Implications of the European Renewables Directive on RES-E Support Scheme Designs and its Impact on the Conventional Power Markets

By Marco Nicolosi and Michaela Fuersch*

Introduction

The desired increase in electricity from renewable energy sources (RES-E) was defined in the EU White Paper (1997) and is the political consensus. Its concrete embodiment, however, has been subject to political debate ever since. The EU parliament recently adopted very ambitious RES-E targets, which require a close look in terms of efficient policy implementation. In the past, the design of RES-E support schemes and their effects on resulting efficiency and effectiveness has been discussed widely. However, the implications on the conventional power market have been investigated mainly on a very abstract level, e.g., purely on the level of increasing RES-E quantities.

This article will show that the optimisation of the RES-E "submarket" does not necessarily lead to an overall efficient solution. Instead, the optimal mix of RES-E and conventional generation is highly sensitive to the long term planning of RES-E policies and targets.

The first part of this article will provide an overview of the recently decided RES policy of the European Union, and then a closer look will be taken on an efficient RES-E support scheme design needed to fulfil the European targets. It will be followed by a discussion on the RES-Es' impact on the conventional power market. The last part will summarise the aforementioned implications and their consequences on the RES-E support scheme design.

The European "Climate Package" and the Renewables Directive

The EU "climate package" was adopted by the EU Parliament on December 17th 2008 (EU Parliament, 2008). This package includes different directives, which define political targets of a 20% CO_2 reduction and 20% energy efficiency increase compared to 2005 and a 20% share of energy from renewable energy sources (RES) in gross final energy consumption by 2020. The renewables directive defines the RES targets for all individual Member States (MS), which can be seen in Table 1. These targets have been set by the EU commission with consideration of the 2005 RES share and two additional elements: First, a flatrate part, which is the same for all MS, and second, a GDP per capita part. Thereby, the effort sharing takes the economic situation of the individual MS into account. Through the possibility of statistical transfers of RES amounts, MS low target and resource rich countries can overshoot their targets and export the surplus to countries, which have a relative high target compared to their national RES potential. In addition to the statistical transfer, the new directive allows certain kinds of cooperation between MS. This cooperation can be project based or even a shared RES-E support scheme. Through this provision a step by step harmonisation is possible, not through an enforced top-down legislative decision, but through self-determined cooperation between MS as intended by the subsidiarity principle.

The allocation of renewable shares between the electricity, heating and cooling as well as transport sectors is the responsibility of the individual MS. By June 30th 2010, the MS need to provide national action plans to the EU commission (Article 4, European Parliament, 2008). While some countries have already defined RES-E targets for 2020 (e.g., Germany 30%), others still have no long term strategy. This article focuses solely on the effects on the electricity sector.

	1997 RES-E Actual	**2006 RES-E Actual**	**2010 RES-E Target**	**2020 RES Target**
Austria	67.5%	56.6%	78.1%	34%
Belgium	1.0	3.9	6.0	13
Bulgaria	7.0	11.2	11.0	16
Cyprus	0.0	0.0	6.0	13
Czech Republic	3.5	4.9	8.0	13
Denmark	8.8	25.9	29.0	30
Estonia	0.1	1.4	5.1	25
Finland	25.3	24.0	31.5	38
France	15.2	12.4	21.0	23
Germany	4.3	12.0	12.5	18
Greece	8.6	12.1	20.1	18
Hungary	0.6	3.7	3.6	13
Ireland	3.8	8.5	13.2	16
Italy	16.0	14.5	25.0	17
Latvia	46.7	37.7	49.3	40
Lithuania	2.6	3.6	7.0	23
Luxembourg	2.0	3.4	5.7	11
Malta	0.0	0.0	5.0	10
Netherlands	3.5	7.9	9.0	14
Poland	1.8	2.9	7.5	15
Portugal	38.3	29.4	39.0	31
Romania	30.5	31.4	33.0	24
Slovakia	14.5	16.6	31.0	14
Slovenia	26.9	24.4	33.6	25
Spain	19.7	17.3	29.4	20
Sweden	49.1	48.2	60.0	49
United Kingdom	1.9	4.6	10.0	15
EU-27	**13.1**	**14.5**	**21.0**	**20**

Table 1: RES-E share 1997, 2006; RES-E targets in 2010 and RES target in 2020.

Source: BMU, 2008; European Parliament, 2008.

What Happened So Far?

The last renewables directive was adopted in 2001 (2001/77/EC). Compared to the 2008 directive, the past directive directly defined RES-E targets for 2010 (see Table 1).

---

* Marco Nicolosi and Michaela Fuersch are with the Institute of Energy Economics, University of Cologne. Nicolosi may be reached at marco.nicolosi@uni-koeln.de

Although, the EU published the first RES-E directive in 2001, some countries had started during the 1990s with the RES-E support (e.g., Denmark, Germany, Spain). Bynow, the amount of RES-E generation has been growing constantly, as can be seen in Figure 1.

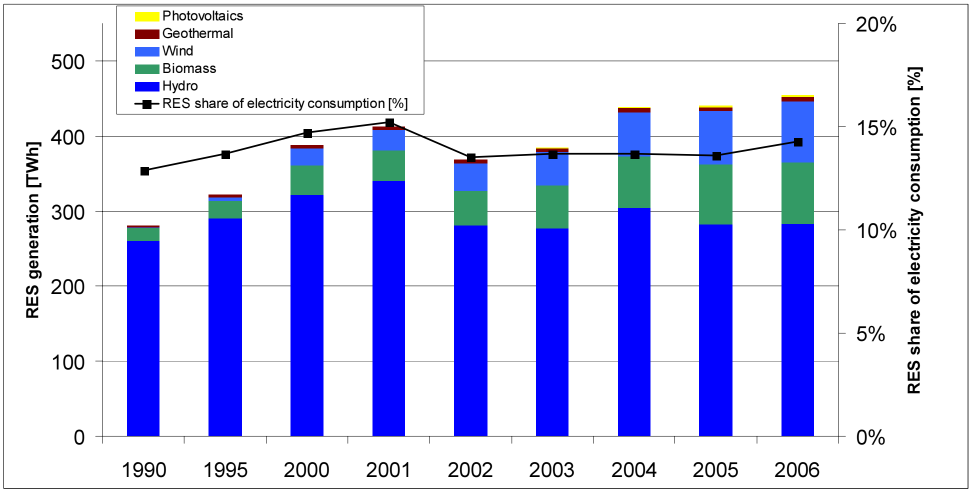

Figure 1: RES-E generation in the EU-25

Source: EWI, based on BMU (2008).

The main share of RES-E generation is based on large hydropower plants, which show a considerable volatility over the years. However, although the amount of the "new renewable technologies", such as wind power and biomass power show a significant increase, especially since 2000, it is striking that the RES-E share (black line) remains more or less at the same level. This is not surprising, considering the increasing electricity demand in some MS. This observation, amongst others, lead to the 20% energy efficiency improvement target of the EU until 2020.

As described above, the 2001 renewables directive has defined RES-E targets for all MS. The overall target for the EU-27 is 21% in 2010. As can be seen in Table 1, some countries are on track to meet their target, while others need to strengthen their effort in order to increase their RES-E share. In 2006, the European RES-E share was 14.5% (see Table 1). The EU Comissions' "Renewable Energy Road Map" (2007) assumes RES-E shares in different scenarios between 34.2 and 42.8 % in 2020.

Taking this target into account while considering the RES-E share of the last 15 years (which can be seen in Figure 1), at least three critical aspects need to be considered. First, the increase in electricity consumption needs to be lowered dramatically. Second, a strengthened effort of RES-E support is required and this needs to be accompanied with a clearer focus on efficiency. Third, since the issue of intermitting RES-E integration is already apparent in various countries (e.g., Germany and Denmark) with its current deployment, future impacts of significantly higher RES-E infeed requires a close look at the effects on the conventional power market. This article will analyse the latter two aspects.

Attributes of RES-E Support Schemes

The attributes of the different RES-E support schemes have been widely discussed in the past (see e.g., Lienert and Wissen, 2006; Sawin, 2004; Meneanteau et al., 2003; Lauber, 2003; Drillisch, 2001). Therefore, just a brief overview will be provided.

The first and main differentiation between FIT and quota systems is the price versus quantity based approach. While quantity based support schemes define a certain percentage of RES-E in the electricity mix which needs to be provided by the market actors, price based support schemes set a fixed price for an energy amount of RES-E (e.g., one MWh). Typically, quantity based support schemes should reach their defined target, but have an inherent uncertainty about the price. In general, quantity based support is accompanied by a tradable certificate system to increase the efficiency and to prove the renewable nature of the electricity. Price based systems, on the other hand, define a fixed price. The resulting amount of RES-E depends solely on political price setting.

The second typical attribute is technology specific versus technology neutral support. While the "typical" FIT scheme has technology specific tariffs to support infant technologies, quota systems are usually technology neutral. This means that every produced MWh RES-E has the same value. Therefore, quota systems should lead to a cost efficient deployment, since the construction starts with the cheapest and usually most mature technology at the best site. Technology specific support, on the other hand, is often justified by the value of a broader RES-E mix in the future. The main argument is that infant technologies should be supported in order to generate experience effects, which lead to cost reductions. However, these statements mirror only the typical designs. It is very well possible, and has happened in reality, that FIT can be designed technology neutral (e.g., the German Stromeinspeisegesetz 1991-2000, which lead to early wind power deployment). On the other hand, quota systems could very well design either bandings (sub quota for individual technologies) or a different value per MWh from a particular technology (e.g., one MWh from wave power plants receives two certificates in the Quota Obligation System, which starts in UK in April 2009).

The third attribute is the possibility of harmonisation. Harmonising support schemes means a shared system for more than one country. The rationale behind harmonisation is efficient geographical deployment, where RES-E generation costs are the lowest. As mentioned above, in the past the deployment has been solely dependent on the national support system. From a political economy point of view it is much easier to harmonise quota systems, by defining common rules and adding EU-wide targets (e.g., Norway and Sweden are discussing a shared quota system with the option for additional participating countries). Harmonising FIT systems requires bargaining about every technology specific tariff. This is already an effort on a national level, since the influence of interest groups plays an important role. In a harmonised system, different resource qualities in different regions would increase the difficulties of the political process.

Economic Criteria

In assessing support schemes, the economic criteria of efficiency and effectiveness should play a crucial role (Häder, 2006; Lienert and Wissen, 2006). The efficiency criterion needs to be subdivided into a static and a dynamic perspective. Static efficiency means that a certain amount of RES-E becomes generated at the lowest possible cost. Dynamic efficiency, on the other hand, also investigates future costs. It could be more efficient to invest in an infant and more expensive technology in order to have lower RES-E costs in the long run. Dynamic efficiency, of course, is very difficult to measure due to the high degree of uncertainty.

From a static efficiency perspective, the quota system has the lead against the FIT since the RES-E deployment is the cheapest possible deployment. When it comes to dynamic efficiency, there is a chance that the FIT system could trigger infant technologies, which become a cheap solution in the future, but there is an inherent uncertainty. It might very well be that the quota system finds the cheapest solution in the long run.

Effectiveness can be subdivided into stimulation and target achievement. Stimulation means the ability to trigger the RES-E deployment. This alone would not be a strong criterion since the more incentives are provided, the higher is the stimulus. The stronger criterion is the achievement of the target, since a target overshooting is as bad as a shortfall. Of course, some countries, such as Germany define minimum targets. However, the impact on consumer cost and the remaining market actors need to be considered here.

The quota system should reach the target per definition, otherwise penalties must be paid. Therefore, the stimulation criterion is reached as well. In theory, the quota system should have the lead. In reality, however, quota systems also fell short of their targets. Of course, this is very dependent on the particular design of the system and on the administrative surroundings (such as grid access) as well as on public acceptance. The stimulation effect of FIT systems also is very dependent on its design, especially in the setting of the tariffs. While some countries have only low deployment rates, others overshoot their targets. Germany, for instance in 2007 has already reached 14.2% RES-E while its 2010 minimum target is 12.5%. However, it is an inherent attribute of price based support that the quantity outcome is uncertain and strongly depends on the available information of the policy designers who set the tariffs.

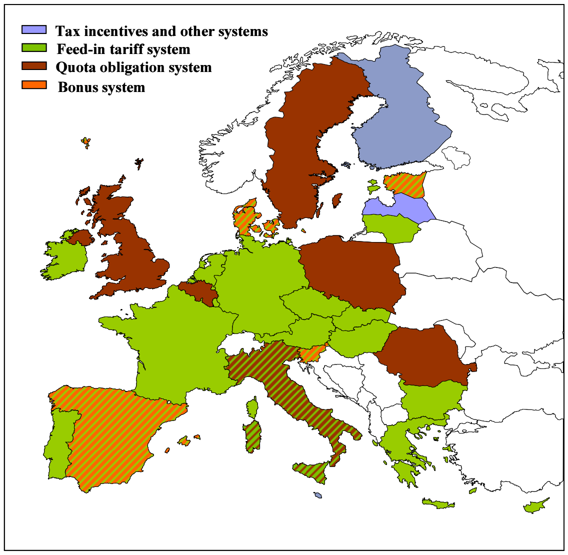

Figure 2: RES-E Support Schemes in the EU
Source: EWI

Current Status of the European RES-E Support Landscape

There are many different RES-E support scheme designs installed in the individual MS. Currently 18 countries have chosen a price based support, such as FIT or premium systems to support their RES-E deployment. Six countries use quantity based support, i.e., quota systems; and three countries have implemented a tax based support or other systems (see Figure 2).

These uncoordinated national activities have lead to an RES-E deployment which is not based on the quality of the natural potential of a region, but solely on the kind of support a certain technology receives in a particular country. Figures 3a and 3b show the spread between the quality of the natural resources and the RES-E deployment.

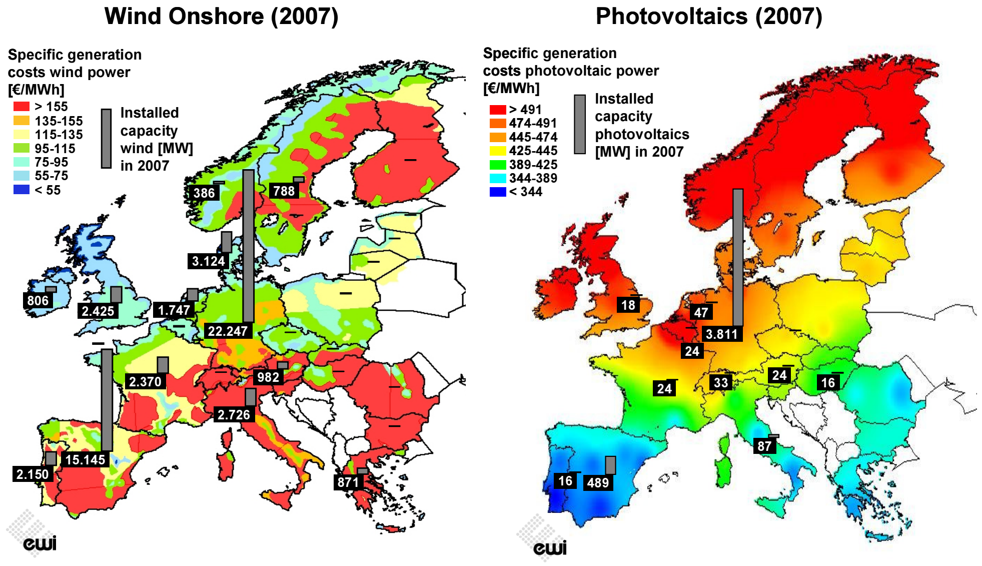

Figure 3a and 3b: Regional Potential Qualities and Deployment of Wind Power and Photovoltaics in 2007

Source: EWI

The colour coding shows the regional electricity generation costs. It can be seen, that the wind power deployment mainly took place in Germany, Spain, and Denmark. These countries have been early starters and chose FIT for their RES-E support. The statement of this picture becomes even more clear when it comes to photovoltaic (PV) support. As can be seen in figure 3b, the best resources are located in southern Europe. Although the generation costs between Spain and Germany differ by more than 100 €/MWh, the deployment in Germany exceeds the Spanish deployment considerably. This as well can be attributed to the technology specific FIT support in these countries.

It seems that the "typical support schemes" have inherent weaknesses, which lead to either inefficiencies and/or a failure when it comes to target achievement. In reality, one can observe that the FIT systems start to adopt also elements of quantity based support, such as capacity caps (e.g., Spain for PV) or afore planned technology deployment paths, which have feedback loops on the tariff setting (German PV tariffs receive a stronger reduction if predefined targets become overshoot). On the other hand, quota systems start with typical price based attributes, such as different values of the tradable certificates (e.g., UK with a higher tradable certificate value for immature technologies).

Taking the possibility of an EU wide harmonisation into account, the quota system should lead to the most static efficient deployment, since the cheapest potential becomes utilised in an ascending order throughout Europe.

Effects of RES-E Integration on Conventional Power Market Through Intermitting RES Technologies

Independent of the support scheme, the vast amount of planned RES-E increase in the near future is going to have an enormous impact on the conventional power system. By now, electricity from onshore wind power plants is one of the cheapest RES-E options. One particular attribute of wind power is that it is strongly dependent on the natural circumstances of the wind. Therefore, the RES-E generation is not guaranteed in the hours of peak demand. However, through regional distribution, it is also unlikely that still air is present at all regions. That means a certain amount of wind capacity can be counted as guaranteed. This guaranteed capacity, which is called capacity credit, is able to substitute for a certain amount of conventional capacity in the power plant mix. Compared to the RES-E infeed however, the share of substitutable capacity is relatively low. Dena (2005) has shown that a wind capacity of 14.5 MW in 2003 in Germany had a capacity credit of between 7 and 9%, meaning that it could substitute for between 1.0 and 1.3 GW of conventional capacity. One important implication is that an increasing penetration reduces the relative capacity credit. The above mentioned study also calculated that the planned 35.9 GW wind capacity in 2015 would have a capacity credit of only 5 to 6%. Figure 4 shows, which effects this attribute has on the conventional power mix. The upper right corner shows marginal cost curves with annuity capacity costs as starting point at the ordinate. It can be seen, that base load plants have relatively high investment cots and low variable costs (especially fuel costs). Peak load plants on the other hand have low investment costs and relatively high variable costs. The abscissa shows the annual utilisation time at which the plant types are efficient. Base load plants are economically feasible when a high utilisation time can be reached and peak load plants are only the efficient choice when the utilisation remains at a low level (see e.g., Stoft, 2002). In the lower right corner, two annual duration load curves are depicted. This means that the annual load hours are arranged in a subsequent order. The highest peak load hour is arranged at the left end and the hour with the lowest demand at the right end. The upper curve is the total load and the lower curve is the residual load curve. The latter is the load curve less the electricity production, which is not part of the conventional power market or has no variable costs, such as some RES-E technologies. In other words, a part of the load is already covered by market exogenous generation. The shift of the shares of the different power plant types can be seen in the lower left corner. The result of high RES-E infeed with a relatively low capacity credit is an increase in peak load capacity and a decrease in base load capacities. Since the RES-E infeed already covers a certain share of the demand, the utilisation time of base load plants will be reduced. This effect will apply especially in hours with low load and high RES-E infeed.

Implications on the RES-E Support Schemes

The above mentioned impact on the conventional power plants indicates that the most efficient RES-E deployment with respect to the RES-E market alone might lead to heavy distortions in the requirement the conventional capacity mix has to fulfil. The corresponding costs could overcompensate the efficiency effects in the RES-E submarket.

The most efficient overall solution cannot be achieved with a mix of RES-E technologies alone, without consideration of a conventional technology mix. Meaning, the conventional power market needs to adapt to the additional requirements that the increasing RES-E share places on it. That is, as a consequence of a relatively cheap increase in wind power deployment, increasing investments need to be undertaken in flexible technologies, which do not require a high utilisation time to be profitable in the market. Additional flexibilities in the power market could be grid extensions, storage technologies and demand side management.

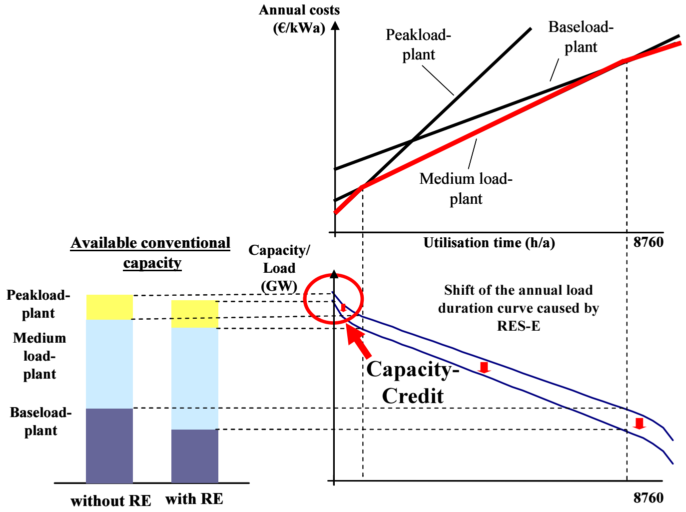

Figure 4: Effect of an Increasing RES-E Share on the Conventional Power Mix

Source: Wissen and Nicolosi, 2008.

One key figure in conventional investment planning is the desired share of RES-E in the power market. Since conventional capacities have long technical lifetimes of more than 30 years, sound financial planning requires an assessment of the utilisation time throughout the lifetime. This explains why the correct achievement of the predefined targets is a strong criterion. If the RES-E deployment overshoots the politically set targets, it has a strong negative influence on the financial plan of a conventional power plant investor. When there is no defined long term plan available, the investor seeks a higher return on the risk, which either increases the investment costs or lowers the available capacity in the market, which on the other hand is necessary to fulfil the requirements of security of supply with a high RES-E share.

In order to start one step earlier and reduce the impact on the conventional power market, a more balanced RES-E support is required. In order to increase the capacity credit without affecting the RES-E amount, a more diversified RES-E mix is desirable. A mix of different RES-E technologies assures a higher capacity credit through the portfolio effect. Thereby, the starting point of the residual load curve in Figure 4 could be lowered, which leads to a decrease in peak load capacity requirement.

Finding the optimal RES-E mix with its corresponding conventional capacity mix requires careful policy design between the European MS. Especially, when a market, such as the conventional power market is so heavily affected by political activities, early signalling of long term plans are required in order to find an efficient solution.

References

BMU (2008): Erneuerbare Energien in Zahlen – nationale und internationale Entwicklung, Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit, Berlin.

Dena (2005): Energiewirtschaftliche Planung für die Netzintegration von Windenergie in Deutschland an Land und Offshore bis zum Jahr 2020, Deutsche Energie-Agentur, Berlin.

Drillisch, J. (2001): Quotenmodell für regenerative Stromerzeugung – Ein umweltpolitisches Instrument auf liberalisierten Elektrizitätsmärkten, Schriften des Energiewirtschaftlichen Instituts, Oldenbourg Industrieverlag, Muenchen.

(continued on page 43)