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Promoting electricity generation from renewable energy sources in emerging and developing countries – Lessons learned from the EU

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ABSTRACT –

Increasing the share of renewable energy sources for electricity generation (RES-E) has a high priority in the energy strategies of many countries . However, to facilitate a breakthrough for RES-E, several economic, institutional, political, legislative, social and environmental barriers have to be overcome. Of core relevance world-wide is currently the implementation of proper financial support systems.

Since the late 1980s a wide range of strategies to increase the share of RES-E has been implemented in different countries. One of the most heavily discussed issues today is whether trading-based (e.g. the recently announced Guarantee-of-Origin (GoO) trade) or technology-specific instruments (like feed-in tariffs (FIT)) lead to preferable solutions for society. This issue is discussed very controversially in industiralized countries like EU-27 and USA. However, it is even more controversial and cmplex if it addresses emerging and developing (E&D) countries..

The major results conclusions of the corresponding analysis in this paper are: (i) FIT will be a proper instruments in emerging countries where a proper grid exists and where a social acceptance of (low) transfer costs from the electricity customers can be expected; This applies to countries like Brazil, China, India, Indonesia … (ii) for developing countries where solutions are mainly focusing on islanding autonomous stand-alone solutions are based only strategies focusing on (international) support of investments are feasible. (iii) With respect to extended international trade (e.g.. from the Sahara to Europe) a two pillar approach is required: a royalty and a cross-border FIT.

Keywords: *renewable energy, electricity, promotion strategies*

I. INTRODUCTION

Increasing the share of renewable energy sources for electricity generation (RES-E) has a high priority in the energy strategies of many countries. However, to facilitate a breakthrough for RES-E, a series of economic, institutional, political, legislative, social and environmental barriers have to be overcome. It is important to state that these barriers may vary considerably between industrialized emerging and developing (E&D) countries. Of core relevance world-wide is currently the implementation of proper financial support systems.

Currently, a wide range of strategies is implemented in different countries to increase the share of electricity from renewable energy sources: One of the most controversial discussions is whether trading-based (e.g. the recently announced Guarantee-of-Origin (GoO) trade) or technology-specific instruments (like feed-in tariffs (FIT)) lead to preferable solutions for society.

This issue is discussed very controversially in industiralized countries like EU-27 and USA. However, it is even more controversial and complex if it addresses emerging and developing (E&D) countries. In this context it also of interest that the European Commission puts strong focus on the aspect of International cooperation on promotion of RES-E., see [10].

Moreover with respect to international trade in recent months the idea of constructing large solar power plants, e.g. in Northern Africa, and transporting the electricity to e.g. Europe has attracted attention again. In this context a major question is, to what extent and in which form the population of the "host" country could benefit from such a project.

The core objective of this paper is to discuss the perspectives for regulatory promotion systems for electricity from RES in emerging and developing countries based on the lessons learned from EU-countries. Major focus is put on the following promotion schemes: (i)

quota-based GoO trade; (ii) feed-in tariffs (FIT) and (iii) investment subsidies.

II. HOW PROMOTION STRATEGIES WORK

In this section first a survey on regulatory promotion strategies and their features is given. Table 1 provides a classification of regulatory strategies for encouraging the use of RES-E. Of course, a specific programme put into practice may consist of a mix of different strategies. Next it is clarified what the core objectives of promotion strategies are and that with respect to every regulatory strategy an artificial market is created. How different types of promotion strategies work and what are important aspects of promotion strategies from customer's / the public's point-of-view is analysed at the end of the chapter.

The following analysis is based on the concept of static (and further-on dynamic) cost resource curves of RES (see e.g. [3]). Fig. 1 depicts the typical profile of a stepped static cost curve taking into account that every location is slightly different from each other. Different sites are put into certain categories and then a stepped curve emerges Moreover, as Fig. 1 depicts these cost curves are associated with uncertainties. These uncertainties are the higher the more right we move in the diagram.

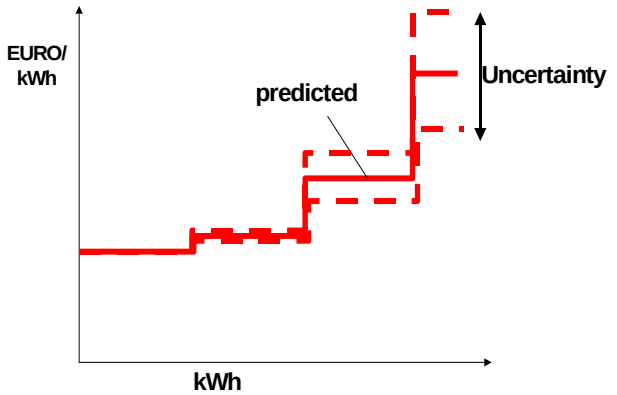

Figure 1 – Stepped (discrete) static cost curve

Based on this static (and further-on dynamic) cost resource curves a TGC-based quota system works as follows: A quantity / quota (=certain percentage of electricity to be guaranteed from renewable energy sources) is set by a government. The generators (producers), wholesalers, retailer or consumers (depending who is obligated in the electricity supply chain) are obligated to supply / consume a certain percentage of electricity from renewable energy sources. At the date of settlement, they have to submit the required number of certificates to demonstrate compliance.

Figure 2 depicts the relationship between total generation costs and the producers' surplus. Of course, investors in new RES-E generation plants should be compensated in a fair way but not by means of exaggerated profits. Hence, the major challenge for policy designers is to strike a reasonable balance between total generation costs and the producers' surplus. The FIT and premium systems in country without trading systems have proven that the RES-E investors accept this approach and provide the proper corresponding investments.

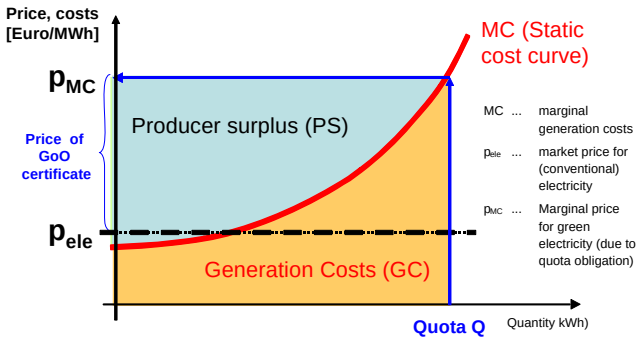

Figure 2 – Basic definitions of the cost elements (illustrated for a tradable GoO certificate system)

III. THE SUCCESS STORY OF PROMOTING RES-E IN THE EU

The success of European promotion strategies for RES-E is depicted in the following Fig. 3 and 4. An almost exponential growth took place since the beginning of the 1990s.

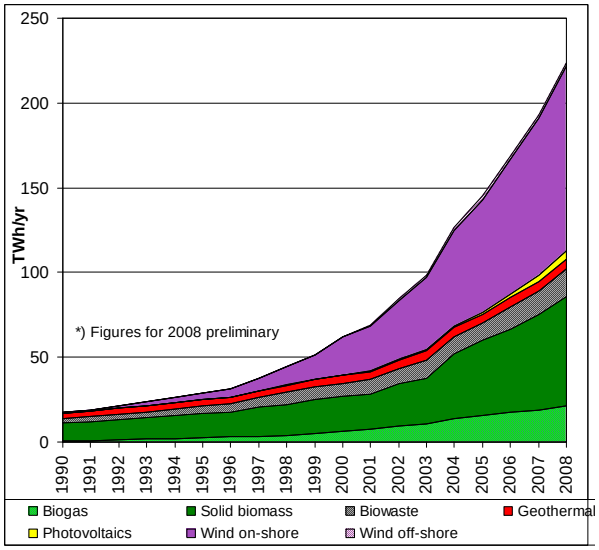

Figure 3 – Development of "new" RES for electricity generation (Source: EUROSTAT)

Of specific interest is the success story of wind in Europe. Figure 4 depicts that first the fore-runners Denmark, Germany and Spain increased the deployment of wind capacity significantly. Since about 2005 other countries like Italy, UK, Ireland, France and Portugal has caught up and today the distribution of new wind capacities installed is broad spread.

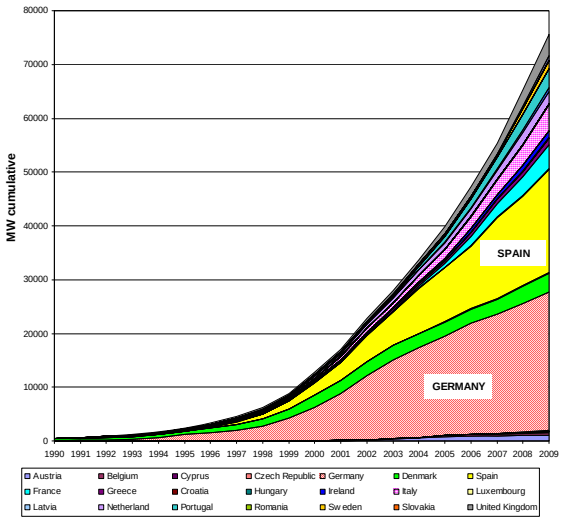

Figure 4 – Development of cumulative wind capacity for electricity generation (Source: EWEA, EUROSTAT)

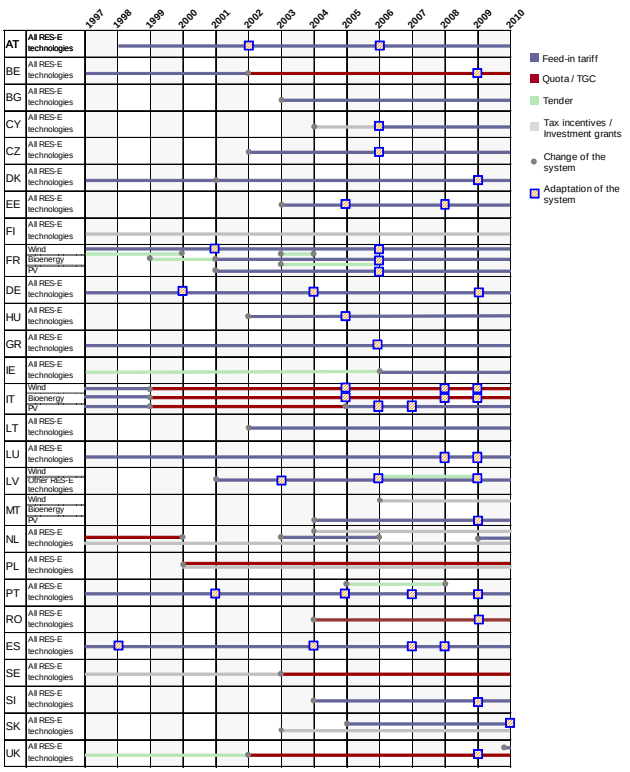

Figure 5 – Evolution of support instruments in EU-countries 1997-2010

Figure 5 depicts the evolution of RES-E support instruments in the 27 EU member states for the period from 1997 to 2010. It can be observed that a number of changes have been introduced to res-e support schemes in the past. As a result of these changes the quota system has been established as the second major support instrument in the EU next to feed-in-tariffs by replacing formerly existing support schemes in Belgium, Italy, Sweden, Poland an United Kingdom. While in the initial stage of RES-E support in the EU often changes of the support instruments took place, in the more recent phase rather adjustments were conducted. In many cases this included a modification of the schemes towards a technology specific support. Also further improvements were implemented based on the experiences with the RES-E support schemes gained in the member states.

Furthermore, the case of France, with comparable support conditions to e.g. Germany, but significantly less wind deployment has demonstrated that only FIT are not self sufficient. In France bureaucratic barriers have hindered en effective wind deployment for a long time. Support schemes are effective to remove financial barriers, but it is of equal importance to address non-economic barriers. Especially administrative procedures, long lead times and grid connection issues have been named in several Commission reports as major obstacles that need to be overcome, see [7].

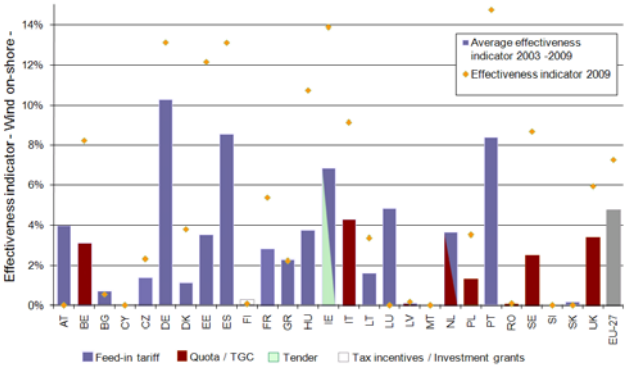

Figure 6 – Effectiveness for wind on-shore in the period 1998-2009 in EU-27 (Source: [8])

Eventually the efforts of the member states have led to continuous, albeit varying progress, building on their experiences gained and recommendations made by the commission. Figure 6**Hata! Başvuru kaynağı bulunamadı.** shows the latest effectiveness indicator for wind onshore relating the RES-E produced to the remainig potential. Compared to former editions one can observe that countries with quota systems have improved, while FIT countries still take the lead. Overall the experience with the support schemes has shown that depending on the instrument some “best practice” design criteria have emerged, which will be addressed below.

To identify the major country-specific lessons learned, next the relation between quantities deployed and the level of support is analysed for some trading and some FIT systems in recent years.. It is often argued that the reason for higher capacities installed is a higher support level. Paradoxically, countries with highest support levels – Belgium and Italy for example – are among those with the lowest specific deployment (Figure 1). On the other hand, high FITs especially in Germany and Spain are often

named as the main driver for investments especially in wind energy. However, the support level in these countries is not particularly high compared with other countries analysed here.

Currently in various European countries different strategies are in force. Next the relation between quantities deployed and the level of support is analysed for some trading and some FIT systems in recent years. It is often argued that the reason for higher capacities installed is a higher support level. And it is accepted that the resource endowments of RES-E vary from country to country.

Regular progress reports from the European Commission, monitoring the deployment of renewable energies in the EU, have shown that countries with FIT as main promotional instrument have been most successful in the deployment of RES-E. It is often argued that the reason for higher capacities installed is a higher support level. Paradoxically, countries with highest support levels – Belgium and Italy for example – are among those with the lowest specific deployment (Figure 6 and Figure 7). On the other hand, high FITs especially in Germany and Spain are often named as the main driver for investments especially in wind energy. However, the support level in these countries is not particularly high compared with other countries analysed here. In fact it has become evident that stable planning conditions play a more important role than high tariffs. Traditionally FIT are best suited to guarantee these stable planning conditions, but countries with quota systems as support instrument have also used their experiences to gradually improve the planning conditions. Exemplary is the case of Italy and UK who have introduced technology specific quotas, extended the duration of their schemes, allowed for banking of certificates and introduced a guaranteed minimum tariff (UK only).

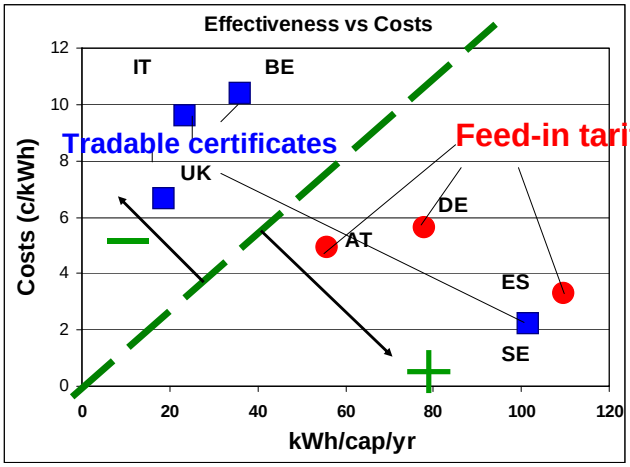

Figure 7 – Effectiveness vs costs of promotion programmes for electricity from RES (except Photovoltaics) in selected countries 2003-2007 (Source: own investigations)

IV. Prospects for RE technologies in the electricity sector

Finally, prospects for RE technologies are presented in this section at a global level. Thereby, the feasible deployment of these technologies is discussed by means of scenarios depending on the applied energy policies. These future projections as published in the latest IEA "World Energy Outlook" [12] were conducted with the model **World*RES***.

Two different cases are presented which show the feasible RE deployment exemplarily for the electricity sector:

– A *reference* scenario, illustrating a conservative view of the future RE deployment based on the currently applied energy policy support and the corresponding observed framework conditions that often comprise several deficits for an accelerated RE deployment.

– In contrast to this, an *alternative policy* scenario aims to indicate the feasible RE deployment if support measures as currently in the pipeline of political decision making will become effective. This also comprises an improvement with regard to pending non-economic obstacles.

Therefore, the following paragraphs focus on the future deployment of RES-E generation for selected countries / regions, at global scale as well as on technology level.

Hata! Başvuru kaynağı bulunamadı. provides a comparison of the future RES-E deployment up to 2030 in absolute terms by country / region in the alternative policy scenario. In this scenario electricity generation from renewable energy sources increases especially in economically emerging regions such as China and India. Remarkably, China would then also take over the global lead by 2025. Summing up at global scale a higher renewable electricity exploitation of 1637 TWh can be observed in the alternative policy case.

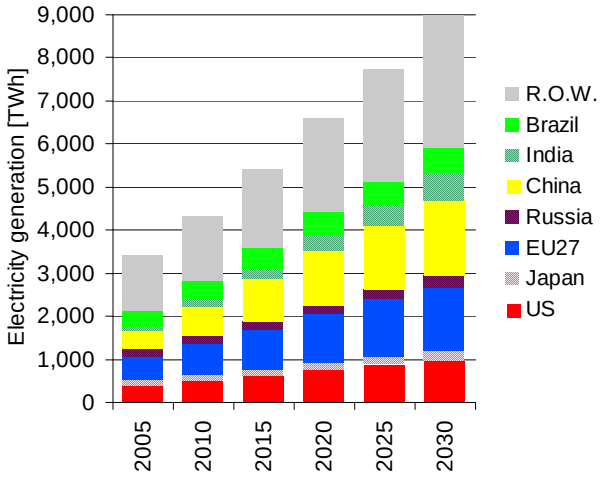

Figure 8 – Comparison of the future RES-E deployment up to 2030 in absolute terms by country / region for the

IEA alternative policy scenario (Source: Own investigations and (IEA, 2007 [12]))

V. LESSONS LEARNED FOR DEVELOPING COUNTRIES

In an IEA study, the same methodology as shown above **Hata! Başvuru kaynağı bulunamadı.** was extended to assess the effectiveness of RES support policies in OECD and BRICS countries (IEA 2008 [6]). The study concluded that the different countries show substancial diversity in the effectiveness of policies implemented to support the RET and that OECD-EU countries, which have overall a longer history of renewable energy support policies, feature among the countries with the highest policy effectiveness for all new renewable electricity generation technologies. This shows that a transfer of the lessons learned with EU RES-E support could add value to RES-E promotion in developing countries. Exemplary this will be done here for two developing / emerging countries, China and Turkey. Firstly their currently implemented support instruments will be revisited briefly.

With the adoption of the Renewable Energy Law on January 1st 2006 China established for the first time a statutory framework for the development of renewable energy. Concerning the financial support of RES-E, two different instruments are foreseen, depending on the type of technology: Wind power projects are allocate dto investors through c ompetitive bidding. The government guarantees the successful bid price combined with an obligation to feed the power into the grid. Biomass electricity receives a guaranteed premium feed-in price in size of 0,25 Yuan / kWh, decreasing by 2% yearly from 2010 on. Feed-in prices for PV systems are set by the government on a project-base, and mechanisms for other renewable energy technologies such as wavepower or geothermal electricity have to be established in the future.

Turkey introduced initially a FIT for the support of RES-E in May 2005. The tariff was slightly increased in May 2007 to a level of 50 € / MWh to 55 € / MWh, which can neither be gone below nor exceeded. The tariff is determined by the Electricity Market Regulation Authority and is the previous years wholesale price. In addition the national transmission company is obliged to provide grid connection for all RES-E projects. In general the Turkish support scheme is kept simple.

So what can the developing / emerging countries learn from the EU? The experiences in Europe have shown, that especially at earlier stages of RET deployment FIT work best. Also the support instruments alone are not of high effectiveness if non-economic barriers like bureaucratic hurdles or grid connection issues are not solved. We have also seen that countries once they had found their appropiate support scheme have used the experiences gained to fine tune and gradually improve their schemes. This has led to increasing RES-E deployment and also formerly very uneffective countries could raise their effectiveness indicator.

Out of the experiences with the support schemes in the EU a list of “Best Practices” emerged that have either been introduced in the countries or have been recommended. Since both countries we have looked at in this article use FIT, and FIT are the most widespread instrument, we discuss some best practices in the following, that emerged from the experiences with RES-E promotion in the EU:

- RES-E support requires continuity and log term investment policy. Therefore FIT should be accompanied by long term targets and sufficiently long periods for which the tariff is guaranteed. A long term strategy for deploying significant amounts of RES-E generation has to build on fundamental R&D technology development which provides by means of proper technology transfer to E&D countries successful implementation of projects. In this chain financing in different forms is a fundamental requirement, see Fig. 5.
- Technology specific tariff levels should be applied in order to reflect the varying electricity generation costs. The levels should be set so that the policy goals of a country can be reached and the most cost efficient RET at a particular location are deployed first. On the other hand the tariffs should also support promising technologies that are not ready yet for the market.
- RES-E support policies should consider market integration. In the case of FIT this could e.g. be reached through a bonus tariff. With the option to sell the electricity on the free market. Another important aspect in this context is a forecasting obligation.
- An annual taiff degression provides an incentive for cost reductions and technology improvements.
- Stepped tariffs can be applied to reflect different power generation costs within the same technology. This is an appropriate measure to keep the producer profits moderate, but it has to be assured that the profits are still the highest at the most (cost) efficient sites.
- Moreover, especially for electricity and biofuels it is very important to strike a socially and ecologically acceptable balance between local use and international trade, see Fig.6. In this context it is also important to consider that local use will be cheaper and energetically more efficient because of lack of transport losses.

A long term strategy for deploying significant amounts of RES-E generation has to build on fundamental R&D technology development which provides by means of proper technology transfer to E&D countries successful implementation of projects. In this chain financing in different forms is a fundamental requirement, see Fig. 9. Moreover, especially for electricity and biofuels it is very important to strike a socially and ecologically acceptable balance between local use and international trade, see Fig.10. In this context it is also important to consider that local use will be cheaper and energetically more efficient because of alck of transport losses.

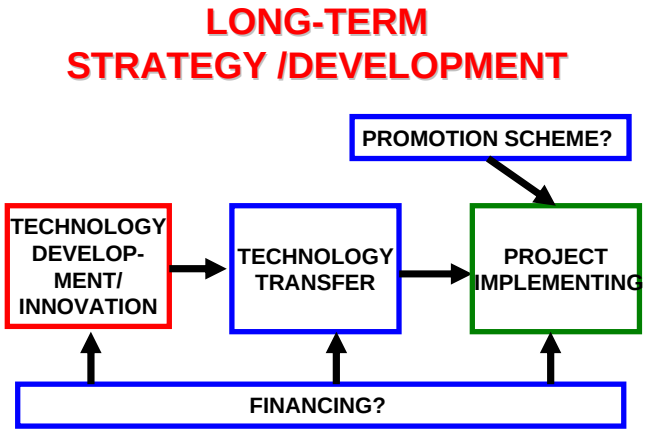

Figure 9 – Financing in different forms for providing successful implementation of projects

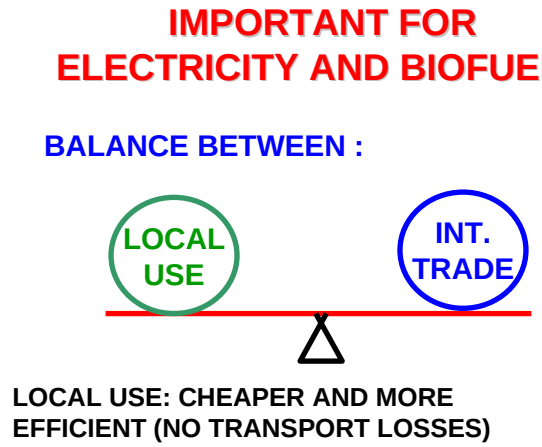

Figure 10 – The relevance of a reasonable balance between local use and international trade of energy products

VI. Conclusions

The major conclusions of this analysis are: (i) FIT will be a proper instruments in emerging countries where a proper grid exists and where a social acceptance of (low) transfer costs from the electricity customers can be expected; This applies to countries like Brazil, China, India, Indonesia … (ii) for developing countries where solutions are mainly focusing on islanding autonomous stand-alone solutions are based only strategies focusing on (international) support of investments are feasible.

References

[1] European Parliament and Council. 2001. Directive of the European Parliament and of the Council on the promotion of electricity produced from renewable energy sources in the internal electricity market, Directive 2001/77/EC - 27 September 2001, Brussels.

[2] Haas, R.; Meyer, N.I.; Held, A., Finon, D.; Lorenzoni, A.; Wiser, R.; Nishio, K. 2008. *A review of promotion strategies for electricity from renewable energy sources* in F.P.Sioshansi "Competitive Electricity market". Elsevier Publishers, 2008.

[3] Haas, R.; Eichhammer, W.; Huber, C.; Langniss, O.; Lorenzoni, A.; Madlener, R.; Menanteau, P.; Morthorst, P.-E.; Martins, A.; Oniszk, A. (2004): How to promote renewable energy systems successfully and effectively. *Energy Policy*, 32(6): 833-839.

[4] Held, A.; Haas, R.; Ragwitz, M. 2006. On the success of policy strategies for the promotion of electricity from renewable energy sources in the EU. *Energy & Environment*, 17 (6), p. 849-868.

[5] Resch G., Faber T., Ragwitz, M., Held A., Panzer C., Haas R. 2008. 20% RES by 2020 – a balanced scenario to meet Europe's renewable energy target. Report compiled by TU Wien / EEG in cooperation with Fraunhofer ISI within the Intelligent Energy for Europe - project futures-e (Contract no. EIE/06/143/SI2.444285), Vienna, Austria.

[6] International Energy Agency. 2008. Deploying Renewables – Principles for Effective Policies, Paris, France

[7] European Commission. 2009. Fortschrittsbericht „Erneuerbare Energien", KOM(2009) 192

[8] Ragwitz, M. 2010. Effective and efficient long-term oriented RE support policies, Presentation held at International Energy Agency Renewable Energy Working Party's Workshop "Renewables, from Cinderella options to mainstream energy solution", March 15th 2010, Paris

[9] Klein, A., Pfluger, B., Held, A., Ragwitz, M., Resch, G., Faber, T. 2008. Evaluation of different feed-in tariff design options – Best practice paper for the International Feed-In Cooperation, BMU Berlin, Germany.

[10] European Parliament and Council. 2008. Directive of the European Parliament and of the Council on on the promotion of the use of energy from renewable sourcesof, Brussels, COM 2008 (30) Final.

[11] Rathmann, M., Winkel, T., Stricker, E., Ragwitz, M., Held, A., Pfluger, B., Resch, G., Panzer, C., Busch, S., Konstantinaviciute, I. 2010. Renewable Energy Policy Country Profiles 2009 version, prepared within the Intelligent Energy Europe project ReShaping (Contract no.: EIE/08/517/SI2.529243)
[12] International Energy Agency. 2008. World Energy Outlook, IEA, Paris, France.

BIOGRAPHIES

Reinhard Haas – is Associate Professor of Energy Economics at Vienna University of Technology. He studied Mechanical Engineering and he holds a PhD in Energy Economics. at Vienna University of Technology.

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Mario Ragwitz – is senior scientist in the Competence Center Energy Technology and Energy Policy at the Fraunhofer-Institute for Systems and Innovation Research (ISI) - heading the research area of renewable energies. He is physicist with professional experience in the fields of modelling complex dynamical systems, data analysis, wind energy conversion and solid state physics. He studied physics at the universities of Düsseldorf, Waterloo (Canada) and Heidelberg, and earned his doctorate degree in physics (Dr. rer. nat.) from the University of Wuppertal.

He has conducted several research projects in the field of renewable energy for the European Commission. His current scientific work includes the topics of innovation research, policy analysis and financing in the field of renewable energy sources, the derivation of R&D and market introduction strategies for renewable energy technologies and modelling energy systems with renewable sources.

Dr. Mario Ragwitz was appointed in 2008 as an advisor to the European Parliament on the EU Directive on Renewable Energy and as an expert to the German Bundestag concerning the amendment of the German Renewable Energy Sources Act..