Increasing the effectiveness and efficiency of renewable energy support policies in the European Union

(met een samenvatting in het Nederlands)

Proefschrift

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I. Introduction

1. The need for renewable energy sources (RES) support policy

While traditional forms of RES like biomass combustion, solar drying, hydro power, and windmills have been utilised for thousands of years (see Blok 2006a for a brief history of energy use), the public interest in RES has increased significantly in the last four decades (see e.g. Meyer 1995 for the evolution of Danish wind power support policy and Hirschl 2008 for a stakeholder analysis of the German RES policy development). In the 1970s, during and after the first oil crisis, proponents of RES stressed the advantage of becoming independent from the finiteness and price volatility of fossil energy sources (e.g. Bach and Matthews 1979). Furthermore, with increasing concerns about the environmental damage of fossil fuel combustion and the risks of nuclear energy in the late 1970s and 1980s, the environmental benefits of clean RES use[1] were recognised, in the first place focusing on the diminished local damage like air and water pollution. Since the 1980s, the greenhouse gas emissions of fossil fuel combustion and their impact on the global climate have become an increasingly pressing problem. Increasing the share of RES in the energy system has evolved as one major strategy for combating climate change (e.g. Speth 1989, Edenhofer et al. 2011).

Policymakers have recognised that, in order to compete in the energy market and replace conventional energy sources, RES need to be promoted with specific RES support policies. These support policies should overcome the major market barriers for RES.

Common barriers for increased RES deployment are

- Economic and market barriers
    - RES are not cost-competitive under current market conditions (high capital costs, unfavourable market pricing rules, subsidies for competing fuels, etc.)
    - Limited access to finance and high cost of capital due to high perceived risk
    - Power markets are not prepared for RES (lack of access to the power markets, exercise of market power by large players, design not favourable for supply-driven RES, etc.)
- Administrative and legal barriers

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[1] The actual environmental benefit or damage of RES use largely depends on the type and mode of application.

    - Inefficient administrative procedures (high number of authorities involved, lack of coordination among authorities, lack of transparent procedures, long lead times, high costs for applicants, etc.)
    - RES are excluded from or are insufficiently considered in spatial planning
    - A lack of or insufficient standards and codes for RES equipment (specifications not well defined, not expressed in EU/international standards, etc.)
    - Tenancy and ownership laws impede the development of building-integrated RES technologies
- Grid related barriers
    - Grid access is difficult to obtain (network operators are not open to RES, lack of transparent procedures, long approval times, unfavourable cost allocation leading to high grid connection costs)
    - Lack of available grid capacity (weak grid environment, lack of interconnection capacity, non-existing or slow grid reinforcement and/or extension, grid congestion leading to curtailment)

See chapter II for a literature review and discussion on RES barriers.

2. The evolution of the European RES market and policy framework

Up until the 1990s, policy support for RES in Europe focused mainly on research and development (R&D) (Blok 2006b). After several countries introduced support policies for RES delivery (e.g. Denmark, Germany, UK, etc.), the focus gradually shifted from R&D to market deployment policies during the 1990s. In 1997, the European Commission published a White Paper that set the first target for RES deployment in the EU: the contribution of RES to the gross inland consumption of (primary) energy was to increase from 5.4% in 1997 to 12% in 2010 (European Commission 1997). In the following years, this 2010 target was underpinned by two European directives that formulated requirements of the EU member states, particularly the requirement to introduce policy measures to increase the market share of RES. The Renewable Electricity Directive 2001/77/EC and the Biofuels Directive 2003/30/EC set indicative targets for the RES share in the electricity and transport sectors in 2010: the RES share in electricity consumption should increase to at least 21% in the EU-27 (22% in the EU 15), broken down into individual member state targets; the share of biofuels in total diesel and petrol transport fuels should increase to at least 5.75% in all EU member states. In contrast to the White Paper, these two directives define more concrete policy requirements to the member states. Member states are requested to introduce effective policies to promote RES electricity and fuels, to remove administrative and grid access barriers for RES electricity installations, and to regularly report the progress made towards their national RES electricity and biofuel targets.

As mentioned above, a number of member states had already implemented national support instruments for RES at this point in time but the two directives triggered additional attention to RES support policy design (see e.g. Reiche 2006). For RES electricity, the most common support instruments have been feed-in tariffs, feed-in premiums, and quota schemes with tradable green certificates. Furthermore, different fiscal and financial support instruments have complemented the main support schemes. In the RES heat sector, investment grants and tax incentives are the most common schemes. Lately, some member states have also introduced RES heat use obligations and premium systems. In the RES transport sector, tax incentives and quota obligations for biofuels are the dominating schemes.

The effectiveness of these support instruments in reaching the 2010 targets varied greatly. While a few member states overachieved their targets already before 2010, many states were not on track to reaching their 2010 targets, which led to a discussion on the need for binding targets. Shifting the focus from 2010 to 2020, the European Council agreed on new, binding RES targets for Europe in March 2007 that are based on an earlier proposal by the European Commission (European Commission 2007a): the share of RES in overall energy consumption[2] should increase to at least 20% by 2020 (Council of the European Union 2007); the share of biofuels in total transport consumption to at least 10%. The RES Directive 2009/28/EC, which entered into force in June 2009, translates these binding targets into a legislative framework: the European target of 20% RES in the gross final consumption of energy is broken down into binding national targets for the EU-27 member states; the biofuels target is translated into a 10% RES target in the final consumption of transport energy that applies to each member state individually. Based on the experience with the earlier directives, the 2009 RES directive also addresses the prevailing barriers and policy challenges more specifically:

- An indicative trajectory defines interim targets for each member state.
- Member states need to draw up National Renewable Energy Action Plans (NREAPs) that define sector targets and specify policy measures for reaching the targets.
- Member States shall improve/ensure the appropriateness of authorisation, certification, and licensing procedures.
- Member States shall take the appropriate steps to develop transmission and distribution grid infrastructure, to guarantee transmission and distribution of RES

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[2] The Council conclusions do not specify whether this means primary or final energy consumption, but Directive 2009/28/EC specifies that the target should be measured in relation to gross final energy consumption. The target is therefore not directly comparable with the 2010 target of the 1997 White Paper, which was defined in relation to primary energy consumption.

electricity, to provide for priority/guaranteed access to the grid, and for priority dispatch.

Other elements of the directive concern the availability of information and training, the standardisation of guarantees of origin, and the implementation of sustainability criteria for biofuels and bioliquids.

A new and prominent element of the RES directive is the introduction of target flexibility mechanisms. Member states may use different types of cooperation mechanisms to statistically transfer RES target shares from one country to the other and/or to achieve their targets jointly. The aim of introducing these cooperation mechanisms is to allow for a better exploitation of low-cost RES potentials across Europe and a more cost-efficient RES target achievement. The cooperation mechanisms of the RES directive replace earlier proposals by the European Commission to introduce a European-wide trading system of green certificates.

3. Research to date: evaluations of the member states' RES support policies and RES target achievement

Effectiveness and efficiency are two key criteria in climate policy evaluation (see Gupta et al. 2007). They are also commonly used by the European Commission in their assessment of RES support policies. Closely related is the criterion cost-effectiveness, which refers to the cost-efficiency of reaching a predefined target.

As described above, all member states have implemented support instruments and regulatory frameworks for RES but their effectiveness varies greatly. The European Commission regularly monitored the progress towards the 2010 target and concluded that only a few member states were likely to meet their targets (European Commission 2007b, 2009, 2011[3]). The question arises: what changes in policy are required to reach the 2020 targets which tend to be more ambitious than the 2010 targets? This question has not yet been comprehensively analysed. According to their National Renewable Energy Action Plans (NREAPs 2011), all member states except for Italy and Luxembourg forecast the achievement of their RES targets domestically. But according to de Jager et al. (2011), the annual level of RES investments in the EU will need to be almost double compared to 2008 in order to meet the targets. Since the large majority of RES investments in the EU have been policy driven so far, this implies that the effectiveness of RES support policies needs to be improved considerably. The question of increasing the effectiveness of RES support policies is closely linked to the questions about their efficiency and cost-effectiveness, i.e. the policy cost required to reach the 2020 RES target, which will be burdened on tax payers and energy consumers.

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[3] These Commission reports are largely based on scientific analysis conducted within Ragwitz et al. (2007), Coenraads et al. (2008) and de Jager et al. (2011).

Important lessons on effective and efficient RES support policy design can be derived from the ex-post evaluation of the existing instruments, in particular for RES electricity. A large number of studies have evaluated and compared support instruments for RES electricity in different European member states (e.g. Menenteau et al. 2003, Reiche and Bechberger 2004, Mitchell et al. 2006, Ragwitz et al. 2007, Butler and Neuhoff 2008, just to mention a few relevant assessments), while support instruments for RES heat and fuels have received less attention in RES policy analysis.

Ragwitz et al. (2007) developed quantitative indicators for measuring the effectiveness and the efficiency of the member states' support policies for RES electricity in relation to the available RES potential, i.e. independently of any specific targets. The European Commission has also used these indicators to evaluate the support instruments of the member states (see European Commission 2005 and 2008). One main finding of these indicator-based assessments was that the effectiveness of RES support instruments was low in the majority of member states and that it did not correlate with the level of financial support provided. For most RES electricity technologies countries, using well-adapted feed-in systems showed higher effectiveness and efficiency scores in promoting RES than countries using quota schemes, meaning that these feed-in systems achieved higher RES growth at lower specific consumer costs. According to the updated indicator assessment in Held et al. (2010), this result is still valid today even though the effectiveness of quota systems for low-cost RES technologies has improved in recent years. Ragwitz et al. (2007) explain the higher effectiveness and efficiency of feed-in systems with the lower price risk and higher investment certainty provided under such schemes. They also point out that administrative barriers have a strong impact on the effectiveness and efficiency of support instruments.

The crucial role of risk in RES policy design has been analysed in further detail by Mitchell et al. (2006) who compare the UK quota scheme with the German feed-in tariff scheme. They point out that risk reduction is an important way of increasing the effectiveness and efficiency of a support instrument because lowering project risks reduces the costs of capital for the project developer and makes a larger number of projects attractive. They distinguish more precisely between price risk (electricity sales price), volume risk (limitation of sales volume), and balancing risk, which are all minimised under fixed feed-in tariff schemes. Justice and Hamilton (2009) differentiate further risk categories (country and financial risks, policy and regulatory risk, technical and project specific risks, market risks) and discuss their impacts on RES financing conditions. De Jager and Rathmann (2008) quantify the effect of RES policy design on the financing cost of RES projects for different country case studies. They conclude that stable, reliable, and predictable policy instruments can reduce the cost of capital and thus the cost of RES electricity by 10 to 30%. Luethi and Wuestenhagen (2010) use choice experiments with market actors to quantify the effect of reducing different types of administrative and policy risks on the required return on investment.

In summary, these studies all recommend the same best-practice criteria for effective and efficient RES support instrument design: long-term commitment, stability, and risk reduction. These conclusions seem very valid, but some open questions remain:

- whether the respective project risks reduced by RES support policies would otherwise lead to a system optimised behaviour of RES projects and thus indirectly reduce societal costs
- how risk reduction relates to the future transformation of power markets and infrastructures required to integrate high shares of RES into the power system
- what other options exist for increasing the effectiveness and efficiency of RES support policies
- what increase in effectiveness and efficiency is required to meet the member states’ 2020 targets cost-effectively

These questions will be further discussed in this thesis.

While the above-cited studies mainly focus on the effectiveness and efficiency of national support instruments in the member states, there has also been a continuous debate on the role that cooperation and/or harmonisation can play for cost-effective European target achievement. There are two predominant lines of argument. Some studies favour a harmonised RES support that would lead to RES investments at the best available sites and consequently lower capital cost requirements than a purely national target achievement (e.g. Pyöry 2008), while others stress the benefits and innovation of domestic RES support (e.g. Jacosbson et al. 2009) and warn of higher policy costs due to increased producer rents in a European support system with uniform support levels (Resch et al. 2009). One should be aware that this is not only a debate about the cost-effectiveness of RES support, but also about the member states’ national sovereignty on energy policy (see chapter V for a wrap-up of the European debate on guarantees of origin trade during the negotiations of the current RES directive). The cooperation mechanisms of the RES directive can be interpreted as a compromise between these positions, as they allow member states to tap lower cost RES potentials in Europe without endangering the effectiveness and efficiency of their national RES support policies. A question that has not been analysed so far is how these cooperation mechanisms can be implemented in practice in order to contribute to a cost-effective target achievement.

4. Research objective and outline of this thesis

The central research question for this thesis is:

How can policy makers increase the effectiveness and cost-efficiency of renewable energy support policies in the European Union in order to reach the 2020 targets?

Effectiveness and cost-efficiency will be the two leading criteria for the RES policy assessments in this thesis, as these are the predominant criteria in the European RES policy discussion. Other important evaluation criteria, such as public acceptance, distributional and administrative aspects, will be considered where they seem of special relevance.

The thesis discusses the central research question along the major discussion lines of the European RES policy debate developed in sections 2 and 3:

- Comparing the effectiveness of national support policies between the member states and with regard to meeting the 2020 targets
- Estimating the cost savings potential of different policy cost reduction options compared to a business-as-usual policy strategy
- Assessing the role of market risk exposure and market integration for RES deployment and cost-efficient RES support
- Assessing if and how different models of cross-country cooperation can make RES target achievement more cost-efficient

Chapter II sets the scope by exploring the status of RES deployment and support policy in the European Member States. Using quantitative effectiveness and deployment status indicators, it compares the recent effectiveness of support policies in the Member States with the effectiveness level required for reaching the 2020 targets and identifies key challenges that need to be tackled to meet the 2020 targets.

Chapter III discusses how the consumer (or tax payer) costs for reaching the 2020 target can be reduced compared to a continuation of current support policy, while in both cases a reduction of non-economic barriers and increasing investment levels are assumed. It analyses RES technology cost reduction and growth stimulating policy options with respect to their effect on project costs and consumer costs. Then, it discusses their role for achieving the EU 2020 RES targets. Special attention is paid to the impact of policy and market risk reduction strategies.

Chapter IV analyses the pros and cons of exposing RES electricity producers to market risks in more detail, differentiating three types of markets: forward electricity markets, balancing markets, and support markets.

The following chapters discuss the role and design of the cooperation mechanisms introduced by Directive 2009/28/EC. Chapter V traces back the evolution of these mechanisms and evaluates the principle trading options under discussion during the negotiation process of the RES directive. Chapter VI explores design options for the effective and efficient implementation of the cooperation mechanisms.

Chapter VII summarises the main outcomes of the thesis and draws conclusions on the overall state of RES support policy and the RES policy debate in Europe.

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II. Status and perspectives of renewable energy policy and deployment in the European Union–what is needed to reach the 2020 targets?[1]

Abstract

This article evaluates the status of current RES deployment, policies and barriers in the EU-27 member states and compares it to the required to meet the 2020 targets. The evaluation relies strongly on the quantitative deployment status and policy effectiveness indicators. European RES deployment and policy has progressed strongly in recent years, but the growth here has been mainly driven by effective policies in a small or medium number of top runner countries. Across Europe, the highest average policy effectiveness over six years was reached for onshore wind (4.2%), biofuels (3.6%) and biomass electricity (2.7%), while in the heat sector, all technologies score below 2%. Comparing the recent progress to the required growth for meeting the 2020 target, it appears that some countries largely exceed the interim targets of the RES directive 2009/28/EC. Despite this, Europe will need additional policy effort to reach the 2020 target. Critical success factors include implementing effective and efficient policies that attract sufficient investments, reducing administrative and grid related barriers, especially in currently less advanced countries, upgrading the power grid infrastructure, dismantling financial barriers in the heat sector, realising sustainability standards for biomass, and lowering energy demand through increased energy efficiency efforts.

1. Introduction

Up until the 1990s, policy support for renewable energy sources (RES) in Europe focused mainly on research and development (R&D) (Blok 2006). Once several countries had introduced support policies or obligations for RES delivery (e.g. Denmark, Germany, UK, etc.), the focus then shifted gradually from R&D to market deployment policies during the 1990s. In 1997, the European Commission published a White Paper that set the first target for RES deployment in the EU: The contribution of RES to the gross inland consumption of energy was to increase from 5.4% in 1997 to 12% in 2010 (European Commission 1997). In the following years, this 2010 target was underpinned by two European directives that formulated requirements of the EU member states, in particular, the requirement to

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introduce policy measures to increase the market share of RES. The Renewable Electricity Directive 2001/77/EC and the Biofuels Directive 2003/30/EC set indicative targets for the RES share in the electricity and transport sectors in 2010: The RES share in electricity consumption should increase to at least 21% in the EU-27 (22% in the EU 15), broken down into individual member state targets; the share of biofuels in total diesel and petrol transport fuels should increase to at least 5.75% in all EU member states. Shifting the focus from 2010 to 2020, the European Council agreed on new, binding RES targets for Europe in March 2007 which are based on an earlier proposal by the European Commission (European Commission 2007a): The share of RES in overall energy consumption should increase to at least 20% by 2020 (Council of the European Union 2007); the share of biofuels in total transport consumption to at least 10%. The RES Directive 2009/28/EC, which entered into force in June 2009, translates these binding targets into a legislative framework: The European target of 20% RES in the gross final consumption of energy is broken down into binding national targets for the EU-27 member states; the biofuels target is translated into a 10% RES target in the final consumption of transport energy that applies to each member state individually.

The European energy statistics for 2010 are not yet available, but it is unlikely that the above mentioned renewables targets for 2010 will be fully achieved, despite the considerable growth in RES compared to preceding decades. According to the latest progress reports by the European Commission (European Commission 2009, European Commission 2007b), which are based on projections of Eurostat data from 2005 and 2006, the EU could reach a 19% RES share in electricity in 2010, rather than 21% (the starting point in 1997 was approx. 12.8%[2]), and 4% instead of 5.75% in the transport sector (starting point in 2003 was 0.5% for the EU-25). Member state progress varies significantly, with many countries missing and a few countries over-achieving their targets. The Commission identifies several barriers to achieving the 2010 targets: “surrounding administrative procedures, grid access, and guaranteeing adequate support and measures from Member States to ensure that growth occurs” (European Commission 2009). To some extent, these barriers were already addressed by the 2001 directive 2001/77/EC, which provides member states with some guidance in how to improve administrative and grid connection procedures. The Commission states that the 2009 RES directive provides a new and stronger legislative framework that addresses these known barriers (European Commission 2009). By 30 June 2010, member states were required to present national RES action plans (NREAPs) outlining how they plan to overcome existing barriers and meet their binding national targets. By January 2011, all 27 NREAPs had been published (which seems quick compared to the implementation of other EU legislations, e.g. on co-generation or energy efficiency). According to the NREAPs, member states plan to over-achieve the overall 20% target by 0.6 percentage points (NREAPs 2011, Naegler 2011). Whether the proposed actions will be enough to actually achieve these targets remains to be seen.

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[2] The official reference year for the 2010 target is 1997 for the EU-15 member states and 2000 for the new member states (European Commission 2009).

In this article, we evaluate the status of current RES deployment, policies and barriers in the EU-27 member states, relying strongly on country-specific information and quantitative indicators which we compiled and updated within the EU-sponsored project RE-SHAPING (see Rathmann et al. 2009 and Held et al. 2010), as well as on other literature sources. We then discuss whether the EU member states are on track to meet the 2020 targets, and the major success and fail factors. This is done by comparing the current progress with the RES projections presented in the NREAPs.

Section 2 gives an overview of the current RES deployment status in the electricity, heating/cooling and transport sectors, both for Europe as a whole and for the EU-27 member states, based on a technology-specific RES deployment status indicator. Section 3 looks at current RES policies and assesses their effectiveness using an extended version of the effectiveness indicator developed by Held et al. (2006) (see also Ragwitz et al. 2007 and European Commission 2005). Section 4 reviews and classifies major barriers and success factors for RES market deployment in the EU based on a broader literature analysis (particularly Ceña et al. 2010, Ecorys et al. 2010, Ecofys and Golder 2009, Coenraads et al. 2008 and Ragwitz et al. 2007). As a synthesis, section 5 discusses whether Europe is on track to meet the 2020 RES targets, comparing recent progress with the required RES increase and the respective NREAP projections provided by the member states. Section 6 draws conclusions and identifies key challenges for the RES policy of the coming decade.

2. Status of current RES deployment in the EU-27

This section gives an overview of the current RES deployment in Europe. First, it summarises the development of RES in total and per energy sector (electricity, heat and transport energy) and relates this to the European 2010/2020 targets. Then it compares the deployment in the individual member states.

Since the European member states vary significantly in size, energy consumption and RES potential, a deployment status indicator is used for the member state analysis that allows the technology deployment by country to be compared in relative terms independent of the size of the country. This deployment status indicator measures the deployment status of RES-E and RES-H technologies in the EU-27 on a scale between immature and advanced, aggregating data on production, installation and potential per technology and country (see Appendix and Held et al. 2010 for details). We do not calculate the indicator for RES transport (RES-T): Due to the fact that biofuels are a global commodity and are often imported to a high degree, the indicator - which is meant to reflect the status of domestic production - is considered to be less meaningful.

2.1. Overall RES deployment and targets

The contribution of RES to the gross inland consumption of (primary) energy[3] in the EU-27 increased from 5.4% in 1997 to 6.6% in 2005 and to 8.4% in 2008 (Eurostat 2009). The target for 2010 is 12% (European Commission 1997). Looking at the contribution of different RES, biomass contributes the largest share to RES primary energy consumption in 2008 with 66.1%, followed by hydropower (21.2%), wind energy (6.9%), and geothermal energy (4.7%) (Eurobserver 2009).

The RES share in gross final energy consumption, a target indicator that was introduced for the 2009 RES directive[4], was 8.5% in 2005 and 10.3% in 2008 (Eurostat 2010a). RES-H currently contributes more than half of the RES final energy, RES-T less than 10%. The target for 2020 is 20% RES in gross final energy consumption. Broken down into national targets per member state, the 2020 targets vary from 10% for Malta up to 49% for Sweden.

2.2. Deployment of RES-E technologies

The share of RES-E in gross electricity consumption in the EU-27 increased from 13.1% in 1997 to 16.6% in 2008 (Eurostat 2009 and Eurostat 2010a), which is still considerably below the 2010 target of 21%.

Figure II-1 shows the development of RES-E generation in the EU between 1990 and 2008. Hydropower is still the dominant RES, but its importance has decreased over the last few years due to a marked upswing of emerging RES technologies, particularly wind and biomass. Whereas hydropower accounted for 94% of RES-E generation in 1990, its overall share in total RES-E generation had dropped below 60% by 2008. The varying hydro electricity generation is not due to a decrease in hydropower capacity, but rather a consequence of changing meteorological conditions.

Focussing on the development of emerging RES-E (all RES technologies with the exception of hydropower) shows that electricity generation increased tenfold from 19 TWh in 1990 to 223 TWh in 2008 (see Figure II-2). Onshore wind and the use of solid biomass made the biggest contributions to this development.

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[3] The gross inland consumption of energy is calculated as follows: primary production + recovered products + total imports + variations of stocks - total exports - bunkers. It corresponds to the addition of final consumption, distribution losses, transformation losses and statistical differences (Eurostat 2009).

[4] The renewable energy share in final energy consumption corresponds to the sum of the final consumption of renewable energies for heat production (including final consumption of derived heat of renewable origin), for gross electricity production and liquid biofuels for transport, divided by the final energy consumption including the consumption of the energy sector and the losses on the power grids for producing electricity and heat (Eurobserver 2008).

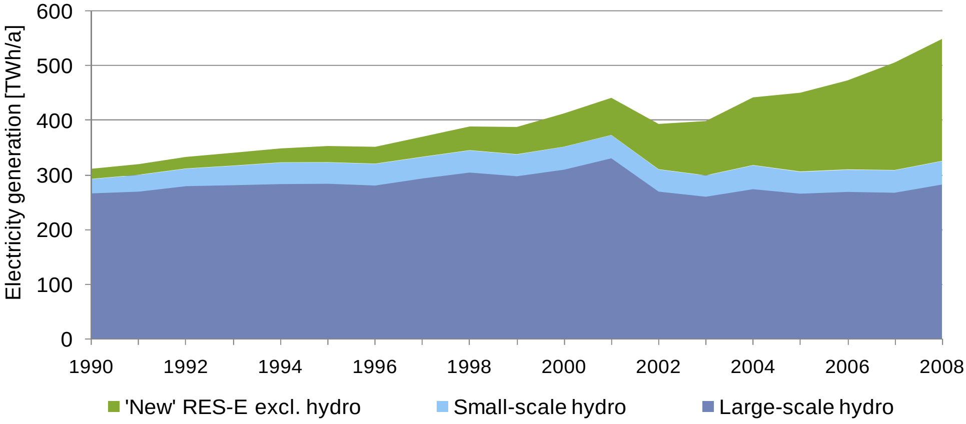


Figure II-1. Electricity generation from RES in the EU-27 from 1990-2008 (based on Eurostat 2010a)

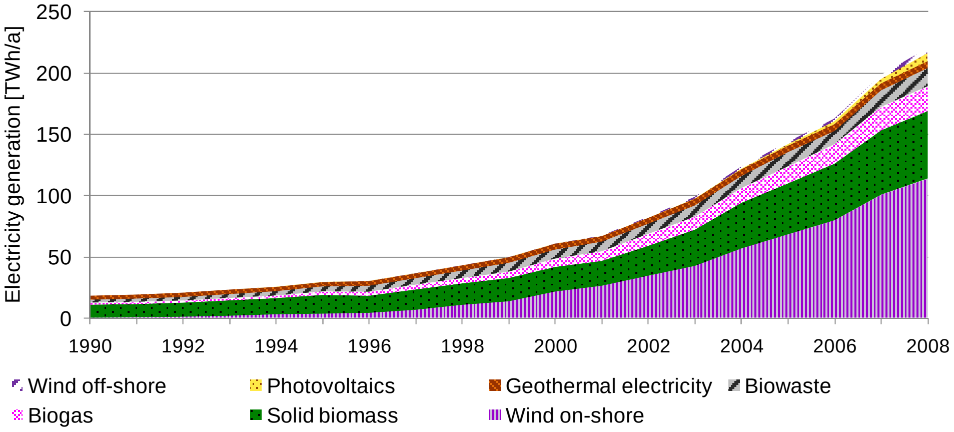


Figure II-2. Development of 'new' RES-E in the EU-27 (based on Eurostat 2010a)

How does this development relate to the situation in the individual member states? Figure II-3 gives an overview of the deployment status indicator for the different “new” RES-E technologies in the EU-27 member states in the year 2008 (2009 for wind and PV). Not shown is hydropower (which has an advanced deployment status in most member states), solar thermal electricity, and tidal and wave energy (in 2008 deployment status in all member states still close to zero). Member states with very low potential or deployment status indicators close to zero are not shown in the figure, but indicated by the placeholder "other MS".

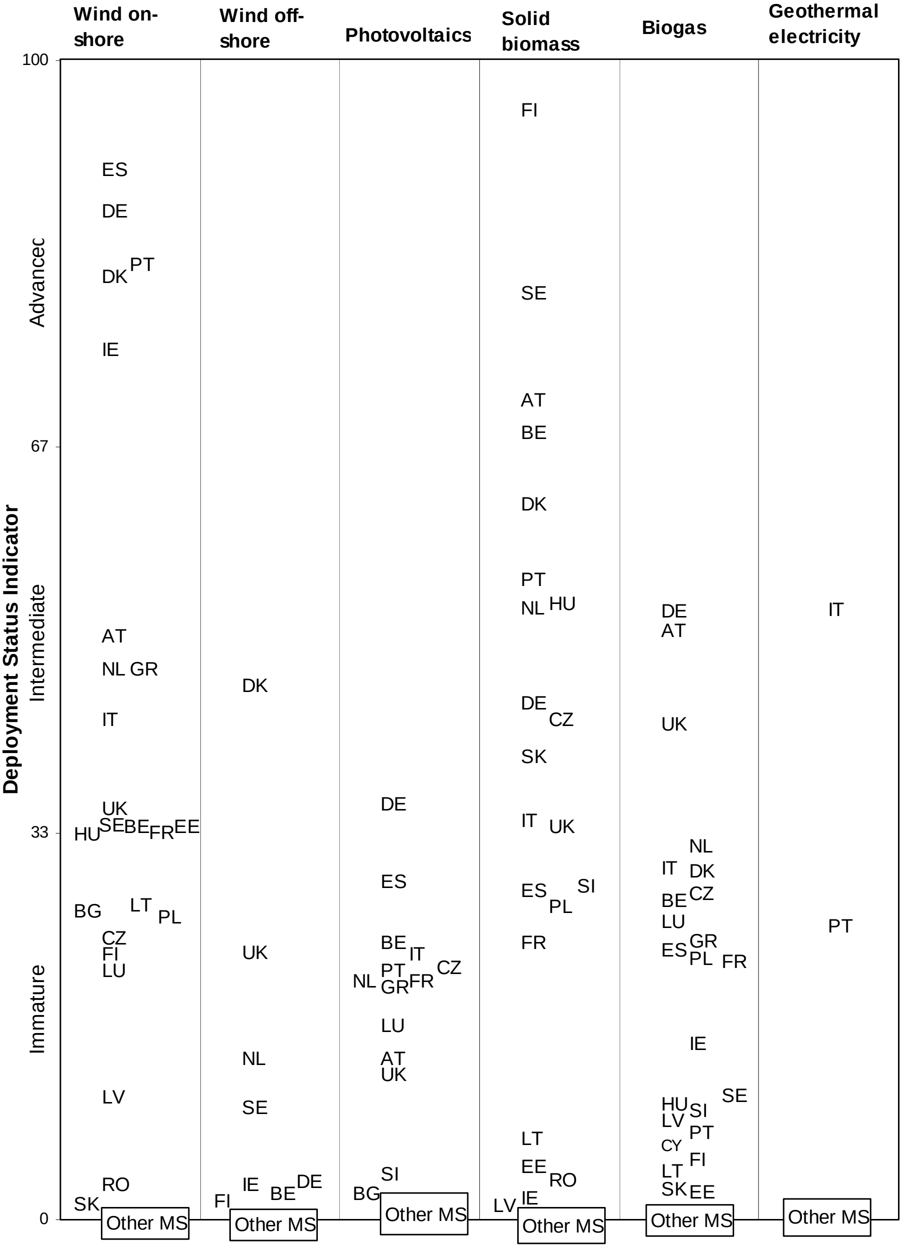


Figure II-3. Deployment status of RES-E technologies in the EU-27 member states

The figure shows that only a few member states have reached an advanced deployment status for some RES-E technologies: the onshore wind markets in Spain, Germany, Portugal, Denmark and Ireland and solid biomass in Finland, Sweden, Austria and Belgium (one should note, however, that solid biomass is a very heterogeneous category, which comprises different technologies, e.g. pure biomass plants and co-firing, as well as domestic and imported biomass; this limits the comparability between countries). For onshore wind and biomass, the spread of results is very broad, with other countries having intermediate and others immature scores. For the other technologies (offshore wind, PV, biogas and geothermal), a clear majority of countries is characterized by immature deployment. Nevertheless, there are still top runner countries for each technology: Denmark for offshore wind, Germany for PV, Germany, Austria and the UK for biogas, and Italy for geothermal electricity, all of them with intermediate deployment status.

While some countries have immature scores for all technologies, no country manages an advanced score in more than one technology. The best scores across all technologies are achieved by Germany, Denmark and Austria. This picture would change, however, if hydropower were included in the assessment.

2.3. Deployment of RES-H technologies

RES-based heat generation increased from 452 TWh to 770 TWh between 1990 and 2008, corresponding to an annual growth rate of 3 % on average (see Figure II-4). The share in gross final energy consumption for heat was 11.9% in 2008 (Eurostat 2010a). Regarding the heat generation technologies, two forms of heat supply can be differentiated. The first describes decentralised heating applications where the heat is produced on-site at the consumers' location, whilst the second refers to central installations. In the latter case, the heat is distributed to the final consumer via heating networks. Due to the difficulty of measuring on-site heat production, data gathering in this sector is complicated and the final statistics involve a degree of uncertainty. Domestic, decentralised heating appliances based on biomass clearly dominate the RES-H market, but the use of biomass in centralised heating plants or CHP-plants has also increased. Solar thermal heating technologies, ground source heat pumps and geothermal heating technologies only account for a marginal share of RES-H production so far.

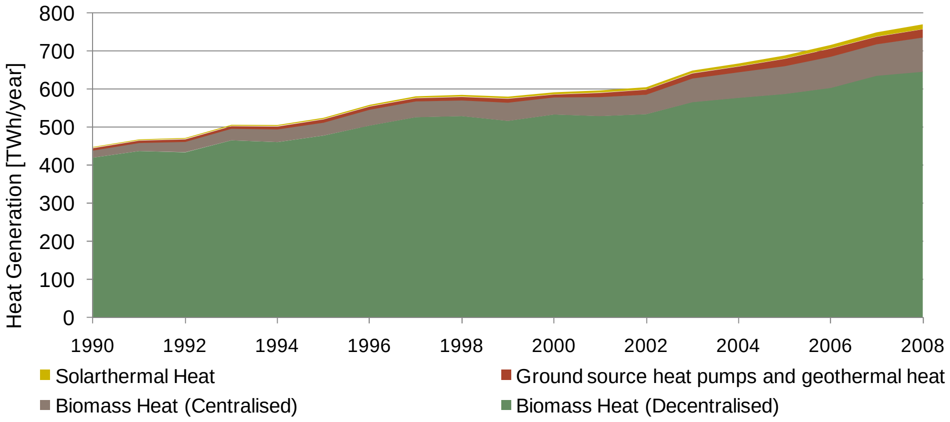
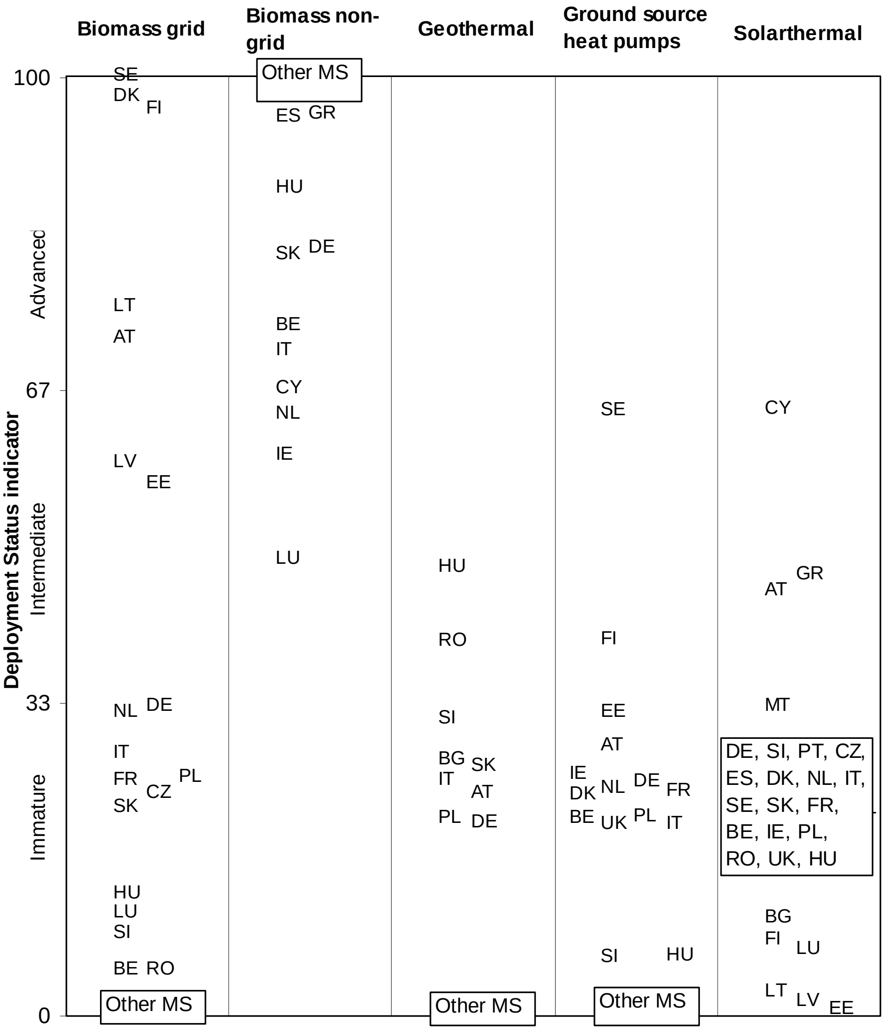


Figure II-4. RES heat generation in the EU-27 from 1990-2008 (based on Eurostat 2010a)

The market development of RES-H production is modest in comparison to the higher growth rates in the electricity and transport sectors.

Figure II-5 shows the heterogeneous deployment status of RES-H technologies in the EU-27 member states in 2008 (2009 for solar thermal heat). Member states with a very similar deployment status are indicated by the placeholder "other MS". The most advanced technology group is non-grid biomass, a category which comprises traditional and modern decentralised biomass heating technologies. The majority of countries have advanced scores, many of them very high scores. Grid-connected biomass heat installations are very advanced in the Scandinavian countries (Sweden, Denmark, and Finland), and to a lesser extent in the Baltic countries and Austria. Their deployment status in other countries is still rather low. The other heat technology markets - geothermal heat, ground source heat pumps and solar thermal - are still immature in the majority of countries, although most states have made some progress and are at the border to an intermediate market status. Only a few countries achieve the intermediate status: Hungary and Romania for geothermal heat, Sweden and Finland for ground source heat pumps, Cyprus, Greece and Austria for solar thermal. Across all the technologies, Sweden, Austria and Finland score the highest.



Note: RET markets where the share of the potential in sector consumption is < 1% are not shown.
For example in case of biomass non-grid this applies to UK and MT.

Figure II-5. Overview deployment status RES-H technologies

2.4. Deployment of RES-T technologies

The share of biofuels in diesel and petrol consumption in the EU-27 increased from 0.14% in 1997 to 3.5% in 2008 (Eurobserver 2009, Eurostat 2010a). This corresponded to 112 TWh/a in 2008 (see Figure II-6). Considering that the EU 2010 target is 5.75%, it seems unlikely that this will still be met.

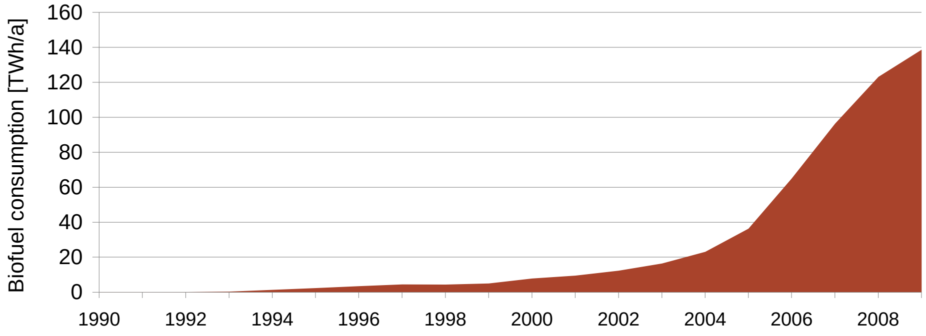


Figure II-6. RES development in the transport sector in theEU-27 (based on Eurostat 2010a)

Biofuel consumption in the EU is clearly dominated by the use of biodiesel, which totalled 78% in 2008. Bioethanol consumption amounted to 16% in 2008, the use of other biofuels, consisting mainly of vegetable oils, to 6%.

For the 2020 target of 10% RES-T energy in total transport energy consumption (including non-road transport), other RES energy carriers are also eligible, notably RES electricity used in trains and electric vehicles, or biogas used in gas engines, but so far they do not play a relevant role.

Looking at the biofuel use in the member states, the deployment rate varies greatly, despite the uniform targets for all member states (see Figure II-6). Until 2007, the clear front-runner was Germany (8.4% biofuels in transport fuels in 2007); however, since 2008, the German biofuel share has declined due to policy changes. In 2008, Austria had the highest RES share in transport fuels (7.1%). Three countries (Germany, Slovakia and Sweden) over-achieved their 2010 target in 2008.

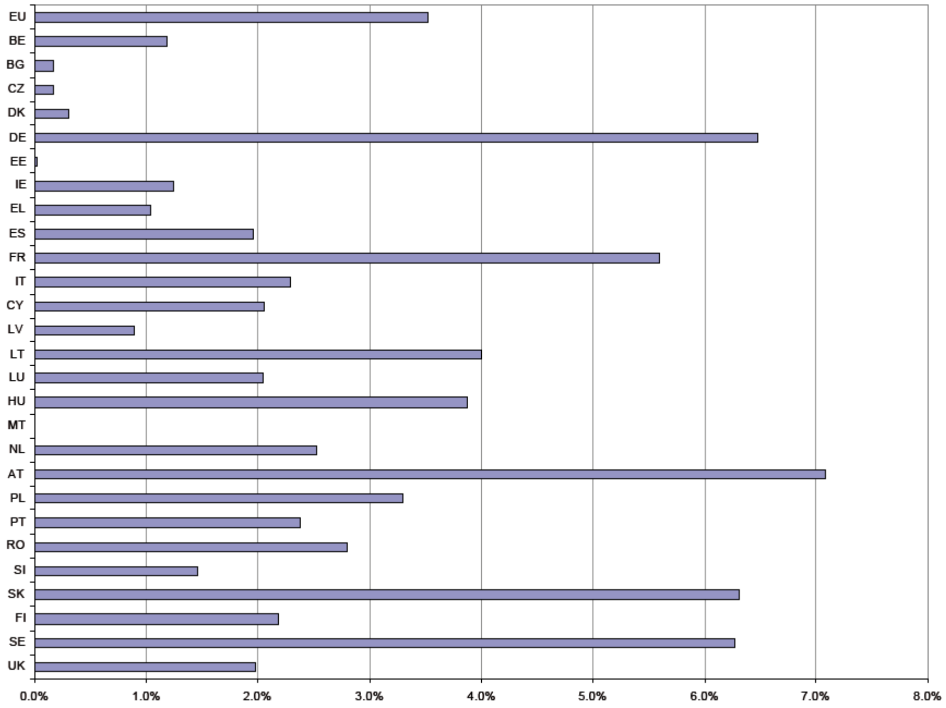


Figure II-7. Share of RES in transport fuel consumption per member state in 2008 (Eurostat 2010b)

3. Current support policies for RES deployment in the EU-27 member states

This section provides an overview of the RES support policies applied in the European member states. The focus is on the national level; regional or local policies are not analysed. For each sector (electricity, heat and transport), the main support instruments per member state are summarised based on Rathmann et al. 2009. In a next step, we evaluate and compare the effectiveness of these instruments. For the latter, we refine the quantitative effectiveness indicator developed by Held et al. (2006) (see also Ragwitz et al. 2007). This indicator was also used by the European Commission in their evaluation reports (European Commission 2005 and European Commission 2009). While this has only been calculated for RES-E so far, we also introduce RES-H into the quantitative evaluation. Details on the scope and methodology are provided in the Appendix.

3.1. Electricity from renewable sources

3.1.1. Overview of support instruments

Table II-1 provides an overview of the primary (dominating) and supplementary RES-E support instruments applied in the EU-27 member states based on Rathmann et al. (2009). Figure II-8 shows only the primary RES-E support schemes in each country. The vast majority of member states use feed-in tariffs or premiums as the dominant support scheme. Six countries apply quota obligations. Tender schemes are no longer used in any member state as the primary policy scheme, but they are applied in some member states for specific projects or technologies (e.g. biomass and onshore wind in Portugal, offshore wind in Denmark and the Netherlands and biomass in France). Other policy measures such as production tax incentives and investment grants represent the dominant policy measure in Finland and in Malta, but Finland has announced that it will introduce a feed-in tariff in 2011. In many countries fiscal incentives are used as supplementary support instruments.

Table II-1. Overview of RES-E support instruments in the EU-27

	AT	**BE**	**BG**	**CY**	**CZ**	**DE**	**DK**	**EE**	**ES**	**FI**	**FR**	**GR**	**HU**	**IE**
Feed-in tariff	**X**	**X**	**X**	**X**	**X**	**X**		**X**	**X**		**X**	**X**	**X**	**X**
Feed-in premium					**X**		**X**	**X**	**X**					
Quota obligation		**X**												
Investment grants		**X**		**X**	**X**					**X**		**X**	**X**	
Tax exemptions		**X**							**X**	**X**		**X**		
Fiscal incentives			**X**			**X**		**X**						
Tendering schemes							**X**				**X**			

	IT	**LT**	**LU**	**LV**	**MT**	**NL**	**PL**	**PT**	**RO**	**SE**	**SI**	**SK**	**UK**
Feed-in tariff	**X**	**X**	**X**	**X**	**X**			**X**			**X**	**X**	**X**
Feed-in premium						**X**					**X**		
Quota obligation	**X**						**X**		**X**	**X**			**X**
Investment grants		**X**	**X**	**X**	**X**								
Tax exemptions				**X**		**X**	**X**			**X**		**X**	**X**
Fiscal incentives					**X**	**X**	**X**				**X**		
Tendering schemes						**X**		**X**					

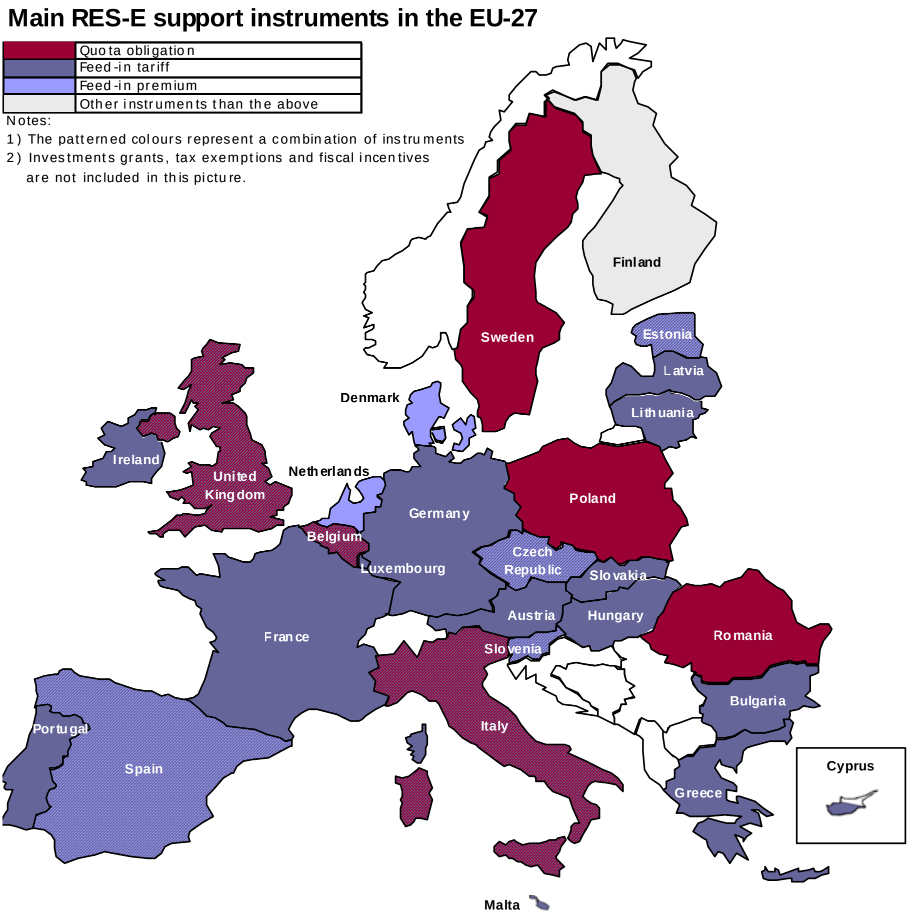


Figure II-8. Main RES-E support schemes in the EU-27

3.1.2. Effectiveness of applied support instruments for RES electricity

The effectiveness of support instruments is evaluated using the effectiveness indicator, which expresses the increase in RES electricity production compared to the remaining 2020 potential (see Appendix for details). Figure II-9 shows the example of policy effectiveness for onshore wind. The countries are presented in the order of their deployment status (immature, intermediate, advanced, see section 2).

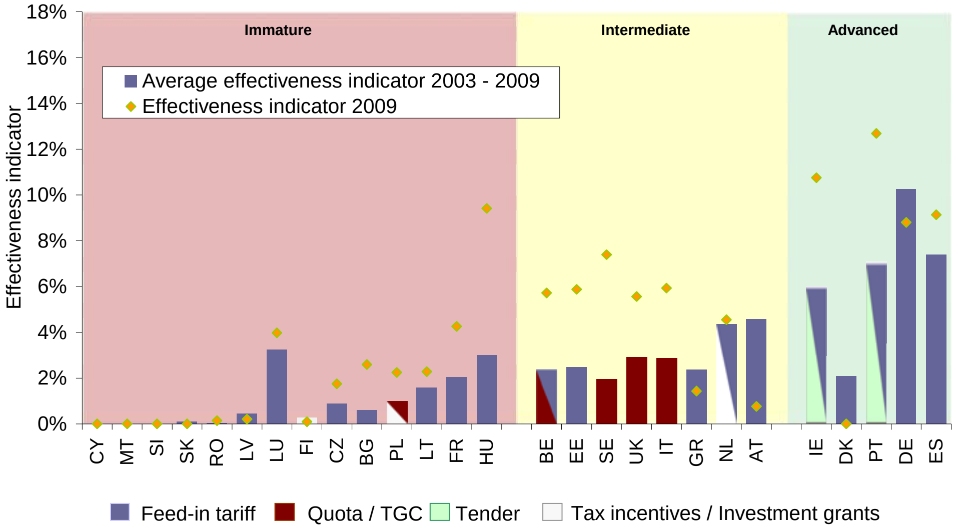


Figure II-9. Effectiveness indicator for onshore wind (based on Eurostat and Green-X 2010, for more details see Held et al. 2010)

Figure II-10 compares the average effectiveness rate per technology for the years 2003-2009 and for the year 2009 (2002-2008 and 2008 for biomass and biogas, since 2009 data were not yet available). Furthermore, Table II-2 shows the effectiveness of the three top runner countries per technology.

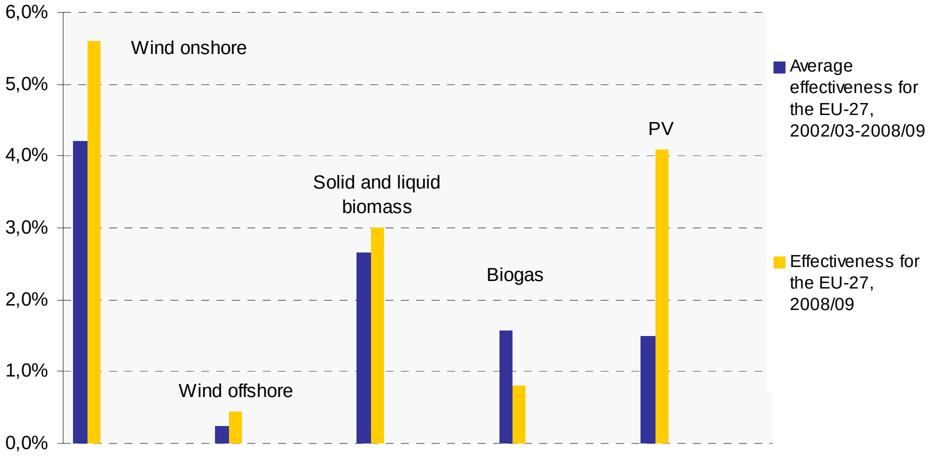


Figure II-10. Average effectiveness of RES-E support policies in the EU-27

Table II-2. Comparison of RES-E policy effectiveness across countries and technologies

Technology	**Average effectiveness for the EU-27, 2002/03-2008/09**	**Effectiveness for the EU-27, 2008/09**		**Top runner countries for the years 2002/03-2008/09 (top 3)**				**Top runner countries for the year 2008/09 (top 3)**		
				Country	Support scheme	Average effectiveness 2002/03-2008/09		Country	Support scheme	Effectiveness for the year 2008/09
Wind onshore	4.2%	5.6%		Germany	FIT	10.2%		Portugal	FIT/tender	12.7%
				Spain	FIT/FIP	7.4%		Ireland	FIT	10.8%
				Portugal	FIT/tender	7.1%		Hungary	FIT	9.4%
Wind offshore	0.2%	0.4%		Denmark	FIP/tender	1.6%		Denmark	FIP/tender	6.0%
				Finland	Grants/ tax incentives	0.8%		Sweden	Quota	1.0%
				Sweden	Quota	0.6%		UK	Quota	0.3%
Solid and liquid biomass	2.7%	3.0%		Belgium	Quota/FIT	28.9%		Belgium	Quota/FIT	97.7%
				Sweden	Quota/ tax incentives	7.9%		Netherlands	FIP/ tax incentives	17.3%
				Netherlands	FIP/tax incentives	6.4%		Slovenia	FIT	13.6%
Biogas	1.6%	0.8%		Austria	FIT	6.9%		Austria	FIT	9.9%
				Germany	FIT	6.8%		Cyprus	FIT/tax incentives	7.9%
				Luxembourg	FIT	4.0%		Luxembourg	FIT	6.2%
PV	1.5%	4.1%		Germany	FIT	6.2%		Germany	FIT	21.6%
				Spain	FIT	2.1%		Belgium	FIT/quota	11.7%
				Belgium	FIT/quota	2.0%		Italy	FIP	5.5%

Abbreviations: FIT – feed-in tariff; FIP – feed-in premium

Onshore wind is the RES-E technology segment that shows the highest average policy effectiveness (4.2%/a for the years 2003-2009, 5.6% for 2009), followed by solid and liquid biomass. Offshore wind shows the lowest average effectiveness (<0.5%), which corresponds to the low deployment status of this technology so far. PV shows a relatively low average effectiveness between 2003 and 2009 (1.5%), but a high effectiveness rate in 2009, which can be attributed to a large extent to the substantial PV growth in Germany. With the exception of biogas, the average effectiveness for the EU-27 increased in 2008/09 compared to the previous years.

In many cases, the countries with high effectiveness scores are those that have reached intermediate or advanced market status, but some countries with an immature market status also achieve high effectiveness rates, e.g. Hungary for onshore wind and Slovenia for biomass in 2009. For all the technologies except onshore wind, two of the three top runners in 2008/09 had already held this position beforehand. For onshore wind, three new top runners have emerged, which shows that wind energy is being more widely applied across Europe. Caution should be exercised when considering the high effectiveness scores for solid biomass: Some of these are actually triggered by high biomass imports in comparison to the domestic potential (e.g. in the case of Belgium).

The indicator also allows some conclusions to be made about the effectiveness of different support instruments. With regard to onshore wind, the countries with the highest policy effectiveness - Spain, Germany, Portugal and Ireland - all apply feed-in tariffs or premiums as their primary support schemes (in Portugal, tenders also play an important role). Compared with previous analyses for onshore wind (European Commission 2005; European Commission 2008), countries using quota obligations such as Italy, Sweden and the United Kingdom have caught up in terms of policy effectiveness, in particular in 2009, but their performance still lags behind the group of countries using effective feed-in systems. For biogas and PV as well, all the top runner countries use feed-in tariff or premium systems, in some cases combined with other support schemes. For solid and liquid biomass, on the other hand, countries with quota schemes are among the top runners. There is no clear picture for offshore wind so far due to its low deployment status.

Despite the success of feed-in systems in some countries, they also show very low effectiveness in several countries, either because the support level is too low, or because severe non-economic barriers exist (or a combination of these reasons). The pros and cons of different RES-E support instruments have been discussed extensively before (e.g. Ragwitz et al. 2007, Butler and Neuhoff 2008, Klessmann et al. 2008, Jacobsson et al. 2009, de Jager et al. 2011). Major success factors and barriers are summarised in section 4.

3.2. Heat from renewable sources

3.2.1. Overview of support instruments

Most member states put considerably less effort into supporting RES heating and cooling than is the case for RES-E. This might be partly explained by the lack of a European heating and cooling directive - and therefore the absence of Europe-wide targets and support requirements - until the new RES directive entered into force in 2009.

Table II-3 provides an overview of the main RES heating and cooling support instruments used in the EU-27 member states based on Rathmann et al. 2009. RES cooling is not analysed separately. The overview only includes the instruments applied specifically for heat, not the instruments used to support biomass CHP through electricity incentives, such as feed-in premiums, etc.

Table II-3. Overview of main RES-H support instruments in the EU-27

	AT	BE	BG	CY	CZ	DE	DK	EE	ES	FI	FR	GR	HU	IE
Investment grants	X	X	X	X	X	X		X		X	X	X	X	X
Tax exemptions	X	X					X				X	X		
Fiscal incentives			X			X		X			X			
Use obligations						X			X					

	IT	LT	LU	LV	MT	NL	PL	PT	RO	SE	SI	SK	UK
Investment grants		X	X	X	x	X	X	X		X	x	X	X
Tax exemptions	X	X				X				X			X
Financial incentives								X					
Use obligations								X					

The most common RES-H support instruments are investment grants and – to a lesser extent - tax exemptions. Other fiscal incentives such as soft loans are available in combination with these schemes in several member states.

The 2009 RES directive asks member states to introduce use obligations for RES-H, i.e. the obligation to use minimum levels of RES-H in new buildings and in existing buildings that are subject to major renovation. So far, only a few countries have introduced such obligations on a national level (Spain, Portugal, Germany), but with limited scope in all cases.

3.2.2. Effectiveness of applied support instruments for RES heat

The effectiveness of support instruments is evaluated using the effectiveness indicator for heat (see above), which expresses the increase in RES heat production in a specific year compared with the remaining 2020 potential. The average effectiveness 2002-2008 is calculated as an average of the yearly effectiveness rate; moving averages over three years are calculated to smooth out the time series (for details, see Held et al. 2010).

Figure II-11 and Figure II-12 show the example of policy effectiveness for centralised biomass (district heating and CHP) and decentralised biomass heating installations. The countries are presented in the order of their deployment status (see section 2). Decentralised biomass applications are traditionally advanced market segments in most member states, but the policy effectiveness of promoting them varies greatly across member states, which indicates that the advanced deployment status must have been partly achieved prior to 2002. In contrast, only the five countries with the highest policy effectiveness for centralised biomass in 2002-2008 (Denmark, Finland, Sweden, Lithuania and Austria) have reached an advanced deployment status.

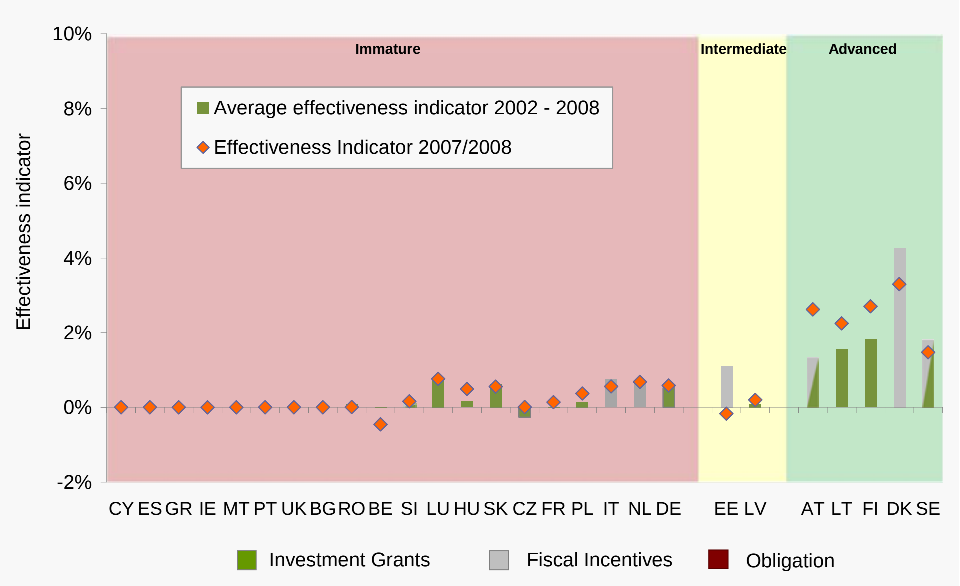


Figure II-11. Effectiveness indicator for centralised biomass heating plants (district heating plants and CHP plants) in the period 2002 – 2008 (based on Eurostat and Green-X 2010, for more details see Held et al. 2010)

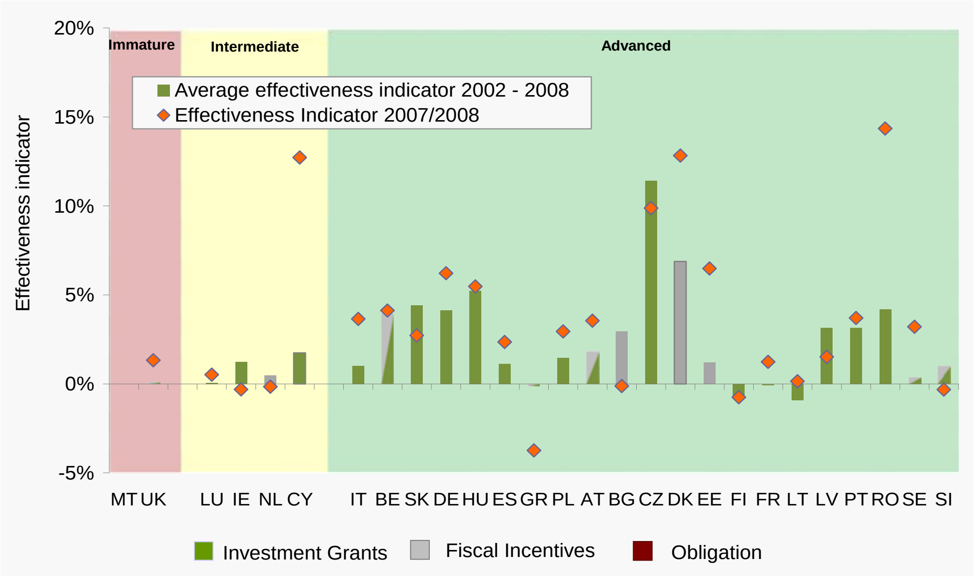


Figure II-12. Effectiveness indicator for decentralised biomass heating plants (boilers and stoves) in the period 2002 – 2008 (based on Eurostat and Green-X 2010, for more details see Held et al. 2010)

Figure II-13 compares the average effectiveness rate per technology for the years 2002-2008 and the year 2008. Table II-4 shows the effectiveness of the three top runner countries per technology.

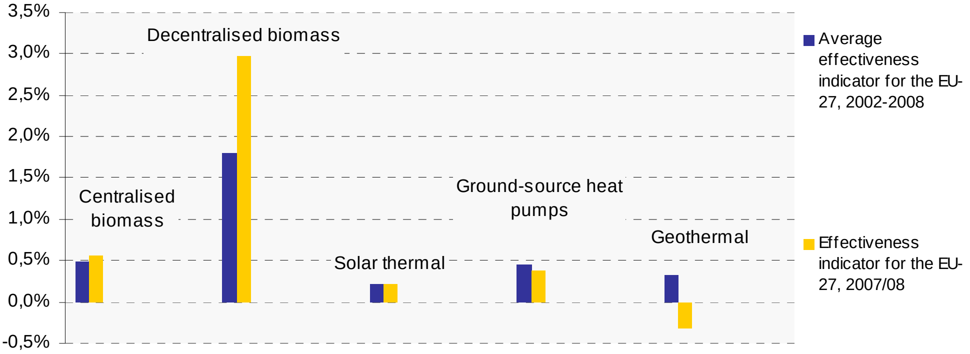


Figure II-13. Average effectiveness of RES-H support policies for the EU-27

Support policies for decentralised biomass reach the highest average effectiveness in the RES-H sector with 3% in 2007/08 and 1.8% in 2002-2008. Some countries manage double-digit effectiveness rates, particularly the Czech Republic (on average) as well as Romania, Denmark, and Cyprus (for 2007/08). One should be aware, however, that decentralised biomass includes traditional, cost-competitive biomass use such as wood stoves. Policies for centralised biomass use (district heating and CHP) show the second highest effectiveness (0.5%/0.6%). This value is rather low compared with the average effectiveness rates for bioenergy use in the electricity sector. The average effectiveness for the other technologies (solar thermal, ground-source heat pumps, geothermal) is below 0.5% and thus very low, even though the top runner countries score around 5% in average effectiveness (e.g. Cyprus for solar thermal with a 4.8% average in 2002-2008; Sweden for ground-source heat pumps with a 5.2% average in 2002-2008).

Overall, the average effectiveness of RES-H support policies is considerably lower than for RES-E. One important reason might be that RES-H support schemes are almost entirely financed by public budgets. The uncertainty of government budgets often creates stop-go investment cycles in the RES-H sector. The scientific policy discussion therefore calls for new, budget-independent RES-H support instruments, such as RES obligations for heat fuel suppliers or building owners, bonus systems comparable to RES-E feed-in systems, or a combination of these (e.g. Buerger et al. 2008). So far, however, no member state has introduced such innovative schemes except for the above mentioned building obligations in Germany, Portugal and Spain.

RES-H use obligations for new or majorly renovated buildings are therefore the main budget-independent support scheme at the moment. These have received a lot of attention and are promoted in the 2009 RES directive[8]. Solar obligations have a successful track record at local level, e.g. in Barcelona, and for the past 30 years in Israel (ESTIF 2007). According to the indicator results, however, the success of RES-H obligations at national level still very limited. This can be partly explained by their recent introduction (2006 in Spain and Portugal, 2009 in Germany) and partly by limitations in the obligation design (e.g. missing quality criteria, generous exceptions and substitution measures, or, like in Germany, the exclusion of major renovations).

When looking at the effectiveness of investment grants and fiscal measures, it is difficult to draw clear conclusions. Most top runner countries use investment grants, but fiscal incentives also have top runner scores. The availability of a proper policy mix consisting of sufficient financial support and measures to dismantle non-economic barriers (see section 4) seems much more important than the type of support scheme.

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[8] Article 13 of the directive states that “by 31 December 2014, Member States shall, in their building regulations and codes or by other means with equivalent effect, where appropriate, require the use of minimum levels of energy from renewable sources in new buildings and in existing buildings that are subject to major renovation.” Member states are therefore in principle required to introduce RES-H obligations, but the directive allows for alternative measures to bypass this obligation.

Table II-4. Comparison of RES-H policy effectiveness across countries and technologies

Technology	**Average effectiveness indicator for the EU-27, 2002-2008**	**Effectiveness indicator for the EU-27, 2007/08**		**Top runner countries for the years 2002-2008 (top 3)**				**Top runner countries for the year 2007/08 (top 3)**		
				Country	Support scheme	Average effectiveness for 2002-2008		Country	Support scheme	Effectiveness for the year 2007/08
Centralised biomass	0.5%	0.6%		Denmark	fiscal incentives	4.3%		Denmark	fiscal incentives	3,3%
				Sweden	investment grants/ fiscal incentives	1.8%		Finland	investment grants	2.7%
				Finland	Investment grants	1.8%		Austria	investment grants/ fiscal incentives	2.6%
Decentralised biomass	1.8%	3.0%		Czech Republic	Investment grants	11.4%		Romania	Investment grants	14.3%
				Denmark	fiscal incentives	6.9%		Denmark	fiscal incentives	12.8%
				Hungary	Investment grants	5.2%		Cyprus	investment grants	12.7%
Solar thermal	0.2%	0.2%		Cyprus	Investment grants	4.8%		Cyprus	Investment grants	7.5%
				Greece	investment grants/ fiscal incentives	5.2%		Greece	investment grants/ fiscal incentives	2.5%
				Austria	investment grants/ fiscal incentives	1.0%		Austria	investment grants/ fiscal incentives	0.7%
Ground-source heat pumps	0.4%	0.4%		Sweden	investment grants/ fiscal incentives	5.2%		Hungary	Investment grants	2.0%
				Hungary	Investment grants	4.6%		Sweden	investment grants/ fiscal incentives	1.7%
				Bulgaria	investment grants/ fiscal incentives	3.9%		Finland	Investment grants	1.7%
Geothermal	0.3%	-0.3%		Hungary	Investment grants	2.9%		Hungary	Investment grants	1.2%
				Portugal	Investment grants	2.2%		Slovenia	Investment grants	0.8%
				Greece	Investment grants	0.4%		Romania	Investment grants	0.8%

3.3. Transport energy from renewable sources

3.3.1. Overview of support instruments

Up to the present, member states have focused almost entirely on biofuels in their support of RES transport fuels. Other forms of RES transport energy, such as biogas for gas engines and RES electricity for electric vehicles, are therefore not included in the analysis.

Table II-5 gives an overview of the support policies for biofuel consumption in the EU-27. Most member states use a combination of a quota obligation with tax exemptions. In some countries, only one of these two instruments is applied.

Table II-5. Overview of main biofuels support instruments in the EU-27

	AT	BE	BG	CY	CZ	DE	DK	EE	ES	FI	FR	GR	HU	IE
Quota obligation	X		X	X	X	X	X		X	X	X			X
Tax exemptions	X	X		X	X	X	X	X	X		X	X	X	X

	IT	LT	LU	LV	MT	NL	PL	PT	RO	SE	SI	SK	UK
Quota obligation		X	X	X		X	X	X	X		X	X	X
Tax exemptions	X	X	X	X	X		X	X	X	X	X	X	X

3.3.2. Effectiveness of applied support instruments for RES transport

As explained in the Annex, we do not apply the effectiveness indicator to biofuels on a country level, because the domestic potential of each country is not a meaningful sub-indicator for internationally traded biofuels. On the other hand, the average effectiveness for the EU-27 is a relevant figure, as this refers to the exploited potential in Europe: This was 3.6% as a European average in 2002-2008 and 4.3% in 2007/08. This means that biofuel policies achieve the second highest effectiveness of all RES after wind onshore.

In order to compare the progress at country level, we look at the recent development of biofuel shares in total transport fuel consumption for each country as documented by Eurostat. In contrast to the effectiveness indicator, however, an increase in the biofuel share can also be achieved by a change in total transport fuel consumption and does not require actual biofuel market growth. Figure II-14 shows the increase and decrease of biofuel shares in percentage points across countries and compares this to the biofuel share achieved in 2008[9]. The resulting picture is quite mixed. Some countries with no or a very low

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[9] If no figure is given this either means that the share was zero or that no data was available.

increase until 2007 strongly expanded their biofuel shares between 2007 and 2008 (e.g. Slovakia, Poland, Austria and Hungary). Germany, which demonstrated high growth until 2007, lowered its biofuel share subsequently due to the phase out of tax exemptions and setting a quota below 2007 consumption levels.

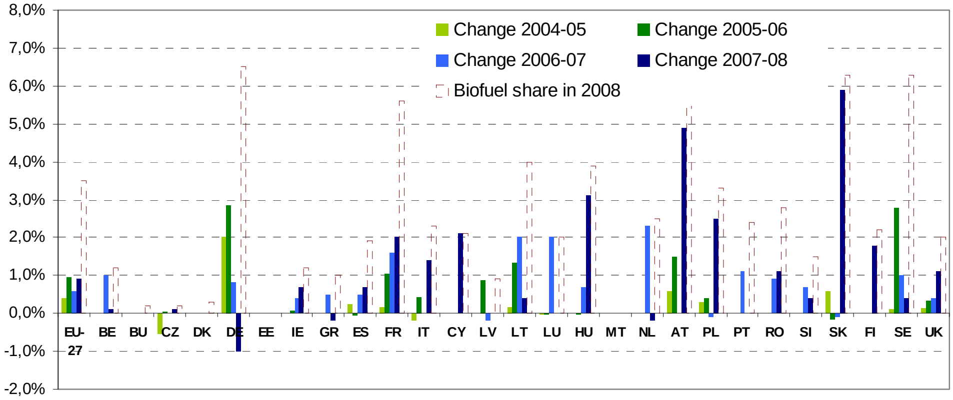

Figure II-14. Annual change of biofuel shares in transport fuel consumption in %-points 2004-2008 (based on Eurostat 2009 and 2010a)

Neither the effectiveness indicator nor the biofuel shares allow a clear conclusion about whether tax exemptions or biofuel quotas are the more effective instrument. The effectiveness strongly depends on the level of the quota and the financial incentive of the tax measures. In the past, countries with both instruments performed best, but from the perspective of a simple and transparent policy design, it may be questioned whether tax exemptions are really necessary to complement a well implemented quota system. In any case, quotas are the more reliable policy instrument, since they tend to deliver the required biofuel share, but are not financed through the state budget.

Finally, European biofuel policies and growth ambitions are being increasingly affected by concerns about the efficient use of biomass and the sustainability of the required cultivation of energy crops (competition with food markets, greenhouse gas balance, etc.). Therefore, implementing effective sustainability certification schemes, as required by the RES directive, will play an important role in the future, as will alternative forms of RES transport energy.

3.4. Other criteria for support policy evaluation

Obviously, apart from effectiveness, there are also other important criteria for evaluating the success of support instruments, particularly cost-effectiveness/efficiency, but also – as evaluated e.g. by de Jager et al. 2011 – energy market conformity, investment certainty, competitiveness and governance. In addition, social and environmental criteria play an important role, albeit more broadly. We do not evaluate all these criteria, but integrate some of them in the discussion of barriers and success factors in the next section.

4. Barriers and policy success factors for further RES deployment

The basic concept behind all the support instruments for RES technology (RET) commercialisation is to try and overcome the existing barriers to RET market development, so the success of RES policies is linked to their ability to surmount these economic and non-economic barriers. Based on a literature review, this section describes the key barriers and policy success factors for RES deployment in Europe. We then discuss which barriers represent the biggest obstacles in the years ahead.

Barriers to RES deployment have been analysed by a variety of studies. In analogy to the RES policy discussion, barriers to RES-E technologies receive considerably more attention than barriers to RES-H technologies and biofuels. Painuly (2001), Beck and Martinot (2004) and Kofoed-Wiuff et al. (2006) provide an inventory of generic RES barriers based on a synthesis of other studies. Studies that analyse predominant RES barriers in Europe will be discussed in further detail below.

Table II-6 gives an overview of the major economic and non-economic RES barriers based on a summary of various studies (sources mentioned in brackets) and our own analysis. The second column shows the available policy responses to address these barriers. The implementation of these policy features varies strongly across European member states.

Table II-6. Common RES barriers and policy responses to address these barriers

Barrier	Options for policy response
Economic and market barriers (Painuly 2001, Beck and Martinot 2004, Kofoed-Wiuff et al. 2006, Ragwitz et al. 2007 Neuhoff 2009, Held et al. 2010, de Jager et al. 2011 i.a.)	
RES not cost-competitive under current market conditions (high capital costs, unfavourable market pricing rules, subsidies for competing fuels, long reinvestment cycles of building-integrated technologies etc.)	Support instruments that provide financial support or force market entry: • Price setting policies (FIT/FIP) • Quantity forcing policies (quota obligations for RES-E, RES-H, biofuels) • Cost reduction policies (investment subsidies, soft loans, tax reductions etc.) Phase-out subsidies for fossil fuels Carbon pricing

Barrier	Options for policy response
Limited access to finance / high cost of capital due to high perceived risk	Support instruments that reduce market risks and provide long-term investment certainty; key features: • Stability of support scheme • Guaranteed revenues, e.g. support payment guaranteed for 15-20 years • Limitation of price risk, e.g. FIT or floor prices for TGC/FIP Financial instruments that provide low-cost capital, e.g. low-interest loans, public-private partnerships, publicly backed guarantees etc. Public finance participation through public-private cooperation models
Favourable PPAs are difficult to obtain	Guaranteed purchase Obligation for certain parties to offer long-term PPAs
Power markets are not prepared for RES (lack of access to the power markets, exercise of market power by large players, design not favourable for supply-driven RES, etc.)	Guaranteed purchase Priority dispatch Adjustment of power market design for the integration of intermittent RES (availability of liquid intraday and balancing markets, adjustment of gate closure times, changes in pricing rules, etc.)
Administrative and legal barriers (Painuly 2001, Kofoed-Wiuff et al. 2006, Ragwitz et al. 2007, Coenraads et al. 2008, Ecofys and Golder 2009, Ceña et al. 2010, PV Legal 2010, Ecorys et al. 2010 i.a.)	
Inefficient administrative procedures (high number of authorities involved, lack of coordination among authorities, lack of transparent procedures, long lead times, high costs for applicants etc.)	Improving and streamlining administrative procedures towards transparent and non-discriminatory processes (“one-stop shop” approach for applications, maximum response periods for authorities, clear guidelines and capacity building for civil servants, limiting administrative requirements to the relevant elements, simplified procedures for small plants, etc.)
RES not or insufficiently considered in spatial planning	Improved spatial planning rules Definition of RES priority areas Information and capacity building for local authorities Participation and/or compensation options for local communities

Barrier	Options for policy response
No or insufficient standards and codes for RES equipment (specifications not well defined, not expressed in EU/international standards, etc.)	Improvement of technical specifications and codes Implementation of EU/international standards and certifications
Tenancy law and ownership law impede the development of building-integrated RES technologies	Implementation of RES-use obligations Adapt tenancy and ownership law to facilitate RES deployment (facilitating cost sharing, provision of energy services etc.)
Grid-related barriers (mainly power grids, but also gas and district heat) (Ragwitz et al. 2007, Coenraads et al. 2008, Ceña et al. 2010, Ecorys et al. 2010 i.a.)	
Grid access is difficult to obtain (TSOs/DNOs not open to RES, lack of transparent procedures, long approval times, unfavourable cost allocation leading to high grid connection costs)	Guaranteed grid access Priority grid access Introduction of transparent and non-discriminatory procedures (see administrative barriers) Regulations to limit grid connection costs Close control of procedures by regulator, including sanctions for TSOs/DNOs
Lack of available grid capacity (weak grid environment, lack of interconnection capacity, no or slow grid reinforcement and/or extension, grid congestion leading to curtailment)	Priority dispatch for RES electricity Obligation or favourable regulation for TSOs/DNOs to enforce/extend grids Compensation for RES project in case of curtailment Obligations or incentives for district heating operators Tight control of procedures by regulator Long-term grid planning strategy and incentives Harmonisation of European regulatory frameworks
Lack of skilled labour (Painuly 2001, Philibert 2006, Kofoed-Wiuff et al. 2006, Ecorys et al. 2010 i.a.)	
Lack of skilled labour (e.g. for planning and installation), problems with the guarantee/warranty/ maintenance regime	Provision of sufficient training and qualification programmes, integration in vocational programmes, guidelines for planners or architects, legal requirements for guarantee/warranty
Lack or shortcomings of certification schemes for installers	Appointment of certification bodies, improvement of certification schemes

Barrier	**Options for policy response**
Supply chain bottlenecks (Painuly 2001, Neuhoff 2009, a.o.)	
Restricted access to technologies (only a few technology providers, lack of production capacity, lack of R&D capacity), bottlenecks regarding feedstock supply (e.g. steel, silicon)	Stable and long-term policy framework and targets to build trust in future markets and reduce risks of investments in supply chain
Information and acceptance barriers (Painuly 2001, Kofoed-Wiuff et al. 2006, Ragwitz et al. 2007, Ecorys et al. 2010 i.a.)	
Lack of knowledge (about benefits of RES, about available support measures, etc.)	Information and training programmes Demonstration projects in public buildings Integration of RES in education programmes Regulations on information and awareness raising, involving various municipalities and public institutions Publication of regular progress reports that incentivise governments to prove the success of their policies to the public
Lack of acceptance (NIMBY opposition to RES plants and power lines, public concerns about sustainability of biofuels etc.)	Specific measures to address the concerns, e.g. legal facilitation of underground cables, sustainability certification for biofuels, etc. Participation and/or compensation options for local communities
Abbreviations: TGC – tradable green certificate; FIT – feed-in tariff; FIP – feed-in premium; PPA – power purchase agreement; TSO – transmission system operator; DNO – distribution network operator	

A number of studies focus particularly on the status of RES barriers in the EU. Ragwitz et al. (2007) analyse RES-E barriers in the European member states based on a stakeholder survey. They find that, for all RES-E technologies except waste energy, unfavourable administrative and legal framework conditions are perceived as the biggest barrier in almost all member states. In addition, infrastructural, grid-related barriers are identified as a major obstacle for onshore and offshore wind. Financial barriers also play a significant role, especially in many new member states and for higher cost technologies (PV, CSP, offshore). Social acceptance barriers are ranked lower, but do play a role for (especially large-scale) hydropower and wind. Coenraads et al. (2008) substantiate the significance of administrative and grid barriers with a stakeholder survey on grid- and permitting related barriers. Further studies on technology-specific administrative and grid connection barriers in the EU member states include Ceña et al. (2010) for wind, Ecofys and Golder Associates (2009) for bioenergy (electricity, heat and biofuels) and PV Legal (2010) for PV. Ecorys et al. (2010) provide an in-depth survey of non-cost RES barriers for most RES-E and RES-H technologies in all EU-27 member states. They also conclude that administrative and grid connection barriers are the biggest barriers across Europe.

All these European studies develop and apply qualitative and quantitative indicators for measuring the severity of barriers, e.g. lead time for permitting and grid access, number of authorities involved, percentage of administrative or grid connection costs in total project costs etc. However, all the studies mention that some or indeed all of the quantitative results should be considered cautiously, or taken only as rough indications due to problems with data gathering and/or non-representative sample numbers. Furthermore, even if the samples are partly representative, as in Ceña et al. (2010), there are still some peculiarities in the survey results that need further investigation. Ceña et al. (2010) argue that a high annual installation of wind power should be a good indicator of the (low) level of barriers for countries with similar wind resources, but the results of their survey on administrative and grid barriers do not fully support this statement. While Spain, which is the second largest and fastest-growing wind power market in Europe, shows very high administrative- and grid-related barrier scores, some countries with immature wind markets, e.g. Romania or Latvia, have rather low scores. Similar results are also provided by Coenraads et al. (2008) and Ecorys et al. (2010) despite significant deviations in the country results between the studies. The high barrier scores in some fast growing markets imply that non-economic barriers are not necessarily prohibitive for RES deployment, even though they prolong lead times and increase project costs. One possible explanation for the higher barrier scores in fast growing or mature markets could be that the administrations in these countries have to deal with a lot more projects than those in immature markets, and therefore lead times increase. Market players here may also be more critical and aware of barriers than those in immature markets, or, as Neuhoff (2009) puts it, that these barriers become apparent only after the removal of other initial (e.g. financial) barriers. Furthermore, cultural differences between EU countries might play a role. Therefore, further research on reliable indicators for the cross-country comparison of non-economic barriers might be required.

Naturally, economic barriers are easier to quantify than non-economic ones. One approach applied in Ragwitz et al. (2007) and Held et al. (2010) is to calculate the minimum to average generation costs per technology and country (€/MWh, based on country-specific data) and to compare this with the average to maximum support level provided by the relevant RES support policies in that country (€/MWh). This reveals the potential financial gap from the project developer’s perspective. This analysis for the EU-27 shows that if support levels are below generation costs, little or no capacity growth can be observed (with a few exceptions if investments are motivated by other than economic reasons). On the other hand, high support levels do not always lead to substantial capacity growth. Usually this is due to flaws in the support instrument or non-economic barriers, as described above. The evaluation also shows that the support levels for renewable heat generally appear to generate lower profits than those in the RES-E sector, despite the low generation costs of many RES-H technologies. This is one explanation for the lower average policy effectiveness in the heat sector (see section 3).

An important element for breaking down financial barriers is the removal or reduction of RES project risks (see Table II-6). Reducing risks reduces the costs of capital; this is a basic economic principle for RES support instruments that has been demonstrated in many studies (e.g. Mitchell et al. 2006, de Jager and Rathmann 2008, de Jager et al. 2011). This is the main reason why feed-in tariffs, which minimize revenue risks for the RES-E generator, tend to result in the lowest specific consumer costs (per MWh of new RES-E) of all European RES-E support schemes (European Commission 2005 and 2008, Held et al. 2010) assuming they are well designed and non-economic barriers are manageable. The risk perspective also provides the link between non-economic and economic barriers: Administrative, grid and other non-economic barriers are project risks from the perspective of RES project developers and investors, therefore they increase project development costs or capital costs for the project. Furthermore, they can also reduce energy sales revenues. In consequence, removing non-economic barriers also helps to reduce financial barriers and the required policy costs of RES promotion.

Another fact that needs attention in the barrier discussion is that some barriers evolve or increase with RES market growth. For example, grid congestions and the need for new transmission lines usually only occur once significant RES-E capacities are installed. In general terms, the RES market development in European member states can be characterized using the deployment stages described by the deployment status indicator in section 2: While in immature RET markets, typical market-entry barriers prevail (low or unreliable financial support, grid access barriers, etc.), intermediate, fast-growing markets are likely to encounter typical growth-related barriers, e.g. infrastructural (rather local) and supply chain bottlenecks (both local and global). Administrative barriers can occur across all the market stages (see Ceña et al. 2010), but are most prominent in immature and intermediate markets. In advanced markets, market players may encounter typical high-end barriers that cannot be easily overcome: Competition for sites and resources because the most cost-effective RES potential has already been exploited, or power system limitations like temporary curtailment of certain supply-driven RES-E technologies[10], etc.

With regard to reaching the RES 2020 targets, this means that some countries with advanced RET markets might not be able to maintain their growth rate, while other, less mature markets could still grow very quickly, if they manage to overcome the described

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[10] While curtailment due to grid congestion is a typical barrier in growing RES-E markets in which the grid infrastructure has not yet been adapted to the new generation capacities, most experts also agree that curtailment can occur in advanced power and RES-E markets. For example, depending on the generation technology, supply- driven RES-E will need to be curtailed in power systems during periods of high instantaneous RES-E penetration (see e.g. Ecofys et al. 2010). Also, it may be more cost-efficient to curtail supply- driven RES-E at certain times than to extend grid and storage capacities to the extent where the full output of RES-E generation is used at all times.

barriers. As many of these market-entry barriers are addressed in the 2009 RES directive (e.g. administrative barriers in Article 13), proper implementation of the directive should facilitate this process. Other barriers remain a severe challenge that will not be easily overcome in the coming decade, especially infrastructural requirements like the need for major transmission grid expansions. Also, higher environmental and social standards are evolving in certain segments. Particularly the European sustainability criteria for biofuels and bioliquids (which may be extended to solid biomass in the future) are well-founded requirements which are crucial to ensure public acceptance of biofuel deployment and therefore reduce acceptance barriers, but which may also introduce new, growth-limiting barriers in the short term. Therefore, the major question facing policy makers in advanced countries is no longer how to remove all the barriers preventing RES growth, but how to manage RES growth under the new system limitations.

5. Discussion: Is Europe on track to meet the 20% RES target in 2020?

This section discusses whether Europe is on track to reach the 2020 RES targets by comparing the results of the preceding sections with the required RET growth. Furthermore, we discuss the limitations and uncertainties of our results.

5.1. Progress in the years 2005-2008

Are European member states on track to meet the 20% RES target in 2020? The Eurostat statistics summarised in section 2 allow only limited insights, since they only provide data until 2008, while the RES directive was adopted in 2009. Still, the RES development in the years 2005 to 2008 does provide a first trend indication.

On average, the 2005 EU share of 8.5% RES in final energy consumption needs to increase by 0.77 percentage points each year to reach the 20% target in 2020. With linear progress, 20% of the target would need to be achieved by 2008. The indicative trajectory defined by the 2009 RES directive for the member states allows for a lower increase between 2005 and 2018 (20% target achievement by 2011/12, 30% by 2013/14, 45% by 2015/16, 65% by 2017/18), but requires steep growth in the last two years (35% of target achievement, from 16% to 20% RES in final energy consumption). According to this trajectory, the average required increase for the years 2005-2012 is only 0.33 percentage points.

In the period 2005-2008, the EU RES share in final energy consumption increased by 0.6 percentage points per year on average and was therefore below the average required increase (linear trajectory), but above the official trajectory of the RES directive (this is only an average indication, however, since the required increase varies among member states[11]). The remaining required increase 2008-2020 is 0.81 percentage points on average. Eight member states (Austria, Germany, Finland, Hungary, Portugal, Romania, Sweden and Slovakia) already exceeded their 2011/12 interim target in 2008 and are therefore also above the linear trajectory (see Figure II-15 and Figure II-16).

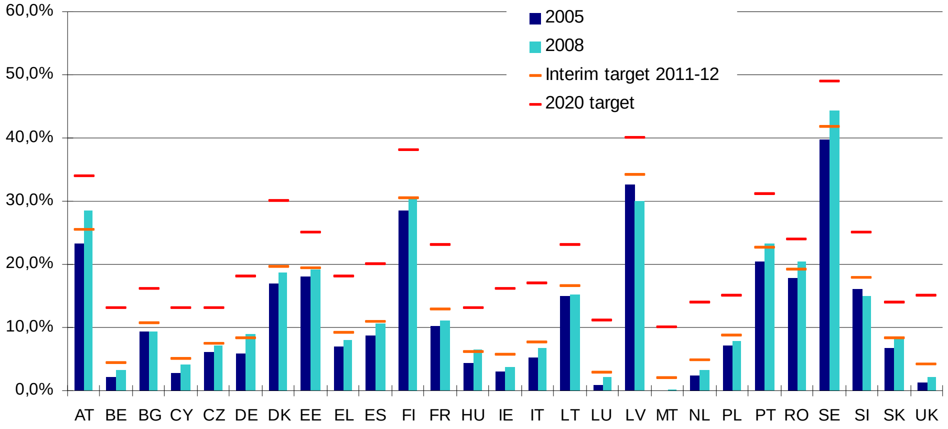

Figure II-15. RES share in gross final energy consumption per year (based on Eurostat 2010a and directive 2009/28/EC)

On the other hand, the charts confirm that progress varies greatly across member states. In two countries, the RES share even decreased between 2005 and 2008, most likely due to increasing energy demand. Three countries (Austria, Romania and Sweden) already achieved more than 40% of the required increase in 2008, largely driven by an over-proportionate increase of the RES-H share[12], which means they are close to the 2016 interim target according to the EU trajectory. We do not know whether and to what extent this growth was triggered by RES-H policies, by a decreasing overall heat demand, or by changes in heat statistics[13].

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[11] The allocation of the national RES targets was based on a flat rate increase (same additional share for each country) adjusted to the member state’s GDP.

[12] The targets of the RES directive are defined in terms of gross final energy. This definition favours heat over electricity, because 1 MWh of heat has a much lower exergetic and monetary value than 1 MWh of electricity. Despite this, most member states still focus RES support on RES-E (see section 3).

[13] Possibly, statistical offices could have paid more attention to covering RES-H installations than in earlier years, but this is hypothetical. Due to the difficulty of measuring on-site heat

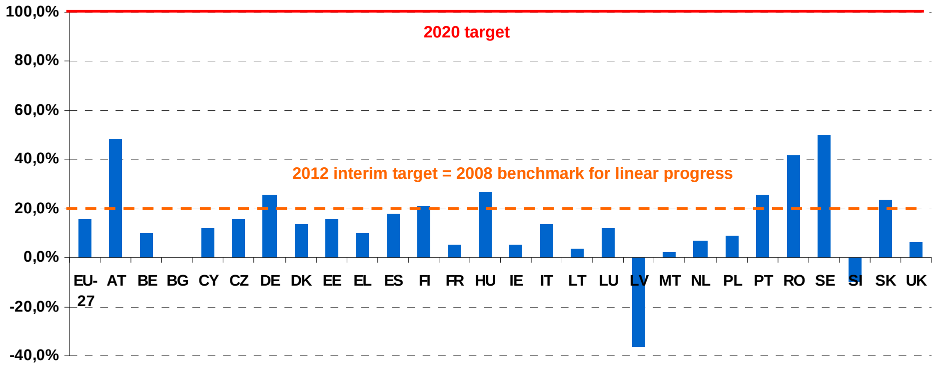

Figure II-16. Relative progress 2005-2008 towards the 2020 target, neglecting changes in future energy demand (based on Eurostat 2010a and own calculations)

In a nutshell, most member states seem to be on track to meet or even exceed the first interim target in 2012, but the majority of them will have to increase their RES shares more rapidly in the future to meet the 2020 target. So far, progress among member states varies greatly.

5.2. Brief comparison of the evaluation results with the NREAP projections

The NREAPs recently presented by the EU-27 member states provide more detailed country projections. According to them, 25 of 27 countries intend to fulfil their 2020 targets domestically. Only Italy and Luxembourg expect to stay below their national targets and use the RES cooperation mechanisms of the RES directive to access the RES potentials of other countries to achieve their national targets. 15 member states plan to exceed their national targets. Overall, this results in a projected RES share of approx. 20.6% in 2020 (NREAPs 2011, Naegler 2011[14]). These figures sound rather ambitious considering the moderate RES growth in many member states over the past few years. Further analysis will be required to evaluate whether the policy measures proposed in the NREAPs can achieve this growth. An initial scan of 24 of 27 NREAPs (all except Estonia, Hungary and Poland)

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production, data gathering in this sector is complicated and the final statistics involve a degree of uncertainty.

[14] EREC (2011) comes to slightly different results (20.7% RES gross final energy consumption) probably because different tables of the NREAPs were used as the basis for calculation. Tables 4 and 11 are not fully consistent in all NREAPs.

suggests that this is doubtful because there seems to be a strong focus on continuing and gradually adjusting current policy, rather than on major improvements. However, some new policy measures are also proposed: At least 8 member states want to introduce new policy schemes in the heat sector, including new RES-H obligations and feed-in premiums. The NREAPs also mention new measures in the RES-E and RES-T sectors, as well as the removal of administrative barriers. The question remains how these plans will actually be put in practice.

The NREAPs also provide information about where the projected RES growth is supposed to occur, in which RES sectors and technology segments. Table II-7 shows the relative and absolute contribution of the three RES sectors, as well as the projected sector growth. The projected increase of the RES-E share in total electricity consumption is considerably higher than the increase of the RES-H share and the RES-T share, which shows a preference for RES-E compared to RES-H and RES-T, as observed in the past. The relative sector growth is highest in the transport sector.

Table II-7. NREAP projections by sector (based on Eurostat 2010a, NREAPs 2011, Naegler 2011, own calculations)

Sector	Share in total sector consump-tion 2008	Share in total sector consump-tion 2020	Required average increase of sector share	RES sector contribution in 2020 (Mtoe)	RES sector growth 2008-2020 (Mtoe)	Required average RES sector growth	Share in total RES consump-tion 2020
RES-E	16.6%	34.5%	1.49%-points/a	105	57	6.7%/a	43%
RES-H	11.9%	21.4%	0.73%-points/a	108	40	3.9%/a	44%
RES-T	3.4%	10.3%	0.58%-points/a	32	22	10.2%/a	13%
RES total	10.3%	20.6%	0.86%-points/a	245	119	5.7%/a	100%

The NREAPs assume that wind power will be the dominating RES-E technology in 2020 (40.6% of RES-E generation, Naegler 2011). According to the NREAP analysis by EREC (2011) and Beurskens and Hekkenberg (2010), wind onshore will contribute the largest share, but more than 1/4 of the newly installed RES capacity is supposed to come from offshore wind. Hydropower will contribute 30.4% of RES-E generation, followed by biomass electricity with 19.1% and PV with 8.5% (Naegler 2011). In the heat sector, 80.3% of all RES-H generation will come from bioenergy (mainly solid biomass), complemented by heat pumps (11.4%) and small contributions from solar thermal (5.8%) and geothermal energy (2.5%). In transport, biodiesel will continue to be the dominant RES-T source. RES-

E provides less than 10% of the RES transport energy, almost entirely in non-road transport (EREC 2011).

How do these sector and technology projections relate to the policy effectiveness per technology observed in section 3? The increase in RES production between 2008 and 2020 projected in the NREAPs is approx. 119 Mtoe, i.e. half of the remaining potential for 2008-2020 provided by Green-X[15]. Relating the projected increase per technology to the available potential, one can calculate the average policy effectiveness required to reach the 2020 target scenario. The NREAPs do not provide disaggregated data for all RET, but we will indicate the required average policy effectiveness and exploitation of RES potential for two key technology categories which are expected to contribute most to RES growth, wind power and biomass heat. The assumption is that the total realisable 2020 potential does not change over the years (in reality, it will probably increase slightly due to technological progress). For comparison we also calculate the effectiveness with 2030 potentials (taken from Green-X 2010), which reflects the required policy effort until 2020 in relation to the mid-term potential which can be realised within 10 to 20 years[16].

Table II-8 shows the resulting effectiveness scores.

Table II-8. Average required effectiveness to reach the NREAP projections for 2020 (NREAP 2011, Green-X 2010, own calculations)

Technology	**Average required effectiveness 2008-2020 in relation to 2020 potential**	**Average required effectiveness 2008-2020 in relation to 2030 potential**
Wind power (onshore and offshore)	7.2%/a	4.9%
Biomass heat (all types)	10.1%/a	7.8%

The higher required effectiveness for wind power derived with the 2020 potential reflects the challenge of realising the projected wind power growth under the existing infrastructure

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[15] According to Green-X (2010), the feasible mid-term potential for 2020 amounts to approx. 366 Mtoe gross final energy consumption; the additionally remaining potential compared to 2008 RES deployment (Eurostat 2010) to approx. 241 Mtoe. Broken down into sectors, 44% of the remaining potential is RES-E, 44% RES-H and 12% RES-T.

[16] The average policy effectiveness for the years 2002 until 2008 (see section 3) was calculated with the 2020 mid-term potential. Therefore, the time period between the year of assessment and the reference year was also approx. 10 to 20 years, which makes the values comparable.

constraints. The faster the power grids are enforced, the larger the available potential and the lower the support policy challenge. Both results for wind power imply that even for onshore wind, the average policy effectiveness needs to increase still further, but that the gap is quite small. Top runner countries already reach the required level (scores up to 13%/a, see Table II-4). In contrast, the recent policy effectiveness for offshore wind is far below the level required in the coming years. This is not surprising as relatively little offshore capacity has been installed so far, while huge capacity increases are being planned. The crucial question is whether these offshore parks can be realised and connected to the power grids in time.

For biomass heat, the average effectiveness in the period 2008-2020 would need to be even higher than for wind power. In recent years the average scores have been much lower, but again, the top runner countries have been able to achieve even higher scores (up to 14%, see Table II-4). The high required value can be explained by the relatively limited potential for European biomass, which is exploited to 90% in 2020 and remains a major constraint in the period beyond 2020. Due to this challenge, member states should consider to focus their support on a broader set of RES-H technologies than they have done so far.

5.3. Critical success and fail factors

While comparing the projected RES growth with achieved growth rates and effectiveness indicator scores can help to gauge whether the 2020 RES target will be reached, they are not suitable indicators for assessing future RES market barriers and growth rates. From the qualitative discussion in section 4, the following success and fail factors can be derived for the 2020 pathway described in the NREAPs:

- Effective policies to overcome the existing financial barriers are needed across Europe, not only in top runner countries. To attract sufficient capital, the support schemes should limit RES project risks and promote high success rates for projects under development: If too few projects are supported, there will not be enough investment in early stage project development. On the other hand, consumer expenditures per unit of energy need to be minimised as far as possible in order to maintain public acceptance of RES support.
- The assessment showed that administrative and grid-access barriers, which are hindering the market uptake of RET in many countries, are among the biggest obstacles to faster RES growth across Europe. In principle, it is in the hands of policy makers to significantly lower such barriers, and it does seem possible to do so within the next decade.
- On the other hand, growth-related barriers have evolved that threaten continued RET development, particularly the required power grid extensions that mainly affect wind power growth, but increasingly also other technologies. Current top runner countries in terms of RET deployment status may be hardest hit by such barriers. Upgrading the power grid infrastructure requires massive investments and legal measures to speed up the process.

- For offshore wind, which is supposed to contribute approx. 25% of the additional wind power capacity in the electricity sector, there is a clear gap between recent policy effectiveness and that required in the future. Tackling infrastructural challenges and investment risks is of particular importance here.
- In the heat sector, steadier financial support and implementing support instruments which are independent of the state budget (e.g. effective use obligations as requested by the RES directive or incentives financed via heat fuel surcharges) could play a key role in overcoming the existing financial barriers.
- Member states see biomass as playing a crucial role in all RES sectors, so the sustainability of the utilised potentials needs to be ensured both within and outside the EU. The sustainability criteria for biofuels and bioliquids introduced in the RES directive are an important step in this direction, but they still need to be implemented across member states. Furthermore, the possible extension of the criteria remains an issue for the coming years (e.g. to cover indirect land-use changes or solid biomass; this issue cannot be dealt with here). At the same time, policy makers need to avoid creating new market barriers to biofuels during this process.
- Energy efficiency is another crucial element for reaching the 2020 RES targets that has not been discussed so far. Limiting energy demand in all end-use sectors by employing effective energy efficiency policies decreases the required amount of RES, most notably in the heat sector. In the NREAPs, member states have also provided overall energy demand projections: These predict that final energy demand will drop slightly compared to current levels from 1214 Mtoe in 2008 (Eurostat 2010b), to 1189 Mtoe in 2020 (NREAPs 2011), mainly driven by the decreasing energy consumption of the largest energy consuming member states (Germany, France and the UK). Achieving these energy efficiency levels will also require additional energy efficiency policy efforts. Such additional efforts are required in any case in order to meet the EU energy efficiency target for 2020 (whether the NREAP demand projections are in line with the energy efficiency target requirements cannot be judged here).The member states with the largest energy consumption levels (Germany, France, the UK, Italy, Spain and Poland) have a special responsibility to meet both the European RES and energy efficiency targets as they are predicted to consume 67% of total final energy in the European Community in 2020.

Finally, it is important to understand that RET are no longer a niche market. According to EWEA (2010), more than 60% of the newly installed power capacity in Europe in 2009 already came from renewables. Furthermore, the 2020 target is only one milestone on the way to a considerably higher share of RES in the long term. The only post-2020 target set by the EU so far is to reduce greenhouse gas emissions by 80-95% until 2050 compared to 1990 levels. To reach this target, the large majority of scenarios foresee very high shares (up to 100%) of RES in energy supply. While the bulk of RES final energy in 2020 will be produced by RET that are already close to the market in terms of costs, i.e. different types of biomass, wind energy, hydropower and heat pumps, other promising RET with currently higher costs (i.e. the different solar technologies, geothermal, tide and wave) need to be developed in time, i.e. partly before 2020. Similarly, energy infrastructures and market designs need to be preparing now for higher shares of RES beyond 2020.

5.4. Limitations and uncertainties of the analysis

For the analysis conducted here we relied mainly on the effectiveness and deployment status indicators elaborated in the RE-SHAPING project (Held et al. 2010), complemented by other sources of information. These indicators are based on aggregated statistics that facilitate the cross country comparison of all EU-27 member states, but do not provide information about the specific circumstances and barriers in each country. An additional limitation of the deployment status indicator is that it relies on pre-defined thresholds for the deployment stages, which are derived from somewhat subjective market perceptions. Also, the indicators evaluate policy and deployment progress independent of policy targets and are therefore not target progress indicators; instead, they allow RES policies and deployment to be assessed from the neutral viewpoint of the available potential. However, as discussed above, calculating the average policy effectiveness per technology which will be required to achieve the 2020 target projections of the NREAPs can be a useful contribution to quantifying the policy challenge lying ahead. This has not been done for all technologies yet. Another useful exercise could be to combine our backward-looking indicators with a forward-looking market indicator describing the probable market development for the short-term future based on sub-indicators for current or evolving market barriers. The literature analysis in section 4 showed that there is a lot of information on RES-specific barriers, but that indicators need to be further refined to provide reliable quantitative results.

Taking these limitations into account, how reliable are the presented results? Some uncertainties arise from the fact that the applied indicators are sensitive to the definition and related uncertainties of the realisable 2020 and 2030 potential. However, the potentials from Green-X (2010) have been continuously checked and updated and therefore seem to provide the best available information. Methodological challenges arise for biomass because primary biomass potentials have to be allocated across sectors, and domestic potentials have limited meaning for an internationally traded commodity. This is the reason why the results for biofuels and biomass electricity have been handled with care.

When comparing the past to the future required effectiveness, the question arises which reference year the mid-term potential should refer to. Using the 2020 potential tends to over-estimate the challenge compared to the past, since the effectiveness values always increase with decreasing remaining potential. When policies are compared independent of target periods, it seems therefore advisable to adjust the mid-term potential to a constant period of approx. 15 years. On the other hand, the reference to 2020 was useful for the 2020 target discussion: The increase of required effectiveness reflects that infrastructure and potential constraints become more challenging as the target year approaches.

Overall, the analysis showed that the quantitative assessment provides a good starting point for policy evaluation, but that this needs to be combined with a qualitative assessment of policy success factors and barriers in order to provide a comprehensive picture of European RES policy and technology development.

6. Conclusions

This article analysed the recent progress in RES deployment and policy in the European member states using aggregated deployment status and policy effectiveness indicators and combining European statistics and country-specific data.

Marked progress has been made in European RES deployment and policy over the last few years. The RES-E sector has grown rapidly, mainly due to the mature but still evolving technologies of onshore wind and biomass electricity. Biodiesel in transport has also experienced high growth rates. In contrast, RES growth in the heat sector was rather moderate, possibly also due to the absence of a specific EU legislation for RES-H until 2009. Small-scale, wood-based biomass applications were the dominant technology for heat. The market growth in all the sectors has been mainly driven by effective policies in a small or medium number of top runner countries. The top runners with the highest deployment status and policy effectiveness differ for each technology. Still, even though all EU-27 member states have RES policies in place, many countries have a very low policy effectiveness and deployment status for almost all RET.

RET support policies focus strongly on removing financial barriers in order to force RET entry into the energy markets. As previous analyses have shown, the success factors for an effective and efficient support policy design include policy stability, the reduction of project risks, a stable financing source independent of the state budget, and a regular adjustment of support conditions to market progress. At the same time, success is often also determined by non-economic factors, particularly the removal of administrative and legal barriers, e.g. for permitting and grid access. Best practice examples from different countries show that these barriers can be successfully dismantled. Growth-related barriers that have evolved in recent years in more advanced markets pose a greater challenge, e.g. infrastructural barriers and curtailment in the power sector.

Comparing the recent progress in RES deployment to the required to meet the European target of 20% RES in gross final energy in 2020 shows that Europe will need to make additional policy efforts, but that this seems manageable. According to the NREAPs, 15 member states are even planning to over-achieve their national 2020 target, but it is not yet fully clear which policy strategy they will employ to do so. Our quantitative analysis indicated that the majority of member states are on track to achieve the interim trajectory provided by the RES directive, which allows for moderate RES growth until the last two years before 2020. In order to achieve the higher growth rates required by the end of the target period, the majority of member states will need to enhance their policy effectiveness, and close the gap to the top runner countries. This seems even more important as some top runners may well struggle to maintain their RES growth under the evolving growth-related barriers. While it is true that member states propose additional policy actions in their NREAPs, it remains doubtful whether these will be sufficient to trigger the projected targeted growth.

Critical success factors for reaching the 2020 targets include the implementation of effective and efficient policies that promote high project success rates and attract sufficient investments, the reduction of administrative and grid-access barriers, especially in currently less advanced countries, upgrading the power grid infrastructure, dismantling financial barriers to RET in the heat sector, e.g. through budgetary-independent support instruments, the proper implementation and possible extension of sustainability standards for biomass, and – last but not least – the reduction of energy demand through increased energy efficiency policy efforts.

Appendix: Rationale and methodology of the utilised indicators

Deployment Status Indicator

Since the European member states vary significantly in size, energy consumption and RES potential, a deployment status indicator is used for the member state analysis that allows the technology deployment by country to be compared in relative terms independent of the size of the country. This deployment status indicator measures the deployment status of RES-E and RES-H technologies in the EU-27 on a scale between immature and advanced. The indicator aggregates three sub-indicators that all express a different aspect of the RET deployment level:

- Production of RET as share in total sector (electricity/heat) consumption; this sub-indicator reflects the relevance of a technology for its energy sector and how visible it is to policy makers.
- Production as share of mid-term (2030) realisable potential[17]; this sub-indicator reflects the extent to which the mid-term potential for a specific RET has already been exploited, or, in other words, to what extent the potential that can be realistically developed until 2030 has already been tapped.

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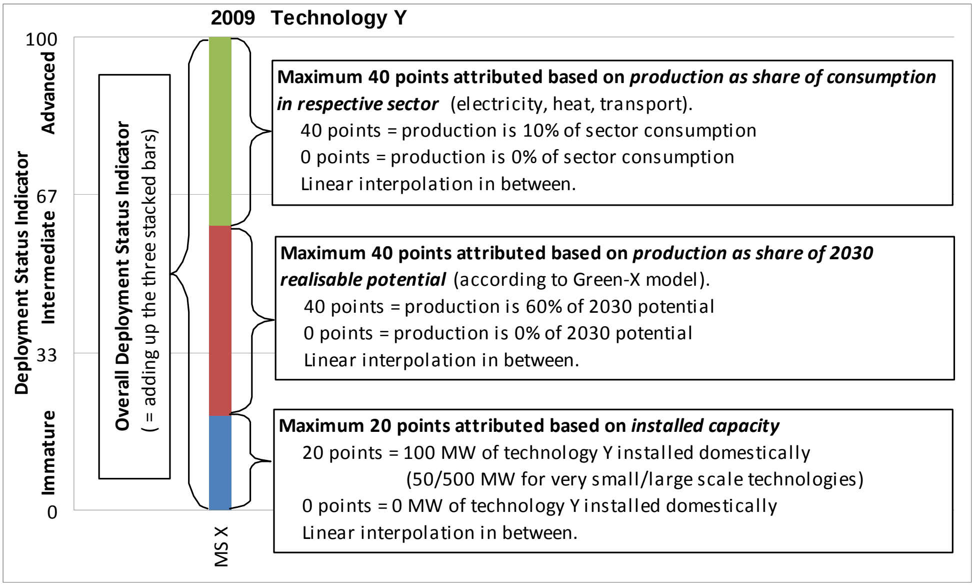
[17] The 2030 mid-term realisable potential is based on Green-X data (Green-X 2010). The realisable potential is an estimation of the RES deployment that can be reached in a certain time frame assuming maximum diffusion rates. These diffusion rates have been derived from best practice examples in the past and take into account short-term infrastructure constraints. The long-term potential can be much higher. In contrast to the effectiveness indicator in section 3, we deliberately use the 2030, not 2020, realisable potential for the deployment status indicator to reflect which deployment can be reached in the medium-term future with adapted energy infrastructures.

- Installed capacity of RET; this sub-indicator serves as a minimum threshold and reflects whether a minimum capacity of this RET has been realised, in which case project developers, investors and banks have gained a certain level of experience in the national RET market.

Figure II-17 shows the aggregation of the three sub-indicators. Input data is taken from Eurostat (2009) and (2010), Eurobserver (2009) and Green-X (2010).



Maximum 40 points attributed based on *production as share of consumption in respective sector* (electricity, heat, transport).
40 points = production is 10% of sector consumption
0 points = production is 0% of sector consumption
Linear interpolation in between.

Maximum 40 points attributed based on *production as share of 2030 realisable potential* (according to Green-X model).
40 points = production is 60% of 2030 potential
0 points = production is 0% of 2030 potential
Linear interpolation in between.

Maximum 20 points attributed based on *installed capacity*
20 points = 100 MW of technology Y installed domestically
(50/500 MW for very small/large scale technologies)
0 points = 0 MW of technology Y installed domestically
Linear interpolation in between.

Figure II-17. Composition of RES deployment status indicator

The thresholds for the three sub-indicators are set arbitrarily, but are calibrated based on earlier market surveys.

We differentiate three types of RET deployment status:

- Immature RET markets are characterized by small market sizes and few market players. Market growth has been low so far (which does not mean that markets cannot grow dynamically in the present or future). Typically, local, regional and national administrations, local banks as well as energy companies have little experience with the use and promotion of RET.
- Intermediate RET markets are characterized by larger market sizes, typically accompanied by strong market growth in the past and the interest of many market players. The increased market size reflects the fact that the energy sector, the administration and parties involved in financing have gained experience with RET.

Not all intermediate markets display fast market growth, however; in some countries, this status may also mean that the market has stopped growing at an intermediate level, e.g. due to a cessation of support policy (one example is onshore wind in Denmark); in other countries the potential for a specific RET is so limited that the market cannot progress beyond the intermediate stage to reach advanced deployment status.

- Advanced RET markets are characterized by established market players and fully mature technologies. Market growth may start to slow down at this advanced stage. Market players may encounter typical high-end barriers: competition for increasingly scarce sites and resources as the most cost-effective RES potential has already been exploited, power system limitations like curtailment, etc.

Obviously, this categorisation is somewhat generalizing. The indicator – due to its aggregated nature - only provides a rough indication of the actual RES deployment status. On the other hand, it allows a neutral comparison of achieved RET deployment across countries and technologies and aggregates different aspects of RET deployment in one comparable figure. It is important to understand that the deployment status indicator is a cumulative indicator that measures the historically achieved market size, not current market dynamics or market maturity; therefore it complements the policy effectiveness indicator (see below) that measures annual market growth. Furthermore it allows for an improved interpretation of the effectiveness indicator by testing the hypothesis that more mature countries tend to be more effective as well.

Effectiveness indicator

In principle the effectiveness of a policy instrument serves as a measurement for the degree to which a predefined goal could be achieved. Nevertheless, this definition of the effectiveness complicates a cross-country comparison of the effectiveness, as the setting of objectives and their ambition level might vary significantly among countries. A less ambitious objective is easier to attain than a more ambitious one. In this case, the degree of achievement does not serve as an appropriate indication for the quality of a support scheme (Dijk 2003). Consequently, we understand the effectiveness of a policy scheme for the promotion of renewable energy as the increase in the supply of renewable final energy due to this policy compared to a suitable reference quantity. A suitable reference quantity is from our point of view the additional available renewable energy generation potential.

Against this background, Ragwitz et al. (2007) and Held et al. (2010) define the effectiveness indicator of a member state policy as the ratio of the change in the normalised final energy generation during a given period of time and the additional realisable mid-term potential until 2020 for a specific RET. The additional realisable mid-term potential until 2020 is based on Green-X data (Green-X 2010).

The renewable final energy provided may show some volatility from year to year which cannot be attributed to changes in policy support, but rather to weather-related factors. This mean that hydro or wind power electricity generation may vary from year to year as a result of changing precipitation or wind speed conditions. In the case of RES based heating systems, the space heating demand may vary according to the average temperatures. To exclude the influence of weather conditions, the renewable final energy produced in a specific year is normalised for hydropower, wind power and RES heat (see Held et al. 2010 for the specific normalisation formulas).

The exact definition of the policy effectiveness indicator reads as follows:

$$E_n^i = \frac{Q_{n(norm)}^i - Q_{n-1(norm)}^i}{POT_{n-1}}$$

where:

E_n^i := *Effectiveness indicator for RET i in year n;*

$Q_{n(norm)}^i$:= *Normalised renewable final energy of RET i in year n (corrected by weather-related influences);*

POT_n := *Additional realisable mid-term potential in year n until 2020*

The indicator does not evaluate the effectiveness of a single policy instrument, but of the overall RES policy mix applied per technology in a country. Nevertheless, since all countries apply main support instruments that are considered dominant for their RES policy, such an analysis also allows conclusions to be drawn about these main support schemes.

By reflecting the remaining achievable RET potential, the indicator accounts for the fact that RET potentials, and consequently the achievable RET deployment, differ between countries: Member states need to develop specific RETs proportional to their achievable potential in order to show comparable effectiveness of their support policies. Therefore, the indicator is unbiased with regard to the available potentials of a specific country. The drawback of this indicator definition is its sensitivity to assumptions regarding the realisable potential, which is based on estimates of implementation rates and infrastructure developments until 2020. Furthermore, if the available potential is very low, the effectiveness indicator can reach very high values without substantial growth in RET deployment. The indicator therefore seems less meaningful for RETs that are subject to strong natural constraints. For this reason, we exclude large and small-scale hydropower from the analysis in section 3. Technologies that are only being applied in a very few countries so far (geothermal electricity, solar thermal electricity and tide and wave energy) are also not included. For solid and liquid biomass, additional methodological problems arise from the fact that they are internationally traded commodities, which makes the available domestic potential less meaningful. This is why we do not apply the indicator for the use of biofuels in transport on a country level[18].

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[18] In Held et al. (2010) we also calculated the indicator for biofuels on a country level, but the results were not very meaningful. The reason: the effectiveness indicator refers to the

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realisable potential per country, while in practice such potential restrictions are not relevant to internationally traded bioufels. We therefore only use the average European effectiveness, which gives an indication of the policy effectiveness in relation to the domestic European potential (see section 3.3).

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III. Policy options for reducing the costs of reaching the European renewables target[1]

Abstract

The article analyses multiple policy options for reducing the costs of renewable energy technology (RET) investments on the one hand and for reducing the overall policy costs for consumers or taxpayers on the other hand. It then discusses their role for achieving the EU 2020 RES targets. The results show that risk-conscious, investment-grade RET policies are crucial for attracting sufficient RET investments until 2020 and achieving the RES targets cost-effectively. They do not only reduce the RET financing costs, but also reduce the project development costs and increase market revenues. From the macro-economic perspective, there are also other options that can significantly reduce the RES support costs, i.e. the adjustment of support levels to generation costs, phasing out subsidies for fossil and nuclear energies, and the cost-optimisation of the supported RET portfolio, either through increased cooperation between member states or through changes in the supported technology mix. These latter options do not appear as a precondition for 2020 RET target achievement, but hold the potential to significantly reduce the cost of target compliance for consumers and tax payers. Overall, further improvement and coordination of existing policy frameworks seems more promising than drastic system changes, as the latter would create additional uncertainties and potentially negative effects on RET growth and project costs.

1. Introduction

In June 2009, the EU directive on the promotion of renewable energy sources (2009/28/EC) entered into effect. It sets binding national targets for all EU member states to reach the European target of 20% renewable energy sources (RES) share in EU gross final energy consumption by 2020. In addition, the minimum share of RES in final consumption of transport energy shall be 10%. To reach these targets, substantial additional investments in RES plants and infrastructure are required.

According to Bloomberg New Energy Finance (BNEF 2010) and de Jager et al. (2011), the capital flowing into renewable energy technology (RET)[2] assets investments in the EU was

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[2] We will use the term RET if the focus is on technology, RES if we refer to renewable energy generically.

approx. € 35 billion in 2008[3], which was the peak investment over the period 2002-2009. Ragwitz et al. (2011) recalculate the RET investments based on newly installed capacity and assumed investment costs per technology as provided by Held (2010) and come to similar results: approx. € 34 billion investments in 2008 (for 2009 they come to higher results than BNEF: approx. € 40 billion investments in 2009). More recent figures are not available yet.

According to scenarios modelled with the Green-X tool in de Jager et al. (2011), the average required capital investments to reach the 2020 RES targets need to be in the order of € 61 to 70 billion per year between 2011 and 2020, depending on the chosen policy and technology path. The resulting investment gap is in the order of € 26 to 35 billion per year compared to current investment levels as provided by BNEF (2010). While all these figures are linked to some uncertainties, it is clear that substantial additional investments need to be mobilised in order to reach the 2020 targets.

Since investments in RET in Europe are largely policy driven, additional policy effort is needed to reach the targets. A crucial question is therefore how additional capital investments can be mobilised by policy makers and at which consumer (or tax payer) expenditures. Currently, the effectiveness of support policies and the support payment provided per MWh vary greatly between member states (Held et al. 2010 and Klessmann et al. 2011). This article discusses different policy options for attracting additional capital for RET investments and, at the same time, minimising the consumer costs of reaching the 2020 targets. In other words, we will discuss how the cost-effectiveness of RES policies can be increased until 2020. Where possible, we will also quantify the cost savings potential.

The analysis is largely based on our results from the EU funded project RE-SHAPING (see Rathmann et al. 2011) and a study commissioned by the European Commission (de Jager et al. 2011). The latter served as input for the Commission Staff Working Document “Review of European and national financing of renewable energy in accordance with Article 23(7) of Directive 2009/28/EC” (European Commission 2011). Our quantitative estimates refer to costs scenarios for reaching the 2020 targets, which were developed with the Green-X model, as well as bottom-up cost estimations derived with the Ecofys cash flow model (see de Jager et al. 2011 for details). Furthermore, we use information from more than 20 interviews conducted with lenders, equity investors, project developers and project financing experts within the RE-SHAPING project (see Rathmann et al. 2011 for details). The interviews asked the market actors to describe and quantify the impact of various policy options on RET project costs in the member states where they are applied. Additionally, we integrate the findings of different literature sources on RES financing costs and policy (e.g. Wiser and Pickle 1997, Wiser 1997, Justice and Hamilton 2009,

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[3] This figure is cited by de Jager et al. (2011) from the BNEF database. Ragwitz et al. (2011) reassess the investment levels based on completed transactions in the BNEF database, which results in higher uncertainty, with annual transactions ranging between approx. € 22-50 billion in 2008 and € 20-52 billion in 2009.

Luethi and Wuestenhagen 2010, Mostert et al. 2010, BNEF and CEG 2010). When discussing project finance, we focus on (large) grid-connected RES electricity plants, especially wind and PV, which make up the largest share of new RET investments in Europe (Ragwitz et al. 2011). For the wider cost discussion, we refer to the full range of RES electricity, heat and biofuel projects.

We analyse the principal costs and cost reduction options for target achievement along the following structure: Section 2 gives an overview of the cost components of RET deployment both from the project developer's and the policy maker's perspective. Section 3 discusses how policies and public finance measures can reduce the specific costs for the RET project developer or investor, looking at options for reducing the investment and operation costs for RET on the one hand and for reducing the financing costs on the other hand. Section 4 takes the macro-economic perspective of policy makers and analyses how the policy cost and related consumer expenditures for meeting the 2020 target can be reduced, considering improvement of policy design and support levels as well as the optimised use of available RES potentials. Section 5 discusses the role and importance of the analysed cost reduction options for reaching the 2020 target. Section 6 draws conclusions and recommendations for policy makers.

2. Cost elements of RES technology deployment

This section describes major cost constituents of RES deployment from the policy maker's/ consumer's and the RES generator's/ investor's perspective.

2.1. The policy maker's perspective

From the policy maker's perspective, the costs of incentivising additional private sector investments in RES generation capacity are the support costs paid to RES energy producers or technology providers. Policy makers use different types of support schemes for different development stages. In the pre-deployment phase, research and development support provides financial incentives for the development and demonstration of innovative technologies. In the commercialisation phase, support schemes aim to close or reduce the financial gap between the generation costs of RES and conventional energy in the energy market[4]. Production support for RES electricity makes up the largest share of RES support expenditures in the EU member states (see Figure III-1). For the EU-27, in total, overall net support expenditures for RES are estimated at approx. € 35 billion in 2009 (de Jager et al.

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[4] In addition, support policies may help to overcome market imperfections and non-economic barriers; these aspects will be reflected in the risk discussion in section 3.2.1.

2011 based on Green-X model calculations[5]; this assessment does not include R&D support).

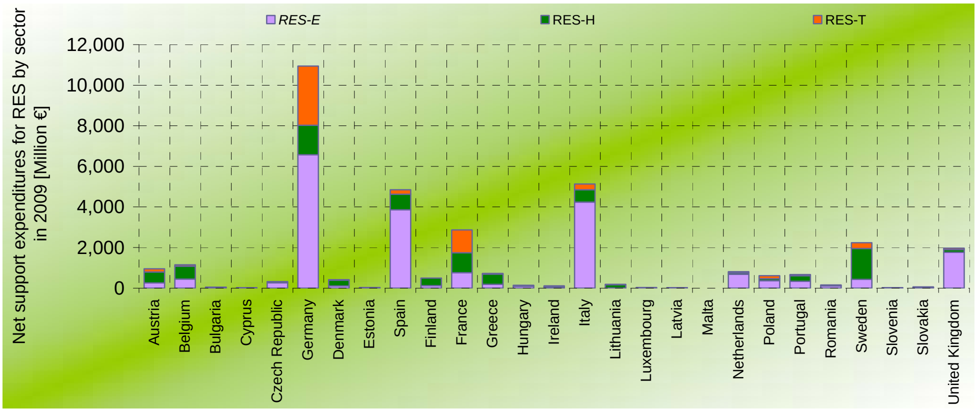

Figure III-1. Net support expenditures for RES by sector in 2009 (de Jager et al. 2011 based on Green-X calculations)

A good understanding of RES generation costs is required to quantify the gap towards conventional energy market prices. Defining the right financial support level is therefore a crucial element of price-setting support policies, i.e. feed-in tariffs and premiums, but also of other financial support instruments, such as investment grants and fiscal incentives. Even in quantity based policies like quota obligations for RES electricity, heat or fuels, which do not define remuneration levels upfront, the costs of RES need to be reflected when defining the penalty for non-compliance (and, if applicable, the floor price and technology banding factors[6]).

When assessing the costs of RES deployment, policy makers may not only look at the occurring support costs, but also at indirect costs and benefits, such as infrastructural costs, effects on energy market prices, employment effects, economic impulses, environmental benefits, etc. (see e.g. Breitschopf et al. 2009 and Klessmann et al. 2010). These wider costs and benefits will not be assessed here.

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[5] The figure corresponds to the total RET investments in 2008 (according to BNEF 2010), but this can be considered a coincidence.

[6] Technology banding signifies that different technologies are granted different amounts of green certificates per MWh, in order to account for their cost differences.

2.2. The RES project perspective

The RES generation costs from the RET project/ investor's perspective consist of the following elements:

- The upfront capital expenditures, consisting of
    - The investment costs, i.e. the cost for technology, land, construction and project development (costs for permits, grid connection contracts, consultancy, structuring finance etc.);
    - The financing costs, i.e. the cost of capital determined by the interest rate for debt, the required return on equity, the debt-equity ratio, the period for which debt and equity need to be committed, and fees paid for acquiring the required capital[7];
- The operating expenditures, i.e. fuel and maintenance costs and cost for service contracts, guarantees and insurances, once the RES plant is operational.

With these variables, one can calculate the levelised generation cost, which represents the present value of the total cost of building and operating a plant over its financial life, converted to equal annual payments and amortised over the expected annual generation. The calculation of levelised generation cost allows the comparison between different energy technologies, as well as the determination of the financial gap between RES generation costs and energy market prices (see Figure III-2).

Compared to other energy technologies, the capital costs of RET projects are typically high, while the operating costs are very low, especially for supply driven RES technologies that do not have any fuel costs, such as solar and wind energy. Only for biomass plants they are a significant cost element that can vary considerably, at least for internationally traded biomass. To assess the financing costs, it is common to calculate the weighted average cost of capital (WACC), which is the weighted average rate of return desired by all investors (equity and debt providers). The WACC is used as an estimate of the required internal discount rate of a project. The WACC strongly depends on the investment risk, which is expressed as a risk premium on top of the risk-free reference rate (e.g. Euribor). The investment risk subsumes all kinds of project risks, i.e. technology, country, policy, bank- and investor-specific risks.

Calculating the levelised cost of electricity with different WACC rates shows that the cost of capital can represent 20 to >50% of levelised cost of electricity in an average wind or PV project, i.e. in projects without fuel costs (Rathmann et al. 2011 for WACC of 5% versus 10%).

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[7] The cost of capital is sometimes subsumed under the investment costs. We explicitly differentiate investment costs and cost of capital, since both cost categories can be influenced by different policy measures.

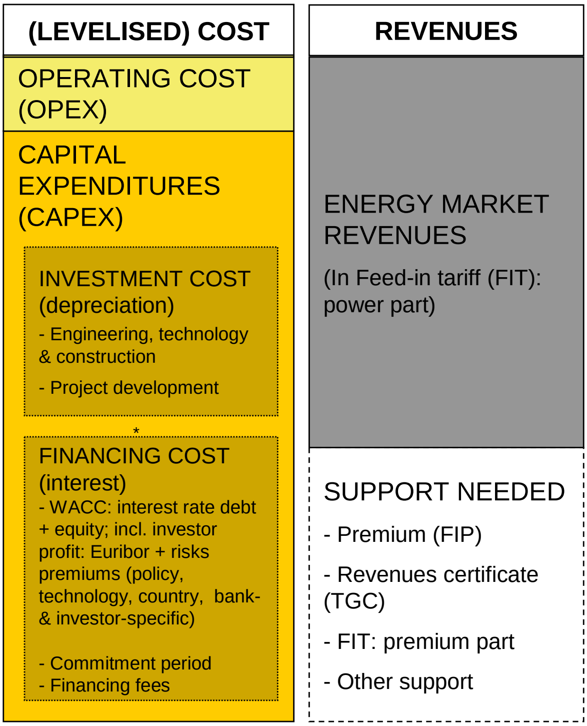

Figure III-2. Cost and revenue categories of a RET project

Another important parameter that influences the financing cost is the commitment period (debt term). The longer the debt amortisation period, the lower the levelised cost of energy (see e.g. Wiser 1997). Finally, also the contract fees of banks and other financial service providers add to the financing costs of a RET project.

Using a default setting for the WACC (6.5%) and the payback time (15 years[8]), Figure III-3 to Figure II-5 depict the typical bandwidth of long-run marginal generation costs per RET for the electricity, heat and biofuel sector in Europe in 2010, using cost data from the Green-X database for 2010 (Green-X 2011). The cost range reflects the different available technology options and resource potentials. Note that the average electricity market price is not homogenous across Europe.

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[8] This period reflects the investor's horizon rather than the lifetime of the installations, which for most RET is 20-30 years.

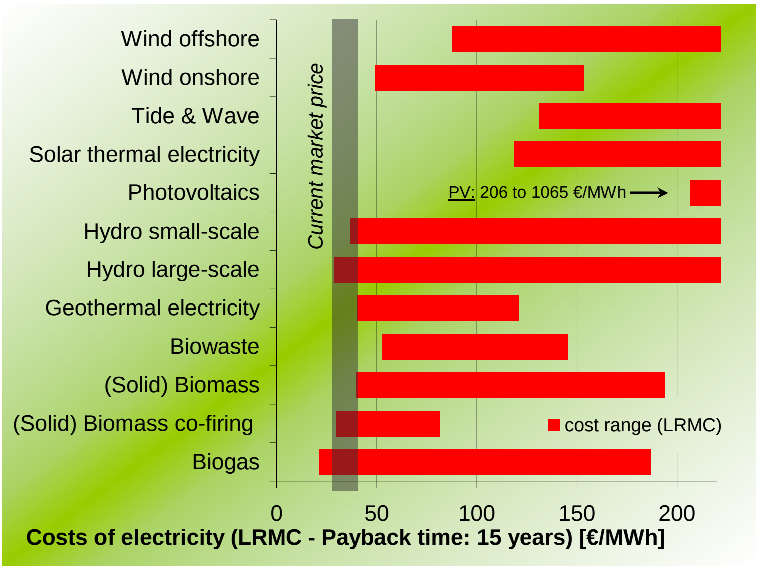

Figure III-3. Long-run marginal generation costs for the year 2010 for various RES-E options in EU countries (Green-X 2011)

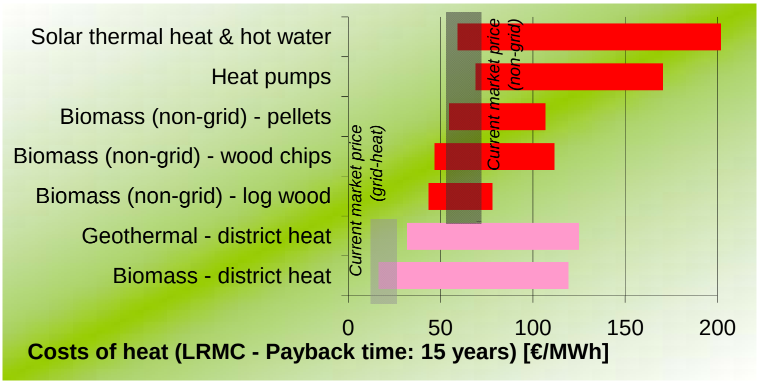

Figure III-4. Long-run marginal generation costs for the year 2010 for various RES-H options in EU countries (Green-X 2011)

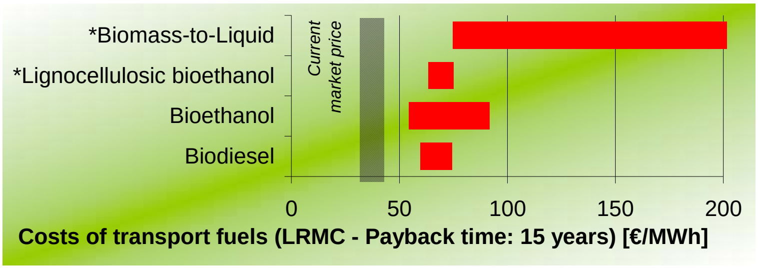

Figure III-5. Long-run marginal generation costs for the year 2010 for various RES-T options in EU countries (Green-X 2011)

3. Policy options to reduce the project specific costs for the investor

This section analyses the principle policy options for lowering the RES project costs for the investor, i.e. the investment cost, the financing cost, and to a lesser extent the operation cost.

3.1. Reducing the technology specific need for capital, i.e. lowering the required investment costs

Cost elements that can be effectively reduced by policies are the technology costs and the project development costs:

- Investments in research and development (R&D) reduce the technology cost of RET. They complement and enhance the technology cost reductions achieved through mass deployment and the related technological learning.
- Project development costs can be reduced via transparent and stable permitting, grid connection and support policies.

3.1.1. Reducing the technology costs through R&D and mass deployment

There is a huge financing need during the early-stage of RE technology development.

Public R&D funds for renewables are provided by member states and the European Commission. On EU level the Seventh Framework Programme (2007-2013) bundles all research-related EU initiatives under a common programme with a total budget of over € 50 billion. In the FP7 Energy Theme, 45 % of the European Commission contribution has been dedicated to renewable energies (RES-E, biofuels and to a small extent RES-H). By the end of 2009, the largest funding went to second generation biofuels (24% or € 83 million) and photovoltaics (22% or € 76 million) (CORDA 2010; see de Jager et al. 2011 for details). The demand for grants under the FP7 Energy Theme of the renewable energy activities is between six and eight times higher than the European Commission contribution (CORDA 2010). This shows that R&D support could still be increased significantly.

Private funding for R&D is provided via venture capital funds. Linked to the high risk of early stage technologies, these funds have high return requirements (according to Justice and Hamilton 2009, 50-500% internal rate of return). The investment risk and cost of capital can be reduced through publicly backed guarantees made available for venture capital funds (Mostert et al. 2010; see also section 3.2.2)

While it is beyond dispute that R&D funds and publicly backed guarantees help to reduce the technology cost of RET, particularly during the development, but also in the commercialisation phase, the cost reducing effect and thus the cost-effectiveness of these policy measures cannot be quantified here.

R&D in conjunction with mass deployment of renewables, triggered by effective support policies for RET deployment and the removal of market barriers, further reduces the technology costs through technological learning, as can be seen from the high cost reductions for PV and wind (53% for onshore wind over the period 1990-2004 and approx. 40% for PV 2006-2010, according to Ragwitz 2011; for an in-depth analysis of RET learning rates, see also Neij 2003 and Junginger 2004). The realisable cost reduction depends also on other factors, however, e.g. material prices, and is not quantified here for the period up to 2020.

3.1.2. Reducing the project development costs by improving the regulatory framework

During the project development phase, the project developer will undertake financial modelling, business plan preparation, resource assessment and stakeholder consultation[9]. Fundraising is also one of the main tasks at this stage. Project development costs during this phase include costs for planning and consultancy (feasibility studies etc.), obtaining the necessary permits (land use authorisation, environmental permit, construction permit, operation permit, grid connection permit, see Ecofys and Golder 2009) and other required tasks.

Lengthy and intransparent permitting and grid connection procedures are widely considered the biggest non-economic barriers to RET project development across Europe (see e.g. Ragwitz et al. 2007 and Ecorys et al. 2010 for cross-technology barriers). This result is also confirmed by the choice experiments of Luethi and Wuestenhagen (2010) for PV: project

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[9] We only look at larger projects here, not at small, building integrated installations.

developers rank the duration of the administrative process as the most important attribute for their investment decision, even slightly higher than the level of feed-in tariff. For wind energy, project developers rank legal security as most important, remuneration as second and administrative process duration as third most important (Luethi and Praessler 2010).

Improving legal security (including policy stability), permitting and grid access procedures reduces the lead times and increases the success rate of RET project development. This reduces the required project development cost and hence the levelised generation cost by reducing the required project development effort and the sunk costs for unsuccessful projects that need to be recovered in successful projects. Furthermore, more project developers are attracted to the market, as the risk of unsuccessful projects and non-recoverable sunk costs decreases.

As summarised in Klessmann et al. (2011), policy options to improve administrative and grid connection procedures include:

- Improving and streamlining administrative procedures towards transparent and non-discriminatory processes (“one-stop shop” approach for applications, maximum response periods for authorities, clear guidelines and capacity building for civil servants, limiting administrative requirements to the relevant elements, simplified procedures for small plants, etc.)
- Improved spatial planning rules
- Definition of RES priority areas
- Guaranteed and possibly priority grid access
- Regulations to limit grid connection costs (shallow or shallowish grid connection charging)

According to the interviews with RET financing experts, stable and transparent procedures can save more than 10% of levelised electricity cost for wind and PV projects (Rathmann et al. 2011). The choice experiments of Luethi and Wuestenhagen (2010) even display cost savings in the range of 10-40%: for every half-year increase in the duration of the administrative process, a government would have to pay PV project developers a feed-in tariff premium of 37€/MWh. According to the cash-flow calculations of de Jager et al. (2011), the effect is in the range of 5 to 10% of levelised generation cost.

The variations of cost estimates might be explained by the fact that Luethi and Wuestenhagen (2010) perform open choice experiments, while in practice investors will not accept project development costs that cannot be recovered by the financial support provided (often max. 5-10% project development cost). This means that higher project development costs in countries with comparatively low support levels compared to levelised cost reduce the profit margin of project developers and thus attract less project developers – improved procedures would allow more growth rather than levelised cost reductions. In countries with comparatively high support levels compared to generation cost, higher project development costs are acceptable for investors, and thus higher cost savings may be feasible through improved procedures. There might be also some effect of administrative barriers on the cost of capital (see section 3.2) which is not quantified in the cash-flow calculations.

Next to the administrative procedures, the stability of the support policy framework may also have a strong impact on the project development costs, as analysed in Rathmann et al. (2011):

- If market actors do not expect abrupt policy changes for upcoming projects, the levelised cost of electricity can be more than 10% lower than in a case of frequent changes. In the free choice experiments of Luethi and Wuestenhagen (2010), market actors would ask for 102 €/MWh more PV remuneration in case three instead of zero unexpected policy changes occurred in the last five years.
- Also rigid capacity caps for RES support pose a considerable project development risk, because they introduce the uncertainty if planned projects will still be granted support. If the support scheme is not restricted by budget or capacity caps, the levelised cost of electricity is reduced by approx. 10% (in addition to the cost reduction achieved by general policy stability). According to the choice experiments of Luethi and Wuestenhagen (2010), project developers would ask for a 108 €/MWh higher PV remuneration in the case that the cap would be reached within the next year than in the case of no cap.
- In the case of feed-in tariffs/premiums, the levelised cost of electricity can be reduced by approx. 3% if the payments are financed via consumer surcharges, off the government budget, which increases the reliability of the payments.

Again, the choice experiments provide stronger cost effects than the expert interviews, which can be explained by the fact that project development costs will be limited in practice (see above). For this reason we will only use the numbers provided by Rathmann et al. (2011) and – for macro-economic estimates - de Jager et al. (2011) in the summary tables in section 5.

3.2. Reducing the financing costs

As discussed in section 2.2, the cost of capital strongly depends on the investment risk and therefore is reduced by policies that lower RET project risks. This section will further examine existing risks and available policy options. An additional cost-reduction option is to involve the public sector in RES financing, which may not only reduce project risks, but may also provide direct access to low-cost capital.

3.2.1. Reducing the cost of capital by reducing project risks

Before investing in RES projects, investors undertake a detailed assessment of risk factors. Justice and Hamilton (2009) differentiate the following risk categories:

- Country and financial risks (such government stability, maturity of legal system, transparency of business dealings, currency risks, etc.)
- Policy and regulatory risk (Risk of sudden and/or retro-active changes in the support policy framework, budget or capacity caps, permitting and grid access risks, etc.)
- Technical and project specific risks (construction risks, technological risks, environmental risks, operation and management risks)
- Market risks (market price risks that influence project costs and revenues, e.g. feedstock prices, energy market prices, carbon prices, new competitors, etc.)

The risks that can be most easily reduced by energy policy makers are the policy and regulatory risks as well as certain types of market risks, particularly the market revenue risk. To a certain extent, policy makers can also play a role in reducing the technical and project specific risks, especially for emerging technologies.

Reducing the policy and regulatory risk

Even though RES policies aim to facilitate the accelerated market uptake of RET, they can also introduce new risks for project developers. In many countries, the additional stream of income that is provided by the RES support scheme is not reliable. Frequent or retro-active support policy changes increase the project development risk and undermine the confidence of debt and equity providers. The perceived risk increases the cost of capital, which is reflected in the higher risk premium in the WACC (see section 2.2). Commitment, stability, reliability and predictability are all elements that increase confidence of market actors, reduce regulatory risks, and hence significantly reduce the cost of capital. This effect can be significant: According to the cash-flow modelling in de Jager and Rathmann (2008), the levelised cost of electricity can be reduced by 10 to 30%, as compared to a support scheme with no particular attention to risk mitigation. The interviews with financing experts (Rathmann et al. 2011) and the choice experiments of Luethi and Wuestenhagen (2010) delivered more detailed cost saving estimates:

- As mentioned in section 3.1.2, the levelised cost of electricity can be more than 10% lower if market actors do not expect abrupt policy changes for upcoming projects. Only part of this additional cost may be attributed to potentially higher cost of capital, however; the higher project development cost will probably have the largest influence (see section 3.1.2 and Rathmann et al. 2011).

- On the contrary, if retro-active policy changes for existing projects occurred in the past (e.g. like in Spain and the Czech Republic) and are expected to reappear, this increases the cost of capital and the levelised generation costs by approx. 20%. For many investors it is a no-go criterion and may therefore have severe impacts on future growth.

Reducing the market revenue risk

Another important risk that can be directly influenced by RES support policies is the market revenue risk, particularly for RES-E technologies. Depending on the support scheme, the RES-E generators are more or less exposed to electricity market price risks (see Mitchell et al. 2006 and Klessmann et al. 2008): not at all in feed-in tariff schemes, which provide fixed revenue per kWh, and in principal fully exposed in quota and feed-in premium schemes. However, there has been a tendency to limit the revenue risk of these support schemes in recent years, e.g. through cap and floor prices for feed-in premium schemes (Spain), premiums that refer to the average yearly electricity market price (Netherlands) or floor prices for green certificates in quota schemes (Belgium). In case RES generators are exposed to the electricity market price risk, they usually hedge it through a power purchase agreement (PPA) with a creditworthy intermediary, often an energy company. In return, the intermediary keeps part of the profit margin. For balancing charges, the same logic applies: RES-E generators are not exposed to these charges in feed-in tariff schemes, but partly or fully exposed in feed-in premium and quota schemes. Again, the risk is hedged through PPAs. An additional price risk introduced in quota schemes with tradable green certificates is the certificate price risk, since the certificate price is determined in an independent green certificate market. In feed-in tariff and premium schemes, the support payment or the sum of support payment and electricity market price are predictable.

A price risk that can occur under all RES-E support schemes is the risk of curtailment due to grid congestion or safeguarding system stability. The future grid development is difficult to predict for project developers, but in countries that implement guaranteed priority dispatch of RES-E (which is required by Article 16 of the EU RES Directive), the curtailment risk is lower than in countries without priority dispatch. As an additional risk reduction measure, some countries have introduced compensation payments for RES-E plants that are curtailed due to grid congestion (e.g. Germany).

The cost of capital is significantly reduced under support schemes with low market revenue risk. The interviews with financing experts provide some quantitative cost savings estimates (Rathmann et al. 2011):

- According to the interviewed financing experts, if a predictable feed-in premium is applied instead of a green certificate scheme with volatile prices, this reduces the levelised generation cost by more than 10%.

- A fixed feed-in tariff that removes the power market revenue and balancing risk reduces the levelised generation cost by approx. 8%, compared to a feed-in premium.
- Properly implemented priority dispatch reduces the levelised cost by approx. 10%, in case grid congestion is likely to occur.
- Compensation for forced curtailment in case of grid congestion reduces the levelised generation cost by an additional 4%.

While much of this cost reduction may be attributed to lower cost of capital, other cost categories may also have an effect, as analysed in Rathmann et al. (2011): Support schemes with low market revenue risk may lower the investment and operational cost, because risky support schemes may require contracting very established companies and technology providers, or having especially complete and long performance guarantees and service contracts, in order to minimise overall project risk. Also, counterparties for power or certificate purchase will require higher margins in risky systems.

Reducing the technical and project specific risk

The technology and project specific risks are the genuine risks of the project developer. Policies usually do not cover these risks, because understanding these risks requires very detailed knowledge, and risk exposure may stimulate improving and ensuring proper technology and project management. Policy makers can, however, play an important role in facilitating risk management by private market actors and initiating public-private insurance and guarantee mechanisms, especially for less mature technologies that pay high risk premiums.

As one option, they can facilitate the provision of independent risk assessment tools and ratings for the performance of RES technologies or projects (see de Jager et al. 2011 and Michelez et al. 2011). Such tools increase the assessability of risks for investors and the developers' ability to attract investment. The possibility to rate some projects as “investment grade” projects (i.e. above a specific rating level) would attract investment and enable access to capital at reduced costs. Such rating would include a review of the full range of risks, i.e. country, site-specific, construction, technological, environmental, operation and management risks. This rating could be performed by traditional rating agencies or possibly by a dedicated EU rating agency. An EU agency might have easier access to empirical data from different member states and could provide direct advice to financial bodies in charge of issuing loans, loan guarantees, letters of credit, and insurance support, and/or by taking direct equity stakes. Making empirical data on RET performance internationally available would help substantially to facilitate risk assessments. In projects receiving government support, support could be made conditional to the (anonymous) disclosure of data to a dedicated international risk database. This could include all data relevant for further development of risk assessments, insurances, and the technology and project development in general, e.g. on project risks, problems occurring in practice, performance and wind/solar resource in practice compared to expectations beforehand, geothermal drilling success rates, etc.

Another risk reduction option is the provision of guarantees and insurance on specific technology and operational risks.

UNEP SEFI (2004) estimates that private sector investment in RET could grow by a factor of four or more, if commercial insurance policies were available for certain technology and operational risks (in the meantime, the availability of insurances has improved, therefore the potential can be assumed to be lower today). The development of technology-specific private insurances could be encouraged by public institutions that improve the flow of information about real insurance risks of RET and provide historical and technical data needed by insurers (e.g. on technology performance and failures, see idea of an international risk database above).

A similar financial risk mitigation instrument that would involve both public and private actors is suggested by BNEF and CEG (2010) based on industry consultation: a private-public “efficacy insurance” that covers RES technologies regarded as too risky for conventional insurances. Commercial insurers with appropriate levels of technical expertise could assess and support selected technologies with such insurance and receive support in turn for a portion of their risk in the form of publicly guaranteed or funded reinsurance pools. Project developers would pay a premium and transfer the performance risk of the new technology elements to the insurance pool.

Similarly, also publicly backed guarantees for RET loans or investments could bring down the risk premiums and financing costs for emerging or higher risk technologies, as explained by Mostert et al. (2010): “A publicly backed guarantee is a contractual obligation by which a government (institution), against payment of a fee, assures compensating payment to a lender or an investor in case of default on an obligation that another party is committed to. Whereas insurance involves two parties, guarantees involve interlocking contracts between three parties.” Such schemes would remove much of the technology risk and facilitate access to capital for novel RES technologies (see also next sub-section).

The financing experts interviewed by Rathmann et al. (2011) estimated that standards for risk assessment and rating could lower the levelised cost of energy by 4%. The availability of insurances for project and technology risks not yet insurable by conventional insurances could decrease the levelised cost by 2%.

3.2.2. Providing access to low-cost finance

For certain RET projects, project developers face difficulties with obtaining the required capital, i.e. both equity and debt. Particularly the 2008-09 financial crisis made the access to capital increasingly difficult and increased the cost of debt. According to Justice and Hamilton (2009), this resulted in a decreased average debt equity share for RET projects: “while 80% debt to 20% equity might have been fairly common pre-financial crisis, the debt share typically decreased to 70% after the crisis”. At the same time, it became increasingly difficult to attract equity for RET projects. In this situation, but also under normal circumstances, public sources of finance can play an important role to provide RES project developers access to low-cost finance and decrease the cost of capital.

The public sector may become involved in RET financing by several mechanisms (see Mostert et al. 2010, de Jager et al. 2011 and Rathmann et al. 2011):

- Publicly backed loan or insurance guarantees that mitigate the investment risks and steer private finance towards these projects (see section 3.2.1).
- Investment subsidies or soft loans with interest rate subsidies that improve the cash flow and ease the investors’ access to debt finance. Comparable effects can be achieved via tax law allowing accelerated or flexible depreciation or via front-loading the production support: Instead of having a constant support level for the complete support duration, support is increased during the first years of a project and decreased in the last years, while the total sum of financial support stays constant or can be reduced in line with the reduced cost of capital.
- Refinance facilities for RET loans and public investments in private equity and venture capital funds. Such public finance injections are used when lack of liquidity in the finance sector is a major constraint for private finance.
- Public Private Partnership (PPP) models, e.g. public private joint ventures or the direct participation of state-owned companies in RET projects. Such models are also applied in other energy sectors (for instance in the Netherlands and Denmark state-owned companies participate in the exploration, development and production of oil and natural gas by providing 20-40% of the equity). At a later stage – e.g. when the project has proven to operate successfully for two years and risk is therefore reduced - pension funds may take over the government shares, and the government money can be reinvested in new projects (revolving fund). Especially for large-scale RET projects, requiring investments of € 50 million or more and linked to significant technological, regulatory, or market risks (e.g. offshore wind, large geothermal or large biomass plants), government participation may help to establish financial close at lower cost of capital. According to expert interviews of Rathmann et al. (2011), a (temporary) government participation in wind and PV projects can reduce the levelised generation cost by approx. 5%. However, this only holds if government participation is administered well and does not create additional administrative risks.

Another option to provide access to low-cost finance, which does not require any public sector involvement, but could be facilitated by governments, is the provision of “patient equity”, i.e. equity funding with return requirements that are delayed in time or lower in profitability than normal commercial thresholds. This approach relates to the challenge that equity providers mostly aim at limited investment durations (4-5 years) before divesting, and expect relatively high profitability (often over 15% rate of return for the entire portfolio). Equity providers whose investment horizon and return expectations would match

PPA durations (20 years for example) would facilitate the realisation of additional RES projects. Market players which traditionally seek long-term investments with low risks and secure returns (e.g. family offices, insurance companies, pension funds) could be addressed to become “patient” investors.

4. Reducing the required consumer expenditures for RES support

Section 3 examined policy options decreasing the project costs for the RET project developer/investor. This section takes the macro-economic perspective of the policy maker and the consumers that pay for the support cost. It will discuss under which conditions the identified project cost reduction options are cost-effective for the consumer, and which additional options exist for increasing the cost-effectiveness of the 2020 target achievement. We examine four principal cost reduction strategies:

- Design risk-conscious RET policies and regulatory framework (reflecting the cost reduction options discussed in section 3)
- Adjust the financial support level to the RET generation costs
- Abandon subsidies for conventional energy sources and internalise external costs
- Optimise the supported renewable energy technology (RET) portfolio

4.1. Designing risk-conscious policies and regulatory framework

The results of section 3 showed that policy measures that reduce the policy, regulatory, revenue and project specific risks significantly reduce the cost of capital as well as the project development, investment and operation cost. As a result, the levelised generation costs of RET can be reduced: Rathmann et al. (2011) present 20 policy options each potentially leading to 2-20% cost reduction, and de Jager et al. (2011) expect, on average, 25% cost reduction potential. More RET projects become economically viable and bankable and more investments into RE projects can be attracted. For these reasons, the importance of risk-conscious policies has been widely recognised in the scientific literature on policy design, e.g. Wiser and Pickle, (1997), Mitchell et al. (2006), de Jager and Rathmann (2008), Justice and Hamilton (2009).

In principle, the reduction of project risks also reduces the required support costs for RET projects, as the lower generation cost leads to a lower gap in comparison to conventional energy prices. However, there is also a downside to risk reduction, since risks can have a positive effect: triggering developers and projects to adapt to the risk and deliver an optimised product. For example, if RES-E generators are exposed to electricity market prices (and related risks), they will tend to adjust their generation profiles to the electricity demand and therefore provide optimised generation profiles, at least if their fuel costs and the price spread between peak and base prices are sufficiently high. From the macro-economic perspective on societal costs, market risk reduction may thus have two opposing effects: efficiency gains due to lower risk premiums and lower required support payments, and potential efficiency losses due to reduced market response and less system optimised behaviour (see Klessmann et al. 2008). To judge the overall effect, policy makers should carefully evaluate whether there is a positive effect of risk exposure, and how it relates to the cost of risk. For some risks the positive effect is zero or very low compared to the cost increase, and the public or a publicly regulated entity might be better prepared to cover the risk.

Taking again the example of electricity market price risks, one can observe that supply driven RES-E will react to (positive) power market price signals to a very limited extent, since their operational costs are zero, therefore price risk exposure will provide little benefit (a positive effect might be observed in times of over-supply though, which will be limited by negative prices). By sliding premium systems, where the average premium level is indexed to the electricity price, such risk exposures can be minimised. Similarly, their ability to respond to balancing price risks is limited. RES-E producers will hedge the market price and balancing risk by power purchase agreements (PPAs) with intermediaries, but in return, the intermediaries providing services will also charge a margin and aim to share in upside price potential. Additionally RES-E producers - as any other electricity producer - may respond to balancing price risks by creating portfolios of RES-E plants (and possibly other power plants) as well as of demand side management options, which can be activated in case of high balancing prices. In feed-in tariff systems, where RES-E producers are not exposed to market risks, forecasting and trading will be done centrally by the transmission system operator (TSO). In principle, the latter option should be more cost-effective, because the TSO has the advantage to pool a larger number of generators. In practice, the cost-effectiveness will also depend on other factors, i.e. how effectively the TSO is regulated, whether the TSO has an incentive to minimise cost, on the availability and quality of PPAs, etc. The main drawback of the TSO as trader of RES-E generation is based on the fact that the TSO has typically only limited access to RES-E plants and may be unable to react to market price signals.

While the pros and cons of market risk exposure are ambiguous, the picture tends to be clearer for the other project risks identified in section 3. The policy and regulatory risks are generally risks that do not trigger any cost-optimised behaviour on the RET project side, but can be effectively reduced by governments at no or very low costs.

The technology and project risk should not be fully burdened on the public, because they are generally better understood by the RET project developers than by the public sector. The risk can be reduced at low public cost, however, by the risk reduction options discussed in section 3.2.1: providing information and guarantee mechanisms to market actors. Mostert et al. (2010) point out that the public costs of guarantee mechanisms are relatively low, because fees for guarantees can be set at levels that cover the cost of expected losses. Furthermore, they stress as an advantage that governments do not need to “pick winners”, as guarantee instruments leave all project decisions to the market. Other, potentially more costly risk reduction options are direct subsidies, grants and public investments or participations in RET projects. Which option is appropriate will differ between countries and technologies and should be thoroughly assessed for each case.

According to the Green-X scenarios in de Jager et al. (2011), even moderate risk reduction policies, which reduce the average WACC by 0.8 percentage points[10], reduce the yearly consumer costs for 2020 target achievement by approx. € 3.3-3.8 billion, i.e. by approx. 10%, compared to target achievement without such risk mitigation. From the analysis in section 3, providing project cost reductions of approx. 25%, it can be expected that the potential for reducing consumer cost through risk reduction is even higher than 10%. The trade-off between lower consumer costs due to risk reduction and increased consumer costs due to missing risk exposure cannot be quantified here, but we expect that the policy options discussed in section 3 - if implemented properly - can be implemented at low additional cost.

4.2. Adjusting the financial support level to the RET generation costs

As discussed in section 2, support policies that aim to increase the market deployment of RET need to close the gap between the RET generation cost and the conventional energy market price (allowing sufficient profit margins to the involved market parties to attract investments). If the support level is lower than this gap, there is no incentive for additional RET investments, and it is unlikely that RES targets will be reached. If the support level is significantly higher, this will increase the profit margin of the investor and/or other involved market parties, but increase the support cost per MWh that needs to be covered by consumers. Limiting the producer margin by aligning the support level to the RET generation costs is therefore an important policy feature to control policy costs. For the most common RES-E production support instruments, this alignment is organised in different ways, as member state examples show:

- The feed-in tariff level should directly reflect the assumed generation costs (levelised over the duration of the feed-in tariff payment), but allow for a producer rent that is high enough to attract investors with moderate risk appetite and return expectations. A regular review of tariffs is useful to evaluate the accuracy of the cost estimates. A yearly degression of tariffs (like in Germany) may be used to reflect technological learning in a simplified way and to stimulate further cost reductions (even though such features alone might not be sufficient to avoid over-stimulation, as can be seen from the example of PV in Germany).

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[10] The scenarios use 8.3% WACC for the high risk assessment and 7.5% WACC for the proactive risk mitigation scenarios.

- For feed-in premiums, the same logic applies, but the reference parameter for determining the support level is the difference between generation cost and electricity market revenue. Since electricity market prices are volatile, over- or under-support should be avoided by cap and floor prices (like in Spain) or other provisions (e.g. the determination of the premium based on the average yearly electricity price like in the Netherlands)[11].
- In quota systems with tradable green certificates, the maximum certificate price can be controlled by the price of the penalty for non-compliance, at the risk of lower RES-E production than envisaged by the quota. In addition, floor prices have proven to be beneficial for limiting the certificate price risk (e.g. in Belgium). Technology banding is the central tool to adapt certificate revenues to technology-specific generation cost.

Under all support instruments, the differentiation of technologies and their specific cost ranges are of high importance. Huge production cost differences exist between technologies, but also depending on site quality (high or rather average wind/solar conditions) or fuel source (biowaste, landfill gas, woody biomass, energy crops, etc). Applying uniform support to all technologies and/or sites leads to higher producer rents for cheaper technologies and good sites, which increases the respective cost to consumers compared to technology specific support. On the other hand, in case the support level is aligned with the cost of the very low cost technologies and sites, more expensive technology options, which might be needed to achieve the 2020 or long-term targets, will not be developed, or need to be supported by additional support mechanisms (see section 4.4.2). The importance of technology specification for cost-effective RES support has also been demonstrated in quantitative terms (Held et al. 2010). One should be aware, however, that there is no “one size fits all” solution: Policy differentiation should also reflect that RET are at different development stages, have different characteristics, different project sizes and type of investors involved (e.g. utility-scale offshore wind, domestic PV, agricultural biogas, community-owned onshore wind), which results in different return on investment expectations.

The effect of aligning the support level to generation costs has not been quantified compared to the continuation of current support policies, which show different levels of alignment across member states. According to Resch et al. (2009), the yearly average support expenditures for reaching the 2020 target would increase by at least € 10 billion per year, if uniform, technology-neutral support was applied for all of Europe. In their scenario, this equals a cost increase for 2020 target achievement of more than 40%.

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[11] Both systems have shortcomings preventing optimal functioning, however: In the Spanish system cap and floor values are applied hourly, which prevents any meaningful positive demand-response by RE projects. Cap and floor values should rather be applied to annual averages. In the Dutch system the premium is not further increased in case the average yearly electricity prices falls below a pre-defined minimum. This is in order to increase public budget certainty, but imposes a major revenue risk on projects.

4.3. Phasing-out subsidies for conventional energy sources and internalising external cost

Another option to close the gap between the generation cost of conventional energy technologies and RET and to reduce consumer costs is to lift the price of fossil and nuclear energy by removing existing subsidies and internalising external costs that are currently paid by society. Direct or hidden subsidies for fossil or nuclear energy are still in place in many European countries, despite the trend to reduce subsidies for coal mining (European Commission 2010). EEA (2004) provides an overview of energy subsidies by energy carrier and country. Examples of hidden subsidies are e.g. the government participation in the oil and gas sector, lower than average requirements regarding deposits for demolition at decommissioning, or the provision of free emission allowances under the EU Emission Trading Scheme. If these direct and indirect subsidies were removed, the support payments required for RET and from consumers in general would decrease.

Similarly, fossil and nuclear energy producers do not yet fully pay for the cost caused by their impact on climate change, security of supply, resource depletion and other environmental impacts (external cost). The EU Emission Trading System was designed to partially internalise the cost of CO_2 emissions, but so far prices are below the assumed external cost of CO_2 (see Stern et al. 2006 and Tol 2008 for the calculation of external costs). Higher CO_2 emission allowance prices would increase the competitive advantage of RET and decrease the required support costs. For the consumer, this might not necessarily lead to short-term cost savings, since the higher CO_2 prices paid by conventional power generators and industry would most likely be passed on to consumers. On the other hand, cost savings should occur on the broader macro-economic level, since the external costs would otherwise be paid by society.

The cost savings potential of removing fossil and nuclear subsidies is significant, but no data is available on its influence on 2020 target achievement cost.

4.4. Optimising the RET portfolio

Another strategy for increasing the cost-effectiveness and reducing the consumer costs of RET support in the member states is the optimisation of the supported RET portfolio. Generally speaking, cost savings can be accomplished in two ways:

- European cooperation for optimised resource exploitation
- Improving the (dynamic) efficiency of the supported RET portfolio

The pros and cons of these closely related options have been discussed controversially on European level for many years, particularly in the context of risks and benefits of European harmonisation.

4.4.1. European cooperation for optimised resource exploitation

The EU RES directive breaks down the EU 2020 RES target in national RES targets for the member states. The allocation of differentiated national targets is based on a flat rate approach (same additional share for each country) adjusted to the member state’s GDP. This target allocation approach does not correlate with the member states’ natural RES potentials, which vary substantially. In consequence, also the expected policy and investment costs for reaching the national targets domestically differ between member states. In order to account for these differences, the RES directive introduces flexible cooperation mechanisms which allow those member states with low or expensive RES potential, to partially fulfil their RES target in other countries with higher RES potential or lower generation costs. According to the Green-X scenarios developed in de Jager et al. (2011), intensified cooperation between member states until 2020 could lead to cost savings in consumer expenditures of approx. € 2.3-2.8 billion per year compared to purely national target achievement. Nevertheless, only few member states have revealed any plans to use the cooperation mechanisms so far (NREAPs 2011). While it is still possible that they will start using the cooperation mechanisms in the coming years, there are also some structural reasons for the reluctant use of the cooperation mechanisms: In their RET deployment and cooperation strategy, member state governments may also consider indirect costs and benefits of RET deployment that are not included in the direct support cost assessment, e.g. domestic benefits like job creation and other local added value, or domestic costs like grid reinforcement, impact on landscape etc. (see Klessmann et al. 2010 and Breitschopf et al. 2009). Also, the acceptance of consumers to pay for RET support tends to be higher in case RET are installed domestically, rather than in foreign countries.

The European Commission has criticised the lack of cooperation between member states (European Commission 2011) and announced additional actions to facilitate further cooperation in the future, pushing for cost savings on European level. With the same argument, the Commission promoted the idea of European harmonisation of RET support instruments and European-wide guarantees of origin trade in the past, particularly in its first proposal for the EU RES directive (European Commission 2008). These plans met strong opposition by the member states and RET industry associations, however (see Fouquet and Johansson 2008 and Klessmann 2009 for a summary of the policy discussion preceding the adoption of the RES directive 2009/28/EC). Also many researchers were critical of the approach, pointing out that a uniform European-wide certificate system would lead to high additional producer rents for low-cost technologies and therefore to strongly increased consumer costs for reaching the 2020 targets (Resch et al. 2009). It would also lead to higher risks for independent power producers and a betterment of incumbent utilities, which would prevent the EU from meeting the innovation challenge of combating climate change (Jacobsson et al. 2009). Their analysis shows that harmonisation of RES support, if realised in such manner, would lead to additional costs and problems. One can assume, however, that these disadvantages could be largely avoided if risk-conscious support schemes were applied and support instruments and financial support levels were adjusted to the local resource conditions (see section 4.1 and 4.2). A clear advantage of aligning the support conditions between member states is that it will avoid a “race for the highest subsidies” between project developers across Europe. Without such coordination, governments may be tempted to increase the financial support level for favoured technologies, in order to attract more investments than their neighbours (at least when technology and project development capacities are scarce, like in the case of offshore wind). An important precondition for successful coordination appears to be the bottom-up approach towards the improvement and alignment of existing support schemes, as a forced top-down harmonisation of RES support would create (transitional) regulatory uncertainty and potentially other negative effects (support not aligned to local conditions, conflicts with national and local administration structures, teething problems of implementing a new support scheme, etc.).

In a nutshell, increased cooperation between member states does hold the potential for increasing cost-effectiveness of RES target achievement, but policy makers need to pay attention to avoiding high producer rents for low-cost technologies and sites that may offset the benefits of cooperation. Furthermore, indirect costs and benefits and public acceptance need to be considered in the assessment. In some cases, member states may consider them more important than potential efficiency gains. A forced top-down harmonisation of support policies does not seem recommendable in the current situation, as it would create transitional uncertainty and other implementation problems.

4.4.2. Improving the (dynamic) efficiency of the supported RET portfolio

A closely related option for reducing the consumer costs of RES target achievement is focusing the policy support on low-cost technologies, rather than on more costly technology options. According to de Jager et al. (2011), the deployment of less innovative technologies for the RES 2020 target could lead to consumer cost savings of approx. € 3.4-3.7 billion per year until 2020, but they add that the resulting RET portfolio may not be balanced from a long-term perspective.

Again, the focus on less-costly technologies is not a straight-forward approach, as other considerations may influence the choice of technology, e.g. the mix of supply-driven and flexible RETs, as well as indirect costs and benefits of the RET deployment, including local acceptance issues and industrial policy considerations to support innovative, more expensive RET in order to gain a front-runner advantage and create lead markets. Furthermore, supporting solely low-cost RETs may prevent the timely development of innovative, more expensive technologies needed for future climate and RET target achievement (Resch et al. 2009) and the timely upscaling of their supply chain in order to avoid future supply chain constraints and scarcity rents increasing support cost in the long-term (dynamic efficiency). The challenge is therefore to support a technology portfolio that is cost-efficient from a dynamic point of view, both until 2020 and beyond. In some member states it seems possible to shift the support towards a less expensive technology portfolio, even without neglecting dynamic efficiency. This applies to cases where innovative technologies like PV or wind offshore are developed at a faster pace than low-cost alternatives like wind onshore or renewable heat options (e.g. PV in Germany or wind offshore in UK, see policy effectiveness indicators in Held et al. 2010 for details). The majority of member states does not support any innovative technologies, however, and therefore neglects dynamic efficiency considerations.

A challenging question for policy makers is how to steer RET support towards the right technology mix. Leaving the technology choice to the market, like in the case of technology neutral support instruments, has proven to be an expensive support option (see section 4.2 and 4.4.1). Rigid support caps per technology tend to create stop and go and high investment risks. Against this background, some member state governments are experimenting with different types of flexible support caps (e.g. the accelerated PV tariff degression based on growth corridors in Germany).

While the support of low-cost technologies has been discussed extensively for the electricity sector, governments usually pay less attention to the heating sector, which provides lower cost RET options in terms of final energy than the electricity sector. Since the RES 2020 target is measured in final energy, increasing the RES-H share in the overall RES target achievement would also lead to cost-savings. On the other hand, there are relevant barriers that hamper such an approach, e.g. the scarcity of biomass potentials and the slow retrofit of heating systems in buildings.

One can conclude that shifting the support towards a less expensive RET portfolio holds significant cost savings potential in some member states, but that dynamic efficiency should be preserved. Other member states solely focus their support schemes on the lowest cost technologies available and may need to further consider the dynamic efficiency, in order to avoid unnecessarily high support cost in the future. Either way, the policy design feature for selecting the technology mix should avoid introducing substantial additional risks.

5. Summary and discussion

5.1. What is the effect of the analysed cost reduction options on reaching the 2020 target?

Table III-1 provides a summary of the analysed cost reduction options, their cost savings potential and their growth stimulation effect from a project development perspective, while Table III-2 summarises the available cost reduction options on macro-economic level, i.e. from the perspective of policy makers and consumers.

Table III-1. Summary of the analysed cost reduction options on project level

Cost reduction option	Cost category	Status	Effect on RET generation costs	Effect on attracting investments in RET (growth)
Reducing the technology cost through R&D support and support for mass deployment	Investment cost / capital expenditures	R&D support could be intensified; mass deployment only in few countries	Not quantified; potentially high effect on less mature technologies and post-2020; medium to low effect on technologies needed for 2020 target achievement	Low effect of R&D, high effect of mass deployment policies
Reducing the project development costs by removing administrative barriers	Investment cost / capital expenditures	In most European member states, administrative barriers and instable policy frameworks lead to high project development costs and risks; only few countries with low risk environment	>10% of levelised cost of energy	High
Reducing the project development and cost of capital by reducing policy, revenue and technology risks	Financing costs, investment and operational cost, revenues		10 to 30% of levelised cost	High
Providing access to low-cost finance	Financing costs	Publicly backed guarantees, low-interest loans and state participation in large projects are only partly available across Europe	Medium; 2-5% of levelised cost per policy option	Medium to high, depending on availability of capital

Table III-2. Summary of the analysed cost reduction options on policy maker/ consumer level

Cost reduction option	Cost category	Status	Effect on support cost until 2020 (efficiency)	Effect on attracting investments and achieving 2020 targets (effectiveness)
Designing risk-conscious policies	Lower RET generation cost reducing support costs (for consumers)	Only few member states pay attention to risks, see above	€ 3.3-3.8 billion/ year for 0.8%-points WACC reduction (8-9% of required yearly consumer expenditures for new RET up to 2020); potential even higher	Essential / precondition for attracting investments and achieving 2020 targets
Adjusting the financial support level to the RET generation costs	Lower investor profits reducing support costs (for consumers)	Significant differences between support levels of member states	Crucial role for cost-effective target achievement; > € 10 billion per year compared to uniform support (Resch et al. 2009)	No direct effect on investment activity unless supply chain constraints lead to preferred supply of high-support/ high-profit countries
Phase-out subsidies for conventional energy sources and internalise external cost	Higher energy market revenues for RET projects reducing support costs (for consumers)	Direct or indirect subsidies still in place in most countries; some subsidies are abandoned and cost internalised (EU-ETS)	Increases RET market revenues and reduces required support cost for RET; effect not quantified, but potentially high savings potential	Strong effect, if not already compensated by support scheme: increases attractiveness of RET investments as some RET become competitive in the market

Cost reduction option	**Cost category**	**Status**	**Effect on support cost until 2020 (efficiency)**	**Effect on attracting investments and achieving 2020 targets (effectiveness)**
European cooperation for optimised resource exploitation	Lower RE generation cost reducing support costs (for consumers)	So far no active cooperation between member states; some discussion ongoing	€ 2.3-2.8 billion per year, if implemented properly (6-7% of required yearly consumer expenditures for new RET up to 2020); Savings potential needs to be weighed against indirect costs and benefits; Forced harmonisation could lead to additional costs.	Indirect effect on investment activity by increasing the availability of financial support in more countries; Policy transition (uncertainty) may temporarily lead to negative effect
Improving the (dynamic) efficiency of the supported RET portfolio	Lower generation cost reducing support costs (for consumers)	Few member states over-proportionally support high-cost technologies. Most member state neglect innovative technologies and the dynamic efficiency of RET support.	€ 3.4-3.7 billion per year, if less expensive RET portfolio is implemented (8-9% of required yearly consumer expenditures for new RET up to 2020); Only part of the savings potential can be tapped dynamically efficient; Challenges: avoiding risk increase; potential increase of post-2020 cost	No direct effect on investment activity, but reduces required investment cost (potentially freeing capital for additional investments)

The project-specific cost estimates in Table III-1 are taken from the expert interviews in Rathmann et al. (2011). The macro-economic estimates in Table III-2 are from de Jager et al. (2011), unless indicated differently (see section 3 and 4 for details). Except for R&D, the project cost reductions options in Table III-1 are subsumed under the first macro-economic option “designing risk-conscious policies” in Table III-2.

Whether the project cost reduction options also lead to macro-economic cost savings needs to be assessed from case to case, evaluating the project cost savings through government support and risk reduction against the support costs for consumers and the benefits of risk reduction. Reducing administrative barriers and policy reliability risks in any case has a positive effect on project and consumer cost, as the costs of such measures are generally low and policy and administrative risks do not provide any positive effect. Reducing the market revenue risk, facilitating the management of technology risks and providing access to low-cost finance also holds the potential to reduce consumer costs, but much will depend on the detailed design and implementation of the respective policy options.

Which role the different options can play for the 2020 target achievement will be further discussed below. We differentiate the effect on target compliance cost on the one hand, and on attracting additional investments/ achieving the target on the other hand.

The policy options that have the highest effect on attracting additional investments for reaching the 2020 targets are the design of risk-conscious policies that reduce administrative barriers and project development risks, and the increase of energy market prices through the phase-out of subsidies and the internalisation of external costs. In fact, the European 2020 target will not be reached without the removal of regulatory barriers, according to the Green-X scenarios in de Jager et al. (2011): Only scenarios that presume the mitigation of current non-cost barriers reach the 2020 target. In addition, low risk policies may attract additional investors with low risk appetite, e.g. infrastructure funds, institutional investors, pension funds, etc. Next to this growth stimulating effect, risk conscious policies also hold a significant cost savings potential, as discussed above. In the scenarios of de Jager et al. (2011), the effect is up to € 4 billion per year, i.e. 10% of annual target compliance costs, only reflecting the effect on WACC; including the effect on project development costs, the cost savings might be even higher.

Reducing direct and hidden subsidies to fossil and nuclear energy plants and internalising external costs does not only reduce the cost of RES target achievement, but also reduces the cost burden for society from a wider macro-economic perspective, even though consumer costs may increase on the short term, due to the higher energy prices. In practice, it is rather unlikely that these measures will contribute significantly to the 2020 RES target achievement, since they would require a joint effort of European energy policy makers (not just RES policy makers) and are closely interlinked with other industry interests. The EU emission trading system does play a certain role for internalising carbon costs, but recent analysis shows that carbon prices are expected to stay low (below 20 €/t CO2) until 2020 (Graus et al. 2009) and therefore do not give a strong incentive for RET investments. This could change, however, if the EU would move from a 20% to a 30% emission reduction target for 2020.

One of the most important policy features for lowering the target compliance cost and increasing the cost-effective RES support is the definition of an adequate support level (or the introduction of a policy mechanism that determines the support level accordingly), i.e. the adjustment to the technology- (and possibly site-) specific generation costs, which also includes the adjustment to the country and technology specific risk level. Such adjustment controls the RES producer profits and is crucial for limiting the required consumer costs. There is no direct disadvantage of limiting the producer rents, as long as the support level still attracts a sufficient number of investors. What return on investment is required to attract investors depends on the technology and the type of investor, which differs according to project size and investment risk. In practice, defining the right support level or price determination mechanism is a challenging task that requires intense monitoring of RET market and cost developments. The overall cost savings potential has not been quantified compared to a continuation of current support levels, but the large support level variations between member states (see Held et al. 2010) indicates that there is significant optimisation potential. Compared to a target compliance scenario based on technology-neutral European-wide support, the cost savings potential is estimated to be more than € 10 billion per year (Resch et al. 2009).

Reducing the overall RET technology and support costs through increased cooperation between member states and applying more lower cost technologies holds a substantial cost savings potential, but also poses a number of risks and challenges. In particular, cooperation and portfolio optimisation should not endanger the stability of RET support or create additional risks for RET market actors; such uncertainties would lead to additional costs that could offset the cost advantage. For these reasons, a forced European harmonisation of support schemes appears to be a problematic option before 2020 (in case of uniform European certificate trade, this would even lead to high additional consumers costs, see above). On the other hand, minimum design criteria for support schemes defined on European level could help to align the support conditions and force member states with ineffective support schemes to improve the framework conditions and cost-effectiveness of RES support. Furthermore, increased voluntary cooperation between member states could tap the cost savings potential at low risk.

Another issue to consider in this context is the dynamic cost-efficiency of RES support, ideally reflecting the long-term strategy for the transition towards a low carbon economy with very high shares or renewable energy. Without such long-term considerations, policy makers might risk focusing on low cost options and minimum RET deployment levels without considering which innovative RET options need to be developed to reach high deployment levels in the future.

In a nutshell, the analysis showed that investment-grade policy improvements that reduce project development risks are crucial for reaching the 2020 target, but also reduce the target compliance costs compared to the continuation of current policies. Internalising external effects of conventional energy sources could have a similar effect, but is less likely to occur until 2020. While the impact of policies on effectiveness and cost-efficiency of target achievement cannot always be separated, the impact of other important policy options, such as the adjustment of support levels to generation costs, increased cooperation between member states and the cost-optimisation of the supported RET portfolio do not necessarily attract additional investments, but hold the potential to significantly reduce the cost of target achievement for consumers. The latter increases the likeliness of achieving the 2020 target. Overall, further improvement and coordination of existing policies seems more promising than drastic system changes, as the latter would create additional uncertainties and potentially negative effects on growth and RET project costs.

5.2. Uncertainties

In this article we presented different policy options for reducing the RET project costs and the cost of European RES target achievement. The cost savings effect on project and macro-economic level has been roughly quantified based on literature findings, expert interviews and Green-X scenario results. While there is robust evidence that the identified options can lead to cost savings, the presented numbers are not fully compatible and subject to a certain degree of uncertainty.

Particularly the cost saving figures regarding project development and financing costs are only expert estimates that cannot be directly validated empirically. This way of quantifying obviously is no exact science, but neither are the risk assessments made before investment and lending decisions; the results represent the effect of policies as it is perceived by the interviewed market parties. in NLincess amalia offshorer demmdpatort conditional to providing th-manifestaties kan ik berichten dat je er ook een leuk Furthermore, they partly explain the difference in cost-effectiveness of support policies between member states, as quantified in Held et al. (2010).

The quantitative results of the macro-economic scenarios developed in de Jager et al. (2011) are sensitive to a number of underlying assumptions that cannot be discussed in full detail here. Exemplarily, we will briefly look at the assumptions for risk reduction.

With regard to the influence of risk mitigation on investment and policy costs (see section 3.2.1) the assumptions of the scenarios are rather conservative: the high risk assessment is performed with a WACC of 8.3%, while the low-risk assessment is performed with a WACC of 7.5%. This WACC difference is in line with the bottom-up cash-flow calculations provided in de Jager et al. (2011), but lower than the estimated influence of risk-conscious policies on WACC in some member states provided in the expert interviews (according to them WACC reduction can even be in the order of 5% for some countries and technologies). On European and technology average, the WACC reduction potential is significantly lower than this upper value, however, which may justify the assumptions of de Jager et al. (2011). Furthermore, the interviews revealed that positive effects due to more risk-conscious policies occur also in other cost and revenue categories than WACC, particularly in investment cost and market revenues. This is an indication that the overall cost-savings potential of risk conscious policies might be higher than the results of low-risk scenarios that only reduce the WACC.

6. Conclusions and recommendations

The article analysed RET cost reduction and growth stimulating policy options with respect to their effect on project costs and policy/ consumer costs and discussed their role for achieving the EU 2020 RES targets. The results show that risk-conscious, investment-grade RET policies are crucial for attracting sufficient RET investments until 2020 and achieving the RES targets cost-effectively. Risk-conscious policies do not only reduce the RET financing costs, as frequently pointed out in other studies (e.g. Justice and Hamilton 2009), but also reduce the project development costs and increase market revenues. If risk does not affect WACC it may be because the higher risk is reflected in other cost categories, leading to higher investment cost, operating cost or lower revenues from power or support.

From a consumer cost perspective, not all project risks should be burdened on the public, as risk exposure may also lead to cost-optimised behaviour by RET projects. For many risks, however, the macro-economically positive effect of burdening the risk on the project is zero or very low compared to the cost increase for the project, and the public or a publicly regulated entity might be better prepared to cover the risk. Reducing such risks therefore also reduces support costs for consumers. Particularly policy and administrative risks do not show any positive effect and can be reduced at low cost. The removal of market revenue risks might be somewhat more ambiguous, but the experience across Europe shows that reducing revenue risks is a crucial policy element for attracting investments and stimulating RET growth. Technology risks should rather not be burdened on the public, but policy makers can facilitate the successful management of such risks through private entities.

Generic policy recommendations for reducing RET project risks and costs while keeping the costs for consumers low are

- Ensuring long-term commitment towards renewable energy and increasing the stability of the regulatory framework, which increases the trust of market players,
- Removing risks by removing administrative and market barriers,
- Removing revenue risk where risk exposure does not trigger macro-economically efficient risk mitigation actions by RET projects, and
- Removing risk by sharing risk, at least in case the public sector is sufficiently equipped to take (part of) the risk.

From the macro-economic perspective, there are also other options that can significantly reduce the RES support costs, i.e. the adjustment of support levels to generation costs, phasing out subsidies for fossil and nuclear energies, and the cost-optimisation of the supported RET portfolio, either through increased cooperation between member states and/or through changes in the supported technology mix. Contrary to the risk reduction options, these latter options do not appear as a precondition for 2020 RET target achievement, but hold the potential to significantly reduce the cost of target compliance for consumers and tax payers, which in return increases the likeliness of target compliance, given the limited government budgets and consumer willingness to pay for RES support.

On the other hand, the analysis also showed that European coordination and focusing on lower cost technologies are no straight forward policy strategies that need to be evaluated and implemented with care, in order to avoid additional risks, costs and acceptance problems. Overall, further improvement and coordination of existing policy frameworks seems more promising than drastic system changes, as the latter would create additional uncertainties and potentially negative effects on RET growth and project costs.

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IV. Pros and cons of exposing renewables to electricity market risks–a comparison of the market integration approaches in Germany, Spain, and the UK[1]

Abstract

The article examines how renewable electricity (RES-E) producers are integrated into the electricity market under the support legislations and regulatory frameworks of Germany, Spain, and the UK. Focus is on wind power, which faces the highest market integration challenge of all RES-E. The analysis shows that the three countries follow contrasting approaches of exposing RES-E producers to the market risks of forward electricity markets, balancing markets and system planning requirements. Risk exposure is highest in the UK and lowest in Germany. From a policy maker's perspective, there is a trade-off between a "high risk" and a "low risk" approach. When RES-E face high market risks, a higher level of financial support is required to stimulate RES-E development than in a low risk environment, but the exposure to market risks may also give an incentive to make efficient use of the respective market, thus limiting the indirect costs to society. The special characteristics of wind energy, however, put natural limits to the response of wind power plants to market prices and locational price signals and will increasingly influence electricity markets and grid infrastructure. These interdependencies should be recognised in the design of RES-E policies and market regulations.

1. Introduction

This article focuses on the interaction between support policies and electricity market designs. It examines how renewable electricity producers participate in the electricity markets of Germany, Spain and the UK, and how these markets are influenced by renewable electricity (RES-E) integration respectively. Based on this analysis, pros and cons of exposing renewable generators to market risks will be discussed.

Many policy analyses mainly compare RES-E support policies as such, especially focusing on the most common support instruments: feed-in tariffs and quota systems, to a lesser extent also tenders and financial incentives (e.g. Ragwitz et al. 2006 and 2007, Mitchell et al. 2006, Morthorst et al. 2005). Ragwitz et al. (2007) have analysed the effectiveness and efficiency of support instruments for RES-E in different European countries. They come to

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the conclusion that the success of RES-E support policies is strongly influenced by electricity grid and electricity market related barriers. In other words, the success of renewable energy deployment does not only depend on the design of the support policies but also on the electricity market design and the interaction of both fields of regulation.

In the political discussion about RES-E support schemes in Europe, the market integration and participation of RES-E is a controversial issue. Advocates of liberal market concepts favour “market based” support schemes (usually meaning quota systems) to provide competition and least-cost RES-E (e.g. Eurelectric 2003). Opponents argue that renewable energy support should not be market based as long as European electricity markets are not fully unbundled and competitive (e.g. EREC 2005). It is important to recognize that the term “market” is used in an ambiguous way, sometimes referring to the support mechanism, sometimes referring to the electricity market participation. As a matter of fact RES-E always influence and in some way participate in electricity markets. We will discuss the way RES-E are involved in several types of electricity markets and identify the specific chances and challenges of market integration. This article will distinguish the participation in the following markets:

- Forward electricity markets: Trade of RES-E ahead of delivery, via bilateral contracts or on the power exchange. We will focus on the day-ahead market. Since day-ahead market prices are a major benchmark for all forward trades, the day-ahead market is of special significance for electricity price assessments.
- Balancing markets: Participation of RES-E in imbalance settlement and balancing services markets.
- Support markets: Trade of RES-E on special tradable green certificate (TGC) markets, most relevant under a RE quota obligation. The most prominent example of a TGC market is the British Renewables Obligation Certificate (ROC) market. TGC markets have been analysed extensively, e.g. by Bertoldi and Huld (2006) and Midturn et al. (2005), and will only be shortly touched upon here.

While green certificate markets only trade the green value of energy, the other mentioned markets are submarkets of the power market that overlap and interact. A precondition for power market participation is the physical integration of RES-E into the electricity network. For this reason, aspects of grid access and system planning will also be considered.

The article will examine how renewables are integrated into these electricity submarkets operationally and economically under different RES-E support legislations and discuss the pros and cons of assigning market responsibilities and risks to RES-E generators.

Section 2 introduces general electricity market architecture and principles of power system operation. Section 3 summarises basic influences of RES-E deployment on those markets, independent of specific country cases or support schemes. Section 4 will examine the electricity market integration of RES-E in three countries, representing the three most prominent RES-E support schemes in Europe:

- A fixed *feed-in tariff* scheme, represented by Germany’s Renewable Energy Sources Act (“Erneuerbare-Energien-Gesetz”, EEG 2004).
- A *feed-in premium* scheme, represented by the “market option” in Spain’s Real Decreto 661/2007 and formerly Real Decreto 436/2004.
- A *quota* scheme, represented by the UK “Renewables Obligation” (RO 2002).

For those three case studies, five questions will be analysed that reflect on the economic and operational integration of RES-E into the electricity markets:

1. Economic integration into forward markets: How do forward electricity market prices affect the RES-E generator’s revenues under these support schemes?
2. Operational integration into forward markets: How is the renewable electricity integrated into the electricity market?
3. Operational integration into balancing markets: Who is responsible for the forecasting and balancing of the RES-E production?
4. Grid integration: What are the regulations for grid access and who pays for RES-E related grid reinforcements?
5. Effect of RES-E on electricity markets: What is the effect of RES-E on electricity market prices and is this effect relevant for RES-E producers?

Since wind energy, as fluctuating renewable energy source with – for the time being – the highest potential in Europe, poses the greatest integration challenge for electricity and balancing markets, the focus will be laid on the market impact of and on wind energy. It will be briefly discussed how applicable the results are to other renewable energy sources.

Section 5 will compare the market integration approaches of the three countries and discuss the pros and cons of exposing RES-E generators to specific market risks. This will be examined from two perspectives:

- the implication for the RES-E generator
- the implication for overall societal costs.

Based on this discussion, conclusions and policy recommendation for the market integration of RES-E will be drawn.

2. Introduction to power market architecture and basic principles of power system operation

This section gives a short overview of the basic power market architecture and operation.

2.1. Power system operation as precondition of electricity trade and delivery

Electricity poses a special challenge to market design; it is a product that can only to a very limited extent be stored in a commercially viable way. The power system can only function in a stable manner if supply and demand are continuously balanced. Since the demand of electricity is highly inelastic, the balance has to be achieved mainly on the supply side (de Vries and Hakvoort 2003). In every electricity market, a *System Operator* ensures reliable system operation by purchasing and dispatching reserve power to provide the balancing services. Since the System Operator has a monopoly in this function, it is always regulated by the State. Through this regulation, governments have the possibility to significantly influence the electricity market.

2.2. Forward markets

Forward markets are financial markets that trade electricity ahead of its delivery. Trading periods reach from years ahead until hours-ahead. Most prominent when speaking about electricity markets are day-ahead markets. Intraday markets have been introduced only recently to some European countries and are closely linked to balancing markets. A customer who buys electricity in a forward market will receive either electricity delivered by the seller or financial compensation (Stoft 2002).

Within forward markets, electricity can be traded via bilateral contracts (“over the counter contracts”, OTC), or as standardised products at a power exchange. Power exchanges usually offer platforms for long-term trade (futures market) and short-term trade (spot market[2]). Day-ahead spot market prices are a major benchmark for all forward trades.

For stochastic RES-E like wind energy, short term markets (day-ahead and intraday) are of special relevance, because their output cannot be predicted far in advance.

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[2] The term *spot market* implies that commodities are bought and sold for cash and delivered immediately. While Stoft (2002) uses the term only for the real-time market, it is frequently used to include the day-ahead and intraday markets. We will use the latter terminology, since the spot markets of most European power exchanges are day-ahead markets.

2.3. Balancing markets

The balancing market (also called real-time market) is a physical market, as all trades correspond to actual power flows. Any power that is sold in the day-ahead market but not delivered in real time is deemed to be purchased in the balancing market from the System Operator at the imbalance energy price (two-settlement system, see Stoft 2002). The System Operator buys the required balancing energy/capacity on special balancing service markets.

The balancing procedure can be described from two perspectives:

- The use of balancing services for the imbalance settlement
- The provision of balancing services on balancing service markets

Figure IV-1depicts the basic transactions.

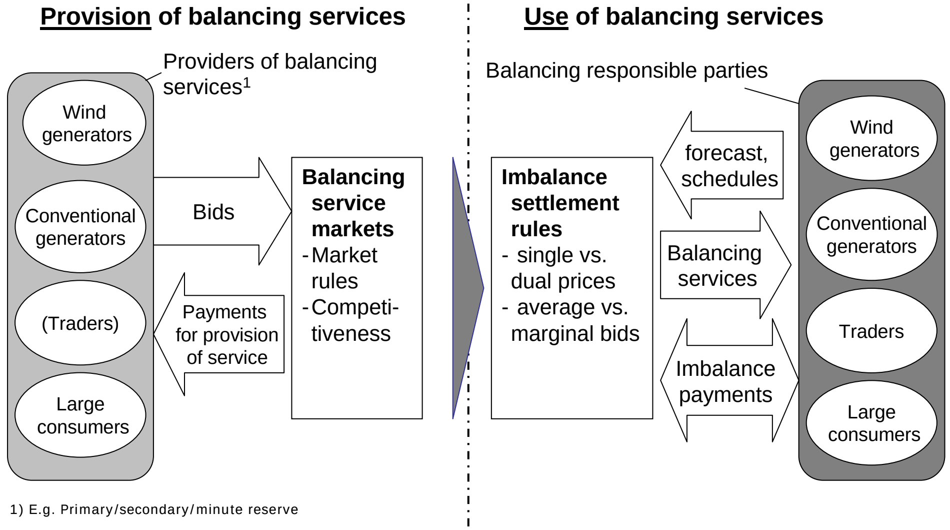

Figure IV-1. Use and provisions of balancing services

2.4. Use of balancing services (imbalance settlement)

Balancing responsible parties are generally all generators or traders of electricity. They are required to submit day-ahead schedules to the system operator that estimate their electricity feed-in or consumption. Schedules can be modified before *gate closure*, which is generally 1-3 hours before real-time delivery. The obligation to deliver schedules is attached to the financial responsibility for any deviation from the schedule in actual delivery or consumption. The *imbalance settlement rules* define the way how deviations are priced, i.e. how prices of the balancing service markets are transformed to imbalance prices for the users of balancing services. According to these rules, balancing responsible parties receive payments or have to pay for the imbalance volume of energy. There are two principle pricing options:

- Single imbalance pricing where a single imbalance price is used independently whether the imbalance is positive or negative
- Dual imbalance pricing where a different price is applied to positive imbalance volumes and negative imbalance volumes.

The settlement of the imbalance volume is done by the System Operator[3] subsequent to the actual delivery. Dual imbalance pricing gives a stronger incentive to deliver correct schedules than single imbalance pricing, since generators that do not deliver the scheduled energy face higher imbalance charges. Strategic gaming (e.g. scheduling less production than actual delivery) however also occurs.

2.5. Balancing service markets

Balancing services are used by power system operators to match real-time electricity demand and supply and guarantee a constant network frequency. The balancing services (energy and/or reserve capacity) are sold daily on special *balancing service markets* by parties who are able to provide them. These are mostly generators, or to a lesser extent, large consumers. Different balancing service categories are distinguished according to the time horizon that needs to be balanced: primary reserve (seconds ahead), secondary reserve (minutes ahead), replacement reserve (hours ahead). The economic value of these services decreases in the same order. The balancing of wind power mainly requires relatively cheap replacement reserve.

A great variety of market designs exist with respect to pre-qualification requirements, bid evaluation and settlement rules of balancing service markets. The market's competitiveness is crucial for the pricing of schedule deviations, since the pricing for imbalance energy is determined by market results of the balancing service market.

3. Principle influence of RES-E on the power market

3.1. Principle influence of RES-E on the dispatch of power plants and on spot market prices

Power plants are generally dispatched in such a way that the lowest possible costs of produced electricity are attained at each moment. Therefore power plants with the lowest variable production costs are put into operation first (Blok 2006). There are practical deviations from this order, however, because fossil power plants (especially coal, lignite

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[3] In some market designs, e.g. Spain, there is a market operator that is in charge of imbalance settlement.

and nuclear) are limited in their operational flexibility. A certain share of the generation also has to be provided by synchronous generators that establish the system frequency.

Most renewable energy technologies are characterised by high capital costs and low fuel and operational costs. This is especially true for intermittent renewables (wind, solar, hydro) that have zero fuel costs. For this reason they come first in the merit-order of power plant dispatch4. The deployment of RES-E thus changes the structure of power supply and decreases marginal prices, due to the increased supply at low variable costs (see Figure IV-2). This effect is short term and not straight forward, as the price building of electricity market prices is influenced by many variables.

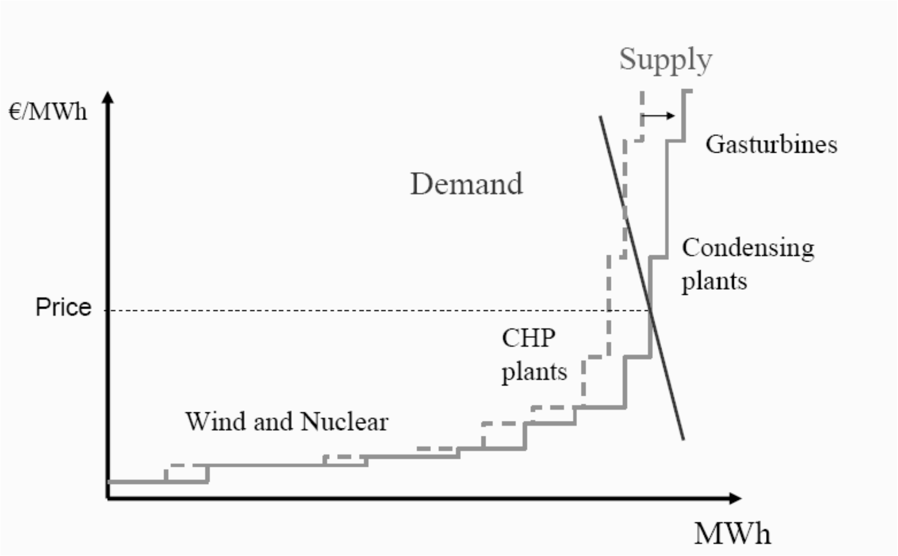

Figure IV-2. Decrease of marginal price due to increased wind deployment (Morthorst 2007)

Until recently, penetration levels of wind power were too low to noticeably affect the electricity market prices empirically. With increasing wind energy deployment, the decreasing effect of wind energy on spot market prices is starting to become significant in some countries, notably Denmark, Spain and Germany. Figure IV-3 shows the spot market price curves for Western Denmark on a winter day with practically no wind (blue line) and

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[4] If a regulated priority for the feed-in of RES-E (e.g. like in Germany) exists, all renewables – including bioenergies, which have higher fuel costs – are dispatched before fossil power plants.

on days with medium or high wind feed-in (as a function of MW system load, see Morthorst 2007). For peak hours, the spot price difference between times of high and low wind feed-in is in the order of 30 €/MWh (and even higher for system loads >1000 MW). Morthorst estimates that wind power feed-in decreased the average spot market price in 2005 by almost 14%. The magnitude of the effect can be explained with the high wind power penetration in Denmark. Wind power covers approximately 25% of total power consumption in Western Denmark. The installed wind power capacity (2400 MW) is about one third of the total installed power plant capacity.

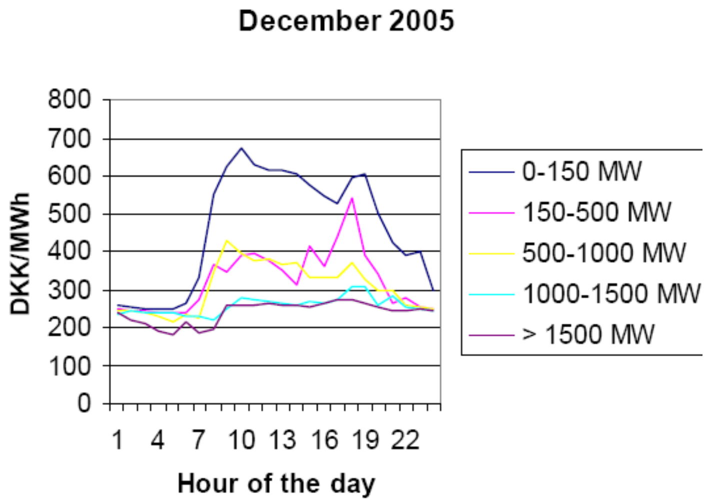

Figure IV-3. Decreased spot market prices due to wind power feed-in in Western Denmark (Morthorst 2007; 7,5 DKK = 1€)

In the long term, there is another side effect of increased wind power feed-in that might influence market and consumer prices. Because renewables are employed first in the merit order of power dispatch, the commissioning and the market revenues of fossil fuel plants will decrease. On a long-term scale, decreased revenues may lead to lower new capacity investments or even de-investments (see Nabe 2006, Wissen and Nicolosi 2007). At times of low or no wind power availability, this reduced capacity could then facilitate increased spot prices for fossil fuel plants.

There are further direct and indirect effects of renewables deployment on electricity wholesale prices, e.g.

- Decrease of CO2 allowance prices (Rathmann 2007)
- Hedging of fuel price risk (Awerbuch and Sauter 2006, Wiser and Bolinger 2004)

- Shift in the structure of the conventional power plant mix in the direction of more flexible power stations with lower capital costs and higher fuel costs (DENA 2005)

A complex cost analysis would be required to estimate the net macroeconomic effect of these different influences on wholesale market and consumer prices. In the following sections we will concentrate on the decreasing effect on spot market prices described above. This short term effect is highlighted as it directly affects the market revenues of wind power producers, if they are exposed to market prices: Whenever their wind yields are high, their market revenues are lower than average market prices.

3.2. Principle influence of RES-E influence on balancing requirements and regulation costs

Non-intermittent RES-E only require the conventional balancing provisions. They are as predictable as any conventional power generator, if the employed technology is reliable.

Intermittent RES-E that are characterised by limited predictability (especially wind energy) influence the dispatch of conventional generators in the system. They usually increase the total dispatch cost of conventional generation, since they needed to be combined with flexible power plants that usually have higher variable costs than inflexible power plants. Through this combination, their stochastic load profile is integrated in the conventional plant dispatch to meet the demand load profile. Only part of this transformation is done with the service of balancing markets; most of it can already be settled day-ahead. The better the intermittency of RES-E can be integrated into generation dispatch, the lower the remaining balancing demand and costs. A way of achieving this is to reduce the forecast error for RES-E production. In this context, intraday markets can play an important role, since they open the opportunity to adjust schedules to improved forecasts on the day of delivery. Such adjustments are of special importance for wind energy. For example, if wind power plants are concentrated in one area (e.g. the North Sea coast in Germany), their prediction errors are correlated. Sudden drops in wind speed will increase the system imbalance in the same direction. At high wind capacity shares in total system load, this can lead to high overall imbalance volumes and costs.

Several studies have demonstrated that an increasing share of wind energy in system load results in higher balancing costs (IEA 2007, IEA 2005, DENA 2005). According to the studies compared in Holttinen et al. (2007) and IEA (2007), at wind penetrations of up to 20% of gross energy demand, system operating cost increases arising from wind variability and uncertainty amount to about 1-4 €/MWh. The designation of these costs however depends on the characteristics of the given electricity system and market (Verhaegen et al. 2006). Due to this complexity, we will not analyse this aspect in the country case studies.

4. Electricity market integration of RES-E under different support schemes – the country cases Germany, Spain and UK

This section will examine how renewable electricity is economically and operationally integrated into the electricity markets of Germany, Spain and the UK, focusing on the role of each country's main RES-E support policy in the integration process. The examined support policies represent the three predominant support schemes in Europe:

- *Feed-in tariffs* (Germany) – RES-E generators sell their produced electricity at a legally regulated price per kWh to the electricity suppliers
- *Feed-in premiums* (Spain) – RES-E generators sell their produced electricity on the electricity markets and receive a fixed bonus payment (*premium*) per kWh on top of the electricity price
- *Quota obligation* based on *tradable green certificates* (UK) – RES-E generators sell their produced electricity on the electricity markets and the "green value" of their production on special green certificate markets. The demand for green certificates is created by quota obligations for electricity suppliers.

4.1. Market integration under the German feed-in tariff scheme

Germany has implemented a feed-in tariff scheme since 1991. The first scheme provided one single tariff for all RES-E technologies and led to considerable wind energy development. Rapid market growth also for other RES-E technologies occurred after the Renewable Energy Sources Act ("Erneuerbare Energien Gesetz") was introduced in 2000. This legislation guarantees priority feed-in and fixed feed-in tariffs for each renewable energy source. The tariffs are guaranteed for a fixed period of time. For most technologies the period is 20 years. Tariffs for new installation are decreased every year by a certain percentage in anticipation of technological learning. Table IV-1 gives an overview of the 2007 rates and degression rates for wind onshore. After an amendment in 2008, revised tariffs and degression rates will become effective in 2009. The German government also considers the introduction of a *feed-in premium* option in parallel to the fixed tariff scheme, i.e. the option to sell RES-E directly on the electricity markets and receive a premium payment on top of it, but no detailed proposal has been put forward so far.

Technically, the tariffs are paid to the RES-E generator by the Distribution Network Operator (DNO) to whose grid the RES-E plant is physically connected. Large wind parks sometimes connect and sell directly to the transmission system operator (TSO). The additional costs of the feed-in tariff (i.e. price difference between feed-in tariffs and market prices) are passed from the network operators via the electricity suppliers to the consumers (see below).

Table IV-1. German feed-in tariffs and degression rates for wind energy 2007 (EEG 2004)

Technology	Feed-in tariff 2007 (€/MWh$_e$)	Degression rate
Wind onshore		
- initial tariff (year 1 – T*)	81.9	2%/a
- base tariff (year T* – 20)	51.7	
*T depends on yield of wind power plant		

The German feed-in tariff scheme has been effective in promoting RES-E. The RES-E share in total electricity consumption increased from 4.5% in 1997 to 10.4% in 2005 (European Commission 2006) and 14% in 2007 (BMU 2008). The installed wind power capacity increased from 2,080 MW in 1997 to 22,247 MW in 2007 (BWE 2008).

How do electricity market prices influence the RE generators' revenues?

Under a fixed feed-in tariff regime, RES-E generators do not financially participate in the electricity market. They sell their electricity at a guaranteed price; therefore electricity market prices are not relevant for them. Theoretically, RES-E generators are free to sell energy on the market, directly to end-users or via traders or the power exchange.

How is the renewable electricity integrated into the electricity market?

Even though RES-E generators are not confronted with the rules and risks of the electricity market, the electricity sold under the feed-in tariff regime is still integrated into the market. The main responsibility is taken by the Transmission System Operators (TSO).

The Distribution Network Operators transfers the electricity for the fixed price to the respective TSO (Germany has four TSOs), which transforms the load fluctuating profiles to a standard load profile[5] . The transformed standard load profiles are sold to all utilities that deliver electricity to final consumers. The utilities charge the average tariff to their customers.

The financial implications of the transformation process from the fluctuating load profile into a fixed profile are supervised by the regulator ("Bundesnetzagentur"). The

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[5] The standard load profile is currently defined as constant load; the load level is changed monthly.

transformation costs are passed on to the network customers and are included in the Use of System Charges (UoSC).

The profile transformation mechanism is not fully transparent. The German TSOs are not only responsible for system operation but also assume trading functions by predicting RES-E-production and trading electricity for the profile transformation (see Zander et al. 2004). Since the costs of the profile transformation are passed on to the network customers, there is no systematic incentive to minimise these costs. The German TSOs claim to perform the transformation under market conditions. This practice has, however, been challenged by the German regulator, who indicated in summer 2006 that the transformation costs of several TSOs were too high. This finding was underpinned by a study by LBD (2007) that found that the average transformation costs for RES-E of 8.3 €/$\mathrm{MWh}_{\mathrm{RES\text{-}E}}$ declared by the TSOs for 2006 were considerably higher than the costs of 3.4-5.4 €/$\mathrm{MWh}_{\mathrm{RES\text{-}E}}$ that resulted from their own cost assessment. One option to increase transparency of transformation costs would be a public call for tenders to purchase these services or to increase regulatory oversight of this process.

It can be concluded that the intransparent and not cost-optimised transformation mechanism is one major weakness of the German feed-in tariff system.

Who is responsible for the forecasting and balancing of the RES-E production?

All RES-E generators that sell their electricity under the feed-in tariff scheme are exempted from the balancing responsibility; they neither have to deliver generation schedules nor carry balancing costs. Forecasting, scheduling and balancing are done by the TSO. In principle, because of the high number of wind power plants supervised by one TSO, this central approach allows high forecasting precision as opposed to decentralised forecasting. On the other hand, the TSOs are not forced to minimise the forecast error and thus the balancing cost for RES-E, since they can pass them via the Use of System Charges to the customers.

A structural problem of the German balancing service market is its low liquidity and thus relatively high price level. If RES-E generators were balancing responsible, they would thus be confronted with relatively high balancing costs.

What are the regulations for grid access and who pays for RES-E related grid reinforcements?

The Renewable Energy Sources Act guarantees grid access of renewable energy plants. The RES-E plant operator only pays for the connection to the nearest grid connection point (low or medium voltage level). If the distribution or transmission grid has not enough capacity to transport the generated electricity, the network operator is obliged to reinforce the grid. The costs can be charged to the consumers via the Use of System Charges[6]. In practice, the required transmission grid reinforcement advances very slowly. This is mainly due to the long permitting procedures for transmission grid construction.

As long as the network reinforcement has not been accomplished, RES-E plants in Germany can connect to the grid under the “congestion management” arrangement of the Renewable Energy Sources Act. According to this clause the network operator is allowed to curtail the output of RES-E plants if the network is already congested with electricity from other RES-E plants. Newly installed plants need to be equipped with technical provisions for such curtailment. This arrangement was introduced in 2004 to bridge the time gap until transmission and distribution networks are reinforced by the network operators. According to the law, the plants that have been connected to the network last will be cut off first, but for practical reasons, usually all plants that fall under the arrangement are curtailed to the same output rate. In regions with high RES-E penetration and weak grid infrastructure (especially northern Germany), such congestion management on distribution and transmission level poses an increasing risk to the RES-E generator. The curtailment results in a loss of feed-in tariff revenues to the RES-E project. In the most affected region in Northern Germany, the curtailment of wind power plants amounted to approximately 5% of their annual yield in 2005, with increasing tendency (Jarass and Obermair 2005). The insecurity introduced by the fact that the rate of curtailment is difficult to predict for RES-E operators might be considered more significant than the actual losses of income. Hence, the revised feed-in law foresees that generators will be compensated for their losses from 2009 onwards.

Is the effect of intermittent RES-E on electricity market prices relevant for RES-E producers?

Neubarth et al. (2006) show that spot market prices at the European Energy Exchange in Leipzig, Germany, were lower than average on days with high predicted wind power feed-in in the 12 months period between September 2004 and August 2005. They find a weak but robust correlation, and estimate an average spot market price reduction of 1.89 €/MWh for every 1000 MW forecasted wind power[7]. The overall spot market price reduction in Germany is estimated at 2.7 €/MWh for the 12 month period. Diekmann et al. (2007) estimate the spot market price reduction of RES-E for the following years:

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[6] The network operators argue that the density of RES-E installations varies substantially across the country and so does the increase of charges in their area. In contrast to the feed-in tariff costs, no mutual compensation between network companies applies to grid reinforcement costs.

[7] They claim that his correlation is only valid up to a total wind power load of 7000 MW; loads higher than 7000 MW were too rare to be statistically analysed.

- 3-4 €/MWh in 2005
- 6-8 €/MWh in 2006[8]

For comparison: The RES-E share in total electricity consumption was 10.4% in 2005 and 12.0% in 2006 (BMU 2007).

The price decreasing effect is not relevant for RES-E producers, since they are paid fixed feed-in rates. It is relevant for the TSO, however, that trades parts of this electricity day-ahead on the spot market or via OTC contracts and will be affected by the reduced market price. The price spread between days with high and low wind feed-in translates to additional costs for the profile transformation by the TSO and will be passed to its customers via the Use of System Charges (Neubarth et al. 2006).

4.2. Market integration under the Spanish feed-in premium scheme

The Spanish feed-in premium scheme was introduced in 1998. It was amended by the Royal Decree 436/2004 in March 2004 and Royal Decree 6 61/2007 in May 2007. RES-E generators are granted priority grid access and priority feed-in. Financially they can choose between two remuneration options:

- a technology specific fixed feed-in tariff
- a technology specific feed-in premium on top of the electricity market price ("market option"): electricity market price + premium (+ "incentive", only before 2007)

The first option is more or less analogous to the feed-in tariff scheme in Germany. In the second option, the RES-E generator sells the produced electricity on the electricity market via bilateral contracts or the power exchange. On top of the price achieved on the market, a technology specific premium is guaranteed by law. Before 2007, this premium was paid independent of the market price. After electricity market prices increased significantly in 2004-2006 and resulted in high revenues for wind power projects, RD 661/2007 introduced upper and lower boundaries for the RES-E generator's revenues (i.e. it grants a minimum tariff independent of the market price, and limits the maximum value of market price plus premium). The premium option is still the preferred scheme for wind power operators. About 97% of wind parks were using this remuneration option in 2007 (Ceña 2007a). Table IV-2 gives an overview of the tariffs and premiums for wind onshore. Market prices, premiums, and actual market revenues in the first nine months of 2007 are shown in Figure IV-4.

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[8] For a detailed assessment of the spot price effect, see also Sensfuss (2008).

Table IV-2. Feed-in tariff, premium, and upper and lower boundaries for wind power producers in Spain (RD 661/2007)

Technology	**Regulated feed-in tariff (€/MWh$_e$)**	**Premium (€/MWh$_e$)**	**Upper limit premium + market price (€/MWh$_e$)**	**Lower limit premium + market price (€/MWh$_e$)**
Wind onshore				
- 1-20 years	73.20	29.29	84.94	71.27
- After 20 years	61.20	0		

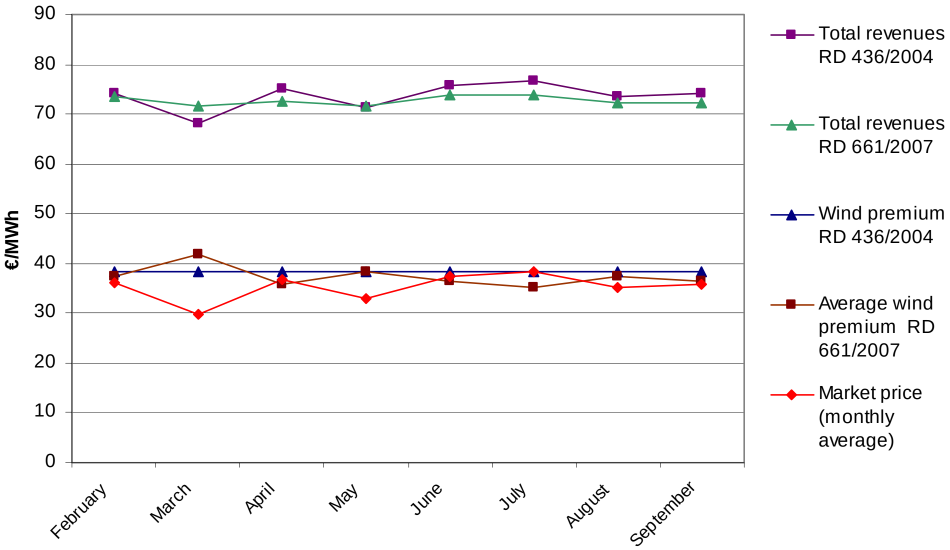

Figure IV-4. Spanish wind premiums and market revenues 2007 in €/MWh (Ceña 2007b)

RES-E generators can switch between the fixed tariff and the premium option every 12 month, as many times as they like. The costs of the premium and the additional costs of the fixed tariff are passed on to the electricity consumers via the electricity distributor and the regulator CNE.

The Spanish support scheme has been effective in promoting RES-E development, mainly in the wind energy sector. The installed wind power capacity increased from 839 MW in 1998 to 15,145 MW in 2007 (AEE 2008).

How do electricity market prices influence the RES-E generators’ revenues?

Under the premium regime, electricity market prices are an integral part of the RES-E generators’ revenues. They sell the renewable electricity on the electricity market and receive a premium payment on top of the achieved price, but market risk and profit margin have been limited by the upper and lower boundary tariffs introduced within the RD 661/2007.

Under the feed-in tariff regime, RES-E generators are not exposed to market prices.

How is the renewable electricity integrated into the electricity market?

No special regulation is needed to integrate renewable electricity under the premium option. RES-E generators can sell their electricity on the day-ahead market or via bilateral contracts like any other electricity producer. The Spanish wind power market is dominated by large utilities that also act as wind power operators (Iberdrola, Union Fenosa etc.). These utilities can easily integrate the produced RES-E into their portfolio and sell it directly to their clients. Smaller RES-E generators close power purchase agreements (PPAs) with intermediaries (utilities or independent traders) that trade the electricity on the market. Such intermediaries can achieve better prices than RES-E operators would do on their own, but will keep part of the sales profit for their trading services.

Under the fixed feed-in tariff option, the RES-E is bought at the regulated price by the utility, integrated into its portfolio, and directly sold to its customers. Thus, the produced electricity is directly transformed to the demand load profile. There is no transformation to base load profiles as under the German feed-in tariff scheme.

Who is responsible for the forecasting and balancing of the RES-E production?

In Spain, the balancing responsibility of RES-E generators depends on the choice of the support option.

Under the fixed feed-in tariff option, RES-E generators are only partly responsible. Wind farms and other RES-E with a capacity > 10 MW must predict their daily schedule 30 hours before the start of the day. Imbalance prices are fixed at 7.8 €/MWh. This price applies to the deviation between scheduled and actual delivered volume beyond fixed tolerances. For wind and solar energy, the tolerance margin is 20%, for other renewables 5% (i.e if delivery deviates more than 20% from the scheduled volume, 7.8 €/MWh have to be paid for the deviation >20%). According to Ceña (2007a), these balancing charges result in average costs of 1.5 €/MWh wind power production under the fixed feed-in tariff option. Since the RES-E production under this option is integrated into the large portfolio of the distributor, who can adjust the schedule during the day, the actual imbalance costs are assumed to be even lower.

Under the premium option, RES-E generators are fully responsible for balancing and have to deliver schedules like any other market participant. Independent wind power producers usually make arrangements with intermediaries that accumulate generators under their contract and schedule the electricity production. This increases prediction accuracy. Spain has a well established and liquid intraday market with six intraday trading periods that can be used to minimise the costs of schedule deviations.

Imbalance prices that apply for schedule deviations are fluctuating with hourly market prices, but upper limits are set by the regulator (for all electricity producers, not just for wind; Ceña 2007a). Imbalance prices are high for schedule deviations that enhance the total system imbalance and zero for those that reduce it (dual imbalance pricing). Average imbalance costs for wind power plants under the premium option are estimated at 2.6 €/MWh for 2006 and 1.4 €/MWh for 2007 (Ceña 2007c).

What are the regulations for grid access and who pays for RES-E related grid reinforcements?

Grid access for RES-E is guaranteed and regulated by several royal decrees. If the distribution or transmission grids need to be reinforced due to the connection of the RES-E plant, the plant operator has to carry the full costs on distribution level and a negotiable part of the reinforcement costs on transmission level. Negotiations about the costs to be carried by the project developer in case of reinforcement are a major obstacle in the grid connection process.

Costs for transmission grid reinforcement usually cannot be clearly attributed to the connection of RES-E since electricity demand increases and the necessity of network reinforcement exists also without RES-E integration. The network operator Red Eléctrica therefore carries the major share of the costs of transmission grid reinforcement. Nevertheless, a certain share of typically 20% is assigned to the involved RES-E plant operators. This share is established with the connection offer.

Grid congestion and curtailment are a serious problem in Spain, both on the 220 kV level and in some distribution networks. Electricity demand and generation capacity are growing rapidly, while network reinforcement advances slowly.

Is the effect of intermittent RES-E on electricity market prices relevant for RES-E producers?

In 2007, wind power had a decreasing effect on spot market prices in the order of 2-3 €/MWh for every 1000 MW of wind power in the system. This amounted to a price decrease of approx. 20 €/MWh in times of high wind feed-in (7000 MW system load)[9], as depicted in Figure IV-5 (Ceña 2007c). The lower than average spot market prices directly

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[9] This equaled about 55% of the total installed wind power capacity and 8% of the total installed power plant capacity (see Ceña 2007c).

affect the revenues of the wind power producers, but the price risk is limited by the minimum tariff for market price plus premium introduced under the RD 661/2007.

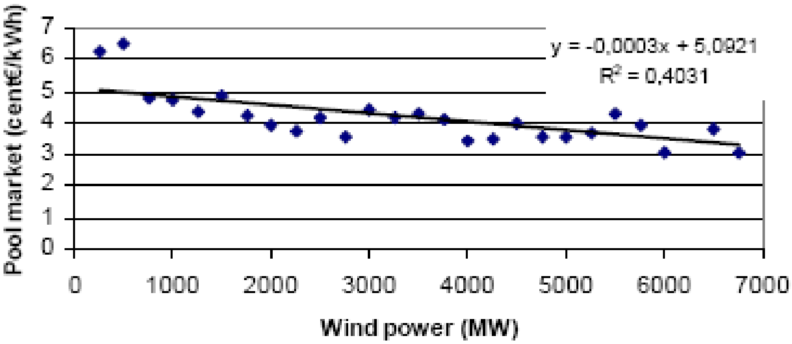

Figure IV-5. Decreasing effect of wind power feed-in on spot market prices in July 2007 (Ceña 2007c)

4.3. Market integration under the British quota obligation

The Renewables Obligation (RO) was introduced in England, Wales and Scotland in April 2002 and in Northern Ireland in April 2005. The RO requires electricity suppliers to supply an increasing percentage of electricity from renewable energy sources. The 2006/07 target was 6.7% (2.6% in Northern Ireland) rising to 15.4% by 2015/16 and remaining at least at this level until 2027 (RO 2002).

Suppliers meet their obligations by presenting Renewable Obligation Certificates (ROCs, 1 ROC = 1 MWh). ROCs are issued by the regulator Ofgem for all domestic RES-E generation. All renewables are treated the same (with the exemption of large hydro that is not eligible), thus favouring least-cost RES-E technologies. From 2009 it is intended to “band” the RO to award more or less than one ROC per MWh depending on the technology type (Energy Bill 2008).

If suppliers do not have sufficient ROCs to cover their obligation, they must pay a penalty per MWh into a buy-out fund. The buy-out price is adjusted annually in line with retail price index. The buy-out fund is recycled annually to electricity suppliers in proportion to the number of ROCs they surrendered in the compliance period. Market players which have met their obligation gain extra revenues, at the expense of those who did not meet their obligation. This buy-out recycling mechanism gives suppliers an extra incentive to hold ROCs and has kept the ROC market price above the buy-out price, because the ROC’s value for the electricity supplier equals the buy-out price plus the recycle payment. Table IV-3 provides an overview of RO targets, buy-out price, recycle and market prices. The annual expenditure of the RO is paid by the electricity customers. It is kept constant through the definition of the buy-out price.

Table IV-3. RO targets, buyout prices & ROC value for England and Wales (Ofgem 2007a and b, NFPA 2008)

Year	Targets	Non-compliance buyout price	Recycle price from buy-out fund	Total "value" of ROC (buyout + recycle)	Average ROC's price at quarterly auction
	% supply (consumption target)	€/MWh*	€/MWh*	€/MWh*	€/MWh*
2002-03	3	43.5	23.1	66.6	67.8-69.9
2003-04	4.3	44.2	33.2	77.5	66.6-55.5
2004-05	4.9	45.5	19.8	65.3	66.3-68.4
2005-06	5.5	46.9	14.8	61.7	55.7-58.9
2006-07	6.7	48.2	Not yet known		65.0-69.8
2007-08	7.9	49.7			
2008-09	9.1				
* Exchange rate used £1: €1.45					

Independent RES-E producers can sell their ROCs directly to traders or suppliers via purchase agreements, or sell them at the quarterly auctions of the Non-Fossil Purchasing Agency NFPA. Since the introduction of the Renewables Obligation in 2002, the ROC's price at the quarterly auctions has fluctuated between £38 (lowest value in January 2006) and £52 (highest value in July 2004). In the January 2008 auction just less than 65,000 ROCs were purchased at an average price of £49.95 (~72.43 €/MWh, see NFPA 2008). Wholesale electricity prices were in the order of 40-50 €/MWh.

So far, the Renewables Obligation has not delivered the envisaged target share. The British RES-E share increased from 1.7% in 1997 to only 4.1% in 2005 (European Commission 2006), compared to a target of 5.5% in 2005-2006. Total installed wind power capacity amounted to 2400 MW in 2007 (BWEA 2008).

How do electricity market prices influence the RE generators' revenues?

In terms of reflecting electricity market developments, a quota scheme has common properties with a feed-in premium scheme. The RES-E generators sell the generated electricity on the market, and the obtained price is an integral part of their revenues. The essential difference is that the revenues from the electricity market are not supplemented by a fixed premium, but by the ROCs revenues. Since the price on the ROCs market is fluctuating and not correlated to the electricity market price, the RES-E generator has to deal with the uncertainties of two independent markets, i.e. the forward electricity market and the TGC market.

How is the renewable electricity integrated into the electricity market?

No special mechanism is needed to integrate the renewable electricity into the electricity market. RES-E generators can sell their electricity on the electricity markets. Independent RES-E producers may close power purchase agreements with utilities or other intermediaries who integrate the electricity into their portfolio.

Who is responsible for the forecasting and balancing of the RES-E production?

In the UK, RES-E operators have full balancing responsibility. In most cases, electricity suppliers act as intermediary and balancing responsible parties.

Settlement prices for deviations depend on the total imbalance of the transmission system as well as on the direction of the individual scheduling deviation (dual imbalance pricing):

- If the balancing responsible party increases the system imbalance, imbalance prices are derived from the balancing service market price. In this case system-buy and system-sell prices are very volatile and sometimes take values tens of times larger than their average (Angarita-Márquez et al. 2007), e.g. up to 200 £/MWh on 18.12.2007 (Elexon 2008). This price mechanism therefore means a high risk for wind energy projects, especially if the prediction was higher than the actual generation.
- If system imbalance and individual deviations have opposite directions (i.e. they neutralise each other), system-buy and system-sell prices are based on market prices from short-term energy trades. These prices are usually lower than the prices of the balancing service market.

Gate closure is 1 hour before delivery, much later than in most other countries, and competitive intraday-markets are available. This allows RES-E producers to adjust their schedules to improved forecasts.

What are the regulations for grid access and who pays for RES-E related grid reinforcements?

Grid access requirements for renewable generators are regulated under the UK Grid Code as for any other generators. Depending on the intended point of connection, the developer has to apply for a grid connection with National Grid or the respective distribution system operator. In the latter case, the impact on the transmission level has to be assessed for projects larger than 100 MW. Grid connection offers expire after 90 days, which is often too short for project developers to get all consents.

At distribution level, grid reinforcement costs are largely burdened on the RES-E project. Charging depends on the location of the connection point and the respective network topology. If infrastructure works are exclusively beneficial for the project, the respective ‘sole assets’ are completely charged to the project in advance.

At transmission level the costs for the extension or reinforcement of networks are paid by the TSO and recovered from the network customers via the Use of System Charges. Considerable financial risk is still burdened on the project developer by the so called “final sums liability”. Before the plant is connected to the grid, the generator has to cover the liability for the infrastructure investments of the network operator. Final sums have increased due to the huge demand for transmission access by renewable generators in Great Britain (e.g. for more than 6 GW onshore wind only in Scotland, DTI 2005). In practice, this mechanism is one of the most serious obstacles, in particular for larger projects.

Is the effect of intermittent RES-E on electricity market prices relevant for RES-E producers?

There are no figures available on the influence of RES-E on spot market prices in the UK. Presumably wind energy penetration in the UK is still too low to notice its effect on spot market prices. Assuming higher wind energy shares in the future, the resulting price decrease would directly affect the revenues of the RES-E producer.

5. Discussion: Comparison of market integration approaches in the countries examined

Table IV-4 summarises the research questions and results of the country case studies. It becomes clear that these countries follow contrasting approaches in allocating the responsibility for the power market integration of RES-E. The responsibilities are not only defined by the RES-E support scheme, but also by balancing regulations, grid code, and other market regulations.

This section will summarise the pros and cons of these market integration approaches and discuss under which conditions it seems justified to exempt RES-E generators from their market responsibility, or to assign full or partial market responsibility to them.

Table IV-4. Summary of the country case studies for Germany, Spain and the UK

	Germany	**Spain**			**UK**
RES-E support scheme	**feed-in tariffs**	**feed-in tariff option**	**feed-in premium option 2004**	**feed-in premium option 2007**	**quota obligation based on tradable green certificates**
Overview					
RES-E share 2005	10.4%	17.2%			4.1%
Wind power capacity 2007	22,250 MW	15,145 MW			2,400 MW
Maturity of wind market	Mature	Mature			not mature
Grid congestion barrier	High	Medium			high for Scotland
Average support payment for onshore wind 2007 (incl. electricity price)	51.7-81.9 €ct/kWh	73.2 €ct/kWh	n.a.	n.a.	n.a.
Average support payment for onshore wind 2007 (excl. electricity price)	n.a.	n.a.	38.3 €ct/kWh	29.3 €ct/kWh	71.3-84.9 €ct/kWh
Research questions					
(1) Effect of electricity market prices on RES-E generator's revenues	None	None	Full	Limited	Full
(2) Responsibilty for market integration	TSO	utility	RES-E producer		RES-E producer
(3) Responsibilty for forecasting and balancing	TSO	RES-E producers >10 MW: forecasting; low imbalance charges for deviations >20%; balancing: utility	RES-E producer		RES-E producer

	Germany	**Spain**			**UK**
RES-E support scheme	**feed-in tariffs**	**feed-in tariff option**	**feed-in premium option 2004**	**feed-in premium option 2007**	**quota obligation based on tradable green certificates**
Average imbalance costs for wind 2006 (2007)	not available; profile transformation costs for all RES-E, paid by TSO: 3.4-5.4 € per MWh_{RE}*	n.a. (1.5 €/MWh)	2.6 (1.4 €/MWh)		Not known
(4) Cost allocation for grid reinforcement	"shallow": no costs for RES-E producers	"shallowish": full distribution level costs, 20% transmission level costs for RES-E producers			"shallowish": full or partial distribution level costs, no transmission level costs (but liability) for RES-E producers
(5.1) Spot market price reduction per 1000 MW wind power in operation	1.89 €/MWh	2-3 €/MWh			so far not measurable
(5.2) Relevance of effect for RES-E producer	so far low; no relevance for RES-E producers	so far low; no relevance for RES-E producers	so far low; full relevance for RES-E producers	so far low; limited relevance for RES-E producers	so far none; in principle full relevance for RES-E producers

5.1. Pros and cons of market risk minimisation

RES-E support schemes are frequently compared under the aspect of risk minimisation for RES-E projects (e.g. Mitchell et al. 2006, Ragwitz et al. 2007). Mitchell et al. (2006) point out that risk reduction is an important way of increasing the effectiveness and efficiency of a support scheme, because lowering project risks reduces the costs of capital for the project developer and makes a larger number of projects attractive. They distinguish more precisely between price risk (RES-E electricity sales price), volume risk (limitation of sales volume) and balancing risk[10]. Mitchell et al. (2006) conclude that risk minimisation is the major reason why the German support system has been more effective and efficient than the British so far.

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[10] One can argue, however, that in the end all these risk translate to price risks: electricity price, ROC price risk, imbalance price risk.

This argument is supported by Ragwitz et al. (2007) that give quantitative evaluation of the efficiency of RES-E support in different European countries in 2004 and 2006[11] by comparing the effectiveness of the main support instrument (increase of electricity generation compared to the additional realisable mid-term potential to 2020) with the expected profit[12] of the RES-E generator. For onshore wind, the assessment by Ragwitz et al. (2007) clearly shows that the Spanish and German feed-in tariff schemes reach the highest effectiveness rates (in 2006 approx. 21% Spain, 16% Germany), despite relatively low expected producer profits (approx. 20 €/MWh in Spain, 7 € /MWh in Germany). This is explained by the low market risk. The Spanish feed-in premium option is found equally effective while providing higher profit margins (approx. 29 €/MWh in 2006), reflecting the higher market risks. In the same assessment, the UK quota system shows a low effectiveness rate for onshore wind (approx. 4%), despite high expected profits (approx. 69 €/MWh in 2006). This is correlated directly to high risk premiums for financing wind projects in the UK.

The comparison of types of policy instruments provides however only part of the picture. As the country analysis has shown, the market risk for RES-E generators does not only depend on the predominant support instrument, but also on balancing and grid regulations. The coverage of grid reinforcement or imbalance costs can be considered as indirect public support that is not included in most quantitative comparisons of support schemes. Furthermore, administrative barriers and other non-financial issues are a high influence on the producer risk (see also Ragwitz et al. 2007).

There is another important issue when comparing the efficiency of RES-E support policies. Exempting RES-E from market risk means that they will not respond to market price signals. They have no incentive for cost optimised operation with regard to market and system demand. The same is true for the grid infrastructure. If there are no locational price signals, RES-E projects have no incentive for locational efficiency with regard to the electricity grid. From the macroeconomic perspective on societal costs there are thus two opposing effects of market risk minimisation:

- efficiency gains due to lower risk premiums and lower required support payments
- efficiency losses due to reduced market response and less system optimised behaviour.

When assessing the second effect, it is also important to consider to what extent wind energy and other RES-E are able to respond to the respective market signals. In the following sections we will compare the exposure and response of wind power and biomass

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[11] An update for 2006 was provided within the Commission Staff Working Document SEC(2008) 57;

[12] According to Ragwitz et al. (2007), the profit was calculated as specific discounted average return on every kWh produced, taking into account income and expenditure of the entire lifetime of a technology.

technologies to the three types of market risks that have been investigated in the country case studies:

- price risks from forward electricity markets
- scheduling and imbalance price risks
- costs and risks associated with grid connection and grid reinforcement.

5.2. Exposure to price risks in forward electricity markets

5.2.1. Attribution of electricity market price risks

The interaction of the examined support schemes with electricity market prices is depicted by Figure IV-6. The price risk allocation can be summarised as follows:

- Fixed feed-in tariffs like in Germany and the regulated tariff option in Spain isolate RES-E generators from market prices and risks. Since the supplementary payment varies with market prices, consumers carry the price risk.
- Feed-in premiums like in Spain 2004-2006 (RD 436/2004) let RES-E generators face the full market price risk and give them incentives to adjust their operation to market demand. They may also lead to high RES-E profits that can endanger political acceptance. Potentially they could also result in low profits that could endanger the project profitability, although in Spain this risk is limited through the fallback option of the fixed feed-in tariff.
- Bounded feed-in premiums like in Spain since 2007 (RD 661/2007) adjust the bonus during project lifetime according to market prices by giving a lower floor or an upper cap. They expose the RES-E generator to market price signals, but limit both price risks and profit margins.
- Quota schemes expose the RES-E generators to two independent market price risks, the electricity price risk and the certificate price risk. With regard to electricity market integration, they have the same characteristics as a feed-in premium scheme.

The exposure to market price risks favours large RES-E producers that can hedge these risks effectively. Independent producers need to close PPAs with utilities or other intermediaries. This will require higher revenues to make their projects profitable. If network operators are obliged to buy the produced RES-E at a fixed tariff, the direct support level will be structurally lower, since it does not need to cover a risk premium for the market price risk. On the other hand, the feed-in tariff scheme isolates RES-E producers from the electricity market.

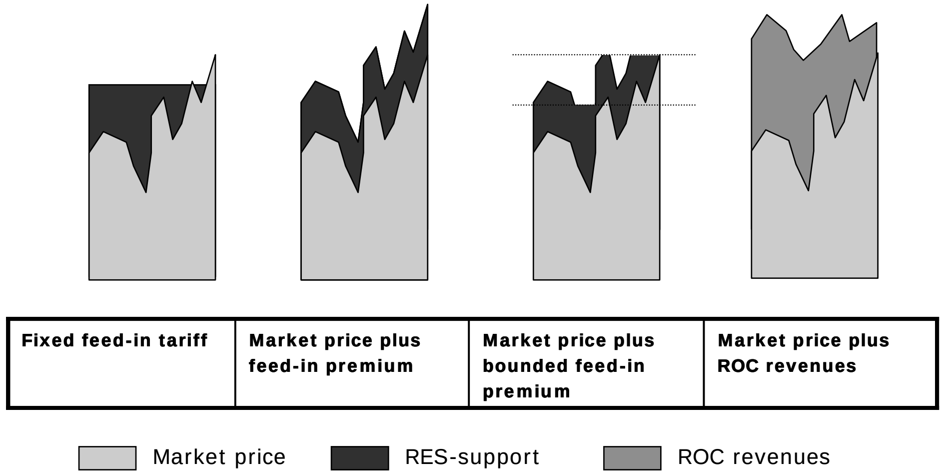

Figure IV-6. Role of market prices in different support schemes

5.2.2. Response of RES-E to electricity market price signals

As discussed earlier, wind power plants have zero fuel costs and very low operational cost, but cannot influence the availability of their fluctuating source. Whenever their source is available, they will be inclined to feed their full production into the grid. In fact, this behaviour is promoted by all the examined support schemes, since the support payment is paid per produced kWh, and thus the production revenues are above zero even if market prices are close to zero. Wind power operators will therefore hardly react to electricity price signals, except in the scheduling of their maintenance periods. This would change, if “negative” market prices (i.e. penalties for over-feeding the system) were applied, or if support payments were organised in a more flexible way.

On the other hand, biomass and other RES-E with certain fuel costs and/or storage capacity will adjust their operation to market price signals, at least to some extent, depending on their ability to adjust operation in a flexible way (storage of biogas or other primary energy).

5.2.3. Future challenges

At high RES-E penetration rates, the characteristics of wind energy may lead to new market price challenges. In power markets with high wind concentrations, market prices will erode whenever wind feed-in is high. Currently, this effect is of limited relevance in most countries (Denmark is a notable exception). In the future, it may threaten the profitability of wind power plants in case they are exposed to market prices and the support scheme does not recognise the level of their revenues. Even if they close a power purchase agreement with an intermediary, this effect may still become relevant, because the value of the PPA will be estimated on the basis of market prices, and the intermediaries will anticipate the price decrease. Under a fixed feed-in tariff regime, this price risk will be transferred to consumers. Under a quota scheme, structurally higher certificate prices can be expected. Under a premium scheme, the premium would have to be adapted to keep projects profitable.

On the other hand, the increased use of wind energy will also lead to a devaluation of existing conventional power plants due to decreasing full-load hours. A cost-efficient structure of conventional power plants will reflect the impacts of renewable energies in the system. If the increased shares of renewables and the adjustment of the structure of conventional power plants do not happen at the same pace, the market may react with extreme prices. Capacity payments may help the market to adjust the power system to provide appropriate amounts of flexible (backup) capacity.

Options to limit the spot price effect of wind energy could be a better interconnection of European power markets, which would decrease the effect by delivering electricity to other power markets with less low-cost electricity supply, or an effective demand side management that increases electricity demand in times of high wind power penetration, e.g. by utilizing certain electric appliances mainly during these hours. The latter option is already used in Denmark. Table IV-5 summarises the RES-E price risks and response in forward markets.

Table IV-5. Summary: forward market price risk and response of RES-E

	Germany	**Spain**			**UK**
RES-E support scheme	**feed-in tariffs**	**feed-in tariff option**	**feed-in premium option 2004**	**feed-in premium option 2007**	**Quota obligation based on tradable green certificates**
Expected profit for onshore wind 2006 (Ragwitz et al. 2007, update 2008)	approx. 0.7 €ct/kWh	approx. 2.0 €ct/kWh	approx. 2.9 €ct/kWh		approx. 6.9 €ct/kWh
Electricity market price risk	no price risk	no price risk	full risk	limited risk	full risk
Incentive to respond to market demand	(--)	(--)	(++)	(+)	(++)
Ability to respond to market price signals: wind	(-)				
Ability to respond to market price signals: biomass	(+)				
Future price risk for intermittent RES-E due to decreasing spot market prices	no risk	no risk	full risk	limited risk	full risk

5.3. Exposure to generation scheduling and imbalance settlement risks

5.3.1. Attribution of forecasting and balancing risks

The forecasting and balancing risk does not only depend on the support scheme, but also on general market regulations.

- In Germany, the forecasting and balancing of RES-E production supported under the feed-in tariff scheme is done by the TSO, therefore RES-E producers carry no balancing risk. In principle, central forecasting has the potential for high precision, but only if the TSO has an incentive to minimise costs. It remains a regulatory challenge to ensure a cost effective profile transformation.
- Under the Spanish feed-in tariff option, all RES-E generators are obliged to forecast their production, but scheduling is done by the utility. The RES-E generators pay only very limited penalties for schedule deviations. This limits their risk to a low level, but still gives some incentive for accurate forecasting. Individual forecasting for the stochastic production of wind power is however not very reliable. Central forecasting is still done by the utility and the transmission network operator.
- Under the Spanish feed-in premium option, RES-E generators are fully responsible for scheduling their production and paying imbalance charges, but imbalance prices – and thus price risks for RES-E generators – are limited. Except for utilities that produce both RES-E and conventional power, wind power generators will tend to use intermediaries that will pool larger number of generators and hedge the balancing risk.
- In the UK, RES-E generators are fully balancing responsible and have to pay full imbalance charges. They thus carry the full balancing risk. Again, independent wind power producers benefit from intermediaries that forecast their generation, schedule the production and sell the electricity.

An individual forecasting obligation thus favours large players and strengthens the role of intermediaries, because the forecasting quality improves with the number of forecasted generators. It also guarantees smooth system integration, because the wind power producers or their intermediaries will adjust their schedule during the day and delivery and thus minimise imbalance costs. Competitive intraday and balancing service markets are a precondition for the efficient integration.

5.3.2. Response of RES-E to imbalance price signals

The predictability of wind is limited. It becomes more accurate the shorter the time period to actual delivery. The availability of intraday markets and a late gate closure for schedule adjustments thus improve the market response of wind energy and lower the individual imbalance costs of the wind power operator. Nevertheless, the stochastic generation profile of wind power needs to be combined with other flexible power units.

Biomass technologies face no significant problems when scheduling their generation, and they also do not require other balancing requirements than conventional producers. Thus, balancing issues are of low relevance for biomass technologies.

Table IV-6 summarises the RES-E price risks and response in forward markets.

Table IV-6. Summary: imbalance price risk and response of RES-E

	Germany	**Spain**			**UK**
RES-E support scheme	**Feed-in tariffs**	**feed-in tariff option**	**feed-in premium option 2004**	**feed-in premium option 2007**	**quota obligation based on tradable green certificates**
Imbalance charges for RES-E generator	None	RES-E producers <10 MW: none; RES-E producers >10MW: limited imbalance charges	full imbalance charges, but price limitations		full imbalance charges
Price risk from forecasting and balancing RES-E	None	low risk	medium risk (full risk, but limited for all market players)		high risk
Incentive for RES-E generators to adjust schedules to improved forecasts	(-) / n.a. (forecasting by TSO)	(+)	(++)		(++)
Ability to respond to imbalance price signals: wind	(-)				
Ability to respond to imbalance price signals: biomass	(+)				

5.3.3. Future challenges

New challenges arise at high concentrations of wind power plants, at least in regions with strongly fluctuating wind occurrence and steep wind gradients. Since almost all wind power plants will influence the system imbalance in the same direction (e.g. in the case of a sudden wind calm), system imbalance may increase to a high level in the case of unpredicted wind conditions, and possibly even create challenges for system stability. In such situations, the imbalance cost for wind energy projects may become very high, even under competitive conditions. Imbalance costs thus pose a high end barrier to wind power development, if the wind power projects are fully exposed to this price risk. Across Europe there are intense regulatory and technical discussions on adequate answers to these problems (e.g. balancing across control zone, incentives for additional regulation reserve, advanced support schemes that promote system adequacy, etc.).

5.4. Exposure to grid connection and system planning risks

5.4.1. Attribution of grid connection and system planning risks

Lengthy and untransparent administrative procedures for grid connection are often the highest entrance barrier to RES-E development. Examples of such barriers are the intransparent grid connection negotiation process in Spain and the limited validity of grid connection offers in the UK. In Germany, the guaranteed grid access coupled with relatively smooth administrative procedures has been one major factor for rapid market growth.

Grid connection is also a financial issue for RES-E projects, especially if the integration of RES-E plants requires grid reinforcement. The allocation of grid connection charges influences project profitability as well as the spatial allocation of generators.

- Under “shallow” grid connection charges like in Germany, only the costs of the physical connection to the nearest grid connection point have to be carried by the RES-E project; upstream reinforcement costs are split among all network users. This approach minimises the costs for the project developer, but gives no incentive to consider grid requirements in the choice of plant location.
- Under “deep” connection charges, as formerly applied in the UK, upstream reinforcement costs are to be carried by the RES-E project. This gives an incentive to minimise grid reinforcement costs, but burdens high costs on the project developer.
- Under “shallowish” connection charges like in Spain and now in the UK, only a certain share of grid reinforcement costs has to be carried by the RES-E project. This approach is partly cost-reflective and limits development risk, if the share of the reinforcement costs to be borne by the project is fixed in time. If the process to determine these costs is intransparent like in Spain, or if financial liabilities considerably exceed the actual cost share like in the UK, the hindrance to the project development may be more significant than the overall cost benefit.

Cost reflective behaviour of the project developer will limit the necessary grid reinforcement and minimise the additional costs for the electricity system. On the other hand, from a macroeconomic perspective, grid reinforcement costs will be lower if assigned to the system operator, because the RES-E project developers will have to pay higher cost of capital than the TSO.

5.4.2. Response of RES-E to locational price signals regarding system planning

Most RES-E technologies are decentralised generation technologies that depend on the availability of their source at the site of RES-E production. The network integration of RES-E may require reinforcement of the electricity system that was designed for central fossil power plants and not for distributed generation. In this respect wind energy poses a special challenge, since sites with high wind yields are often located in weak grid environments. If RES-E projects have to pay part of the related gird reinforcement costs, this will give them an incentive to choose a plant location that requires minimum grid reinforcement. Depending on the respective grid infrastructure, however, this choice is often limited. The project developer needs to balance the reinforcement costs against the conditions of an alternative site with better grid conditions. A major criterion for the site selection is the availability of the wind source. If distribution grid reinforcements are concerned, there is some potential for locational optimisation. On the other hand, if transmission grid reinforcements are required, their costs may become a prohibitive barrier to RES-E development in a whole region.

Biomass technologies pose less of a challenge to grid integration, but they also exhibit limited flexibility in adjusting their location to grid requirements (e.g. agricultural biogas plants are bound to their farm environment; large plants with external feed are more flexible).

5.4.3. Future challenges

If the ambitious European RES-E deployment targets are to be met, adaptations of the network infrastructure are unavoidable to integrate large shares of wind power. It seems reasonable to minimise the related costs by locational price signals, but full cost coverage of necessary grid extensions by the RES-E projects could prevent substantial market growth. Alternatively, high costs for RES-E projects would need to be compensated by high support payments. Thus, the adaptation of grid infrastructure required to integrate large shares of wind power will, in any case, require a proportion of public financing.

The long lead times of transmission grid reinforcements remain a critical obstacle for RES-E generators, even if reinforcement costs are carried by consumers. The political challenge is to speed up the required infrastructure projects, and, in the meantime, to implement efficient mechanisms for congestion management that do not endanger the profitability of RES-E plants.

Table IV-7 summarises the locational price risk and response.

Table IV-7. Summary: locational price risk and response of RES-E

	Germany	Spain	UK
Grid connection charging	"shallow": no grid extension charges for RES-E producers	"shallowish": full distribution level costs, 20% transmission level costs for RES-E producers	"shallowish": full or partial distribution level costs, no transmission level costs (but liability) for RES-E producers
Incentive for locational optimization	(-)	(+)	(+)
Ability to respond to locational price signals: wind	(+) distribution grid; (-) tramsmission grid		
Ability to respond to locational price signals: biomass	(+-)		
Further transmission grid reinforcement required	Yes	Yes	Yes

5.5. Which market integration approach seems suitable under which conditions?

There is no straight forward answer to what extent RES-E should be assigned market risks. There is a trade-off between higher risk premiums in the case of market risk exposures on the one side, and lower risk premiums but additional regulatory challenges on the other side. The right choice strongly depends on the level of RES-E penetration, the competitiveness of the respective market and the goal of the policy maker. At low rates of RES-E penetration the integration challenge is not significant and the cost reflective behaviour of RES-E of less importance than if RES-E hold a significant share in the electricity system. If the goal is to effectively introduce renewable energies to a market in a short period of time, it seems appropriate to minimise their risks and system responsibility. This approach will also minimise the level of support payments required to make RES-E projects profitable, but will require a high level of state regulation. If RES-E shares are higher and their impact on the system becomes more relevant, it seems justified to burden more responsibility and risks on RES-E projects in order to give them an incentive for cost reflective market behaviour. A precondition should be that the respective markets are mature and competitive. Furthermore, policy makers should consider the ability of different RES-E technologies to react to these market signals, i.e. to adjust their operation according to market prices, to minimise their schedule deviations, and to avoid grid reinforcements. Without such ability, the exposure of RES-E to market signals will hardly lead to cost benefits for society. In this case, alternative regulatory incentives for efficient market integration should be considered.

Looking at the three examined countries under this perspective, some draft policy recommendations can be derived.

In Germany, the increasing RES-E share may allow for a direct electricity market participation of larger RES-E projects. The currently discussed introduction of a feed-in premium option could thus be a good step towards further market integration of RES-E, but introduces the problem of over- and under-compensation. On the other hand, the low liquidity of the German balancing service market might decrease the efficiency of market integration. Thus, integration policies should not only focus on renewables but also on increasing the competitiveness of the markets. An option to improve the efficiency of market integration under the feed-in tariff scheme could be an optimised design of the profile transformation mechanism, i.e. incentives for cost-efficient profile transformation. Different options are discussed in the course of the Renewable Energy Sources Act amendment 2009. Regarding system planning, the switch to a partly shallowish regime could help to control grid reinforcement costs on distribution level.

Spain follows a dual approach to RES-E market integration: generators can choose between low and almost full responsibility. For taking more responsibility and risks, they are awarded higher profit margins, but price risks in the forward electricity and the balancing market are still limited by upper and lower boundaries. There are, however, possibilities to improve the cost efficiency of wind power support, considering the good Spanish wind conditions and the relatively high financial support level (the fixed tariff and the minimum support level under the flexible option are considerably higher than the average remuneration for good wind sites in Germany). Furthermore, improvements could be made regarding grid connection procedures and allocation of grid reinforcement costs. The shallowish approach seems generally justified, but its transparency should be increased.

Considering the relatively small market share of RES-E in the UK, RES-E generators are exposed to very high risks, both in the electricity market and the support scheme. In order to reduce these risks for smaller RES-E projects, the introduction of long term power-purchase agreements could be considered (Johnston et al. 2007). Adjusted balancing regulations, e.g. introducing upper ceilings to the imbalance market price, could limit the risks for wind energy. Also, it seems appropriate to further adjust grid connection procedures, e.g. to prolong the validity of grid connection offers (as already started in 2007), and to decrease liabilities for grid reinforcement.

Looking at the broader picture of the European Union, there are many countries with a low RES-E share. A general recommendation for developing the RES-E markets of these countries is not to burden the full market and grid connection risk on the RES-E generators from the beginning, but to start with a limited risk approach. This will also allow smaller and independent RES-E producers to enter the electricity market. Particularly in the wind energy sector a high risk approach clearly favours large and well established power producers, since fluctuating RES-E are confronted with higher market risks than other power producers.

These recommendations could be next steps from the current market perspective. On a medium timescale, if wind energy shares are becoming higher, more advanced policy instruments might be required to tackle the new price and balancing risks (i.e. the decreasing electricity market revenues in times of high wind feed-in and the risk of high imbalance costs), which could become a high-end barrier for wind energy development. How such policies could look in detail cannot be investigated here, but one might think of new types of power purchase agreements to hedge these risks (see e.g. Johnston et al. 2007). Furthermore, electricity market regulations might need to be adapted to the special characteristics of wind energy, in order to profit from this energy source in an optimal way.

6. Conclusions

The analysis has shown that there are contrasting approaches for integrating RES-E into electricity markets. In Germany, the full responsibility for electricity sales, balancing and grid integration of RES-E is transferred to the TSO, and related costs are passed to consumers. In Spain, RES-E generators can choose between full and partial responsibility for market integration of their produced electricity. In the UK, RES-E generators are fully responsible. No matter what approach is chosen, RES-E is physically integrated into the market and will influence its price level in forward and balancing markets.

In all three fields of analysis, there are trade-offs between a “high risk” and a “low risk” approach:

- Price risks in forward electricity markets: The exposure to price risks will lead to higher risk premiums for the RES-E generator than the isolation from price risks. It will, however, also lead to a better match of supply and demand, if RES-E generators are capable of scheduling their generation according to market prices. Wind power plants will hardly react to such price signals.
- Forecasting and balancing risks: Central forecasting of RES-E production by the TSO has the potential for high precision, but only if the TSO has an incentive to minimise costs. It remains a regulatory challenge to ensure a cost effective profile transformation. If RES-E generators are responsible for balancing their generation, it is an incentive to RES-E producers to minimise imbalance costs. On the other hand, such an approach leads to higher risk premiums for smaller RES-E producers and possibly to a market concentration of larger players in the wind power market, since the forecasting quality improves with the number of forecasted generators.
- Grid connection and system planning risks: The allocation of grid reinforcement costs to the project developer will lead to cost reflective behaviour, limit the necessary grid reinforcement and minimise the additional costs for the electricity system. On the other hand, given the current structure of the electricity grid that is not prepared for large scale RES-E integration, these costs can become a high barrier for further RES-E deployment, especially in the wind energy sector.

From a policy maker’s perspective, the assignment of market risks to RES-E projects is thus a two-sided issue. Compared to a minimum risk approach, higher market risks increase the project costs for RES-E generators. Consequently, a higher level of financial support is required to stimulate RES-E development. In contrast, the exposure to market risks may also give an incentive to RES-E generators to make efficient use of the respective market and act in a cost-reflective way, thus limiting the indirect costs to society. If RES-E generators are not exposed to market risks, the regulatory challenge arises how to organise central market integration (mostly by the TSO) in a cost efficient way. Without incentives for efficient integration and respective control mechanisms, the indirect costs to society might be higher than necessary.

The special characteristics of wind power will increasingly influence forward markets, balancing markets, and system planning requirements. They also set natural limits to the response of wind power to market prices and locational price signals. For this reason, policy makers should consider with care to what extent wind power and other RES-E should be exposed to such price risks. Wind and solar energy seem more critical in this respect than other RES-E technologies. The attribution of market risks should be based on a number of parameters: the share and structure of renewables in the system, the specific regulatory framework of the electricity market, and on the competitiveness of the electricity market. In any case it is clear that in order to integrate large shares of wind energy into the system, electricity grids and market regulations will also need to be adapted to the new generation characteristics.

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V. The evolution of flexibility mechanisms for achieving European renewable energy targets 2020–ex-ante evaluation of the principle mechanisms[1]

Abstract

In December 2008, the European Council and the European Parliament agreed on a final compromise for a new European renewable energy directive. One of the most debated issues prior to this compromise was the design of “target flexibility mechanisms”, which should allow member states with low or expensive renewable energy potential to partly fulfil their national renewable energy target in other countries. This article traces back the political discussion that has led to the evolution of the different flexibility options. It then evaluates the most prominent flexibility mechanisms against a set of qualitative criteria. It concludes that free or restricted certificate trade based on guarantees of origin (GOs) – as proposed earlier by the European Commission – is not a viable option due to some “knockout” criteria, despite other potential advantages. The mechanisms that have replaced GO trade in the final compromise – joint projects, joint support schemes and statistical transfer between member states – provide less flexibility, but score better against a number of other important criteria. The crucial question for the coming years is how their utilisation can be facilitated. One first step might be that proactive member states define open design issues for implementing the mechanisms.

1. Introduction

In January 2008 the European Commission proposed a new EU directive on the promotion of the use of renewable energy sources (RES) (COM 2008a). It sets binding targets for all EU member states to reach the overall target of 20% RES share in EU energy consumption by 2020, as agreed upon by the European Council in March 2007. The Commission’s proposal was debated throughout the year 2008. In December 2008 the European Parliament and the European Council reached a final agreement on an amendment text for the RES directive, clearing the way for the formal approval and implementation of the directive in 2009-2010. One of the controversial issues before the adoption of the final compromise was the issue of RES “target flexibility”, i.e. the question how to virtually exchange renewable energy – mainly meaning renewable electricity – across member state borders in order to create more flexibility in reaching national RES targets. This question

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[1] This article was published in Energy Policy, Volume 37(11), Klessmann, C., The evolution of flexibility mechanisms for achieving European renewable energy targets 2020–ex-ante evaluation of the principle mechanisms, pages 4966–4979, Copyright Elsevier (2009).

had been debated even more fiercely in 2007, in the months before the Commission published its proposal.

Different target flexibility mechanisms have been proposed to allow member states with low or expensive RES potential to partly fulfil their RES target in other countries with higher RES potential and lower production costs. All of these mechanisms were meant to complement national RES support schemes, not to replace them. Early, unofficial drafts by the Commission foresaw a mandatory RES certificate trading system between private parties based on Guarantees of Origin (GOs) (COM 2007). Within this system, the GO obtains a new function: it becomes a tradable green certificate that would account for the compliance with RES targets. So far, GOs are not used for target compliance. They serve for the disclosure of the electricity supply mix and for the supply of green electricity in the voluntary market, as defined in the European directive 2001/77/EC.

The Commission proposal from January 2008 introduced a more moderate form of flexibility: Member state governments are obliged to install a GO trade system between private parties, but may restrict this system by certain non-discriminatory criteria. Furthermore, private GO trade is complemented by GO trade between governments. The European Parliament, several member state governments and most RES industry associations criticised the proposed private GO trade (e.g. Turmes 2008, BMU 2008, EREC 2008). Other stakeholders – mainly large utilities and energy traders – defended the idea of European GO trade and called for less trade restrictions (e.g. Eurelectric 2008). The European Parliament and the European Council came forward with own amendments on the Commission’s proposal. The final compromise of the trilogue negotiations between the European Council, the European Parliament and the European Commission rejects the concept of GO trade for target flexibility. Instead, it allows statistical renewable energy transfer between member states. Furthermore, new types of flexibility mechanisms are introduced: so called “joint projects” and “joint support schemes”. Joint projects are project-based agreements between two or more Member State governments, defining that the renewable energy production of a new RES installation in one country will fully or partly count towards the RES target of another country (most likely because this country provides financial support to the installation, although this is not explicitly stated in the text). In the case of joint support schemes, member states join or coordinate their support schemes and (virtually) split the produced renewable energy for target compliance.

What are the strengths and weaknesses of the different flexibility mechanisms? Up to now, the variety of options has not been evaluated systematically. The mechanism that has received the most analytical attention is GO trade between private parties (e.g. Klessmann et al. 2007, de Jager 2007, Toke 2008). Neuhoff et al. (2008) and Ragwitz et al. (2008) evaluate and compare the two flexibility mechanisms proposed in the Commission draft – GO trade between private parties and GO trade between member state governments. Statistical transfer between governments has not been evaluated autonomously, but follows the same principle as GO transfer between governments. The joint project mechanism has not been evaluated at all so far. Options for coordinating or harmonising support schemes have been investigated earlier (e.g. by Ragwitz et al. 2007a), but not in the specific context of target flexibility.

This article aims to evaluate the different flexibility mechanisms proposed during the flexibility debate and derive their specific strengths and weaknesses. The evaluation criteria will be criteria that are commonly used for evaluating environmental policies (e.g. Höhne 2006, Gupta et al. 2007): effectiveness and cost-effectiveness, in conjunction with political and technical criteria. Focus will be on their use for RES electricity, but RES heat installations are included in principle.

First, in order to provide a thorough understanding of this debate, the political discussions that have led to the evolution of the different flexibility options are traced back. The most prominent flexibility mechanisms are then qualitatively evaluated against the above mentioned criteria. Since none of the flexibility mechanisms has been implemented yet, this evaluation will be ex-ante, facing a number of uncertainties regarding the final design of the discussed flexibility mechanisms. To account for these uncertainties, the article indicates open design issues that would need to be tackled when implementing the flexibility mechanisms. Based on the evaluation, conclusions are drawn on the expected performance of the different flexibility mechanisms and on future key issues for their implementation.

The article only examines flexibility mechanisms for RES target achievement; the discussion on GOs for disclosure and the voluntary market for RES certificates is left aside.

2. Wrap-up of the political discussion and proposals for target flexibility

2.1. Background: The policy debate prior to the publication of the draft directive

In March 2007 the European Council agreed on a binding target of 20% RES share in final energy consumption 2020. In order to reach this target, the European Commission was asked to draft a new directive on the promotion of the use of RES. It was announced that a key element of the directive would be a breakdown of the overall 20% target into binding national RES targets for all member states. The Commission decided to base the target sharing between member states not on the RES potential of each member state, but on a flat rate increase of RES share per member state, modulated by the member state’s GDP. Such a target sharing approach does not reflect the resource availability of the member states; e.g. the countries facing the Atlantic or the North Sea have much higher wind resource potential than the countries with no coastline; some small countries (e.g. Luxemburg) have a high GDP but very limited RES potential, etc. Therefore, member states with low or expensive RES potential should receive the opportunity to fulfil part of their national RES target in other member states with higher and cheaper RES potential (“target flexibility”). A political discussion started how such transfer could be organised in a fair and transparent way. It should be noted that this discussion only focused on the virtual transfer of renewable energy for RES target accounting. The physical trade of the produced electricity would not, or only indirectly, be affected by such a virtual transfer system. Furthermore, none of the discussed flexibility mechanisms aimed to replace national RES support schemes. Instead, the mechanisms should complement national support schemes by providing additional options for virtual cross-border transfer of renewable energy.

The early, unofficial drafts by the Commission in late summer 2007 foresaw a system of GO trade between private market actors, similar to the GO trade system proposed by RECS International (RECS International 2007). GOs were originally introduced in the European directive 2001/77/EC. They are standardised certificates that are issued on request to certify the green origin of renewable electricity and can be transferred independently of the produced electricity. From the trading perspective, this is a great advantage, because the physical flow of electricity cannot be followed and the interconnection of European electricity markets is limited. So far, the GO mainly serves for disclosure of the electricity supply mix and for labelling the supply of green electricity in the voluntary market. Within the GO trade system proposed by the Commission, the GO should obtain a new function: it should be used as tradable certificate that accounts for the compliance with national RES targets under the new RES directive. To facilitate such trade, the Commission proposal required a mandatory opening of national support schemes for foreign renewable energy production, meaning that a renewable energy generator could choose if it wanted to be supported by the national support scheme of its own country or by a foreign, presumably more favourable support scheme. This mandatory opening was justified by the argument that private market actors would have the flexibility to develop additional low-cost RES projects in other European countries. Proponents expected that this would allow the use of least-cost RES potentials in Europe, create additional RES market dynamics, and lead to lower overall costs for reaching the European RES targets than a continuation of purely national RES support systems. In contrast, the GO trade proposal was heavily criticized by a number of stakeholders - especially some national governments and the RES industry associations – for destabilising national support schemes. They argued that the GO trade system would create a uniform European GO price that would decrease the cost-effectiveness of technology-specific support, in particular feed-in tariff or premium schemes (see section 4.2.2).

They predicted that the GO trade system would create high producer surpluses for low-cost renewable energy, thus increasing the overall costs to reach the European RES target. Furthermore, they expected that only large actors would profit from the trading scheme, due to its high transactions costs. They claimed that only member states should be allowed to exchange renewable energy for target compliance (“RES transfer between member states”), in order to safeguard their national support schemes and control their domestic RES potential. Under such a member state flexibility regime, private parties would not be able trade RES for target compliance. RES installations would be bound to the support scheme of the country in which they are installed.

It followed a fierce debate on how RES target flexibility should be organised (see e.g. EREC 2007, EURELECTRIC et al. 2007). The main arguments of this discussion will be reflected in the evaluation of flexibility mechanisms in section 4 .

2.2. The European Commission’s proposal

The RES directive proposal which the Commission presented in January 2008 foresees two types of flexibility mechanisms:

a) Exchange of GOs between member states
b) GO trade between (legal) persons in different member states, i.e. trade between private parties

For both GO trade options, certain restrictions are introduced. Under option a), only those member states whose RES share equalled or exceeded the interim target of the preceding two-year period are allowed to transfer GOs to another member state. For option b), several provisions are defined:

- Only those RES installations are allowed to transfer GOs that haven been commissioned after the entry into force of the directive. This means that the renewable energy production from already existing installations is excluded from trading. The aim of the exclusion of existing installations is to avoid interference with support that was already granted to existing installations and to avoid overcompensation of renewable energy producers.
- A renewable energy producer can choose to profit from the main support scheme of another member state, i.e. to receive feed-in tariff payments, premium payments, tax reductions or payments resulting from calls for tenders, or quota schemes. In this case all future RES production of that RES installation has to be supported under the chosen support scheme. The GOs are counted towards the target of the member state that provides the financial support.
- GOs that are not financially supported by any of the above mentioned support schemes can be transferred and used for the disclosure of a RES share in the energy mix of a supplier or consumer. The GOs count towards the target of the member state in which the respective energy mix is consumed.
- Member states may introduce a system of prior authorization to control GO trade, if the trading scheme is likely to impair their security of supply, the environmental objectives of their support scheme or the ability to comply with their national RES targets. This system should not, however, be discriminatory.

In summary, the Commission’s proposal introduces the option of “private GO trade” and “GO transfer between member states” in parallel, both restricted by certain framework conditions. While the GO transfer between member states is optional, private GO trade is introduced as common standard for the EU, but the “system of prior authorisation” might allow member states to restrict trade. According to COM (2008b) such a system would even allow member states to opt-out of the trade system completely. A key question in order to judge the impact of private GO trade would thus be how such systems of prior authorisation could look in practice.

2.3. Main lines of criticism against the Commission's flexibility proposal

The European Commission's proposal was criticized both by opponents and supporters of private GO trade. While their opinions and concepts for amendments differed strongly, there was wide agreement on one issue: both sides questioned if the "prior authorisation" clause would be legally sound (e.g. Poschmann 2008, Neuhoff et al. 2008, RECS International 2008). The argument goes as follows. Since the Commission's proposal defines GOs as tradable good[2], the principle of "free movement of goods" applies (article 28 of the European Community Treaty). A system of prior authorisation, i.e. the introduction of trade restrictions, could thus infringe Article 28. Possibly, such trade restrictions would be permitted insofar as the justifying reason explicitly laid down in the directive could not be achieved by measures less restrictive of trade (see Neuhoff et al. 2008). On the contrary, EFET (2008) and RECS (2008) do not see any sufficient legal basis for such trade restrictions. Due to this legal controversy, the legitimacy of trade restrictions could be brought in front of the European Court of Justice. This situation would create temporary legal uncertainty, no matter how the court would finally rule.

Further concerns were raised regarding the applicability of the proposed terms that allow for trade restriction, particularly by the German government. BMWi (2008) and BMU (2008) elaborate that such trade restrictions could only apply in exceptional cases and would not provide a means to effectively restrict or block trade. They thus expect that member states would have to open their support schemes, facing a strong increase in the cost of technology-specific feed-in tariff schemes (the same arguments against mandatory GO trade as laid down in section 2.1).

2.4. The proposal by the rapporteur of the European Parliament

The European Parliament needed to approve the draft RES directive. In May 2008, Claude Turmes, the Parliament's rapporteur for the RES directive, presented an amendment proposal to the Parliament (Turmes 2008a). After slight changes, the Parliament's Committee on Industry, Research and Energy (ITRE) approved the amendment proposal in September 2008 (Turmes 2008b).

Supporting the criticism of GO trade established above, the report criticises the Commission's proposal on GO trade for creating legal uncertainty and undermining national support schemes. Regarding the question of target flexibility, a number of amendments are suggested:

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[2] According to Fouquet (2008), GOs are no tradable good under the present directive 2001/77/EC, where they are clearly distinguished from tradable green certificates.

- In contrast to the Commission’s proposal, target accounting is fully based on energy statistics, not on GOs. Consequently, member states may transfer (i.e. buy or sell) renewable energy for target compliance on a statistical basis, not based on GOs as suggested by the Commission. The transfer of renewable energy is only allowed if the transferring (i.e. selling) member state exceeded its interim target of the preceding two-year period.
- For the purpose of RES transfer between (legal) persons, tradable transfer accounting certificates (TACs) are introduced. Such TACs may be issued and used by member states who want to set up a voluntary certificate trading scheme or a joint project mechanism for target flexibility. Compared to the Commission’s proposal, the TAC thus replaces the GO as certificate of target flexibility. The transfer of TACs is only allowed if the TAC-emitting member state has exceeded its interim target of the preceding two-year period.
- GOs are limited to their original disclosure function as foreseen in directive 2001/77/EC.
- Member states may agree on joint projects where “investor countries” support a RES project in a “host country” and statistically transfer renewable energy between the host country and themselves[3]. A member state may only become a host country if it has exceeded its preceding interim target.
- As an additional flexibility option, member states may agree on joint target compliance and establish joint cross-border support or open their support schemes for renewable energy from other member states.

In short, the amendment proposal by the rapporteur of the European Parliament takes up the main criticism against the GO trading scheme proposed by the Commission (see section 2.1 and 2.3) and proposes additional flexibility mechanisms for virtually exchanging renewable energy for target compliance. These mechanisms are partly based on statistical RES transfer and partly on TACs that replace GOs as tradable RES certificate for trade between private parties. This approach is justified by the concern that using GOs for RES transfer and target accounting would create legal problems (see section 2.3). By separating the function of GOs and TACs, and defining the transfer of certificates not as standard, but as voluntary “opt-in” system, the proposal tries to avoid the legal uncertainty regarding the restriction of “free movement of goods” created by the Commission’s proposal[4]. Even though the

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[3] In Turmes (2008a), this transfer could also be based on TACs. The final article on joint projects in Turmes (2008b) adopts the provisions proposed by Germany, Poland and the UK (Non-paper 2008, see next section).

[4] Nevertheless, it is the legal opinion of RECS (2008) that an opt-in trade system would be against the EU Treaty. These legal arguments cannot be judged here. It should be noted, however, that closed support schemes combined with voluntary trade systems already exist today and have not been legally challenged so far.

proposal includes trading between private parties, all transactions underlie the control of the government. Political emphasis is thus put on maintaining member states' sovereignty on national RES support schemes, and on (interim) target compliance as a precondition of participating in target flexibility mechanisms. Target compliance is further stimulated by mandatory interim targets and a direct penalty mechanism for non-compliance.

2.5. The joint proposal by Germany, Poland and the UK

In June 2008, a joint amendment proposal for the flexibility provisions of the draft RES directive was put forward by the governments of Germany, Poland and the UK. This proposal was circulated in the European Council as non-paper, i.e. as unofficial discussion document (Non-paper 2008). Since the proposal found support by further member states in the European Council, it became an important alternative to the Commission's proposal.

The document proposes some fundamental amendments to the GO trade regime proposed by the Commission. These amendments correspond in many but not all aspects to the proposal by Claude Turmes.

Key features of the proposed flexibility system are:

- Certificates are not used for RES target compliance purposes, neither in the form of GOs nor as TACs. Transfer of RES between member states for target compliance is solely based on statistical transfer notified to the Commission. The aim of this amendment is to reduce the administrative burden that would be created by a certificate system. GOs are not defined as tradable certificates, but serve for disclosure of green electricity and heat (installations > 5MW) in the voluntary market.
- Like in the Turmes proposal, all flexibility options are voluntary and directly controlled by the member states themselves. There are three forms of flexibility: statistical transfers between member states, joint projects, and the combination of national targets for the use of joint support schemes.
- Unlike the Turmes proposal, member states do not need to exceed their interim targets in order to participate in the different flexibility regimes. It is explained that this shall allow member states to plan ahead and enter into agreements as soon as the directive comes into force, without waiting to achieve their own interim targets and without risk that other member states will drop below their interim target and not be able to transfer renewable energy.

The flexibility option of joint projects is elaborated in more detail. In the explanatory note, they are described as "project-based agreements between two or more member states governments for an operator to build a renewable installation in one member state, and for the renewable energy generated by this project to count towards another member state's share of the target". In order to establish joint projects, the country hosting the project ("host member state") and the country investing and receiving the credits ("receiving member state") need to find an agreement on the conditions of their cooperation and notify the Commission on the terms of this agreement. In particular, the host member state shall describe the proposed installations, notify the Commission of the proportion or amount of energy which is counting towards the national target of the receiving member state, identify that member state, and specify the period during which the installation counts towards this member state's target. During this period, the host member state needs to issue a letter of notification at the end of each calendar year which states the total amount of renewable energy produced during that year, and the amount counting toward the target of the receiving member state. This share is deducted from the host member state's total, and added to the receiving member state's total. The related payments from the receiving country to the project operator and/or the host country are not specified.

In short, the joint proposal adopts the same types of flexibility mechanisms as the Turmes proposal, but abandons the concept of using certificates for target compliance purposes. Like Turmes, the proposal emphasises that member states will be in control of all flexibility mechanisms, but the participation in the flexibility mechanisms is not based on the condition that member states meet their interim targets.

2.6. The final compromise by the European Council and the European Parliament

In December 2008, the European Parliament and the European Council came to a final compromise on the RES directive (Council of the European Union, 2008). With regard to flexibility, this compromise strongly resembles the non-paper by Germany, Poland and the UK. As in the proposal by the three member states, GO trade is completely rejected and replaced by flexibility mechanisms based on the statistical transfer of renewable energy:

- Statistical transfer between member states
- Joint projects between member states
- Joint projects between member states and third countries[5]
- Joint support schemes

Complying with interim targets is not a precondition for transferring renewable energy, however it is stated that "statistical transfer shall not affect the achievement of the member state making the transfer".

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[5] These projects need to be accompanied by the physical transfer of energy. Under a different title, this option was already part of the Commission's proposal. Joint projects with third countries will not be further examined in this article, since the discussion of their additional advantages and drawbacks would open up a new discussion.

2.7. Summary of the flexibility mechanisms discussed

Summing up the proposals above, the flexibility discussion centred around seven types of flexibility mechanisms:

1. A GO trade system between private parties with a mandatory opening of all member states’ support systems for GO trade, as proposed by the Commission in the early phase of the flexibility discussion.
2. A European GO trading system between private parties which is mandatory for all member states, but can be restricted under certain conditions, as specified in the Commission proposal.
3. A voluntary certificate trading system which follows the same trading principles as the above mentioned GO trade, but uses TACs instead of GOs as certificates of trade, and does not force member states to participate in the scheme, as defined in the Turmes proposal.
4. GO transfer between member states, as proposed by the Commission proposal.
5. Statistical transfer of RES volumes between member states, as proposed by Turmes, the non-paper and the final compromise document.
6. A joint project mechanism that allows RES installations in one member state to be financially supported by other member states, but is controlled by the participating member states, as proposed in the non-paper, the Turmes proposal and the final compromise document.
7. Joint support schemes between several member states, as defined in the Turmes proposal, the non-paper and the final compromise document.

The first two options which introduce mandatory rules for certificate trading did not find a majority, but will still be included in the evaluation in section 3 and 4, due to their importance for the overall flexibility discussion. The third, voluntary certificate trade option was also not included into the compromise, but could theoretically be implemented voluntarily between member states as part of a joint support scheme. For this reason, it will not be evaluated separately in section 3 and 4. Also the 4th option, GO transfer between member states, was not included in the compromise and will not be evaluated separately, since it strongly resembles statistical transfer between member states. The last three options have been adopted by the European Parliament and the European Council and will become part of the new RES directive. They will be included in the evaluation, since it is of special interest to understand their strengths and weaknesses.

Table V-1 summarises the flexibility mechanisms that will be evaluated in section 3 and 4.

Table V-1. Summary of flexibility mechanisms included in the evaluation

Use of mechanisms would be mandatory for member states		**Use of mechanisms is voluntary for member states**		
GO trade between private parties	GO trade with trade restrictions (“prior authorization”)	Joint projects	Joint support schemes	Statistical transfer between member states

3. Criteria for the evaluation of the different design options

Many criteria for assessing flexibility schemes have been implicitly mentioned in the last section. As a basis for qualitatively evaluating the different flexibility schemes in section 4, this section structures the evaluation criteria that evolved from the political discussion in a systematic way, distinguishing main-criteria and sub-criteria.

Four groups of criteria will be used for the evaluation of the different flexibility mechanisms:

- Effectiveness in reaching the national and European RES targets for 2020, determined by different sub-criteria
- Cost-effectiveness[6] (efficiency) of reaching these targets, determined by different sub-criteria
- Political criteria that need to be met to find wide political support for the proposed flexibility mechanisms
- Technical criteria that reflect to what extent the flexibility scheme can be smoothly operated in practice

These types of criteria are commonly used for evaluating environmental policies (e.g. Höhne 2006, Gupta et al. 2007, Ragwitz et al. 2007).

3.1. Effectiveness

The first and most important evaluation criterion for a flexibility mechanism is its effectiveness, i.e. that it should facilitate overall RES target achievement by allowing RES exchange within Europe. There are different aspects to this objective:

The political side of facilitating target achievement is to enable (or even force) member states to meet their national RES targets. This can be achieved by a combination of means:

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[6] Cost-effectiveness describes the extent to which a policy can achieve its objectives at a minimum cost to society (Gupta et al. 2007).

- Providing member states with flexibility options to use (low-cost) RES potentials in others member states for their own national RES targets.
- Leaving member states the possibility to develop their domestic RES potential by improving the design of their national support instruments.

An important additional criterion for facilitating that member states will meet their RES targets may be to provide meaningful penalties for the case that targets are not met. For instance, Turmes (2008b) foresaw direct financial penalties for non-complying member states, in contrast to the final compromise agreement by the European Council and the European Parliament. Such penalty provisions are part of the general target definition and not of the flexibility mechanisms, however. Since it is not possible to distinguish flexibility mechanisms by penalty provision, the penalty criterion is not included in the evaluation in section 4.

The business side of facilitating RES target achievement is the provision of favourable investment conditions for RES installations, thus boosting the RES market in Europe. Framework conditions for a dynamic RES market development are

- Creating new market opportunities for RES producers.
- Providing stable conditions for RES investments; this can either be done within national support schemes or by a flexibility mechanism.
- Involving private market actors in the practical utilisation of the flexibility mechanism; private actors are usually more proactive in realising their benefits than governments.

3.2. Cost-effectiveness

The main economic evaluation criterion for flexibility mechanisms is their cost-effectiveness in reaching the European RES target for 2020.

One sub-criterion of cost-effectiveness is that the flexibility mechanisms help to develop untapped low-cost RES potentials in Europe, which - compared to purely national target achievement – would potentially decrease the total costs of achieving the RES targets and thus also limit the required amount of financial incentives.

A long term aspect of cost-effectiveness is the promotion of the early development of RES technologies needed on the medium or long term. If such technological options are not developed in time, they might not be commercially available or very expensive when needed later on (Ragwitz et al., 2007a). An example of such a technology is geothermal electricity, which is hardly used in Europe so far, but holds a promising potential for the future. Such long-term strategy is of special relevance for the future RES development beyond 2020, but might also play a role in reaching the 2020 target.

Another aspect of cost-effectiveness is the influence of the flexibility mechanisms on the cost-effectiveness of national support instruments, which determines the RES support costs for the member states. One sub-criterion of cost-effectiveness could thus be that a flexibility mechanism should not decrease the cost-effectiveness of national support schemes. On the other hand, it is clear that – depending on the available domestic potential - the use of any flexibility mechanism could influence the support costs paid within national support schemes, since part of the (low-cost) member state's domestic RES potential is used by other member states. This could lead to a decreasing cost-effectiveness of the national support scheme, but this effect might be intended as long as it leads to a reduction of EU-wide costs. A suitable criterion might therefore be that the flexibility mechanism should not have a negative effect on the cost-effectiveness of national support schemes that is not offset by a positive effect elsewhere.

3.3. Political criteria

A number of political criteria need to be met to find wide political support for the proposed flexibility mechanisms.

One major political criterion defended by the European member states is their sovereignty on their national RES policy, i.e.

- To decide upon the design of their national RES support schemes,
- To control which RES installations are supported by their national support scheme, and
- To control the use of their national RES potentials (even though some limits are set by the rules of the European internal market).

The political sovereignty of the member states is justified by the subsidiarity principle of the EU. In the case of the RES directive, it is further spurred by the Commission's approach to define binding national RES targets, which requires the member states to define national support policies to meet these targets.

The European Commission advocates criteria for achieving an internal European market, which conflicts to some extent with the member states' urge for sovereignty. Realising a single European market is one of the broadly accepted aims of the European Union. This target is partly explained by the institutional goal to increase the unity of the European Union. It is further justified by the expectation that a single European market will provide economic benefits compared to several closed-up markets. Sub-criteria for realising an internal European market are:

- Reducing restriction to a single European market; it is politically controversial if this should only mean the European energy market or also a separate market for supported renewably energy[7].

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[7] Some stakeholders claim that closed support schemes as well as restrictions to a certificate trade system illegally restrict the internal market for renewable electricity (RECS 2008, EFET 2008, see above). Others believe that there should only be an internal market for electricity,

- Facilitating the mid- to long term harmonisation of national RES support instruments (even though the Commission acknowledges that it is “currently inappropriate” to harmonise European support schemes, see COM (2008d)).

A more general political criterion is the public acceptability of governmental policies. One component of public acceptability is the perceived fairness or equity of a policy. A key issue in this regard is to split of RES costs and benefits between the member state where the RES installation is located (host member state) and the member state that pays (most of) the financial support and receives (part of) the renewable energy production for its target (receiving member state). RES installations create some local costs and benefits that cannot be transferred to other member states.

Such local benefits for the host country comprise:

- Increased security of supply
- Environmental benefits (e.g. improved air quality)
- Local job creation
- CO_2 emission reduction benefits for the host country (less relevant under a harmonized European emission trading scheme)

Local costs and disadvantages for the host country may include:

- Increased costs to reach national targets due to “sell-out” of low cost potentials (this would depend on the available potentials and their cost curve)
- System integration costs (e.g. for RES electricity grid connection and possibly reinforcement, imbalance costs)
- Secondary support costs (e.g. tax incentives) that are paid to the RES installation by the host country
- Local acceptance problems (“Not in my backyard” opposition)

If a member state supports a RES installation in another member state, it may miss out on the local benefits. This seems only attractive if the price of the foreign renewable energy is lower than domestic renewable energy generation, if RES equipment from the receiving country is used (as a kind of export promotion), or if certain RES installations face acceptance problem in the receiving country.

From the perspective of the host country, the use of a flexibility mechanism, i.e. the “sale” of renewable energy production or projects to other member states, seems only attractive if the benefits (i.e. the sales price plus the local benefits) outweigh the local costs and disadvantages.

To be acceptable for both the host country and the receiving country, the flexibility mechanism needs to provide a split of costs and benefits that combines these two interests.

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not a separate internal market for renewable certificates; they interpret national support schemes as temporary tool to help renewables into the electricity market (Fouquet 2008).

Another issue determining public acceptability is the spending of public or consumer money on RES support. In order to be acceptable, the flexibility mechanism should avoid the over-compensation of supported RES installations.

3.4. Technical criteria

Technical criteria will be used to evaluate to what extent the flexibility scheme can be smoothly operated in practice.

One important criterion is that the flexibility mechanism should be easy to implement, i.e. that its implementation should not require complex rules and regulations.

Another technical criterion is transparency:

- The accounting system for RES target compliance and transfers should be transparent and fraud resistant, avoiding double counting of renewable energy production for different targets.
- The rules of the flexibility mechanism should be transparent to other member states and to private actors, e.g. RES project developers that can use the flexibility mechanism.

Furthermore, how legitimately robust the flexibility mechanism is, can be considered a technical criterion, meaning that it should not conflict with existing legislation.

4. Ex-ante evaluation of the flexibility proposals

This section will evaluate the proposed flexibility schemes against the criteria developed in section 3. This evaluation will be qualitative and ex-ante. Since none of the flexibility proposals has been put into practice, the evaluation will face the difficulty that few design details of the mechanisms are defined; such details could determine if a flexibility mechanism meets the evaluation criteria or not. Cases where the evaluation result is not clear will be indicated.

4.1. Evaluation against the sub-criteria for effectiveness

4.1.1. Enabling member states to meet their national RES targets

In principle, all flexibility mechanisms provide member states with the flexibility to access the RES potentials of other member states, but in different ways. The statistical transfer at member state level seems the least flexible, since a member state that wants to buy renewable energy shares for target compliance fully relies on the ability and willingness of other member states to develop their RES potentials beyond their own compliance. Even though there is an economic incentive to develop additional renewable energy and sell it to other member states, it is not certain that the member state governments would follow this economic logic in practice. If no country is willing or able to offer renewable energy in 2020, no flexibility is given. One way to avoid this problem could be that member states close early agreements, defining how much renewable energy will be transferred at what conditions in the target year.

With regard to target achievement, joint projects and joint support schemes can be seen as types of early agreements between member states. They provide more flexibility than ex-post transfer between member states, since the split of both RES support costs and consequent RES target accounting is agreed on between the member states beforehand. Flexibility remains low, however, if few member states are willing to participate in such joint mechanisms.

Mandatory certificate trading schemes provide high flexibility to access RES potentials in other member states, depending on the trade restrictions in place, but member states have little control which RES plants are supported by their support scheme.

Enabling member states to meet their national RES targets also means that the flexibility mechanism should allow member states to develop their domestic RES potential by increasing the effectiveness of their national support instruments. This would be possible under all voluntary flexibility instruments, but problematic under a mandatory, unrestricted trading regime, where member states would lose control of what domestic or foreign RES installations would profit from their support schemes. Furthermore, member states would not be able to control the use of their own domestic RES potentials, thus risking the sell-out of their low-cost potentials. In the case of a restricted trading regime, it would depend on the allowed restrictions to what extent such negative consequences could be avoided.

4.1.2. Facilitating dynamic RES market development

In order to be attractive for private market actors, new market opportunities need to be created by the flexibility mechanism. There is no definite answer which mechanism would best create such opportunities. For least-cost RES installations, the most opportunities would clearly be created under a mandatory GO trade system. On the other hand, such a system would be a disadvantage to more expensive technologies, at least if no technology banding were introduced. Furthermore, GO trade would favour large market players compared to small ones (see Ragwitz et al. 2008b). Transfer on member state level does not provide any new market opportunities to private actors. There could be an indirect positive effect, however, because the mechanism would give member states an incentive to improve their national support schemes. Joint support schemes and joint project mechanisms in principle do open up new market opportunities. To what extent depends on their effective design and on the number of member states that participate in the mechanism.

Stable conditions for RES investments can be achieved (1) by stable flexibility arrangements and (2) by robust (joint or national) support schemes that provide a reliable framework to finance RES investments.

In principle, all flexible mechanism can be designed in a stable way, but no design details are known so far. If joint projects are negotiated on a case-by-case basis, they provide less stable conditions than the other mechanisms. On the other hand, they could also be designed as stable framework agreement.

A mandatory, unrestricted GO trading system would endanger the stability of national support schemes and thus not fulfil the second criterion. According to Neuhoff et al. 2008 and Poschmann 2008, a restricted GO trading system would create legal uncertainty and thus also endanger the stability of national support systems (see section 2.3). The other mechanisms would hardly affect the stability of the underlying support schemes.

Another key element of facilitating dynamic RES market development is the involvement of private market actors into the flexibility mechanisms. If private market actors have an economic interest in using flexibility mechanisms, they usually push it more proactively than governments. Except for statistical transfer on member state level, all proposed flexibility mechanisms involve private market actors. With the exception of GO trade, all flexibility mechanisms need to be authorised or pre-defined by the member states before private actors can get involved. This could turn out to be a serious hurdle for using flexibility mechanisms: If governments do not take the first step, no additional market dynamics can be created.

4.2. Evaluation against the sub-criteria for cost-effectiveness

4.2.1. Use of low-cost RES potentials

The use of additional low-cost RES potentials would be stimulated most by a mandatory GO trading system, but also the joint project mechanism provides some incentive. Transfer between member states only provides an indirect incentive by creating new opportunities of income for countries with high RES potential. Joint support schemes would allow the access to low-cost RES potentials within their system boundaries. How many countries participate in such a system, and under what conditions, would thus be decisive.

None of the discussed flexibility schemes would help to develop medium- and long-term RES potentials in time. On the contrary, the basic concept of flexibility is to access existing low-cost potentials in other countries, rather than to domestically develop more expensive RES technologies that look promising on the long term. The development of such long-term potentials can be achieved by technology-specific national support schemes, however; in this regard, a mandatory, technology-neutral trading scheme would have a negative effect, as explained above.

4.2.2. Preserve the cost-effective design of national support schemes

The cost-effectiveness of national support schemes would not be affected directly by a pure member state exchange. It could be affected by the other voluntary flexibility schemes, but this effect would be under the control of the participating member states, who presumably would not agree to the mechanism if it outweighed other advantages. On the other hand, the cost-effectiveness of national support schemes would be seriously threatened by a mandatory trading regime, depending on the allowed trade restrictions and the overall trade design: If member states had to fully open their borders for technology-neutral GO trade, technology-specific support schemes would be affected in a negative way by a harmonised European GO price. This would be especially true for feed-in tariff or premium support systems. Assuming a medium technology-neutral GO price on the European market, the feed-in premiums would be lower than this harmonized European GO price for low-cost technologies, and higher for high-cost technologies (at least if tariffs were designed efficiently). As a result, low-cost technologies like onshore wind energy would have a high incentive to export from a country with feed-in system; high-cost technologies would have a high incentive to import to a country with feed-in system. In consequence, the GO trade system would lead to high producer surpluses, increase the overall support costs of the feed-in scheme, and thus decrease its cost-effectiveness (see Klessmann et al. 2007, Ragwitz et al. 2008b). Similarly, technology-neutral GO trade would have a negative effect on domestic quota schemes that use technology banding for technology differentiation (as e.g. planned in the UK). It can be expected that these negative effects would outweigh the positive economic effects of GO trade (see Resch et al. 2008)[8].

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[8] The existing quantitative assessments of a GO trading scheme on European level come to very contradictory results: While the Impact Assessment of the Commission (COM 2008a) expects cost savings of 8 billion Euros by 2020, Ragwitz et al. (2007b) expect a cost increase of up to 30 billion Euros per year by 2020. COM (2008a) does, however, not take into account the effect on national support schemes. Resch et al. (2008) consider negative and positive effects of trade. They calculate that – compared to the continuation of national policies - uniform certificate trade leads to lower additional generation costs in the order of 2 billion Euro per year by 2020, but at the same time to higher average support policy costs (i.e. consumer expenditures) in the order of 12 to 15 billion € per year (approx. 36 billion € average yearly consumer expenditures for new RES plant 2006 to 2020, compared to approx. 23 billion € in the case of improved national policies). None of the cited calculations, however, gives a full representation of a European GO trade system co-existing with national policies.

4.3. Evaluation against the political criteria

4.3.1. Preserving the sovereignty of member states on RES policy

As explained in section 3, member states have a strong interest to preserve their sovereignty on the design of their national RES support instruments. They also aim to control their national RES potentials, at least within the limits set by the rules of the European internal market. From a member state's point of view, a mandatory GO trade regime is therefore hardly acceptable, because it would endanger this sovereignty in both respects. Also a restricted European trade system limits the sovereignty to some extent; how much depends on the allowed restrictions and further design details. Statistical transfer between member states and joint projects give member states full sovereignty. In principle, this is also the case for joint support schemes. On the other hand, member states have to agree on a common support scheme design and share their RES potentials. This means that they voluntarily give up part of their national sovereignty for the sake of a coordinated approach.

4.3.2. Realising a single European market

One step to achieve an internal European market is to reduce restrictions to this market. For the evaluation it is important to differentiate between an internal market for electricity and an internal market for supported renewable energy. Since none of the investigated flexibility mechanisms directly affect the trade of electricity but only the virtual exchange of renewable energy, none of them reduces market barriers to the electricity market.

A European market for RES electricity so far only exists for non-supported RES electricity production. As long as national support schemes are closed, no trade of supported RES electricity takes place. This is criticised by some stakeholders, e.g. Eurelectric et al. 2007. A mandatory European GO trade system would push for a European market for supported renewable energy, but at the expense of national support schemes. The other flexibility schemes still would allow the maintaining of closed support schemes.

Another tool for realizing a single European market for renewable energy is the mid-term harmonisation of RES support schemes. The introduction of a mandatory GO trade system would strongly push towards an alignment of national support schemes to the trade system, and thus towards a harmonisation of support conditions. On the other hand, voluntary joints support schemes can also facilitate a stepwise harmonisation, if member states will indeed use this option. Joint projects and statistical transfer between member states do not give any direct incentive for harmonisation.

4.3.3. Public acceptability

To be publically acceptable in both the host country and the investing country, the flexibility mechanism needs to combine the interest of both countries. This can only be the case if both countries agree on common rules for the split of costs and benefits of the respective RES installations (see section 3.3). Furthermore, the flexibility mechanism should avoid the over-compensation of supported RES installations.

In the case of GO trade between private parties, the transfer of renewable energy is not determined by the involved member states, but by renewable energy producers or traders thriving to maximise their profit. Member states can only indirectly influence imports and exports by the design of their national RES support framework (primary and secondary support instruments, grid access provisions, etc.). The country with the best support framework would automatically attract the highest imports and consequently carry the support costs for the respective foreign installations, no matter if such imports are intended or not. The mechanism thus does not provide the possibility to negotiate the conditions for renewable energy transfer. Furthermore, a technology-neutral scheme would over-compensate low-cost renewable energy. These two issues are likely to create severe public acceptance problems in the importing country. Under a restricted GO trading scheme, these problems would be alleviated but not principally solved.

In the case of joint projects and joint support schemes, it would depend on the actual allocation of costs and benefits if these mechanisms would be perceived as fair. If they could manage to avoid over-compensation of RES installations, would depend also on the design details. The advantage of joint projects is that appropriate provisions could be negotiated for certain types of installations, possibly detached of national support schemes. Joint support schemes also allow the negotiation of appropriate solutions, but these might be more complex to determine, since they need to apply to the full support schemes of the involved member states.

Statistical transfer between member states is not likely to create any acceptance problems, since the transfer is controlled by governments and dissociated from the direct installation level. It could be relevant how the transferring member state reinvests the revenues from the transfer, however; the acceptability would probably be higher if the revenues would be used to reduce the support cost for consumers that enabled the prior increase in renewable energy production.

4.4. Evaluation against the technical criteria

4.4.1. Easy implementation

In order to be implemented smoothly, the flexibility mechanisms should avoid high design complexity, e.g. not require the involvement of many actors or complex procedures. It is difficult to judge this criterion before actual implementation of the mechanisms. In principle, private GO trade as well as direct statistical transfer between member states seem to be straightforward mechanisms. Their practical implementation, however, might be more complicated than it looks on first sight.

Statistical renewable energy transfer between member states is probably the simplest procedure: One member state sells a certain renewable energy share to another member state and reports this transfer to the Commission. In practice, some issues will still need to be tackled:

- Both member states would probably need to appoint accredited agents to support the negotiations and handle the transfer.
- In the absence of an actual market, prices would need to be negotiated year by year between governments or their accredited agents. Questions remain how this would work in practice, e.g. if the sales price would be paid directly from the state budget, how revenues would be spent, if prices will be public or not, etc. Generally governments have limited experience in trading.

Also private GO trade is based on a simple certificate trading principle, but the example of existing trading schemes, e.g. national tradable green certificate schemes or the EU emission trading scheme show that the detailed design requirements of trade are more complex and crucial for the effectiveness of the trading schemes. Some design options for GO trade are investigated by de Jager (2007). Overall, a GO trading system would be significantly more complex than statistical transfer between member states.

Joint support schemes also follow a rather simple principle – several member states share the same support instrument – but in detail, they pose a number of challenging design questions, e.g.:

- Would the support conditions be equal in the participating member states (“least cost” approach) or should they be regionally differentiated? If yes, how?
- If the objective is to create equal support conditions across member states, also secondary support instruments (tax incentives etc.) and general energy market conditions (in the case of electricity: grid cost allocation schemes, balancing costs, scheduling rules and gate closure etc., see Klessmann et al. 2008) would need to be harmonised. If not, the differences of the energy markets would need to be accounted for.
- How would the costs for consumers be shared between the participating member states (see Sensfuß et al 2007 and Ragwitz et al. 2008b for cost-sharing approaches under a coordinated feed-in system)?

The joint project mechanism seems relatively complicated on the first sight, because two governments are involved in the support of one project. On the other hand, the mechanism has the advantage that it does not need to cover the full range of RES project conditions covered by a support scheme. Instead, it defines special support conditions for certain types or certain numbers of projects. Again, a number of design questions would need to be answered, e.g.:

- How would the costs and the target accounting of the joint RES installation be split between the host country and the receiving country of the joint project?
- How would the financial support by the receiving country be organised (e.g. via a tender, a support programme, or negotiated project-by-project)? Who would administer the support?
- How could such a project mechanism be made transparent and attractive for private project developers?

In short, renewable energy transfer between member state seems to be the most straightforward mechanism, but all discussed mechanisms require the definition of a variety of design questions that will determine the practicability of implementation.

4.4.2. Transparency

One sub-criterion of transparency is that the accounting system for RES target compliance and transfers should be transparent and fraud resistant, avoiding double counting of renewable energy production for different targets. The accounting system is not necessarily linked to a certain flexibility mechanism, however. The Commission's GO trade proposal foresaw a harmonised accounting system based on GOs, but also on national RES statistics. The other proposals are based on statistical transfer of renewable energy volumes for target compliance, coupled with a notification to the Commission (however, earlier drafts foresaw GO transfer between member states). In principle, both systems could provide for reliable accounting, if implemented properly. The accuracy of statistical transfer depends on the quality of the underlying RES statistics, which needs to be improved in some member states. A GO accounting system could be more accurate, if designed fraud-resistant, but would require additional effort and transaction costs by the member states.

Another aspect of transparency is that the rules of the flexibility mechanism should be transparent to other member states and to private actors, e.g. RES project developers that can use the flexibility mechanism. A restricted GO trade system and the joint project mechanism seem to pose the highest risk of arbitrary case-to-case design and thus of intransparent flexibility rules. This will, however, depend on the actual design of these mechanisms. Unrestricted GO trade and transfer between member states seem to be most straightforward, but it is questionable if the price building in a European GO market would be transparent to small actors.

4.4.3. Legal robustness

According to Neuhoff et al. 2008, Poschmann 2008 and RECS International 2008, a restricted GO trading system could create legal problems. If tradable green certificates are introduced as European standard, un-proportionate restrictions of such certificate trade could breach European law (see section 2.3). The other mechanisms are not regarded critical by most legal experts (there is, however, a general controversy on the legitimacy of closed support schemes which also was introduced into the flexibility discussion; see Fouquet 2008 versus RECS International 2008).

4.5. Summary of evaluation results

Table V-2 summarises the results of the evaluation.

Table V-2. Summary of the evaluation results

		Mandatory for member states		**Voluntary for member states**		
Main criteria	**Sub-criteria**	**GO trade between private parties**	**GO trade with trade restric-tions**	**Joint projects**	**Joint support schemes**	**Statistical transfer between member states**
Effectiveness (facilitate RES target achievment)						
Enable member states (MSs) to meet their national RES targets	Providing MSs with flexibility options to use RES potentials in others MSs for their own national RES targets	++ (but high price risk)	+	+/-	+/-	+/-
	Allowing MSs to develop their domestic RES potential by increasing the effectiveness of their national support instruments	--	+/- (depends on allowed restrictions)	+	+	+
Facilitate dynamic RES market develop-ment	Creating new market opportunities for RES producers	++ only for low-cost RES	+	+	+/-	- (only indirectly)
	Involve private market actors into the utilisation of the flexibility scheme	++	+	+	+/-	-

		Mandatory for member states		**Voluntary for member states**		
Main criteria	**Sub-criteria**	**GO trade between private parties**	**GO trade with trade restrictions**	**Joint projects**	**Joint support schemes**	**Statistical transfer between member states**
	Stable conditions for RES investments	-- (destabilisation of support schemes)	- (legal un-certainty)	+/- (depends on design)	+ (in case of stable support scheme)	+ (in case of stable support scheme)
Cost-effectiveness						
Use of low-cost RES potentials	Develop additonal low-cost RES potentials in Europe	++	+	+	+/- (depends on design)	- (only indirectly)
	Help to develop medium- and long-term potentials in time	--	-	+/- (depends on support scheme)	+/- (depends on support scheme)	+/- (depends on support scheme)
Preserve the cost-effective design of national support schemes	No negative effect on the cost-effectiveness of national support schemes that is not off-set by a positive effect elsewhere	--	+/- (depends on allowed restrictions)	+	+	++
Political criteria						
Preserve sovereignty of MSs on RE policy	Sovereignty on RES support instrument design	--	+/- (depends on allowed restrictions)	++	+ (agree-ment with other countries required)	++
	Sovereignty to control use of domestic RES potentials	--	+/- (depends on allowed restrictions)	+	+	++

		Mandatory for member states		**Voluntary for member states**		
Main criteria	**Sub-criteria**	**GO trade between private parties**	**GO trade with trade restric-tions**	**Joint projects**	**Joint support schemes**	**Statistical transfer between member states**
Realise single European market	Reduce restric-tions to an internal European electricity market	0	0	0	0	0
	Reduce restrictions to an internal European market for supported RES	++	+	-	+	-
	Facilitate European harmonisation of RES support	++	+	-	+	-
Public accept-ability	Allow fair distribution of costs and benefits between the involved MSs	--	-	+	+	+
	Avoid over-compensation of supported RES installations	--	-	+/- (depends on design)	+/- (depends on design)	+
Technical criteria						
Easy to implement	Low design complexity	+/-	+/-	+/-	+/-	+
Trans-parency	Transparent, fraud resistant RES accounting system that avoids double counting	+	+	+	+	+

		Mandatory for member states		**Voluntary for member states**		
Main criteria	**Sub-criteria**	**GO trade between private parties**	**GO trade with trade restrictions**	**Joint projects**	**Joint support schemes**	**Statistical transfer between member states**
	Flexibility rules are transparent to other MSs and to private actors	+	+/- depends on design	+/- depends on design	+	+
Legal robustness	No conflict with existing legislation	+	--	+	+	+

On inspection of the table, it becomes clear that there is no obvious optimal mechanism. The most contrasting proposals are unrestricted GO trade between private parties and statistical transfer between member states.

Unrestricted GO trade scores extreme on many of the criteria. It performs very positively with regard to tapping additional low-cost RES potentials, involving private market actors, and pushing towards a harmonised European RES support. On the other hand, it performs very negatively with regard to allowing member states to optimise their RES support schemes and developing their domestic RES potentials. Furthermore, it endangers public acceptability by not reflecting local costs and benefits of RES installations and by potentially over-compensating low-cost RES installations. These negative sides can be considered “knockout criteria”, especially as long as member states have to fulfil national targets.

Restricted GO trade scores similar to unrestricted GO trade, but less extreme. Its performance would largely depend on the type and the extent of restrictions that would be installed. Under a legal point of view, it seems questionable if such trade restrictions could be maintained at all. This legal uncertainty can also be considered a knockout criterion.

The performance of joint projects depends largely on design features that have not been defined yet. For this reason, the evaluation result remains open for many criteria. Principal strengths of the joint project mechanism are that it leaves member states their sovereignty on domestic RES potentials and policies, yet also involves private actors. Furthermore, the mechanism may apply only to certain RES projects, volumes or technologies, which could speed up its implementation compared to joint support schemes. Principle weaknesses of the mechanism include that it is negotiated from case to case, which could lead to complicated agreements and increased complexity of RES support in Europe. They would also create two “classes” of RES support in the host country.

Similar to joint projects, the performance of joint support schemes largely depends on their design details. One principle advantage is that they would lead to a partial harmonisation of RES support, but give member states the sovereignty to design this system themselves. Joint support schemes do not have any principle disadvantages except that member states find it difficult to negotiate them, because they have to agree on all aspects of a common support scheme. It is thus questionable if such system will be implemented without external pressure.

Statistical transfer between member states is a simple, straightforward mechanism. It gives full sovereignty to member states and can be easily implement. Its major drawback is that it solely relies on the national support schemes of the member states to develop additional RES potentials. The RES transfer takes place ex-post, without the involvement of private actors. For this reason, the mechanism provides only limited flexibility.

4.6. Uncertainties of the evaluation

The partial uncertainty of the evaluation results has already been stated. This uncertainty is due to the fact that none of the flexibility mechanisms has been put into practice yet, leaving open many design details that would be decisive for the performance in practice. To give an example: Even GO trade, which has been evaluated as the most critical option, could probably be designed in a way to avoid some of its negative consequences, but a number of challenging design issues would need to be solved (e.g. the questions of technology specification, trade limitations, inter-linkage with support schemes, etc.)[9]. Nevertheless, the principle strengths and weaknesses of the different mechanisms have been highlighted and remain valid.

5. Discussion: Flexibility under the new RES directive

The final compromise on the RES directive sets the framework for the three voluntary flexibility mechanisms – statistical transfer between member states, joint projects and joint support schemes. The GO trade option has been completely abandoned. This political outcome is supported by the major evaluation results: Technology-neutral GO trade does not meet important political and economic criteria. The main “knockout criteria” are that it endangers the effectiveness and cost-efficiency of national support schemes, and that it would lead to high producer surpluses for low-cost RES installations, which is expected to

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[9] Proponents of GO trade have also argued that the latter should not be judged by the status quo of RES support, but that support schemes – especially feed-in systems – would need to adapt to the flexibility mechanism. This argument seems questionable, however: It would mean that those national support schemes which have been most cost-effective in promoting RES electricity over the last years would need to be changed to fit with a new trading system which has not yet been proven to be cost-effective.

offset its positive economic effects. For restricted GO trade, the main knockout criterion is the legal uncertainty it creates.

The remaining voluntary mechanisms do not interfere with the national RES support in the member states, but they perform weaker than the GO trade mechanism with regard to creating flexibility and tapping low-cost potentials in other member states. How much flexibility they will provide strongly depends on how many member states will actually use them. In principle, the binding national RES targets give member states a significant incentive to use flexibility mechanisms, at least if their RES target is high compared to their domestic RES potential, or if their RES potential is high enough to sell renewable energy to other member states[10].

Whether member states will take action to implement the flexibility mechanisms also depends on other factors:

- Without any direct economic penalties in place, the threat of not meeting national targets is mainly a moral one. The Commission could start an infringement procedure only after 2020, and it seems unlikely that the latter would result in financial consequences. The question is thus if the moral pressure and the existing incentives are sufficient for member states to use flexibility mechanisms well before 2020. If not, it will need to be investigated how additional incentives for using flexibility mechanisms can be established.
- The attractiveness of the voluntary flexibility mechanisms will also depend on their design and manageability. In principle, member states have total freedom to design the mechanisms according to their needs. One can expect that in practice, many member states will not spend much effort on investigating suitable options. Most likely, some member states will have to go ahead and create some well functioning “pilot” mechanisms before others will join.

The more proactive member states should thus start defining further design features for the three flexibility mechanisms. Attention should be given to the following issues:

- Statistical transfer between member states is the most straightforward, but also the least flexible mechanism. In order to ensure sufficient RES availability in 2020, member states should consider closing early agreements with other member states about a transfer in the target year.

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[10] According to Resch et al. (2008), the availability of domestic potentials suggests that the member states’ need for RES imports is rather low in the year 2020, however: only approx. 100 of nearly 3000 TWh total RES deployment in Europe would need to be transferred across member state borders. On the other hand, the experience with implementing European energy directives shows that in practice many member states lag behind their national targets (e.g. in 2005, only 9 out of 25 countries were on track towards their national target under the RES electricity directive 2001/77/EC, see COM 2006). If this tendency persists, there could be a high demand for RES imports in 2020, but only limited supply.

- Concepts for joint support schemes have been discussed for several years already (e.g. Midttun et al. 2004, Gunderson 2006, Ragwitz et al. 2007, Muñoz et al. 2007), but never been put in practice so far. Without additional efforts, this will not change in the future, because the involved member states would have to find an agreement on all aspects related to RES support. A key issue is the cost sharing between the involved member states.
- Joint projects have been introduced as a compromise between RES transfer on member state level and RES trade between private parties. Out of the three mechanisms in the directive, joint projects allow the most active involvement of private actors. One crucial question is therefore how to design such projects in a way that makes them attractive for private investors. From the perspective of the involved member states, joint projects allow many different design options – e.g. setting conditions for whole technology categories, for certain volumes, or for single projects. On the other hand, they also pose the highest risk of becoming complicated and intransparent. Member states should thus focus on investigating pragmatic, transparent design options.

6. Conclusions

The evaluation has shown that there is no optimal flexibility mechanism. The most extreme evaluation results were found for GO trade, with some clear advantages regarding flexibility, but strong drawbacks regarding the sovereignty of the member states on their support policies and the overall cost-effectiveness of RES support. Since these drawbacks can be considered “knockout criteria”, it seems reasonable that the GO trade mechanism has been excluded from the final RES directive.

The remaining three mechanisms can all be used in parallel, but it is uncertain to what extent they will actually be used by the member states. The crucial question is thus how their utilisation can be facilitated. One first step might be that proactive member states find solutions for open design issues for implementing the mechanisms. The effective design of the joint project mechanism and of joint support schemes will especially need to be further elaborated. In a second step, pilot mechanisms should be implemented to gain practical experience. Once in place, these mechanisms can be further optimised and might motivate further member states to use the mechanisms.

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VI. Design options for cooperation mechanisms under the new European Renewable Energy Directive[1]

Abstract

In June 2009, a new EU directive on the promotion of renewable energy sources (RES) entered into effect. The directive 2009/28/EC, provides for three cooperation mechanisms that will allow member states to achieve their national RES target in cooperation with other member states: statistical transfer, joint projects, and joint support schemes. This article analyses the pros and cons of the three mechanisms and explores design options for their implementation through strategic and economic questions: How to counterbalance the major drawbacks of each mechanism? How to reflect a balance of costs and benefits between the involved member states? The analysis identifies a number of design options that respond to these questions, e.g. long term contracts to ensure sufficient flexibility for statistical transfers, a coordinated, standardised joint project approach to increase transparency in the European market, and a stepwise harmonisation of joint support schemes that is based on a cost-effective accounting approach. One conclusion is that the three cooperation mechanisms are closely interlinked. One can consider their relation to be a gradual transition from member state cooperation under fully closed national support systems in case of statistical transfers, to cooperation under fully open national support systems in a joint support scheme.

1. Introduction

In December 2008, the European Parliament and the Council of the European Union agreed on a new EU directive on the promotion of the use of renewable energy sources (RES), which was formally adopted in April 2009 (2009/28/EC). It sets binding targets for all EU member states to reach the European target of 20% RES share in EU gross final energy consumption by 2020. The allocation of differentiated national targets is based on a flat rate approach (same additional share for each country) adjusted to the member state's GDP. This target allocation approach does not necessarily correlate with the member states' RES potentials. The available biomass, wind, hydro, tidal, wave and solar resource base varies significantly across the different member states. In order to account for these differences,

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the RES directive introduces “flexibility” or “cooperation”[2] mechanisms which allow those member states with low or expensive RES potential, to partially fulfil their RES target in other countries with higher RES potential or lower production costs. The three intra-European cooperation mechanisms are: statistical transfer, joint projects, and joint support schemes. Additionally there is the option to physically import RES electricity from third countries outside the EU (“joint projects between member states and third countries”), an option which is not discussed in this paper.

Statistical transfer means that renewable energy which has been produced in one member state is ex-post and virtually transferred to the RES statistics of another member state, counting towards the national RES target of the latter member state. The directive does not specify if this renewable energy is electricity, heat or fuel. Joint projects are RES electricity or heating/cooling projects that are developed under framework conditions, jointly set by two or more member states; one member state may provide financial support for a RES project in another member state and count (part of) the project’s energy production towards its own target. RES fuel projects are not eligible for joint projects. In the case of joint support schemes, member states combine (parts of) their RES electricity or heating/cooling support schemes to achieve their national RES targets jointly. The produced RES energy (only electricity or heat/cold, not fuel) can be allocated to the member states via statistical transfer or a distribution rule agreed by the participating member states. The directive defines general accounting rules for using the mechanisms, but does not give any specification of their design. The detailed design and practical implementation of the mechanisms are left to the member states. Member states have begun to discuss the implementation of the mechanisms (e.g. BMU 2009a), but no results have yet been presented in public. According to the member state forecasts that had to be submitted to the European Commission in December 2009, only a comparatively small quantity of energy is expected to be subject to the cooperation mechanisms: Only five member states expect to have a deficit of in total 2 Mtoe in 2020, less than 1% of the total renewable energy needed in 2020; ten member states expect to have a surplus of in total 5.5 Mtoe in 2020, around 2% of the total renewable energy needed in 2020 (European Commission 2010).

This article explores principle design options for implementing the three cooperation mechanisms. So far, very limited research has been conducted on this issue. Most analytical attention has been given to the design of joint support schemes, which have already been considered for several years, independent of the RES directive; e.g. Ragwitz et al. (2007) analyse the distribution of costs and benefits under common quota or feed-in schemes; Muñoz et al. (2007) suggest a harmonised methodology for defining modular feed-in premiums; Sensfuss et al. (2007) propose a minimum European feed-in tariff combined with a country specific premium. Klessmann (2009) evaluates the new cooperation mechanisms under the RES directive against a set of qualitative criteria, but does not look

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[2] The final RES directive uses the term “cooperation mechanisms” instead of “flexibility mechanisms”, in order to distinguish these mechanisms from the Kyoto flexible mechanisms (BMU 2009a).

into practical design features. Conclusions can be drawn on the economic challenges of flexibility from the evaluation of European guarantees of origin (GO) trade as proposed by the European Commission in 2008 (e.g. Ragwitz et al. 2008, Toke 2008). Further lessons may be drawn from the flexible mechanisms under the Kyoto Protocol, i.e. the implementation of the Clean Development Mechanism (CDM), Joint Implementation (JI), and International Emission Trading. There are several similarities between the flexible mechanisms introduced under the Kyoto Protocol and those outlined in the EU RES directive. Just as Parties to the UNFCCC which have ratified the Kyoto Protocol and form part of the list of Annex I countries, have binding emission reduction targets, EU member states also have binding RES targets. EU member states are entitled to implement joint projects between EU member states (analogy to JI) and with third countries (analogy to CDM). In addition, RES units can be statistically transferred between EU member states, just as the International Emissions Trading allowed the transfer of Assigned Amount Units (AAUs) under the Kyoto protocol. On the other hand, the practical comparability of the Kyoto and the RES cooperation mechanisms is limited. In the case of International Emissions Trading, AAUs were assigned to the Annex I countries. Countries that hold a surplus of AAUs (i.e. transition countries in Eastern Europe and the former Soviet Union) can sell them to other countries at no (current) cost (see discussion on “hot air”, e.g. Point Carbon 2009). On the contrary, RES transferred under the RES directive must originate from newly installed RES plants. The transferred RES amount is thus verifiable and related to respective costs in the selling country. A major challenge of CDM and JI is the “additionality”[3] of the projects compared to a baseline that is defined according to predefined guidelines. The RES joint project mechanism does not require the definition of a baseline; it only measures the energy production of specified RES installations, independent of the overall energy production and consumption. The additionality of joint RES projects between member states is safeguarded by the eligibility requirement that only new plants that started operation after the entry into force of the RES directive can qualify for such projects, and that all member states have binding national RES targets. For joint projects with third countries, the additionality of the projects shall be safeguarded by the requirements that only new installations are eligible and that an equivalent amount of the electricity produced in these new installations needs to be physically imported into the EU[4]. A lesson that might be learnt from Kyoto, however, is the importance of simple administrative frameworks: JI did not attract a lot of projects, because the international emission trading proved to be much easier from the administrative point. This may also apply to statistical RES transfers compared to joint projects.

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[3] Qualifying for additionality implies that the project has to demonstrate that it goes beyond the business-as-usual (BAU) scenario.

[4] One may question if the import criterion and the sub-criteria for proving import to the EU are sufficient to judge such joint projects “additional”, but this issue would need further discussion.

All three cooperation mechanisms have to be agreed upon bi- or multilaterally between member states. It can be expected that member states will make use of the mechanisms only if the economic and non-economic benefits are larger than the associated costs and risks. Therefore, a mutually beneficial situation needs to be created for both, the country statistically providing renewable energy and the country statistically receiving renewable energy. To create the framework conditions for such a mutually beneficial situation, a number of questions need to be answered from the perspective of the member states:

1. Strategic: What are the political advantages and drawbacks of each mechanism? How can major drawbacks be counterbalanced?
2. Economic: How can costs and benefits of the transferred renewable energy be balanced between the involved countries? How can this balance be reflected in the design of the cooperation mechanisms?
3. Legal and administrative: How can the mechanisms be designed in a legally sound and reliable way? How can the transparency and practicability of the mechanisms be ensured?

The first two questions are fundamental, and will be qualitatively investigated in this paper for each of the three cooperation mechanisms of the RES directive. The third group of questions concern design details that will become very relevant in the future, but require the predefinition of a basic framework by the member states. Therefore, they will only be briefly touched upon, and not examined in detail.

The first step is to investigate the direct and indirect costs and benefits of RES installations that need to be defined and balanced under all three mechanisms (section 2). Secondly, the strategic pros and cons and economic design alternatives will be discussed for each mechanism (sections 3-5). Based on this analysis, conclusions and recommendations for the effective and efficient design of the mechanisms will be derived (section 6).

2. Direct and indirect costs and benefits of RES deployment

The basic concept that underlies all three cooperation mechanisms of the RES directive, is allowing member states with low or expensive RES potential (“receiving” or “importing” member states) to use renewable electricity or heat produced in other countries with higher RES potential and lower production costs (“host” or “exporting” member states) to comply with their national target, thus leading not only to overall cost savings for reaching their national RES targets, but also for the overall European target for 2020. A question that arises under all mechanisms is, how to share the costs and benefits of this RES deployment.

This section gives an overview of direct and indirect costs and benefits that are linked to RES deployment and might therefore be reflected in the cooperation mechanisms.

Under current energy market conditions, most RES technologies are competitive, only if they receive some financial incentive through a RES support scheme. In fact, the European

RES directives 2001/77/EC, 2003/30/EC and 2009/28/EC oblige member states to introduce RES support schemes that facilitate the market introduction of renewables and, in the medium or long term, the competitiveness of RES technologies in the energy markets. With the exception of RES building and fuel obligations, all of these support schemes provide some kind of financial support to RES installations (e.g. investment incentives, feed-in tariffs or premiums, tradable green certificates) that is paid by energy consumers, suppliers, or the state budget. If another member state wants to count the renewable energy production of a RES installation located abroad towards its own target, it indisputably needs to cover the financial support costs, either indirectly, by paying money to the host member state or directly, by providing support to the RES installation. The direct costs reflected in a cooperation mechanism are the primary support costs and the direct benefit of the RES installation that is transferred to the receiving member state, is its contribution to RES target compliance.

In addition to these direct, transferrable costs and benefits, RES deployment is also linked to indirect domestic costs and benefits that occur in the host country. Such domestic, indirect costs and benefits cannot be transferred directly through a cooperation mechanism, but they might still be reflected in the RES transfer price and, possibly, also the design of the mechanism.

Domestic, non-transferrable benefits in the host country include increased security of supply, local job creation, innovation and added value as well as reduced local air pollutants and other environmental benefits, depending on the applied RES technology. Other indirect benefits for the host country are reduced CO2 emissions and the gradual transition into a low-carbon energy system,

There are also domestic costs that occur only in the host country and which are not reflected in the direct RES support. Significant domestic cost elements are the cost for integrating RES electricity or heat in the electricity or heating network (grid reinforcement, balancing, system capacity costs, etc.); however, they appear to be relevant only if they are then passed on to energy consumers and not paid by the RES producer itself. Relevant are also the indirect support costs that are not part of the primary support scheme (e.g. tax rebates, subsidised loans etc.). The exporting country may also consider the potentially increased costs in order to reach its national target, due to “sell-out” of low-cost potentials (this would depend on the available potentials and their cost curve). Further domestic, indirect costs include the cost of regulation (permits, political decision making, programme management, etc.) and the societal and environmental costs (e.g. impact on landscape or biodiversity).

With the increasing importance of renewable energy and related support costs for society, governments are more inclined to become interested in quantifying these indirect costs and benefits (see e.g. Breitschopf et al. 2009 for Germany). Theoretically, in order to come to a “fair” price for the RES transfer, all the above mentioned costs and benefits would need to be taken into account within the price setting for RES transfer. In practice, many of them can hardly be quantified and monetarised. This is particularly true for the value of local benefits. Nevertheless, it can be expected that member states will implicitly reflect them when negotiating the price of RES transfer or when setting up a mechanism to determine the price. Simultaneously, costs and benefits that are difficult to quantify bear the highest potential for conflicts between the involved negotiation parties.

Another price that is difficult to determine, is the price of non-compliance with the RES directive. The European Commission is expected to start an infringement procedure against member states that do not comply with their binding national targets (or, as previously established, against member states that do not comply with the requirement to install effective RES support instruments). The penalty resulting from such an infringement may be regarded as the upper price ceiling of any RES transfers. One should be aware, however, that this penalty does not only consist of a financial penalty (which may be set by the European Court, but is difficult to predict) but also of the moral penalty of being publicly "pilloried" by the European Commission.

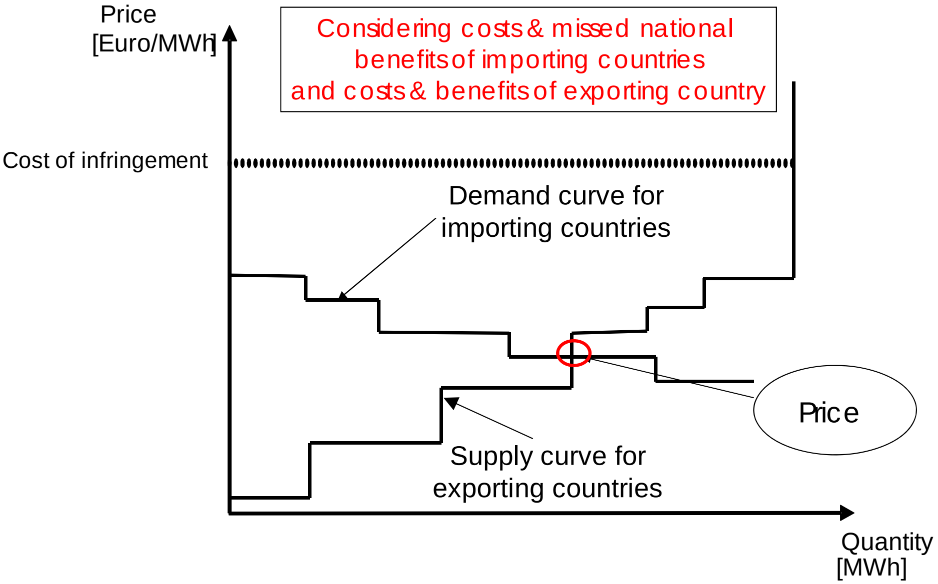

Figure VI-1. Possible price determination for cooperation mechanisms

Figure VI-1 presents some of the aspects of price determination for cooperation mechanisms discussed above. Important elements in this process will be the anticipated cost of infringement (acting as an upper price ceiling)[5], the total demand from importing

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[5] An infringement procedure will normally result in a certain amount of fine to be paid. Assuming that these costs of the infringement will be linked to the amount of energy that is missing for target compliance, the amount could be expressed in relative terms, i.e. €/MWh. It

countries as well as the net demand / supply curves from importing / exporting countries considering costs and benefits of national RES generation. As there are significant uncertainties in the determination of any of these parameters, the future price for the implementation of the cooperation measures is difficult to predict. In particular the price setting mechanism, which will actually apply in practice, is unclear. In the case of a trading platform, where both sides are price takers, a supply and demand curve as depicted in Figure VI-1 can be applied. In a situation where bilateral contracts might be the dominating instrument for the transfer such price setting mechanism as shown in Figure VI-1 would not apply.

3. Statistical transfer between member states

3.1. Definition

In the case of statistical transfer between countries, the member states are themselves responsible for trading. Any surplus of RES generation which is not required for a country’s own target compliance could qualify for such trade. Article 6 of the RES directive defines the option of statistical transfer for target achievement. It states that "member states may agree on and may make arrangements for the statistical transfer of a specified amount of energy from renewable sources to be transferred from one member state to another member state." Therefore, surplus or deficit of renewable energy generation are exchanged between member states by subtracting the corresponding amount from the statistical figures of the "exporting" member state and adding it to the official RES statistics of the "importing" member state.

3.2. Pros and cons of the mechanism

The pros and cons of RES transfers on member states level in comparison to transfers on company level, have been analysed in the discussion on GO trade, originally proposed by the Commission (see e.g. Neuhoff et al. 2008, Ragwitz et al. 2008, Klessmann 2009).

The advantages of this cooperation mechanism in comparison to the other cooperation mechanisms of the RES directive include: Statistical transfer is a simple and straight forward mechanism that does not require the definition of a new and potentially complex cross-border support framework. Contrary to the other cooperation mechanisms, statistical transfer between member states does not have a direct effect on the efficiency of national RES support schemes. Furthermore, member states that act as sellers can recover costs for supporting their domestic RES production and, in doing so, may also benefit financially; this may strengthen their national support scheme. There is no need to apply a regulation

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is however speculative whether there will be a linear relation between the amount of target non-compliance and infringement fine.

that takes into account technology-specific requirements, because the exporting member state only sells the RES technology mix it used to produce the virtually transferred energy.

The disadvantages of such a cooperation mechanism include: The mechanism depends strongly on the proactive behaviour of member states that develop additional RES potentials which they can sell to other member states (and of the expressed demand of other member states). If only few member states show such initiative, the mechanism will provide limited flexibility for cross-border target compliance; RES energy is only transferred ex-post, after its production, and member states will still need to ensure that they achieve their national (interim) targets[6]. Consequently, potential buyers face the risk that no country will be willing or able to sell in 2020. Potentially, there will also be a lower market dynamic than under a flexibility regime involving private actors,, as private RES producers have a less active role than they may have under joint projects[7]. Private project developers do not have an incentive beyond the national support scheme to look for the lowest-cost RES projects throughout Europe. The RES development depends substantially on the *national* support scheme in place in the exporting country. Therefore, in countries offering low or ineffective support, comparatively cost-effective RES potentials would remain untapped, which could limit the overall cost-efficiency of RES support and RES target fulfilment, respectively, from the European perspective.

3.3. Design options and critical aspects

The principal regulations of statistical transfer have been introduced in the Directive: RES volumes that exceed a member state’s interim target can be virtually transferred to another member state and can contribute towards that member state’s target. Nevertheless, a number of detailed design features so far remain largely undefined, and these need to be elaborated upon in the future.

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[6] See Article 6.1 of directive 2009/28/EC: “A statistical transfer shall not affect the achievement of the national target of the Member State making the transfer.” This clause is less strict than the earlier proposal by the European Commission, which foresaw that only those member states “whose share of energy from renewable sources equalled or exceeded the indicative trajectory” would be allowed to transfer renewable energy to another member state (COM 2008).

[7] Joint projects do not necessarily allow the active involvement of private developers in the project design,; this will depend e.g. on the tender specification defined up-front by the government, see section 4.

Addressing the key questions which have been developed in section 1, the following questions will be discussed for the design of statistical transfers:

- Strategic: Counter-balancing major drawbacks of the mechanism
    - How to increase flexibility? - short term versus long term agreements
- Economic: Balancing of costs and benefits
    - trading platform versus individually negotiated contracts
    - mechanisms for price determination
- Legal and technical aspects
    - transfer of the risk of non-compliance to the exporting country
    - bilateral versus multilateral agreements
    - agents responsible for the transfer activities
    - procedures for incorporating statistical transfers into the national renewable energy statistics

3.3.1. Counterbalancing major drawbacks of the mechanism

Short term versus long term contracts

One may consider short term (e.g. one year) versus long term (e.g. 15 years) contracts for statistical transfers. The preferred option is closely related to the way in which the mandatory targets as well as the interim targets (defined by the indicative trajectory) set in the Directive will be interpreted. Formally the mandatory targets are set only for the year 2020. Therefore, importers would be most interested to import virtual RES for the target year. As this year is the relevant year for all exporting and importing countries, however, parties will scarcely be interested (or able) to offer surplus generation for only one year. In particular, in the instance that Europe as a whole is short in reaching the 20% target, exporting countries would be in the position to ask for a price that reflects the additional support costs for the lifetime of the plant. In the instance that Europe as a whole would have an excess of RES generation in 2020, exporters may not be able to request the full additional costs for generation to be sold. By closing a transfer agreement well before 2020, the importing country could hedge its price risk for reaching its 2020 target. This would also bring the importing country in a better position to reach its interim targets. These interim targets, even though they are not of a binding nature, may create a relevant demand also before the year 2020[8].

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[8] This is particularly due to the fact that not complying with the respective indicative trajectory can be regarded as evidence that the member state failed to comply with its general

3.3.2. Balancing of costs and benefits

Trading platform versus individually negotiated contracts

The establishment of contracts may be done based on individually negotiated bilateral or multilateral contracts or by the establishment of an open trading platform.

A European trading platform may take a similar form as trading desks for other commodities in the energy market, e.g. wholesale electricity or CO_2 emission allowances. The obvious advantage of such a procedure is the transparency of the approach. A disadvantage may be that it would be difficult to create a liquid market in a situation with a very limited number of actors in that market (probably only few member states will be able to sell excess RES volumes). Only the theoretical possibility to abuse market power in such a market (e.g. by a large exporting country) may lead to significant acceptance problems in a market with an artificially created demand, based on politically negotiated targets. Therefore, in order to have the necessary acceptance, any price bids in such a market would probably need to be based on the support costs in the exporting countries.

Statistical transfers are initiated and conducted by member states. Therefore, it is most likely that contracts will be negotiated individually between the governments of the involved member states. In this case the price would need to be settled based on the specific objectives of the negotiating countries. It is an open question whether or not the prices levels resulting from such negotiations would become generally disclosed and transparent. Experience from government based International Emission Trading shows that little price information is publicly available[9]. In the case of RES, such missing price transparency could create public acceptance problems, because the RES transfer costs are paid in one

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obligation according to Article 2 of the RES directive to introduce effectively designed measures to ensure compliance with the indicative trajectory. The same approach was followed by the Commission under the 2001/77 directive and is now expressively codified in Article 2 of the RES directive.

[9] International Emission Trading only came to life with entering the first compliance period of the Kyoto protocol (2008-2012) in 2008. On the demand side, it was initiated by government entities from Annex I countries whose economies are expected to exceed their emission allowances by 2012. Countries that were reportedly involved in transactions include Japan, Austria, the Netherlands, Belgium, and Spain (see Capoor and Ambrosi, 2009). On the supply side, surplus AAUs were offered by countries from the former Eastern Bloc whose emissions have declined since the basis year 1990 – mainly due to historical economic events. Sales of AAUs in 2008 and 2009 were reported from Ukraine, Czech Republic, Slovakia, Hungary, and Latvia. General information on the likely surplus units and interested buying countries seems to be available on the market. However, little information is available on the price and structure of transactions (Capoor and Ambrosi, 2009).

way another, by consumers or tax payers in the buying or selling country[10]. On the other hand, national parliaments could also force governments to disclose this price information.

Mechanisms for price determination

Different mechanisms for price determination can be considered. Generally, the price may be negotiated between the contracting parties, or it may be determined in a sort of auction, or it may be based on a transparent price rule. Where the first option is rather straightforward, the second one is related to the option of a trading platform as elaborated above. The third option deserves some explanation. A price rule could be based on the level of support for the renewable energy portfolio in the exporting countries. This would provide a good level of transparency and would include the request of "fairness" for these transfers. "Fairness" has always been a condition during the target setting process and may therefore also be perceived as an important criterion for the design of statistical transfers. In contrast to negotiated prices, where the use of market power (also through governments) can never be excluded, prices set by a transparent rule have a lower risk of being perceived as "unfair". One possible option would be that the average support level for all new RES plants supported in the exporting country serves as the price basis for any transferred RES generation in the following year. Of course, other rules for determining the price for the transfer are also possible, e.g. based on the average support level in the EU-27.

The RES directive already establishes a certain degree of transparency as article 6 (3) requests that “Transfers shall become effective only after all member states involved in the transfer have notified the transfer to the Commission” and furthermore article 24 stipulates that “The Commission shall make public on the transparency platform the following information: [...] member states' offers to cooperate on statistical transfers or joint projects, upon request of the member state concerned.” If member states would provide price information to the transparency platform, this would increase the level of transparency and public acceptance.

3.3.3. Legal and administrative aspects

Transfer of the risk of non-compliance to the exporting country

A critical legal question for long-term contracts is how to deal with the risk of non-compliance, in the situation that the exporting country fails to produce the RES volumes it agreed to transfer. Generally, the risk of non-compliance of the importing country may be borne solely by the exporting country (complete transfer of the compliance responsibility)

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[10] Public interest in RES support costs and their legitimisation tends to be high once the financial volume is perceived as significant, see e.g. the discussion on the cost of the Renewable Energy Sources Act in Germany (e.g. Welt Online 2009 based on RWI 2009, BMU 2009b). There is no evidence about a similar public interest in AAU sales prices.

or to an agreed fraction by the importing country also. The precise definition of the risk sharing between importing and exporting country needs to be defined between the contracting parties.

Bilateral versus multilateral agreements

One may consider agreements between only two countries, or between three or more member states[11]. The motivation for multilateral agreements could be a risk sharing between countries, e.g. in case more than one exporting country is involved, and underperformance of one exporting country could be compensated by others. Risk mitigation and stability could be arguments in favour of multilateral agreements. Conversely, the complexity of multilateral agreements also seems to be much higher. This then creates the question of responsibility, in the instance that the group of countries does not achieve the mutual target. Of course one possible solution, combining the advantages of both alternatives, is the option that a country signs several bilateral agreements with different member states. In this case, the complexity of the individual contracts is still small but the risk of non-compliance for the importing country can be mitigated. This latter option may be easier to implement if the available surpluses are published on the transparency platform, or if a European trading platform was established. In conclusion, several bilateral contracts for a member state might be the preferable solution.

Spending of the revenues from statistical transfer

The exporting country needs to decide how it spends revenue from the statistical transfer. Since the domestic RES support has been paid by consumers or tax payers, it would seem advisable to reinvest the revenues either in the national support scheme or in additional green projects, in order to increase the public acceptance of the transfer both in the exporting and importing country[12]. On the other hand, governments need to consider that reinvesting their revenues into a consumer financed support scheme could create state aid problems, The question, how revenues from statistical RES transfer are spent, also applies to joint projects and joint support schemes, but will not be separately mentioned there.

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[11] Whereas statistical transfers are only definded for bilateral agreements, joint projects and joint support schemes can be defined based on bilateral or multilateral agreements.

[12] This is also a lesson that can be learned from International Emission Trading under the Kyoto Protocol; responding to public concerns about the climate effectiveness of AAU trade, Green Investment Schemes have been introduced to ensure that sellers of AAUs invest the revenues in projects or measures that reduce emissions, see Atur et al. 2004, Ürge-Vorsatz 2008, Point Carbon 2009.

Additionally, a number of less substantial administrative aspects need to be defined, e.g.

- Who is the responsible agent for the transfer activities? The transfer may e.g. be handled by the government itself or by accredited agents (state owned banks, agencies, etc.) authorised by the government.
- Procedures for incorporating statistical transfer into the national renewable energy statistics; generally the amounts transferred by the member states should appear as an additional element in the national statistics of exporting and importing countries. It should not be directly added to / subtracted from the domestic production figures of the importing / exporting country because the domestic production figures should not contain any imports or exports. Rather the statistical transfers could be included as an additional category in the national consumption figures.

3.4. Conclusions

In a nutshell, statistical transfers between member states can be easily applied without negotiation of e.g. a long-term support framework. This appears as both a strength and a weakness because the mechanism could be used for short-term transfers in 2020 that allow member states to achieve their national RES target; a weakness because such short-term behaviour does not ensure long-term planning by the member states. Consequently, there might be only very limited RES volumes available for statistical transfer. One option to avoid this deadlock would be the negotiation of early, long-term agreements between member states, in order to give the exporting member state an incentive to produce excess RES volumes. A key challenge of such agreements is the ex-ante price setting and the risk transfer arrangement, in the instance that the exporting country will not be able to offer the agreed amount of energy. As only very few detailed implementation rules are given in the RES Directive (e.g. with respect to the notification to the European Commission), there is significant amount of freedom for the member states to implement statistical transfers. One important aspect to be considered by both member states concerns the fact that “A statistical transfer shall not affect the achievement of the national target of the Member State making the transfer.”

4. Joint projects between member states[13]

4.1. Definition

The RES Directive does not provide a detailed definition of joint projects between member states. It only states that “two or more member states may cooperate on all types of joint projects relating to the production of energy from renewable electricity, heating or cooling” (Council of the European Union 2008). The terms of the joint agreement and the design of the joint project mechanism are defined by the involved member states.

The directive defines the basic accounting rules for joint projects, however, the host member state on whose territory the RES installation is built shall notify the Commission regarding the proportion or amount of renewable energy that shall be attributable to the national target of another member state (in the following this is called the receiving member state). It shall also specify the period of this transfer. Only RES installations that become operational after the date of entry into force of the directive (i.e. 2009) are eligible to become joint projects. After the initial notification, the host member states are required to send an annual letter of notification to the Commission and to the receiving member state, stating the total amount of renewable energy that has been produced in one year and the share that counts towards the target of the receiving member state. Obviously, this share is then deducted from the RES volumes counting towards the target of the host member state and added to those of the receiving member state.

Figure VI-2 depicts the institutional framework for joint projects.

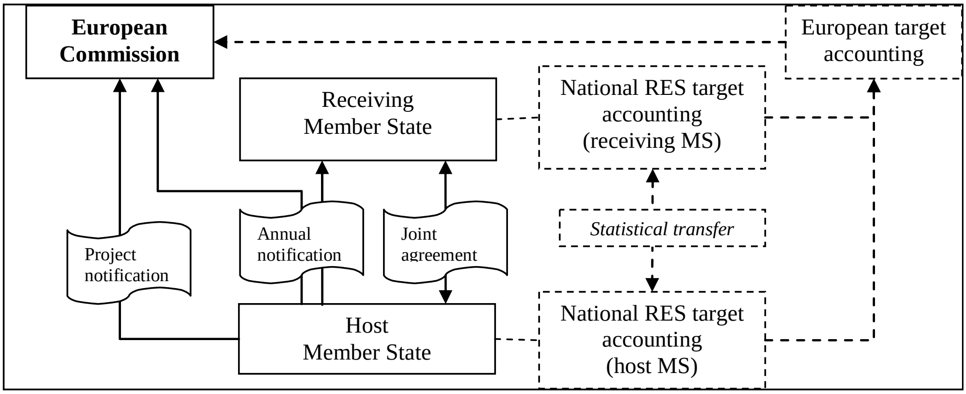

Figure VI-2. Institutional framework for joint projects

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[13] As mentioned above, the directive also provides for the option of joint projects between member states and third countries outside the European Union. For this option, additional requirements apply. Joint projects with third countries are not discussed in this article, because they open up a new range of opportunities and problems.

4.2. Pros and cons of the mechanism

Major pros and cons of joint projects compared to the other cooperation mechanisms have been evaluated by Klessmann (2009).

Joint projects offer a range of generic benefits**.** They provide the opportunity to develop additional RES potentials in countries which are neither interested nor obliged to develop these potentials themselves via their national support scheme. Hence, they allow an additional deployment of (low cost) RES within Europe, which may reduce overall costs of reaching European 2020 targets. Furthermore, joint projects increase the requested flexibility for member states in achieving their national RES targets. Member states can actively initiate a joint project framework to ensure sufficient renewable energy production to meet their targets. They are not dependent on the effectiveness of other countries' support schemes. Joint projects in principle also allow involving private RES project developers in the choice of suitable projects, who are inclined to be more proactive in realising their opportunities than governments. However, governments need to set the joint project framework before private actors can become involved. While this might be a barrier to quick project development, it also ensures that pubic and consumer interests are preserved.

Joint project also have several disadvantages. One disadvantage is that many different joint project arrangements tend to complicate the European support conditions for RES project developers. In addition, if the joint project arrangement and the domestic support scheme in the host country overlap, the effectiveness and efficiency of the domestic support scheme could decrease. Investment in innovative technologies with higher costs, but potentially needed for fulfilling the 2020 targets, is likely to be unattractive for joint project agreements. The development of these technologies might therefore be delayed, unless supported by national support schemes.

4.3. Design options and critical aspects

The following subsections discuss design options for the setup of the joint agreement between member states.

Addressing the key questions which were developed in section 1, the following aspects will be analysed for the design of joint project agreements

- Strategic: Counter-balancing major drawbacks of the mechanism
    - How to avoid the complication of European RES support conditions
    - How to avoid interference between the joint project support and the national support scheme
- Economic: Balancing of costs and benefits
    - By which mechanism can the receiving member state provide financial support to joint projects
    - How can the host member state secure sufficient local benefits
- Legal and administrative aspects
    - How to avoid legal complications between the joint project scheme and the national support scheme of the receiving country
    - Handling and control of financial transactions

4.3.1. Counterbalancing major drawbacks of the mechanism

How to avoid the complication of European RES support conditions?

The accumulation of many different joint project arrangements in the EU member states could inhibit transparency and complicate the support conditions for RES project developers. From a European and project development perspective, a coordinated approach between several member states would therefore be preferable. In order to achieve coordination, member states should exchange their views and requirements on the joint project design at an early stage and explore options for model agreements that can be adopted by several member states and, if necessary, adjust it to their specific needs. Options for coordination could be to use the same type of support mechanism (e.g. tender, standardised feed-in premium) and / or the same type of cost sharing approach for joint projects in several member states.

Regardless if member states manage to coordinate their approaches, they should design the joint project mechanism in a transparent manner in order to make it attractive for other member states, as well as project developers. Important transparency criteria are:

- Clearly defined limits and eligibility criteria of the mechanism
- Appoint a central information desk
- Limit the number of authorities and procedures involved.
- Reflect the split of costs and benefits in the agreement of the involved member states

How to avoid interference between the joint project support and the national support scheme?

By creating a separate support mechanism that co-exists with the primary national support instrument in the host country, the two mechanisms compete with each other. In order to avoid that, the effectiveness and efficiency of the national support instrument decrease, member states may limit the joint project agreement to certain RES technologies or regions or even ex-ante identified technology-specific sites that are not covered by the national support scheme. In the instance that the host country has set a volume cap for domestic RES support, the mechanisms could be used to increase that volume. Also, the host country and the receiving country could coordinate their schemes by implementing the same type of support mechanism for the domestic and joint projects. Such a coordinated approach might already instigate progression toward a joint support scheme.

4.3.2. Balancing of costs and benefits

Before setting-up a joint project framework, both the host country and the receiving country need to reflect on their costs and benefits (see section 2). Within the joint project arrangement, they need to agree:

a) By which financial mechanism, and at what budget, the receiving member state supports the joint project
b) If and by which mechanism the receiving member state compensates the host country for local costs.

The following paragraphs explore different design options for these two questions.

Design options for the direct financial support of RES installations in other member states

In order to receive RES credits for a joint project, the receiving member state needs to provide financial support for RES installations in another member state. This support can be organised in different ways:

1. On a project-by-project basis
2. Through a special support framework for joint projects

The difference between the two options might be gradual. Nevertheless, one can distinguish pros and cons.

Option 1: The support conditions are defined on a project-by-project basis

The support conditions for joint projects could be negotiated for single projects. This procedure could be initiated by the receiving country's government (e.g. launching a tender for a certain RES volume) or by the host country (looking for a cooperating country to participate in a large RES development). Probably, in order to guard public procurement law, financial support would need to be provided via a public tender, in which RES project developers could participate. The tender specifications (minimum requirements, technology specification, payment period, etc.) would therefore be critical for the success of the joint project.

Option 2: The involved member states define a special support framework for joint projects

An alternative is that the involved member states agree on a special support framework for joint projects, under which the receiving member state supports certain types of RES installations in the host member state, against statistical RES transfers towards its own target. One can also think of a setup where the support costs and resulting RES production are shared between the host and the receiving member state. This special support for joint projects could be organised in many different ways, e.g. as investment subsidy, loan, tender, feed-in premium etc[14].

The project-by-project support approach tends to be less complex than setting up a general support framework that applies to many types of RES projects. One can therefore expect that it would be quicker to implement. Also, it allows experimentation with the set-up of joint projects and so seems particularly suitable for the pilot phase of implementing joint projects. Designing the framework for a support mechanism may take more initial effort than for a single project, but once operational, it is available to a larger number of projects, without any further negotiations on a project-by-project basis. The framework support approach therefore seems more suitable on the medium term, and when many joint projects shall be developed. Furthermore, it allows the support of small scale RES installations, while the project-by-project support seems suitable only for large RES projects, e.g. offshore wind farms or large biomass power plants. One issue that needs more consideration for a support framework than for the support of a single project is the potential overlap and interaction with the existing support scheme in the host country.

Design options for the host member state to recover indirect costs

The direct financial support provided by the receiving country is paid to the RES projects. Simultaneously, the RES projects generate domestic costs and benefits for the host country (see section 2). One can expect that the host country will only allow certain technologies, regions or volumes to qualify for joint projects, in order to avoid undesired domestic costs (e.g. additional infrastructure costs or the “sell-out” of low-cost RES potentials which the host country would like to keep for own target achievement). Alternatively, if the domestic

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[14] The difference between such a joint project support framework and a joint support scheme seems gradual. The main distinction may be that the joint project support only applies to RES projects in the host country, while the national support scheme of the receiving country is maintained. In the case of a joint support scheme, the same support framework would apply to both countries.

costs are higher than the domestic benefits, the host country might ask for some kind of compensation for these indirect costs. In order to be acceptable for both the receiving and the host country, this compensation should be settled within a transparent rule or regulation.

The following section will examine two options of how host countries could recover their indirect costs from joint projects:

1. The host country retains a share of the RES production for its own target:
    a) Cost-reflective split between the involved countries
    b) ‘Commission’ fee
2. The host country directly profits financially through transfer premiums:
    a) Fixed transfer premiums
    b) Tendering of transfer premiums

Option 1: The host country retains part of the renewable energy share for its own target

a) Cost-reflective split between the involved countries

If the host country is interested in the joint project’s renewable energy production for its national target achievement, the host and the receiving country might agree to share the financial support costs and the renewable energy production of the joint project. The host country could receive a higher RES share for its target than the share of financial support it provided, to account for local costs.

b) ‘Commission’ fee

Another option could be that the full amount of produced renewable energy is supported by the receiving country, and a certain proportion of the production, counts toward the target of the host country (as a ‘commission’ fee). The host country fixes this share for all joint projects between the two countries, or even for all joint projects hosted. It could also introduce technology-specific shares; for instance, as the system integration costs of wind energy are usually higher than those of biomass electricity, the RES share retained by the host country for wind energy installations might be set at a higher level than that for biomass installations.

Option 2: The host country adds a financial premium per transferred renewable energy unit to recover indirect costs

a) Introduction of fixed transfer premiums

Another option for the host country to recover its indirect costs, is to add a financial premium (e.g. €/MWh) on to the transferred renewable energy volume. The premium would have to be paid by either the receiving country or by the project developer. It could be set e.g. technology specific or differentiated according to the grid environment.

b) *Tendering of transfer premiums*

The host country or its accredited agent could also determine the premium in an auction or tender. Project developers that want to benefit from foreign support for joint projects would need to present bids for covering the indirect costs of the host country. The premium would thus be determined by a market mechanism.

In option 1 (compensation for indirect costs by target shares) the receiving country's investment contributes directly to the host country's target fulfilment. This approach seems attractive if the host country is uncertain if it will meet its own national RES target. Depending on its need, the involvement of the host country can be significant (case a) or small (case b). Furthermore, this approach is easy to communicate and may increase the acceptance of joint projects in both the host and the receiving country. A disadvantage from the European policy perspective may be that the system does not provide the host country with any further incentive to improve its domestic support scheme; on the contrary, one could theoretically think of a situation where the host country could fulfil its target mainly through keeping RES shares of joint projects.

Option 2 (financial compensation for indirect costs) provides direct financial revenues and therefore quantifiable benefits for the host country. This option might be particularly interesting for host countries that are likely to meet their national target and therefore are less interested in additional RES target shares. However, the definition of the transfer premium might be subject to substantial debate and complicate the joint project negotiation. The receiving country could face problems to justify such payments to its tax payers or consumers. In this respect, an auction or tender would hold the advantage that prices are defined by supply and demand and paid by project developers. On the other hand, if not aligned well with the joint project support, the tendering or auctioning process for determining the premium for indirect costs could cause disproportionate transaction costs. Also, large market players could exercise market power, creating market entry barriers for smaller players.

Both options give the host country an incentive to engage in joint project activities with other countries. The host country is, however, advised to keep the retained RES share or the financial compensation at a moderate level to ensure the attractiveness of joint project investments for receiving countries; both types of compensation make the statistical RES import more expensive and thus less attractive for the receiving country. As mentioned above, one can also think of a situation where the host country judges the local benefits of a joint project higher than the resulting benefits and thus will not ask for any compensation.

An issue that needs to be considered under all above mentioned arrangements is the local acceptance of joint projects. Governments need to carefully examine if the "not-in-my-backyard" (NIMBY) opposition against RES projects increases for RES projects which count towards a foreign RES target. They should ensure that local communities participate sufficiently in the benefits of joint projects.

4.3.3. Legal and administrative aspects

Joint project arrangements can be designed as a special type of support scheme, or possibly even as extension of an existing national support scheme. An important legal question is how to combine the two schemes without creating legal complications (see discussion on legal problems of guarantees of origin trade, Johnston et al. 2008). This complex issue cannot be further investigated here, but it is a question of design detail and does not challenge the implementation joint project in general.

4.4. Conclusions

Joint project arrangements can be considered a versatile cooperation mechanism: They can be implemented as short or long term and allow many different design variants. Private project developers will probably have considerable interest in the use of such mechanisms that allow them to tap additional RES potentials in other countries. Conversely, the interest of different lobby groups also poses a challenge to governments: they need to provide a framework that provides open access to all commercial parties. Governments may find it complicated to define a suitable framework. The main risk from the project developer's perspective is that the joint project framework is complicated to apply in practice.

Designing joint project frameworks for single projects (project-by-project approach) may help initiate the process and gain experience. In the medium term, a broader support framework for joint projects seems more favourable with regard to avoiding bureaucracy and reaching significant RES volumes.

Whether the host country will ask for compensation, for allowing joint projects on its territory will depend on the project specific balance of local costs and benefits. If so, retaining part of the project's RES production for its own target seems to be the most straightforward solution, but asking for financial compensation would also be possible. It is expected, however, that the definition of a direct financial premium will be more controversial or complicated than an agreement to split the project's RES production.

A considerable risk of joint project arrangements is that they complicate the European RES support conditions and interfere with national support instruments. Therefore it is important that member states will exchange and coordinate their design approaches at an early stage.

5. Joint support schemes

5.1. Definition of joint support schemes

Article 11 of the renewable energy Directive, defines the option of mutual target achievement between two or more member states, based on *joint support schemes*. It states that "two or more member states may decide, on a voluntary basis, to join, or partly coordinate their national support schemes. In such cases, a certain amount of energy from renewable sources produced in the territory of one participating member state may count towards the national overall target of another participating member state."

Article 11 provides two alternatives how to implement the reallocation of RES volumes. Member states concerned may, according to §1 (a), "make a statistical transfer of specified amounts of energy from renewable sources from one member state to another member state"; or, according to §1 (b), "set up a distribution rule agreed by participating member states that allocates amounts of energy from renewable sources between the participating member states". Such a distribution rule needs to be "notified to the Commission no later than three months after the end of the first year in which it takes effect".

In practice, the two options are likely to be quite similar: In the case of option (a), using statistical transfers in a procedural manner as necessary for joint support schemes would require some sort of at least internal distribution rule as specified explicitly for option (b). In both cases, the involved member states would also need to agree on some internal distribution rule for costs and benefits of the transferred RES (see below).

5.2. Pros and cons of the mechanism

Major pros and cons of joint support schemes have been evaluated by Ragwitz et al. (2007), Sensfuss et al. (2007) and Klessmann (2009).

Advantages of joint support schemes in comparison to the other cooperation mechanisms include: They inherently allow a better relation of the available RES potentials with the agreed RES targets by establishing (partly) equal financial incentives for RES projects in all participating countries, and, consequently, it can be expected that deployment takes place at the most cost-efficient sites. Furthermore, joint support schemes have strong future perspectives by paving the way to a more coordinated and potentially harmonised EU support framework. They may create an added value in addition to the sole flexibility between member states, e.g. by creating larger markets for RES, which improves economies of scale for investors.

Disadvantages of joint support schemes may be: They require an intense coordination between member states that need to share their sovereignty to design joint support schemes, e.g. parliaments of two member states have to jointly agree on a law. Despite the overall willingness to follow such an approach, long lead times for their practical implementation can be expected. Joint support schemes also provide less flexibility to adjust imports or exports of (virtual) RES generation to the member states’ actual level of target achievement. In other words, member states using a joint support scheme still face the ex-ante uncertainty if they produce the right amount of renewable energy needed to achieve their targets. Adjusting the incentive of the joint support scheme to the required level may take a relatively long period, and thus fail to become effective in the allocated time frame. Finally, joint support schemes require intense debates regarding the cost and benefits of different renewable technologies among the participating member states, which, in addition to differences in their national support schemes, may also have different cultures and attitudes with respect to certain technological choices.

5.3. Design options and critical aspects

For implementing a joint support scheme, different principal decisions are necessary with respect to the overall design of the system.

Addressing the key questions which were developed in section 1, the following aspects will be analysed for the design of joint support schemes:

- Strategic: Counter-balancing major drawbacks of the mechanism
    - Achieving an agreement on the joint support instrument and its detailed design. Measures to speed up its implementation
    - Assuring sufficient flexibility for actual target achievement
- Economic: Balancing of costs and benefits
    - Inclusion of different cost elements and benefits into the joint support scheme
    - Principal variants for the accounting of costs and benefits
- Legal and administrative aspects
    - Accounting RES deployment
    - Establishment of a common fund

5.3.1. Counterbalancing major drawbacks of the mechanism

Achieving an agreement on the joint support instrument and its detailed design. Measures to speed up its implementation

Initially, member states are required to select and design the joint support system. Most criteria that are important for a bilateral or multilateral implementation are similar to those needed for a national implementation. Therefore, it can be expected that less discussions are necessary on the choice of the system itself, because all participating member states have already expressed their implicit commitment by voluntarily opting for a joint support system. Discussions may well occur, however, with respect to the detailed design e.g. due to differing technological preferences etc. Additionally, member states need to define a set of regulations for the accounting of RES volumes and corresponding cost and benefit prior to the start-up of the system itself. At first glance, this appears to be less important in the case of a joint quota system accompanied by a certificate trading scheme as both RES volumes (by means of certificates) and corresponding support cost are balanced between the countries by the system implicitly. However, in the case that besides support costs also other cost elements and benefits shall be taken into account, a distribution rule needs to be set up which will be discussed in further detail in the subsequent section 5.3.2.

In order to speed-up the practical implementation, a clear ranking of necessities is recommended, where decisions on accounting variants may be given priority. A stepwise implementation of the joint support system may appear beneficial. In a start-up phase, only a partial harmonisation of RES support could be implemented. For instance, in the case of a joint premium system, equal technology-specific feed-in premiums could be applied only for a set of low- to intermediate-cost RES technologies (e.g. wind energy, biomass, biogas, biowaste, hydro). For more costly, innovative RES technology options (e.g. photovoltaic, solar thermal electricity, tidal and wave power), financial support would be defined in accordance with national circumstances, but generic design criteria (i.e. guaranteed duration of support, technology coverage) would be applied for all participating countries[15]. This could then become a more harmonised system in the future.

Assuring sufficient additional flexibility for actual target achievement

As stated above, a possible disadvantage of joint support systems is that they may provide less flexibility to adjust imports or exports of (virtual) RES generation to the actual level of target achievement in time. A pragmatic solution for solving this may be to leave sufficient authority to the individual member states for applying additional cooperation measures. Another possibility would be the ex-ante inclusion of implicit correction measures in the policy design of the joint system itself – e.g. by opting for periodic assessments and corresponding amendments if the predefined criteria are not met.

5.3.2. Balancing of costs and benefits

As joint support schemes are the most comprehensive and long-lasting cooperation mechanism, we consider the clear rules for sharing costs and benefits to be the most crucial aspect for establishing a joint support scheme. We will elaborate on such rules in some detail in the subsequent paragraphs. Before defining the accounting rules, however, the involved countries need to agree on the considered cost elements and benefits. This is discussed below.

Inclusion of different cost elements and different benefits into the joint support scheme

Before the administrative development of a joint support scheme can be started, participating countries have to reach an agreement which costs and benefits can be attributed to renewable energies supported by this scheme. Only after such a general agreement on the costs and benefits caused by RES is reached, options may then be

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[15] The harmonisation of support conditions would also require the harmonisation of electricity market conditions that interact with the support scheme, see Klessmann et al. 2008 and Ragwitz et al. 2007.

discussed regarding how these costs and benefits will be attributed to each party. Both costs and benefits may involve significant uncertainties and may be subject to substantial debate (e.g. this point was the reason for the unsuccessful attempt to set up a joint quota system between Norway and Sweden[16]).

Principal variants for the accounting of costs and benefits

Also in the case of joint support schemes, one can identify importing and exporting countries, based on a statistical transfer of electricity and heat generation. The additional costs of the exporting country have to be covered in a well defined manner by the importing country. In order to achieve this, clear rules for accounting need to be set up. In the instance of a joint quota system accompanied by a certificate trading scheme, such a rule would be implicitly set – i.e. a harmonised sharing of support costs would occur where obliged actors face equal specific cost (i.e. the certificate price) per unit of RES (virtually) consumed. However, with this approach no redistribution of benefits or other cost elements besides the direct support costs would occur.

We have identified five feasible principles for accounting for costs and benefits which are addressed briefly below. These accounting approaches are exemplarily illustrated for the case of a joint feed-in premium system:

- <u>Accounting approach I: Average premiums for RES surplus</u>

  Approach I describes a methodology to share the cost for RES support between the involved countries solely for the surplus / shortage of RES. Cross-border exchange (i.e. financial transfer and reallocation of RES volumes) takes place only for the country-specific deployment of new RES installations which is not needed for

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[16] The only existing experience with the attempt to introduce a joint support scheme in Europe is the example of the joint green certificate scheme between Norway and Sweden, which was discussed between the two countries between 2001 and 2006. Despite the fact that the two countries had very favourable framework conditions for the introduction of such joint system (e.g. common power market, similar attitude towards the manner of RES-E support) the attempt failed in 2006. The main reason was that it was very hard to find a final agreement how to share the costs and benefits in such system. The reason the Norwegian Ministry gives in its press release of February 26, 2006, for the failure of the plans is that the support system “would become too expensive for the Norwegian consumers and the industry” (Norwegian Ministry of Petroleum and Energy 2006). The question of how to finance the system became the final and insurmountable political barrier to the introduction of a common system. Although both countries had the best preconditions for the introduction of a common support system, the plans could not be carried out. Mari Hegg Gundersen from the Norwegian Water Resources and Energy Directorate stated it was a question of “how to split the bill” (Hegg Gundersen 2007).

target fulfilment in the country of origin. Therefore, average premiums arising for the support of new RES installations in the exporting country are used for pricing.

- Accounting approach II: Marginal premiums for RES surplus

  Similar to approach I, the cost sharing methodology is applied solely for the surplus / shortage of RES. In contrast to approach I, however, the price (per unit of RES generation) used for cross-border exchange is set by the additional RES generation that is not required for the domestic target fulfilment in the exporting country. Therefore, the average premium of the additional basket of RES technologies is applied for price setting. Casually speaking, this represents a sort of marginal pricing.

- Accounting approach III: Negotiated premiums for RES surplus

  Participating countries agree on a uniform minimum premium for all RES options (aiming to reflect the international benefits of RES generation) which is then shared equally between all countries in accordance with the national RES exploitation. Similarly to accounting approach I and II, a cross-border monetary exchange occurs only for the surplus / shortage of RES. The main difference to both approaches discussed above, is that the price of cross border exchange is determined by an ex-ante negotiation process.

- Accounting approach IV: Harmonised sharing of costs (neglecting pure national benefits)

  In this variation, a “full harmonisation” with regard to the resulting support costs for RES takes place. The arising expenditures are equally distributed among all participating countries in accordance with the national RES targets - independent from where the actual RES deployment takes place. For establishing the financial transfer, a common fund could be a suitable option, even though legal aspects (e.g. state aid) need to be considered. This fund would be fed by the individual countries in accordance with their RES targets (or more precisely the corresponding required new RES deployment). The redistribution would then be completed in accordance with the realised new RES exploitation. The local / national benefits of RES are neglected in this approach because only (support) costs are taken into consideration for the monetary cross-border exchange.

- Accounting approach V: Harmonised sharing of costs & benefits (considering pure national benefits)

  This accounting approach can be described as a “full harmonisation” of both the resulting costs, as well as the benefits of RES support. In contrast to accounting approach IV, only an agreed share of the total support costs occurring at cluster level are equally distributed among all cluster countries in accordance with the national RES targets. The remaining part of the costs, representing pure national benefits, has to be retained by the country of origin – i.e. where RES deployment actually takes place. Again, in order to establish the financial transfer, a common fund may be a suitable option.

5.3.3. Legal and administrative aspects

Accounting RES deployment

Before any accounting of support expenditures can take place, an agreement on the accounting of the RES deployment has to be found, in case of joint solutions for the fulfilment of national RES targets. Obviously, a crucial situation occurs when there is non-compliance with binding RES targets at the aggregated cluster level (i.e. comprising all participating countries of the joint support system). In the following paragraph, a few ideas and remarks are discussed in this respect.

- Initially, the accounting problem appears to be resolved in the case of a joint quota system accompanied by a certificate trading scheme. In practice, however, this changes if technology banding is included for certain reasons (e.g. to assure the required contribution of more costly RES options, and / or to avoid over-support of low-cost RES options). Consequently, a further agreement still needs to be taken, as a deviation of certificates and RES volumes appears feasible.
- The cost accounting principle does not predetermine the use of a certain accounting scheme with regard to RES deployment.
- Jointly tuned action plans describing the expected future RES deployment in accordance with future targets represent a necessary tool in this respect. Accompanying this with a binding bi- or multilateral agreement (involving e.g. also financial penalties in case of non-compliance against the agreed trajectory) might already be sufficient to determine country-specific RES accounting (where the financial cross-border transfer would then be determined by the corresponding cost accounting scheme).
- Besides, positive encouragement by means of providing technical and / or administrative assistance might be soft tools to ensure delivery of the agreed objective.

Establishment of a common fund

In order to create a mutual component of the support system, i.e. an equal premium, which can then be equally distributed among all participating countries, a common fund may be appropriate. This common fund needs to be based on an agreement between the participating countries. However, legal aspects in the context of establishing and administrating such a common fund (e.g. state aid) need to be taken into account.

5.4. Conclusions

From a theoretical view, a joint (harmonised) support system inherently allows a better utilisation of the RES potentials available in the involved member states by establishing (partly) equal financial incentives for RES projects in all participating countries.

Consequently, it can be expected that deployment takes place at the most cost-efficient sites.

Furthermore, joint support schemes may provide valuable experience to the discussion on a more coordinated and potentially harmonised EU support framework for RES. In addition, they may also create an added value besides the sole flexibility between member states, e.g. by creating larger markets for RES, which improves economies of scale for investors.

Compared to the other cooperation mechanisms, a joint support scheme represents the most extensive option, which need intensive coordination and debate, whereby e.g. parliaments of all participating countries have to jointly agree on a law. Consequently, regardless of the general willingness to utilise such an approach, long lead times for its practical implementation can be expected. Several agreements on e.g. clear accounting rules need to be taken well in advance to the actual implementation of a joint system. There is a need for such agreements even in the case of at first glance simple solutions – compare e.g. the discussion above on the use of statistical transfers for reallocation of RES volumes (as defined in Article 11, §1 (a)), or the implicitly solved reallocation of (support) costs in the case of a joint quota system (accompanied by a certificate trading scheme).

6. Overall conclusions and recommendations

The RES directive introduces the cooperation mechanisms to account for the uneven distribution of RES potentials across member states, allowing those member states with low or expensive RES potential, to partially fulfil their national RES target in other countries with higher RES potential or lower production costs. According to the current member state forecast documents, most countries prefer to rely on their national support schemes for target compliance, reflecting their desire to reap the economic, social and environmental benefits of developing RES nationally (European Commission 2010). This picture may still change in the coming years, however, depending on the success of national support policies, In any case, the cooperation mechanisms have a strategic relevance from the European policy perspective: experience gained from implementing cooperation mechanisms might contribute to the discussion on a more coordinated European RES support framework.

From a policy design perspective, none of the three cooperation mechanisms can be identified as a preferable or superior option. Instead, one should consider these options as a gradual transition from member state cooperation under fully closed national support systems (in case of statistical transfers) to cooperation under fully open national support systems (in a joint support scheme). Joint projects can be implemented under fully closed support schemes, but their standardisation heralds the implementation of joint support schemes.

All three mechanisms have their specific benefits and disadvantages:

- Statistical transfers between member states can be applied easily, without the negotiation of a complex framework, but if applied solely (i.e. not as part of joint projects or joint support schemes), they tend to be an ad-hoc instrument that might not help developing additional RES potentials.
- Joint projects provide the opportunity to develop additional RES potentials in Europe and allow the active involvement of private RES project developers, but pose the risk of complicating the European RES support conditions and interfering with national support instruments.
- Joint support schemes could expose the prospects for the medium to long-term future – potentially leading the way to a more coordinated EU support framework, but they also need intensive debate and coordination between individual member states. For this reason, long lead times for their practical implementation can be expected.

Design options to counterbalance the major drawbacks are:

- The set-up of long-term arrangements for statistical transfers, in order to promote the development of additional RES potentials and ensure sufficient flexibility
- A coordinated joint project approach of several member states to increase transparency for project developers
- Measures to speed up the implementation of joint support schemes, e.g. a stepwise harmonisation for different technologies

Another key issue for the design of all three cooperation mechanisms is the balance of costs and benefits between the involved member states. Besides the direct support costs, member states should consider the indirect costs and benefits for RES deployment in their cooperation. We have proposed several options to transparently reflect the direct and indirect costs and benefits in the design of the three mechanisms. The final balance, however, will be the result of a negotiation process between the involved member states.

To this day, it remains unclear whether member states will start negotiation processes in time to actually implement the cooperation mechanisms. It therefore seems practical and significant that some member states assume a leading role to initiate the first implementation steps. Within such initiatives, they should consider the different time perspectives of the three cooperation mechanisms. Statistical transfers can be realised within relative short timeframes, e.g. to meet the interim targets or to compensate for unforeseen forecast deviations. However, in the case that member states want to use them as a reliable cooperation instrument in 2020, they should negotiate long term agreements at an early stage. Joint projects and joint support schemes allow for a more intense and long-lasting cooperation, but they require longer lead times and potentially more complex agreements. If member states decide to go for this route, they need to start negotiating soon, preferably before the Commission will evaluate their efforts in 2014. Joint pilot projects could be used as testing grounds for a broader cooperation framework between two or more member states, if the latter does not find political support at such early stage. Experimenting with statistical transfers may also provide valuable experience in this respect.

A blueprint for cooperation agreements, derived from first common experiences, could help overcome the inertia connected to the lack of national experience and the initial hesitation to implement the new mechanisms on a larger scale across Europe. A first step towards practical cooperation should be the exchange of views and (national) interests between interested national governments, as well as the exchange between governments and RES industry representatives.

While some lessons can be drawn from the RES support policy design and the flexible mechanisms under the Kyoto protocol, the current lack of national experience and supporting scientific evaluation of any of the three mechanisms will most likely create uncertainty regarding the effect of the first cooperation initiatives. It is therefore important to continuously monitor the development and evaluate the performance of the cooperation mechanisms in the future. Scientific support of government actions taken to implement the mechanisms should prioritise the balancing of costs and benefits. In addition, the impact of the cooperation mechanism chosen on the manner in which countries assist each other in reducing non-economic barriers will be interesting.

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VII. Summary and conclusions

1. Summary

The thesis discussed the effective and cost-efficient design of renewable energy sources (RES) support policies in the European Union along some major discussion lines of the European RES policy debate:

- the effectiveness of the different national support policies in the member states
- the cost savings potential of different cost reduction policies for reaching the 2020 RES target
- the role of market risk exposure and market integration for RES deployment and the cost-efficiency of RES support
- the role and design of cross-country cooperation mechanisms for efficient RES target achievement.

Chapter II analysed the recent progress in RES deployment and policy in the European member states by using aggregated deployment status and policy effectiveness indicators that combine European statistics and country-specific data. The results show that significant progress toward furthering European RES deployment and policy has been made in recent years. The RES electricity sector has grown rapidly, mainly due to the mature but still evolving technologies for onshore wind and different types of biomass electricity (co-firing and pure biomass combustion). The use of biodiesel in the transport sector has also experienced high growth rates. In contrast, RES growth in the heating sector was rather moderate, also due to the absence of a specific EU legislation for RES-H until 2009. Small-scale, wood-based biomass applications were the dominant technology for heating. Over a six year period, onshore wind, biofuels and biomass electricity reached the highest average policy effectiveness across Europe, while in the heating sector, all technologies reached less than half of the score compared to wind onshore. The market growth in all the sectors has mainly been driven by effective policies in a small or medium number of top runner countries. The top runners with the highest deployment status and policy effectiveness differ for each technology. For the promotion of onshore wind, biogas, and PV, all top runner countries used feed-in tariff or premium schemes. For solid and liquid biomass electricity (including biomass co-firing), quota schemes have also figured among the top runners. Even though all EU-27 member states have RES policies in place, the majority of countries have a low policy effectiveness and deployment status for almost all RES technologies. As many of these countries are small in population and energy consumption, these low scores do not fully show on European average.

RES support policies focus strongly on removing financial barriers in order to force RES technology entry into the energy markets. As previous analyses have shown (e.g. Ragwitz et al. 2007, de Jager and Rathmann 2008, etc.), the success factors for an effective and efficient support policy design include policy stability, the reduction of project risks, a stable financing source that is independent of the state budget, and the regular adjustment of support conditions to market progress. At the same time, success is often also determined by non-economic factors, particularly the removal of administrative and legal barriers, e.g. for permitting and grid access. Best practice examples from various countries show that these barriers can be successfully dismantled. Growth-related barriers that have evolved in recent years in more advanced markets pose a greater challenge, e.g. infrastructural barriers and curtailment in the power sector.

A comparison of the recent progress in RES deployment to the increase required to meet the European target of 20% RES in gross final energy by 2020 shows that, though Europe will need to make additional policy efforts, this does seem manageable. According to the National Renewable Energy Action Plans (NREAPs), 15 member states are even planning to over-achieve their national 2020 target, though it is not yet fully clear which policy strategies they will employ to do so. The results of the quantitative analysis indicate that the majority of member states are on track to achieving the interim trajectory provided by the RES directive, which allows for moderate RES growth until the last two years before 2020. In order to achieve the higher growth rates required by the end of the target period, the majority of member states must enhance their policy effectiveness, thereby closing the gap to the top runner countries. This is even more critical as some top runners may well struggle to maintain their RES growth under the evolving growth-related barriers. While it is true that member states propose additional policy actions in their NREAPs, it remains doubtful whether these will be sufficient to trigger the projected targeted growth.

Critical success factors for reaching the 2020 targets include: the implementation of effective and efficient policies that promote high project success rates and attract sufficient investments; the reduction of administrative and grid-access barriers, especially in currently less-advanced countries; upgrading the power grid infrastructure; dismantling financial barriers to RES technologies in the heat sector, e.g. through budgetary-independent support instruments; the proper implementation and possible extension of sustainability standards for biomass; and—last but not least—the reduction of energy demand through increased energy efficiency policy efforts.

Chapter III analysed multiple policy options for reducing the costs of RES project development and financing on the one hand and for reducing the overall RES policy costs for consumers or taxpayers on the other hand. The discussion then focused on how far these options are interlinked and what role they can play in achieving the EU 2020 RES targets. The results show that risk-conscious, investment-grade RES policies are crucial for attracting sufficient RES investments by 2020 and for achieving the RES targets cost-effectively. The results also show that risk-conscious policies not only reduce the cost of capital, as frequently pointed out in previous analysis (e.g. de Jager and Rathmann 2008), but also reduce the project development costs. Indirectly, they may also increase market revenues, e.g. through the facilitation of more favourable power purchase agreements.

From a consumer/taxpayer cost perspective, not all project risks should be made a public burden, as risk exposure may also lead to cost-optimised behaviour by RES project developers and operators. For many risks however, the macro-economically positive effect for risks carried by RES producers is zero or very low compared to the cost increase for the project, and the public or a publicly regulated entity might be better prepared to cover the risk. Reducing such risks therefore also reduces support costs for consumers. In particular, policy and administrative risks do not show any positive effects and can be reduced at low cost. The removal of market revenue risks might be somewhat more ambiguous but the experience across Europe shows that reducing revenue risks is a crucial policy element for attracting investments and stimulating RES growth. Technology risks should rather not be made a public burden but policy makers may facilitate the successful management of such risks through private entities.

Generic policy recommendations for reducing RES project risks and costs while keeping the costs for consumers/taxpayers low are:

- Ensuring long-term commitment towards renewable energy and increasing the stability of the regulatory framework, which increases the trust of market players;
- Removing risks by removing administrative and market barriers;
- Removing revenue risk where risk exposure does not trigger macro-economically efficient risk mitigation actions by RES projects; and
- Reducing risk by sharing risk, at least in cases when the public sector is sufficiently equipped to take on (part of) the risk.

From the macro-economic perspective, there are also other options that can significantly reduce the RES support costs, i.e. the adjustment of support levels to generation costs, phasing out subsidies for fossil and nuclear energies, and the cost-optimisation of the supported RES technology portfolio, either through increased cooperation between member states and/or through changes in the supported technology mix. Contrary to the risk reduction options, these latter options do not appear as a precondition for 2020 RES target achievement but rather hold the potential to significantly reduce the cost of target compliance for consumers and tax payers which, given the limited government budgets and consumer willingness to pay for RES support, in return increases the likeliness of target compliance. On the other hand, the analysis also showed that European coordination and focus on lower cost technologies are by no means straightforward policy strategies. If implemented in the wrong way, they can lead to additional risks, costs and acceptance problems. Overall, further improvement and coordination of existing policy frameworks seems more promising than drastic system changes, as the latter would create additional uncertainties and potentially negative effects on RES growth and project costs.

Chapter IV discussed the pros and cons of exposing renewable electricity (RES-E) producers to electricity market risks, based on the analysis of how RES-E producers are integrated into the electricity market under the support legislations and regulatory frameworks within Germany, Spain, and the UK (status 2007). The focus was on wind power, which faces the highest market integration challenge of all RES-E. The analysis showed that the three countries follow contrasting approaches in exposing RES-E producers to the market risks of forward electricity markets, balancing markets and system planning requirements. In Germany, the transmission system operator (TSO) receives full responsibility for electricity sales, balancing, and grid integration of RES-E and related costs are passed on to consumers. In Spain, RES-E generators can choose between full and partial responsibility for the market integration of their produced electricity. In the UK, RES-E generators are fully responsible. No matter which approach is chosen, RES-E is physically integrated into the market, influencing its price level in forward and balancing markets.

From a policymaker's perspective, there is a trade-off between a "high risk" and a "low risk" approach:

- Price risks in forward electricity markets: The exposure to price risks will lead to higher risk premiums for the RES-E generator than the isolation from price risks. However, this also leads to a better match of supply and demand, if RES-E generators are capable of scheduling their generation according to market prices. Wind power plants will hardly react to such price signals.
- Forecasting and balancing risks: Central forecasting of RES-E production by the TSO has the potential for high precision, but only if the TSO has an incentive to minimise costs. If RES-E generators are responsible for balancing their generation, this creates an incentive for RES-E producers to minimise imbalance costs. On the other hand, such an approach leads to higher risk premiums for smaller RES-E producers and possibly to a market concentration of larger players in the wind power market, since the forecasting quality improves with the number of forecasted generators.
- Grid connection and system planning risks: The allocation of grid reinforcement costs to the project developer leads to cost reflective behaviour, limits the necessary grid reinforcement and minimises the additional costs for the electricity system. On the other hand, given the current structure of the electricity grid that is not prepared for large scale RES-E integration, these costs can become a high barrier for further RES-E deployment, especially in the wind energy sector.

The assignment of market risks to RES-E projects is thus a two-sided issue. Compared to a minimum risk approach, higher market risks increase the project costs for RES-E generators. Consequently, a higher level of financial support is required to stimulate RES-E development. In contrast, the exposure to market risks may also give an incentive to RES-E generators to make efficient use of the respective market and to act in a cost-reflective way, thus limiting the indirect costs to society. If RES-E generators are not exposed to market risks, the regulatory challenge arises of how to organise central market integration (mostly by the TSO) in a cost-efficient way. Without incentives for efficient integration and respective control mechanisms, the indirect costs to society may be higher than necessary.

The special characteristics of wind power will increasingly influence forward markets, balancing markets, and system planning requirements. They also set natural limits to the response of wind power to market prices and locational price signals. For this reason, policy makers should assess carefully whether RES-E should be exposed to such price risks and under which framework conditions. As supply driven energy technologies, wind and solar energy seem more critical in this respect than other RES-E technologies. The attribution of market risks should be based on a number of parameters: the share and structure of renewables in the system, the specific regulatory framework of the electricity market, and the competitiveness of the electricity market. In any case, it is clear that in order to integrate large shares of wind energy into the system, electricity grids and market regulations will need to be adapted to the new generation characteristics.

Chapter V and chapter VI dealt with the option of cross-country cooperation for RES target achievement. Chapter V traced back the political discussion that led to the evolution of the flexible cooperation mechanisms introduced by RES directive 2009/28/EC. One of the most debated issues prior to the adoption of the directive was the design of "target flexibility mechanisms", which would allow member states with low or expensive RES potential to partly fulfil their national RES targets in other countries. The chapter evaluated the most prominent flexibility mechanisms under discussion during the negotiation process of the RES directive, i.e. unrestricted guarantees of origin (GO) trade between private parties, GO trade with trade restrictions, joint projects, joint support schemes, and statistical transfers between Member States, using the following set of qualitative criteria:

- Effectiveness in reaching the national and European RES targets for 2020, determined by the sub-criteria
    - Enabling Member States to meet their national RES targets
    - Facilitating dynamic RES market development
- Cost-effectiveness (efficiency) of reaching these targets, determined by the sub-criteria
    - Use of low-cost RES potentials
    - Preserving the cost-effective design of national support schemes
- Political criteria that need to be met to find wide political support for the proposed flexibility mechanisms
    - Preserving the sovereignty of Member States on RES policy
    - Public acceptability
- Technical criteria that reflect to what extent the flexibility scheme can be smoothly operated in practice
    - Easy implementation
    - Transparency
    - Legal robustness

The evaluation shows that there is no optimal flexibility mechanism. The most extreme evaluation results were found for GO trade. Though there were some clear advantages regarding flexibility, there were also strong drawbacks regarding the sovereignty of the member states on their support policies and the overall cost-effectiveness of RES support due to the expected “cherry picking” of the highest available support level by RES producers and the resulting over-support of low cost RES projects. Since these drawbacks can be considered “knockout criteria”, it seems reasonable that the GO trade mechanism has been excluded from the final RES directive. The mechanisms that have replaced GO trade in the directive—joint projects, joint support schemes and statistical transfer between member states—provide less flexibility but score better against a number of other important criteria, particularly preserving the cost-effectiveness and stability of national support schemes as well as public acceptability. The crucial question for the coming years is how their utilisation can be facilitated. One first step might be that proactive member states define relevant design issues for implementing the mechanisms. The effective design of the joint project mechanism and of joint support schemes will especially need to be further elaborated. In a second step, pilot mechanisms should be implemented to provide practical experience. Once in place, these mechanisms could be further optimised and may motivate further member states to use the mechanisms.

Chapter VI explored in more detail the potential design options for the three inter-European cooperation mechanisms (statistical transfers, joint projects between member states, joint support schemes), answering the following lead questions: How to counterbalance the major drawbacks of each mechanism? How to reflect a balance of costs and benefits between the involved member states?

From a policy design perspective, the three cooperation mechanisms can be identified as a gradual transition from member state cooperation under fully closed national support systems (in case of statistical transfers) to cooperation under fully open national support systems (in a joint support scheme). All three mechanisms have their specific benefits and disadvantages:

- Statistical transfers between member states can be applied easily, without the negotiation of a complex framework, but if applied in solo (i.e. not as part of joint projects or joint support schemes), they tend to be an ad-hoc instrument that might not help to develop additional RES potentials.
- Joint projects provide the opportunity to develop additional RES potentials in Europe and allow the active involvement of private RES project developers, but pose the risk of complicating the European RES support conditions and interfering with national support instruments.
- Joint support schemes could expose the prospects for the medium to long-term future, potentially leading the way to a more coordinated EU support framework; however, they also need intensive debate and coordination between individual

member states. For this reason, long lead times for their practical implementation should be expected.

Design options to counterbalance the major drawbacks are:

- The set-up of long-term arrangements for statistical transfers in order to promote the development of additional RES potentials and to ensure sufficient flexibility
- A coordinated joint project approach of several member states to increase transparency for project developers
- Measures to speed up the implementation of joint support schemes, e.g. a stepwise harmonisation for different technologies

A key issue for the design of all three cooperation mechanisms is the balance of costs and benefits between the involved member states. In addition to the direct support costs, member states should also consider the indirect, domestic costs and benefits for RES deployment that are involved in their cooperation. The chapter proposed several options for transparently reflecting the direct and indirect costs and benefits in the design of the three mechanisms. The final balance, however, will be the result of a negotiation process between the involved member states.

According to the Member States' forecasts, almost all countries prefer to rely on their national support schemes for target compliance, reflecting their desire to reap the various benefits of developing RES domestically. This picture may still change in the coming years, however, depending on the success of national support policies. In any case, from the European policy perspective, the cooperation mechanisms have a strategic relevance: experience gained from implementing cooperation mechanisms may contribute to the discussion on a more coordinated European RES support framework.

2. Conclusion and outlook

The analysis showed that the effectiveness and efficiency of RES support policies is still low in many European member states but that top runner countries have gained significant experience in tailored RES policy design.

The key recommendations for improving the effectiveness and efficiency of RES support policies across Europe are:

- Reducing policy and market risks, particularly those that have no or little potential to trigger cost-optimised behaviour of RES generators
- Ensuring long-term commitment and increasing the stability of the regulatory framework for RES

These recommendations are not new but their potential effects on RES investments, project development, and market operation have been described (and partly quantified) in new detail in the preceding chapters. The overall cost savings potential of risk conscious policies for reaching the 2020 RES target has been estimated at € 3.3-3.8 billion per year for the period 2011-2020 (based on the model based Green-X calculations in de Jager et al. 2011).

In addition to improving the effectiveness and efficiency of their national support instruments, policymakers should consider the increased use of cooperation mechanisms that could potentially further decrease the cost of European RES target achievement, at least if the respective cooperation mechanisms do not introduce additional risks and uncertainties. The model based assessment with Green-X in de Jager et al. (2011) estimates the cost savings of European cooperation at € 2.3-2.8 billion per year from 2011-2020. In practice it seems unlikely that the full potential will be reached. For many member states, local benefits (job creation, security of supply, etc.) and public reservations against the support of RES in other countries tend to make the domestic deployment of RES much more attractive than a pure assessment of generation and support cost would suggest. These domestic benefits have not been systematically quantified on a European scale nor have they been compared with the cost savings in support costs through the increased use of cooperation mechanisms.

The chapters of this thesis were written between 2007 and early 2011. How have policy debate and implementation developed during this period and what are the perspectives until 2020 and beyond?

Some of the issues discussed have been further "mainstreamed" in the last years:

- The importance of risk mitigation for successful policy design has been more widely recognised, yet not widely implemented.
- Policymakers and analysts have recognised that RES-E affect European power market prices and that increasing shares of supply driven RES-E not only require tailored support instruments, but also changes in power market design. However, there is still no consensus as to what this transition and new design should look like in detail.
- Despite their initial reluctance to use the cooperation mechanisms (according to their national RES action plans, all but two countries plan to meet their targets domestically), member states increasingly explore the possibility of implementing these mechanisms. In particular, the first initiatives to realise joint projects with countries outside the EU have been launched, e.g. by Italy with Montenegro, Albania and Tunisia as well as France with Morocco.

On the other hand, some new challenges have emerged, particularly as a result of the worldwide financial crisis:

- The 2008/2009 financial crisis has significantly increased the difficulty of finding sufficient capital for the necessary RES investments. This problem may reoccur as a result of the current (2011) European crisis and thus might endanger the timely target achievement.
- As a result of the financial and economic crisis, the debts of many member states have increased dramatically. In response, governments have cut their budgets rigidly (or intend to do so). This constellation tends to have a negative effect on

their RES policy: less money is available for RES support and the goal of reaching RES targets drops in priority.

- At the same time, the current crisis is likely to result in increased cooperation and coordination of the EU economic policy. Whether this will also affect the level of cooperation on RES support remains to be seen.

Against the background of this risk-averse financial environment and the new budgetary constraints, it has become even more important for governments to take measures to reduce RES financing risks. Without such risk reduction, it seems unlikely that sufficient investments will be attracted to reach the EU 2020 targets.

One discussion that has continued nearly unchanged is the political debate pro and contra the opening and harmonisation of national support schemes and the introduction of a separate European market for (financially supported) green electricity. The debate dates back to the European Commission’s report on harmonisation requirements in 1998 (European Commission 2008) and was refuelled during the negotiation and evaluation phase of the RES electricity directive 2001/77/EC as well as during the negotiation of the current RES directive 2009/28/EC in the years 2007-2008, when the Commission proposed to introduce a Europe-wide guarantees of origin trading scheme (see chapter V). The debate now seems to perpetuate towards the European Commission’s review of the RES directive in 2014, when the Commission may propose “appropriate adjustments of the cooperation measures provided for in this Directive in order to improve their effectiveness for achieving the target of 20 %” (Directive 2009/28/EC). Without knowing the outcome of this next harmonisation attempt, it is remarkable how the debate on harmonisation and cooperation has dominated the European RES policy debate over the last decade. This fixation seems rather unbalanced, considering the availability of more obvious and easy to implement cost saving options for European target achievement, such as the reflection of risk in RES policy design and stating the huge challenges lying ahead, particularly the conversion of European power infrastructures and markets in order to cope with high shares of RES. On the other hand, European cooperation might indeed play an increasingly crucial role in triggering the required investments.

From the analysis in this thesis, it appears that bottom-up cooperation between member states and alignment of regulatory frameworks according to best-practice criteria is a more promising approach than drastic harmonisation measures that will unsettle the market and require another learning period to improve their effectiveness and efficiency. This is particularly true for the time frame up to 2020. We have seen that RES policy design has gone through a phase of intense policy learning in the last decade. For the more advanced countries, effective and efficient policy design is an increasingly complex issue that requires individual and fine-tuned approaches. The question remains how the countries whose RES markets are lagging behind can be motivated to learn from this process and to improve their support policies and regulatory frameworks despite the existing economic constraints. Unless there is a forced European solution, this question will need to be answered for each country individually but the realisation of domestic benefits is likely to play an important role in the answer.

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Samenvatting

Binnen de Europese Unie wordt de ontwikkeling van duurzame energiebronnen actief gestimuleerd. In dit proefschrift wordt onderzocht of deze stimulering effectiever kan en tegen lagere kosten mogelijk is. De volgende thema's worden behandeld:

- de effectiviteit van de verschillende typen nationaal ondersteunend beleid in de lidstaten van de Europese Unie;
- de mogelijkheden om de doelstelling voor duurzame energiebronnen voor 2020 tegen zo laag mogelijke kosten te halen;
- de rol van marktintegratie en de relatie tussen enerzijds blootstelling aan marktrisico's en anderzijds de kosteneffectiviteit van de ondersteuning van duurzame energiebronnen;
- welke rol samenwerkingsmechanismen tussen de lidstaten kunnen spelen om de doelstellingen kosteneffectief te bereiken.

In hoofdstuk II worden de recente vorderingen geanalyseerd in de inzet van duurzame energiebronnen en in het beleid hiervoor in de Europese lidstaten. Hiervoor zijn indicatoren voor de beleidsinzet en -effectiviteit verzameld en gecombineerd met Europese statistieken en data per land. De resultaten tonen in de afgelopen jaren een aanzienlijke vooruitgang in de bevordering van de Europese inzet van duurzame energiebronnen. De groei van de markt is voornamelijk veroorzaakt door effectief beleid in een klein aantal voorlopende landen. Bij het vergelijken van de recente vorderingen in de groei die nodig is om het doel voor 2020 te behalen, blijkt dat sommige landen de tussentijdse doelen van de *Renewable Energy Sources* (RES)-richtlijn 2009/28/EC ruimschoots overschrijden. Desondanks zal Europa aanvullend beleid nodig hebben om het doel voor 2020 te bereiken.

Succesfactoren voor een effectief en efficiënt ondersteunend beleid zijn o.a. stabiliteit, verlaging van projectrisico's, een stabiele financieringsbron die onafhankelijk is van het overheidsbudget en de regelmatige aanpassing van voorwaarden voor ondersteuning aan de marktontwikkelingen. Tegelijkertijd wordt het succes vaak ook bepaald door niet-economische factoren. Het gaat dan voornamelijk om het verwijderen van administratieve en juridische hindernissen, bijvoorbeeld voor vergunningverlening en toegang tot het elektriciteitsnet.

In hoofdstuk III worden verschillende beleidsopties geanalyseerd om enerzijds de kosten van projectontwikkeling en financiering van duurzame energie te verminderen, en anderzijds de totale kosten van het duurzame energiebeleid voor de consument of de belastingbetaler te verminderen. De discussie richt zich vervolgens op de mate waarin deze opties onderling zijn verbonden en welke rol zij kunnen spelen bij de verwezenlijking van de EU-doelen voor duurzame energie in 2020. De resultaten tonen aan dat risicobewust, investeringsvriendelijk beleid cruciaal is om tot 2020 voldoende investeringen in duurzame energie aan te trekken en om de doelstellingen kosteneffectief te realiseren. Zulk beleid vermindert niet alleen de financieringskosten voor duurzame energie, maar ook de kosten voor projectontwikkeling, terwijl de marktinkomsten stijgen.

Vanuit macro-economisch perspectief zijn er ook andere opties die de kosten van ondersteuning van duurzame energie aanzienlijk kunnen verminderen. Dit zijn de regelmatige aanpassing van de niveaus van ondersteuning aan de dalende opwekkingskosten, de afbouw van subsidies voor fossiele en nucleaire energie, en de kostenoptimalisatie van de ondersteunde duurzame energieportefeuille, hetzij door meer samenwerking tussen de lidstaten of door veranderingen in de ondersteunde technologiemix. Deze laatste opties komen niet naar voren als een voorwaarde voor verwezenlijking van de 2020-doelstelling, maar hebben wel het potentieel om de kosten daarvan voor consumenten en belastingbetalers aanzienlijk te verminderen. Over het geheel genomen lijken verdere verbetering en coördinatie van de bestaande beleidskaders veelbelovender dan drastische systeemveranderingen, aangezien de laatste zouden leiden tot extra onzekerheden en mogelijk negatieve effecten op de groei van duurzame energie en op de projectkosten.

In hoofdstuk IV worden de voor- en nadelen besproken van het blootstellen van producenten van duurzame elektriciteit aan de risico’s van de elektriciteitsmarkt, op basis van een analyse van de verschillende manieren waarop deze producenten worden geïntegreerd in de elektriciteitsmarkt in Duitsland, Spanje en het Verenigd Koninkrijk (status 2007). De nadruk lag hierbij op windenergie, die van alle duurzame energietechnologieën voor de grootste uitdaging staat qua marktintegratie. Uit de analyse blijkt dat de drie landen sterk uiteenlopende benaderingen volgden bij het blootstellen van duurzame elektriciteitsproducenten aan de marktrisico’s van de termijnmarkt voor elektriciteit, bij het uitbalanceren van de markten en bij de eisen aan systeemplanning. De risicoblootstelling is het hoogst in het Verenigd Koninkrijk en het laagst in Duitsland.

Vanuit het perspectief van een beleidsmaker is er een uitruil tussen een ‘hoog risico’- en een ‘laag risico’-benadering. Wanneer duurzame elektriciteitsproducenten hoge marktrisico’s lopen is een hoger niveau van financiële steun nodig om de ontwikkeling van elektriciteit uit duurzame energiebronnen te stimuleren dan in een lage risico-omgeving. Maar de blootstelling aan marktrisico’s kan ook een stimulans geven om efficiënt gebruik te maken van de betreffende markt, en zo de indirecte kosten voor de samenleving beperken. De speciale kenmerken van windenergie stellen echter natuurlijke grenzen aan de reactie van windenergie-installaties op de marktprijzen en locatiespecifieke prijssignalen en zullen steeds meer invloed hebben op elektriciteitsmarkten en de netinfrastructuur. Met deze onderlinge afhankelijkheden moet rekening worden gehouden bij het ontwerp van beleid voor elektriciteit uit duurzame bronnen en bij de regulering van de elektriciteitsmarkt.

Hoofdstuk V en hoofdstuk VI gaan over de mogelijkheid van internationale samenwerking bij het behalen van de doelstelling voor duurzame energie.

Hoofdstuk V behandelt de politieke discussie die leidde tot de evolutie van de flexibele samenwerkingsmechanismen van de RES-richtlijn 2009/28/EC. Een van de meest besproken onderwerpen voorafgaand aan de goedkeuring van de richtlijn vormden de ‘flexibele mechanismen’, die het lidstaten met een laag of duur duurzaam potentieel toestaan om een deel van hun nationale doelen te realiseren in andere landen. Het hoofdstuk evalueert de belangrijkste flexibiliteitsmechanismen die werden besproken tijdens het onderhandelingsproces over de RES-richtlijn. Uit de evaluatie blijkt dat er geen optimaal flexibiliteitsmechanisme bestaat. De meest extreme resultaten werden gevonden voor handel in garanties van oorsprong (GvO’s). Al is er een aantal duidelijke voordelen ten aanzien van flexibiliteit, er zijn ook grote nadelen op het punt van de soevereiniteit van de lidstaten in hun ondersteunend beleid en de totale kosteneffectiviteit van ondersteuning van duurzame energie. Dit laatste vanwege het te verwachten ‘*cherry picking*’ van het hoogst mogelijke ondersteuningsniveau door duurzame producenten en de daaruit voortvloeiende overstimulering van goedkope duurzame projecten. Aangezien deze nadelen elk kunnen worden beschouwd als ‘*knock-out criteria*’ lijkt het redelijk dat het GvO-handelsmechanisme is uitgesloten in de uiteindelijke RES-richtlijn. De mechanismen die GvO-handel in de richtlijn hebben vervangen – gezamenlijke projecten (joint projects), gezamenlijke steunregelingen (joint support schemes) en statistische overdracht (statistical transfer) tussen lidstaten – bieden minder flexibiliteit, maar scoren beter op een aantal andere belangrijke criteria, met name op behoud van de kosteneffectiviteit en stabiliteit van de nationale steunregelingen en publieke acceptatie.

Hoofdstuk VI analyseert de voor- en nadelen van de drie mechanismen en verkent ontwerpopties voor hun invoering via strategische en economische vragen: Hoe is tegenwicht te bieden tegen de grote nadelen van elk mechanisme? Hoe is een balans te krijgen tussen kosten en baten van de betrokken lidstaten? De analyse identificeert een aantal ontwerpopties die aan deze vragen tegemoet komen. Voorbeelden zijn lange termijncontracten die voldoende flexibiliteit garanderen voor statistische overdrachten, een gecoördineerde, gestandaardiseerde aanpak voor gezamenlijke projecten (joint projects) om de transparantie in de Europese markt te vergroten, en een stapsgewijze harmonisatie van gezamenlijke steunregelingen (joint support schemes) die is gebaseerd op een kosteneffectieve boekhoudkundige benadering. Een conclusie is dat de drie mechanismen voor samenwerking nauw met elkaar verbonden zijn. Men kan hun onderlinge samenhang beschouwen als een geleidelijke overgang van samenwerking tussen lidstaten onder volledig gesloten nationale steunregelingen in geval van statistische overdrachten naar samenwerking onder volledig open nationale steunregelingen in een gezamenlijke steunregeling.

Conclusie en vooruitzichten

Uit de analyse blijkt dat de effectiviteit en de kosteneffectiviteit van ondersteunend beleid voor duurzame energie in veel Europese lidstaten nog steeds laag zijn, maar dat de voorlopers aanzienlijke ervaring hebben opgedaan in het ontwerp van op maat gemaakt beleid.

De belangrijkste aanbevelingen voor verbetering van de effectiviteit en efficiëntie van ondersteunend beleid voor duurzame energie in Europa zijn:

- vermindering van de beleids- en marktrisico's, met name van die risico's die geen of weinig potentieel hebben om kostengeoptimaliseerd gedrag op te roepen bij duurzame producenten;
- zorgen voor lange termijn commitment en verhoging van de stabiliteit van de regelgeving voor duurzame energiebronnen.

Naast het verbeteren van de effectiviteit en kosteneffectiviteit van hun nationale ondersteuninginstrumenten zouden beleidsmakers moeten overwegen om meer gebruik te maken van de flexibele mechanismen, die de kosten van realisatie van de Europese doelen voor duurzame energiebronnen mogelijk verder kunnen verminderen – mits die mechanismen niet leiden tot extra risico's en onzekerheden.

Uit de analyse in dit proefschrift blijkt dat *bottom-up* samenwerking tussen de lidstaten en aanpassing van de regulerende kaders volgens *best practice* criteria een veelbelovender benadering is dan drastische harmonisatiemaatregelen die de markt zullen verstoren en nog een leerperiode vereisen om hun effectiviteit en efficiëntie te verbeteren. Dit geldt met name voor de periode tot 2020. We hebben gezien dat het ontwerp van beleid voor duurzame energie in het afgelopen decennium een intens leerproces heeft doorlopen. Voor de verder gevorderde landen is effectief en efficiënt beleidsontwerp een steeds complexer probleem, dat een individuele en verfijnde aanpak vereist. De vraag blijft hoe de landen met achterblijvende markten voor duurzame energie kunnen worden gemotiveerd om te leren van dit proces en om hun steunbeleid en regelgeving te verbeteren, ondanks de huidige economische beperkingen. Tenzij er een opgelegde Europese oplossing komt, zal deze vraag voor elk land individueel beantwoord moeten worden. Maar de realisatie van binnenlandse voordelen zal in dat antwoord waarschijnlijk een belangrijke rol spelen.

Vertaling / translation: Groenvoer Communication (www.groenvoer.nl), Jaap Rodenburg

Curriculum Vitae

Corinna Kleßmann was born on 17th August 1973 in Bochum and grew up in Bielefeld, where she graduated from high school in 1993. She spent one high school year in Sacramento, California. After school she worked for one year in Paris and studied French at the Sorbonne. From 1994-2001 she studied Energy and Process Engineering and German Philology at the Technical University of Berlin. During her studies, she spent eight months at the Israel Institute of Technology (Technion) in Haifa, where she worked on a research project on solar air conditioning. In 2000 she wrote her Master thesis at the research unit "Technology and Society" of the Daimler Chrysler AG, analysing the stakeholder and discourse constellation for introducing a hydrogen and renewables based transport system in the future, in cooperation with the Institute for Technology Studies of the Faculty of Sociology. In January 2001 she graduated in Energy Engineering (Dipl. Ing.) with the grade "very good". Supported by a scholarship of the Carl Duisberg Society, she then worked for several months at a solar company in South Africa, supporting the preparation of a solar pilot project for a rural community. In 2001-2002, she worked for half a year as lecturer for decentralised energy applications at the Energy Seminar of the TU Berlin, while finishing her studies in German Philology. She graduated in German Philology (M.A.) in October 2002 with the grade "very good".

From 2003-2006 she worked as project manager at the German Energy Agency (dena) on the implementation of the German Renewable Energy Export Initiative. She coordinated the dialogue with the German solar industry, supervised international market studies on renewable energies, prepared and participated in international conferences and workshops in more than 20 countries, and managed the EU funded project "PV Policy Group".

Since March 2006 she has been working in the Energy and Climate Policy unit of Ecofys in Berlin. She carried out numerous research and consulting assignments on policy and market frameworks for renewable energy and energy efficiency, e.g. for the German government, the European Commission, the International Energy Agency, and many other public and private institutions. She is specialised on European renewable energy policy and the cooperation mechanisms of the renewables directive.

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