

Resch, Gustav; Ragwitz, Mario; Held, Anne; Faber, Thomas; Haas, Reinhard

Article

Feed-in Tariffs and Quotas for Renewable Energy in Europe

CESifo DICE Report

Provided in Cooperation with:

Ifo Institute – Leibniz Institute for Economic Research at the University of Munich

Suggested Citation: Resch, Gustav; Ragwitz, Mario; Held, Anne; Faber, Thomas; Haas, Reinhard (2007) : Feed-in Tariffs and Quotas for Renewable Energy in Europe, CESifo DICE Report, ISSN 1613-6373, ifo Institut für Wirtschaftsforschung an der Universität München, München, Vol. 05, Iss. 4, pp. 26-32

This Version is available at:

<https://hdl.handle.net/10419/166923>

Standard-Nutzungsbedingungen:

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.

Terms of use:

Documents in EconStor may be saved and copied for your personal and scholarly purposes.

You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.

If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.



FEED-IN TARIFFS AND QUOTAS FOR RENEWABLE ENERGY IN EUROPE*

GUSTAV RESCH**,

MARIO RAGWITZ***,

ANNE HELD***,

THOMAS FABER** AND

REINHARD HAAS**

Renewable electricity has increased significantly in recent years on a global scale and especially within Europe. A major reason for this development at the European level is the national support strategies triggered by Directive 2001/77/EC on renewable energies in the electricity sector (European Parliament and Council 2001), which set the renewable energy sources (RES-E) target of 21 percent at the EU-25 level for the year 2010 and specified corresponding targets for all 25 member states. All EU member states have introduced policies to support the market introduction of RES-E and most of them have started to improve the corresponding administrative framework conditions (e.g. planning procedures, grid connection) as well. The market diffusion of new renewable energy technologies has increased significantly over the last decade. The existing support instruments encompass feed-in tariffs (FITs), quota-based tradable green certificates (TGCs), investment grants, tender procedures and tax mea-

sures. Up to now, these policies have been implemented exclusively on a national level and aim to fulfil the national targets as set in the RES-E directive. However, based on the currently implemented policies, these targets will most likely not be met in the majority of countries, which indicates that RES-E support systems are still not designed in a suitable way.

Evaluation of policy instruments for promoting renewable electricity from a historical perspective

Classification of policy instruments and development of RES-E policies in the EU

Within this study, the assessment of direct regulatory promotion strategies is carried out by focusing on a comparison between price-driven (e.g. FITs) and quantity-driven (e.g. quotas based on TGCs) strategies, which can be defined as follows:

Feed-in tariffs (FITs) are generation-based, price-driven incentives. The price that a utility or supplier or grid operator is legally obligated to pay for a unit of electricity from RES-E producers is determined by the system. Thus, a federal (or regional) 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 when evaluating the actual financial incentive. FITs allow technology-specific promotion and acknowledge future cost-reductions by applying dynamically 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 or consumer) with their fulfilment. Once defined, a parallel market for renewable energy certificates is established and their price is set following

* This assessment of the effectiveness and economic efficiency of support schemes for renewable electricity was conducted for the European Commission, DG TREN within the European research project OPTRES (www.optres.fhg.de). For a detailed discussion of the above illustrated topic we refer to Ragwitz et al. 2007.

The authors and the whole project consortium gratefully acknowledge the financial and intellectual support of this work provided by the Intelligent Energy for Europe – Programme. In particular, special thanks go to the project officers Beatriz Yordi, DG TREN, and Ulrike Nuscheler, IEEA.

** Vienna University of Technology, Institute of Power Systems and Energy Economics, Energy Economics Group, Vienna, Austria.

*** Fraunhofer Institute Systems and Innovation Research, Karlsruhe, Germany.

E-mail of lead author: Gustav.Resch@tuwien.ac.at.

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. In principle, technology-specific promotion is also possible in TGC systems. But it should be noted that separate markets for different technologies will lead to much smaller and less liquid markets.

Figure 1 shows the evolution of the main support instrument for each country. Only 8 of the 15 countries regarded did not experience a major policy shift during the period 1997–2006. 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 have replaced existing policy instruments in some European countries, such as Belgium, Italy, Sweden, the UK and Poland. Other policy instruments, such as tender schemes, are no longer 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.

Effectiveness of policy instruments

The effectiveness of a policy for renewable electricity is based on its ability to increase the generation of

electrical power. The definition of effectiveness used in this analysis is given in the following equation:

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

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 Directive 2001/77/EC, are also mainly based on the realisable generation potential of each country.

Figure 2 shows the average annual effectiveness indicator for wind onshore electricity generation for 1998–2005 for EU-15 countries. Several findings can be derived from these figures. Firstly, the three member states showing the highest effectiveness during the considered period – Denmark, 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 the section below, the tariff level is not particularly high in these two countries compared with the other countries analysed here. This indicates that a long-term and stable policy environment is actually the key criterion for the

Figure 1

EVOLUTION OF THE MAIN POLICY SUPPORT SCHEMES IN EU-15 MEMBER STATES

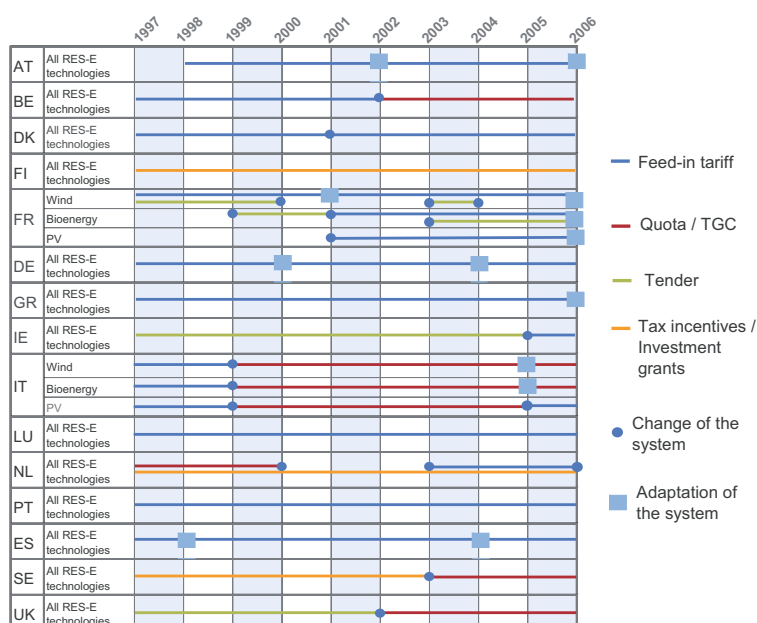
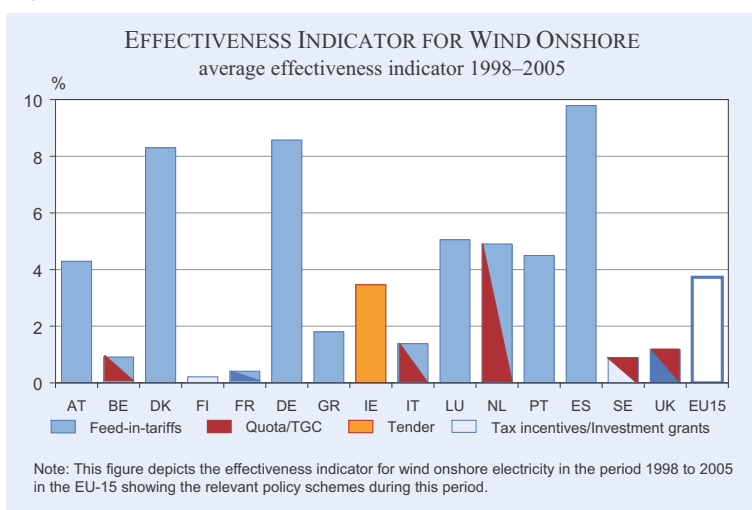


Figure 2



success of developing RES-E markets. As can be observed in 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.

Economic efficiency from society's point-of-view

In order to analyse the economic efficiency of support from a historical perspective we compare the level of support in the case of wind energy onshore and the corresponding costs of electricity generation. Based on this definition the analysis shows (see Figure 3) 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, where support is presently significantly

higher than the costs of generation. The reasons for the higher support level expressed by the current green certificate prices include still immature TGC markets, the non technology-specific design of the currently applied TGC-systems as well as the higher risk premium requested by investors. In the case of Spain and Germany, the support level indicated in Figure 3 appears to be above the average level of generation costs. However, the low cost potentials have already been exploited in these countries due to recent

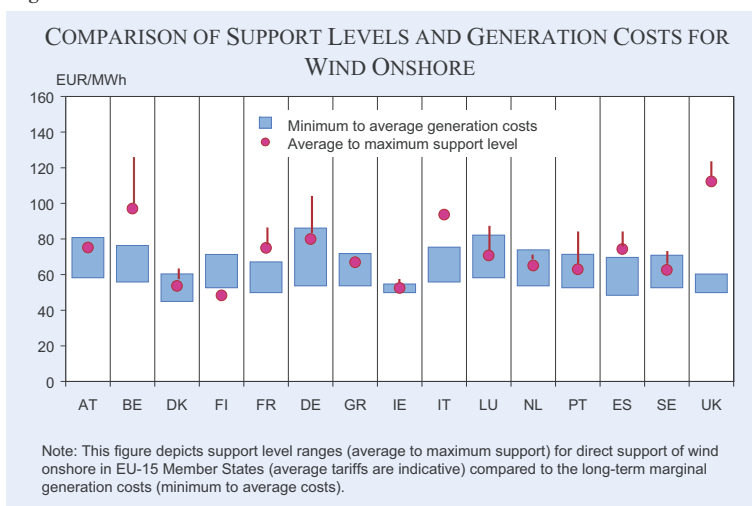
success in market growth. Therefore a level of support that is moderately higher than average costs seems to be reasonable.

Expected revenues and profits for investors

In order to correlate the effectiveness of an instrument with the efficiency of support as defined in the previous section, the levelised profit of potential wind energy investments was calculated for Austria, Belgium, the Czech Republic, France, Germany, Ireland, Italy, Lithuania, Spain, Sweden and the UK for the year 2004. Thus, calculations are based on the effective support conditions in each country during 2004.

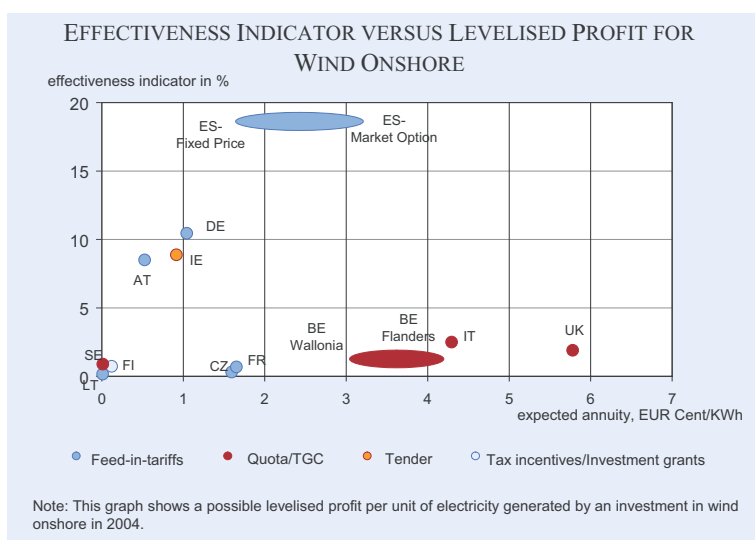
By plotting the effectiveness versus the levelised profit as shown in Figure 4, the correlation between the levelised profit for investments and the level of effectiveness attained by the support instrument in the respective year is analysed.

Figure 3



In Figure 4, the expected levelised profits as well as the effectiveness show a broad spectrum 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 transformed their markets by introducing quota systems as the main support instrument

Figure 4

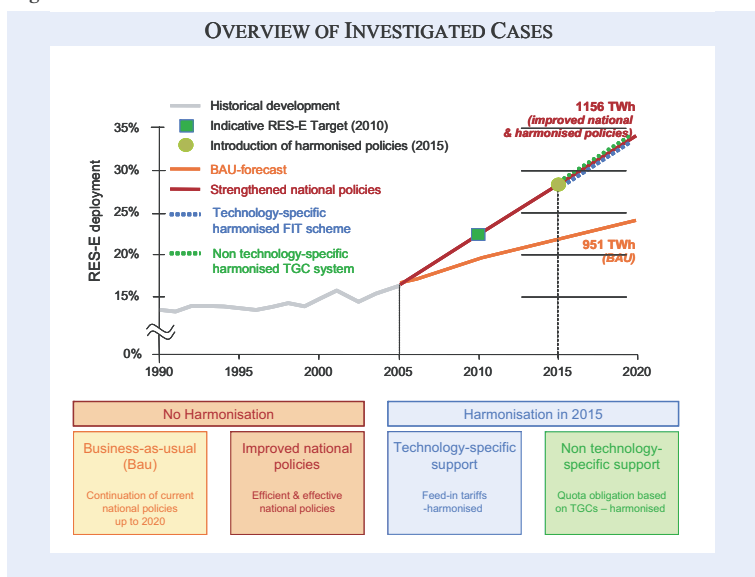


between 1999 and 2002, are characterised by expected high levelised profits but low effectiveness. The high levelised profit results in particular from the extrapolation of the presently observed certificate prices. The results show that certificate systems lead to higher producer revenues than FITs, which compensate for high investment risks. Furthermore, the recent development of certificate prices does not show any decreasing tendency. 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 from the investor's perspective is significantly lower for FITs is directly linked with a higher efficiency of this strategy because additional costs for consumers are lower.

based on applied energy policy strategies in a dynamic context. Geographically the assessment refers to the European Union as of 2006, comprising 25 member states (EU-25).

Figure 5 indicates the investigated scenario paths and the resulting RES-E deployment – comprising a business-as-usual (BAU) case based on a continuation of current national support schemes (BAU), a national improvement and a harmonisation of RES-E support at the European level based on either technology-specific support, i.e. a feed-in tariff system with technology-specific differentiated tariffs, or uniform support, i.e. a quota obligation based on TGCs commonly applied for all RES-E options.

Figure 5



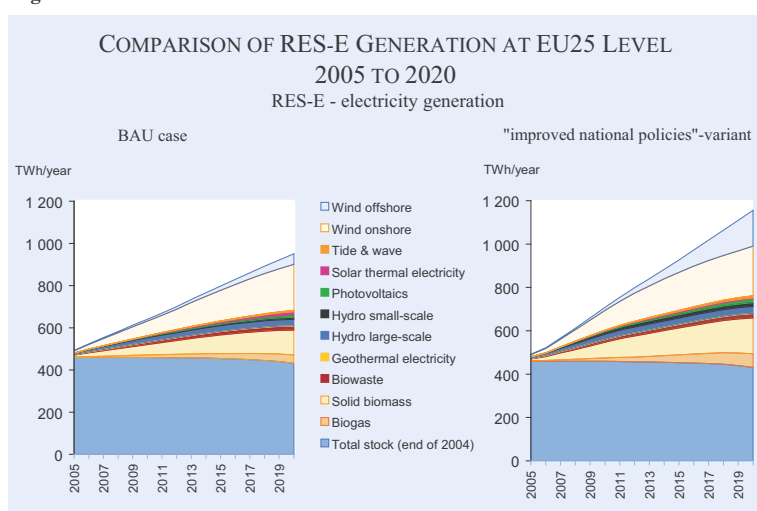
Prospective analysis based on the model *Green-X*

In this section we aim to signpost the way forward by presenting a prospective analysis of possible future RES-E support options at the European level. The effectiveness and efficiency of support schemes is based on the results obtained from simulation runs using the Green-X model (www.greenx.at). This tool enables us to make a comparative and quantitative analysis of the future deployment of RES up to 2020 in all energy sectors (i.e. electricity, heat and transport)

Results with regard to non-harmonised conditions – BAU & improved national policies-scenario

In 2004 the total amount of RES-E generation within the EU-25 was around 460 TWh, corresponding to a share of about 15 percent of gross electricity demand. Without any changes to the current support schemes of the various member states, RES-E would achieve a demand share of 18.2 percent in 2010 at EU-25 level. If RES-E support is accompanied by energy efficiency measures as assumed for a sensitivity variant to the BAU case, a higher

Figure 6



demand share of 18.8 percent is feasible in 2010. By 2020, these differences will become more apparent: a share of 23.6 percent is projected for the default BAU case, whilst deployment in relative terms is 27 percent for BAU with accompanying DSM.

In contrast, it would be feasible to meet the European target as set by the RES-E Directive by improving the support conditions for RES-E rigorously and immediately in all EU countries, including a removal of non-financial deficiencies and the implementation of energy efficiency measures. In the “improved national policies” case, a RES-E share of 20.9 percent is reached in 2010, rising to 34.1 percent in 2020.

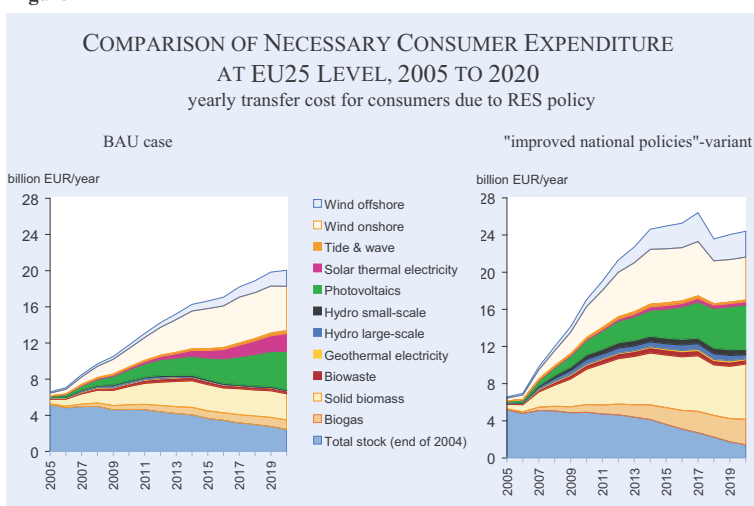
The dynamic development of RES-E generation in both cases is depicted in absolute terms at the EU-25 level in Figure 6. This graph illustrates the technology-specific deployment for new RES-E plants and shows the total RES-E stock (indicated by the blue area) comprising all plants installed up to the end of 2004. If currently implemented RES-E policies are maintained, as assumed in the BAU case, the total amount of RES-E generation will increase from 460 TWh in 2004 to about 951 TWh in 2020. This 2020 figure comprises almost equal contributions of new RES-E installations (from 2005 to 2020) in the order of 520 TWh (55 percent of total RES-E) and the stock of exist-

ing RES-E plants installed prior to 2005, which account for 431 TWh (equal to a share of 45 percent in total RES-E generation) by 2020 in the BAU case. “Improved national policies” will induce a much higher deployment of new RES-E in the investigated period: by 2020 this will amount to 725 TWh from new RES-E plants installed between 2005 and 2020, corresponding to 63 percent of the total RES-E generation of 1156 TWh.

Figure 7 illustrates the required consumer expenditure for both cases investigated at the EU-25 level due to the underlying national RES-E policies and the corresponding induced RES-E deployment. In this context, the consumer / societal expenditure due to the support for RES-E represents a net value based on the direct costs of applying a certain support scheme. This figure also illustrates both the technology-specific shares of new RES-E plants and the expenditures associated with the stock of existing RES-E plants (indicated by the blue area).

The required consumer expenditures will increase steadily over the next ten years with BAU. In relative terms, expressing the expenditures as a premium per MWh total demand, these are projected to rise from a level of 2.1 EUR/MWh_{DEMAND} in 2005 up to about 5.0 EUR/MWh_{DEMAND} in the final years 2019 and 2020. Obviously, within the “improved national poli-

Figure 7



cies” variant, characterised by a 40 percent higher RES-E deployment in the investigated period 2005 to 2020, even greater financial support is required to achieve the ambitious RES-E target set for 2010. Accordingly, a steeper increase in expenditure in the period up to 2017 occurs, culminating in a peak at 7.7 EUR/MWh_{DEMAND} in 2017.

Harmonisation: Technology-specific versus uniform support

Besides the above discussed national support options (i.e. BAU and “Improved national policies”) the following policy options at the European level are investigated below:

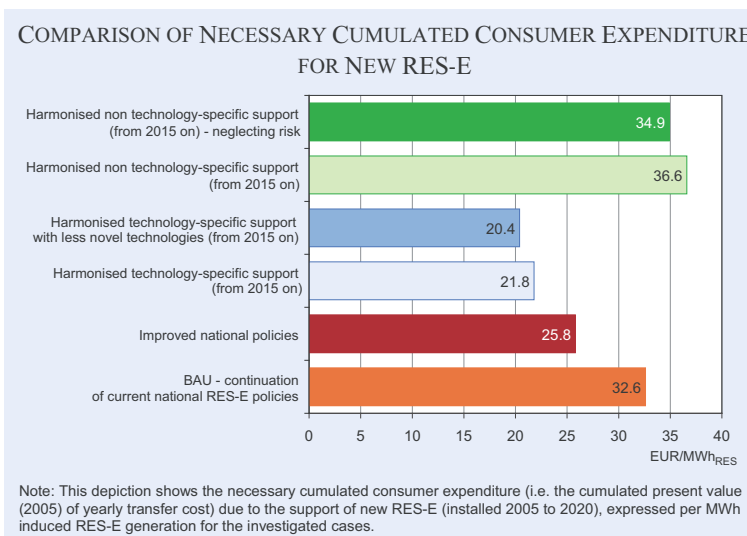
- *Harmonisation of support based on a uniform (non technology-specific) support scheme*, i.e. a quota obligation based on TGCs commonly applied for all RES-E options.
- *Harmonisation of support based on a technology specific support scheme*, i.e. a feed-in tariff system with technology-specific differentiated tariffs.

In addition, a further variant of each harmonised RES support case is also taken into consideration. Thereby, in case of technology-specific support it is assumed that the support is limited to less novel RES-E technologies, whilst in the case of non-technology-specific support the variant refers to the negligence of the investor’s risk (as commonly associated with uncertain earnings in the TGC market).

One target is assumed for future RES-E deployment in 2020 in all cases based on harmonised support in order to be able to compare the economic efficiency of the different policy options – i.e. it is assumed that about 1156 TWh have to be generated by RES-E at the EU-25 level by 2020, similar to the “improved national policies” case. Note that regarding harmonised support options a transition period is taken into account. Accordingly, new and improved harmonised policies offering equal financial incentives throughout Europe are then applied to new RES-E installations from 2015 onwards.

A comparison of the cumulated consumer expenditure for new RES-E installations – i.e. the total trans-

Figure 8



fer costs due to the promotion of new installations in the observed period 2005 to 2020 as well as the residual costs after 2020 – is shown in Figure 8 for the investigated cases. This figure illustrates both the cost-efficiency and the effectiveness of RES-E support options, expressing the cumulated consumer expenditures in specific terms, i.e. per MWh induced RES-E generation. The following conclusions are drawn from this diagram:

- The cumulated transfer costs for consumers are lowest when applying technology-specific support harmonised throughout Europe achieved by applying feed-in tariffs. There are marginal differences between the two variants, i.e. by considering or neglecting novel RES-E options.
- Improved national policies with a similar deployment of new RES-E result in slightly higher specific costs corresponding to an increase of +18 percent compared to the technology-specific support provided within a harmonised scheme (including novel RES-E options).
- Higher specific costs can be expected from continuing current RES-E support. With BAU, the specific costs are 49 percent higher compared to harmonised technology-specific support. It is worth mentioning that the overall deployment of new RES-E is 29 percent lower with BAU than with all other policy options.
- The most inefficient policy option in terms of costs is harmonised, but non technology-specific support as provided by a uniform EU-wide TGC system, which results in much higher consumer expenditures ranging from + 60 to + 68 percent compared to its technology-specific coun-

terpart incl. novel RES-E options – depending whether the investor's risk is neglected or taken into account.

Conclusions

The empirical findings presented in this paper show that instruments which have proven to be effective also tend to be economically efficient. Feed-in systems, which are implemented in the majority of EU member states, have initiated significant growth of renewable energy generation at moderate costs for society. The main reason for this observation is the long-term price security of the system combined with technology diversification of support. Compared to short-term trading in renewable certificate markets, the intrinsic stability of feed-in systems appears to be a key element for success.

The key criterion for achieving an enhanced future deployment of RES-E in an effective and efficient manner, besides the continuity and long-term stability of any implemented policy, is the technology specification of the necessary support. Concentrating on only the currently most cost-competitive technologies would exclude the more innovative technologies needed in the long run. Furthermore, it would not be possible to achieve any moderate to ambitious RES-E target without considering these novel RES-E options. In other words technology neutrality may be cost-efficient in the short term but is more expensive in the long term.

Even in the short term, the producer profits involved in the promotion of RES-E as well as observable cost differences among cheap to moderate RES-E options suggest a diversification of support. Most of the European success stories of promoting RES-E over the past decades in an effective and economically efficient way were driven by feed-in tariffs, which are implemented in a technology-specific manner.

The results of the modelling exercise clearly indicate that the major part of possible efficiency gains can already be exploited by optimising RES-E support measures at the national level – about two thirds of the overall cost reduction potential can be attributed to optimising national support schemes. Further efficiency improvements at a considerably lower level (about one third of the overall cost reduction potential) are possible through an EU wide harmonisation of the support schemes provided that technology-

specific support is implemented. In contrast, if harmonisation meant putting all the RES-E options in one basket and giving equal support to all the RES-E technologies considered, then the accompanying consumer expenditures would increase significantly if the RES-E target is ambitious. Consequently, a harmonised non technology-specific support would decrease efficiency of support.

References

- European Parliament and Council (2001), Directive 2001/77/EC of September 27th 2001 on the Promotion of Electricity Produced from Renewable Energy Sources in the Internal Electricity Market.
- Ragwitz, M., A. Held, G. Resch, T. Faber, R. Haas, C. Huber, P.E. Morthorst, S.G. Jensen, R. Coenraads, M. Voogt, G. Reece, I. Konstantinaviciute and B. Heyder (2007), *OPTRES: Assessment and Optimisation of Renewable Energy Support Measures in the European Electricity Market*, final report of the research project OPTRES of the European Commission, DGTREN, Intelligent Energy for Europe - Programme (Contract No. EIE/04/073/S07.38567), Karlsruhe, Germany.