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An analysis of feed-in tariff remuneration models: Implications for renewable energy investment

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ABSTRACT

Recent experience from around the world suggests that feed-in tariffs (FITs) are the most effective policy to encourage the rapid and sustained deployment of renewable energy. There are several different ways to structure a FIT policy, each with its own strengths and weaknesses. This paper presents an overview of seven different ways to structure the remuneration of a FIT policy, divided into two broad categories: those in which remuneration is dependent on the electricity price, and those that remain independent from it. This paper examines the advantages and disadvantages of these different FIT models, and concludes with an analysis of these design options, with a focus on their implications both for investors and for society.

1. Introduction

Feed-in tariffs[1] are increasingly considered the most effective policy at stimulating the rapid development of renewable energy sources (RES) and are currently implemented in 63 jurisdictions worldwide (Klein et al., 2008; Ernst and Young, 2008; Mendonça, 2007; IEA, 2008; European Commission, 2008; REN21, 2009). They have consistently delivered new renewable energy (RE) supply more effectively, and at lower cost, than alternative policy mechanisms (Menanteau et al., 2003; Ragwitz et al., 2007; Stern, 2006; Lipp, 2007; Butler and Neuhoff, 2008; de Jager and Rathmann, 2008; Fouquet and Johansson, 2008; IEA, 2008). Indeed, according to a recent European Commission update on renewable energy policies in the European Union (EU), "*well-adapted feed in tariff regimes are generally the most efficient and effective support schemes for promoting renewable electricity*" (European Commission, 2008).

The central principle of feed-in tariff policies is to offer guaranteed prices for fixed periods of time for electricity produced from Renewable Energy Sources (RES). These prices are generally offered in a non-discriminatory manner for every kWh of electricity produced, and can be differentiated according to the type of technology, the size of the installation, the quality of the resource, the location of the project, as well as a number of other project-specific variables (Mendonça, 2007; Fouquet and Johansson, 2008; Langniss et al., 2009). This enables a greater number of investors to participate, including homeowners, landowners, farmers, municipalities, and small business owners, while helping to stimulate rapid renewable energy deployment in a wide variety of different technology classes (Klein et al., 2008; IEA, 2008; Lipp, 2007; REN21, 2009).

In the most successful[2] jurisdictions, the FIT payment levels offered to particular projects are determined as closely as possible in relation to the specific generation costs (Mendonça, 2007; Klein et al., 2008). More specifically, they are designed to make it possible for *efficiently operated* RE installations to be cost-effectively developed (RES Act, 2000; Fell, 2009).

By basing the payment levels on the costs required to develop RE projects, and guaranteeing the payment levels for the lifetime of the technology, FITs can significantly reduce the risks of investing in renewable energy technologies and thus create conditions conducive to rapid market growth (Lipp, 2007; IEA, 2008). This structure provides a high degree of security over future cash flows, and enables investors to be remunerated according to the actual costs of RE project development. This security is particularly valuable for financing capital-intensive projects with high upfront costs, and a high ratio of fixed to variable costs (Guillet and Midden, 2009; see also Harper et al., 2007).

Ensuring that the FIT payments are adequate to recover project costs over the life of the project, while allowing for a reasonable

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[1] Feed-in tariffs (FITs) are also known as Standard Offer Contacts, Feed Laws, Minimum Price Payments, Renewable Energy Payments, and Advanced Renewable Tariffs.

[2] Successful here means that substantial amounts of renewable energy deployment have taken place, in relation to the existing electricity supply portfolio. Examples of such jurisdictions include Germany, Spain, Portugal, and Denmark (REN21, 2009; BMU, 2009).

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return, remains one of the central challenges of a successful FIT policy (Klein et al., 2008; Mendonça, 2007).

2. FIT policy design: focus on remuneration models

Beyond ensuring the FIT payments are adequate to cover project costs, experience has shown that the specific design and stability of the remuneration scheme is essential to efficient and well-functioning FIT policies, and crucial to maintaining investor confidence (Ragwitz et al., 2007; Held et al., 2007; European Commission, 2008; Dinica, 2006). However, a survey of the different jurisdictions that currently employ FIT policies for renewable energy development reveals that there are many different ways to structure the remuneration of a feed-in tariff policy, and that different jurisdictions have had varying degrees of success (European Commission, 2008; Langniss et al., 2009; Klein et al., 2008; REN21, 2009). This paper focuses on seven models that are in use in different jurisdictions around the world, with a particular focus on their impacts on overall renewable energy investment risk. Each subsection explores a different policy design option, drawing on particular examples to show where each particular design has been, or is being, used.

It is important to note that these policy design options are not mutually exclusive; they can be used in conjunction with one another as policies are tailored to a jurisdiction's specific context and needs. These different policy options represent different ways of structuring the way in which feed-in tariff policies remunerate renewable energy developers for the electricity they produce. Properly designing the remuneration scheme so that it offers sufficient investment security, and a reasonable return on investment, is essential to leveraging significant amounts of capital for renewable energy development (see IEA, 2008; Dinica, 2006).

As renewable energy continues to develop to meet the combined challenges of mitigating climate change, increasing energy security, and reducing exposure to fossil fuel price volatility, it is expected that FIT policies will continue to be used as a policy option to drive renewable energy development. This focus on the design of FIT payment models provides a focused perspective on FIT policy design, one that sheds light on the way FIT payments can change over a project's lifetime, and the way in which these changes can influence investor confidence and the pace of RE deployment.

3. Market-dependent vs. market-independent FIT models

A central difference between feed-in tariff policies is whether the remuneration they offer to renewable energy developers is *dependent* or *independent* from the actual electricity market price (Klein et al., 2008). Market-independent FIT policies are generally known as fixed-price policies, since they offer a fixed or minimum price for electricity from RES delivered to the grid (Mendonça, 2007; IEA, 2008). Market-dependent FIT policies are generally known as premium price policies, or feed-in premiums, since a premium payment is added above the market price (Mendonça, 2007; IEA, 2008). This premium can be designed either to represent the environmental and social attributes of renewable energy, or to help approximate the generation costs of different RE technologies (Ragwitz et al., 2007).

The most commonly employed feed-in tariff policy option is the market independent, fixed-price option (European Commission, 2008; Klein et al., 2008). Fixed-price FITs typically offer a guaranteed minimum payment level based on the specific development cost of the technology for every kWh of electricity sold to the grid. Note that the final determination of the FIT payment can also be influenced by the public policy objectives of the jurisdiction.[3] Furthermore, fixed-price FIT policies are generally accompanied by a purchase guarantee (Mendonça, 2007; Fouquet and Johansson, 2008).

In contrast, market-dependent FIT policies require that renewable energy developers provide their electricity to the market, effectively competing with other suppliers to meet market demand (IEA, 2008); they then receive a premium above the spot market price for the electricity sold (Langniss et al., 2009; Mendonça, 2007).[4] Under market-dependent FIT policies, payment levels tend to rise in step with rising retail prices, and vice versa. In order to avoid windfall profits when average market prices rise, some jurisdictions have begun to implement caps and floors on FIT premium amounts to ensure that overall remuneration remains within a reasonable range without placing undue burden on ratepayers when market prices increase. For instance, Spain has recently adopted both a cap and a floor for its premium amounts (Spanish Royal Decree 661/2007), and similar proposals have been made for Germany, though they have not yet been adopted (Langniss et al., 2009; Diekmann, 2008).

In order to allow greater investor choice, some jurisdictions offer both the fixed price and the premium price option to renewable energy developers, leaving them the choice to decide which policy option is best suited to their individual risk appetite and investment model.[5] However, the added transaction costs of marketing one's electricity on the spot market arguably make the premium price option better suited to larger market participants, rather than individual homeowners or community-based investors.

4. FIT policy design options

Seven different ways to structure market-independent and market-dependent remuneration schemes are examined here, discussing four in the former category and three in the latter category, on the basis of experience from a number of jurisdictions across Europe and North America. A brief analysis will accompany each model, focusing in particular on each model's impact on investment risk, analyzing the main strengths and weaknesses of these different ways of structuring FIT policies.

4.1. Market-independent FIT policies

In market-independent FIT policies, the first and most basic option is to establish a fixed, minimum price at which the electricity generated from RES will be bought for a contracted period of time, and to leave that price fixed for the duration of the contract, irrespective of the retail price of electricity (Fig. 1). The *fixed price model* therefore remains independent of other variables, such as inflation, the price of fossil fuels, etc. and can be determined in a project-specific manner in relation to the cost of developing each renewable energy resource.[6]

[3] For instance, this could include consideration of what the targeted rate of return should be, or whether the FIT payments should be designed aggressively or conservatively. For instance, Fell (2009) states that Germany targets a rate of return of 7%, while Gonzalez (2008) refers to Spain targeting returns of 5–11% depending on the technology type.

[4] The possibility of signing bilateral contracts is also allowed in jurisdictions like Spain.

[5] Spain, the Czech Republic, and Slovenia each offer both the premium and the fixed tariff option (Klein, 2008).

[6] In these projections, it is assumed that retail prices for electricity will trend upward due to increases in the prices of commodities, fossil fuels, and the

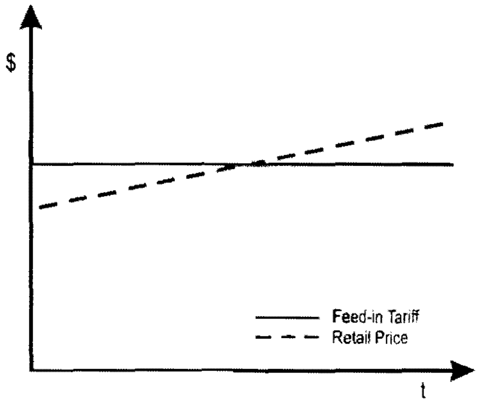

Fig. 1. Fixed price model for FIT policy design.

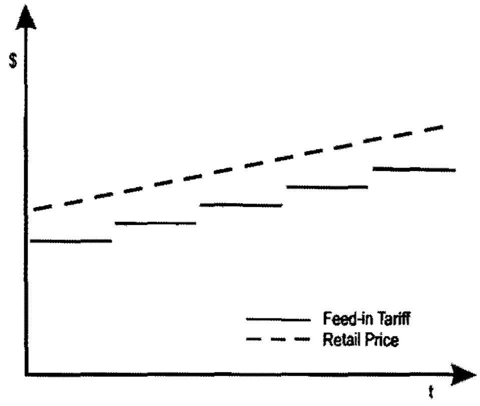

Fig. 2. Fixed price model with full or partial inflation adjustment.

The fixed price model offers the purchase price required to encourage investment in RES, leaving the tariff unchanged for the duration of the contract term (Fouquet and Johansson, 2008; Langniss et al., 2009). In order to ensure that these payments adequately cover project costs, significantly higher payment levels are currently offered for solar photovoltaic systems, for instance, than for onshore wind power.

Germany continues to employ the basic fixed price model it launched in 2000, opting not to adjust for inflation in the payment levels it offers to renewable energy developers (RES Act, 2000, 2004, 2008). Germany compensates for the absence of external inflation adjustment by including it in its assumptions as part of its tariff calculation methodology (BMU, 2007). These guaranteed payment levels encourage aggressive rates of deployment by offering sufficiently high revenues in the early years, while diminishing the marginal rate impact of the payments in later years.

One of the consequences of the fixed price model is that because the price is set at a flat rate, it neglects inflation and variations in the consumer price index (CPI), which will tend to lead to a gradual decline in the real value of renewable energy developers' revenues (Fell, 2009). In other words, if the purchase price offered to developers does not change in some way to track changes in the broader economy, the actual value of the revenues obtained will tend to decrease over time.

On the other hand, since the purchase price is known in advance, while inflation can never be known in advance with certainty, the fixed price model still provides a reliable formula to calculate future project revenues, if not their precise value. In addition, the basic fixed price model also leaves open the possibility of offering special price premiums above the minimum price targeted at specific attributes, such as higher efficiency systems, the use of particular waste streams, or innovative technologies (e.g. RES Act, 2008). Other modifications to the basic fixed price model can be included as well, depending on the specific policy goals of the jurisdiction.

As long as the fixed payment levels are guaranteed for a sufficiently long period of time (usually for the duration of the operational life of the technology), and are methodologically based on the costs of generation, they are likely to provide adequate investment security to attract investor interest. In this way, the basic fixed price model can be designed to ensure that investments in renewable energy will be profitable by creating a stable and reliable investment environment, one that provides predictable revenue streams over the course of the project's life.

The second feed-in tariff policy option is the *fixed price model with full or partial inflation adjustment* (Fig. 2) Inflation adjustments guard renewable energy developers against a decline in the real value of project revenues by tracking changes in the broader economy.

Methodologically, it is worth noting that inflation adjustment can be done in a number of different ways. Some jurisdictions do so according to a pre-established formula that readjusts the entire tariff price to inflation, calculated on an annual basis (e.g. Ireland, 2006). Others offer this adjustment only to a portion of the tariff price, where the inflation adjustment is added on a percentage of the base tariff offered (e.g. Ontario Power Authority, 2006). And in some cases, inflation adjustment is calculated by adjusting for inflation fully, minus a certain number of basis points (e.g. Spanish Royal Decree 661/2007). Finally, inflation can be adjusted annually or at every quarter.[7]

In addition to employing different methodologies, different jurisdictions offer varying degrees of inflation adjustment to renewable energy developers. For instance, the Canadian province of Ontario offers an inflation adjustment on a 20% portion of the base price of electricity for all eligible technology types, with the exception of solar (Ontario Power Authority, 2006). This 20% adjustment is offered over the course of 20-year contract terms for wind, biomass, and hydroelectric projects.

France, on the other hand, offers to track inflation according to a formula that allows an adjustment that ranges from 40% to 100% of the base price of electricity depending on the technology type, while Ireland offers full, or 100%, inflation adjustment for renewable energy projects (France, 2006; Ireland, 2006).[8] Finally, Spain adjusts fully for inflation, minus a few basis points, depending on the technology type (Spanish Royal Decree 661/2007; see also Gonzalez, 2008). Each of these jurisdictions represents a different approach to the calculation of inflation adjustments in feed-in tariff rates, and provides a means of tracking changes in the broader economy.

A consequence of a high level of inflation adjustment is that it is more likely to secure a high level of remuneration near the end of a project's life, when capital costs are generally paid for, and most of a project's revenues are effectively profits. It could be

(*footnote continued*)
expansion of carbon legislation, which will directly or indirectly target a significant portion of the existing capital that supplies the world's electricity.

[7] In the Spanish Royal Decree 661/2007, the tariff adjustments are either done on quarterly terms, or every year, on the basis of changes in the CPI, and relative changes in the price of coal. For certain technology types, tariffs are not adjusted fully for these changes, allowing for a slight depreciation in the real value of project revenues.

[8] For France's (2006) renewable energy law as it applies to wind power, see <http://www.industrie.gouv.fr/energie/electric/pdf/tarif-achat-eolien.pdf>

argued that this puts an undue burden on the electricity ratepayer in the long term, by requiring continually high payments until the end of the contract term. It should also be noted that the provisions surrounding inflation adjustment are likely to be more consequential in jurisdictions where inflation rates are comparatively high.

On the other hand, tracking inflation in the FIT payments can provide greater value for investors than the basic fixed price model. This could help encourage risk-averse investors to invest in RES, due to the high degree of security offered by the guaranteed payment structure, and the added protection against changes in the CPI. In spite of the fact that FIT prices under this model escalate over time, this model may also be easier to implement politically due to the lower initial tariff prices. Finally, the practice of adjusting the long-term purchase price is also consistent with common practice in utility Power Purchase Agreements (PPAs). Thus, not adjusting for changes in the CPI could be considered a break with traditional utility procurement policy.

The third feed-in tariff policy design option examined here is the *front-end loaded model* (Fig. 3).[9] In this model, higher payments are offered in the early years than in the later years, effectively skewing the cash flows in favor of the earlier years of the project's life.

An example of front-end loading is implemented under the State of Minnesota's Community-Based Energy Development (C-BED) policy (State of Minnesota, 2007). This policy offers a higher tariff for the first 10 years of the contract term, while offering a lower tariff for the remaining 10 years. In the wake of new changes to the State's C-BED program, renewable energies other than wind are accepted, and each will receive the higher initial payments under the front-end loading policy (State of Minnesota, 2007).

Another example of the front-end loaded tariff design is Slovenia's FIT policy. In Slovenia, both tariffs and FIT premiums drop by 5% after the first 5 years of the project's life, dropping further to 10% below the initial tariffs and premiums after 10 years (Held et al., 2007). This differentiation reduces the long-run costs of renewable energy supply, and reflects the declining costs that a project developer has to pay over time.

In a different approach to a front-end loaded design, countries like Germany, France, Cyprus, and Switzerland employ a variant on this design to adjust FIT payments according to resource quality (Klein et al., 2008; Swiss Federal Energy Office, 2008). In these examples, which currently apply only to wind power, a higher payment is offered for an initial period of time (typically ranging from 5 to 10 years), after which the payment is adjusted downward.

This model has been implemented in one of two ways: in the first approach, projects with lower electricity production in relation to a common benchmark receive the higher initial payments for a longer period of time. This model is currently employed in Germany and in Switzerland (RES Act, 2008; Swiss Federal Energy Office, 2008). In the second approach, the per-kWh payments are adjusted downward for the remainder of the contract period based on the number of annual full load hours[10] in which the project generated power. Projects with higher full load hours of production receive a lower payment after the initial period of time, based on a linear function of annual full load hours. This model is currently employed in France and in Cyprus (France, 2006; Klein et al., 2008).

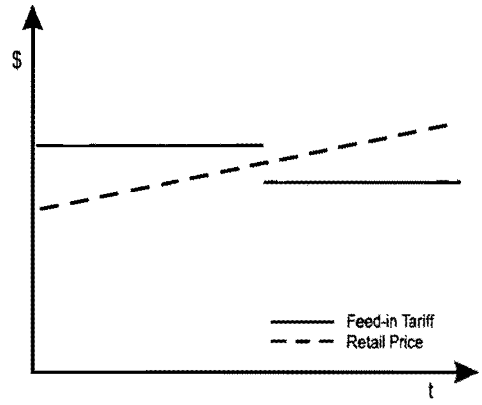

Fig. 3. Front-end loaded tariff model.

The primary reason for introducing this variant on the front-end loaded design is to avoided overcompensation for the projects at the windiest sites, thereby reducing the overall costs of the policy over time. Further reasons include reducing balancing costs through greater geographic dispersion of projects, to increasing the opportunities for different regions to participate in RE development, to promoting greater siting flexibility (Mendonça, 2007; BMU, 2007).

Shifting project revenues to the earlier years of a project's life risks putting greater near-term upward pressure on policy costs, as higher initial payments must be made in the initial years of production. This can make the policy seem more costly in the early years. In addition, when used to adjust for resource intensity (as in France, Germany, Cyprus, and Switzerland), this model ends up offering higher average FIT payments to projects in less windy areas. This can put upward pressure on the costs of RE development, while working against the principle of comparative advantage, which would suggest that the most productive sites should be tapped first.

On the other hand, there are a number of advantages of the front-end loaded policy design. First, it enables project operators to benefit from higher revenues streams when they are needed most (i.e. during the period in which the loans and/or equity investors are being repaid), while leaving lower revenues, and therefore diminished impact on retail electricity prices, in the later years of a renewable energy project's life. This approach enables renewable energy developers to receive the same total revenue they would receive through a fixed price policy, while allowing for proportionally higher net profits through higher cash flows when interest payments are highest. This practice enables developers to pay off loans and/or equity investors more quickly, while retaining reliable revenue streams after debts are fully, or largely, paid back.

The front-end loaded tariff design model, when used in this way, also has the advantage of offering predictable project revenues until the very end of the project's useful life, adding significant investment security by making the remuneration framework clear to all investors at the outset.

Alternatively, when used to allow FIT payments to be differentiated according to resource intensity, as in the case of wind power in Germany, France, Cyprus, and Switzerland among others, this strategy can reduce the risks of overcompensation at the windiest sites, while providing a number of benefits for grid

[9] This design option is placed in the category of "stepped tariff designs" in Klein et al. (2008), Ragwitz et al. (2007), and Mendonça (2007) among others. However, in these analyses, the term "stepped" is used inclusively to refer to a wide range of tariff differentiations, including by resource quality, project size, as well as fuel type. The terminology of "stepped tariff designs" is avoided here to avoid confusion with these other design options, and to focus more specifically on policy designs in which revenues are structured to be higher in the earlier years than in the later years.

[10] The term "annual full-load hours" refers to the hypothetical number of hours in which a wind turbine would need to operate, if it were operating at full capacity, to produce its total annual production.

operators and project developers, in addition to facilitating participation for local communities.

The fourth policy model considered is the *spot market gap model*.[11] In this model, the actual FIT payment is comprised of the gap between the spot market price and the required FIT price. As a result, the total remuneration is a fixed price consisting of the sum of the spot market price and the variable FIT premium, which, when combined, make up the total FIT payment (Fig. 4). Naturally, offering technology-specific payment levels will require that different technology classes be awarded a different marginal payment.

In this policy model, if the market price goes up the FIT premium declines, and vice versa. For this reason, this model could have been classified within the market-dependent category, but from a producer perspective, it is arguably closer to the market-independent model, because the remuneration level remains fixed.

A variant on this policy is currently implemented in the Netherlands. In this approach, instead of the added marginal costs being passed on to electricity customers, they are covered by government subsidy (Van Erck, 2008). As a result, this model shifts the added marginal costs of promoting renewable energy deployment from the ratepayer to the taxpayer, since the gap between the market price and the tariff price is paid directly from government coffers.

This policy model broadly follows the principle mentioned at the outset that is common to the most successful FIT policies, that of cost-covering compensation (Fell, 2009; see REN21, 2009), except that instead of the difference being covered by the ratepayers, where costs are integrated into the electricity rate base, the respective top-up is paid by government subsidy.[12] As a result, each allowable technology class is granted a different budget amount, according to the desired quantity of renewable energy development in each class (Van Erck, 2008).

The advantages and disadvantages of passing on the costs to tax payers versus ratepayers are considered first, followed by a brief evaluation of the spot market gap model itself.

First, there are a few disadvantages to covering the costs through government treasury. Due to the fact that the resource development is contingent on a specific budgetary allocation, there is the further risk that the budget will be exhausted, or fail to be renewed, by the time a proposed project begins supplying electricity to the grid. In addition, since FIT payments under the Netherlands' model depend on the continuation of government subsidy, projects in this policy environment are arguably riskier to develop than under other FIT policies that integrate the cost of new renewable energy into the rate base. The lack of ratepayer backing increases the counterparty risk, which could put upward pressure on the required returns.

Finally, if the policy is successful, this is likely to increase the budgetary commitment required, further jeopardizing the longevity of the policy framework. In addition to hindering RE project development, these added uncertainties are also likely to influence whether or not associated manufacturing investments take place, as these, even more than project-level investments, require a stable and reliable policy framework (Fell, 2009).[13]

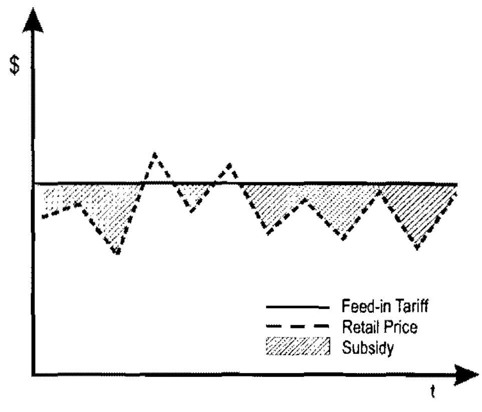

Fig. 4. Spot market gap model.

The role of these uncertainties on dampening investor confidence can be significant, and can play a decisive role in determining the actual amount of renewable energy investment a jurisdiction attracts, and at what price.

On the other hand, covering the difference by government subsidy means that no impact will be felt on electricity rates, and hence, on economic competitiveness. In other words, by subsidizing the renewable energy development through the taxpayer, electricity rates remain uninfluenced. Furthermore, in the event that the fossil fuel prices (which typically determine the marginal cost of electricity generation) increase, the average marginal subsidy required for every new kWh into the system would tend to decline as well, up to a point where no subsidy will be required. The burden of the financial risk is thus taken by the government, which must ensure adequate budgetary allocations in order to fulfill its contractual obligations to renewable energy developers. It should be noted that this policy model could also be designed to pass added marginal costs onto ratepayers, much like the other options examined thus far.

Turning to an evaluation of the spot market gap model itself, if electricity generators have to market their own power on the spot market, this could increase the burden on smaller developers, and could put them at a disadvantage. Due to the added transaction costs of selling one's electricity on the spot market, it may not be a suitable model for smaller project developers, such as homeowners, community groups, and farmers. Even though they may still receive the same total sum of payments, this added requirement could increase the likelihood that smaller projects will be disadvantaged in relation to larger ones.

On the other hand, the spot market gap model arguably increases the "market integration" of renewable energy sources, by requiring them to participate within existing electricity markets. This market participation can increase renewable energy sources' compatibility with existing electricity markets, while potentially reducing the transaction costs for the purchasing utilities. And unlike the full-fledged premium price options

[11] The term "spot market gap model" is being used to remain consistent with usage adopted by the National Renewable Energy Laboratory in a forthcoming report.

[12] Note that unlike the previous market-independent FIT models, the Dutch model retains the possibility that the FIT price can be influenced by the market price. If the electricity market price drops below 2/3 of the expected long-term market price, thereby increasing the required subsidy, the latter drops with the average market price, thereby diminishing the generator's remuneration until market prices increase again above 2/3 of the stated projection (Van Erck, 2008). This nuance is introduced to slow down the rate at which the assigned budget allocation is depleted in the event that market prices drop unexpectedly and the gap between market prices and renewable energy prices increases significantly. This introduces a supplementary risk that renewable energy developers must factor into their investment decisions.

[13] The risks of funding a FIT through government budgets was recently highlighted by Spain, which funds a portion of the FIT through tax revenues. Following an unexpected surge in project development in 2007–2008, Spain had to drastically reduce its FIT payments to solar PV projects, and impose caps on annual installed capacity for this technology (Wang, 2009). This surge in PV projects put unexpected pressure on government coffers, and forced a drastic revision in the policy, which significantly increased the risk perception of Spain's RE policy for investors and manufacturers (Wang, 2009).

explored below, this model retains the purchase obligation, which further increases investor security.

In addition, the transparency of the spot market gap payments enables total policy costs to be more readily calculated over time, as the sum of the premium payments. This transparency could also help facilitate cost sharing between utilities operating in different areas of one jurisdiction.

4.2. *Market-dependent FIT policies*

Following the presentation of the four different options for market-independent FIT policies, this section presents three different types of market-dependent FIT policy options.

The first market-dependent feed-in tariff policy option examined here, the *premium price model*, offers a constant premium or bonus over and above the average retail price (Fig. 5). The premium can be designed either to reflect the environmental and social attributes of renewable energy, or to approximate RE project costs.

To date premium price policies generally operate in deregulated electricity markets where the retail price for electricity fluctuates continually according to fuel costs, as well as supply and demand factors. With the premium price remuneration scheme, the price paid to the renewable energy developers fluctuates according to the market price of electricity at the time. In this way, renewable energy producers are remunerated more if market prices go up, and less if market prices go down, all else being equal. Similar to fixed-price policies, the premium amounts can be differentiated according to technology type, and project size, allowing a diversity of renewable energy projects and technologies to be profitable (see Spanish Royal Decree 661/2007; Held et al., 2007).

Due to the fact that the premium amount is awarded on top of a variable market price, there is a greater risk that payment levels will be either too high, or too low, which can have negative consequences for market growth, investor security, and for society at large (Klein et al., 2008). In particular, a number of analyses have shown that on average, premium price policies have been found to be more costly per-kWh than fixed-price policies (Ragwitz et al., 2007; Held et al., 2007; Mendonça, 2007).This higher cost is reflected in a risk premium that ranges, in Europe, from 1 to 3 Euro cents/kWh (Ragwitz et al., 2007).

This appears to be partly to compensate for the added risk, and partly due to the greater likelihood of divergence between the total remuneration and actual project costs (see Langniss et al., 2009). In addition, premium price policies do not typically offer a purchase guarantee, which can increase the risks for project developers, putting further upward pressure on the required returns.

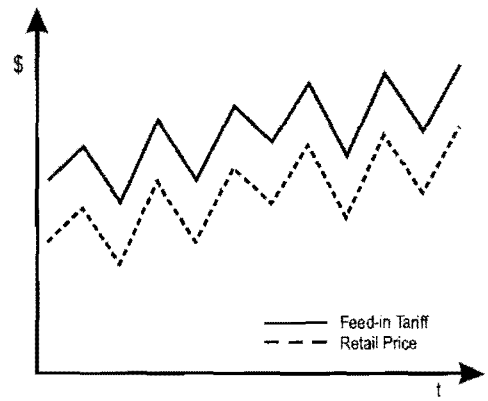

Fig. 5. Premium price model.

On the other hand, it has been argued that premium price policies are more compatible with competitive (or deregulated) electricity markets than fixed-price FITs (Langniss et al., 2009; Ragwitz et al., 2007; Held et al., 2007; Klein et al., 2008). In premium price policies, electricity is sold on the spot market, rather than through guaranteed, long-term contracts. Furthermore, by allowing the total remuneration to rise when electricity prices increase, they can create an incentive to produce electricity when it is needed most. Improving the alignment between supply and demand in this way can therefore help improve the integration of RE electricity into the electricity system, while providing added benefits for grid operators and society (Langniss et al., 2009).

The premium price model is currently offered as an option in the Czech Republic, Slovenia, Estonia, Denmark, and Spain, though the latter has recently moved to a more sophisticated variable premium price policy, which will be examined next (Klein, 2008).

Recently, Spain introduced a *variable premium FIT policy design* that includes both caps and floors into its FIT policy structure, effectively allowing the premium to vary as a function of the market price (Fig. 6). In this model, the premium amount declines in a graduated way until the retail price reaches a certain level, at which point the premium declines to zero, and the producer receives the spot market price (Spanish Royal Decree 661/2007).

In this representation, the higher line on the graph represents the development of the total remuneration (premium + market price) that an electricity producer would receive (y axis), depending on the current market price (x axis). As electricity prices increase (on the x axis), the premium amount declines. Thus, the lower line represents the development of the premium amount awarded, as it acts to keep the remuneration between the "bottom" and the "top" limit indicated. As shown in the graph, if the market price approaches zero, the premium increases to make up the difference, until the premium represents the entire remuneration offered. This is effectively the floor, or "bottom" limit that this model guarantees for RE producers. With regards to the "top" limit, this is the upper limit on remuneration that can be supported by the premium—any higher than this, and the premium falls to zero, and the producer simply receives the spot market price.

This variable premium model is designed partly to minimize windfall profits in the event that retail prices rise unexpectedly, and partly to introduce a greater degree of investment security in the event that market prices drop (Gonzalez, 2008). It does this by introducing a "corridor" within which the premium amount fluctuates (Langniss et al., 2009). This can help keep actual remuneration more closely aligned with project costs.

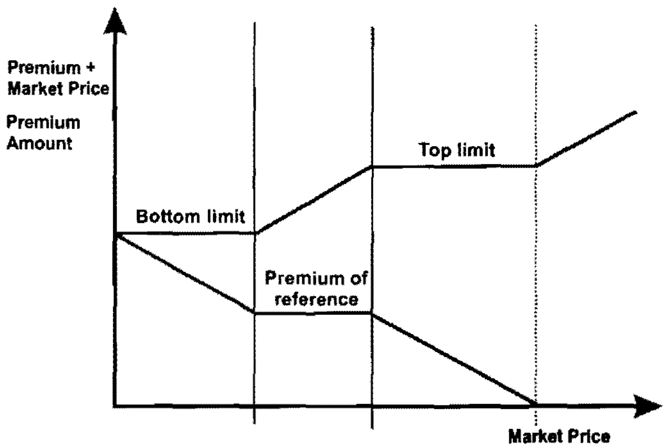

Fig. 6. Variable premium FIT policy design.

Although this policy option is more complex to design than the premium price model examined above, and despite the fact that it also does not offer a purchase guarantee like the fixed price models examined above, it has a number of advantages over both the constant premium price and the fixed price designs.

First, the variable premium model allows payment levels to more accurately reflect renewable energy technology costs over time. Although payment levels are still dependent on market prices, they are no longer linearly dependent; this retains the incentive to generate electricity in times of high demand, while mitigating volatility in the project's revenue streams. Second, the variable premium model also has the advantage of reducing the risks for investors by providing a floor on the minimum payment price, while reducing the risks for society by introducing a cap on the total premium price. This latter innovation will also help reduce costs to society by reducing the chances of excessive remuneration when market prices increase, while the former provides protection against unexpected drops in electricity prices. Thus, the cap and floor structure addresses a disadvantage of the constant premium price model examined above.

The variable premium model therefore retains a number of the advantages of premium price designs, while avoiding some of the pitfalls. It represents a more market-compatible FIT design that simultaneously provides the necessary protections against both upward and downward price movements, reducing risks both for society and for investors.

The seventh and last feed-in tariff policy option discussed here is the *percentage of the retail price model*, which establishes a fixed percentage of the retail price at which the electricity from RES will be purchased (Fig. 7). Note that this percentage can establish the FIT price to be either above, equal to, or below the average market price.

Under this model, the total remuneration paid to renewable energy producers is entirely dependent on changes in the market price for electricity. This means that if prices increase suddenly, RE producers are likely to benefit from sudden windfall profits, while if they decrease suddenly, they are likely to fall short of the revenues required to ensure profitability. This exposure to market volatilities that have no immediate relationship to RE generation costs makes this policy option significantly more risky from a producer's perspective, as cash flows are no longer primarily contingent on efficient project operation, but instead on uncontrollable factors in conventional energy markets.

The percentage of retail price model was used in Germany and in Denmark in the 1990s to drive wind development, as well as in Spain between 2004 and 2006 (Jacobsson and Lauber, 2006; Nielsen, 2006; Gonzalez, 2008).

From 1991 to 2000, Germany's renewable energy policy employed a percentage of the retail price model, which proved effective at promoting large wind development in Germany at that time (see RES Act, 2000). The price paid for renewable energy was established as a maximum of ninety percent (90%) of the retail electricity price, depending on the project size and technology type (Germany, StrEG 1990; Jacobsson and Lauber, 2006). Denmark also had a percentage of retail price policy, though it was established at eighty-five (85%) percent of the retail price (Lipp, 2007), while Spain's established percentages that ranged from 80% to 575%, depending on the technology type and project size (Spanish Royal Decree 436/2004; Gonzalez, 2008).

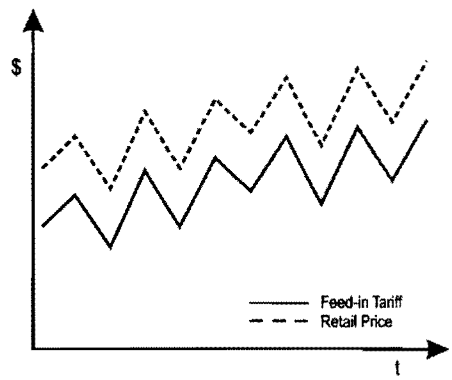

Fig. 7. Percentage of retail price model.

Germany abandoned its percentage-based model in 2000 (RES Act 2000; see also Jacobsson and Lauber, 2006), while Denmark followed suit in 2001 (Lipp, 2007; Mendonça et al., 2009). Finally, Spain also abandoned the percentage-based approach in 2006, making way for its current FIT framework, outlined in its Royal Decree 661/2007 (Gonzalez,2008).

There are a number of different reasons why FIT policies designed as a percentage of the retail price have fallen into disfavor. In Germany, the change to a fixed-price model based on RE project costs was made to increase investor security through more stable prices, accelerate RE development, and improve technological diversity (RES Act, 2000). There were other features of the Germany's 1990 RE law that needed to be amended, and the 2000 legislation provided the opportunity to revise the percentage-based policy design while addressing a number of other issues, such as the need for a mechanism to distribute costs to different geographic areas. In Denmark, the changes were driven largely by a desire on the part of the new government to move toward what was believed to be a more "market-based" support mechanism, one that would make use of tradable green certificates, and to a decline in government interest in renewable energy (Mendonça et al., 2009). Finally, in Spain the percentage-based model was abandoned primarily due to concerns over costs, as the percentage-based payments led to highly volatile payments when electricity increased in 2005–2006 (Gonzalez, 2008).

For these and other reasons, percentage-based FIT policies are unlikely to be used again in a comprehensive manner to encourage renewable energy development. However, they were an important part of the policy learning process that has led to newer, more effective, and more sophisticated FIT policy designs.

5. Analysis of market-independent and market-dependent FIT policies

Experience with different approaches to feed-in tariff policy design has helped provide a base of evidence from which certain general conclusions can be drawn. As explored above, there are different advantages and disadvantages to each of these different design options and some of them can have significant impacts on the market growth that occurs, as well as on the per-kWh costs of electricity generated from RES. This section provides an analysis of market-independent FIT models with a focus on the basic fixed-price design, followed by an analysis of market-dependent FIT models with a focus on premium price designs. This helps highlight the main differences between these two approaches to designing FIT remuneration.

5.1. Analysis of market-independent options

This section considers first the disadvantages of market-independent FIT designs, followed by an analysis of their strengths.

First, it has been argued by some authors that fixed price FITs in which the remuneration remains independent from prevailing electricity prices distort competitive electricity prices (Lesser and

Su, 2008). This distortion arises because the purchase prices offered under fixed-price FITs remain fixed over time, regardless of electricity market price trends. This means that even if conventional prices decline dramatically, or any other reasons that may lead to lower overall electricity prices, RE producers will continue to receive the guaranteed prices, leading to higher prices for electricity customers, and thus to an alteration of what the "real" market price would be otherwise.

Second, it is also argued that fixed price FITs ignore prevailing electricity demand, offering the same prices regardless of the time of day at which electricity is supplied (Langniss et al., 2009).[14] This indifference to the time of day can increase costs for utilities and ratepayers, as electricity may be supplied from RE sources when demand is low, which means lower marginal cost generation options have to be scaled back.

On the other hand, since the payment levels are predetermined and guaranteed under the market-independent models, they tend to offer greater investment security by allowing more reliable and predictable revenue streams for developers. This greater stability should lead to higher growth rates in markets with fixed price policies, due to the lower overall risks. This has been shown in jurisdictions that have implemented stable, fixed-price FIT policies such as Germany.

Indeed, since 2000 the RES Act has raised the share of RE sources within Germany's electricity mix from 6.3% of final electricity consumption to 14.8% in 2008, leading to an increase in non-hydro RE generation from 9.2 TWh at the end of 1999 up to a total of 70.5 TWh by the end of 2008 (BMU, 2009). Expressed in terms of installed capacity, this represents an addition of over 4900 MW of grid-connected solar PV capacity and over 19 000 MW of wind power between 2000 and 2008 (REN21, 2009; BMU, 2009; Global Wind Energy Council, 2009). These policy outcomes are frequently attributed to the high level of investment security provided by Germany's FIT framework, which represents perhaps the most widely recognized and commonly cited example of a successful FIT policy.

In addition to helping foster market growth, the higher investment security created under market-independent models is likely to enable investors to obtain a lower cost of capital, which can help lower the costs of renewable energy deployment (de Jager and Rathmann, 2008). This greater security is also likely to attract a greater *diversity* of investors (private, corporate, institutional, community-based, cooperative, etc.), due to the more secure contract terms and the greater transparency of the remuneration scheme (Lipp, 2007; see also Dinica, 2006; Mendonça et al., 2009).This is reflected perhaps most clearly in the high levels of local ownership found in countries like Germany (Lipp, 2007).

The greater stability of the revenue streams is also likely to be more suitable for emerging technologies, which may not be able to absorb the fluctuations in project revenues as readily as larger and more well-established technologies.

Furthermore, the fact that market-independent FIT policies are decoupled from market volatilities can confer a significant risk-hedging advantage on electricity generated from RES, one that is only fully captured if the price paid for them is fully decoupled from prevailing electricity prices.

[14] Note that some jurisdictions, such as Hungary, Slovenia, and Spain have begun to offer time-differentiated FIT prices within their fixed-price FIT policies. They do so by creating a graduated tariff structure, according to which the fixed prices offered increase in a step-like manner during certain hours of the day according to a pre-established formula (Klein et al., 2008). This creates an incentive to generate electricity in times of high demand for technologies that are able to adapt their supply in this way.

5.2. *Analysis of market-dependent FIT policies*

First, this section considers the disadvantages of market-dependent FIT designs before turning to an analysis of their strengths.

Recent analyses have shown that market-dependent policies that make use of premium payments over the market price have resulted in higher overall renewable energy deployment costs, and therefore, in higher per-kWh costs for each unit of renewable electricity generated (Klein et al., 2008; Ragwitz et al., 2007; Held et al., 2007). As noted earlier, a risk premium of 1–3 Euro cents/kWh can be observed under premium price designs (Ragwitz et al., 2007). This means that market-dependent FIT policies have a lower cost-efficiency than fixed price policies based on the cost of generation (see IEA, 2008).

Due to the fact that electricity retail prices cannot be reliably predicted in advance, particularly over a period of 10–20 years, the premium price policy creates greater uncertainty for investors and developers because the future payment levels are not known in advance. This uncertainty is an important consideration for projects in which the majority of the costs are borne up front in paying for technology, and amortized over periods of 15 years or more. This also presents difficulties for smaller investors or community-owned projects, both of which require more stable and predictable revenue streams to obtain project financing.

According to Mendonça:

> The risk for the [renewable energy] producers is larger in the case of the premium [market-based] option, because the total level of remuneration is not determined in advance and there is no purchase obligation as is typically the case with the fixed option. Therefore the remuneration of the premium option has to be higher than the one of the fixed tariff option in order to compensate the higher risk for [renewable energy] producers (if the same investments in new installations are to be achieved) (Mendonça, 2007, p. 98).

This could make premium price policies less appealing for a jurisdiction that is hoping to achieve a higher degree of cost-efficiency with its policy in order to minimize the costs to ratepayers.

A further consequence of pegging renewable energy prices to market prices is that any potential reduction in market prices created by large increases in RES is lost. In this case, the total remuneration offered to RE developers not only tracks electricity price increases, but risks exacerbating them. The problem of over or under compensation for renewable energy projects remains under the premium option as long as the premium offered remains fixed. This is one reason why certain jurisdictions such as Spain are beginning to move away from fixed premiums, and toward variable premium designs (Spanish Royal Decree 661/2007; see also Held et al., 2007).

On the other hand, market-dependent policies like the premium option also have some clear benefits. Although they are not accompanied by a purchase obligation, they have other features that arguably make them more compatible with deregulated electricity markets (Klein et al., 2008; Langniss et al., 2009). By letting the remuneration vary with market demand, an incentive is created to supply electricity to the grid in times of high demand, when prices are highest. This can create a more efficient electricity market, by encouraging supply in times when electricity is needed most. More specifically, according to Klein et al.:

> The premium option shows a higher compatibility with the liberalized electricity markets than fixed feed-in tariffs. This

involves a better and more efficient assignment of grid costs, particularly as regards the management of the alternative routings and supplementary services (Klein et al. 2008, pp. 53–54).

In addition, market-dependent FIT policies like the premium price model could be employed to help meet peak demand in jurisdictions where daily price volatility is common, and where the spread between peak and off-peak prices is significant. Encouraging demand-sensitivity on the part of RE generators could help alleviate some of this price volatility by creating an incentive to supply power in times of high demand,[15] which may provide benefits to both grid operators and society (Langniss et al., 2009). In addition, it can also be argued that market-dependent policies require a smaller degree of administrative intervention than fixed price policies, since only the premiums are set, rather than the entire payment amount (Gonzalez, 2008).

However, as seen earlier, if the premium is a fixed quantity and market prices rise significantly, there is a considerable risk of overcompensation. This can lead to a less efficient market outcome, where prices are higher than necessary to encourage renewable energy market development. This could effectively undermine the gains in market efficiency offered by the premium price model.

In response to this last challenge, some jurisdictions have begun implementing variable premium policies, as explored in Section 4.2. One of the strengths of the approach employing variable premiums is that it offers greater flexibility than fixed premiums, and can be structured in order to account for changes in market conditions. Without premiums that vary in relation to the market price, the gap between the costs of generation and the payment levels can increase significantly, potentially increasing the overall costs of the policy.

Market-dependent FIT policies could also help create a more harmonized electricity market because renewable energy developers are feeding their power into a competitive market place, effectively removing the difference between renewable and conventional electricity. In the long-term, this market integration could be desirable, as RE sources grow in market share, the external costs of conventional generation begin to be factored in, and renewable energy prices continue to move toward parity.

6. Conclusion

This paper provided an overview of various feed-in tariff remuneration models for electricity generated from renewable energy sources. An overview of the different models suggests that the different ways of structuring FIT payments have important impacts on investor risks, and overall rates of RE deployment. While fixed price policies that offer remuneration that is independent from prevailing electricity prices can help lower investment risks, premium price policies create incentives to generate electricity when it is needed most, which can alleviate peak supply pressures and improve the market integration of RE sources.

Supplementary design options such as inflation adjustment can provide added protection against depreciation in the value of project revenues; this can provide important investment security, and increase the number of investors willing to invest in RE projects. Designs such as front-end loading can allow the total FIT remuneration to be adjusted to offer higher payments in the early years which can help project owners to repay loans and/or equity investors more quickly; alternatively, it can provide a formula that allows project-specific data to be gathered during the early years of the project's life to inform the tariff level awarded during the later years. This design can reduce the pressure to get the prices "right" at the outset, by allowing the actual site-specific production to determine the final FIT payment offered.

For a number of reasons, market-independent, fixed price models create greater investment security and lead to lower-cost renewable energy deployment than market-dependent models. This is primarily due to the lower risk investment conditions created, and the greater predictability of future cash flows. In addition, renewable energy development under market-independent FIT policies can better harness the potential rate stabilization value of RE sources, while providing a more cost-based payment level for encouraging renewable energy development.

Market-independent models could also expand the financial participation of smaller and more risk-averse investors by creating lower-risk investment conditions, which can help facilitate RE project financing for non-traditional investors (Hvelplund, 2005). Insofar as market-independent models are accompanied by a purchase obligation, they can also lower the barriers to entry, as well as the associated transaction costs, by removing the need to actively market the project's electricity on the spot market. Thus, the fixed price option is more likely to be favorable to smaller investors and community-based projects, by making it easier for them to participate either on equity basis, or by contributing debt financing. This community buy-in and participation can help reduce opposition to RE deployment, thereby helping to create the broader public support that may be required to reach higher levels of RE penetration in the future (see Mendonça et al., 2009; Hvelplund, 2005).

One of the further benefits of fixed price policies is that they also impose a limit on the maximum price that renewable energy developers can obtain. This limit is not present in premium FIT policies unless a cap is explicitly introduced; under most premium price policies, the payment levels received by renewable energy generators track market trends, which are typically driven by fossil fuel prices, rather than cost-of-generation trends. This makes it more likely that market-dependent FIT policies will deviate from actual RE project costs, and lead either to over, or under-compensation.

Due to the fact that most RES are exempt from a dependence on a fuel source (with the exception of biomass and biogas), and are characterized by a high ratio of fixed to variable costs, they are largely immune from market volatilities, particularly when compared to conventional sources of generation such as natural gas. Furthermore, they are not vulnerable to inflation in the prices of those fuels, having only operations and maintenance (O&M) cost inflation to impact profitability after initial capital costs are paid. The potential price-stabilizing influence of RES is likely to grow in importance, and should be considered a strong argument in favor of greater renewable energy deployment, as well as an argument in favor of market-independent FIT policies.

On the other hand, as RE sources increase in market share, the need to further their integration into existing electricity markets is expected to grow (Langniss et al., 2009). This suggests that there is likely to be increasing interest in how the strengths of both approaches can be integrated within one policy framework,

[15] Despite the advantages of demand sensitivity, it is important to note that this may not act as an incentive for some RES like wind power or solar PV, which are less able to correlate supply with the existing hour-by-hour demand. Naturally, this could create an incentive to equip facilities with some form of storage for wind energy (e.g. pumped storage, hydrogen, compressed air, etc.), or solar thermal storage for solar installations, which make it possible for electricity output to be modulated, and even dispatched. Absent these technological innovations, it is important to note that only RES that can directly control their supply like biomass, biogas, solar thermal, and small hydroelectric generators could profit from this incentive structure.

one that increases this integration over time. One example of this can be found in Spain's current policy framework (Spanish Royal Decree 661/2007), which offers generators the option to sell their electricity into the spot market while benefiting from a variable premium payment that increases the predictability of future revenue streams by introducing a cap and floor on the total premium amount. This design can help increase the likelihood that the total remuneration will remain broadly cost-based over time, retain the incentive to produce electricity in times of high demand, while simultaneously increasing the market compatibility of RE generation. It is conceivable that models such as this will become more common, particularly as RE sources come to supply a larger share of total electricity demand.

This notwithstanding, market-independent policies are proving a stronger and more cost-efficient policy option in the near-term than market-dependent options. Given the lower-risk and greater revenue certainty they provide, fixed price models have thus far proved to be more effective at encouraging broader participation in RE development, while providing a policy structure more conducive to leveraging large amounts of capital toward renewable energy development.

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References

Butler, L., Neuhoff, K., 2008. Comparison of feed-in tariff, quota and auction mechanisms to support wind power development. Renewable Energy 33, 1854–1867.

de Jager, David and Max Rathmann, 2008. Policy instrument design to reduce financing costs in renewable energy technology projects, ECOFYS. Commissioned by the International Energy Agency—Renewable Energy Technology Employment, Utrecht.

Diekmann, J., (coordinator) 2008. Economic analysis and evaluation of the effects of the renewable energy Act. Prepared for the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety by DIW, DLR, ZSW, IZES, Berlin, Stuttgart, Saarbrucken, February 2008.

Dinica, Valentina, 2006. Support systems for the diffusion of renewable energy technologies—an investor perspective. Energy Policy 34, 461–480.

Ernst & Young 2008. Renewable Energy Country Attractiveness Indices 2008, Quarter 1–2. 〈http://www.ey.com/Global/assets.nsf/International/Industry_Utilities_Renewable_energy_country_attractiveness_indices/ampdollar;file/Industry_Utilities_Renewable_energy_country_attractiveness_indices.pdf〉.

European Commission, 2008. Commission Staff Working Document, Brussels, 57, 23 January 2008. Accessed November 17, 2008 at: 〈http://ec.europa.eu/energy/climate_actions/doc/2008_res_working_document_en.pdf〉.

Fell, H.-J., 2009. Feed-in tariff for renewable energies: an effective stimulus package without new public borrowing, member of the German Parliament, co-author of German Feed-in Tariff Legislation. Accessed June 19, 2009 at: 〈http://www.globalwarmingisreal.com/EEG_Fell_09.pdf〉.

Fouquet, D., Johansson, T.B., 2008. European renewable energy policy at crossroads: focus on electricity support mechanisms. Energy Policy 36 (11), 4079–4092.

France, 2006. Arrêté du 10 juillet 2006. Ministère de l'économie, des finances et de l'industrie. Accessed August 11, 2009 at: 〈http://www.industrie.gouv.fr/energie/electric/pdf/tarif-achat-eolien.pdf〉.

Germany Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU), April 2009. Development of renewable energy sources in Germany, 2008: graphics and tables, Berlin, Germany. Based on Working Group on Renewable Energies Statistics. Accessed August 10, 2009 at: 〈http://www.erneuerbare-energien.de/files/english/pdf/application/pdf/ee_in_deutschland_graf_tab_2008_en.pdf〉.

Germany, Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU), 2007. Renewable Energy Sources Act Progress Report 2007. Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU), Berlin, Germany. Accessed October 10, 2008 at: 〈http://www.erneuerbare-energien.de/files/pdfs/allgemein/application/pdf/erfahrungsbericht_eeg_2007_zf_en.pdf〉.

Germany, Renewable Energy Sources Act (RES Act), 2008. Act Revising the Legislation on Renewable Energy Sources in the Electricity Sector and Amending Related Provisions—Renewable Energy Sources Act. Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit, Berlin, Germany. Accessed October 9, 2008 at: 〈http://www.bmu.de/files/pdfs/allgemein/application/pdf/eeg_2009_en.pdf〉.

Germany, Renewable Energy Sources Act (RES Act) (2004). Act Revising the Legislation on Renewable Energy Sources in the Electricity Sector. Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU). Accessed May 15, 2009 at: 〈http://www.wind-works.org/FeedLaws/Germany/EEG-New-English-final.pdf〉.

Germany, Renewable Energy Sources Act (RES Act) (2000).Act on Granting Priority to Renewable Energy Sources. Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU), Berlin, Germany. Accessed May 15, 2009 at: 〈http://www.wind-works.org/FeedLaws/Germany/GermanEEG2000 pdf〉.

Germany, Stromeinspeisungsgesetz (StrEG) (1990). Germany's Act on Feeding Renewable Energies into the Grid of 7 December 1990. Federal Law Gazette I p.2663, unofficial translation. Accessed July 9, 2009 at: 〈http://wind-works.org/FeedLaws/Germany/ARTsDE.html〉.

Global Wind Energy Council (GWEC),2009.Global Wind 2008 Report. Accessed June 10, 2009 at: 〈http://www.gwec.net/fileadmin/documents/Global%20Wind%202008%20Report.pdf〉.

Gonzalez, P., del, R., 2008. Ten years of renewable electricity policies in Spain: an analysis of successive feed-in tariff reforms. Energy Policy 36 (8), 2917–2929.

Guillet, J. and Midden, M., 2009).Financing renewable energy: feed-in tariffs compared to other regulatory regimes, Dexia, Tallahassee, FL, 3 February 2009. Accessed 11 March 2009 at: 〈http://www.publicpower.com/pdf/effective_renewable_energy/Jerome%20Guillet.ppt〉.

Harper, J.P., Karcher, M.D., Bolinger, M. 2007. Wind Project Financing Structures: a Review & Comparative Analysis. Birch Tree Capital LLC, Deacon Harbor Financial, L.P., and Lawrence Berkeley National Laboratory No. 63434, Environmental Energy Technologies Division. Accessed January 20, 2009 at: 〈http://eetd.lbl.gov/ea/emp/reports/63434.pdf〉.

Held, A., Ragwitz, M., Huber, C., Resch, G., Faber, T., Vertin, K., 2007. Feed-in Systems in Germany, Spain, Slovenia: A Comparison. Fraunhofer Institute & Energy Economics Group, APE, Germany.

Hvelplund, F., 2005. Renewable energy: political prices or political quantities. In: Lauber, V. (Ed.), Switching to Renewable Power: A Framework for the 21st Century, Earthscan, London, pp. 228–245.

International Energy Agency (IEA), 2008. Deploying Renewables: Principles for Effective Policies, Paris, 978-92-64-04220-9.

Ireland, 2006. Renewable Energy Feed-in Tariff: Terms and Conditions. Department of Communications, Energy and Natural Resources, May 1, 2006. Accessed August 11, 2009 at: 〈http://www.dcenr.gov.ie/NR/rdonlyres/E260E316-B65A-4FDC-92F0-9F623BA18B55/0/REFITtermsandconditionsV2.doc〉.

Jacobsson, Staffan, Lauber, Volkmar, 2006. The politics and policy of energy system transformation—explaining the German diffusion of renewable energy technology. Energy Policy 34 (2006), 256–276.

Klein, A., Held, A., Ragwitz, M., Resch, G., Faber, T., 2008. Evaluation of Different Feed-in Tariff Design Options: Best Practice Paper for the International Feed-in Cooperation. Energy Economics Group & Fraunhofer Institute Systems and Innovation Research, Germany.

Klein, A., 2008. Feed-in Tariff Designs: Options to Support Electricity from Renewable Energy Sources. Lightning Source Inc., Tennessee, USA.

Langniss, O., Diekmann, J., Lehr, U., 2009. Advanced mechanisms for the promotion of renewable energy: models for the future evolution of the German Renewable Energy Act. Energy Policy 37 (4), 1289–1297.

Lesser, J.A., Su, X., 2008. Design of an economically efficient feed-in tariff structure for renewable energy development. Energy Policy 36 (3), 981–990.

Lipp, J., 2007. Lessons for effective renewable electricity policy from Denmark, Germany and the United Kingdom. Energy Policy 35 (11), 5481–5495.

Menanteau, P., Finon, D., Lamy, M.-L., 2003. Prices versus quantities: choosing policies for promoting the development of renewable energy. Energy Policy 31 (8), 799–812.

Mendonça, M., Lacey, S., Hvelplund, F, 2009. Stability, participation and transparency in renewable energy policy: lessons from Denmark and the United States. Policy and Society 27, 379–398.

Mendonça, Miguel, 2007. In: Feed-in Tariffs: Accelerating the Deployment of Renewable Energy. EarthScan, London.

Nielsen, K.H., 2006. Danish wind power policies from 1976–2004: a survey of policy making and techno-economic innovation. In: Lauber, V. (Ed.), Switching to Renewable Power. EarthScan, London, pp. 99–121.

Ontario Power Authority (OPA), 2006. Renewable Energy Standard Offer Program, Final Program Rules, v.2.0, Ontario.

Ragwitz, M.; Held, A.; Resch, G.; Faber, T.; Haas, R.; Huber, C.; Coenraads, R.; Voogt, M.; Reece, G.; Morthorst, P.E.; Jensen, S.G.; Konstantinaviciute, I.; Heyder, B., 2007. Assessment and optimization of renewable energy support schemes in the European electricity market: Final Report. Optimization of Renewable Energy Support (OPTRES), Karlsruhe, Germany. Available at: 〈http://ec.europa.eu/energy/renewables/studies/doc/renewables/2007_02_optres.pdf〉.

REN21, 2009. Renewables Global Status Report: 2009 Update. REN21 Secretariat, Paris.

Rickerson, W.H., Sawin, J.L., Grace, R.C., 2007. If the shoe FITs: using feed-in tariffs to meet U.S. renewable electricity targets. Electricity Journal 20 (4), 73–86.

Spanish Royal Decree436/2004, Ministerio de Economía, REAL DECRETO 436/2004, de 12 de marzo.:⟨http://217.116.15.226/xml/disposiciones/min/disposicion.xml?id_disposicion=73238&desde=min⟩.

Spanish Royal Decree 661/2007,Ministerio de Economía, REAL DECRETO 661/2007, de 26 de mayo.:⟨http://217.116.15.226/xml/disposiciones/min/disposicion.xml?id_disposicion=240846&desde=min⟩.

State of Minnesota, 2007. C-BED Legislation Omnibus Energy Bill, SF1368 and HF1344.

Stern Sir, Nicholas, 2006. In: The Economics of Climate Change. Oxford University Press, Oxford.

Swiss Federal Energy Office (SFOE), 2008. Ordonnance sur l'approvisionnement en électricité (OApEl), Government of Switzerland, ⟨http://www.admin.ch/ch/f/as/2008/1223.pdf⟩.

Van Erck, Ron, 2008. New Dutch feed-in premium scheme. In: Proceedings of the Fifth Workshop of the International Feed-in Cooperation, April 7, 2008, Brussels. Accessed October 12, 2008 at: ⟨http://www.feed-in-cooperation.org/content/view/51/67//⟩.

Wang, U., 2009. Spain: the solar frontier no more. Published by the Prometheus Institute & Greentech Media, PV News 28 (6).