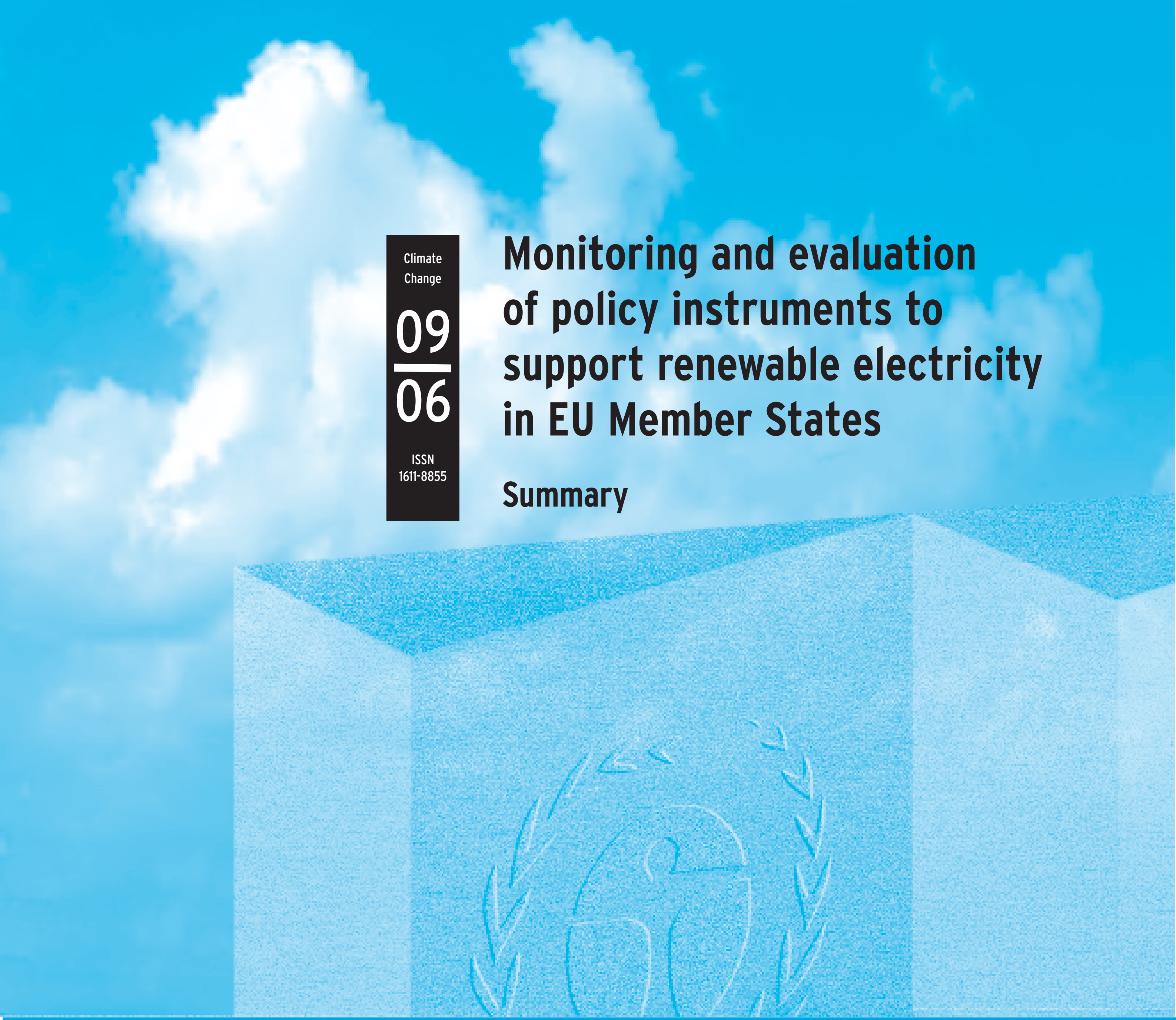
Climate Change



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Monitoring and evaluation of policy instruments to support renewable electricity in EU Member States

Summary

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Summary

Monitoring and evaluation of policy instruments to support renewable electricity in EU Member States

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Authors: Mario Ragwitz (Fraunhofer ISI)
Anne Held (Fraunhofer ISI)
Gustav Resch (EEG)
Thomas Faber (EEG)
Claus Huber (EEG)
Reinhard Haas (EEG)

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Contact details:

Dr. Mario Ragwitz
Fraunhofer Institute Systems and Innovation Research
Breslauer Str. 48
D-76139 Karlsruhe
Germany
Phone: +49(0)721/6809-157
Fax: +49(0)721/6809-272
Email: mario.ragwitz@isi.fhg.de

Dr. Gustav Resch
Vienna University of Technology
Energy Economics Group (EEG)
Gusshausstrasse 25 / 373-2
A-1040 Vienna
Austria
Phone: +43(0)1/58801-37354
Fax: +43(0)1/58801-37397
Email: resch@eeg.tuwien.ac.

1 Executive Summary

Policy strategies for the promotion of electricity from renewable energy sources differ significantly among the Member States of the European Union with respect to the amount of additional installed capacity as well as concerning the country-specific support costs. The present report aims to assess the effectiveness and the economic efficiency of the support policies in the EU based on both historical experiences and prospective model-based analysis. The main message of the investigation is that the most effective policy instruments tend to be cost-efficient at the same time. In particular, feed-in tariff systems were identified as a successful instrument for supporting renewable energies in terms of effectiveness and efficiency, whereas quota systems still have to prove themselves in practice.

2 Introduction

It is the European Union's objective to increase the share of electricity produced from renewable energy sources (RES) to 21 % in the EU-25 (22% in the EU-15) by 2010. This is the core element of Directive 2001/77/EC, which requires the Member States of the EU to apply appropriate instruments in order to achieve the national targets for RES in the electricity sector. The choice of instrument is left largely up to the Member States themselves. However, Articles 3 and 4 of the Directive provide for a monitoring system to observe the development in the individual Member States.

This report examines the development of renewable energy sources in the electricity sector (RES-E) in the individual Member States of the European Union. In particular, the support instruments being used in the Member States are documented and assessed with regard to their impacts on the share of renewable energies in electricity production. This is done using empirical investigations as well as model-based scenario calculations. The report discusses the different possibilities of continuing national policies, mutually coordinating national support measures or even harmonising policies within the EU.

The **core questions** analysed in this report can be summarized as follows:

- Which support instruments for renewable electricity are currently being implemented in the individual Member States of the EU? Which policy changes have occurred in the past or are planned in the future?
- Which of the support instruments used (e.g. feed-in tariffs, investment grants, tender schemes, quotas based on tradable green certificates) are the most effective from an historical perspective as well as from a model based prospective analysis; which are the most efficient?
- What are minimum criteria for effective and efficient support instruments?

The analysis is structured into an historical and a model based prospective analysis.

3 General characterisation of prevailing policy instruments

In order to increase the share of RES, various support schemes are applied throughout Europe. Countries usually do not apply one unique policy instrument to support renewable energies, but tend to combine different policy measures [1].

At present, the system of *fixed feed-in tariffs* is the dominant policy scheme for promoting electricity generation with RES in Europe. This system allows independent electricity generators to sell RES electricity at a fixed tariff for a determined period of time. A federal (or provincial) government regulates the tariff level which is usually based on the marginal electricity generation costs. It normally takes the form of either a total price for RES-E production, or an additional premium on top of the electricity market price paid to RES-E producers. Apart from the level of the tariff, its guaranteed duration is an important parameter when assessing the actual financial incentive. Feed-in tariffs allow technology-specific and band-specific promotion as well as an acknowledgement of future cost-reductions by implementing decreasing tariffs leading to a high dynamic efficiency [2], [3].

Recently, some European countries have replaced their existing policy schemes by a *quota obligation*. The basic principle of this system is the determination of an obligation for consumers, suppliers or producers to provide a certain percentage of electricity using RES. Generally, quota obligations are implemented in combination with tradable green certificates. The revenue from selling green electricity comprises the market electricity price as well as the value of the green certificates. Compared to feed-in tariffs, quota systems are sometimes classified as a strongly market-oriented policy system [4].

Production tax incentives are generation-based, price-driven mechanisms that work by permitting exemptions from the electricity taxes applied to all producers. Thus this type of instrument differs from premium feed-in tariffs solely in terms of the cash flow for RES-E producers: it represents an avoided cost rather than additional income.

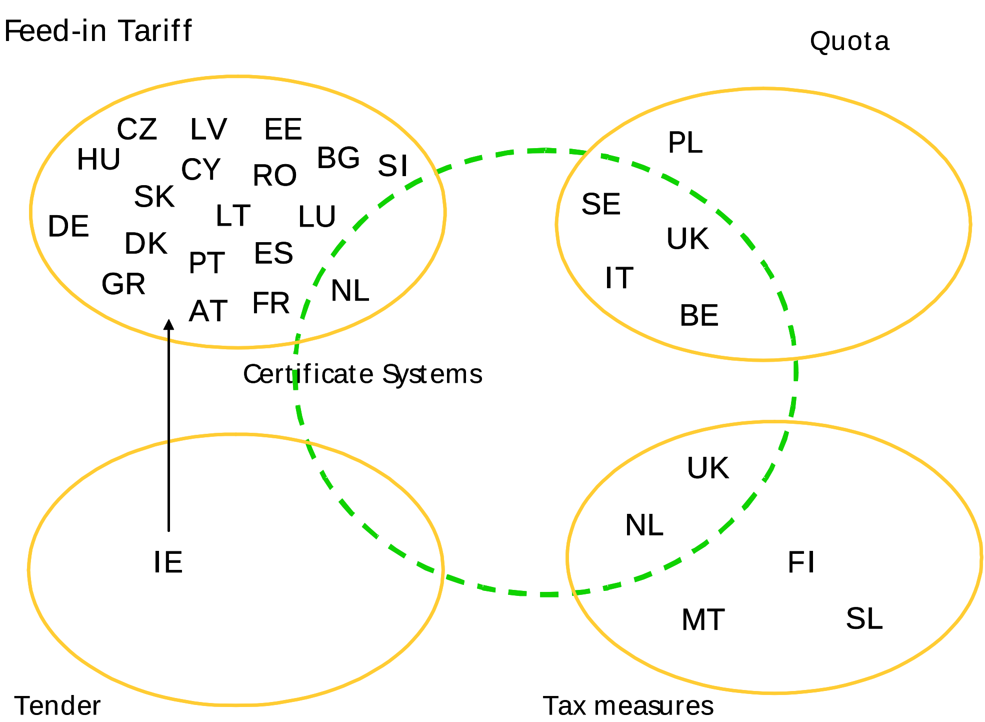
Tendering systems are quantity-driven mechanisms. Financial support can either be investment-focused or generation-based. In the first case, a fixed amount of capacity to be installed is announced and contracts are given following a predefined bidding process which offers winners a set of favourable investment conditions, including investment subsidies 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 size of the 'bid price' per kWh for a guaranteed duration.

Table 1 covers all the strategies currently applied to the promotion of RES-E deployment and classifies these instruments according to different criteria (i.e. whether they affect demand for or supply of RES-E or whether they support capacity or generation). Figure 1 provides an overview of the renewable electricity support systems used in the EU-25 and Bulgaria and Romania.

Table 1: Classification of promotion strategies [2]

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

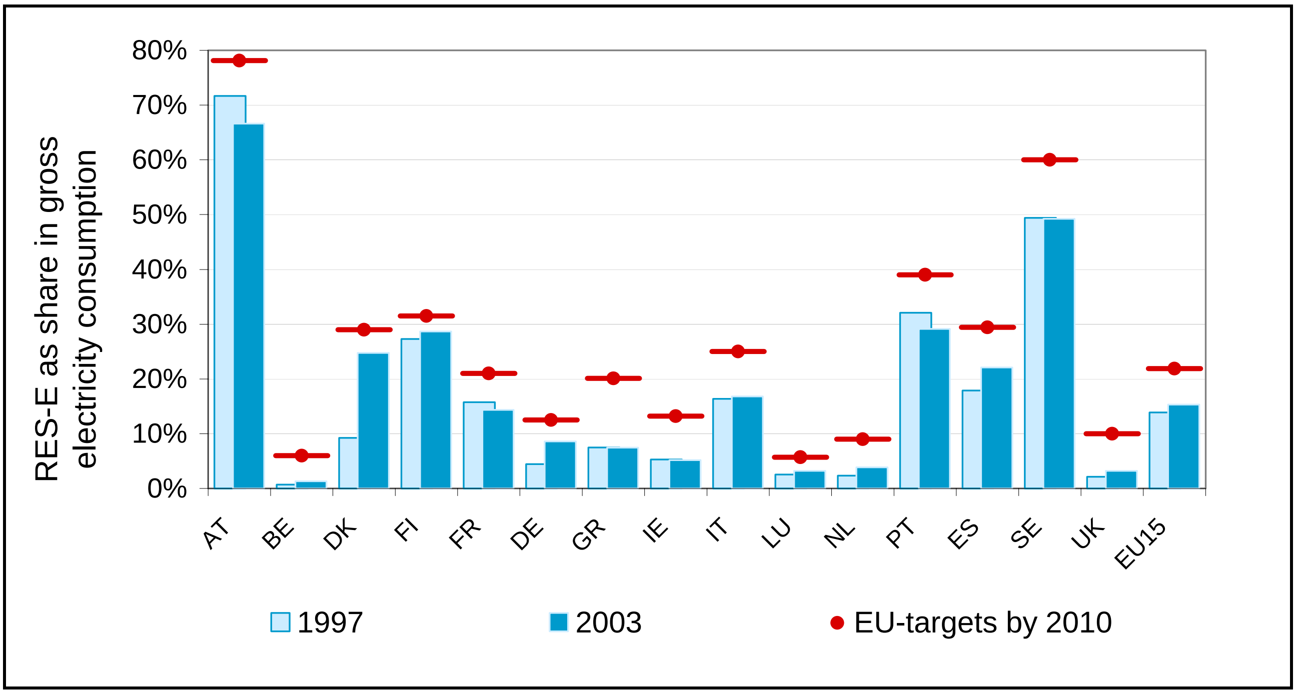
Figure 1: Overview of renewable electricity support systems in EU-25 & BU, RO (2005)



4 Current status of RES-E markets in selected EU Member States

In the next section we give an overview of the progress made by the EU-15 countries towards achieving their targets in terms of the RES-E share in gross electricity consumption. Figure 2 shows the share of RES-E in total electricity consumption for the year 2003 compared with the EU-targets set in Directive 2001/77EC. The share of RES-E in electricity consumption is based on the annual normalised electricity generation which represents the actual generation corrected by the annual volatility of hydropower and wind energy.

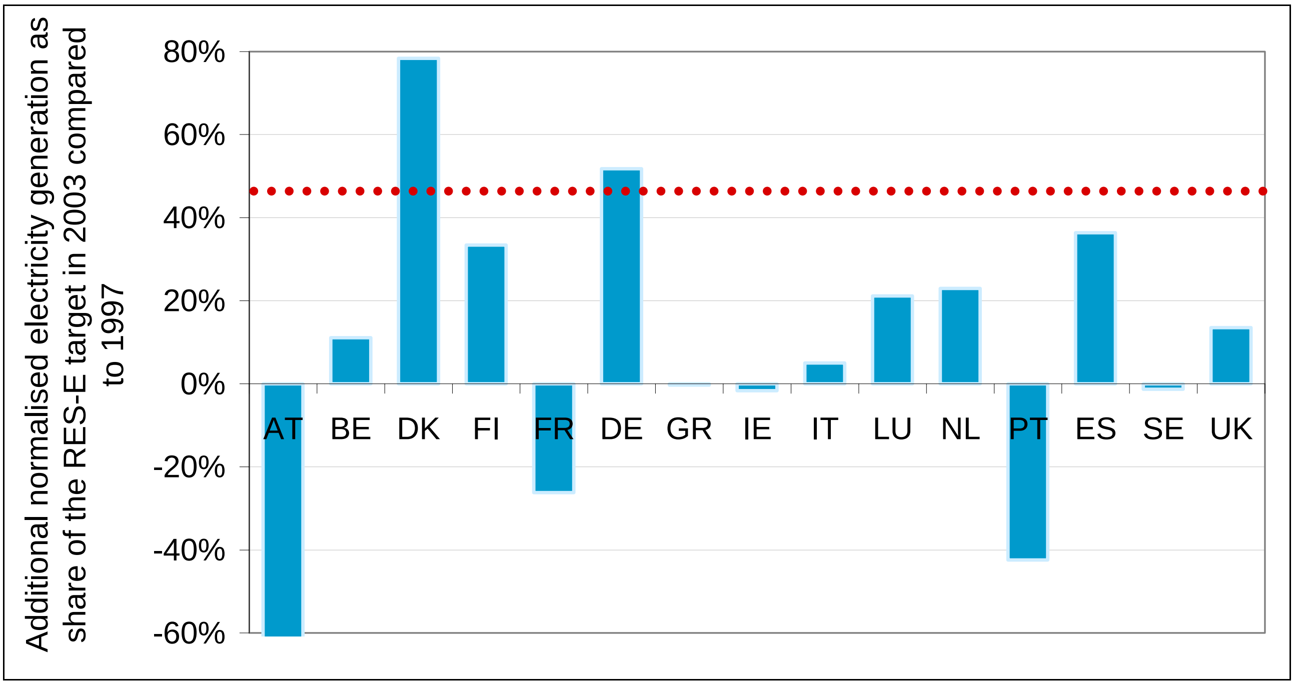
Figure 2: Share of renewable electricity generation potential in gross electricity consumption (2003 versus 1997) based on the normalised electricity generation.



As can be observed, only a few countries have actually significantly increased their RES-E share within the period considered. Notably Denmark, Finland, Germany and Spain have made reasonable progress towards reaching the 2010 targets. The remaining countries will have to make greater efforts to promote RES-E in order to meet the 2010 targets. Clearly, there are two different explanations for slow progress in reaching the RES-E target: Not enough progress in the development of renewable technologies or a high growth in gross electricity consumption.

In Figure 3 we show the progress made in reaching the 2010 Member State targets in more detail by depicting the fraction of the difference to target between 1997 and 2010 already achieved in 2003. If countries are on track, they should have fulfilled 46.2% of the difference to target by 2003 with a linear annual breakdown of the target.

Figure 3: Additional normalised electricity generation as a share of the total additional generation potential needed by 2010 according to the RES-E directive in 2003 compared to 1997 (100% represents the objective of additional electricity generation between 1997 and 2010, the red line shows the interim target from 1997 to 2003).

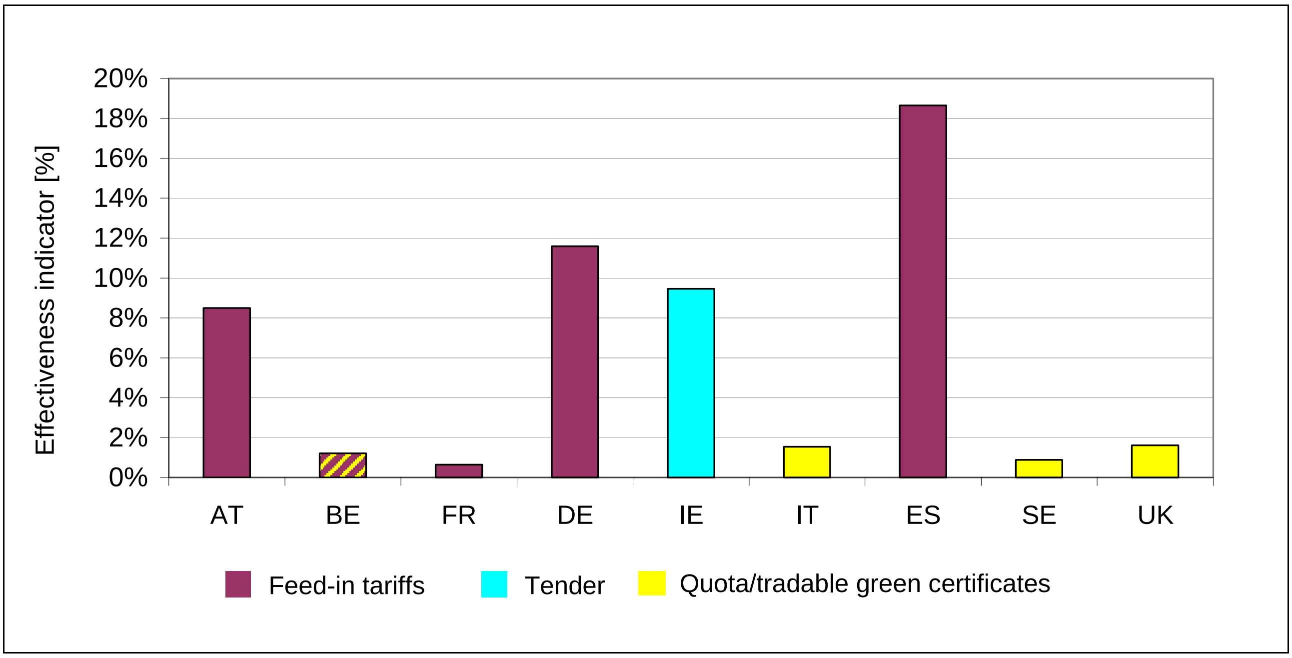


As can be seen, apart from Austria, France and Portugal, most countries have increased their RES-E share since 1997. However, only Denmark and Germany show the growth needed to reach the target based on a linear extrapolation of the historical development, followed by Finland and Spain. The positive development in Denmark was mainly due to a strong onshore wind support system in the 90s, which was abolished in 2001, and some recently realised off-shore projects. Renewable energy policy in Germany, Spain and Finland has not undergone significant changes. This shows that the stability of a policy instrument is a crucial success factor for the promotion of renewable energies. Belgium, Sweden and Italy experienced important policy shifts during the considered time horizon and show a clearly slower market growth of RES-E.

5 Effectiveness and economic efficiency of the implemented support schemes in selected EU Member States – empirical investigations

In this section we present an overview of the effectiveness and economic efficiency of support in the area of **wind energy** for selected EU Member States. Effectiveness is defined by the ratio of the additional annual normalised electricity generation and the realisable remaining potential until 2020. Figure 4 shows the onshore wind effectiveness indicator for the year 2004.

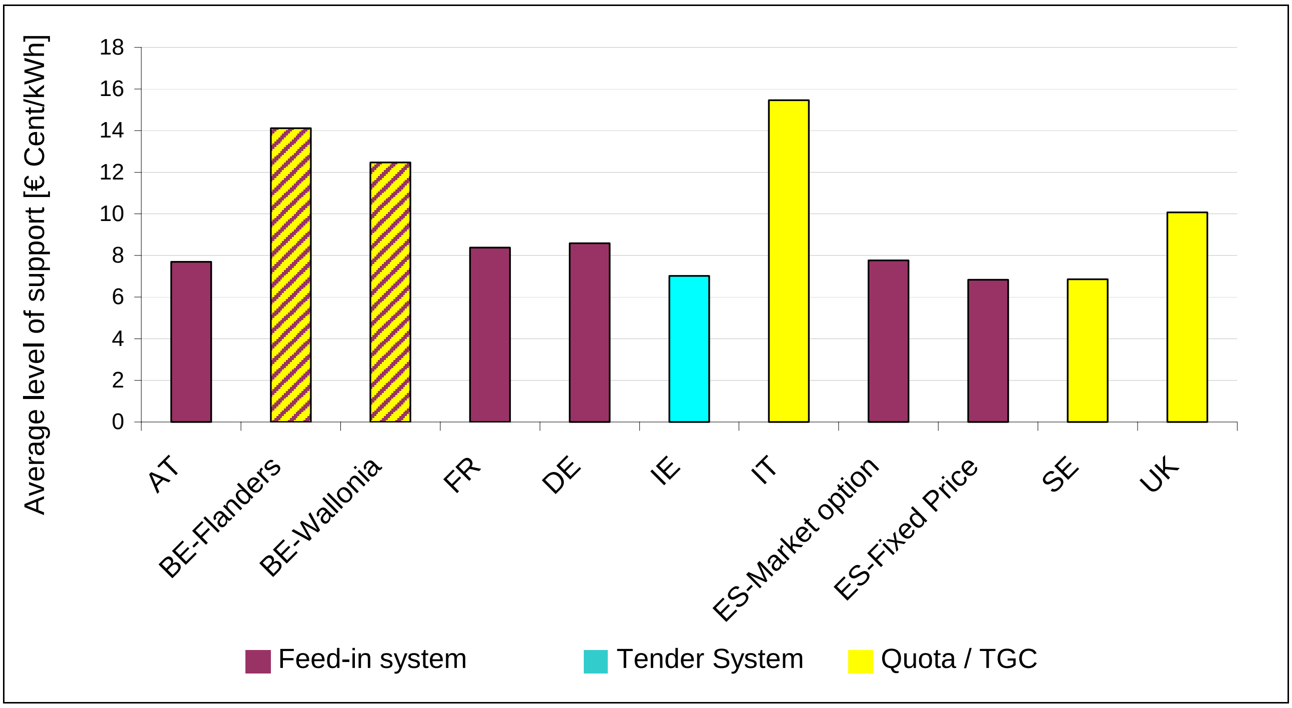
Figure 4: Effectiveness indicator for the market development of onshore wind for selected EU-Member States in 2004. Effectiveness is defined by the ratio of the additional annual normalised electricity generation and the realisable remaining potential until 2020 (diagonal shading for Belgium indicates that the Belgian quota system is combined with a minimum tariff)



Several messages can be derived from Figure 4. Firstly, the three Member States Spain, Germany and Ireland showed the highest effectiveness in 2004. In contrast, the four countries using a quota obligation - Belgium, Italy, Sweden and the UK - only achieved moderate effectiveness. In 2004, the Irish tender system reached a higher level of effectiveness than in former years because of the exceptionally ambitious targets set in the last bidding round in 2003.

In a first step towards analysing the economic efficiency of support, the actual level of payments per kWh of electricity generation in the year 2004 are presented for the policy systems considered (see Figure 5).

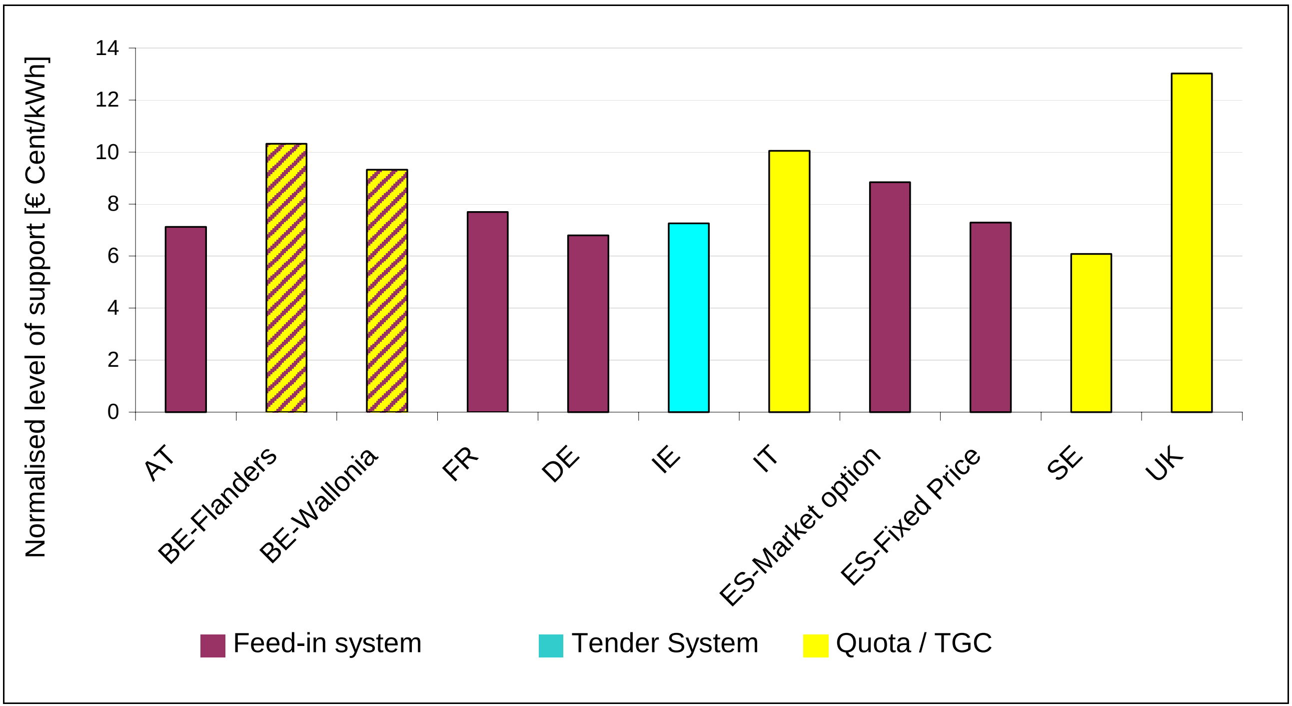
Figure 5: Comparison of support for onshore wind power for selected EU Member States in 2004 (diagonal shading for Belgium indicates that the Belgian quota system is combined with a minimum tariff)



Observing Figure 5, the feed-in tariffs turn out to be generally lower than the sum of certificate price and electricity price in those countries applying quota systems. One exception is the very low support level in Sweden. The Irish tender system is also characterised by a relatively modest support level.

Since the tariff level disregards important characteristics of the support policies such as the duration of payment, relevant additional support measures and country-specific resource availability, the annual payments presented in Figure 5 then have to be translated into a quantity that takes these characteristics into account. Therefore, Figure 6 shows the support level adjusted by the factors mentioned. The duration of support is accounted for by calculating the annuity of the support level based on a uniform interest rate of 6.6% and 15 years. Resource availability is accounted for by normalising the support level to a uniform number of 2000 full-load hours per year. The certificate price is assumed to remain constant within this calculation.

Figure 6: Normalised level of support for onshore wind in selected EU Member States in 2004 (the data presented is scaled for the country-specific duration of support, additional support measures and country-specific resource conditions are considered. Diagonal shading for Belgium indicates that the Belgian quota system is combined with a minimum tariff)



The normalised support level is an adequate indicator of the economic efficiency of the support scheme. The main message of Figure 6 is basically the same as Figure 5 and shows that the support level of countries with feed-in systems is typically lower than those with quota systems. Indeed, normalisation leads to a clear drop in the support level in Italy due to taking the support duration into account (8 years) and a strong increase in the UK due to above-average wind conditions there.

Finally, we correlate the effectiveness indicator and the normalised support level in Figure 7. An alternative approach to calculating the actual support over the entire lifetime is to include electricity generation costs by determining the average expected annuity of the renewable investment (see Figure 8). The annuity calculates the specific discounted average return on every kWh produced by taking into account income and expenditure throughout the entire lifetime of a technology. Thus, country-specific differences with respect to investment costs are considered as well.

Figure 7: Effectiveness indicator in relation to the normalised level of support for onshore wind in 2004

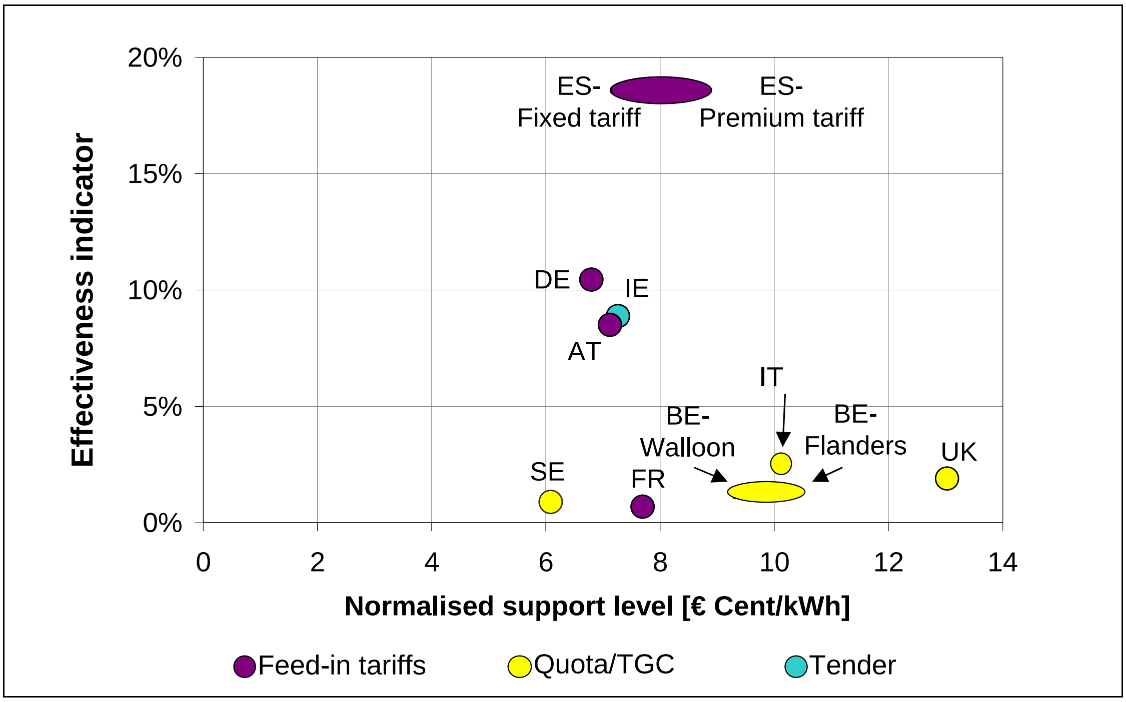


Figure 8: Effectiveness indicator in relation to the annual expected profit for onshore wind in 2004

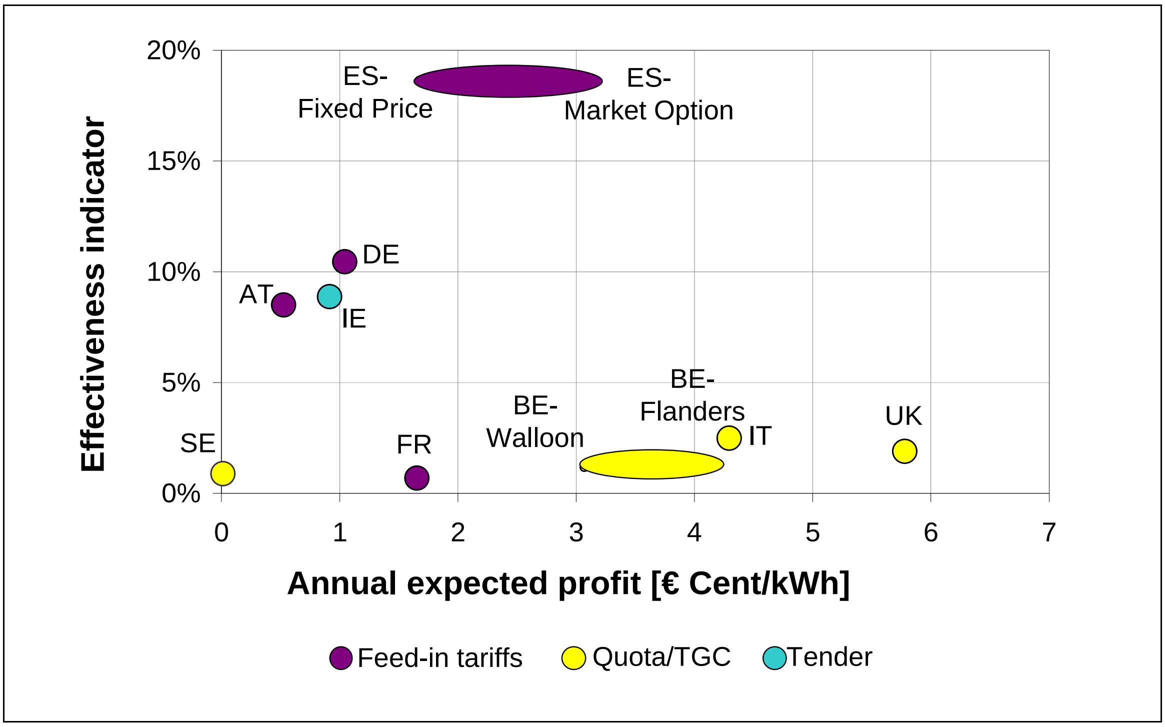


Figure 7 and Figure 8 are interpreted as follows:

- Generally, the expected annuity and the effectiveness show a broad spectrum in quantitative terms for the countries under consideration. It has to be mentioned that there are different levels of experience with the different instruments and that policy schemes in some countries - in particular quota obligation systems - are still in a transitional period.
- It is striking that three countries - Italy, the UK and Belgium - which have recently transformed their markets into quota systems as the main support instrument, have a high expected annuity of support but low growth rates. The high annuity results in particular from the extrapolation of the presently observed certificate prices.
- Based on the assumption of constant certificate prices, which is mainly justified by empirical observations[1], the results show that certificate systems can lead to high producer profits resulting from high investment risks[2].
- On the other hand, it seems typical for countries with feed-in tariffs to be more effective at generally moderate levels of support. An exception to this rule is France, where administrative barriers are preventing the rapid development of wind energy.
- Spain had the highest growth rates in terms of the effectiveness indicator offering an adequate profit. Profits are expected to be higher in Spain than in the other feed-in countries not because of a high support level, but because of relatively low electricity generation costs due to good resource conditions on the one hand and low investment costs on the other hand.
- Ireland reached a level of effectiveness in 2004 similar to countries with feed-in tariffs like Germany and Austria and with a similar expected profit despite a significantly lower absolute support level. A lower support level than in Germany is possible in Ireland because of the significantly better wind resources (2600 full load hours have been assumed for the typical Irish location, the corresponding figure in Germany amounts to 1800).[3]
- Since relatively favourable wind conditions were assumed for Austria, the support level does not seem to be able to stimulate further capacity growth for sites with unfavourable wind conditions. As a consequence it can be suspected that the effectiveness of the Austrian support system will drop in the future since the quality of remaining wind sites usually decreases in line with capacity growth.
- In Sweden, the small growth in wind power is the result of a very low expected profit.

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1 So far there is no clear trend of decreasing certificate prices under the different quota systems in the EU. Such a decrease should be expected only if the risk level on existing certificate markets falls significantly.

2 It should be stated here that if long-term contracts are negotiated by the RES producer and the obliged party, e.g. a utility, only a certain fraction of the 'producer profit' will actually be earned by the RES producer.

3 The high Irish growth rate in 2004 has to be looked at very carefully since the comparatively high capacity development in 2004 is due to the impacts of the last bidding round. The growth rate was much smaller in other years (a tender system seems to be an instrument which supports rapid growth in a short period of time).

As a general conclusion it can be stated that the feed-in systems examined are effective at relatively low producer profits. On the other hand, it can also be observed that the present quota systems only achieve rather low effectiveness at comparably high profit margins. We would like to emphasise, however, that these quota systems are relatively new instruments in the countries currently applying them. Therefore the behaviour observed might still be marked by significant transient effects.

6 Model-based analysis of future transfer costs for consumers

In this chapter, an evaluation of the different support schemes for RES-E is conducted from a future perspective based on calculations made with the help of the computer model ***Green-*****X** developed within the EU-project Green-X (see also www.green-x.at). The independent computer programme ***Green-*****X** applies the concept of dynamic cost-resource curves and allows different scenarios to be simulated, enabling a comparative and quantitative analysis of renewable energy policies in the European electricity sector.

The core questions of the analysis are:

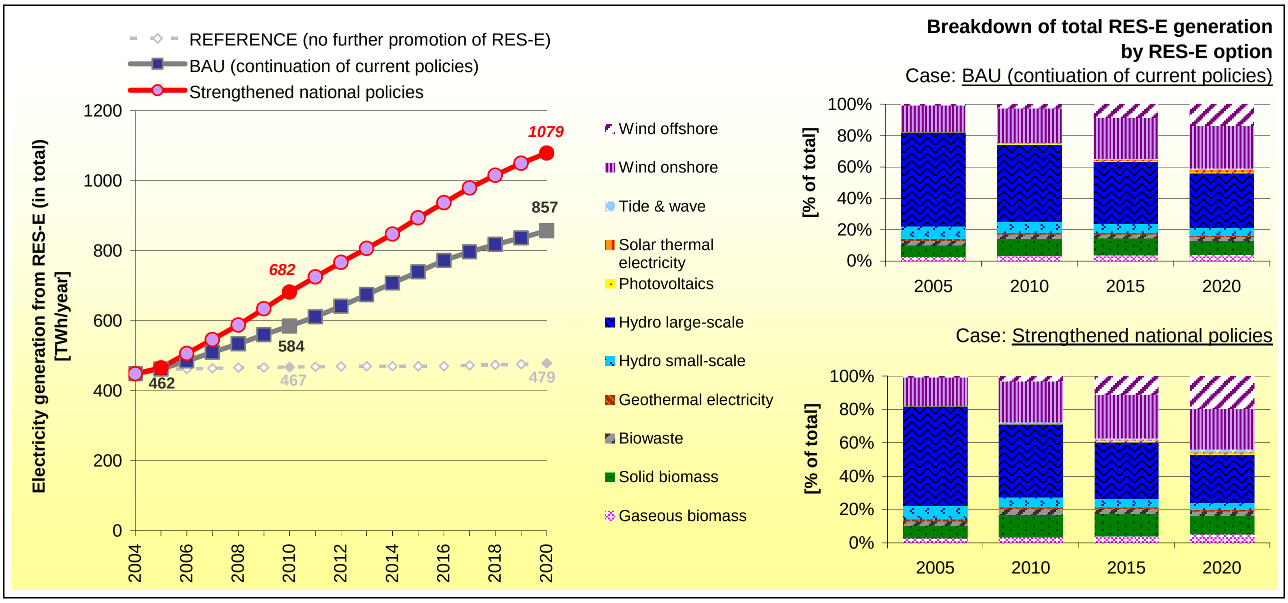
What share of renewable energy sources in gross electricity consumption can be expected for 2010 and 2020 assuming current policies are continued? What are realistic renewable targets for 2020 assuming greater policy efforts? The transfer costs of promoting renewables are analysed for different support strategies with regard to several future policy developments.

In detail, the four scenarios are based on the following assumptions: (1) Current national support policies will continue. (2) Current national policies are optimised. (3) EU-wide harmonisation of renewable support policies. (4) Coordination of instruments between several Member States at "cluster level".

Based on these assumptions, the economic efficiency of policy instruments is analysed in depth. In doing so, the transfer costs for consumers (due to the promotion of RES-E) are the dominant indicator for the assessment.

The possible future RES-E development up to 2020 is outlined in Figure 9. Without any changes in the support schemes in place at country-level (i.e. scenario (1), BAU), electricity production would rise to about 584 TWh/a in 2010 (19.1% of gross electricity demand) and 857 TWh/a in 2020 (24.6%). The figure for 2010 is around 93 TWh/a lower than the indicative target mentioned in the ‘RES-E Directive’ (2001/77/EC). In contrast, a rigorous and immediate improvement of the support conditions (including a removal of non-financial barriers) in all countries (scenario (2)) would make it possible to meet the overall RES-E target at EU-15 level. In this variant, a RES-E generation of 682 TWh (22.2%) will be achieved by 2010, rising to 1079 TWh (30.9%) by 2020.

Figure 9: Development of **total RES-E generation** in the period 2004 to 2020 at EU-15 level in the case of policy continuation and with strengthened national policies

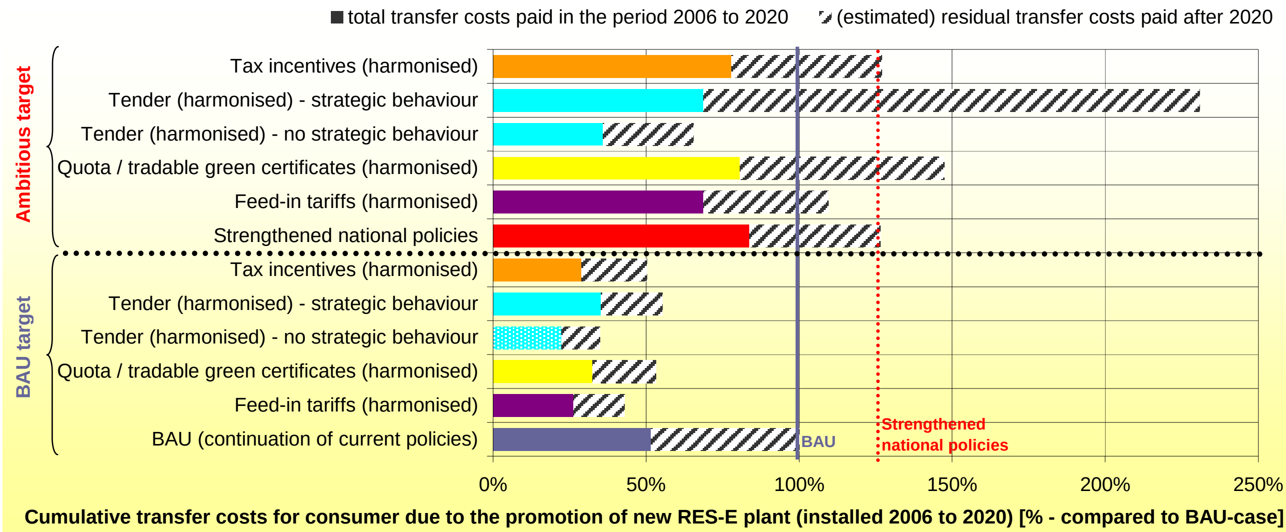


Looking at the economic efficiency of the support schemes, the following conclusions can be drawn: More than two thirds of possible future efficiency improvements can be achieved by optimising the existing policy instruments. Activating national cost reduction potentials is the key factor for increasing cost-efficiency. This is valid for the "business as usual" case as well as for the ambitious target assumption. In addition, removing administrative deficiencies and a stable policy background also bring about efficiency improvements, since stop-and-go policies are likely to result in higher risk premiums and thus to higher transfer costs for society.

Assuming the harmonisation of one policy instrument within Europe or at least between several Member States ("cluster-level"), further efficiency improvements could be achieved introducing technology-specific support. Technology-specific support leads to a reduction of windfall profits. The most suitable system for this is the feed-in tariff model, since special tariffs can be defined for the different renewable energy technologies. In the case of a successful tariff design, low transfer costs can be expected, but if this is not the case, efficiency losses have to be expected even with harmonisation.

The results of the analysis are shown in Figure 10. It is clear that the maximum efficiency is achieved with harmonised feed-in tariffs. Further reductions of transfer costs would be possible when applying tendering schemes – but only if strategic investor behaviour is neglected. However, the historical analysis showed that this assumption seems unrealistic. Taking into account strategic behaviour, the associated support costs of a tender system are even higher than other support schemes. The introduction of a harmonised quota obligation also leads to higher support costs compared to strengthened national policies or a harmonised feed-in system, since investors have to assume higher investment risks. Furthermore, quota systems tend to rise over the years. This is because only the most cost-efficient technologies are supported at the beginning, whilst less mature technologies are neglected. But as soon as quotas can no longer be met just with these mature technologies, more expensive technologies have to be included. Since the most expensive technologies needed to meet the quota determine the certificate price, considerable windfall profits are caused for the cost-efficient technologies.

Figure 10: *Comparison of **necessary cumulated consumer expenditure** for the BAU-target (bottom) and the ambitious target (top) due to the promotion of new RES-E in harmonised support schemes*



7 Conclusions

In this study, the promotion of renewable energy sources in the Member States of the EU was analysed with respect to effectiveness as well as economic efficiency. Regarding these criteria, the promotion instruments should, on the one hand, sufficiently stimulate the markets for renewables and have low social transfer costs on the other. The results of the study make it clear that the level of financial support is not the only reason behind the successful development of renewable energies. Besides the tariff level, a stable and constant policy framework, the reduction of investment risks and the removal of non-economic barriers all represent crucial factors which influence the success of RES-E support. Feed-in tariff systems were identified as an appropriate instrument for supporting renewable energies in terms of effectiveness and efficiency, whereas quota systems still have to prove themselves in practice. Finally, we concluded that the opportunities and risks of an EU-wide policy harmonisation should be analysed in detail based on real-term market experiences. This would help to reduce the risk of endangering the market development in the evolving renewable energy sector.

Design criteria for RES-E support instruments

Some design criteria for RES-E policy instruments are generic, i.e. they should be implemented regardless of the specific support scheme under consideration. We list these design criteria first before moving on to the design criteria for the different instruments: feed-in tariffs, quota systems based on TGCs and tender systems.

Generic design criteria:

- The full basket of technologies given in the RES-E directive which can be reasonably utilised in a given country should be included in a support scheme. This requirement encompasses the inclusion of the least-cost generation options, e.g. refurbishment of large hydropower, as well as of less mature and more expensive technologies, e.g. concentrating solar power in southern European countries. Least-cost generation options contribute to a high static efficiency of the support scheme, whereas the early promotion of less mature technologies increases the dynamic efficiency.
- Long-term and sufficiently ambitious targets should be set in order to ensure a sufficient level of investor security.
- A transparent and fair access to the electricity grid should be provided.
- Generally, the financial support level should be higher than the marginal costs of generation (in the case of a quota system the penalty level is relevant).
- The support offered by any promotion instrument should be restricted to a certain time frame.
- Only new capacities should be considered in any adaptation or change of the instrument.
- The abuse of market power in the different markets should be avoided; it is important to consider compatibility with the conventional power market and other policies. This requirement applies to premium feed-in systems and quota systems in particular.
- Another aspect is to secure stability for investors in RES-E technologies; the policy instrument should remain active long enough to provide stable planning horizons. It follows that stop-and-go policies are not suitable and that, for a given project, the support scheme should not change during its lifetime.

Quota System

- Guarantee a sufficient market liquidity and competition within TGC markets in order to secure market functionality.
- The penalty needs to be set correctly, i.e. it should be significantly higher than marginal production costs at quota level.
- Additional support has to follow the quota system in order to support less mature technologies unless the system is designed to support different types of technologies, e. g. by using tech-

nology-specific certification periods.

- A guaranteed minimum tariff should be implemented in immature markets in order to ensure investment security.
- The quota should be set with a long time horizon in order to ensure investment security.

Feed-in System

- The level of tariffs should be guaranteed for a sufficiently long duration in order to reduce investment risks.
- Technology-specific tariffs should be used and the level of tariffs should be sufficiently high.
- In order to enforce technological learning, the tariff offered for new contracts should decrease clearly over time.
- If possible, a stepped tariff design should be implemented to reduce windfall profits and therefore reduce costs for consumers.

Tender System

- Ensure continuity of calls and predictability over time.
- Tenders should be technology-specific and a reasonable capacity (not too high and not too low) should be included in them. If capacity is too low, administration and transaction costs increase, if the capacity is too high, the options for strategic bidding increase.
- The interaction with other policy objectives has to be considered beforehand, e.g. environmental planning rules have to be coordinated at an early stage in order not to violate the projects (successful bids) in the realisation phase.
- A penalty for non-compliance should be implemented in order to avoid unreasonably low bids.

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