. In Section 2 we describe the key characteristics of the different types of support schemes currently being used in European countries. In Section 3 we analyse the premiums which have been paid for renewable energy in a number of European countries. Section 4 discusses these results and concludes.

2. Designs of RES-support schemes

2.1. Feed-In Tariff (FiT)

In the most generally used FiT system, RES-producers sell their electricity to the network operator (see Figure 1). Electricity produced by RES has priority over other sources of electricity production, which means that the network operator is obliged to accept all renewable energy at each moment in time. The network operator pays a predetermined tariff to the RES producers for each unit of electricity injected into the grid. This tariff is regulated by the government administration or regulator. This tariff is generally based on the expected future cash flow for investors that must equalize the investments costs plus the expected operational costs of the production (Klein et al 2008). This tariff may differ among technologies, locations of RES facilities, starting dates of the facilities as well as the sizes of the project. Such a differentiation aims to prevent over-subsidizing of certain

[3] The value of a ROC in year t is the amount set as the buy-out price in year t + the total proceeds of late-payments and buy-out refunded to the producers of RES under the RO program.

technologies, thereby reducing windfall profits (rents) for RES-producers. FiT contracts have a predetermined period, say twenty years, which length can differ across the other dimensions mentioned above.

The network operator sells the electricity at the wholesale spot market and, consequently, obtains the market price. Because the price the network operator receives in the wholesale market is generally much below the tariff it has to pay to RES-producers, a negative gap occurs for the network operator. This gap can be financed through a predetermined levy at the energy bill of consumers. As a result, consumers are eventually paying for the extra costs of producing renewable energy. A consequence of this system is that the financial risk of investments in renewable energy are carried by end-users, while the decisions by the RES-producers on the supply of renewable energy to market are fully independent of actual price of electricity at the spot market. Electricity producers bears no price or quantity risk by producing at all by producing renewable energy under this system.

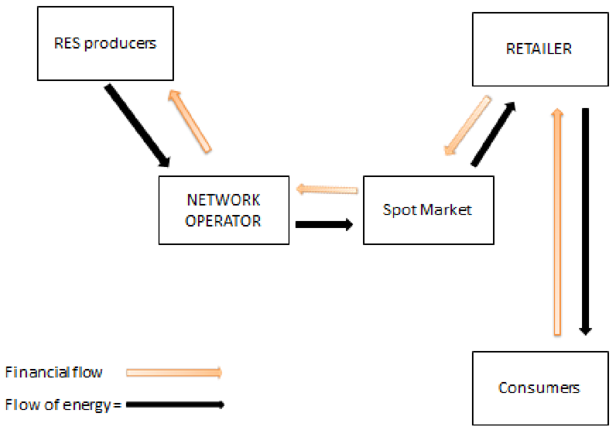

Figure 1 Feed-in Tariff system and the direction of financial and energy flows

2.2. Feed-In Premium (FiP)

In contrast to the FiT system, in a Feed-in-Premium (FiP) system producers sell their electricity directly at the spot market (see Figure 2). Because the price RES-producers receive at the spot market is not sufficient to cover all costs of renewable energy, the producers receive an additional payment. This payment is called the feed-in-premium. This premium is paid by a public authority and is mostly financed by an levy at the energy bill for consumers, but can also be paid directly via the state's budget. Therefore, the consumers (or the tax payers) ultimately bear the costs of RES production as well.

The size of the premium the RES-producers receive is determined ex ante by the public authority. The premium can be differentiated, just as in the FIT-system, to the features of the renewable-energy facility. The premium is based on the expected unit costs of producing renewable energy and the expected spot price (Klein et al 2008; REN21 2009). Hence, the investment decisions by RES producers are based on the expected price at the spot market over the lifetime of the facility, the premium they will receive as well as the investment and expected annual operational costs. Since the premium is ex ante determined based on expected spot prices, the investor in RES runs a financial risk which is that the actual spot prices may deviate from expected prices. Because of this risk, investors will require a risk premium. For Spain, for instance, where investors had to choose beween FiT and FiP compensation, this risk premium was estimated to be 1-3 ct./kWh (Ragwitz et al., 2007).

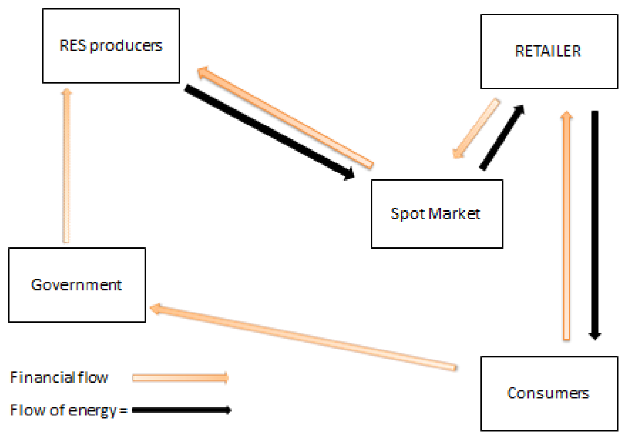

Figure 2 Feed-in Premium system: direction of financial and energy flows

2.3. Sliding Feed-in Premium (SFiP)

A sliding Feed-in Premium (sFiP) system has been developed to reduce the price risk that occurs in a FiP system. Just as under the FiP design, the RES-producer sells its electricity at the spot market. While the FiP is determined ex ante and fixed during the investment period, the sFiP depends on the actual spot market price and a so-called strike price. The difference between the actual spot market price and the strike price determines the compensation: when the electricity price is low, the compensation is high and vice versa (see Figure 3). The so-called ‘strike price’ can be seen as the FiT-price, which producers should at least get to be compensated for the costs of producing renewable energy. The difference between the strike price and the spot market price can be calculated on the basis on yearly average spot market price or, for instance, the daily average spot market price. If the actual spot-market price is high, i.e. close to or even above the strike price, the RES producers do not need a high subsidy and the subsidy (or premium) is low or zero. Within the sFiP-system the price risk for the RES producers is strongly reduced, while also the financial risk for the tax payers (or energy users) is capped through the strike price.

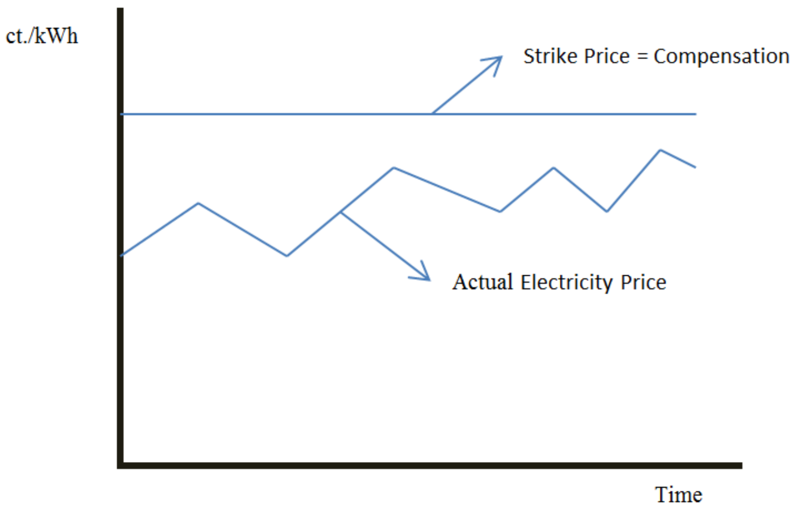

Figure 3 A sliding FiP-system

2.4. A quota system

In a quota system, retailers have the obligation to make sure that a pre-determined share of their sales portfolio is generated by renewable sources. For every unit electricity sold to consumers, retailers need to hand-in certificates to the regulator at the end of each year. If a retailer fails to hand in enough certificates it will get a penalty relative to the number of certificates missing. Retailers can buy the certificates from RES producers, who obtain certificates relatively to the level of electricity they produce. As retailers can be assumed to be indifferent between handing in certificates or paying the penalty at the moment the price of a certificate is equal to penalty, the maximum price of a certificate is the level of this penalty. Besides selling certificates to retailers, RES-producers also sell their electricity. Hence, in this design RES-producers obtain their revenues from two sources: selling electricity as well as selling certificates. Both prices are set within a market, which implies that the risk for the electricity producers is much higher in a quota system than under a FiT, FiP or SFiP system. This higher risk increases the compensation RES producers require for their investment and therefore the required minimum price of the certificates. The price of the certificates which are paid by the retailers is passed on to their consumers. Hence, in this system the extra costs of producing renewable energy are directly paid by the consumers without receiving any subsidy.

2.5. Design of other policy measures to stimulate RES

A number of other policy measures exists which are used to foster the development of renewable energy. Here, we briefly discuss netting, fiscal measures, emissions trading schemes and taxes and, finally, the system of guarantees of origin.

In a netting system, consumers who also produce electricity themselves by renewable-energy sources (e.g. solar cells), may subtract the electricity produced and injected in the grid in a year from the electricity consumption and extracted from the grid in that year. Hence, netting is an administrative procedure to treat the production by renewable sources as negative consumption. Since the retail price of electricity is above the wholesale (commodity) price of electricity, netting gives these consumers (also called ‘prosumers’) an implicit subsidy for producing renewable energy. This subsidy is equal to the difference in price between the commodity price of electricity and the retail price. A major component of this price difference is the energy tax included in retail prices.

Another commonly used method to stimulate the production of renewable energy is the use of investment subsidies. Though this can be done in several ways, a very common way is the use of tax deduction for investments in renewable energy. Main difference is that this subsidy is provided at the moment the investment is done by the market party, reducing the risks for the market participants. A major drawback is the incentive given to producer to invest in production facilities only, not in producing renewable electricity.

The Emissions Trading Systems (ETS) caps the total emissions of carbon dioxide in a certain region for a number of industries and enables these industries to trade with each other in order to find the most efficient way of emissions reduction. Insofar renewable energy sources provide efficient solutions for emission reductions, an ETS fosters this kind of technique. The same holds for carbon tax. For every unit of emitted carbon dioxide a levy has to be paid to the tax authority. Under both designs, the emission of carbon dioxide becomes more expensive compared to renewable energy, providing renewables with a competitive advantage over conventional sources. As a matter of fact, producing electricity with coal becomes more expensive than with coal compared to producing electricity with renewables, at the moment the overall cap of allowed carbon dioxide emissions is falling. Although the ETS and the RES schemes clearly interact with each other in case implemented in the same jurisdiction, both measures have a different initial objective. The main purpose of the ETS is not increasing the share of renewables, but reducing emissions.

The last EU-wide policy to increase the share of renewables is the policy regarding the guarantees of origin. Producers of renewable electricity receive a certificate that can be traded within, but also across countries. Consumers that prefer to consume renewable electricity over electricity produced with conventional sources can buy these guarantees. This system can be criticized because of the rents flowing to already existing facilities, while the impact on fostering renewable energy appears to be limited (Mulder and Zomer, 2016).

3. Premiums paid for renewable energy in a number of European countries

3.1. Germany

Germany promotes the generation of renewable energy by the EEG (Erneuerbare-Energien-Gesetz) since 2000. Initially, the EEG had a classic FiT structure. A RES producer with an onshore windmill, for instance, that applied for a subsidy in 2009 obtains 9.2 eurocents/kWh for all production over a period of twenty years. The total production of renewable energy under this FiT system increased strongly: in 2002 the total production was about 23 TWh and in 2014 it was almost 50 TWh (see Table A.1 in the Appendix). In the same time the total financial compensation given to RES producers increased from about 1.7 billion euro in 2002 to 12.7 billion euro in 2014. As this increase is much stronger than the increase in RES production, the average subsidy given per unit of renewable electricity has increased significantly. In 2002 the weighted average subsidy was about 75 euro/MWh and in 2014 this was about 250 euro/MWh. As the electricity price was about 22.5 euro/MWh in 2014, this means that society paid an average premium of about 230 euro/MWh for renewable energy.

This strong increase in the average premium for RES results from the fact that more expensive technologies are increasingly subsidied. Though PV only produced 25% of the total production of renewable energy in Germany in 2014 (Figure 4), 49% of the EEG-fund flowed to this type of production (Figure 4). In 2002, the share of solar PV in both total RES production and total subsidies was about 1%.

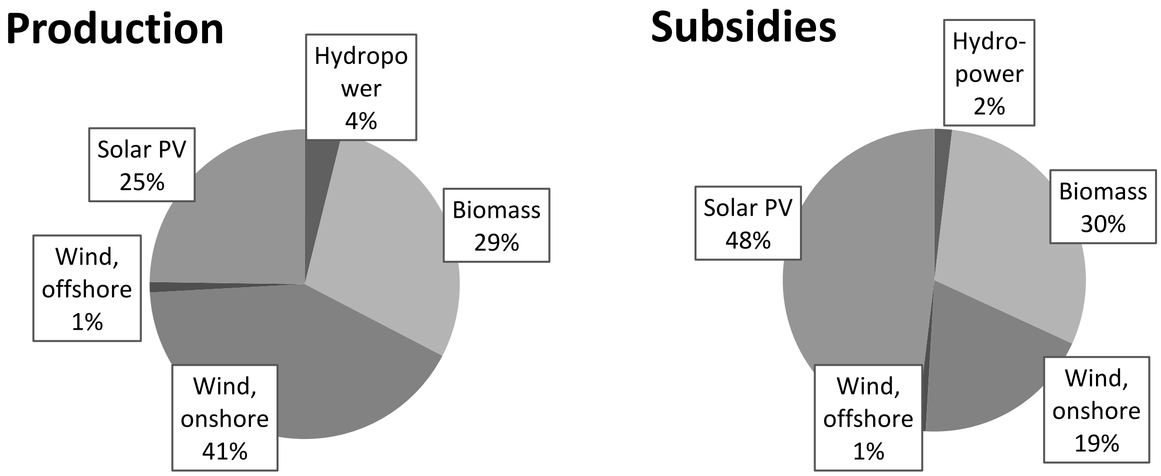

Figure 4 Distribution of RES techniques over production and subsidies, Germany, 2014

The premiums per unit of electricity are for solar PV significantly higher than for other techniques (Figure 5). The differences between the premiums have, however, decreased. The premiums for solar PV have declined from almost 500 euro/MWh in 2002 to about 300 euro/MWh in 2014. The premiums for hydropower and wind (both offshore and onshore) are more or less stable; the fluctuations over time are mainly due to the volatility in the electricity price. The premiums for biomass have, on the contrary, increased strongly. Biomass has become a more expensive renewable-energy technique, with a premium of almost 200 euro/MWh in 2014.

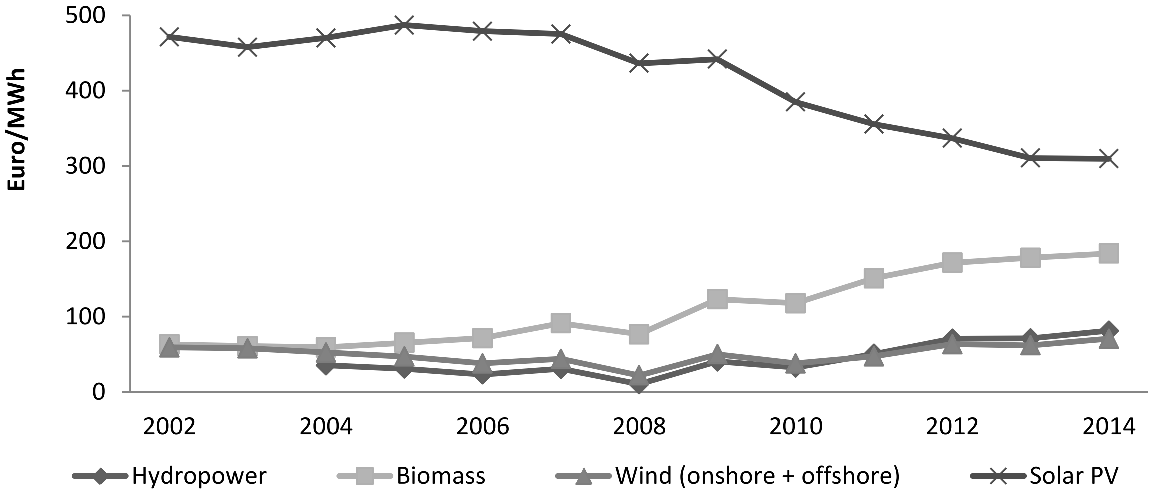

Figure 5 Implicit premium per type of renewable-energy technique by FiT, Germany, 2002-2014

The premium for renewable energy production is financed through a levy on the energy bill of mainly small consumers.[4] Under the EEG, energy consumers pay an additional levy to the retailers which transfer this to the grid operators. This levy increased from 3.6 euro/MWh in 2002 to 62.4 euro/MWh in 2014. As a result, the total revenues coming from this levy increased from about 2 billion euro in 2002 to more than 20 billion euro in 2014 (see Table A.1). The share of RES in total electricity production grew from about 5% to about 25%.

Although the FiT-system of Germany is celebrated in the literature due to the low risk for producers, the system has a major drawback. As a result of the fixed predetermined tariff and the priority dispatch, RES producer do not have any incentive to respond to market circumstances. In order to introduce a more 'market-oriented' renewable energy sector and thereby reducing the costs of RES-production, Germany reformed the EEG in 2012 (Lang and Lang, 2014). In that year, Germany started to compensate a part of the new RES producers via a feed-in-premium (FiP) system. In this system, the producers became responsible for selling the electricity themselves. From 2012 on, producers of renewable energy had the option to sell the electricity directly at the (spot) market

[4] The heavy industry in Germany is excluded from the EEG-surcharge because of international competition consideration. The list of companies which were exempted from paying the levy increased from 297 companies in 2005 to 2098 in 2014.

without receiving the FiT-compensation and to receive a subsidy on top of the market price for electricity.[5]

In 2014, Germany paid an average premium of 70.59 euro per MWh for onshore wind, making the total yield for electricity producers producing electricity with onshore wind turbines 93.14 euro/MWh (Table A.1 in the Appendix). Overall, the premium paid per unit of renewable-energy production is much lower in the FiP system than in the FiT system (Figure 6). A major factor behind this difference is the fact that the expensive small-scale solar PV is not eligible under the FiP-scheme.

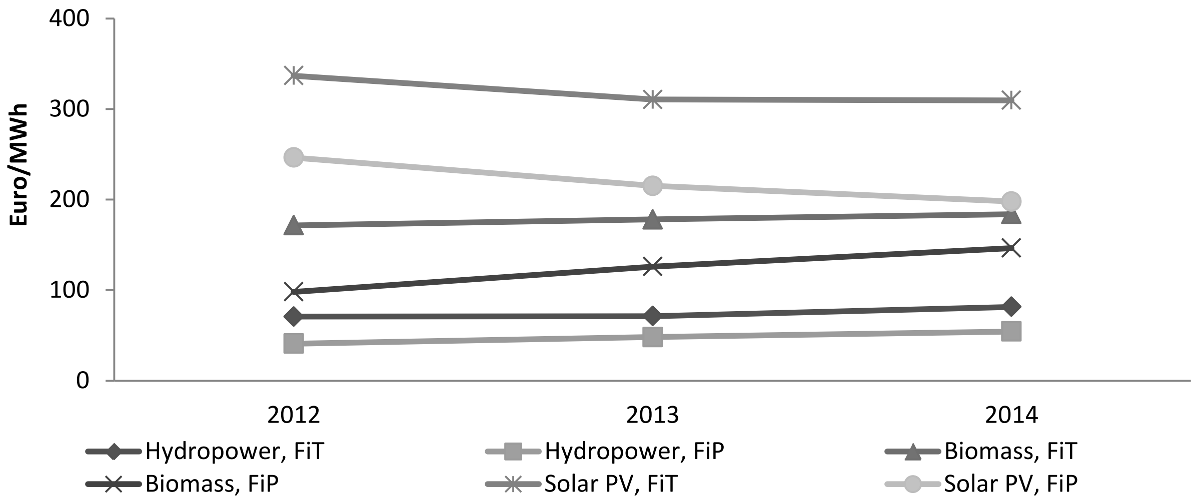

Figure 6 Implicit premium per type of renewable-energy technique and support scheme, Germany, 2012-2014

In 2014 Germany adjusted its EEG further by implementing EEG 2.0. This change included the introduction of a sliding FiP-scheme. Most new producers must sell their electricity at the market directly and therefore take the spot market price into account. The premium paid is the average difference between the actual spot market prices and the technology-specific strike price. The spot-market price is calculated monthly as the nominal technology-specific volume-weighted strike price less the average spot market price in that month (CEER, 2015). Because of this design, RES-producers producing their electricity during peak-load periods (with higher market prices) will receive a higher

[5] The small solar PV producers are, in contrast to the large producers, still eligible under the FiT-system. Small producers and certain technologies were initially excluded from the FiP system and were still supported via the FiT system.

premium than those which produce more during off-peak load periods (with lower market prices). The objective of this change is to stimulate RES producers to become more market oriented.

The second change implemented with EEG 2.0 is the introduction of so-called expansion corridors: specific growth targets for different technologies. One example of such an expansion corridor is the target for solar power of 2500 MW per year. By managing the growth rate of renewables, the government can intervene if certain sources are growing too fast. This ‘breathing cap concepts’ adjusts the strike prices in case newly installed capacity is not growing in line with the target set. The main advantage is that this reform can limit the growth rate of certain expensive technologies or reduce production at places where the grid cannot handle an increased production of electricity.

3.2. The United Kingdom

In 2002, the U.K. implemented the Renewables Obligation (RO) for England, Wales, Scotland. Northern Ireland joined the scheme in 2005. The RO introduced the obligation for retailers to make sure that a certain minimum and increasing percentage of the electricity supplied to electricity consumers, is produced with renewable sources. The RO system will be frozen in 2017 and from that moment no new projects will be allowed to enter the scheme. The scheme will be in place for another 15 years, but new projects are eligible under a FiT in which the strike price will be determined via tendering.

OFGEM, the British energy regulator, provides the certificates (ROCs) to RES-producers, collects the ROCs from retailers at the end of the period and provides data regarding the use of the scheme. The ROCs issued by OFGEM to the suppliers can be traded between the electricity suppliers. At the end of each period, retailers have to hand in the required number of certificates.[6] If a retailer fails to hand in the required number of certificates, it has to pay the ‘buy-out’ price (per ROC missing) into a fund. The proceeds of these funds are collected and allocated among all electricity producers that did hand in the required ROCs. In this system, the proceeds of a RES-producer, therefore, can consist of three components: the spot-market electricity price, the price of the certificates and the

[6] A period starts at 1 April and ends at 31 March each year, the year named 208 is the period April 2008 – March 2009.

proceeds coming from the allocation of the fund. As a result, the cash flow for RES producers is fairly unpredictable, which was especially true during the start of the scheme. The set-up increased the risk premium required by RES producers and this makes the production of renewable energy, ceteris paribus, under a quota system more expensive than under a FiP-system (Haas et al, 2011). Since electricity retailers have to obtain a minimum number of certificates, they will eventually pass on the costs of the renewable electricity production towards the consumers of electricity via a mark-up in the electricity prices.

The value of one ROC is determined by more than one factor. First, the producers can choose between submitting the ROCs to the regulator or paying the buy-out price. Therefore, in case of scarcity the value of a ROC becomes at least as high as the buy-out price. If becomes clear that there is a shortage and retailers are paying the buy-out prices into the fund, the proceeds of this fund are distributed to the firms that did hand-in certificates. The average value per ROC handed in is called the recycle value of the ROCs. The total number of ROCs presented / issued became over the years better matched with the obligation (Ofgem 2015). Since 2011 almost all retailers did hand in a sufficient number of certificates and therefore no longer significant amounts were paid to the buy-out fund. Therefore the recycle value of the ROCs decreased.[7]

Before 2009 all technologies received 1 ROC per produced MWh, but this changed in 2009. Since 2009 the number of ROCs per MWh depends on the technology used, the year the facility was accredited, the location of the accredited facility and the installed capacity of the facility. This system, called banding, aims at reducing windfall profits for production facilities that are able to produce more efficiently than others and to stimulate expensive sources as Solar PV. In figure 7 the implications of these changes are shown. The average value of a MWh produced by an offshore windfarm increased, whereas the average value of a MWh produced with hydropower decreased.

[7] Due to late submitting or late payments of penalties, still a (small) positive recycle value per ROC is found for these years.

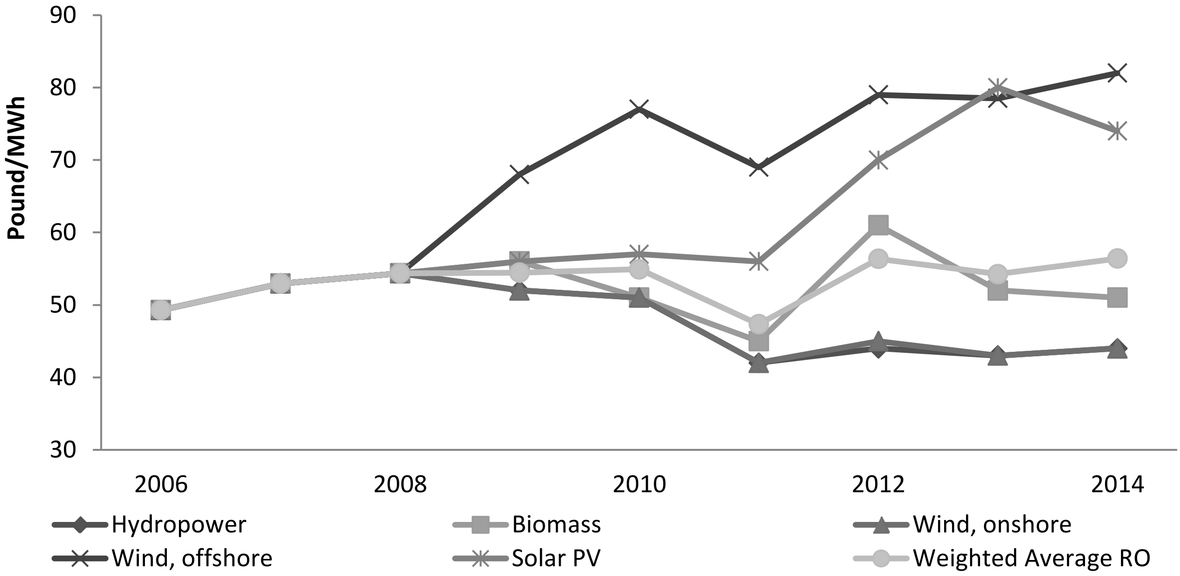

Figure 7 Average implicit premium per type of renewable-energy technique (estimations) and support scheme, United Kingdom, 2006-2014, (source: Ofgem 2015).

The overall premium for renewable-energy production appears to be fairly stable over time. In 2006 the average premium was almost 49.28 pound/MWh while in 2014 this premium was increased to about 56.41 pound/MWh.[8] This low level of the premium is mainly due to the low support for 'expensive' technologies, what results in low shares of these expensive techniques in the mix of renewable electricity. Also under the U.K.'s Renewables Obligation, solar PV and offshore wind were the most expensive technologies. However, in 2014 less than 1% off all renewable energy was produced with the aim of solar PV (Figure 8).

[8] Year report of Ofgem 2015, p. 41.

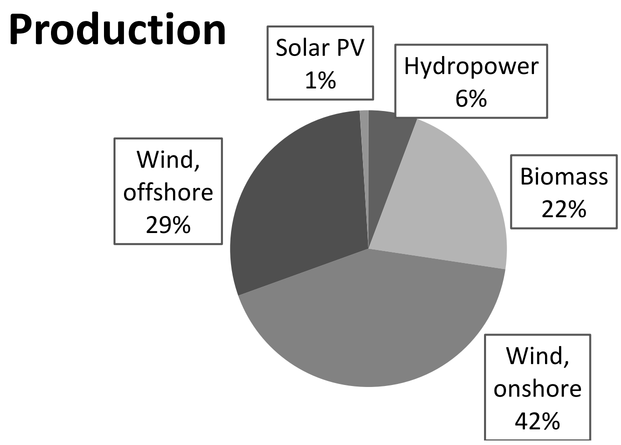

Figure 8 Share of techniques in total renewable-energy production, United Kingdom, 2013

We find that banding had an effect on the technologies used to produce ROCs (Table A.3 in the Appendix). The share of ROCs issued to offshore wind electricity rose from just under 6% in 2008 to just under the 38% in 2013. Where the amount of ROCs allocated to offshore wind electricity grew strongly, the share of solar PV was in 2014 still less than 1% of all electricity produced. The number of ROC allocated to a MWh of Solar PV was not sufficient to increase the production of solar electricity. However, this clearly did suppress the overall costs of the system.

3.3. The Netherlands

The Netherlands has changed in its RES support schemes a number of times in the past decade. In 2011, a revised SDE law came in effect in the Netherlands. This scheme named SDE+, replaced the SDE. Both the SDE and the SDE+ are sliding feed-in premiums. The SDE was introduced in 2008 and replaced the MEP, which was active during the relatively short period 2003-2006. The SDE+ attempts to solve the major drawback of the FiT and FiP designs with regard to quota system. In the FiT and FiP systems all technologies have their own ‘category’ with their own ‘strike’ price and therefore the least expensive technologies (onshore wind for example) do not have an advantage over the more expensive technologies (PV). Because of the lack of a cap on expensive technologies, very expensive outcomes can occur. Under a quota system it is very unlikely that massive solar PV-farms are realized.[9] Under the standard FiT and FIP-systems, different types of projects can apply for a subsidy, in case of the absence of a budget ceiling. In the Netherlands, however, a budget constraint exists. In 2015, the total amount of subsidies approved cannot exceed the available 3.5 billion euro. Therefore technologies are competing with each other over this budget of 3.5 billion euros.

At the start of each year, the more expensive technologies can only apply for a subsidy if they are willing to accept a lower subsidy. Investors can also wait until the government offers a higher strike price, but at the moment the ceiling is reached and no subsidies are granted anymore. The system therefore uses a bit of game theory to stimulate producers to offer their electricity at lower prices. Expensive technologies are only used in case the cheap technologies fail to deliver the demanded level of renewables. In case the ceiling is low, this system seems to work rather well, in case the ceiling is rather high the incentive for producers to apply for a lower strike price disappears (Algemene Rekenkamer 2015). Since the system is only in use since 2012 and most projects started to produce not before 2014, there are no clear figures on the production available yet. The SDE in the Netherlands not only stimulates renewable electricity, but also heating and gas (not shown in Figures).

Figure .. shows that the average MEP premium for solar PV has decreased over the past years, but this premium is still significantly higher than for the other techniques. The average premium under SDE+ is lower than in particular under MEP (see Figure 9).

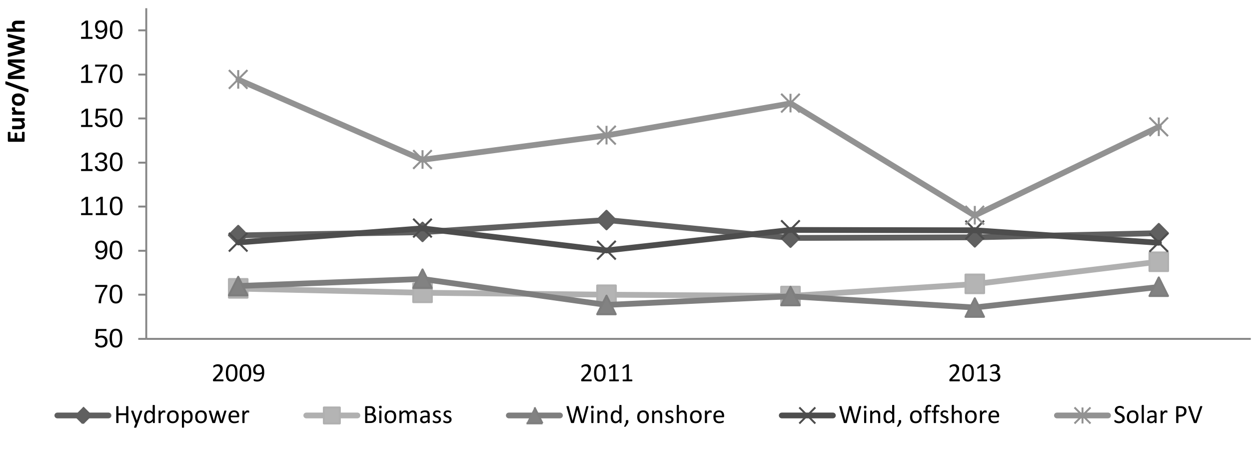

Figure 9 Implicit premium per type of renewable-energy technique via MEP, Netherlands, 2009-2014

[9] This only holds in a system in which all technologies receive the same number of certificates per MWh.

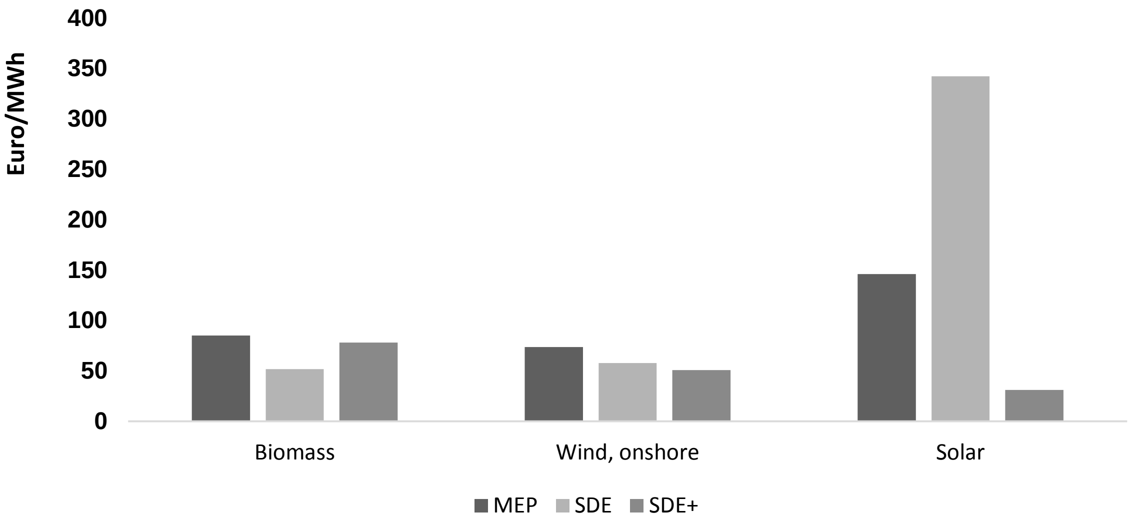

Figure 10 Implicit premium per type of renewable-energy technique via MEP, SDE and SDE+, Netherlands, 2014

The least expensive technique in the Netherlands, i.e. the technique with the lowest premium, is onshore wind. From Figure 11, it appears that about 50% of all premiums are given to onshore wind. This Figure also shows that the distribution of the premiums over techniques is fairly similar to the contribution of each technique to the total renewable-energy production in the Netherlands.

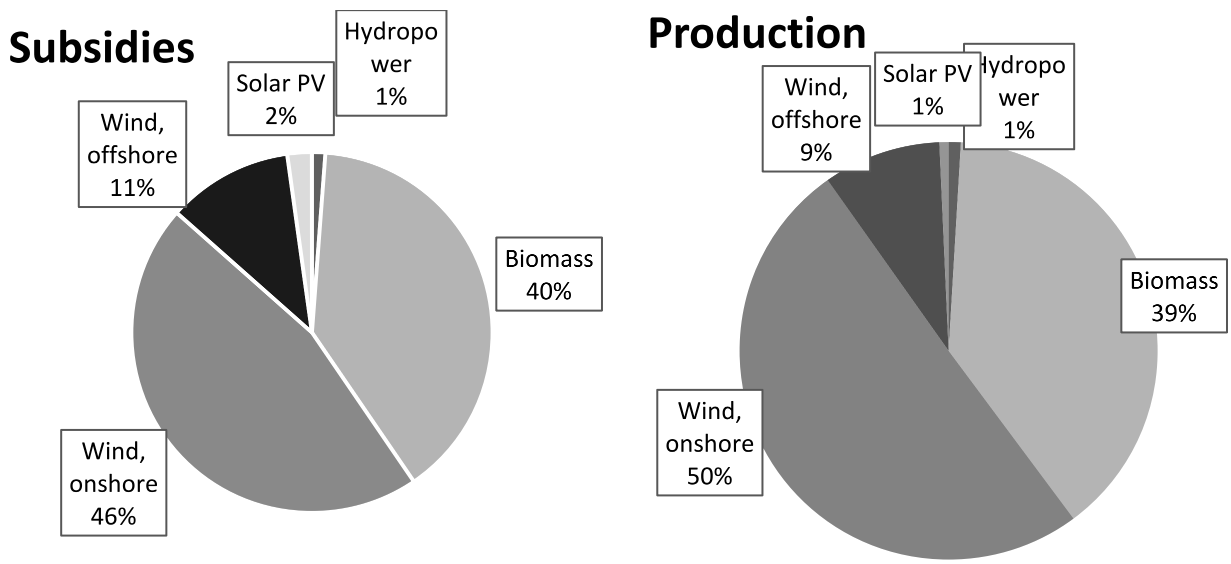

Figure 11 Distribution of RES techniques over production and subsidies, Netherlands, 2014

Besides these subsidy schemes, two other schemes are used to stimulate renewable energy in the Netherlands. One of this schemes is netting. Under this scheme, consumers who utilise solar cells may subtract their injection of electricity in the grid from their own consumption. As a result, the production of renewable electricity is remunerated with the retail price. This price includes energy taxes and VAT. The implicit subsidy for prosumers amounted almost 150 euro/MWh in 2015 (see Table A.2 in the Appendix).

Since 2015, offshore wind are no longer part of the regular SFiP scheme. Locations for offshore wind farms are tendered via auctions, which means that all market parties can apply for the subsidy to develop these parks. The applicant with the lowest price per KWh will receive the subsidy. This system mainly aims at reducing the windfall profits in case the government calculates a wrong strike price. By competition, the lowest possible strike price can be set by the market and the risks of unnecessary windfall profits can be avoided. This way of auctioning a project and granting the project to the lowest bid becomes a more common way to determine the strike price.

3.4 Sweden and Norway

In January 2012, Norway and Sweden established a joint market for electricity certificates. The design of this market is a book-example of a technology neutral[10] quota-system in which certain market participants have a quota obligation. The participants with an obligation are not just retailers, but also participants that consume electricity they produce themselves and those who buy electricity for their own use on the Nordic power exchange or via bilateral agreements. Certificates are supplied by government agencies to the suppliers that produce electricity by using renewable sources. Just as in the U.K. system, producers can sell the certificates. In order to fulfil their obligation, market participants with a quota obligation must have enough certificates on 1 April. At this date the relevant number of certificates for the company for the year before are cancelled and cannot be re-used. Market

[10] All producers receive the same amount of certificates (1MWh = 1 certificate) regardless of the technology or location used to produce the electricity.

participants with quota obligations must buy new certificates in order to fulfil next year's obligation; this creates a constant demand for certificates. An interesting feature is that the common market between Sweden and Norway makes it possible to trade in both Norwegian and Swedish certificates. As a result, electricity from renewable sources is produced at the location where it can be done most efficiently.

4. Discussion and conclusion

In this paper we have analysed the implicit premiums paid by renewable-support schemes used in a number of European countries. We find that the quota system in the UK delivered the lowest premium per MWh of renewable electricity, while the German FiT system by far gives the highest premiums for RES (Figure 12). This premium has even increased over the past periods because of the increasing share of the relatively expensive technique of solar PV.

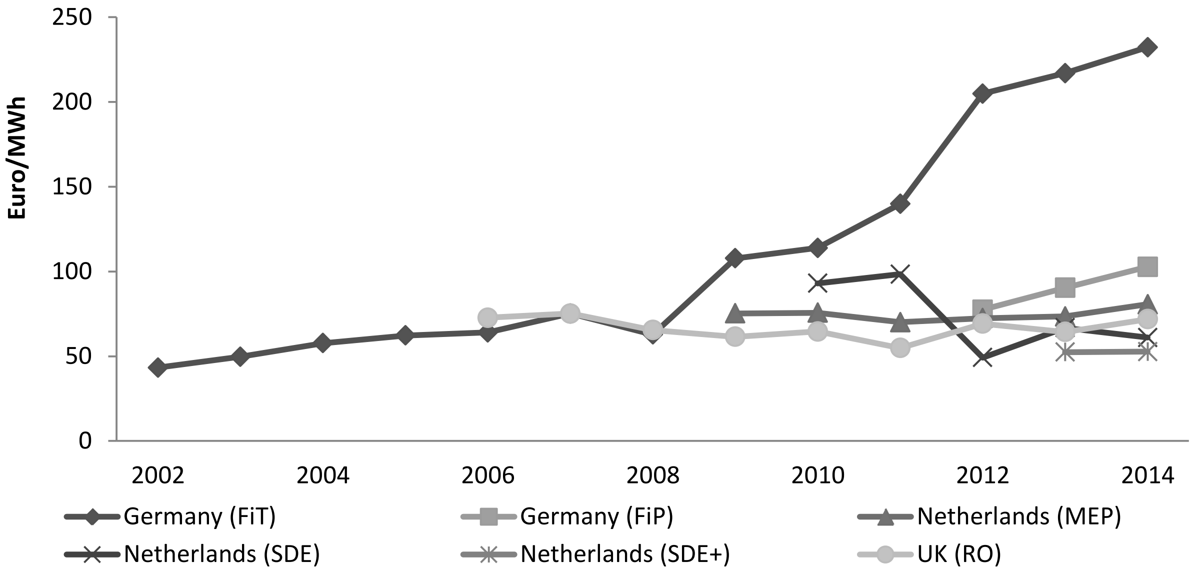

Figure 12 Implicit premium for renewable energy, per country, scheme and year

From the UK example we learn that only raising the obligation for retailers under a quota system is not sufficient to increase the share of renewables. A much more important feature is the level of the penalty. If the penalty is equal to the price of certificates at the market it makes no sense for retailers to buy certificates as just paying the buy-out price has the same result. Another problematic situation occurs when the target is set too low and the resulting price for quota is too low to stimulate future investments. Ideally, the quota is therefore increasing and slightly above the current share of renewables causing steady (non-volatile) and sufficient demand for the certificates.

A key feature of a quota system is the confidence investors have in the period for which the quota system is designed. In case the risk that the quota system might be abolished without a fair compensation for investors is quite substantial, investors will be reluctant to invest, which increases the risk premiums. It is therefore by far not surprising that many studies found that the cost of the initial years of the Renewables Obligation in the U.K. exceeded the costs of the FiT-structure in Germany. When governments, however, succeed to convince investors that the quota system will last for a long period of time, while any surpluses of certificates can be stored, and a clear penalty exists for not meeting the quota obligation, the risks for investors are minimized. However, risk will always be higher than in a FiT-scheme in which both quantity and price risks are both fully vanished (Jacobsson et al. 2009).

One of the objectives of designing RES schemes is to prevent windfall profits (Haas, 2011). One main disadvantage is that in case of an upscale under a quota system in which all sources receive the same certificates, substantial real rents are made by 'cheap' technologies. In such a design, the price of certificates is determined by the marginal costs of the production facility closing the target, or in case of a shortfall, the buy-out price (Bergek and Jacobsson, 2008). A rational electricity supplier will, without buy-out redistributions[11], never pay more than the buy-out price in case of a shortfall, but simply pay the penalty. Whereas an offshore wind farm, just like an onshore, receives 4 ct./kWh at the electricity market and 5 (ct./kWh) for a certificate and the costs of offshore per produced MWh are higher, the onshore wind farm receives rents. Differentiation by characteristics like technology, year,

[11] In the U.K. this is the buy-out price plus the (expected) amount distributed per certificate due to the re-distribution of the buy-out prices paid.

location and size, as is partly done in the U.K. by banding, reduces these windfall profits. However, if more expensive technologies are used, the costs per MWh of produced electricity increase. Although the rents are decreased, the pure costs might offset this decrease of rents and increase the costs per MWh for the electricity consumer. More cost-effective designs therefore focus on using cheap technologies first, and more expensive technologies only if cheap technologies are exhausted or unable to produce. Fixing the allocation of the certificates strict for the expensive technologies and less strict for the more efficient technologies, might help.

Another potential rent within quota-systems is the allocation of certificates to already existing producers, as was done in Sweden at the moment the scheme started in 2003. In the case of melting other systems into the quota systems this is no problem, by just creating supply these are clear rents. These producers are already producing, having a business case and therefore do not need any additional financing.

In FiT/FiP/SFiP schemes, all technologies have their 'own' competitive strike price, and therefore all technologies chosen by the public agency can be used by investors. It makes quite a difference for the total costs if this is done with the aim of cheap technologies or also with the aim of expensive technologies. The possibility always exists that the public agency will not calculate correctly the costs producers have to make, thereby setting the strike price too high. As a result, the agency is over-subsidizing the producers, and therefore producing rents. For instance, the subsidy under the abolished MEP-system in the Netherlands appeared to be much too high. Almost half of the amount paid to the RES-producers resulted in rents (Korteland, Mulder and Went, 2007).

If the public agency chooses to omit expensive technologies as solar PV and offshore wind from support schemes, this might have a downward effects on the effectiveness of the scheme. Consequently, a highly effective design includes all available technologies and provides those technologies with a generous compensation, without ceiling. Moreover, the pace of realizing the objective is increased by signalling that the compensation decreases over time, reducing the risk that investors will postpone their project by speculating on an even better deal next year or period. In the German system, the risk that electricity prices decrease is ultimately borne by the energy consumers. In 2013 the costs for German consumers related to the EEG-surcharge did exceed the costs for the wholesale prices of electricity. In the U.K. the price risk is not borne by the electricity consumer, but by the electricity supplier / investor in renewable energy generation. The main advantage of FiP-system is that the RES-producer must sell its electricity at the market and a RES producers become more market-oriented (Couture and Gagnon, 2010).

A fundamental difference between the first generation of FiT and FiP regimes and quota regimes is related to the presence of competition between technologies. More expensive technologies did have the same opportunity to be eligible for a subsidy as rather cheap technologies under FiT and FiP regimes, whereas in the quota systems only the least expensive technologies were able to attract enough subsidy to have a business-case. Although we showed that, as a result of the design of FiT schemes and sliding FiP schemes in which the compensation towards producers of renewable electricity is inversely related to the electricity price, the total compensation for renewable electricity prices increased significantly over the last years. We found that this was mainly due to the use of expensive sources of electricity production (in particular solar PV) after 2008, and just partly to the merit-order effect that caused electricity wholesale prices to drop. The combination of a collapse of the electricity price in Germany in 2009 and the high share of expensive technologies in the renewable energy mix has increased the electricity bill for Germany electricity consumers and shifted the risks of low electricity prices to consumers (Schmalensee, 2012).

Concluding, the evidence on the European experience clearly shows that a trade-off exists between effectiveness and cost-effectiveness. Germany is not only leading in the highest costs per unit renewable energy, but also leading in terms of the share of renewable energy in total domestic production. In Germany this share is about 35%, while in the UK and the Netherlands it is about 10%. The more a scheme allows all different types of renewable energy sources to make use of support schemes, the more renewable energy will be realised, but at higher average costs per unit of renewable energy. A design that is generous to the investor in RES generally involves high costs, which will ultimately be borne by electricity consumers in the case of a quota system or levy on the electricity bill, or the tax-payer in the case of subsidies via the state-budget.

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Appendix A Production, revenues and premiums paid for renewable energy

Table A.1: Production, revenues and support for renewable energy in Germany, per technique, scheme and year, 2002-2014

Technology	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
a) Average market price (euro/MWh)	31.62	32.77	37.79	42.60	51.14	44.46	65.73	37.93	50.84	45.93	28.52	29.48	22.55
Hydropower (FiT)													
b) Total production (GWh)	4957	3895	4616	4953	4924	5547	4982	4877	5049	2397	2724	3007	2432
c) Total remuneration (in mln euro)	-	-	337.67	364.10	366.56	417.70	378.81	382.38	421.06	231.07	270.47	302.73	252.91
d) Revenues for producer (euro/MWh)	-	-	73.15	73.52	74.45	75.30	76.04	78.40	83.39	96.39	99.28	100.66	103.97
e) Premium paid (euro/MWh)	-	-	35.36	30.92	23.31	30.84	10.31	40.47	32.56	50.47	70.76	71.19	81.43
Hydropower (FiP)													
b) Total production (GWh)	-	-	-	-	-	-	-	-	616	2446	1880	2440	2726
c) Total remuneration (in mln euro)	-	-	-	-	-	-	-	-	-	-	76.97	117.51	148.09
d) Revenues for producer (euro/MWh)	-	-	-	-	-	-	-	-	-	-	69.46	77.63	76.88
e) Premium paid (euro/MWh)	-	-	-	-	-	-	-	-	-	-	40.94	48.16	54.33
Biomass (FiT)													
b) Total production (GWh)	2442	3484	5241	7367	10902	15924	18947	22980	25146	23374	24353	19552	12814
c) Total remuneration (in mln euro)	231.67	326.68	508.46	795.19	1337.37	2162.13	2698.74	3699.99	4240.43	4602.99	4871.90	4059.18	2645.05
d) Revenues for producer (euro/MWh)	94.87	93.78	97.02	107.95	122.68	135.78	142.44	161.01	168.63	196.93	200.05	207.61	206.42
e) Premium paid (euro/MWh)	63.25	61.01	59.22	65.35	71.54	91.32	76.71	123.08	117.80	151.01	171.53	178.14	183.87
Biomass (FiP)													
b) Total production (GWh)	-	-	-	-	-	-	-	-	-	-	9891	16644	25495
c) Total remuneration (in mln euro)	-	-	-	-	-	-	-	-	-	-	969.93	2095.91	3733.53
d) Revenues for producer (euro/MWh)	-	-	-	-	-	-	-	-	-	-	126.58	155.40	168.99
e) Premium paid (euro/MWh)	-	-	-	-	-	-	-	-	-	-	98.06	125.92	146.44
Wind - both onshore and offshore (FiT)													
b) Total production (GWh)	15786	18713	25509	27229	30710	39713	40574		-	-	-	-	-
c) Total remuneration (in mln euro)	1435.34	1695.88	2300.48	2440.68	2733.77	3508.44	3561.04	-	-	-	-	-	-
d) Revenues for producer (euro/MWh)	90.92	90.63	90.18	89.63	89.02	88.34	87.77	-	-	-	-	-	-
e) Premium paid (euro/MWh)	59.30	57.86	52.39	47.04	37.88	43.88	22.04	50.06	37.96	47.25	63.46	62.02	70.75
Wind onshore (FiT)													
b) Total production (GWh)	-	-	-	-	-	-	-	38542	37460	45043	14302	7514	6930
c) Total remuneration (in mln euro)	-	-	-	-	-	-	-	3388.90	3315.64	4164.70	1310.48	687.50	632.87
d) Revenues for producer (euro/MWh)	-	-	-	-	-	-	-	87.93	88.51	92.46	91.63	91.49	91.33
e) Premium paid (euro/MWh)	-	-	-	-	-	-	-	50.00	37.68	46.54	63.11	62.02	68.78
Wind onshore (FiP)													
b) Total production (GWh)	-	-	-	-	-	-	-	-	-	-	34315	41844	48349
c) Total remuneration (in mln euro)	-	-	-	-	-	-	-	-	-	-	2314.91	2835.73	3413.11
d) Revenues for producer (euro/MWh)	-	-	-	-	-	-	-	-	-	-	95.98	97.24	93.14
e) Premium paid (euro/MWh)	-	-	-	-	-	-	-	-	-	-	67.46	67.77	70.59
Wind Offshore (FiT)													
b) Total production (GWh)	-	-	-	-	-	-	-	38	174	568	82	.	150
c) Total remuneration (in mln euro)	-	-	-	-	-	-	-	5.62	26.06	85.22	12.45	.	27.65
d) Revenues for producer (euro/MWh)	-	-	-	-	-	-	-	149.87	150.00	150.00	152.60	-	184.37
e) Premium paid (euro/MWh)	-	-	-	-	-	-	-	111.94	99.17	104.08	124.09	-	161.82
Wind Offshore (FiP)													
b) Total production (GWh)	-	-	-	-	-	-	-	-	-	-	640	905	1299
c) Total remuneration (in mln euro)	-	-	-	-	-	-	-	-	-	-	82.82	99.17	185.34
d) Revenues for producer (euro/MWh)	-	-	-	-	-	-	-	-	-	-	157.91	139.07	165.18
e) Premium paid (euro/MWh)	-	-	-	-	-	-	-	-	-	-	129.40	109.60	142.63
Solar PV (FiT)													
b) Total production (GWh)	162	313	557	1282	2220	3075	4420	6578	11683	19339	24369	25259	27548
c) Total remuneration (in mln euro)	81.71	153.67	282.65	679.11	1176.80	1597.48	2218.62	3156.52	5089.94	7766.07	8903.60	8587.35	9152.73
d) Revenues for producer (euro/MWh)	503.05	490.49	507.91	529.60	530.02	519.56	501.97	479.84	435.69	401.57	365.37	339.98	332.25
e) Premium paid (euro/MWh)	471.43	457.72	470.11	487.01	478.88	475.10	436.24	441.91	384.85	355.64	336.85	310.50	309.70
Solar PV (FiP)													
b) Total production (GWh)	-	-	-	-	-	-	-	-	-	-	1024.52	3525.50	5444.34
c) Total remuneration (in mln euro)	-	-	-	-	-	-	-	-	-	-	252.42	758.69	1077.49
d) Revenues for producer (euro/MWh)	-	-	-	-	-	-	-	-	-	-	274.89	244.68	220.46
e) Premium paid (euro/MWh)	-	-	-	-	-	-	-	-	-	-	246.38	215.20	197.91
Geothermic (FiT)													
b) Total production (GWh)	-	-	0	0	0	0	18	19	28	19	25	68	53
c) Total remuneration (in mln euro)	-	-	0.03	0.03	0.05	0.06	2.64	3.73	5.70	3.90	5.54	16.14	12.97
d) Revenues for producer (euro/MWh)	-	-	150.00	150.00	125.00	150.00	150.00	198.40	205.83	206.90	218.26	236.61	243.25
e) Premium paid (euro/MWh)	-	-	112.21	107.41	73.87	105.54	84.27	160.48	154.99	160.98	189.74	207.14	220.71
Geothermic (FiP)													
b) Total production (GWh)	-	-	-	-	-	-	-	-	-	-	-	-	-
c) Total remuneration (in mln euro)	-	-	-	-	-	-	-	-	-	-	-	-	-
d) Revenues for producer (euro/MWh)	-	-	-	-	-	-	-	-	-	-	-	-	-
e) Premium paid (euro/MWh)	-	-	-	-	-	-	-	-	-	-	-	-	-
Weighted average / overall results (FiT)													
b) Total production (GWh)	23348	26404	35923	40831	48756	64259	68940	73034	79539	90740	65856	55400	49927
c) Total remuneration (in mln euro)	1748.72	2176.23	3429.29	4279.11	5614.55	7685.81	8859.85	10637.14	13098.82	16853.94	15374.44	13652.90	12724.17
d) Revenues for producer (euro/MWh)	74.90	82.42	95.46	104.80	115.16	119.61	128.52	145.65	164.68	185.74	233.46	246.44	254.86
e) Premium paid (euro/MWh)	43.28	49.65	57.67	62.21	64.02	75.15	62.79	107.72	113.85	139.81	204.94	216.97	232.31
Weighted average / overall results (FiP)													
b) Total production (GWh)	.	.	.	.	.	.	.	.	.	.	47750.99	65359.20	83314.04
c) Total remuneration (in mln euro)	.	.	.	.	.	.	.	.	.	.	3697.05	5907.01	8557.56
d) Revenues for producer (euro/MWh)	.	.	.	.	.	.	.	.	.	.	105.94	119.85	125.26
e) Premium paid (euro/MWh)	.	.	.	.	.	.	.	.	.	.	77.42	90.38	102.71
Weighted average / overall results Germany													
b) Total production (GWh)	23348	26404	35923	40831	48756	64259	68940	73034	79539	90740	113607	120759	133241
c) Total remuneration (in mln euro)	1748.72	2176.23	3429.29	4279.11	5614.55	7685.81	8859.85	10637.14	13098.82	16853.94	19071.49	19559.91	21281.73
d) Revenues for producer (euro/MWh)	74.90	82.42	95.46	104.80	115.16	119.61	128.52	145.65	164.68	185.74	179.86	177.93	173.82
e) Premium paid (euro/MWh)	43.28	49.65	57.67	62.21	64.02	75.15	62.79	107.72	113.85	139.81	151.34	148.45	151.27

a) Calculated based on the average spot market price (baseload) for the EPEX (source: c) e) The premium paid above the spot market price for the electricity (Own calculations based on a), b) (and d), for the FiT-schemes) Total remuneration paid by the four übertragungsnetzbetreibers in Germany to all producers (source: Netz-transparenz.de), d) Own calculations based on a), b) (and d, for the FiP-schemes), EPEX), b)Total production of the source in year t (source: Netztransparenz.de),

Table A.2: Production, revenues and support for renewable energy in the UK, per technique and year, 2006-2014									
Technology	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**
a) Average market price (£/MWh)	34.69	27.13	65.68	39.54	42.80	46.54	46.69	52.43	37.68
Hydropower + microhydro (RO)									
b) Total production (GWh)	2447	2443	2305	-	-	-	2205	2527	-
c) Total ROCs distributed (in mln ROCs)	2.45	2.44	2.31	2.13	1.86	2.72	2.21	2.57	2.56
d) ROC per MWh	1.0	1.0	1.0	-	-	-	1.0	1.0	-
e) Total proceeds certificates (in mln £)	120.58	129.36	125.34	111.30	95.37	115.04	97.97	109.74	111.61
f) Premium paid (£/MWh) e)	49.28	52.95	54.37	52.00	51.00	42.00	44.42	43.42	44.00
g) Total revenues for the producers (£/MWh)	83.97	80.08	120.05	91.54	93.80	88.54	91.11	95.85	81.68
Biomass (RO)									
b) Total production (GWh)	2989	3037	3882	-	-	-	6336	9563	-
c) Total ROCs distributed (in mln ROCs)	2.99	3.04	3.88	3.85	4.85	6.07	8.77	11.50	17.16
d) ROC per MWh	1.0	1.0	1.0	-	-	-	1.4	1.2	-
e) Total proceeds certificates (in mln £)	147.29	160.82	211.04	201.59	249.03	256.74	389.38	491.14	748.92
f) Premium paid (£/MWh) e)	49.28	52.95	54.37	56.00	51.00	45.00	44.38	42.72	51.00
g) Total revenues for the producers (£/MWh)	83.97	80.08	120.05	95.54	93.80	91.54	91.07	95.15	88.68
Wind onshore (RO)									
b) Total production (GWh)	4209	4816	6246	-	-	-	12147	18581	-
c) Total ROCs distributed (in mln ROCs)	4.21	4.82	6.25	7.26	7.71	11.80	12.21	18.71	17.79
d) ROC per MWh	1.0	1.0	1.0	-	-	-	1.0	1.0	-
e) Total proceeds certificates (in mln £)	207.42	255.03	339.59	380.31	395.75	498.76	542.06	799.22	776.61
f) Premium paid (£/MWh) e)	49.28	52.95	54.37	52.00	51.00	42.00	44.62	43.01	44.00
g) Total revenues for the producers (£/MWh)	83.97	80.08	120.05	91.54	93.80	88.54	91.31	95.44	81.68
Wind offshore (RO)									
b) Total production (GWh)	721	963	1498	-	-	-	8822	13032	-
c) Total ROCs distributed (in mln ROCs)	0.72	0.96	1.50	2.72	5.03	8.79	15.69	23.94	25.38
d) ROC per MWh	1.0	1.0	1.0	-	-	-	1.8	1.8	-
e) Total proceeds certificates (in mln £)	35.52	51.00	81.44	142.25	258.02	371.35	696.30	1022.56	1107.71
f) Premium paid (£/MWh) e)	49.28	52.95	54.37	68.00	77.00	69.00	78.93	78.47	-
g) Total revenues for the producers (£/MWh)	83.97	80.08	120.05	107.54	119.80	115.54	125.62	130.90	-
Solar PV (RO)									
b) Total production (GWh)	0	1	3	-	-	-	-	446	-
c) Total ROCs distributed (in mln ROCs)	0.00	0.00	0.00	0.01	0.00	0.00	0.02	0.85	3.21
d) ROC per MWh	1.0	1.0	1.0	-	-	-	-	1.9	-
e) Total proceeds certificates (in mln £)	0.02	0.08	0.18	0.59	0.13	0.21	1.10	36.30	8.21
f) Premium paid (£/MWh) e)	49.28	52.95	54.37	56.00	57.00	56.00	70.00	80.00	74.00
g) Total revenues for the producers (£/MWh)	83.97	80.08	120.05	95.54	99.80	102.54	116.69	132.43	111.68
Weighted average / overall results (RO)									
b) Total production (GWh)	10366	11261	13934	-	-	-	29511	44149	55748
c) Total ROCs distributed (in mln ROCs)	10.37	11.26	13.93	15.97	19.44	29.38	38.88	57.56	66.09
d) ROC per MWh	1.00	1.00	1.00	-	-	-	1.32	1.30	1.19
e) Total proceeds certificates (in mln £)	510.83	596.29	757.59	836.05	998.29	1242.10	1725.71	2458.95	2884.97
f) Premium paid (£/MWh) e)	49.28	52.95	54.37	54.45	54.93	47.34	56.36	54.25	56.41
g) Total revenues for the producers (£/MWh)	83.97	80.08	120.05	93.99	97.73	93.88	103.05	106.68	94.09
Exhange rate pound/euro	1.48	1.42	1.20	1.13	1.18	1.16	1.23	1.19	1.27
Premium for RES (euro/MWh)	72.72	75.13	65.44	61.49	64.64	54.89	69.21	64.33	71.90

Notes: b)Total production of the source in year t (source: Ofgem yearly reports), c) Total number of ROCs issued by Ofgem to a certain technology in a certain year d) = calculated as c) / b). e) is c * total w orth of a ROC. f)Total proceeds of having a ROC, based on the price of a ROC and total GWh of produced renew able electricity under RO. g) Calculated as e) the electricity price + a) the amount distributed per ROC as a result of the buy-out prices. For not all years the total production in MWh is available.

Table A.3: Production, revenues and support for renewable energy in the Netherlands, per technique, scheme and year, 2009-2014						
Technology	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**
a) Average market price (euro/MWh) d)	39.20	45.35	52.06	48.05	51.96	41.20
Hydropower (MEP)						
b) Total production (GWh)	72	74	42	75	78	77
c) Total remuneration (in mln euro)	7	7	4	7	8	8
d) Revenues for producer (euro/MWh)	136.18	143.80	155.99	143.89	148.04	139.11
e) Premium paid (euro/MWh)	96.98	98.46	103.93	95.84	96.08	97.91
Biomass (MEP)						
b) Total production (GWh)	4399	5017	4811	4412	3160	2349
c) Total remuneration (in mln euro)	321	356	337	307	237	200
d) Revenues for producer (euro/MWh)	112.07	116.27	122.11	117.51	126.83	126.22
e) Premium paid (euro/MWh)	72.87	70.92	70.04	69.47	74.87	85.02
Biomass (SDE)						
b) Total production (GWh)	-	115	275	879	699	825
c) Total remuneration (in mln euro)	-	10	34	36	53	43
d) Revenues for producer (euro/MWh)	-	130.93	176.22	89.37	127.83	92.95
e) Premium paid (euro/MWh)	-	85.58	124.16	41.32	75.87	51.75
Biomass (SDE+)						
b) Total production (GWh)				4	21	28
c) Total remuneration (in mln euro)	-	-	-	1	2	2
d) Revenues for producer (euro/MWh)	-	-	-	161.97	145.00	119.53
e) Premium paid (euro/MWh)	-	-	-	113.92	93.04	78.33
Wind onshore (MEP)						
b) Total production (GWh)	3643	3049	3740	3270	2867	3050
c) Total remuneration (in mln euro)	270	235	245	227	184	225
d) Revenues for producer (euro/MWh)	113.19	122.56	117.46	117.45	116.21	114.81
e) Premium paid (euro/MWh)	73.99	77.21	65.40	69.40	64.25	73.61
Wind onshore (SDE)						
b) Total production (GWh)	27	51	216	433	984	929
c) Total remuneration (in mln euro)	1	3	9	18	50	54
d) Revenues for producer (euro/MWh)	65.39	109.71	93.64	89.85	102.45	99.21
e) Premium paid (euro/MWh)	26.18	64.36	41.58	41.80	50.49	58.01
Wind Onshore (SDE+)						
b) Total production (GWh)	-	-	-	-	86	169
c) Total remuneration (in mln euro)	-	-	-	-	4	9
d) Revenues for producer (euro/MWh)	-	-	-	-	96.27	92.06
e) Premium paid (euro/MWh)	-	-	-		44.31	50.86
Wind Offshore (MEP)						
b) Total production (GWh)	735	679	802	789	771	748
c) Total remuneration (in mln euro)	69	68	72	79	77	70
d) Revenues for producer (euro/MWh)	133.00	145.55	142.24	147.51	151.30	134.87
e) Premium paid (euro/MWh)	93.80	100.20	90.18	99.46	99.34	93.67
Solar PV (MEP)						
b) Total production (GWh)	4	5	5	3	4	2
c) Total remuneration (in mln euro)	0.6	0.6	0.7	0.5	0.4	0.3
d) Revenues for producer (euro/MWh)	206.89	176.64	194.43	204.94	157.95	187.40
e) Premium paid (euro/MWh)	167.68	131.29	142.36	156.89	105.99	146.20
Solar PV (SDE)						
b) Total production (GWh)	-	4	14	27	43	37
c) Total remuneration (in mln euro)	-	3	7	12	13	13
d) Revenues for producer (euro/MWh)	-	715.66	523.49	473.93	345.42	383.46
e) Premium paid (euro/MWh)	-	670.31	471.43	425.88	293.46	342.26
Solar (SDE+)						
b) Total production (GWh)	-	-	-	-	15	19
c) Total remuneration (in mln euro)	-	-	-	-	0.6	0.6
d) Revenues for producer (euro/MWh)	-	-	-	-	92.30	72.52
e) Premium paid (euro/MWh)	-	-	-	-	40.34	31.32
Solar PV (Netting)						
b) Total production (GWh)	-	-	-	-	-	-
c) Total remuneration (in mln euro)	-	-	-	-	-	-
d) Revenues for producer (euro/MWh)	-	-	-	-	-	-
e) Premium paid (euro/MWh)	132.57	133.4	137.94	142.3	146.17	149.07
Weighted average / overall results (MEP)						
b) Total production (GWh)	8852	8823	9401	8549	6880	6226
c) Total remuneration (in mln euro)	666	667	659	620	505	502
d) Revenues for producer (euro/MWh)	114.50	120.96	122.17	120.52	125.40	121.85
e) Premium paid (euro/MWh)	75.30	75.61	70.10	72.47	73.44	80.65
Weighted average / overall results (SDE)						
b) Total production (GWh)	-	170	506	1339	1725	1792
c) Total remuneration (in mln euro)	-	16	50	66	115	109
d) Revenues for producer (euro/MWh)	-	138.39	150.50	97.28	118.73	102.26
e) Premium paid (euro/MWh)	.	93.04	98.44	49.23	66.76	61.06
Weighted average / overall results (SDE+)						
b) Total production (GWh)	.	.	.	.	122	216
c) Total remuneration (in mln euro)	.	.	.	.	6	11
d) Revenues for producer (euro/MWh)	.	.	.	.	104.36	93.90
e) Premium paid (euro/MWh)	.	.	.	.	52.40	52.70
Weighted average / overall results The Netherlands						
b) Total production (GWh)	8852	8993	9907	9888	8728	8234
c) Total remuneration (in mln euro)	666	683	709	686	627	623
d) Revenues for producer (euro/MWh)	114	121	124	117	124	117
e) Premium paid (euro/MWh)	75	76	72	69	72	76

a) Yearly production of a source, classified to the different schemes. (Source: Yearly reports provided by the Dutch ministery of Economics Affairs (Rapportage Duurzame Energie), b) Total subsidy provided to the ministery of Economic Affairs, c) Calculated based on the wholesale electricity prices in the Netherlands (d+e), d) Average yearly electricity prices producers of renewable energy (source: Yearly reports provided by the Dutch ministry of Economic affairs.

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