ON THE SUCCESS OF POLICY STRATEGIES FOR THE PROMOTION OF ELECTRICITY FROM RENEWABLE ENERGY SOURCES IN THE EU

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ABSTRACT

In recent years, a wide range of strategies has been implemented in different EU-countries to increase the share of electricity generation from renewable energy sources. This paper evaluates the success of different regulatory strategies. The most important conclusions of this analysis are: (i) regardless of which strategy is chosen, it is of overriding importance that there should be a clear focus on the exclusive promotion of newly installed plants; (ii) a well-designed (dynamic) feed-in tariff system ensures the fastest deployment of power plants using Renewable Energy Sources (RES) at the lowest cost to society; (iii) promotion strategies with low policy risks have lower profit requirements for investors and, hence, cause lower costs to society.

1 INTRODUCTION

The promotion of electricity generation from Renewable Energy Sources (RES-E) has high priority in the energy policy strategies of the EU. The Directive on the promotion of RES-E, published by the European Commission (2001/77/EC), sets challenging targets to increase the share of RES in the electricity mix of the EU-25 countries from 12 % in 1997 to 21 % by 2010 [1]. To meet these targets, a wide variety of promotion strategies have been implemented throughout the EU in recent years. The primary target of these strategies is, of course, to increase the capacity installed for generating electricity based on RES in order to enjoy the related environmental and other benefits as laid out in this directive. This deployment should take place at as low a cost as possible. In order to identify the most suitable promotion strategies for application, not only from a purely theoretical point of view, the European Commission (EC) analysed practical experiences gained with the different policy instruments in Europe, focusing on policy effectiveness and economic efficiency. The main message of this communication from the EC is that in general feed-in tariff (FIT)-systems achieved a higher effectiveness than quota obligations at lower costs [2][1].

The aim of this paper is to compare the success of various policy strategies for promoting RES-E in the EU based on experiences made between 1998 and 2005. Attention is paid to differences in the assessment of strategies from the private investors' point-of-view versus society's point-of-view. This study develops a possible approach to evaluating policy instruments taking into account the following success criteria:

- Effectiveness: there should be a substantial increase in RES-E capacity
- Economic efficiency: electricity from RES-E capacities should be generated at competitive costs which should decrease over time (due to learning effects)

Strategy targets derived from these criteria are:

- ensure sustainable growth of the RES-E industry;
- enhance social acceptance and increase public awareness with respect to renewable energy;
- improve technical reliability, technical performance and standardisation;
- remove obstacles with respect to grid-connection; and
- strive for low administration costs, low transaction costs and minimise public financial support to reach a certain level of installed RES-E capacity.

In the literature, reviewing the effectiveness and efficiency of various promotion strategies for RES-E has attracted increasing attention in recent years. One of the first survey papers was published by Meyer (2003) [3]. He concludes that the big challenge for the proponents of market principles is to demonstrate that the dilemma of striving for short-term profits can be solved satisfactorily. Van der Linden et al. (2005) discuss the success of renewable energy obligation support mechanisms [4]. Their major conclusion is that "an obligation is effective and cost-effective in theory. However, it seems too early to conclude that the system delivers these promises in practice". Haas et al. (2004) give a concise summary of comprehensive discussions within a workshop of the former "European Network for Energy Economics Research" (ENER) [5]. Their main conclusions are that the careful design of strategies is by far the most important aspect and that the focus on newly installed plants is crucial for a successful strategy. Moreover, they argue that, up until then, well-designed FITs had been more effective and cost-efficient than other promotion schemes.

Another analysis carried out by Dinica (2006) examines the diffusion of renewable energy technologies (RET) taking into account the role of investors [6]. She argues that a sound and secure investment climate which allows sufficient profitability combined with low investment risks is vital for a significant development of RES-E. Lemming (2003) scrutinises financial risks in a tradable green certificate (TGC) market and con-

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1 This paper is based on the results of EU projects conducted for DG TREN. Some conclusions from these projects were delivered to DG TREN before this communication was published.

cludes that the higher risks associated with TGC-systems compared with FIT-systems result in higher profit requirements by investors [7].

Mitchell et al. (2006) compare the UK bidding system and the German FIT system regarding the correlation between risks for generators or investors and policy effectiveness [8]. They come to the conclusion that low risks imply high policy effectiveness. From the author's point of view, the German FIT-system is better able to provide security for investors than the British Renewables Obligation. A similar analysis was conducted by Butler and Neuhoff (2004) [9]. They conclude that the "resource-adjusted costs to society of the FIT is currently lower than the cost of the Renewables Obligation Certificate (ROC)".

This paper is organised as follows: Section 2 describes the different types of promotion strategies. In Section 3, the policy assessment approach is described. The results are presented in Section 4. The major conclusions for policy makers derived from this analysis complete the paper.

2 SURVEY OF POLICY INSTRUMENTS FOR PROMOTING ELECTRICITY FROM RENEWABLE ENERGY SOURCES

This section outlines the main policy schemes applied in Europe and includes a classification and characterisation of the schemes. A fundamental distinction can be made between direct and indirect policy instruments. In this context, direct policy measures aim at the immediate stimulation of RES-E, whereas indirect instruments focus on improving long-term framework conditions [10]. Besides regulatory instruments, there are also voluntary approaches to the promotion of RES-E, which are mainly based on consumers' willingness to pay premium rates for green electricity. Further important classification criteria are whether policy instruments address price or quantity, and whether they support investment or generation. Table 1 provides an outline of policy instruments used to promote RES-E.

Table 1: Classification of promotion strategies [11]

		Direct		**Indirect**
		Price-driven	**Quantity-driven**	
Regulatory	Investment focussed	• Investment incentives	• Tendering system	• Environmental taxes
		• Tax incentives		
	Generation based	• Feed-in tariffs	• Tendering system • Quota obligation based on TGCs	
		• Rate-based incentives		
Voluntary	Investment focussed	• Shareholder programmes		• Voluntary agreements
		• Contribution programmes		
	Generation based	• Green tariffs		

Within this paper, the assessment of direct promotion strategies is carried out by focussing on the comparison between price-driven, (e.g. FITs) and quantity-driven (e.g. Tradable Green Certificate (TGC)-based quotas,) strategies, see Table 1. These instruments are explained in more detail below.

Feed-in tariffs (FITs) are generation-based, price-driven incentives. The price per unit of electricity that a utility or supplier or grid operator is legally obligated to pay for electricity from RES-E producers is determined by the system. Thus, a federal (or provincial) government regulates the tariff rate. It usually takes the form of either a fixed amount of money paid for RES-E production, or an additional premium on top of the electricity market price paid to RES-E producers. Besides the level of the tariff, its guaranteed duration represents an important parameter for an appraisal of the actual financial incentive. FITs allow technology-specific promotion as well as an acknowledgement of future cost-reductions by applying dynamic decreasing tariffs.

Quota obligations based on Tradable Green Certificates (TGCs) are generation-based, quantity-driven instruments. The government defines targets for RES-E deployment and obliges a particular party of the electricity supply-chain (e.g. generator, wholesaler, consumer) with their fulfilment. Once defined, a parallel market for renewable energy certificates is established and their price is set following demand and supply conditions (forced by the obligation). Hence, for RES-E producers, financial support may arise from selling certificates in addition to the revenues from selling electricity on the power market. With respect to technology-specific promotion in TGC systems this is also possible in principle. Yet it should be noted that a market separation for different technologies will lead to much smaller and less liquid markets. One solution could be to weight certificates from different technologies (e.g. biomass-cofiring=1. wind =2, PV =8). However, the core dilemma is of course to find the correct or at least widely accepted weights[2].

Tendering systems are quantity-driven mechanisms. The financial support can either be investment-focussed or generation-based. In the first case, a fixed amount of capacity to be installed is announced and contracts are given following a predefined bidding process which offers winners a set of favourable investment conditions, including investment grants per installed kW. The generation-based tendering systems work in a similar way. However, instead of providing up-front support, they offer support in the form of a 'bid price' per kWh for a guaranteed duration.

Investment incentives establish an incentive for the development of RES-E projects as a percentage of total costs, or as a predefined amount of € per installed kW. The level of these incentives is usually technology-specific.

Production tax incentives are generation-based, price-driven mechanisms that work through payment exemptions from the electricity taxes applied to all producers. Hence, this type of instrument differs from premium feed-in tariffs solely in terms of the cash flow for RES-E producers: it represents a negative cost instead of additional revenue.

Figure 1 shows the evolution of the main support instrument for each country. Only 8 out of the 15 countries did not experience a major policy shift during the period 1997-

[2] And of course these weights have to be adapted over time.

2005. The current discussion within EU Member States focuses on the comparison of two opposed systems, the FIT system and the quota regulation in combination with a TGC-market. The latter has recently replaced existing policy instruments in some European countries such as Belgium, Italy, Sweden, the UK and Poland. Although these new systems were not introduced until or even after 2002, the announced policy changes caused investment instabilities prior to this date. Other policy instruments such as tender schemes are not yet used in any European country as the dominating policy scheme. However, there are instruments like production tax incentives and investment incentives, which are frequently used as supplementary instruments. Only Finland and Malta apply them as their main support scheme.

In this paper the different promotion schemes are examined with respect to the status quo. This is especially important for the "technology-specific promotion with FITs" vs. "all in one basket-promotion with TGCs". Of course, it might improve TGC-schemes if a technology-specific component were introduced[3]. But because this approach is not currently applied in any country (with the exception of photovoltaics promotion in Italy and Belgium), we are not considering it in this analysis.

[3] The authors of this paper do not share this opinion.

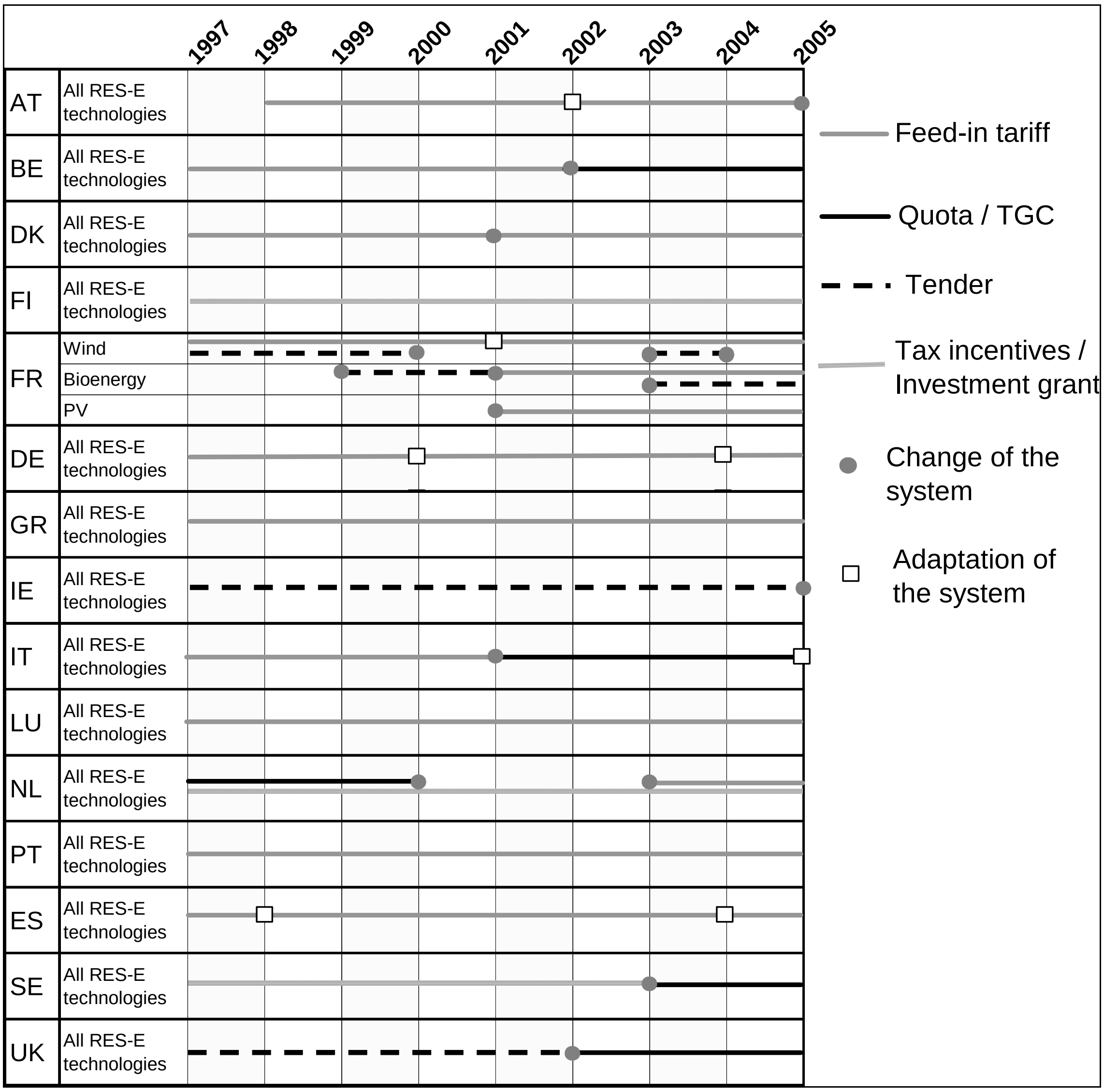

Figure 1 Evolution of the main policy support scheme in EU-15 Member States [12].

3 METHODOLOGY OF POLICY ASSESSMENT

This chapter describes the methodology applied to assess the most important types of promotion strategies depicted in Table 1 based on the criteria of effectiveness and economic efficiency. Moreover, with respect to effectiveness, the role of investors is analysed, as their investment decisions are crucial for the market development of RES-E.

3.1 Effectiveness of policy instruments

In general, the effectiveness of policy instruments can be understood as the degree of achievement of objectives, as defined by van Dijk et al. (2003) [13]. Nevertheless, van Dijk et al. (2003) doubt that this definition is appropriate for the assessment of policy instruments, since it does not allow a cross-national comparison of the effectiveness due to country-specific policy targets. Thereby, it is easier to achieve a less ambitious objective than a more ambitious one. As a result, van Dijk et al. (2003) suggest measuring effectiveness by the impacts made on additional RES-E capacity or the additional electricity generation. But this definition does not represent an appropriate indicator of effectiveness either, since absolute growth of RES-E neither considers the size of the country concerned nor the development status of RES-E. In order to take these factors into account, this study uses an indicator measuring the absolute growth of normalised RES-E generation with respect to a suitable reference quantity, the additional available mid-term potential to generate RES-E. The normalised RES-E generation represents the RES-E output potential of all the plants installed up to the end of each year. It is determined by the product of the installed capacity and the fixed amount of full load hours per year. Since policy instruments do not have any influence on electricity output volatility due to the weather, the normalised electricity generation was used to evaluate the impacts of policy support.

The additional mid-term potential describes the theoretically realisable RES-E generation until the year 2020 considering the country and the technology-specific framework involved [14].

The definition of effectiveness used in this analysis is given in eqn. (1).

$$E_n^i = \frac{G_n^i - G_{n-1}^i}{ADD - POT_n^i} \qquad (1)$$

E_n^i	Effectiveness indicator for RES technology i for the year n
G_n^i	Existing normalised electricity generation by RES technology i in year n
$ADD - POT_n^i$	Additional generation potential of RES technology i in year n until 2020

This definition of effectiveness has the advantage of being unbiased with regard to the available potential for individual technologies in a specific country. Member States need to deploy RES-E-capacities proportional to the given potential in order to demonstrate the comparable effectiveness of their instruments. This appears to be a meaningful approach since the Member State targets, as determined in the Directive 2001/77/EC, are also derived based mainly on the realisable generation potential of each country. The policy effectiveness indicator was calculated for the example of wind onshore energy in the EU-25 (see Section 4.1).

3.2 The relevance of the view of investors for effective strategies

Suitable incentives for investors play a core role for a substantial deployment of RES. Two aspects are important in this context: profitability and risk. As Cleijne et al. (2004) argue “the largest risk a generator faces is the regulatory risk because the market conditions can dramatically change” [15]. The latter crucially depends on the credibility of the promotion system. As has been shown in different analyses – see, e.g. [6] and [15], the security of revenues with low risk results in the expected profitability being much lower.

The profitability of investments in renewable energy projects is evaluated below since this is an important feature of an effective policy instrument [6]. If a renewable energy project is associated with a profitable investment, it can be expected that investments will be realised in the corresponding sector leading to further market development. Thus, investments in renewable energy have to be made attractive to potential investors. Time-adjusted methods of investment analysis are one possible approach for assessing the profitability of a potential investment.

Accordingly, the net present value per unit of electricity generated is calculated taking into account the cash inflows and cash outflows throughout the entire lifetime of a technology. The calculations are based on the assumption that cash inflows correspond to the revenues and cash outflows to the expenses occurred as a result of the investment. To get a clearer picture of the result, the net present value is transformed into a stream of constant profits, the levelised profit per unit of electricity generated. It is defined as follows in eqn (2).

$$A = \sum_{t=0}^{n} \frac{(I_t - E_t)}{(1+i)^t} * \frac{1}{Q} * \frac{(1+i)^n * i}{(1+i)^n - 1} \tag{2}$$

A	Levelised profit per unit electricity generated [€ Cent/kWh]
I_t	Cash inflows (revenues) in t [€ Cent]
E_t	Cash outflows (expenses) in t [€ Cent]
Q	Total amount of electricity generated [kWh]
i	Interest rate [-]
n	Lifetime [years]

A comparison of the levelised profit as defined in eqn (2) is presented in Section 4.2 for selected Member States of the EU.

3.3 Economic efficiency from society’s point-of-view

It should be noted that quota-based TGC systems as well as FIT systems create an artificial market and cause additional costs which are ultimately borne by the electricity customers (households, industry…). To better illustrate the cost definitions used, the various cost elements are depicted in Figure 2.

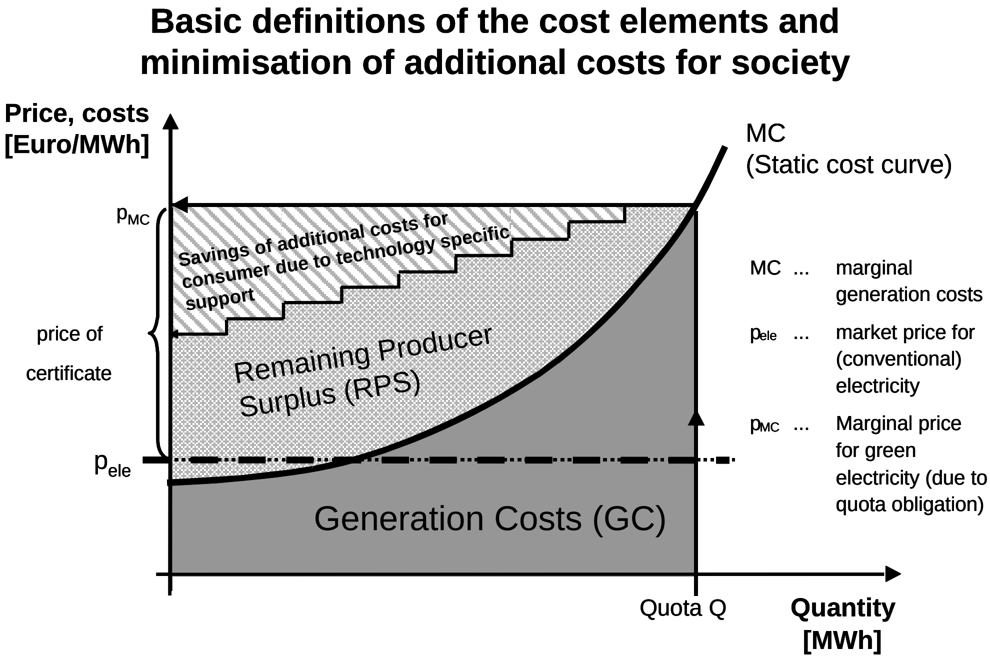

Figure 2 Basic definitions of the cost elements and minimisation of additional costs for society [16]

Of course, from society's point-of-view it is important to minimise these additional costs (fees finally paid by households, commercial and industrial electricity customers)[4] for the following reasons: the lower these additional costs are, the greater the public acceptance and the larger the amount of additional electricity generated from RES per unit of public money. Hence, the total of generation costs and producer surplus (PS) should be minimised. To minimise generation costs, it is important to set incentives for investors in such a way that they choose technologies with the lowest generation costs. To minimise producer surplus (PS)[5], a stepped promotion scheme that limits PS should be introduced, see Figure 2.

The conditions necessary to stimulate the market development of RES-E should also play an important role in the assessment of support mechanisms. They include, for instance, the level of financial support for RES-E. The current level of support for RES-E varies significantly among the different EU Member States. This is due to the country-specific cost-resource conditions as well as principal differences in the support instruments applied. In order to compare the prices paid for the different RES-E generation options with the costs occurring in each Member State, both quantities are analysed

4 Note that regardless which promotion scheme is chosen, these additional costs will ultimately have to be paid by the final customers.

5 The producer surplus is defined as the profit of all green electricity generators. Example: if a green producer receives a feed-in tariff of 6 € cent/kWh and his generation costs are 4 € cent/kWh, the resulting profit would be 2 € cent per kWh. The sum of the profits of all green generators defines the producer surplus.

and shown simultaneously, see Section 4.3. Estimating the support level is done by considering the dominating support measures as well as secondary instruments with a considerable direct impact (in particular investment incentives and soft loans).

Principally, it must be ensured that comparable quantities are being used to compare the costs and support levels among countries. With respect to the support level, the current level of support does not consider important design criteria of the policy instruments, e.g. the duration of support or the future development of the support level. These criteria are included by calculating the annuity of the support level based on an interest rate of 6.6 % and by standardising the country-specific duration of support to 15 years.

Minimum to average generation costs are shown because this range typically contains the presently realisable potentials which investors would normally deploy in order to generate electricity at minimum cost. Furthermore, the maximum generation costs can be very high in each country so that the readability of the graphs would suffer from showing the upper cost range for the different RES-E.

4 GENERAL RESULTS

4.1 Effectiveness of policy instruments

Figure 3 and Figure 4 show the average annual effectiveness indicator for wind onshore electricity generation for 1998-2005 for EU-25 countries. Several findings can be derived from these figures. Firstly, the three Member States showing the highest effectiveness during the considered period, Demark, Germany, and Spain, applied fixed feed-in tariffs during the entire period 1998-2005 (with a relevant system change in Denmark in 2001). The resulting high investment security as well as low administrative barriers stimulated a strong and continuous growth in wind energy during the last decade. It is often claimed that the high level of the feed-in tariffs is the main driver for investments in wind energy especially in Spain and Germany. However, as will be shown in Section 4.3, the tariff level is not particularly high in these two countries compared with other countries analysed here. This indicates that a long-term and stable policy environment is actually the key criterion for the success of developing RES-E markets. As can be observed from a country like France, high administrative barriers can significantly hamper the development of wind energy even under a stable policy environment combined with reasonably high feed-in tariffs. Progress was generally much slower in new Member States than in EU-15 countries. Of the former, Latvia showed the highest relative growth in the period considered.

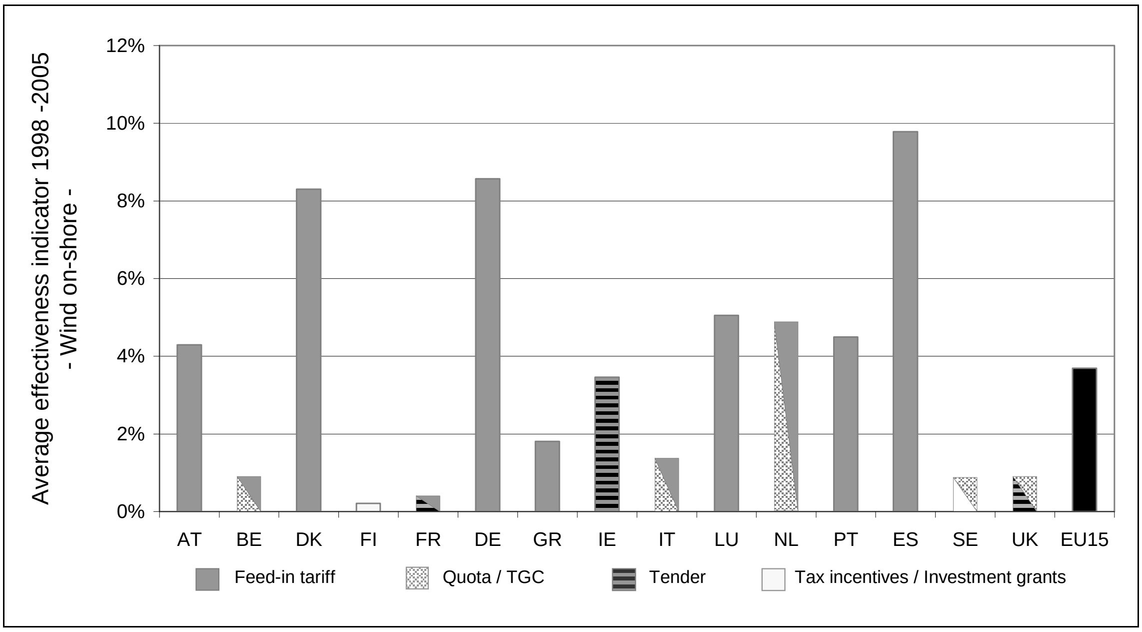

Figure 3 Effectiveness indicator for wind onshore electricity in the period 1998-2005 in the EU-15 showing the relevant policy schemes during this period

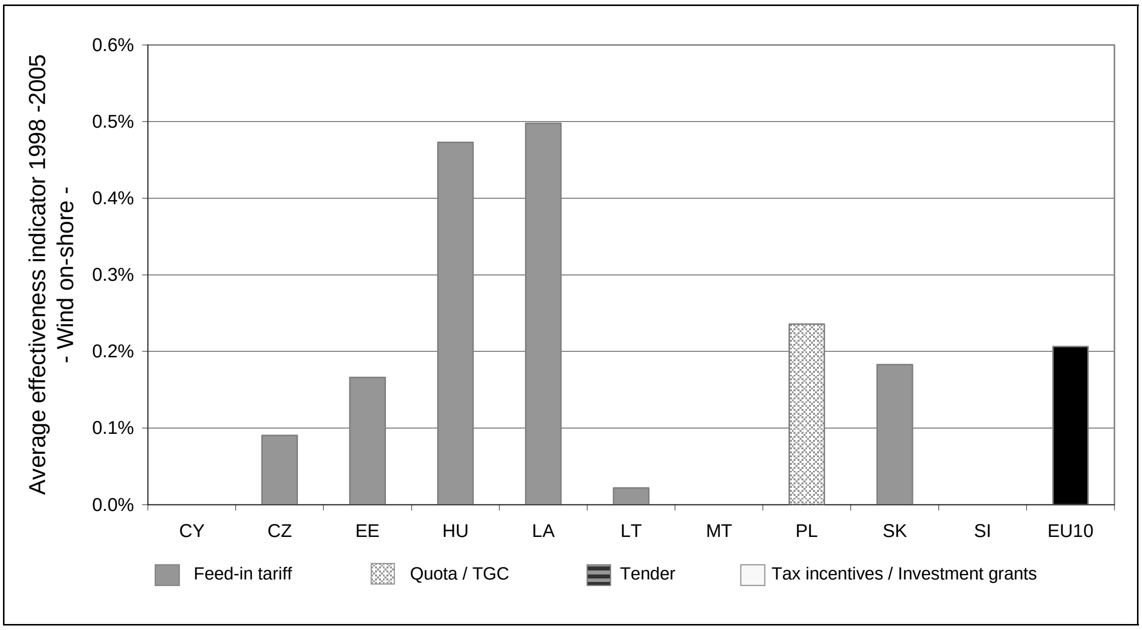

Figure 4 Effectiveness indicator for wind onshore electricity in the period 1998-2005 in the EU-10 showing the relevant policy schemes during this period

4.2 Expected revenues and profits for investors

The levelised profit of potential wind energy investments for Austria, Belgium, the Czech Republic, France, Germany, Ireland, Italy, Lithuania, Spain, Sweden and the UK was calculated for the year 2004. Thus, calculations are based on the effective support conditions in each country. Concerning the countries with FIT-systems, the annual revenues are represented by the tariffs paid for green electricity determined by national governments. The level of support in the German system is adjusted annually according to the degression in the German Renewable Energy Act (EEG) [17]. In Spain, the feed-in law (RD 436/2004) has three different tariff options: a fixed price option, a market-oriented option with a feed-in-premium and a transitional solution with a lower premium price [18]. Whereas the support duration in Germany and Spain is guaranteed for 20 years, French green electricity producers can anticipate 15 years of financial support, and in Austria, tariffs are guaranteed for 13 years.

With respect to the four countries using quota obligation systems, the certificate prices of 2004 were extrapolated for the entire active period of the support system, since there is typically no estimate for the future development of the certificate price. In Belgium it is possible to participate in green certificate trading for 10 years, in Italy for 8. It also has to be mentioned that Belgium has three different quota schemes, one in Walloon, another in Flanders and a third for off-shore wind at the federal level. With regard to Sweden and the UK, it is assumed that participation can take place throughout the entire lifetime of the wind power plants.

Investment incentives are paid in Finland, the financial support here amounts to 40 % of the total investment. Tax exemptions conceded are also taken into account as additional revenues in order to include the tax effect in the investment analysis. In the UK as well as in Sweden, the tax exemption effect was considered in the same manner.

An interest rate of 6.6 % was assumed for all the FIT-countries examined with the exception of Germany, where an interest rate of 4.8 % was used based on the availability of soft loans. In this way the levelised profit considers the country-specific wind resources, the duration of support as well as additional promotion instruments like soft loans and investment incentives.

Consequently, it is possible to analyse the correlation between the levelised profit for investments and the effectiveness reached by the support instrument in the respective year. This is done by plotting the effectiveness versus the levelised profit in Figure 5.

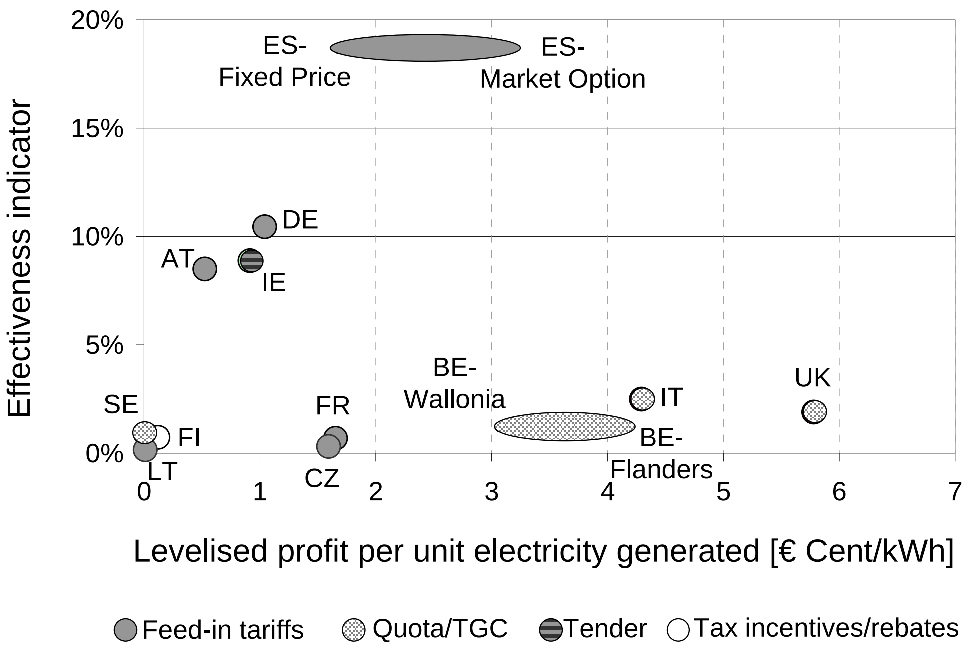

Figure 5 Effectiveness indicator versus levelised profit. The figure shows a possible levelised profit per unit of electricity generated of an investment in wind onshore in 2004

In Figure 5, the expected levelised profits as well as the effectiveness show a broad spectrum in quantitative terms for the countries under consideration. It should be pointed out that the different instruments have different levels of maturity and that policy schemes in some countries - in particular quota obligation systems - are still in a transitional phase. It is striking that Italy, the UK and Belgium, which have recently transformed their markets using quota systems as the main support instrument, are characterised by high expected levelised profits but low effectiveness. The high levelised profit results in particular from the extrapolation of the presently observed certificate prices. Although this assumption is questionable, the results show that certificate systems lead to higher producer revenues than FITs, which compensates for high investment risks. Furthermore, the recent development of certificate prices (see Figure 9) does not show a decreasing tendency, with the exception of the British Renewable Obligation Certificates (ROCs). On the other hand, countries with FITs seem to be typically more effective at generally moderate levelised profits per unit of electricity generated. The fact that expected profitability is significantly lower for FITs is directly linked with a higher efficiency of this strategy because additional costs for consumers are lower. This issue is linked to economic efficiency from society's point-of-view.

4.3 Economic efficiency from society's point-of-view

Economic efficiency from society's point-of-view – see Figure 6 - shows that, for many countries, the support level and the generation costs are very close. Countries with costly potentials frequently show a higher support level. A clear deviation from this rule can be found in the three quota systems in Belgium, Italy and the UK, for which the support is presently significantly higher than the generation costs. The reason for the higher support level expressed by the current green certificate prices is due to still immature TGC markets, the non-technology-specific application form of the currently applied TGC-systems as well as in a higher risk premium requested by investors. For Finland, the level of support for wind onshore is clearly too low to initiate any steady growth in capacity. In the case of Spain and Germany, the support level indicated in Figure 6 appears to be above the average level of generation costs. However, the low cost potentials have already been exploited in these countries due to the recent successful market growth. Therefore a level of support that is moderately higher than average costs seems to be reasonable. Of course, the potential technology learning effects also have to be taken into account.

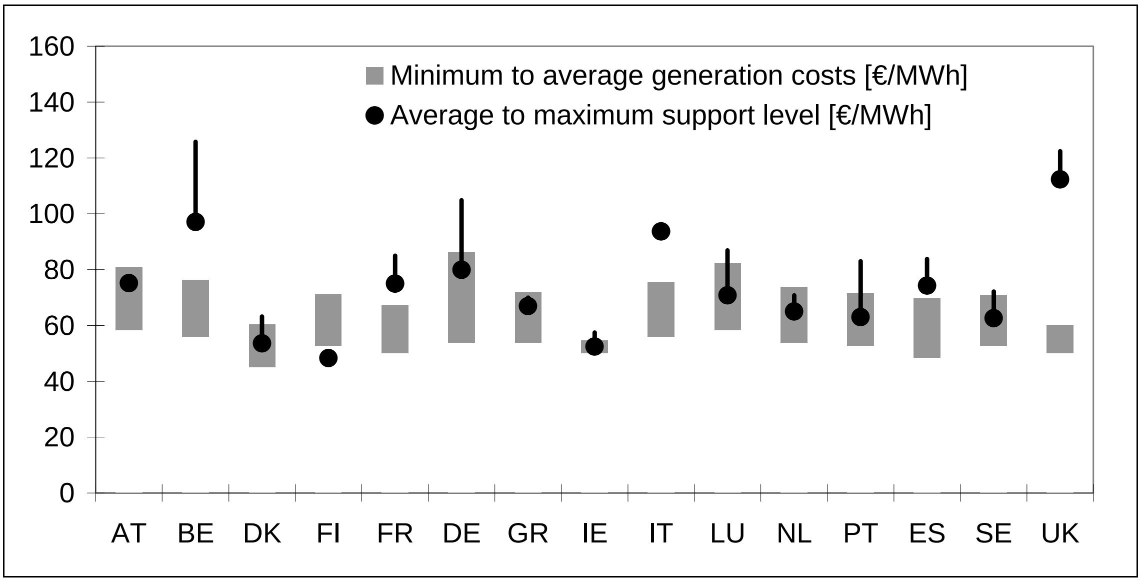

Figure 6 Support level ranges (average to maximum support) for direct support of wind onshore in EU-15 Member States (average tariffs are indicative) compared to the long-term marginal generation costs (minimum to average costs)

The comparison of costs and support level ranges for wind onshore in the EU-10 countries as shown in Figure 7 leads to the conclusion that the support level might be sufficient to stimulate investments in at least four countries: Cyprus, the Czech Republic, Hungary and Lithuania. In most of the other countries, the level of support is below marginal generation costs.

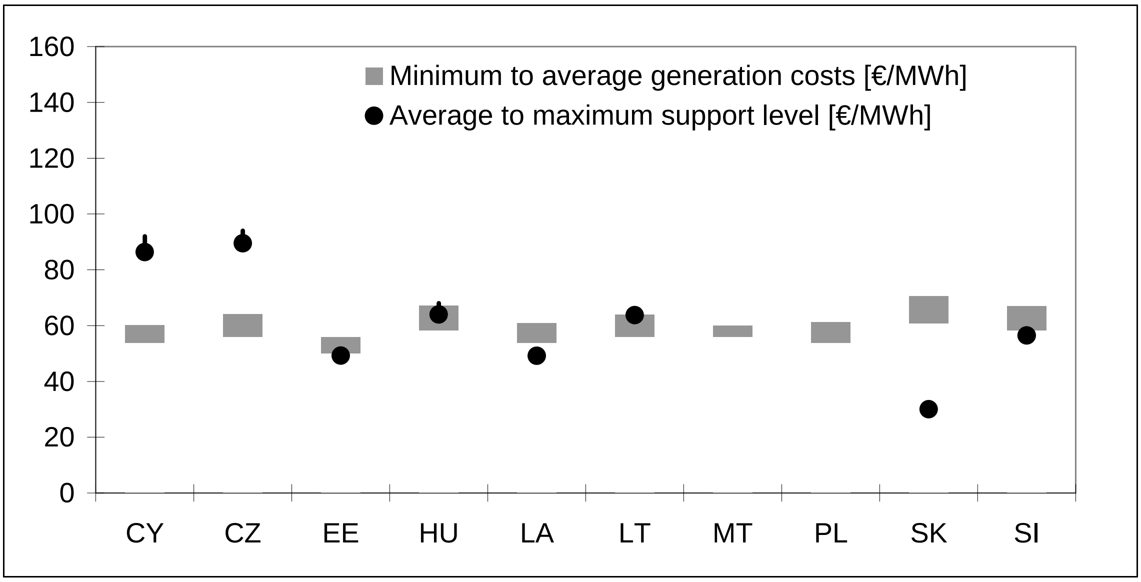

Figure 7 Support level ranges (average to maximum support) for direct support of wind onshore in EU-10 Member States (average tariffs are indicative) compared to the long-term marginal generation costs (minimum to average costs)

In Figure 8 the costs per kWh electricity from RES promoted are compared with the total costs for society per kWh of new RES-e generated for some selected countries. The costs for the latter are significantly higher for Sweden and for Belgium (Flanders). One explanation for this is that old capacity also qualifies for certificates in these two countries. This causes windfall profits due to "free riding" which significantly increases the additional costs for society, see Figure 5.

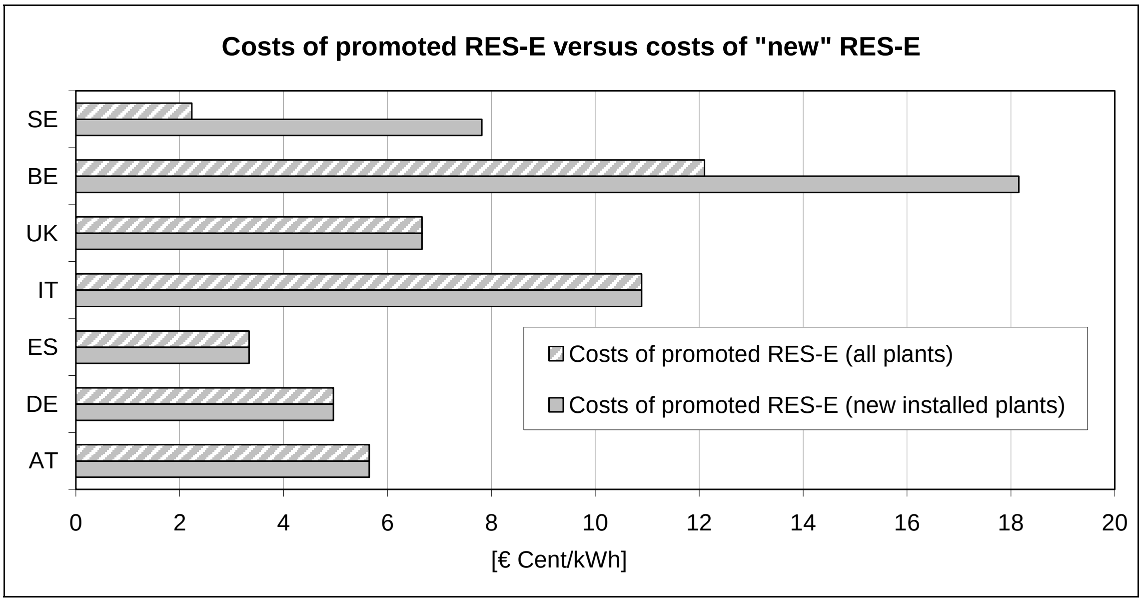

Figure 8 Costs of kWh promoted vs. costs of new kWh generated (promotion costs for Belgium only show the figures for Flanders, not Walloon or the Brussels region)

Finally, it is of interest to analyse whether the dynamics fit. That is to say, it has to be analysed whether the financial support decreases over time. Figure 9 shows the premium support level in selected countries whereas Figure 10 depicts the overall FIT. In Figure 9, the requirement of a noticeable dynamic decrease in the promotion costs is not met for TGCs. However, the promotion costs of FIT-systems decreased in 2005 due to an increase in electricity spot market prices. The overall remuneration provided by FIT-systems, including the value of the common electricity price shown in Figure 10, does not show a clear decrease.

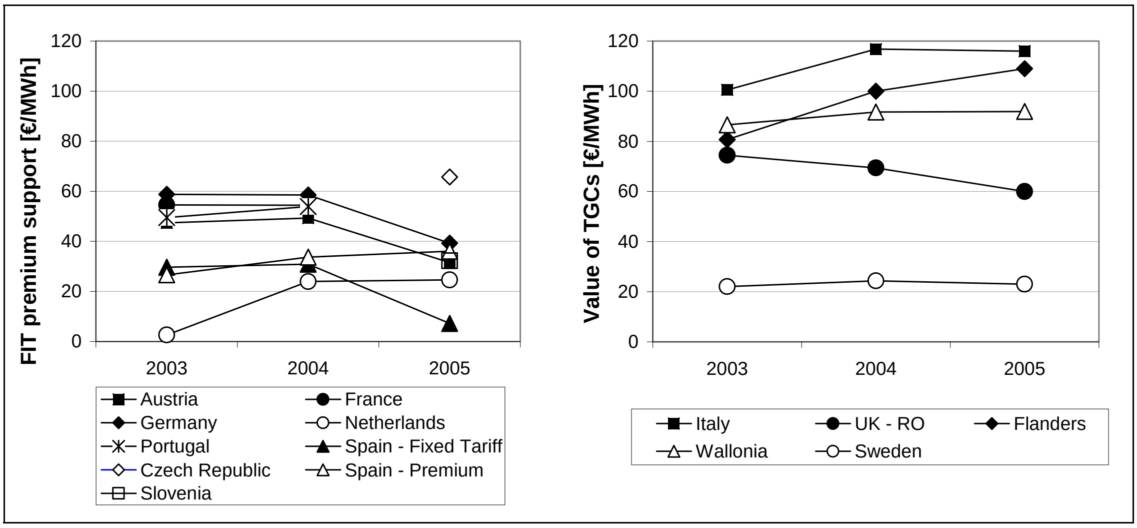

Figure 9 Comparison of premium support level: FIT-premium support vs. value of TGCs. The FIT-premium support level consists of FIT minus the national average spot market electricity price

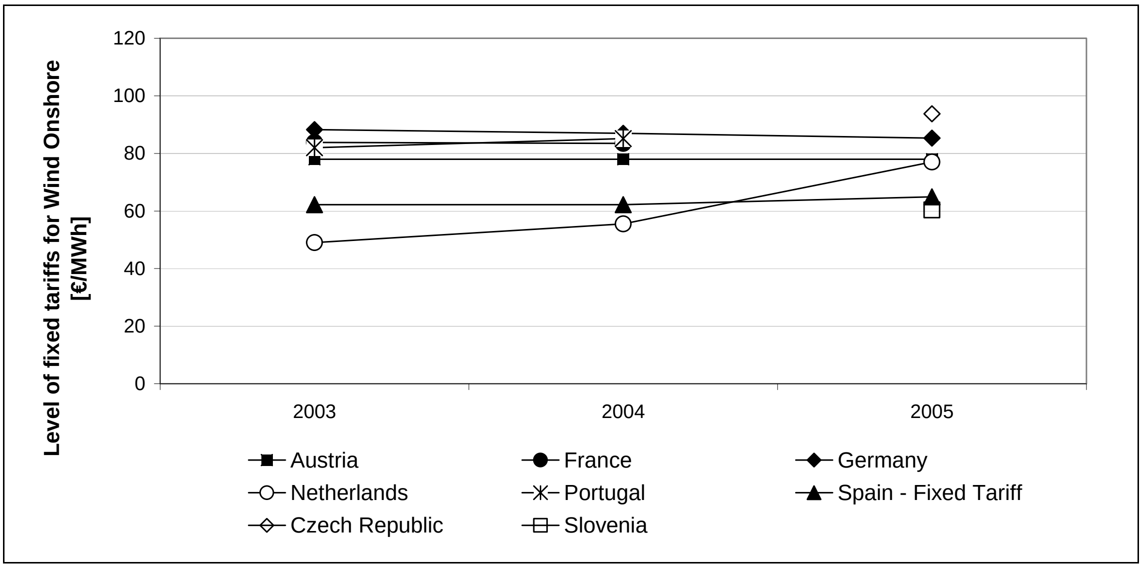

Figure 10 Development of fixed feed-in tariffs for wind onshore in different countries over time

5 COUNTRY-SPECIFIC RESULTS – LESSONS LEARNED

This section presents some of the lessons learned from specific countries with respect to effectiveness and efficiency.

Spain achieved the highest growth rates in terms of effectiveness over the last two years as well as in terms of the average value between 1998 and 2005 combined with an adequate profit for investors. However, the expected profit in Spain, which is higher than in the other feed-in countries, is not due to a high support level, but rather to relatively low onshore wind electricity generation costs as a result of good resource conditions on the one hand and low investment costs on the other. This ultimately results in the lowest costs for society per kWh of new electricity generated from RES as depicted in Figure 8.

Germany shows high average policy effectiveness concerning the support of wind onshore despite an already mature market and partially exploited low-cost potentials in the northern parts of Germany. As a result, wind power plants have been erected at less favourable locations than in former years leading to a lower expected profit than in Spain at a significantly higher support level. The successful market development of wind onshore energy in Germany can be attributed to a favourable level of feed-in tariffs, but also to a stable and continuous policy framework providing investment security for potential investors.

Denmark's promotion system, which was mainly based on FITs, was quite successful. This system was abolished in 2000 and, since then, policy effectiveness in the area of wind onshore support has fallen significantly.

In Austria, the FIT system worked quite well with respect to effectiveness. However, a major problem was that the FIT was not reduced over time and, hence, is now too high. This has led to a drop in acceptance and to an abolishment of the old tariff.

A recent example of a FIT success story, especially with respect to wind, is Portugal. Policy effectiveness for wind onshore support in Portugal has risen significantly over the last three years.

Another specific case is the Netherlands. At the end of the 1990s, the Netherlands were among the first countries to consider a TGC system in addition to tax exemptions for RES-E. This system was based on open trade with other countries including certificates from existing plants. This led to huge imports of green electricity and high windfall profits for owners of depreciated plants (e.g. hydropower) in Austria, Switzerland and Norway. Windfall profits were also caused by the possibility to account for financial support in the country of origin as well as in the Netherlands. Hence, the Dutch support system only stimulated a moderate increase in national RES-E capacities. Finally, in 2003, the system was changed to a mixed system of TGC and FITs.

France is one exception to this cluster of FIT success stories. High administrative barriers here – especially the long and complex processes of obtaining building permits – are preventing a rapid development of wind energy despite the existence of favourable feed-in tariffs.

Slovenia represents another exception so far. Here it is likely that the initially chosen level of FIT was too low to stimulate investment, see also Figure 10.

A tender system has only been practised in Ireland in recent years. In 2004, the Irish tender system achieved a high level of effectiveness similar to countries with feed-in-tariffs like Germany and Austria despite the significantly lower absolute support level. However, the high Irish growth rate in 2004 has to be considered carefully since the comparatively high capacity development in this year is due to the results of the last Irish bidding round. The growth rate was actually much lower in previous years. A tender system seems to be an instrument which can promote rapid growth in a short period of time if ambitious quota targets are set.

In the countries with quota-based TGC systems, the lessons learned are as follows:

In the UK, the major problem – aside from high certificate prices – is that so far the quota has never been fulfilled. In 2004, only 2.2 % of electricity was generated from "new" RES while the quota was 3.3 %. One main reason for this failure is the low penalty and respectively the fact that this penalty is recycled to the RES-E generators. Moreover, because banking is not allowed, RES-e generators fear that the certificate price will drop the closer they come to the quota.

There is a similar situation in Italy. Certificate prices here are high (see Figure 6) and quota fulfilment is moderate (about 80 % of the quota of 2.2 % was fulfilled in 2005). One major reason for the high certificate price is the low validity of the certificates of eight years. Non-fulfilment of the quota can be explained by the low penalty level.

In Belgium there are two parallel TGC systems in Flanders and Walloon. A comprehensive analysis is available for Flanders, see [19]. The TGC prices in Flanders are among the highest in Europe. If the windfall profits due to the promotion of old existing capacity ([19]) are taken into account, the additional costs for customers for generating new electricity from RES increase to about 18 cent/kWh (see Figure 8).

In Sweden, certificate prices are very low – see Figure 6 – but the quantities of new RES-E installed are also very low. One reason is that some old capacity is also allowed[6] in the Swedish quota system. This results in many more certificates being produced than redeemed. These certificates are banked. Yet due to these windfall profits and the high "free rider" rates, the specific costs per kWh of new RES-e generated are high, see Figure 8. Even though TGC prices in Sweden are very low, the costs per kWh of new RES-E generated are by far the highest.

For all other EU countries, it has to be stated that the experiences so far do not yet allow any appraisal of the success of the implemented policies.

6 CONCLUSIONS

The general conclusions of the analysis are:

- It is important for a promotional system to place a strong focus on new capacities and not mix existing and new capacities.
- The dissemination effectiveness of energy policy instruments depends significantly on the credibility of the system for potential investors. It must be guaranteed that the promotional strategy, regardless of which instrument is implemented, persists for a specified planning horizon. Otherwise the uncertainty for potential investors is too high and it is likely that no investments will take place at all.
- With respect to the investors' perspective, it is important to state that, at low risk (the case of FITs), the profitability expected is much lower and, hence, so are the additional costs finally paid by all customers.

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6 Recently, this system has been modified and currently mainly new capacities qualify for certificates traded.

- With respect to the technology-specific focus in the different promotion schemes, it must be stated that this is almost impossible to apply in a TGC market (because a large share of liquidity gets lost) and it is virtually an inherent feature of the difference between TGC systems and FITs.

Regarding the comparison of the different support schemes, the investigated FIT systems are effective at a relatively low producer profit. Hence a well-designed (dynamic) FIT system provides a certain deployment of RES-E in the shortest time and at lowest costs for society. It is preferable to national green certificate trading schemes for three reasons: (a) they are easy to implement[7] and can be revised to account for new capacities in a very short time; (b) administration costs are usually lower than for implementing a national trading scheme. This fact is especially important for small countries where a competitive national trading scheme is difficult to implement; (c) a clear distinction is possible between the non-harmonised strategy for existing capacities (the stepped feed-in tariff) and the harmonised strategy (international trade) for new capacities. This is very important to avoid uncertainties and backlashes in a conceivable period in which the framework conditions for a possible new harmonised system are being negotiated. The most important design criteria for FITs are: (i) a carefully calculated starting value; (ii) a dynamic decrease of the FIT that takes learning into account; (iii) the implementation of a stepped and technology-specific tariff structure (see also [20]).

At present, quota-based TGC systems show a low effectiveness although comparably high profit margins are possible. Market mechanisms seem to fail in TGC-systems, but, why should competition work in a TGC market if it does not function in the conventional European electricity market? In addition, it is hard to imagine that a European-wide TGC market disconnected from the large incumbent generators will work. The large incumbent utilities favour TGC, since this scheme gives them the chance to hedge risks and therefore prefer higher profitability. However, we must emphasise that these quota systems are comparatively new instruments in all the countries using them. Therefore the behaviour observed might still be characterised by significant transient effects. The most important issues for the specific design of TGC-markets are a high penalty, the possibility of banking, a clear focus on new capacities and, to a certain extent, a technology-specific approach.

Finally, a primary question is whether a fully harmonised EU-wide promotion scheme should be pursued. The major conclusion here is: It is not likely that a European-wide harmonised scheme will emerge soon because the objectives of the various governments with respect to a promotion scheme are quite different. However, we also have to bear in mind what happens in the mid-term (after the first wave of investments comes to the end of their depreciation periods). In the light of the dynamic development in the RES-E market (e.g. wind turbine manufacturers, biomass plant developers, photovoltaic system component producers) and in the conventional electricity market (increasing prices due to rising demand and capacities becoming scarce, highly volatile natural gas prices and highly volatile prices for CO_2-emission certificates), it is of course necessary to improve and further develop the promotion schemes for RES-E.

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7 Of course, this requires an understanding of the marginal costs of the various technologies and a follow-up of the individual plants.

Currently, competition exists between the different types of promotion scheme. This should lead to a future development in which the best elements of the different promotion schemes are established and the different systems then gradually converge into an optimal strategy consisting of these best features. Of course, the most important accompanying features of this process are continuity of development as well as adequate credibility for investors. Joint efforts for similar framework conditions such as, e.g. depreciation times, could be a first step in this direction. In other words, the validity of certificates and the duration period for which a FIT is guaranteed should eventually be the same in each country. Furthermore, joint initiatives or lessons-learned clusters for the several categories of instruments could contribute to significant progress in designing the promotion instruments. Such an initiative has already been started for FITs by the Spanish and German governments (The International Feed-In Cooperation). We believe such an approach would be very important for quota-based TGC systems as well and an important step towards a more efficient and effective promotion of RES-E in the future.

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