Cooperation between EU Member States under the RES Directive

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Task 1 report

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1 Introduction

This Task 1 report provides a practice-oriented analysis of current implementation and relevant design features of the renewables (RES) cooperation mechanisms established by the Renewable Energy Directive 2009/28/EC. Based on interviews with EU Member States and a literature review it identifies the Member States engagement in cooperation mechanisms, barriers for a broader application of cooperation mechanisms and potential remedies to overcome these barriers. Furthermore, it provides concrete design options how to design cooperation mechanisms to address different Member State preferences and how to measure and account for costs and benefits from these mechanisms and their impact on the European energy market. This report thereby introduces key concepts that will be analysed in further detail in the course of the project (case studies in Task 4 and 5).

The EU Renewable Energy Directive 2009/28/EC sets the legal framework for the use of cooperation mechanisms with binding national renewable energy sources (RES) targets for EU Member States for 2020. The Directive encourages cooperation between Member States for the 2020 target achievement to increase economic efficiency of their RES target achievement, optimise RES resource utilisation and contribute to the internal energy market. The Directive specifies the general accounting rules of these mechanisms, but their design and implementation is left to the cooperating Member States. Four types of cooperation mechanisms provide for different levels of cooperation between countries:

- Statistical transfer (Article 6): Renewable energy (electricity, heat or transport energy) which has been produced in one Member State is virtually transferred to the RES statistics of another Member State, counting towards the national RES target of that Member State.

- Joint projects between Member States (Article 7): RES electricity or heat projects are developed under framework conditions jointly set by two or more Member States; the involved Member States define which share of the energy production counts towards which Member State's target.

- Joint support schemes (Article 11): Member States merge or coordinate (parts of) their RES support schemes and jointly define how the renewable energy produced is allocated to their national targets.

- Joint projects with third countries (Article 9): Joint projects can also be implemented between Member States and *third countries* i.e. countries outside the EU. A precondition is that an amount of electricity that equals the electricity amount generated from RES and subject to this joint project is physically imported into the EU.

This report focuses on the three inter-European cooperation mechanisms. Joint projects with third countries will not be investigated in this study, as they are analysed in detail in other projects for the European Commission.

So far only Sweden and Norway have engaged in a cooperation mechanism (joint support scheme). Several Member States have however started to assess the use of cooperation mechanisms and have approached potential cooperating states. Chapter 2 provides an overview on the current status of implementing cooperation mechanisms, describing experiences of Member States with exploring or initiating cooperation mechanisms as well as their motivations and expectations. The chapter is based on interviews with representatives from 14 Member State, complemented with a review of publicly available sources.

Chapter 3 investigates the reasons for the current lack of the mechanisms' implementation. By analysing the key barriers based on Member State interviews and literature, it seeks to focus future efforts on key obstacles and potential remedies.

In the interviews Member State representatives repeatedly requested more information on the practical design of cooperation mechanisms. Chapter 4 provides an overview on available design options and their suitability, building on the European Commission's Guidance on the Use of Renewable Energy Cooperation Mechanisms, Member State interviews and literature. The design features analysed include the type of cooperation (e.g. number of involved parties), the scope of cooperation (e.g. technology and duration of support), the flow of support (e.g. determination of support level/transfer price) and the contractual arrangements (e.g. arrangements for non-compliance). Design options for joint projects are investigated in further detail, as Member States judge this cooperation mechanism as particularly interesting but complex.

Member States were also interested to better understand the costs and benefits of cooperation mechanisms and the available allocation options. These are important to determine the transfer payments, but also to communicate the effects of cooperation mechanisms to the public. Chapter 5 provides an overview on the principle costs and benefits for cooperating Member States, as well as approaches to measure and allocated them (an in-depth elaboration is provided in section 9.1)

Finally chapter 6 provides Member States and EU policy makers with a quantitative assessment of the cost-saving potential of cooperation mechanisms. Building on previous analyses of the Re-Shaping project (Ragwitz et al. 2012), it assesses the cost-saving effects of different degrees of cooperation with the Green-X model. In this context the impact of cooperation mechanisms on the integration of the EU energy market is also explored.

2 Member States' progress in the implementation of the cooperation mechanisms

2.1 Overview of interviews with Member State representatives and other sources

In this project we interviewed a number of Member State representatives on cooperation mechanisms. The main objective was to get a better understanding of the countries' status quo with regard to cooperation mechanisms and to identify interest in and barriers to applying cooperation mechanisms.

The team has conducted 14 interviews in total, representing a good mix of the Member States in the various EU regions, including advanced and non-advanced countries and including potential buying and selling countries.

The interviews with Member States that are considered to be advanced in the implementation of cooperation mechanisms are Sweden, Norway and United Kingdom (3 in total). The interviews conducted with Member States that were – based on publicly available information - considered less advanced in implementing cooperation mechanisms comprised Italy, Greece, Spain, Denmark, the Netherlands, Luxembourg, Germany, Estonia, Lithuania, Slovakia and the Czech Republic (11 in total).

2.2 Interest in cooperation mechanisms

The following sections give a structured summary of the interview results.

Interests in cooperation

Currently only few Member States pursue the implementation of cooperation mechanisms actively, but many say they will consider using them in the future. The Member States that are interested in the use of cooperation mechanisms mention that statistical transfers would be the first type of cooperation to consider, because of their assumed ease of implementation and low administrative costs. Among the countries interviewed there is interest in both the selling and buying of renewable energy by means of statistical transfers.

However, there are also countries preferring other types of cooperation mechanisms than statistical transfer. The United Kingdom for example will not consider the use of statistical transfer: A recent Call for Evidence reports that the majority of respondents oppose the use of statistical transfers, because of their uncertainty, inability to confer lasting benefits and the impact on investors' confidence (DECC, 2013). Also for Germany additional benefits than just the virtual transfers of electricity (statistical transfers) seem important (BMU, 2013)[1]. Joint support schemes are not mentioned by any of the interviewed Member States as a realistic option to implement before 2020. In general, this option is considered too complex to implement on the short term.

In that sense the operational joint support scheme between Norway and Sweden is an exception. Talks between the two countries on a joint green certificate scheme already started in the year 2003, years before cooperation mechanisms were included in the RES Directive (in 2008/09). Norway favoured the market-based approach to RES support implemented in Sweden, but the size of the Norwegian certificate market would have been too small to establish such a scheme in Norway alone. Before the start of the joint support scheme in January 2012, the main instrument to support RES deployment in Norway was investment support to wind energy.

The ultimate rationale to use cooperation mechanisms is to exploit renewable energy resources in the most cost-effective way. In principle, this would mean that cooperation mechanisms are not limited to countries with a RES production deficit on one side and a surplus on the other side. Also countries with sufficient RES potential to meet their targets can benefit from cooperating with countries that offer RES production opportunities at lower costs. However, Member States tend to value domestic benefits higher than potential cost savings through cooperation. So far, the main reason for Member States to consider the use of RES cooperation is in relation to 2020 RES target achievement. However, the practical interests in RES cooperation are more diverse. Other reasons to think of RES cooperation are to gain experience in the field and make money by selling RES shares.

Some Member States, such as Denmark and Estonia, which are confident to be able to reach their 2020 RES targets, are considering the option of selling RES shares to other Member States. Estonia already put in place the regulation that would allow for statistical transfers in the future.
Any considerations on actively pursuing the use of cooperation mechanisms will be based on how the trajectory towards 2020 target achievement develops in the coming years. For Member States that see themselves as potential buyers, the motivation for considering cooperation mechanisms is mainly to avoid target deficits, not so much cost-effectiveness.

It is interesting to see that Member State forecasts on eventual surpluses or deficits of RES shares sometimes deviate from forecasts in literature. Several Member States that in literature (ReFlex, 2012) or in their NREAPs have been forecasted to have a surplus now say that they do not consider the use of cooperation mechanisms. One of the reasons could be that countries adapt their assessment to the actual RES development up to 2020.

The interest in cooperation mechanisms is also closely linked to the discussions on 2030 targets. As long as it is unknown whether targets for RES will be in place after 2020, it is unclear if cooperation

[1] BMU (2013). Personal Communication with the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety, Germany.

mechanisms will be part of the European RES framework. Especially the development of joint projects and joint support schemes will depend on the 2030 targets definition, since without strong incentives to cooperate beyond 2020 such long-term joint endeavours and investments are unlikely.

Motivation to use cooperation mechanisms

As said before, Member States interests to use cooperation mechanisms have so far been strongly linked to domestic target achievement. Member States prefer to reach the 2020 RES target by domestic projects alone, but consider the use of cooperation mechanisms to secure target achievement. Member States that already know they will not be able to reach the RES target domestically are the ones that explore cooperation with other Member States most actively as potential buyers. Among the Member States that have looked into the use of cooperation mechanisms because of a potential deficit in 2020 are the Netherlands and Luxembourg. The UK plans to implement a joint project with Ireland as contingency measure for target fulfilment. Also Germany expects that it needs to import renewables after 2020 and testing cooperation mechanisms on a small scale might be interesting already before 2020 (BMU, 2013)[2].

Countries that are potential selling countries see the benefits of cooperation mechanisms in being able to (partly) cover the costs of their excess RES production. In case countries end up in a selling position with excess of renewable energy, which is at this moment highly uncertain for most Member States, some consider selling the excess RES production and transfer the income back into the support scheme for renewable energy. Italy for example, states in its National Energy Strategy that if the RES target will be achieved in 2020, statistical transfers will be considered to sell excess electricity and that it will use the income to lower the pressure on electricity bills of end consumers (Ministry of Economic Development, 2013)[3]. Also for Denmark the main interest in statistical transfers is the economic benefits it might deliver to the country in a situation of oversupply of RES electricity by 2020 (Working Group for Renewable Energy Nordic Countries, 2013)[4].

2.3 Current state of cooperation mechanisms

At the start of each process on RES cooperation countries typically investigate future surpluses or deficits of RES shares. Research on potential costs and benefits of the cooperation (although difficult to do in detail already) is sometimes also done at the beginning of the process. We see that when two countries are planning to cooperate, countries undertake their own studies and do studies together. The two cooperations between countries that are most advanced at the moment, namely Sweden/Norway and United Kingdom/Ireland, both started with national investigations on costs and benefits before the topic was discussed politically.

[2] BMU (2013). Personal Communication.

[3] Ministry of Economic Development (2013). Personal Communication with the Ministry of Economic Development, Italy.

[4] Working Group for Renewable Energy Nordic Countries (2013). Personal Communication.

A number of countries interviewed and not yet applying RES cooperation mechanisms indicate that there have been exploratory talks in the past and currently on-going, often with no concrete follow-up. Some Member States that are expected to have a surplus by 2020 principally agree on selling some of their surplus potential, but prefer to wait with firm statements on the quantity to sell until they have more certainty on the exact amounts available for selling. As long as Member States are not sure about their own target achievement, they are unlikely to agree on selling to another Member State and to close any contracts.

Several Member States indicate the importance of small scale projects or pilots to gain the needed experience with cooperation mechanisms. Such projects might provide the required learning experiences that help other projects to take off in the future.

There are a number of countries that are considered to be in an advanced stage regarding cooperation on RES. It regards the existing joint support scheme between Sweden and Norway and the RES cooperation between the United Kingdom and Ireland. Besides, also other countries, such as Estonia, are taking action in the field of cooperation mechanisms. In this section we provide a short description of these existing cooperation mechanisms and initiatives.

2.3.1 The joint support scheme between Sweden and Norway

Since 1 January 2012, Sweden and Norway operate a joint certificate scheme. Sweden's participation in the scheme means extending the electricity certificate scheme it has been operating since 2003. In Norway, the revenues from certificates replace the former investment support for wind farms provided by the government-owned enterprise Enova. The joint support scheme benefits from nine years of Swedish experience in operating a green certificate market.

Discussions between Sweden and Norway on a joint support scheme already started in 2003, but came to a halt in 2006 when no agreement could be settled on the burden sharing aspect. Sharing the costs and benefits of the joint scheme turned out to be an insurmountable hurdle by that time. The second round of negotiations led to a signed agreement in 2009 and the start of the scheme in 2012. Thanks to a political agreement in the beginning of this negotiation round to share costs and benefits 50-50, this round successfully led to an agreement.

The basics of the green certificate scheme are as follows. For every unit of electricity produced, the State offers green certificates to renewable electricity generation facilities (producers of electricity). Each certificate issued represents 1 mega-watt hour (MWh) of electricity produced. The certificates are commercially tradable assets and increase the income for renewable producers. Companies that sell power have the obligation to sell a certain share of electricity produced from renewable sources and need to buy certificate to prove that by redeeming the respective amounts with the government agency (which?) once per year. The final costs are passed on to the end consumer bills.
Although Sweden and Norway operate a joint support scheme together, the two countries decided that they don’t have to agree on every little detail. There will be differences anyway, e.g. in tax regimes, regulations etc., so each country implemented the scheme slightly different. To give an

example, the phase-out of the scheme differs between Sweden and Norway. Both countries agreed that the scheme shall end in 2035, but have different phase-out strategies when it comes to the details. In Norway all plants shall get 15 years of support and therefore plants build after 2020 will not get any support. Sweden on the other hand leaves the decision up to the investors. If they want to build a new plant in 2025 and are fine with only getting 10 years of certificates then they are allowed into the system (on Swedish side).

The target for the joint market is to increase electricity production based on RES in Sweden and Norway by 26.4 TWh from 2012 to 2020. Sweden and Norway both have the responsibility of realising an additional electricity production of 13.2 TWh, independent of where the production capacity is built. Electricity produced by plants included in the common electricity certificate market will be equally divided between the two parties.

Anticipated benefits from the joint support scheme are 1) a better functioning of the market, 2) increased cost efficiency and 3) increased long term stability. Referring to the first benefit, the increase of the number of parties trading green certificates will reduce the volatility of the market. It is also understood that a joint and larger market will increase liquidity. Secondly, the access to a larger production base will increase cost efficiency as the market has more opportunities to determine where the electricity production capacity will be built. Finally, the joint support scheme provides a politically stable system that can only be substantially changed with the agreement of both countries, which is expected to improve long term predictability to investors. In the end, the cooperation gives mutual benefits to both countries. For Sweden the benefits lay in lower support costs, for Norway the benefits of the cooperation are that the country can join an existing support scheme and have more installed RES capacity developed in their country.

It is often argued that the fact that Norway and Sweden have RES potentials[5] at similarly low costs has contributed to the success of the joint support scheme. It is expected though that first the potentials in Norway will be exploited and then in later years the potentials in Sweden. Investigations on this topic are on-going. The already existing interconnection between the two countries and operation in a common electricity market also is believed to have contributed to the successful implementation and operation of the joint support scheme.

In practice, it turns out that it is easier to agree on the specifics of a cooperation agreement when there is not so much difference in the cost resource curves of both countries because the cooperation would not have a major cost effect. In a situation where the expected benefits for one country are significantly higher compared to the other country, it becomes more challenging to share costs and benefits to the satisfaction of all participants to the cooperation.

[5] Sweden has biomass and onshore wind potentials and Norway has hydro potential at similarly low costs.

Some stakeholders argue that the joint electricity certificate scheme could be opened up to other Member States in the future. In the past some options are have been explored (e.g. with the Netherlands), but never brought to an advanced stage.

2.3.2 The planned joint project between Ireland and UK

United Kingdom and the state of Ireland are working closely together to secure economic benefits for both countries through trade in renewable energy. The joint project consists of exporting renewable power (onshore and offshore wind) from Ireland to the UK up to a maximum of 5 GW (Duggan, 2013). For the UK, the interest in cooperation mechanisms is part of its risk management contingency approach. The UK has defined following key objectives of the joint project 1) safeguarding 2020 targets, 2) realising potential for investment, jobs and growth in Ireland and 3) facilitating renewable energy exports in an integrated energy market.

In January 2013, discussions between the UK and Ireland on RES cooperation developed into a Memorandum of Understanding and the commitment of both countries to a programme of work. The programme of work has to give clarity on the costs and benefits of the planned export of electricity from Ireland to the UK, low carbon support mechanisms, connecting to the United Kingdom and regulation. The aim is to establish an intergovernmental agreement on energy trading, to be signed in 2014.

Uncertainty is regarded as the main barrier to the cooperation process between the UK and Ireland. The cooperation is regarded as contingency measure against 2020 targets and many issues need to be worked through before it can be actually implemented (e.g. physical requirements for interconnections, regulatory framework issues and technical issues).

The benefits from the joint project for the United Kingdom are defined as:

- Improved interconnection;
- Increased amount of green power in the electricity mix;
- Reduced costs for UK end consumers of electricity;

The benefits from the joint project for Ireland are defined as (Rabbitte, 2013):

- Employment opportunities (a 3,000 MW project would create 3,000 to 6,000 jobs in the construction, jobs in on-going maintenance and in manufacturing of turbines, cables and other parts);
- Interconnection benefits such as security of supply, allowing for increased intermittent wind generation and facilitating the operation of the single market;

Public acceptance definitively is an issue to address, but has not been of central importance to the process up to this point. It seems important to prove (also with regards to the public debate) that this cooperation would be more efficient (and thus less costly) than not entering into cooperation and to clearly communicate the direct benefits of the cooperation (e.g. lowering energy bills).

2.3.3 Estonia's draft legislation on using statistical transfer as selling country

In 2011, the share of RES in final energy consumption reached 25.9%, which is already above the EU-target of 25% in 2020. Both the electricity and the heating and cooling sector contributed to this target significantly. The share of RES in transport was relatively small. In 2011, 12.3% of the electricity was produced from RES and is expected to increase to 17.6% in 2020. The RES heating and cooling sector already reached its 2020 target in 2011. In 2009, RES H&C reached 41.8% (2020 target was set at 38.3%). The significant growth in this sector is explained by the combination of low fuel prices and targeted support measures (Tammist, 2013).

There is still a large renewable energy potential in Estonia that currently is untapped (e.g. onshore wind). The above figures showed that Estonia will have a surplus of renewable energy up to 2020. It already expressed interest in exporting its surplus of renewable energy via the mechanism of statistical transfers. Estonia sees statistical transfers as a useful option to promote renewable energy investments in the country, specifically in the electricity market (CA RES, 2013).

The Ministry of Economics has initiated the process to put in place the legal basis for statistical transfers with other Member States. Currently, Estonia has made a draft legislation that sketches the concept for statistical transfers. The motivation of this approach, which emerged from talks with other MS on potential statistical transfer, is to have the legal basis in place at the moment that more close negotiations with other Member States are started. At the core of the legal debate has been the question whether statistical transfers are an asset of the state or an asset of the people, that is, where the income should be distributed to. The draft indicates that statistical transfers will benefit the general public, that is to say, the income shall be transferred back into the support scheme (and decrease the payment obligations for electricity customers).

2.3.4 Less advanced initiatives

Italy has implemented legal provisions that allow cooperation with other Member States long before the RES-Directive. Already in 1999, Law 79/1999 addressed the national quota scheme and established that the quota can be satisfied through the import of green certificates. Law 387/2003 regulated that green certificates can be directly granted for electricity produced from renewables outside of Italy. This resulted in a bilateral agreement with the Albanian electricity market regulator. However, the cooperation was not further pursued. Finally, law 28/03 2011 directly transposes the EU Directive 28/2009 into national law. It regulates statistical transfers and joint projects; joint support schemes are not yet covered. Among other things, the law states that cooperation should be promoted, if the 2016 interim target is not achieved. Moreover, the value of the incentives allowed to joint projects has to be lower than the weighted average value of national incentives in the year before the agreement (solar power is excluded from this) – thus there needs to be an economic advantage for Italy.

Also the **Netherlands** plans to open its support scheme for foreign projects. In October 2013, the Ministry of Economic Affairs announced that they will investigate the possibilities to open up the domestic support scheme SDE+ for foreign projects (Ministry of Economic Affairs, 2013). No preference for one of the types of cooperation mechanisms has been made explicit in this letter to Parliament. On 18 November 2013 the parliament took a vote, stating that the Ministry may proceed with including the flexible mechanisms in the SDE+. The next step will be to define whether the scheme is opened for (joint) projects in other Member States, for statistical transfer, or both. Subsequently the Dutch legislation will have to be adapted and the revised law will have to be submitted to the European Commission for proper state aid approval. The Ministry plans to inform the parliament in 2014 about further details. An issue that is perceived by the Ministry as a potential barrier is indeed political acceptance to open the SDE+.

Luxembourg has expressed interest in the cooperation mechanisms, given the need to imply those to reach its 2020 targets. However, no further official statements have been made on the intention and the potential course of any initiative.

2.4 Conclusions

The overall picture on Member State progress with regard to RES cooperation is that many Member States have a positive attitude regarding the use of cooperation mechanisms in the future, but only a few Member States have implemented or are taking concrete initiatives to implement cooperation mechanisms so far. Over the past years, most of the interviewed Member States have explored the potential use of cooperation mechanisms, but mostly without concrete results. Several barriers, discussed in chapter 3, were mentioned as hindering the use of cooperation mechanisms in practice. The main motivation for Member States to consider cooperation mechanisms is linked to the achievement of their national 2020 RES targets (both from a buyer and sellers perspective), either safeguarding their target achievement through cooperation mechanisms or selling target surplus and gaining additional income. Other reasons to consider the use of cooperation mechanisms are for example to gain practical experience for future longer-term cooperation.

3 Barriers for using the cooperation mechanisms

Member States mentioned **political, technical** and **legal** barriers as obstacles for further application of the cooperation mechanisms:

- **Political barriers** include public acceptance for cooperation mechanisms, the determination of governments to engage in cooperation on RES target achievement and uncertainty on the continuity of the RES framework beyond 2020. These factors go beyond mere technical considerations on how to jointly match excess and surplus of RES production.

- **Technical barriers** include barriers that prevent countries with political will to engage in cooperation from doing so. The interviews with Member States show that there is still a high degree of uncertainty on quantifiable costs and benefits, design options of cooperation mechanisms and difficulties for Member States to forecast their own RES target fulfilments. Uncertainty also surrounds the sanctions for non-compliance of the RES targets. Lacking transmission infrastructure and market integration were also mentioned as barriers for cooperation.

- **Legal barriers** include potential incompatibility of cooperation mechanisms with national and EU legislation.

First, we discuss the different types of barriers in detail and, subsequently, we provide a more general ranking of the barriers, pointing out key obstacles to their implementation.

3.1 Political barriers

The political willingness of Member States to engage in cooperation is a prerequisite for further negotiations on compensation and contractual arrangements to take place. Member States however highlighted a current lack of **public acceptance** as a barrier preventing governments to pursue cooperation mechanisms more actively. Governments face difficulties to **communicate the costs and benefits** of cooperation mechanisms to their national electorate. Further insights to governments on quantifiable costs and benefits of specific projects would help to inform the discussion. Several Member States also suggested that the benefits of cooperation – either costs savings for the buying Member State or revenues for the host Member State – should be clearly communicated to the public and passed on to consumers to reduce their respective support levies. During the implementation of the joint support scheme with Norway, Sweden highlighted the cost savings to consumers in their communication of cooperation mechanisms.

In the context of communicating costs and benefits of cooperation mechanisms some Member States pointed out the general **difficulty to communicate the role of a buying country** that is sponsoring the employment of RES abroad. In statistical transfers the mere virtual import might be criticised as not benefitting the buying Member State's electricity supply. One seemingly obvious demand from a public viewpoint is that electricity which is financed by the off-taking country should also have a physical effect on its electricity system; e.g. a higher share of renewables in the electricity mix and thus increased energy security of the respective country.

Joint projects with **physical transmission of electricity** into the off-taking country might address this problem. However, this case might be criticised for overburdening the grid of the hosting country and exploiting its energy resources for foreign consumption (also see section 4.3). Also, there are numerous technical issues related to the physical transfer of electricity.

Moreover, a Member State raised the issue that also in potential host Member States the public might have reservations about the exploitation of the country's best RES resources by the buying country, leaving the host country and its consumers with the costs of supporting less efficient sites for their own target fulfilment. Also in this context a clear communication of costs, benefits and their compensation is important.

Besides public acceptance issues, concerns about giving up national **sovereignty** through the engagement in cooperation mechanisms were mentioned. Cooperation mechanisms could interfere with domestic support schemes or domestic policy preferences such as the security of supply. From its experience with the joint support scheme, Sweden however mentioned that by accepting differences in national regulation also under cooperation mechanisms countries would not need to give up key principles of their national RES support. By clearly defining the scope of the joint support scheme, e.g. technology development, cooperation mechanisms can complement the objectives of domestic support schemes. Chapter 4 of this report shows design options that allow for different degrees of cooperation and policy integration. Even for countries whose lacking engagement for cooperation mechanisms is based on general scepticism on RES support, statistical transfers might be an option to meet the RES targets without continuing with strong support schemes at home.

The **lacking perspective for a post-2020 RES framework** with 2030 RES targets was stated as a further barrier reducing the incentives for long-term cooperation. The lack of post-2020 RES targets and the non-binding character of the interim targets create an illiquid market for RES allowances in which potential buying countries wait until the final years before 2020 to purchase RES allowances.

A Member State also named the reluctance of countries to assume the **first-mover risks**, i.e. engaging in cooperation mechanisms without building on the experience and best-practices of other countries that have done so previously, as a barrier. Without first projects that could be used as a reference for price setting, the Member State was hesitant to use cooperation mechanisms himself. In order to catalyse first cooperation agreements, Member States could initially limit their cooperation on individual projects and transfers to establish a track record. In cases as the joint support schemes between Norway and Sweden, also strong political leadership helped to overcome first-mover concerns.

3.2 Technical barriers

Technical barriers focus on uncertainty surrounding mechanism design and assessment methodologies that can be resolved with the availability of better information. Almost all Member States mentioned **uncertainty on the design options** of cooperation mechanisms as a barrier. The perceived technical complexity to design the mechanism thereby defers the implementation of cooperation mechanisms. Among others, compensation of consumers, monitoring and operation, accounting of RES amounts for target fulfilment and risk allocation were named as design options that should be further explored.

More comprehensive and timely guidance through the European Commission was mentioned as a contribution to improve information on design options, particularly since assessing the detailed design options proved quite costly for some Member States. Chapter 4 of this report presents design options and their preconditions in greater detail.

Although the importance of communicating the costs and benefits of cooperation mechanisms to improve public acceptance was identified as a key political barrier, lacking information prevents Member States from communicating more effectively. Several member states identified the **lack of quantitative data on costs and benefits** of individual projects, also necessary as key indicator to determine the transfer price or support level, as a major obstacle. Improved information on how to assess and evaluate costs and benefits can overcome this barrier and Chapter 5 of this report presents options on how to assess and quantify costs and benefits from cooperation mechanisms. The **uncertainty on sanctions for the non-compliance** with the 2020 RES targets was also stated as a barrier that makes the costs of missing the RES targets difficult to account for in the cost-benefit analysis of cooperation mechanisms. The contracting parties should therefore ensure compliance in the cooperation agreement for compensation in the case of non-delivery.

A majority of Member States interviewed named **uncertainty on meeting the domestic RES targets** as a key barrier preventing cooperation. As Member States find long-term forecasting towards 2020 difficult, they would only become more interested in cooperation in the years running up to 2020 when they can forecast their surplus or gap with greater certainty. This is why potential buying Member States are still hesitant to use cooperation mechanisms. Although progress on RES deployment is traceable through the interim targets, the Commission might assume a greater role in bringing together Member States that are interested in a role as buying or hosting Member State. Member States that are interested to become a host Member State but are concerned whether they will remain a country with surplus RES might mitigate their risk by looking for back-up statistical transfers with other Member States. They might also include opt-out clauses in the cooperation agreement in case they do not reach their own RES targets, as far as these are acceptable for the buying Member State. Potential buying Member States that are uncertain whether they need additional RES amounts to fulfil their targets risk over-achieving their target with too early cooperation agreements. Therefore also buying Member States could ask for opt-out clauses for the case that they achieve their targets. On the other hand buying Member States risk not meeting their RES targets should the host Member State not be willing or able to deliver the agreed RES amounts.

In order to mitigate the risk of non-delivery, buying Member States could insist in the agreement that the non-compliant seller either arranges for alternative statistical transfers from other Member States or compensates the financial sanctions imposed by the Commission for the amount of non-delivered RES amounts.

A few Member States also mentioned **transmission and electricity market barriers** as limiting further cooperation. The lack of interconnection infrastructure might prevent joint projects with physical imports while insufficiently integrated electricity markets are a barrier to create joint support schemes with market premiums. The introduction of the joint Norwegian-Swedish support scheme built for instance on already highly integrated electricity systems and electricity markets.
While further integration of the electricity systems and electricity markets can pave the way to deeper cooperation, Member States can also choose softer forms of cooperation such as statistical transfers.

3.3 Legal barriers

In general, legal issues were not as strongly identified as limiting factors as political or technical barriers. Still **uncertainty on state aid regulation** and the applicably of state aid provisions to cooperation mechanisms were named as legal barriers. State aid regulation might be particularly problematic if domestic support schemes are selectively opened to Member States or can arise when revenues from joint projects shall be channelled back to consumers. The Commission could provide further guidance on state aid issues and cooperation mechanisms to alleviate these concerns. Estonia also mentioned the lacking progress on **implementing domestic legislation** allowing for the government to participate in cooperation mechanisms as a legal barrier.

3.4 Evaluation of barriers

The barriers to cooperation mechanisms can be assessed according to their impact and the difficulty to implement appropriate remedies. The impact of the barriers on the application of cooperation mechanisms was ranked as show-stoppers, as leading to delays and acceptance problems or as improving efficiency of mechanisms (e.g. by enabling more efficient joint support schemes). The difficulty of implementing remedies for the barriers can be distinguished between, first, merely requiring improved technical know-how and data provision, needing a negotiated solution involving some type of compromise between the cooperating countries and, second, more complex barriers such as requiring changes in the EU RES directive or the grid and market framework conditions. Figure 1 below shows that key barriers with a high impact that currently delay the application of cooperation mechanisms and hinder their acceptance could already be addressed through better availability of know-how and negotiated solutions (the “low-hanging fruits”).

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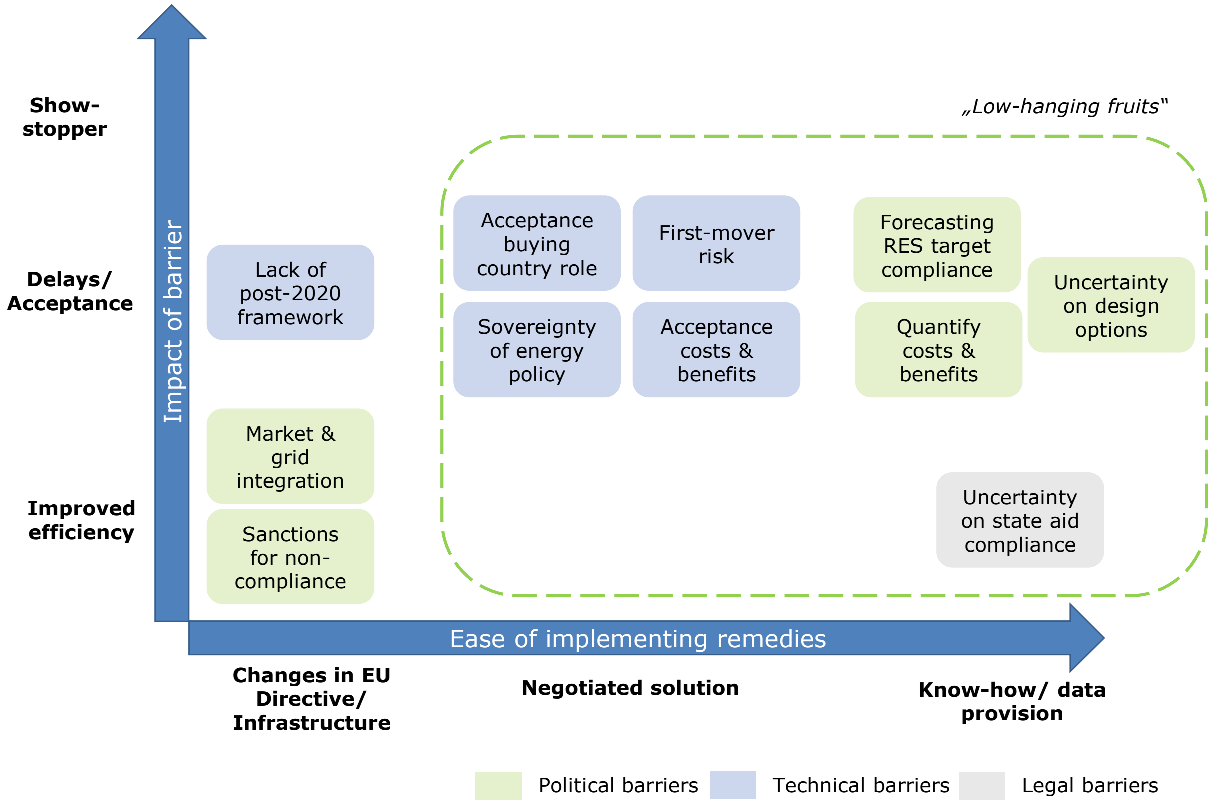

Figure 1: Barriers to cooperation mechanisms: impact and difficulty to implement remedies, (Source: own elaboration)

Thus, the key obstacles to implementing the cooperation mechanisms are clearly the uncertainty of target compliance. As soon as Member States will know more precisely about potential (positive or negative) deviations from their target, incentives to engage in cooperation will significantly increase. However, implementing one of the Cooperation Mechanisms requires preparation; thus, a timely start would be beneficial for those countries considering one of the mechanisms. Second, the uncertainty of costs and benefits of cooperation, the question of how to quantify them and how to adequately distribute costs and benefits are other crucial barriers which can be successfully addressed though (see chapter 5). That is to say, some of the barriers that have been show-stoppers can be addressed through further analysis and guidance. Other crucial barriers are seemingly the lack of public acceptance in the buying country. One specific reason for lack of public acceptance is related to the virtual import (that is, statistical import) of renewable electricity, thus, if there is no direct effect on the domestic electricity system. Moreover, the first-mover risk of those countries that enter into cooperation first is a potential barrier. On a broader scale, but not less important, is the current lack of clarity on the governance framework of the post-2020 framework for renewables, which is required to take decisions that potentially have significant political and economic impact. This issue cannot be directly addressed by single Member States, but it underlines the importance of a reliable and ambitious post-2020 framework for renewables.

4 Design options for cooperation mechanisms

4.1 Elements Member States need to decide on when implementing cooperation mechanisms

Statistical transfers, joint projects and joint support schemes provide opportunities for different depth, scope and duration of cooperation between Member States. In their choice of cooperation mechanisms and their design, Member States need to clearly define and communicate the underlying interest for the cooperation. This might include:

- Lowering the costs of reaching the national 2020 RES targets;
- Closing the potential gap between RES production and RES target and/or interim target;
- Cooperation for technology development;
- Long-term cooperation and electricity imports/exports.

Statistical transfers could be particularly suitable to address cost-efficient fulfilment of the RES targets. Statistical transfers can lower the costs of target compliance and allow Member States to engage in limited cooperation. There is for instance no direct effect on domestic support schemes and statistical transfers are comparatively easy to establish. **Joint projects** can be suitable to jointly develop technologies, save costs of RES target fulfilment and prepare long-term electricity imports/exports. They require a higher degree of cooperation, but only for a limited amount of projects. **Joint support schemes** provide for the highest degree of cost-efficiency and policy and market integration. They however require deep cooperation between Member States who share similar technology preferences and have well integrated electricity markets.

Yet each of the cooperation mechanism types can be designed with a range of options to address the Member States' needs and their willingness to integrate policies with other Member States. The table in section 4.2 presents design options and their suitability for different Member State needs for each cooperation mechanism. These are based on the European Commission's Guidance on the Use of Renewable Energy cooperation mechanisms, literature findings (mainly Klessmann et al. 2010, RE-Shaping, RES4LESS project, GreenStream, International Feed-in Cooperation), expert discussions and interviews with Member States. For each mechanism the **type of cooperation** (e.g. number of involved parties, single-project or multi-project cooperation), the **scope of cooperation** (e.g. technology and duration of support), the **flow of support** (e.g. determination of support level/transfer price) and the **contractual arrangements** (e.g. arrangements for non-compliance) have to be defined.

4.2 Overview: Design options for the different cooperation mechanisms

Statistical transfer (Art. 6)

Table 1: Type of cooperation

Design aspect	Design options	Suitable under which conditions?
Number of countries involved	Bilateral	• Early implementation; • Lower transaction costs to set up the cooperation; • Preconditions: No prior experience necessary.
	Multilateral	• Increasing welfare benefits (reducing costs of achieving 2020-targets); • Adding more flexibility if one country does not deliver; • Preconditions: Prior experience potentially required.
Trading platform vs. individual contracts	Open trading platform	• Increased transparency; • Preconditions: Liquid market for RES amounts (liquidity likely to increase only shortly before 2020 as indicative interim targets are not binding).
	Individually negotiated bilateral or multilateral contracts	• Potentially higher political feasibility to establish cooperation; • Also suitable for early cooperation as no liquid market for RES amounts is needed; • Preconditions: Awareness on Member States interest to become buying/host country.

Table 2: Scope of cooperation

Design aspect	Design options	Suitable under which conditions?
Time-frame/horizon	Specific year	• Suitable to fill short-term gap (for specific trajectory target or for the year 2020); • Limited financial commitment of buying Member State; • Only temporal surplus required for selling Member State; • As indicative interim targets aren't considered a sufficient incentive to trade there might be higher market liquidity towards 2020 (but higher prices as trajectories get steeper and "low hanging fruits" have been exploited); • Precondition: Buying Member States assume risk of not finding selling country for RES amounts by 2020.
	Several years	• Helps to meet indicative trajectory target and binding 2020 target; • Reduces uncertainty for both parties (agreed/stable revenue stream and agreed/stable contribution to target achievement); • Precondition: Interest in longer-term cooperation.

Design aspect	Design options	Suitable under which conditions?
Flexibility on RES amount volumes in contract	Fixed ex-ante RES volumes	• Suitable in case of predictable surplus; • High planning certainty for buying Member State; • Ensures revenue stream for selling Member State; • Preconditions: Selling Member State assumes risk of target under-fulfilment; • Buying Member State assumes risk of target over-fulfilment.
	Flexible RES volumes (e.g. call-option contracts)	• Suitable to reduce risks of long-term agreements where the Member State's surplus/need for additional RES amounts is less predictable; • Less certainty on revenue stream for host Member State and less certainty on target fulfilment for buying Member State; • Increased flexibility for buying Member State reduces its costs if less RES is needed; • Ex-ante minimum level of RES amounts to be transferred and different timeframe options can reduce risk for both parties; • Precondition: Cooperating Member States assume risks on revenue/delivery of RES amounts.

Table 3: Support flows

Design aspect	Design options	Suitable under which conditions?
Redistribution of revenues from statistical transfers	Redistribute revenues to national support scheme	• Reduces levy costs of consumers who paid for surplus of national scheme in host Member States; • Could be source of state aid conflicts;
	Redistribute revenues to budget financed support programme	• Revenues can be transferred to existing budget financed support programme; • Establishing additional support programme in host countries implies an administrative burden,; • Precondition: Availability of budget financed support programme or willingness/capacity to set up additional support programme.
Reference for price determination (see also section 5)	Resources with highest costs ("marginal pricing")	• Maximises benefit for host Member State; • Precondition: Benefits for buying Member State.
	Resources with lowest costs	• Maximises benefit for buying Member State; • Public acceptance issues might arise as selling country will need to use more expensive resources for target fulfilment; • Precondition: Public acceptance and benefits for host Member State.

Design aspect	Design options	Suitable under which conditions?
	Average national or EU remuneration level/ costs of predominant technology	• Potential for compromise between buying and host Member States; • Preconditions: Availability of benchmarks.
	Additional references	• References can also include administrative transaction costs, potential grid enhancement costs and further costs and benefits (see also section 5 on cost and benefits allocation); • Precondition: Availability of benchmarks.
Price development over time	Fixed ex ante price for statistical transfers	• Reduces complexity and provides certainty on revenues and costs; • Precondition: Revenue/delivery stability rated higher than optimisation.
	Flexible price for statistical transfers	• Price for statistical transfers can increase or decrease according to national support cost development over time, reflecting real costs of support of the host Member State; • Higher risk for buying Member State as it cannot control support costs; • Preconditions: Optimisation rated higher than revenue/delivery stability; buying country shows trust in support scheme of the host country.

Table 4: Contractual agreements

Design aspect	Design options	Suitable under which conditions?
Rules against non-compliance of selling Member State	Transfer to buyer regardless of target achievement of seller	• Ensures delivery and contract fulfilment; • Risk for selling Member State if it does not meet its targets; • Precondition: selling Member State is certain that it will fulfil its target.
	No transfer if no surplus, but seller pays for penalty	• Ensures economic incentive to reach targets and protects buying Member State from financial consequences in case of non-fulfilment of contract; • Precondition: Selling Member State mitigates risk.

Design aspect	Design options	Suitable under which conditions?
	No transfer if no surplus + seller pays for replacement (from other seller)	• As above, in addition: potentially increasing use of statistical transfer, solution possible within internal market and potential infringement procedure might be avoided; • Selling Member State faces price risk and uncertainty on the availability of other Member States willingness to sell RES amounts; • Precondition: Selling Member State assumes price risk for back-up transfers.

Joint projects (Art. 7)

Table 5: Type of cooperation

Design aspect	Design options	Suitable under which conditions?
Number of countries involved	Bilateral agreement	• Early implementation possible; • Lower transaction costs to set up the cooperation; • Precondition: None.
	Multilateral agreement	• Suitable for large-scale projects; • Better risk sharing between participating Member States; • Precondition: Inclusion of all relevant/necessary parties.
Individual vs. multiple project framework	Individual project	• Less experience required; • Suitable for swift development of a specific project; • Suitable for first pilot projects that can initiate long-term cooperation; • Precondition: None.
	Multiple project framework	• Suitable for mid- to long-term strategic cooperation; • No definition of single projects required; • Precondition: Interest in longer cooperation.

Table 6: Scope of cooperation

Design aspect	Design options	Suitable under which conditions?
Additional deployment or existing project	Triggering additional deployment	• Additional RES deployment; • Choice of technology, size, site can be tailored to interest of cooperating Member States; • Precondition: Willingness to finance additional deployment.

Design aspect	Design options	Suitable under which conditions?
	Co-financing existing project(s) that entered into operation after June 2009	• Less initial barriers and less transaction costs as existing site, technology and size selection already occurred; • Does not trigger new RES deployment; • Precondition: Host country does not need additional RES amounts.
Physical transmission of electricity *[if technically feasible]*	Physical transmission required	• Particularly suitable for long-term cooperation (increases energy security of buying Member State, support transformation to sustainable energy system in host Member State; • Public in buying Member State might expect physical transmission; • Requirement: either neighbouring countries or all transferring countries need to be included; • Precondition: Sufficient interconnection and grid infrastructure.
	No physical transmission required	• Electricity flows are determined by market prices and not by political rationales; • Less complexity and less technical barriers to overcome; • Physical transmission not always feasible and/or technically and economically recommendable in context of European market coupling (see section 4.3); • Precondition: none.
Distribution of target credits (also see section 5)	Target credits evenly split between Member States	• Equally (or otherwise agreed) shared benefits; • Precondition: Both Member States need RES target credits.
	Target credits serve only one Member State	• Negotiated distribution of costs and benefits; • Possible starting point/precondition: Host country is already likely to meet targets, but is interested in local benefits (jobs etc.) and/or strategic cooperation; • Precondition: Cost-benefit allocation compensates for missed RES amounts.
Joint project support: level of specificity	Technology-specific	• Technology development and innovation in target technologies can be shared; • Design option with regional/site pre-selection can be introduced; • Precondition: Shared objective of technology development.
	Technology-neutral	• Choice of technology left to investor; • Maximises short-term cost efficiency of joint project; • Precondition: Shared objective of cost reduction.

Design aspect	Design options	Suitable under which conditions?
Amount of electricity	Defined fixed amount (or corridor), incl. penalty payment for non-compliance	• Increased reliability for buying Member State on target compliance; • Precondition: Delivery risk for project developer does not increase required support significantly.
	No fixed amount	• High insecurity on potential output and target compliance of buying Member State; • Reduced risk for project developer; • Precondition: Buying Member State mitigates risk of non-delivery.

Table 7: Support flows

Design aspect	Design options	Suitable under which conditions?
Support scheme for the RES installations	Using existing support scheme of one member state	• Decreases initial transaction costs to establish cooperation, therefore suitable for intermediate solutions by using existing arrangements; • Legal challenge of providing support to some projects while excluding others (non-discriminatory allocation mechanism required); • Precondition: Suitable support scheme in place in either Member State (complex for levy-financed support schemes, as offsetting the extra cost for consumer of the host country via payments of the off-taking country would be difficult to arrange for).
	Set-up of a dedicated, new support scheme	• Preferred by many Member State; • Support can be tailored to cooperation projects and optimised based on best practices; • Does not endanger integrity of existing support schemes; • Precondition: Willingness to address administrative cost of setting up new scheme.
Type of support	Upfront support	• Accounts for high investment costs; • Specifically adequate for capital-intensive pilot projects with high technology or regulatory risks; • Does not incentivise maximised output; • Precondition: Risk mitigation for non-delivery necessary.
	Production support	• Incentive to maximise output; • Precondition: Financing costs for project developers are adequate.

Design aspect	Design options	Suitable under which conditions?
	Combination of upfront and production support	• Suitable for pilot projects and less mature technologies; • Combination reduces risk for project developers, reduces the risk premium and thus the required support and burden on consumers/tax-payers; • Precondition: Agreement on mix of support.
Determination of support level	Tender/auction	• Suitable for single large project ("project tender") or a larger number of undefined projects ("volume tender"); • Competitive elements increase efficiency of support; • Risk of strategic bidding/non- implementation of won projects; • Tender procedure might also be used to determine competitive level of feed-in premium; • Precondition: Sufficient number of bidders to create competition.
	Administratively defined premium/tariff	• Suitable for a large number of small projects as transaction costs for project developers are low; • Precondition: Suitable mechanism and sufficient information to set premium/tariff.
	Negotiated solution	• Suitable in case of missing competition for very-first, high-risk projects; • Potentially not in line with EU public procurement rules; • Precondition: high political priority, too little competition for tender.
Design of support scheme	• A detailed discussion on support scheme design is provided in the report of Task 2: Design Features of Support Schemes.	
Costs and benefit sharing	• A detailed discussion of cost & benefits allocation variants will be provided in section 5.	

Table 8: Contractual agreements

Design aspect	Design options	Suitable under which conditions?
Rules against non-compliance of RES project	Penalties for delays and non-delivery of RES project	• Ensure RES amount transfer for target fulfilment of buying Member States; • Precondition: Risk does not overburden developer; low implementation risk in host country.
	Bid bonds for tender qualification	• Increase certainty that tender-winning project developer will implement the project, but increase barrier for participating in tenders; • Precondition: Risk does not overburden project developer; low implementation risk in host country.
	Performance bond for tender	• Increase timely implementation and transfer of RES amounts of awarded projects, but increase barrier for participating in

Design aspect	Design options	Suitable under which conditions?
	qualification	tenders; • Precondition: Risk does not overburden developer; low implementation risk in host country.

Further institutional and administrative considerations:

- Include arrangement for tracking and verification;
- Define procedures for the annual notification to the Commission (notification requires that a letter is sent from the Member State government explaining the quantity and price of renewable energy that is to be virtually transferred).

Joint support schemes (Art. 11)

Table 9: Type of cooperation

Design aspect	Design options	Suitable under which conditions?
Number of countries involved	Bilateral	• Suitable for early implementation; • Lower transaction costs to set up the cooperation; • Precondition: Acceptance in participating Member States.
	Multilateral	• Increase of welfare benefits (reducing costs of achieving 2020-targets), optimised utilisation of RES resources; • More complex to set up the cooperation; • Precondition: Acceptance in participating Member States, inclusion of all relevant/necessary parties.

Table 10: Scope of cooperation

Design aspect	Design options	Suitable under which conditions?
Scope of the joint support scheme	Joint scheme covers all technologies of the former domestic support schemes	• Involved Member States agree on the RES portfolio they would like to support; • Negotiations on portfolio might be complex; • Precondition: Shared technology preferences.
	Joint scheme covers only selected low-cost technologies in both countries	• Member States want to tap the economic benefits of a joint support scheme but have different interests regarding the support of higher-cost technologies; • Precondition: Shared cost preferences.
	Joint scheme covers only selected high-cost technologies in both countries	• Member States want to make a joint effort to bring down the costs of the high-cost technology they are both interested in but want to utilise the benefits of cheaper technologies on their own; • Precondition: Shared preferences for high cost technologies.

Table 11: Support flows

Design aspect	Design options	Suitable under which conditions?
Design of support scheme	• A detailed discussion on support scheme design is provided in the report of Task 2: Design Features of Support Schemes	
Cost and benefits and accounting variants to share costs and benefits	A detailed discussion of cost & benefits allocation variants is provided in section 5.	

Contractual agreements

To be negotiated between participating Member States; may depend on national legislation of participating Member States.

Further institutional and administrative considerations:

- Establish a platform for regular coordination meetings of the participating Member States.
- Fix a common procedure and designate competent authorities for the annual notifications to the European Commission

4.3 In-depth analysis: Design options for joint project support

Member States have expressed interest in engaging in joint projects but consider the broad array of design options to agree on as complex and challenging. Consequently, this subchapter analyses the design options for joint project support in greater detail to help Member States to decide on the key elements of the agreement.

1. Type of support: What type of remuneration could Member States choose to support the joint project?

i. Production support (support payment per kWh)

Production-based support compensates the RES producer for the electricity production. Support payment is therefore directly related to the plant output. Advantages of this support type include an incentive to maximise electricity production and the direct link of support scheme payments to the accounting of RES production. Support costs are furthermore stretched over the support period and do not need to be covered by consumers or tax payers at once. On the other hand this type of support can have a distortive impact on production decisions (particularly strong in case of technologies with higher marginal costs such as power production form biomass or biogas which might be induced to run in base load mode which might not be efficient). However, a premium exposing producers to market price risk can mitigate this issue (compared to a fixed feed-in tariff) and incentivise electricity production when it is most needed.

ii. Upfront financing (e.g. capital grants and low interest loans)

Up-front support in the form of a capital grant or low interest loan provides a share of the projects investment costs before it enters operation to make the project competitive. Up-front support reduces the RES project's investment costs and thereby the costs of capital. Public co-investments and mezzanine investments can also reduce financing costs. Upfront financing might be particularly appropriate for pilot projects or projects with high technology or regulatory risks and high financing costs. Since they do not incentivise the project operator to maximise electricity production they however do not ensure the delivery of a certain RES volume. Although this might be considered more efficient from a general economic point of view it can be a disadvantage in the context of joint projects which contribute to RES target achievement, as Member States would face the uncertainty how much RES-E production they would be able to book for their target. For low marginal cost technologies such as wind and solar, the difference can, however, be expected to be small.

iii. Combination of production and upfront financing support

Member States may also consider a combination of up-front and production support for supporting joint projects with particularly high technology or regulatory risks. Thereby they can combine the risk mitigating elements of upfront support with the production maximisation incentive of investment support.

2. Providing access to support: How could Member States grant financial support to joint projects?

i. Access to buying Member State's support scheme

The buying Member State can open up his domestic support scheme for the joint project, granting joint projects the same benefits and obligations as domestic RES projects. Although Article 3.3 of the EU RES Directive allows Member States to support RES in other countries, there might still be legal concerns to justify the opening of the domestic support scheme for selective joint projects only.

Determining the support level for joint projects in the domestic support scheme framework also might be challenging. Joint projects that are less expensive than domestic RES projects would be overcompensated if they received the same support level. In contrast joint projects could compete with domestic projects via tender or tradable green certificate schemes. This however includes the risk that a large share of domestic projects loses out to joint projects, potentially causing public acceptance problems in the buying Member State. The problem could be addressed by reserving a certain share of tendered volumes to joint projects, thereby separating domestic RES tenders from the competition with joint projects. In case the domestic support scheme does not contain competitive elements, the access of joint projects to the support scheme could be allocated through a tender.

ii. Access to the host Member State's support scheme

Joint projects can also be supported through access to the domestic support scheme of the host Member State. The familiarity of the domestic support scheme's administering authority with site-specific conditions and the reduced complexity of this option ease the implementation of joint projects. Buying Member States that rely on the joint projects RES amounts to fulfil their RES targets might however have reservations on their limited influence to design the joint project's support level and administration. If the host Member State's support scheme is restricted through a capacity, production or budget cap, priority access for domestic projects and for joint projects might have to be handled through separate application procedures. Similar to i), a tender procedure might well be used to grant access of joint projects to the domestic support scheme.

iii. Support by a separate support instrument for joint project(s)

Instead of opening the own domestic support schemes, the cooperating Member States can set up a separate designated support scheme for joint projects. As advantage the support scheme and, if applicable, tender specifications can be tailored to the needs of joint projects. The support scheme level can therefore be designed taking into account costs and benefits of joint projects (e.g. the costs for grid reinforcement). Project specifications such as technology and location can also be designed according to the preferences of both Member States. Setting up a separate designated support scheme for joint projects might however initially result in a higher administrative burden.

Again, the question arises how to select the projects that are supported through the separate support scheme for joint projects. A tendering procedure with competitive bidding seems the most transparent and cost-effective procedure to allocate support payments to joint RES projects. Negotiated solutions with single market participants would lower transparency and potentially be in conflict with public procurement rules.

No matter whether national support schemes are opened for joint projects or a separate support instrument is set up, tendering schemes can be an important option for allocating support as they are cost-competitive and their design can be tailored to Member State needs.

3. Tender/auction design: What principal design options exist for joint project tenders/auctions?

i. Single or multiple projects / project or volume based

Tenders for single joint projects limit the Member State's commitment to a single project. They can thereby reduce barriers for cooperation and enable the gaining of experience through pilot projects. In a single project the project criteria specifications can be defined in detail to address projects with particularly complex regulatory or technological circumstances. In contrast multiple project tenders reduce the administrative burden to tender a series of projects and are more suitable for longer-term cooperation and swift project development. Volume-based tenders focus on a certain volume of energy that is to be generated within a specific period of time. Such tender would be open for various projects. Volume-based tenders enable the development of several projects at a time and are therefore particularly suitable for quick implementation of a larger volume of projects. The diversification of the volume on several RES project also lowers the risk of non-compliance of RES targets for buying countries.

ii. Price-based or multi-criteria tender

With a predefinition of the price, tender focus the selection process on other criteria such as innovative technology or the experience of the project consortium. A focus on price as the decisive tender criterion instead delivers the most cost-competitive bid.

iii. Predefinition of sites

A predefinition of sites could account for site-specific grid conditions or cater for regional structural policy objectives. It could also ensure that support remuneration matches local RES resources and avoids overcompensation. A predefinition of sites does however include an increasing burden for the public administration and does not favour competition between sites.

iv. Suitable qualification requirements and penalties to ensure project implementation

An appropriate penalty in case of non-delivery ensures project implementation but avoids high risks for participating bidders. A bid bond which the tender winner loses should he fail to sign the project agreement should be introduced in the tender procedure. In addition, a performance bond can be used to ensure timely implementation of the project. Suitable qualification requirements provide a pre-selection of potential bidders and reduce the administrative burden.

4. Institutional set-up: Which Member State should arrange the tender for joint project(s)?

i. Tender organisation through host Member State

A tender organisation by the host Member State ensures familiarity of the tendering authority with local regulation. This is particularly suitable for project-based tenders for predefined sites whose criteria definition requires local experience.

ii. Tender organisation through buying Member State

Alternatively, a larger volume-based tender can also be issued directly by the buying Member State if different types of projects can apply.

iii. Tender organisation through a dedicated agency

A joint tender steering committee composed of the involved Member States, potentially with voting rights based on financial contribution to the project, could decide on the predefinition of the tender criteria both for tenders organised through host or buying countries. Host and buyer countries could also agree to create a dedicated agency or commission or choose a development bank, such as the EIB, to conduct the tender (however, in the latter case the EIB could potentially not act as a lender at the same time.

5. Level of financial support: In case the financial support level is not defined in an auction/tender, how should the support level be determined?

While a tender scheme would constitute the most competitive mechanism to determine the support level, Member States could also determine the support level through costs parameters based on the Levelised Costs of Electricity. The European Commission Guidance for the Design of Renewable Energy Support Schemes provide under 4.1 ”Cost elements and calculation methodology” the key cost indicators to determine the support level. In joint projects the cost indicators should be differentiated in cost indicators from the host Member State and cost indicators from the buying Member State. Site-specific indicators (e.g. RES potential, grid connection costs) should be based on the host Member State while financial indicators (e.g. off-taker’s creditworthiness) should be based on the buying Member State. Should a national support scheme be opened and the site-specific or financial indicators not be adjusted there is a risk of under-/overcompensation.

6. Source of financial support: What should be the source of the support remuneration?

i. Public budget financed

Public budget financing reduces complexity and allows for fast implementation, especially for first pilot projects. Challenges include political risks on state budget availability and the classification as state aid (and resulting notification requirements to the European Commission).

ii. Levy financed

Levy financed joint projects, where the support costs are apportioned to the electricity consumer, ensure higher stability of the funding, but may involve a higher administrative burden than budget finance. Also, the question arises whether a levy to electricity consumers is justified in cases where the electricity is not transferred to the buying country physically but only statistically.

iii. EU budget contribution

The EU could also provide additional support for joint projects, particularly to technologies still in the pioneering phase. Such additional support could help to improve public acceptance in buying Member States and stabilise the available budget compared to national budget finance, thus reducing investment risks to the participating RES projects.

7. Administration of support flows: Should Member States use their domestic administrative structures or set up a dedicated fund to manage joint projects?

i. Joint fund

Member States can decide to pool their resources in a joint fund that administers the support flows. Such set-up seems particularly suitable if several Member States join the cooperation agreement. The fund can be managed by a regulatory agency of an involved Member State or by a dedicated regulatory agency. A development bank or European institution can also be appointed to manage the fund. This option could entail additional positive effects such as reducing the country risk related to the participating Member States. The reliability of the income stream needs to be ensured through rules of non-compliance. Payments to the fund should be linked to RES target amount sharing and cost-benefit allocation. Although the establishment of a joint fund initially requires a higher administrative effort, the pooling of support and set up of joint procedures for management and application of the fund eases administration of a series of joint projects. The pooling of resources also improves the risks sharing between participating states.

ii. Use of domestic support scheme administration

Member States can instead agree on a simple bilateral arrangement for the joint project that details the support payment obligations of the Member States for the joint project without setting up a dedicated joint fund. Based on the bilateral agreement, support schemes could either be administered by the host country or the buying country. The advantages and challenges of opening up support schemes in host or buying countries or establishing a separate support scheme have been presented earlier. Which country assumes the administration of support payments would depend on experiences, capabilities and preferences of the national authorities? Advantages of bilateral agreements include lower transaction costs to set up the cooperation and consequently faster implementation of cooperation projects. Familiar and existing institutional structures can be used to arrange the allocation process. While bilateral arrangements might be suitable to initiate first pilot projects, they do not offer the same potential for scalability as joint funds.

8. Commitment period of the buying Member State: Is the buying Member State mostly interested in cooperation for the 2020 RES target compliance or in long-term cooperation?

i. Support lifetime

In general the duration of the joint project agreement should equal the support lifetime. This would not require a shift of the support paying party during the support lifetime and therefore reduce administrative efforts. Particularly for buying countries that are pursuing long-term energy security objectives through physical electricity imports such an arrangement would be suitable. The political uncertainty on the post-2020 EU RES framework however implies the risk that the RES target amounts generated by the joint project after 2020 are of no use for the buying Member State.

ii. Until 2020 or other predefined period

Instead, Member States can agree that the joint project agreement should cease at a previously defined period before the support of the project terminates, thereby shifting the obligation to provide the project support to the hosting Member State. This can be an attractive option of the buying Member State is just interested to purchase a limited amount of RES amounts for target fulfilment rather than a long-term cooperation. This implies, however, that the host Member State is willing to cover the support budget in the post-2020 period. If support payments (in case of production support) are not secured beyond 2020, the uncertainty is prohibitive for RES project developers.

iii. Until 2020 or other predefined period including put/call option for post-2020

Should the uncertainty on the post-2020 EU RES framework prevent the buying Member State to engage in a more long-term off-take agreement, then a put/call option for the buying Member State might be a suitable solution. In this case the buying Member State could renegotiate the off-take conditions for the post-2020 timeframe before 2020 as soon as it has more certainty on a potential use of RES target amounts in a new EU RES framework. This option reduces the administrative effort to continue the buying Member State's engagement after 2020, but implies higher uncertainty for the host Member State that would need to cover the support costs once the buying Member State leaves.

9. Allocation of direct costs and benefits: Do Member States want to share the energy for target compliance or will all renewable energy amounts be transferred to the buying Member State?

i. Shared allocation: Host Member State retains part of the RES target amounts for national target fulfilment

Depending on the need of the host Member State, it can decide to use part of the RES target amounts to fulfil its own target. In any case a certain proportion of target amounts might be retained by the host Member State to compensate for indirect costs and granting access to its national resources, should these not be compensated for monetarily.

ii. Full allocation to buying Member State: Host Member State does not retain RES target amounts

Should a host Member State be already likely to meet its RES targets and base its motivation to participate in the joint project rather on indirect benefits, the buying Member State might buy all the generated RES target amounts.

10. Physical transfer of electricity

One potentially important issue is the direct physical transfer of electricity into the off-taking Member State. This aspect might be relevant regarding public acceptance of cooperation because publically reasoning for support for electricity produced "abroad" will be more feasible, if actual effects on the domestic electricity system take place (such as an increased share of renewables in its electricity mix). However, the question arises whether physical transfer of electricity is economically efficient and technically feasible, especially in coupled electricity markets.

Coupling of electricity markets in Europe is advanced and will further advance in the coming years as it is a necessary step towards the realisation of the internal European electricity market. The underlying principle of market coupling is that neither the physical nor the economic "direction" of electricity flows is explicitly decided. Rather economic and physical electricity flows are the outcome of an optimised algorithm at the electricity exchanges, which ensures that cross-border capacities are used in the most efficient manner. In this context it needs to be further explored whether and how electricity flows can be directed according to political agreements rather than merely according to economic market results.

An alternative to ensure physical imports of electricity would be to build additional, dedicated transmission lines. However, such solution would generally be expensive and can only be imagined for exceptional cases.

In the following section we discuss options to consider and allocate direct and indirect costs and benefits.

5 Cost benefit allocations approaches for the involved parties

This chapter is composed of two parts. At first a blueprint for cost benefit allocation is provided to illustrate the key elements of a cost-benefits allocation scheme for RES-E. This will be complemented by a more comprehensive Annex that provides more details and background information on the specific tasks and also highlights alternative approaches to the ones recommended in the blueprint. Conceptually this chapter is configured to illustrate cost benefit allocation for RES in the electricity sector (RES-E), but with adaptions also can be applied to other sectors.

5.1 Blueprint for a cost-benefit allocation scheme

Table 12 identifies and lists the key steps and corresponding tasks of a cost-benefit allocation scheme for RES-E. Each of the steps naturally raises questions to which answers will be provided in the following.

Table 12: Elements of a cost-benefit allocation scheme for RES-E

Steps	Step 1: Identify project opportunities	→	Step 2: Identify side effects	→	Step 3: Select impact assessment method	→	Step 4: Implement allocation rule
Main tasks	• Define objective / scope • Conduct CBA for support costs		• Draw list of possible side effects • Reduce list to most relevant effects		• Quantify all effects to the extent possible • Handle uncertainty		• Decide institutional set up • Select allocation rule

How can opportunities for cooperation projects be identified?
The first step for each Member State is to gain clearity about the objectives it wants to achieve trough cooperation. The objectives will determine the complementarities that are sought after in the specific project opportunities. The EC´s Guidelines on the cooperation mechanisms lists several possible objectives of cooperation, but eventually each Member State has to determine its own priorities. One general "selection criterion" could be that involved Member States have regionally integrated markets. This would lead to the effects of RES-E expansion (such as lowered wholesale electricity prices) spilling over rather internally and will overall lead to a more balanced allocation of indirect costs and benefits. Also for practical matters this might ease the cost benefit analysis with regards to indirect effects and the whole RES cooperation procedure, respectively.

From specifying the objectives opportunities for cooperation might emerge, however in the end only projects that can contribute to (support) costs savings will be of interest for the off-taking Member State. In order to identify such cost savings, a costs-benefit analysis needs to be conducted. The initial cost benefit analysis can be conducted by a Member State interested in cooperation, but also by a project developer proposing a specific project as joint project.

In order to create value, a host Member State with cheap and/or large potential for RES-E generation and an off-taking Member State with limited and/or expensive potential for RES-E generation need to come together and cooperate. Then, a certain share of the RES-E generation required as default (i.e. in the absence of RES cooperation) in the off-taking member state would be met by additional generation in the host Member State. This leads to cost savings in the off-taking Member State, while the support costs in the host Member State increase, but at a lower rate than the support costs decrease in the off-taking Member State. Thus some net support cost savings can be realised through cooperation. These effects are illustrated on the left hand side of Figure 2.

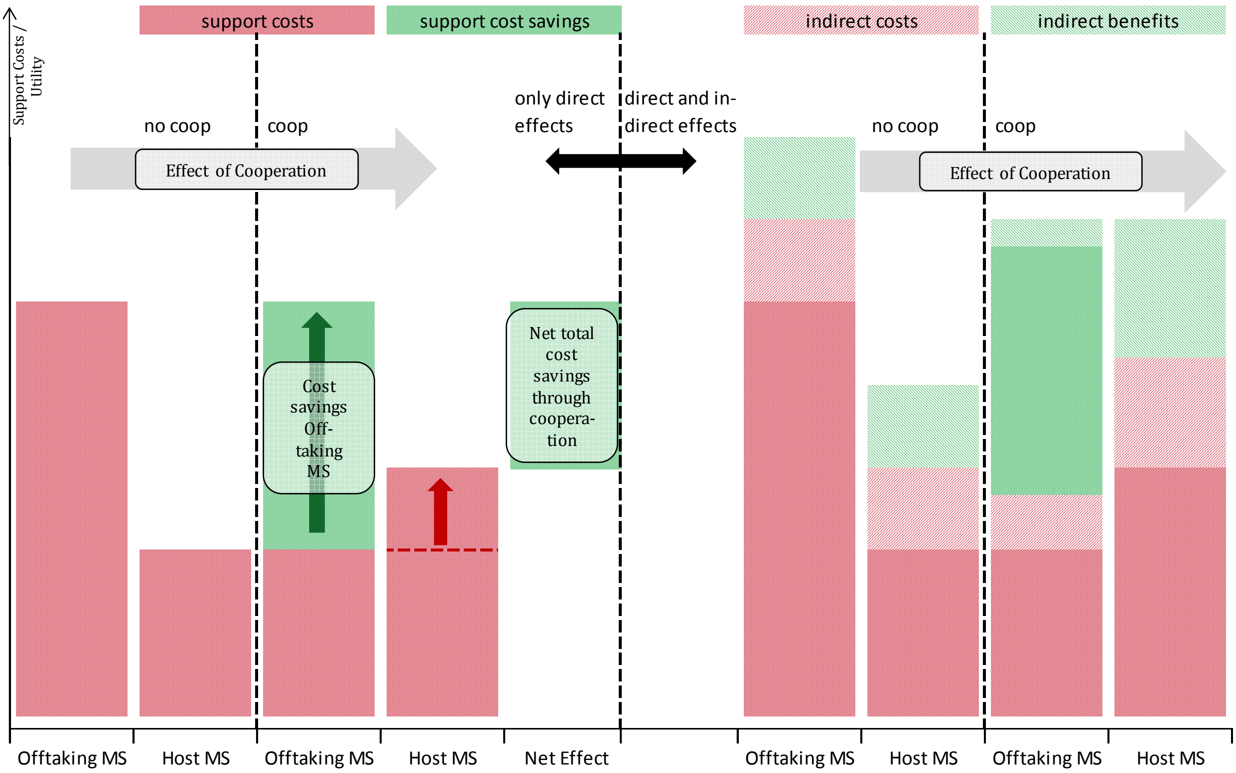

Figure 2: Impact of cooperation on the distribution of direct and indirect costs and benefits – distribution of costs and benefits before compensation has taken place.

What are the side-effects that need to be considered for the cost benefit allocation?

The allocation of RES-E generation to the host Member State will not only have an impact on the support costs, but also redistribute the indirect costs and benefits that are induced by RES-E generation. Even though the effect of their redistribution on the overall net benefit is likely to be small, the allocation of RES-E may induce a distributional inequality in terms of the indirect costs and benefits and their monetary value.

Indirect side effects that are typically listed in the literature are the following: Integration costs that are composed of grid-related costs, ancillary service costs and investment and operational costs of the conventional capacity. Further cost items are the monetary expression of (negatively influenced) biodiversity and landscape. Benefits include avoided local air pollution, GHG savings, security of supply, employment effects, and innovation effects. However in terms of importance not all these effects are at the same level. Taking into account all effects poses quite some complexity on the cost benefit allocation procedure. Therefore it seems advisable to reduce the list to the extent possible, without deteriorating the information basis for the cost benefit allocation too strongly. The following criteria can be applied to evaluate the value of each effect to be included in the reduced list:

- **Distributional impact**: Effects where a reallocation of renewable electricity generation has a low distributional impact can be excluded from the reduced list.
- **Relative weight**: Effects that receive a low relative weight can be excluded from the list. Each effect's relative weight will be derived from its absolute value in terms of costs and benefits compared to all other effects. It can be expected that support costs will define the benchmark in monetary terms and all other effects will have to be evaluated against them. Which of the effects listed above have a high or low relative weight will sensitively depend on the specific project characteristics. A qualitative pre-assessment can already provide useful guidance in this respect.
- **Quantification/Monetisation**: Effects that cannot be quantified have little value for allocation schemes that apply monetary compensation. However, in a specific context Member States may still wish to include "hard to quantify" effects taking into account local specifics (e.g. with regards to security of supply).
- **Costs vs. Benefits:** For practical reasons costs need to be borne by some party whereas benefits are often subjective. Therefore – all other criteria having equal characteristics – costs should be given preference over benefits.

Applying these criteria to the effects listed above would lead to the exclusion of biodiversity and landscape costs, security of supply, employment effects and innovation effects from the list (even though employment effects and security of supply are often emphasised in public communication and may therefore be of political value). Furthermore CO_2 costs are already internalised in the operational costs of conventional power plants and can thus also be excluded from the reduced list. In turn, this means that support costs and integration costs are kept on the list for further consideration. Furthermore, one may add here financial benefits related to concession fees, land lease taxes etc. In addition, avoided air pollution might be considered as well, if feasible to assess and to quantify.

To illustrate the consequences of including indirect effects, the reader is referred to the stylised example on the right hand side of Figure 2. In this example indirect costs (here: integration costs) and indirect benefits (here: avoided local air pollution) have been added to the support costs from the left hand side. In the non-cooperation case RES-E generation induces the same level of indirect effects in both Member States. Corresponding to the effect on support costs, cooperation leads to a redistribution of indirect costs and benefits. In the example cooperation transfers two "units" of indirect benefits from the off-taking Member State to the host Member State, but only one "unit" of indirect costs. Even though the overall impact of cooperation on the indirect effects is neutral (zero), the net impact of cooperation on the indirect effects is negative for the off-taking Member State (and accordingly positive for the host Member State) and therefore needs to be reflected in the overall cost sharing agreement.

How to select an impact assessment methodology?

As a next step all effects that are kept on the reduced list need to be assessed and monetarily expressed. In this respect it has to be distinguished between ex-ante and ex-post assessment of the effects. A realistic assumption is that an ex-ante assessment will never predict the outcomes of the different effects 100% correctly as there are too many uncertainties and complexities involved and an accurate assessment can only be conducted ex-post. However, an ex-ante assessment is inevitable for at least three practical reasons:

- Firstly, a cost-benefit analysis has to be conducted ex-ante to show if the project will actually create any benefits. Moreover the allocation of costs and benefits usually has to be decided on before a cooperation project starts;
- Secondly, the costs and benefits of the non-cooperation case have to be evaluated in order to indicate distributional effects and identify cooperation gains when switching to cooperation;
- Thirdly, not all effects are traded on markets or administrated and thus some effects simply cannot be observed ex-post.

With respect to the ex-ante assessment, different methods are available. Support cost for and integration costs of RES-E generation are best assessed by the use of renewable energy and /or power system models. Such models can also report the avoided local air pollution in terms of tonnes of emissions avoided, or the avoided pollution can be roughly derived from the model results through a follow-up calculation. This physical value then can be multiplied with the (avoided) damage costs to calculate the benefit in monetary terms.

How to choose an allocation rule?

The final step is to allocate the costs and benefits that have been assessed. To some extent the choice of institutional set up for the administration of the support scheme predetermines the type of allocation rule (and the other way around). The two principal options are to create a joint fund/scheme or to select a national support scheme for the administration of support payment flows and install some compensatory transfer pricing element. A joint fund is naturally related to a joint support scheme, while compensation through transfer prices seems more intuitive for statistical transfers. Joint projects are in between and can form a hybrid of both approaches. This would for instance be the case when the off-taking Member State uses a dedicated support scheme (e.g. a tender) to finance a specific RES-E project in the host Member State. However, as will be explained below, also the transfer pricing approach can be applied for compensation with slight modifications.

If a joint fund is selected for the administration of support payment flows, an allocation rule needs to be implemented that allocates the resulting support payments. How this can work is illustrated in section 9.1. From the cost benefit analysis the total support cost for both the cooperation and the non-cooperation case are known. The support costs from the non-cooperation case are summed up in the "virtual joint fund" and are compared to the total support costs that would be required in the joint fund in the cooperation case. The delta constitutes the net cost savings that can be realised through cooperation. Now, any allocation rule that allocates the net cost savings between the partners also allocates the support costs. In the example below the cost savings are shared equally between the partners and are deducted from the (hypothetical) support costs that would have to be borne by each Member State in the non-cooperation case. The remaining support costs define the cost share of each member state in the joint fund. It can be observed that in this example the off-taking Member State would have to bear four times higher support costs than the host Member State, but both Member States are better off than without cooperation and both Member States´ shares in support costs add up to the total costs of the joint fund (see Figure 3.).

Thus, to recapitulate, a rule that shares the net cost savings also allocates the support costs. When two Member States are cooperating, the simplest and best rule is to share the net cost savings evenly (50:50). This will always make each Member State being better off from cooperation and also strengthens the idea that cooperation gains can only be realised jointly (by bringing together complementary resources; here: cheap cost potential curve and high willingness to pay / high opportunity costs). In case more than two Member States are involved, more sophisticated rules for sharing the cost savings may be applied.

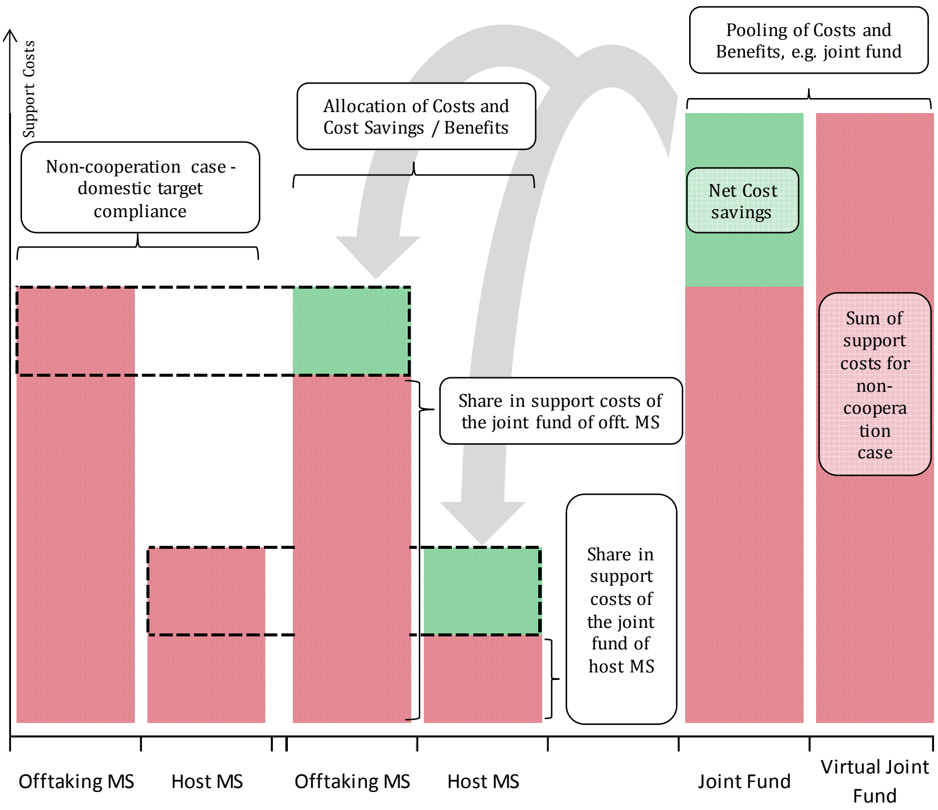

Figure 3: Sharing the net cost savings of cooperation can be interpreted as an allocation of support costs in a joint fund.

How to deal with indirect effects and uncertainty?

In case that cooperation induces an uneven distribution of indirect side effects as shown in Figure 2 the net impact on each Member State in terms of indirect effects can be used to adjust its share in the support costs of the joint fund. For instance in the example the off-taking Member State has a negative net impact in terms of indirect cost and benefits and thus could reduce its support costs by one "unit". On the other hand the host Member State´s share in support costs would be increased by one unit. This will fix an absolute amount of support costs that have to be contributed by each Member State to the joint fund. However, the numbers that are derived depend on the outcomes of the cost benefits analysis that has been conducted ex-ante and it is likely that the absolute amount of support costs required for the joint fund will deviate in the future. A practical approach therefore would be not to fix the absolute contribution of each Member State to the joint fund when the cooperation is agreed, but the relative contribution in terms of share in total costs. Fixing the relative share appears justified, given that the decision to undertake a project would be taken on the basis of the best and collectively approved information at that time. Therefore it would not be appropriate to reallocate the actual incurring costs and benefits in a manner that differs from the original agreed plan (Frontier/Consentec, 2008).

If a national support scheme is selected for the administration of support payment flows, a transfer price needs to be determined that shares the gains of cooperation and compensates for the distributional effects of reallocating RES-E generation. We recommend to determine the transfer price based of the weighted average premiums[6] for RES-E support in both the off-taking and the host Member State. These values are usually published by the parties in charge for the administration of the system, e.g. TSOs. This approach is illustrated in Figure 4.

For instance, the host Member State has large and cheap generation potential based on hydro power and onshore wind. On the other hand the off-taking member state has limited potentials and the marginal technology for target compliance is a more expensive option such as solar photovoltaic or offshore wind. What would be the effects of cooperation – that is the reallocation of renewable electricity generation – on the marginal compliance costs? In this stylised example the host Member State deploys some additional onshore wind generation to be transferred to the off-taking Member State. The off-taking Member State can comply with its target/trajectory without deploying additional, higher cost photovoltaic generation and therefore reduce its marginal costs. As an indicator for this particular allocation of RES-E generation the marginal technology-specific premium for each Member State can be weighted with its corresponding share in production (relative fraction on the horizontal axis), whereby the different weights (α,β,γ) sum up to one (α+β+γ=1). The delta (δ) between the indicators of the host and off-taking Member States defines the space of solutions for negotiating the transfer price. Each solution within this space will make both Member States better-

[6] Premiums are defined as net support on top of market values of the renewable electricity concerned.

off than without cooperation in terms of direct costs and benefits. A practical and seemingly fair solution (in case of two Member States) would be to pick the transfer price that is in the middle (here indicated in orange) between both marginal values.

In case of a joint project where the off-taking Member State is already financing the additional RES-E generation in the host Member State, the transfer price would be reduced by this amount. It is also conceivable that the Member States agree on a solution where the support being paid by the off-taking Member States is assumed to constitute an appropriate implicit transfer payment. In the illustration below the marginal onshore wind generation would already be financed by the off-taking Member State. The payment would now count towards the off-taking Member State's share in the cost savings, which corresponds to half of the grey shaded bar (δ) in the illustration above. In case of a dedicated joint project the marginal premiums might be the more appropriate reference value (compare in this respect also Figure 13 in the Annex).

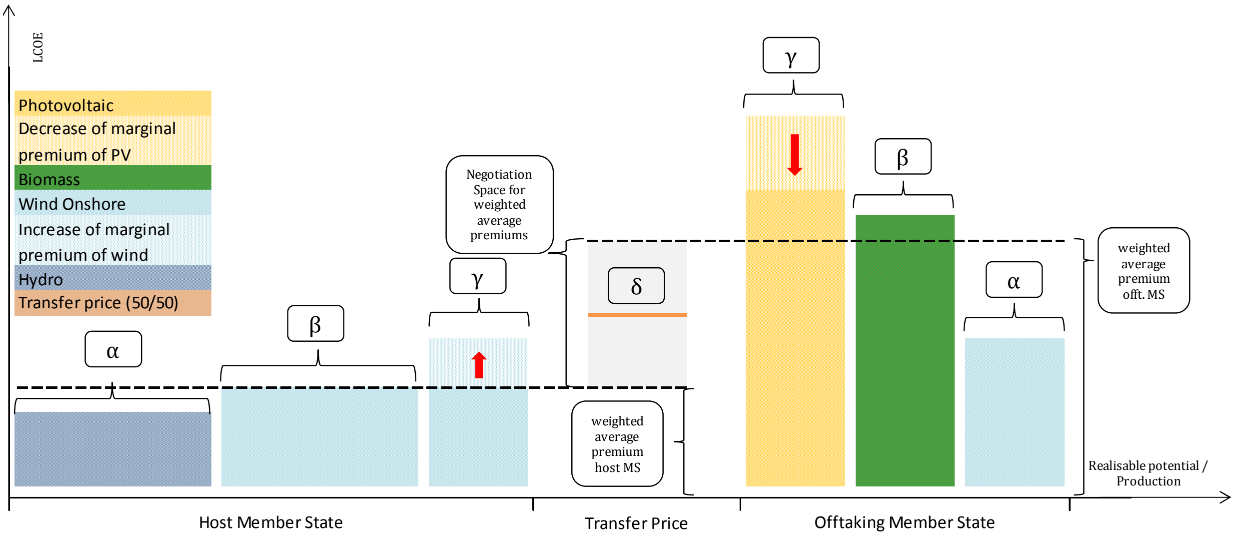

Figure 4: **Transfer price setting based on weighted average premiums.**

5.2 Conclusions

This chapter outlined necessary steps and elements of any cost and benefit allocation agreement between Member States. Each element can take several forms and therefore the specifications will have to be negotiated and agreed on jointly by the involved Member States. In practice it is likely that the different elements will be addressed in an iterative rather than sequential manner. This will help to better determine the specific requirements and implications of each element and enable mutual learning. In this context it may also be helpful to use visualisations.

Some further practical issues of the allocation rules presented will be discussed in the case studies in Task 4 and 5. A flexible approach will be followed in this regard in case the approach presented here needs to be adapted to case-specific circumstances. Moreover, additional approaches to cost benefit allocations for the involved parties are elaborated more in depth in annex 1 (section 9.1).

6 Potential impact of the cooperation mechanisms on the cost-effective increase of RES-E and the integrated European energy market

This section aims to shed light on the need for and impact of RES cooperation between Member States from a quantitative perspective, highlighting outcomes of a model-based prospective RES policy assessment dedicated to identify the cost-saving potential arising from a strong use of cooperation mechanisms at European as well as at country level. The work builds on previous related modelling activities done within the Re-Shaping study (see Ragwitz et al. (2012)) and, thus, provides an update of scenarios related to the use of cooperation mechanisms. Background on the approach taken and scenarios conducted is given next, followed by a discussion of results and findings.

6.1 Background information (methodology and key assumptions)

As in previous European projects such as FORRES 2020, OPTRES or PROGRESS the Green-X model was applied to perform a detailed quantitative assessment of the future deployment of renewable energies on country-, sector- as well as technology level. The core strength of this tool lies on the detailed RES resource and technology representation accompanied by a thorough energy policy description, which allows assessing various policy options with respect to resulting costs and benefits. A short characterisation of the model is given in the annex (Section 9.2) to this report, whilst for a detailed description we refer to www.green-x.at.

6.1.1 Constraints of the model-based assessment

- Time horizon: 2006 to 2020 – Results are derived on a yearly base;
- Geographical coverage: all Member States of the European Union as of 2013 (EU-28);
- Technology coverage: limited to RES technologies for power and heat generation as well biofuel production. The (conventional) reference energy system is based on PRIMES modelling – in particular the PRIMES reference scenario (as of 2013) was taken as reference;
- RES imports to the EU: limited to biofuels and forestry biomass – besides no alternative possibilities such as physical imports of RES-Electricity are considered for national RES target fulfilment;

- Flexibility options for national RES target fulfilment as defined in the RES directive: limited to "statistical transfer between Member States" and the option of (EU-wide) "joint support schemes" (by means of harmonised RES support). Although from a practical viewpoint important, the third principle intra-European flexibility option of "joint projects" as defined in the RES directive was neglected since its incorporation into the modelling approach was not feasible due to the highly case-specific nature of related decision making processes.

6.1.2 Overview on key parameter

In order to ensure maximum consistency with existing EU scenarios and projections the key input parameters of the scenarios presented in this report are derived from PRIMES modelling and from the Green-X database with respect to the potentials and cost of RES technologies. Table 13 shows which parameters are based on PRIMES and which have been defined for this study. The PRIMES scenario used for the subsequent assessment related to RES cooperation is the *PRIMES reference scenario* as of 2013 (NTUA, 2013).

Table 13: Main input sources for scenario parameters

Based on PRIMES	Defined for this study
Energy demand by sector	RES policy framework
Primary energy prices	Reference electricity prices
Conventional supply portfolio and conversion efficiencies	RES cost (Green-X database, incl. biomass)
CO_2 intensity of sectors	RES potential (Green-X database)
	Biomass trade specification
	Technology diffusion
	Learning rates

6.1.3 Assessed cases

A set of three distinct scenarios has been derived to identify the need for and impacts of RES cooperation. Common to all cases is that a continuation of national RES policies until 2020 is assumed. More precisely, the assumption is taken that these policies will be further optimised in the future with regard to their effectiveness and efficiency in order to meet 2020 RES targets (as set by the RE Directive 2009/28/EC) both at EU level and at national level. Thus, all cases can be classified as "strengthened national (RES) policies", considering improved financial support as well as the mitigation of non-economic barriers that hinder an enhanced RES deployment[7].

[7] Note that all changes in RES policy support and non-economic barriers are assumed to become effective immediately (i.e. by 2015).

To identify possible cost-saving potentials that come along with a stronger use of cooperation mechanisms, three different variants of national RES support and RES cooperation, respectively, have been assessed. These scenarios can be distinguished as follows:

- As reference scenario a "national perspective" is researched where Member States primarily aim for a pure domestic RES target fulfilment and, consequently, only **"limited cooperation"**[8] is expected to arise from that;
- A "European perspective" is taken in the second variant that can be classified as **"strong cooperation"** where an efficient and effective RES target achievement is envisaged rather at EU level than fulfilling each national RES target purely domestically[9];
- As third option a moderate level of cooperation between Member States is assumed. Thus, this reference case of **"moderate (RES) cooperation"** can be classified as compromise between both "extreme" options sketched above.[10]

6.2 Results on the need for and impact of RES cooperation

Next the outcomes of the analysis performed on the use of cooperation mechanisms are discussed. We start with results related to the expected future RES deployment, focussing on 2020.

6.2.1 RES deployment and (virtual) RES exchange by 2020

As a starting point, Figure 5 (below) compares the 2020 RES targets as set by the RES directive (2009/28/EC) with the resulting RES deployment according to distinct scenarios on the extent of use of RES cooperation (i.e. from limited to strong). More precisely, the graph shows both at EU and at national level the expected RES shares in gross final energy demand by 2020. While at EU level in all cases a similar RES deployment is achieved[11], the country-specific deployment differs from case to case. Thereby "limited cooperation" shows generally less deviation between target and resulting national RES deployment while in the case of "strong cooperation" the differences are larger in magnitude.

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[8] Within the corresponding model-based assessment the assumption is taken that in the case of "limited cooperation/National perspective" the use of cooperation mechanisms as agreed in the RES Directive is reduced to necessary minimum: For the exceptional case that a Member State would not possess sufficient RES potentials, cooperation mechanisms would serve as a complementary option. Additionally, if a Member State possesses barely sufficient RES potentials, but their exploitation would cause significantly higher support expenditures compared to the EU average, cooperation would serve as complementary tool to assure target achievement.

[9] In the "strong cooperation/European perspective" case economic restrictions are applied to limit differences in applied financial RES support among Member States to an adequately low level – i.e. differences in country-specific support per MWh RES are limited to a maximum of 4 €/MWh_{RES}.while in the "limited cooperation/National perspective" variant this feasible bandwidth is set to 30 €/MWh_{RES}. Consequently, if support in a country with low RES potentials and/or an ambitious RES target exceeds the upper boundary, the remaining gap to its RES target would be covered in line with the flexibility regime as defined in the RES Directive through (virtual) imports from other countries.

[10] In accordance with the explanations given above (i.e. for strong and limited cooperation), the differences in country-specific support per MWh RES are for the case of moderate cooperation limited to a maximum of 17 €/MWh_{RES}.

[11] In accordance with the National Renewable Energy Action Plans as submitted by the Member States throughout 2011 as well as with the PRIMES reference case a slight over-fulfilment of national 2020 RES targets is assumed, leading at EU level to a RES share of 20.7% in gross final energy demand.

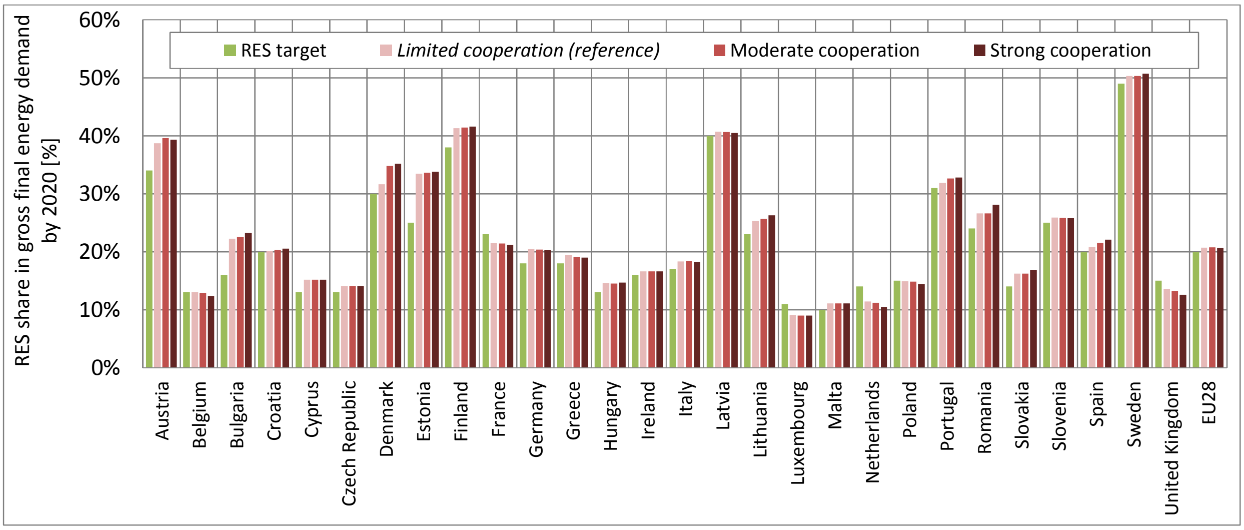

Figure 5: 2020 RES targets versus resulting RES deployment according to assessed scenarios of limited to strong RES cooperation

Next, Figure 6 provides a graphical illustration of (virtual) exchange of RES volumes needed in 2020 for RES target fulfilment according to assessed scenarios, showing the remaining resulting import and export volumes in relative terms (i.e. as share of gross final energy demand (top)) and in absolute terms (i.e. TWh (bottom)). Notably, also with tailored national support schemes in place, not all countries have sufficient realisable[12] potentials to fulfil their 2020 RES obligation purely with domestic action. As shown in the graph, France, Luxembourg, the Netherlands and the UK have to rely, in all cases, on RES imports by 2020[13]. Summing up the required imports of all related countries, a gap of 67 TWh occurs in the case of "limited cooperation" which needs to be covered via imports from other Member States which exceed their national obligations. This accounts for 2.4% of the total of required RES deployment by 2020 or 4.6% of the energy production stemming from new RES installations in the period 2011 to 2020. Thus, this emphasises the need for intensifying cooperation between Member States, even if "national thinking" (of using domestic resources to gain related benefits etc.) maintains its dominance. The variant of "moderate cooperation" indicates a small increase of (virtually) exchanged RES volumes, from 67 to 76 TWh (or 2.7% of total RES volumes) by 2020. The best use of cooperation mechanisms is achieved under the variant named "strong

[12] In the case of "limited cooperation", weak economic restrictions are specified for the exploitation of RES potentials, meaning that support levels for certain RES technologies may differ significantly between Member States (i.e. by up to 30 € per MWh RES).
[13] Compared to the previous assessed conducted in the RE-Shaping study two years ago, this list of countries that require cooperation has got smaller: Belgium and Italy, two former candidates presumed to rely on (virtual) imports from other countries have made significant progress in recent years, partly also caused by a decline of overall energy consumption. On the contrary, the UK appeared new on the list since the gap to meet the given target appears from today's perspective too large to be closed through domestic action only in forthcoming years.

cooperation” which would increase the (net) exchange of RES between countries to 102 TWh (3.6% of total RES or 7.0% of new RES installations (2011 to 2020))[14].

Moreover, “strong cooperation” should allow for more efficient and effective target achievement than domestic action alone. This will be analysed next.

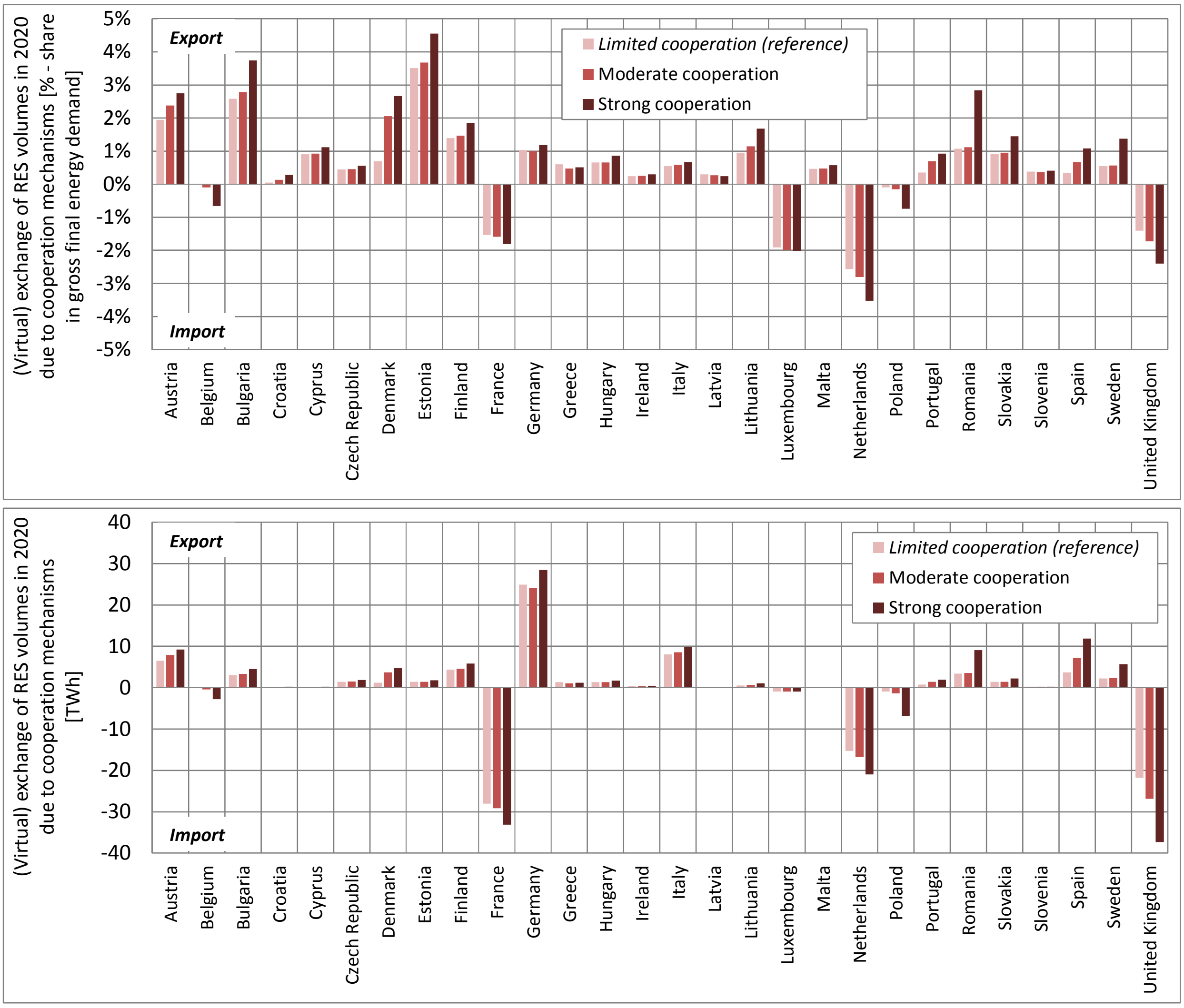

Figure 6: (Virtual) exchange of RES volumes between Member States in 2020 according to selected variants of “strengthened national RES policies”, assuming limited (reference), moderate or strong cooperation between Member States, expressed in relative terms (i.e. share in gross final energy demand) (top) and absolute terms (TWh) (bottom)

[14] Notably, the traded volumes might increase further if no over-fulfilment of the 2020 RES target will take place at EU level, meaning that a RES share of 20.0% and not of 20.7% (as assumed within this analysis) will be reached by 2020.

6.2.2 Costs and benefits of intensifying RES cooperation

A closer look on Figure 7 indicates that cooperation appears to be beneficial at the aggregated (EU) level. Strong (rather than limited) cooperation would increase benefits slightly, for example through fossil fuel avoidance by 0.4% or through the accompanying avoidance of CO_2 emissions by 0.7%. More pronounced is the resulting decrease of related cost and expenditures.

Thus, additional generation cost for new RES installations would decrease by 1.6%. Moreover, less costly investments in new RES technologies would have to be taken, leading to decline of capital expenditures by 2.2% (compared to reference). Of highlight, support expenditures that come along with dedicated RES support would decrease by 10.8% in the case of a strong use of cooperation mechanisms. This corresponds at EU level to cumulative savings of € 31 billion over the whole period up to 2020.

A moderate level of RES cooperation has less pronounced impacts. While for additional generation cost (-0.1% compared to reference), capital expenditures (-0.2%) as well as fossil fuel and CO_2 avoidance (-0.3% (fossil fuel) and -0.2% (CO_2)) the impacts of a moderate intensification of the use of cooperation mechanisms are of negligibly small magnitude, support expenditures show a significantly stronger impact: the need for support of new RES plants (installed 2011 - 2020) can be reduced by slightly less than 6%.

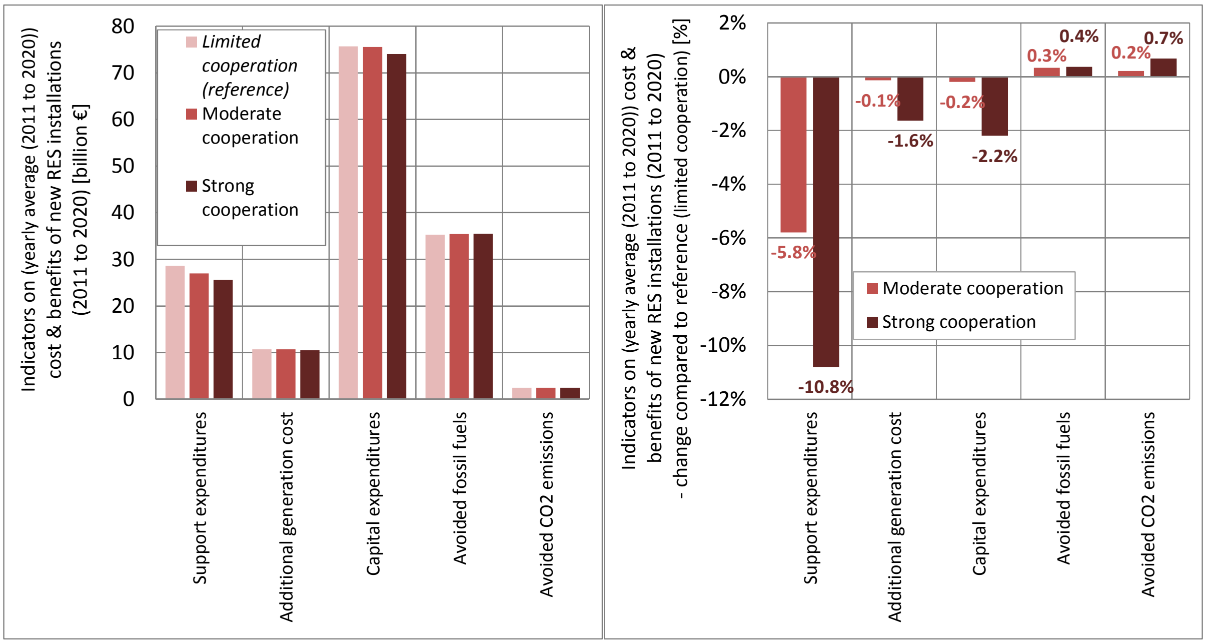

Figure 7: Indicators on yearly average (2011 to 2020) cost and benefits of new RES installations (2011 to 2020) at EU level for all assessed cases, expressed in absolute terms (billion €) (left) and assuming moderate or strong cooperation between Member States, expressed as deviation from the (reference) case of limited RES cooperation (right)

On country level, a more heterogeneous picture with respect to costs and benefits that come along with intensified RES cooperation occurs, cf. Figure 8 and Figure 9. These graphs illustrate the changes in costs, investments and benefits that result from strong instead of limited RES cooperation at country level whereby countries are ranked according to their change in 2020 RES deployment. The strongest decline in RES deployment is in general applicable for countries that have to rely on imports even under limited cooperation (e.g. Netherlands, the UK) but also for other countries that as default may act as exporter could be affected since in the case of strong cooperation in our modelling the assumption is taken support levels are aligned more closely across the EU. A decrease in deployment generally goes hand in hand with a decline of investments (that may have macroeconomic consequences) as well as fossil and CO_2 avoidance[15]. Remarkably, importing countries may gain strongly from cost savings if strong RES cooperation is pursued, since support expenditures could be reduced significantly. The countries with the highest savings in support expenditures in percentage of GDP are Latvia, Poland, France, the Netherlands, UK and Belgium.

[15] The indication of impacts on fossil fuel and carbon avoidance at national level shall be seen as a rough estimate since for RES in the electricity sector it remains hard to predict under which geographical borders actual replacement takes place (due to the interconnected market, at least in parts of Europe).

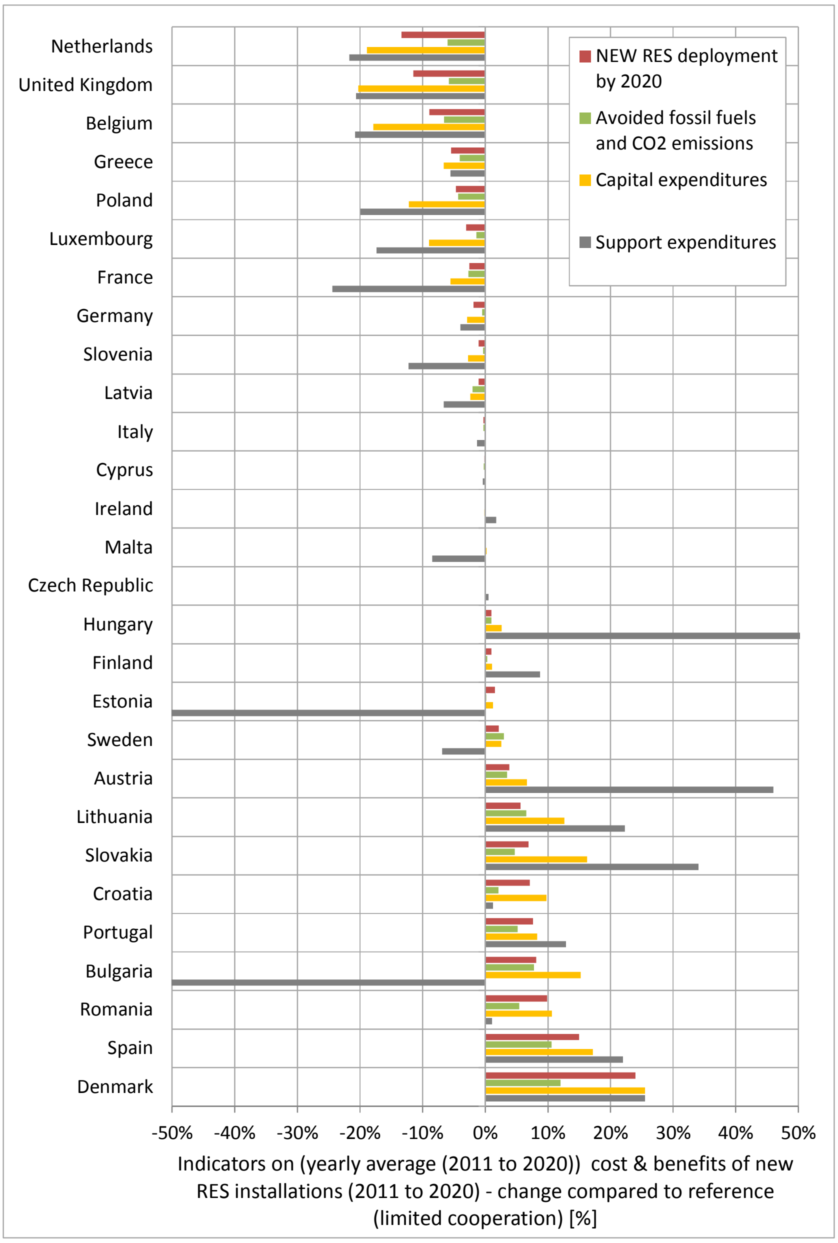

Figure 8: Indicators on yearly average (2011 to 2020) cost and benefits of new RES installations (2011 to 2020) <u>at national level</u>, assuming strong cooperation between Member States, expressed as deviation from the (reference) case of limited RES cooperation (in percentage terms compared to reference)

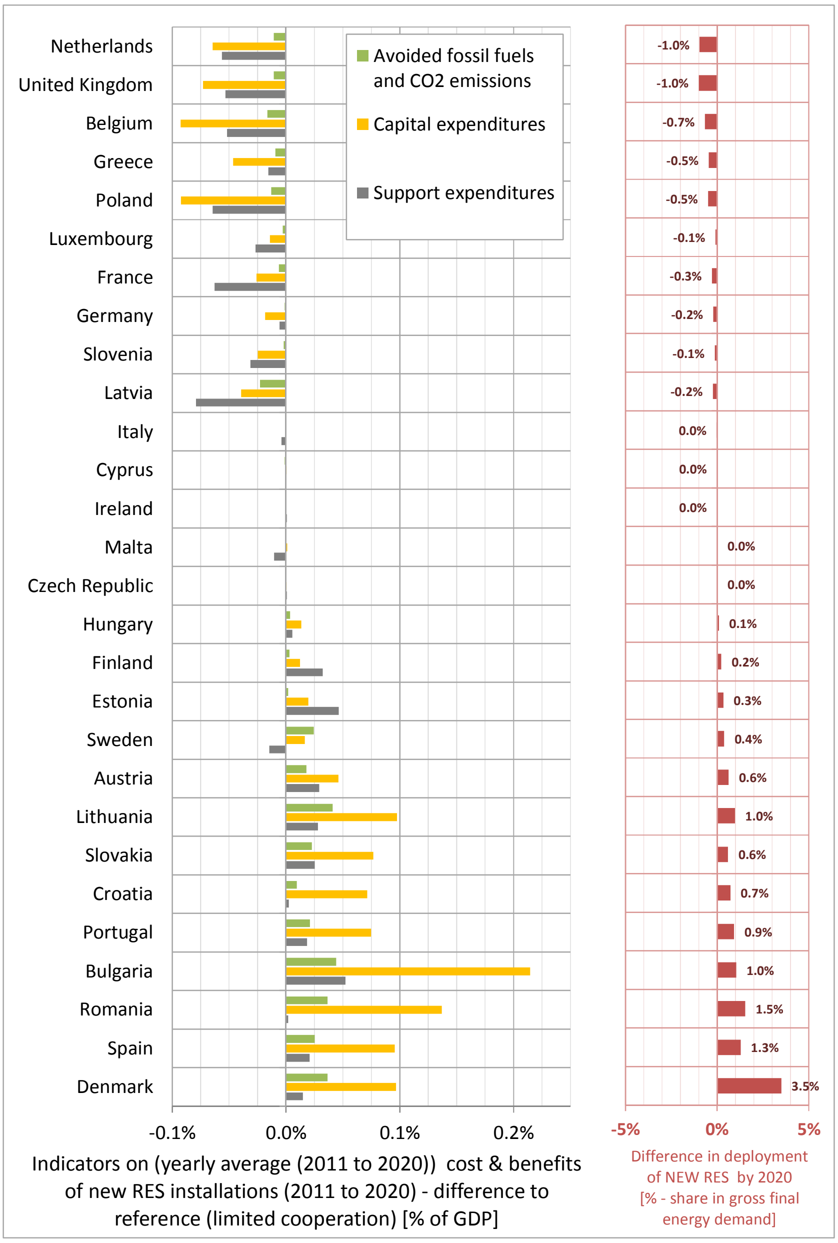

Figure 9: Indicators on yearly average (2011 to 2020) cost and benefits of new RES installations (2011 to 2020) at national level, assuming strong cooperation between Member States, expressed as difference to the (reference) case of limited RES cooperation

In contrast to above, exporting countries show the opposite trend with respect to impacts on costs and benefits. In general, an increase in RES deployment comes along with benefits like carbon and fossil fuel avoidance. Often more important is a possible positive impact of domestic investments on the labour market. Mobilising more investments in RES requires however financial incentives, leading to an increase in support expenditures.

According to Figure 8 this effect appears to be significant in magnitude for some countries like Austria, Hungary or Slovakia. There are however important caveats to consider for avoiding misinterpretations:

- Most important for the impacts on support expenditures at country level is the price that the importer has to pay for the exchanged RES volumes, and that the exporter can book as revenue. In our modelling the simplistic proxy is made that the price for traded RES volumes equals the average EU-level support for a new RES-E installation in a given year. In practice, prices for RES exchange may differ from that and for example rise with increasing demand, depending on what Member States negotiate, cf. section 5. In practice, Member States are likely to find solutions that provide mutual benefits to all involved parties;
- Figure 8 shows the change compared to the reference case of limited RES cooperation. Since increased cooperation is an attempt towards a more efficient resource exploitation, support levels are under these circumstances generally lower, and consequently also prices for RES exchange decline in our underlying modelling caused by the simplification made;
- Thus, for a possible exporting country like Austria or Slovakia this does not mean that RES cooperation is not beneficial at all. It simply means that the assessment and the simplifications made indicate that revenues from selling their surplus in RES volumes may become smaller if a strong cooperation is pursued across the EU due to efficiency gains at the aggregate level.

6.2.3 Maximising the impact of cooperation mechanisms on promoting an integrated European energy market

The European Commission guidance for the design of RES support schemes highlights that maximising the benefits from intra-European trade in renewable energy through cooperation mechanisms is a key measure to ensure that Europe's energy market can function efficiently. The quantitative results above show the **efficiency gains** of cooperation mechanisms through reducing required remuneration costs, additional generation costs and capital expenditures.

Increased use of cooperation mechanisms may also reduce national interventions into the common electricity market. By cooperating for instance through smaller joint projects, Member States can drive a **bottom-up convergence** of their national renewable energy support in a limited scope. Through limited cooperation Member States can progressively introduce a **level-playing field** and reduce unilateral market interventions. Joint support schemes, the closest form of RES policy cooperation, thereby also provides for the highest degree of electricity market integration. In the case of Sweden and Norway the already existing integrated electricity market eased the implementation of a joint support scheme between the countries.

Member States engaging in cooperation mechanisms also profit from **capacity-building** and knowledge transfer between the governments and between market actors that can driver further market integration.

6.2.4 Conclusion

Intensified use of cooperation mechanisms facilitates a more cost-efficient RES target fulfillment at EU level. This is confirmed by the model-based quantitative assessment conducted within this study as well as within previous projects (e.g. RE-Shaping) and analyses.

Different degrees of cooperation between Member States – from pure domestic RES target fulfillment to efficient and effective target fulfillment at EU level – provide different magnitudes of efficiency gains. "Strong cooperation" compared to pure "national thinking" as specified in the case of "limited cooperation" reduces additional generation cost and capital expenditures as well as significantly decreases support expenditures (-10.8% or € 31 billion over the whole period up to 2020 at EU level compared to "limited cooperation"). The "moderate cooperation" scenario, which seems more realistic considering the current Member States preferences, still shows reductions in support expenditures of -5.8% (€ 17 billion) over the whole period up to 2020 at EU level.

7 Conclusions

While only few Member States actively pursue cooperation mechanisms so far, many Member States indicate that they might consider applying cooperation mechanisms in the future. Potential buying Member States are mainly interested in securing their RES target achievement, while potential sellers hope to gain extra income from the cooperation. In addition, interest in long-term cooperation or electricity imports were also mentioned by some countries. In practice, cooperation mechanisms are only used by Sweden/Norway so far. UK and Ireland have a very concrete initiative and already signed a memorandum of understanding. Several Member States have started consultations, but with a lack of urgency, as these policy initiatives are not yet high on the political agenda. Uncertainty on design and cost-benefit allocation aspects as well as key political barriers also halter the implementation of cooperation mechanisms even among the Member States that have expressed an interest in cooperation.

Member States welcomed the guidance document by the European Commission and asked for further information on design options and cost-benefits measurement methods. Although stronger technical guidance would help Member States, the basic functioning, costs and benefits of cooperation mechanisms need to be simple enough to explain them to the public – public scepticism was named as an important obstacle, particularly for the potential buying countries. Overall technical and legal assistance and tools to evaluate cooperation mechanisms could be easy-to-implement instruments that can speed up the implementation of cooperation mechanisms and improve their public acceptance. As one step in this direction, this report has presented quantitative and qualitative analysis to assist Member States in cooperation mechanism design (Chapter 4), cost-benefit allocation (Chapter 5) and the cost savings potential of cooperation (Chapter 6). On the political level, a reliable long-term framework for RES would be a key driver for an increased use of cooperation mechanisms. 2030 RES targets would be a precondition for effectively applying cooperation mechanisms beyond 2020.

Chapter 4 has presented design options to tailor cooperation mechanisms to the needs of the cooperating member states, analysing the suitability of different options regarding type of cooperation, scope of cooperation, financial arrangements and contractual arrangements.

Chapter 5 has shown options how the costs and benefits of cooperation mechanisms can be measured and allocated. It has presented the different realms of costs and benefits – power system, externalities and macro-effects - and assessed the trade-off of addressing a comprehensive set of costs and benefits and the increasing complexity and transaction costs of the cooperation agreement. According to the objective and scope of the cooperation agreement – ranging from lowering the costs of complying with RES targets to maximising the long-term benefits of strategic cooperation – the range of costs and benefits to be allocated in the cooperation agreement should be determined. For enabling early small-scale cooperation agreements, a simple allocation procedure is proposed.

Chapter 6 has identified the cost-savings potential of cooperation mechanisms for Member States and for the whole EU. The "strong cooperation" scenario where an efficient and effective RES target achievement is envisaged at EU level reduces additional generation costs, capital expenditures and support expenditures. The savings in support expenditures are the largest among the cost categories: strong cooperation reduces support expenditures on European level by -10.8% or € 31 billion over the whole period up to 2020 at EU level compared to the "limited cooperation" scenario. This shows the benefits of increased use of cooperation mechanisms. The scenarios also show which Member States would profit most of using cooperation mechanisms: in percentage of GDP the savings in support expenditures would be highest in Latvia, Poland, France, the Netherlands, UK and Belgium.

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9 Annex

9.1 Annex 1: In depth elaboration on cost benefit allocations approaches for the involved parties

9.1.1 Trade-offs between cooperation mechanisms to address different scopes for cooperation

Before any cooperation agreement can be set up the Member States involved have to become clear about the objective(s) they want to pursue through the cooperation. This regards both the general choice to enter into a cooperation agreement and the selection of the specific mechanism. The EC´s guideline lists several possible objectives. To some extent the rationale for pursuing cooperation will already predetermine the choice of the specific cooperation mechanism. The trade-off for the selection of the appropriate mechanism is mainly between the degree of complexity and the degree of coordination of the support instruments (from a single RE project to all projects), which both increase along the spectrum of possible mechanisms (see Figure 10). Thus, if the objective is rather short term, statistical transfers may be most appropriate, if its strategic joint support schemes may fit best. A rule of thumb could be the larger the volume of cooperation in renewable electricity projects that shall be realised the more the choice of a more complex mechanism is justified.

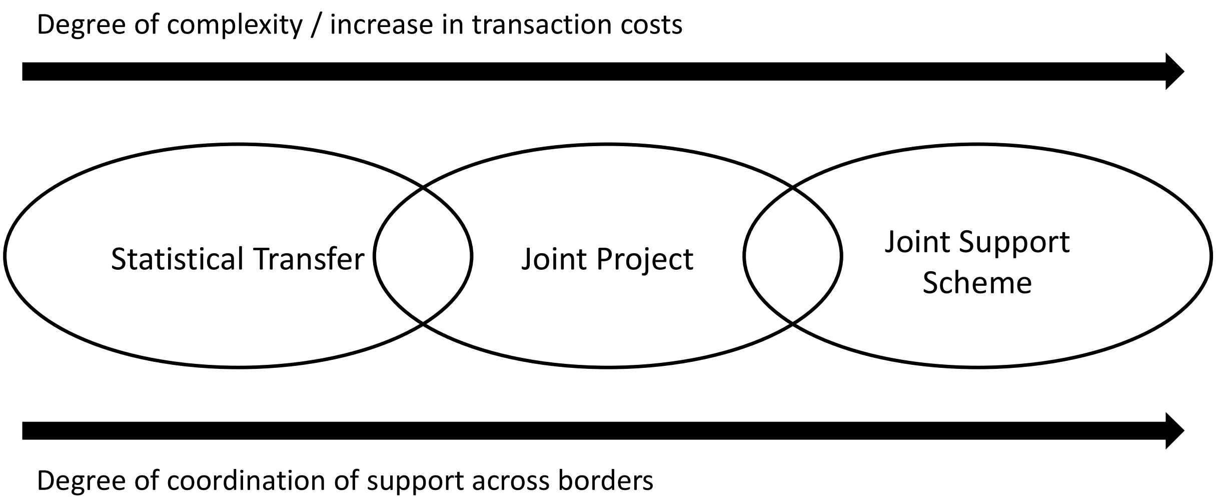

Figure 10: Trade-offs between cooperation mechanisms to address different scopes for cooperation.

Each of the mechanisms offers the potential to reduce costs at different levels of cross border cooperation. Statistical transfers induce some (targeted) additional generation under the support scheme of the Member State with the cheaper generation potential. Joint support schemes set harmonised support conditions across boundaries and the site selection is left to the investor.

This also implies an allocation of RE production to the Member State with the cheaper resources. Depending on the set up Joint projects can be closer to the former or the latter.

For Member States considering to make use of the cooperation mechanisms it is important to understand that no matter which mechanism they choose, cooperation will always lead to a reallocation of renewable generation and thus cost and benefits. With regards to the allocation of cost and benefits the question is to what extent these effects are accounted for in the cooperation agreement.

9.1.2 Evaluation Framework for RES-E cooperation

A good starting point for Member States to think about and evaluate cooperation agreements could be to draw a list of all possible kinds of effects (costs and benefits) that can be related to the expansion of renewable electricity. At first hand, such a list can be created by each Member State on its own. The first column of Table 14 contains a non-exhaustive list of effects that are commonly found in the literature. In the context of cost-benefit allocation several other questions will automatically emerge from this initial list of effects and Member States planning cooperation will need to find joint answers on each of them. In combination all questions define a framework to evaluate cooperation in renewable electricity. The different questions and their elements are discussed in the following.

Table 14: List of questions that need to be answered for each effect to evaluate the outcomes and prospects of cooperation

Cost or Benefit Component		Impact of Cooperation on: Host Member State	Off-taking member state	Net impact	How impotant is effect? Relative weight?	How well ca effect be quantified / monetized?
Direct Effect						
Support Costs						
Indirect Side Effects						
System Integration Costs	Grid-related costs					
System Integration Costs	Ancillary Service Costs					
System Integration Costs	Investment and operational costs of the conventional capacity					
Avoided local air pollution						
GHG savings						
Biodoversity and Landscape Costs						
Security of Supply						
Employment Effects						
Innovation effects						

9.1.3 Cost and benefits of RES-E expansion

The costs that directly can be linked to the expansion of renewable electricity are support costs and transaction costs. Support costs arise as most of the newly built renewable electricity plants cannot yet recover their long range investment and operational costs through sales on the electricity market. Thus the origin of the support costs lays in the relatively higher investment costs of renewable plants. This cost block forms the most important cost driver of renewable electricity expansion and thus offers significant potential for cost reduction through cooperation. In addition transaction costs arise from the administration of the support scheme.

A longer list can be developed for the indirect side effects that are caused by renewable electricity expansion. The expansion of RES-E also induces costs in the residual power system (encompassing non-renewable electricity generation, grids and system operation) that can be summarised as "system integration costs", which can be broken down into the following effects:

- Grid related cost arise in particular if the generation takes place in remote areas. This includes the costs for grid connection and possibly the need for grid enforcement due to additional load flows (which also usually increase with the distance from generation to load).
- Moreover the uncertainty in the output in particular of variable RES-E leads to additional costs of the ancillary services like balancing energy.
- Finally, variable RES-E also have an effect on the infrastructure and production cost of conventional (non-renewable) capacity, which again can be explained by their variable output. The need for more frequent ramping has an impact on the operational costs. The variable energy production displaces much stronger the need for energy than the need for capacity from conventional power, which in turn increases their investment costs.

Combined with the support and the transaction the integration costs constitute all costs that occur within the power system.

It is often argued that comparing the costs of RES-E with conventional generation technologies on grounds of the effects in the power sector alone is not a valid comparison, because this does not indicate the social value or cost of a technology. The argument behind this is that many costs and benefits that are related to RES-E expansion are external to the power sector. Roughly these can be distinguished into (environmental) externalities and effects that take place rather at the macro-economic level.

Externalities related to RES-E expansion include avoided local air pollution, GHG savings as well as biodiversity and landscape costs. As the electricity production of most RES-E (except biomass) is largely free of emissions they offer the potential to reduce local air pollution and GHG emissions (this also applies for biomass) by displacing generation and thus emissions from conventional power plants. As RES-E generally require larger areas of land they cause additional biodiversity and landscape costs compared to a conventional power plant, but these costs might be offset in the long term, when also the (land-)resource intensive extraction of fossil primary energy carriers is reduced.

Macro effects all take place at the level of the economy. RES-E can contribute to security of supply if they save fossils fuels that otherwise would need to be imported from (instable) far regions of the world. As RES-E is more labour intensive than conventional power generation technologies it also offers the potential to stimulate employment and potentially create more quality jobs (compared for instance against assembly line jobs) that can be offered to the domestic workforce. Finally the early deployment of innovative technologies could give Member States a competitive advantage in economic growth. Besides the effects listed in Table 14 other effects might play a role in the particular context of a specific project. In any case at the end of this process it is important to come up with a consolidated list of effects that avoids double counting.

9.1.4 Benefits and distributional effects of cooperation in renewable electricity expansion

Section 9.1.3 above has described the costs and benefits of expanding RES-E generation. Now this section will evaluate how the distribution in costs and benefits changes if renewable electricity generation is reallocated between member states. The proposition that is made here is that the reallocation of renewable electricity generation takes place in a way such that the savings in support costs are maximised. This assumption is justified as support costs in general offer the largest potential to create gains from cooperation from all the effects described above. While the direction of changes in the indirect effects in each Member States can be quite safely predicted, this also implies that the net impact of cooperation (as sum of changes in costs and benefits) on the indirect effects is not clear, it can be positive, negative or neutral. But even if it would be negative it can be expected that benefits in support costs savings would outweigh this by far in absolute terms.

In the remainder of this section the benefits and distributional effects of RES-E cooperation are discussed on the basis of Table 15 below. It should be kept in mind that the evaluations made in the table are only indicative and can differ from case to case.

For support costs the effect is straightforward. RES-E production is shifted to the Member State with the cheaper cost-resource curve so that in sum the support costs decrease. Transaction costs for the administration of support schemes can be assumed to be rather similar across Member States. If in case of joint support schemes the mechanism requires the setup of an additional administrative unit, the additional costs can be assumed to be outweighed by decrease in transaction costs for investors through lower search costs and information requirements. Thus the net effect can be assumed to be neutral. To understand the effect of cooperation on the integration costs it is helpful to imagine that costs depend on the flexibility options available in the system in question (for instance very flexible power plants or options for load shifting) and that these options may be not distributed equally across Member States. In this way, similar like for the support costs, a fictive flexibility supply curve can be constructed and the net effect will depend on the capability of the host Member State to accommodate additional RES-E generation (compared to the off-taking Member State). The effect of avoiding local air pollution and GHG emissions depends on the type of generation that is displaced by RES-E generation. A benefit in the host Member State (and correspondingly a cost in the off-taking Member State) is realised in cases where RES-E generation displaces generation with high emissions such as coal. Thus the magnitude of the effect in each case depends on the power mix of the corresponding Member State. As new RES-E plants usually only receive constructed permit when passing the environmental impact assessment test these effects can be expected to be rather comparable, but local exceptions may apply. Security of supply is increased in the host Member State (and correspondingly lowered in the off-taking Member State) if the shift of generation substitutes the import of a primary energy carrier that needs to be imported to a large extent. For example, if the additional RES-E generation would displace lignite in Germany there would be no effect on security of supply as Germany produces lignite domestically. If on the other hand additional new RES-E generation would be shifted to the Netherlands and would displace gas fired generation there it would have a positive effect on security of supply as the Netherlands, at least partly, import natural gas as a fuel for power generation. Effect on employment and innovation can be assumed to be rather similar across Member States and therefore the net impact is rather neutral.

Table 15: Effects of cooperation on cost and benefit components from perspectives of host MS, off taking MS and aggregated project level.

Cost or Benefit Component		Impact of Cooperation on			How impotant is effect? Relative weight?	How well ca effect be quantified / monetized?
		Host Member State	Off-taking member state	Net impact		
Direct Effect						
	Support Costs	↑	↓	↓	●	●
	Transaction Costs	→	→	→	◔	●
Indirect Side Effects						
System Integration Costs	Grid-related costs	↑	↓	?	◕	◕
System Integration Costs	Ancillary Service Costs	↑	↓	?	◕	◕
System Integration Costs	Infrastructure and production costs of the conventional capacity	↑	↓	?	◕	◕
	Avoided local air pollution	↑	↓	?	◕	◕
	GHG savings	↑	↓	?	◕	◕
	Biodoversity and Landscape Costs	↗	↘	?	◖	◖
	Security of Supply	↗	↘	?	◖	◖
	Employment Effects	↗	↘	→	◖	◖
	Innovation effects	↗	↘	→	◖	◖

9.1.5 Reduced list of effects

Taking into account all the effects listed in Table 14 poses quite some complexity on the cost benefit allocation procedure. Therefore it seems advisable to reduce the list to the extent possible, without deteriorating the information basis for the cost benefit allocation (too strongly). The following criteria can be applied to evaluate the value of each effect to be included in the reduced list:

- **Distributional impact**: The distributional impact of cooperation has been evaluated above in section 9.1.4. Effects where a redistribution of renewable electricity generation has a low distributional impact can possibly be excluded from the reduced list.
- **Relative weight**: Effects that receive a low relative weight can possibly be excluded from the list. Each effects relative weight will be derived from its absolute value in terms of costs and benefits compared to all other effects. It can be expected that support costs will define the benchmark in monetary terms and all other effect will need to be evaluated against them. The evaluation in Table 15 is only indicative and shows typical weights. However eventually the weights need to be decided / negotiated on a case by case basis by the member states.
- **Quantification / Monetisation**: Effects that cannot be quantified have little value for allocation schemes that apply monetary compensation. However in a specific context Member States may still wish to include hard to quantify effects taking into account local specifics (e.g. with regards to security of supply).
- **Costs vs. Benefits:** For practical reasons costs need to be borne by some party whereas benefits are often subjective. Therefore – all other criteria having equal characteristics – costs should be given preference over benefits.

Applying these criteria to the list from Table 14 leads to the exclusion of transaction costs, biodiversity and landscape costs, security of supply, employment effect and innovation effects from the list. Furthermore CO_2 costs are already internalised in the operational costs of conventional power plants (assuming a CO_2 that reflects the social costs) and thus also can be excluded from the reduced list.

9.1.6 Assessing Costs and Benefits

Once the framework for cooperation has been decided on the next step is to assess the costs and benefits that have been included. In that respect it has to be distinguished between ex-ante and ex-post assessment of the effects. A realistic assumption is that an ex-ante assessment will never predict the outcomes of the different effects 100% correctly as there are too many uncertainties and complexities involved and an accurate assessment can only be conducted ex-post. However an ex-ante assessment is inevitable for at least three practical reasons:

- Firstly, a cost-benefit analysis has to be conducted ex-ante to show if the project will actually create any benefits. Moreover the allocation of costs and benefits usually has to be decided on before a project starts;

- Secondly, the costs and benefits of the non-cooperation case have to be evaluated in order to indicate distributional effects and identify cooperation gains when switching to cooperation;
- Thirdly, not all effects are traded on markets or administrated through some scheme and thus some effects simply cannot be observed ex-post.

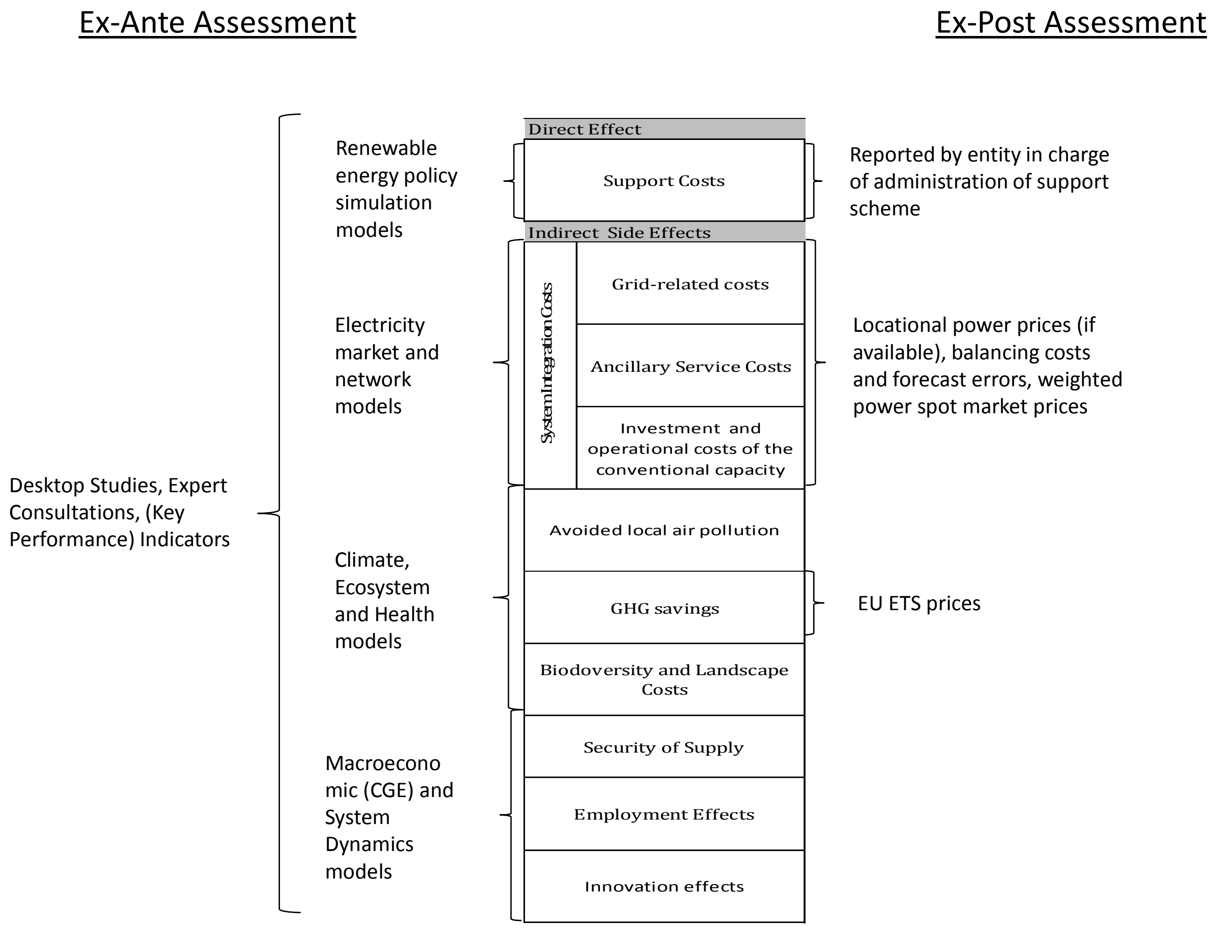

Figure 11: Cost and benefit components and different methods to assess them.

For the ex-ante assessment different methods are available, the most relevant are: desktop studies, expert consultations, development of (key performance) indicators and the usage of modelling tools. In general, there is a trade-off between the resources required to conduct the assessment and the quality of the output from the methods. Models are the most comprehensive tools and offer the advantage to deliver a consistent outlook on future developments. Indicators are much more limited in their scope than models and can range from very simple constructs such as a fraction of two numbers to very simplistic calculation approaches. Desktop research and expert consultations are often less formal than models and indicators, but therefore rather simple to conduct and often also form an input to models and indicators.

To decide on the most appropriate method Member States have to evaluate how well the effects can be quantified and if a more comprehensive method justifies the usage of additional resources in relation to the relative importance assigned to the effects previously.

A practical approach for the way forward could be the following: Effects that are not part of the power system are in general more complicated to quantify and monetise, because of a lack of reliable data and complex interrelationships that are underlying these effects. As can be seen from Table 16 below all the parameters that would eventually be needed to construct simple indicators for these effects are basically output parameters from the power system modelling. The "basic unit" of measure indicates the units of the corresponding output parameter that are needed to construct the indicator. This unit is multiplied with the monetary measure, where monetary values are available, where monetary values are not available a key performance indicator can be constructed that evaluates the effect semi-quantitatively (compare ENTSO-E, 2013 for further explanations).

Support costs and integration costs are reported in monetary terms and therefore already have the desired unit. Avoided air pollution is composed of several kinds of emissions. Power system models often also can report the avoided local air pollution in terms of tonnes of emissions avoided, or the avoided pollution can be roughly derived from the model results through ex-post calculation. This physical value then can be multiplied with the (avoided) damage costs to calculate the benefit. Costs of GHG emissions should already be internalised in the variable costs of fossil fuel fired power plants in the power system modelling. For security of supply, employment effects, innovation effects and biodiversity and landscape costs a monetisation based on an universal monetary measure is difficult, even though values are occasionally reported in the literature. Therefore it seems practical to construct a key performance indicator for the basic units of measurement that refers to the fuel savings (ktoe) or newly installed renewable capacity (MW) reported from the power system modelling. A monetary value is then assigned in the negotiations between the Member States.

Table 16: Overview of parameters and sources to construct indicators for effects.

Effect	Basic unit of measure	Monetary measure / Indicator
Support costs and integration costs	Euros	ibid.
Avoided air pollution	tonnes $SO_{2/}$ No_x/etc.	€ / tonne SO_2/No_x/etc.
GHG savings	tonnes CO_2	CO_2 price (internalized in generation costs)
Security of Supply	ktoe	Key performance indicator
Employment effects	MW	Indicator Jobs (input-Output Tables)
Innovation effects	MW	Key performance Indicator
Biodiversity and landscape costs	MW	Key performance indicator

9.1.7 Allocating costs and benefits

Once the different effects have been assessed and to the extent possible also monetised the next and final step is to allocate the costs and benefits. This comprises two interrelated issues. One regards the financing as each cost component needs some constant revenue stream for funding. The other one is normative and regards the challenge of finding a fair allocation of costs and benefits. Thus for practical reasons it is the costs and not the benefits that need to be allocated. How costs are recovered also depends on the market design. For example if grid-related cost regulation is "shallow" grid costs are borne by the electricity bill payers where the RES-E capacity is connected to the grid. If the regulation on the other hand is "deep" grid costs are borne by the investor of the RES-E plant and thus are internalised in the support scheme costs. In current market design integration costs are mostly socialised in the grid/market zone of the Member State where they occur and thus borne by the domestic electricity bill payers.

The administration of support payment monetary flows can either be provided through the domestic support scheme of a participating Member State or through a joint fund, or a hybrid of both (this could for instance be the case in a joint project when off-taking Member State uses a dedicated support scheme (e.g. a tender) to finance a specific RES-E project in the host Member State – this could constitute both a "national" support scheme or a "joint" fed that is only fed by one party). As is shown in Figure 12 below both concepts differ with regard to how costs and benefits are accounted for. Benefits in this illustrative example are the support cost savings (green bar – net cost savings), which in this example are assumed to be shared equally. In the default case both Member States administer a national support scheme. The off-taking Member State has higher support costs compared to the host Member State. Thus cooperation can create benefit and additional RES-E generation is allocated to the host Member State. This leads to cost savings in the off-taking Member State, while the support costs in the host Member State increase, but at a lower rate as the support costs decrease in the off-taking Member State. Thus some net cost savings can be realised through cooperation.

However in this situation the host Member State would incur higher support costs than in the non-cooperation case, which makes some financial compensation (transfer price) from the off-taking Member State to the host Member State necessary. The transfer price has to be at least as high as the additional support cost incurred by the host Member State and it has to be lower than the total cost savings in the off-taking Member States to provide adequate incentives for both Member States to join the cooperation. This leaves some space for bargaining the transfer price. By comparing the cost savings of the off-taking Member State with the additional support costs of the host Member State one can observe that the bargaining space is exactly given by the net cost savings; or in other words: the net cost savings form the cake that can be allocated between the Member States. By comparing the support costs in both Member States before cooperation and after compensation, one can observe that the transfer price payment to the Host Member State has exactly allocated the net cost savings equally between the Member States.

The alternative institutional approach is to create a joint fund where all support costs are pooled and then allocate the costs or cost savings respectively according to a certain allocation rule in a way that all Member States are better-off than in the default case. Another possible arrangement is that the off-taking Member State directly pays for support costs of the respective plant in the host country.

It can be seen that the outcome of both approaches is the same and the costs-savings have been shared equally by the partners, but both approaches differed in how they account costs and benefits.

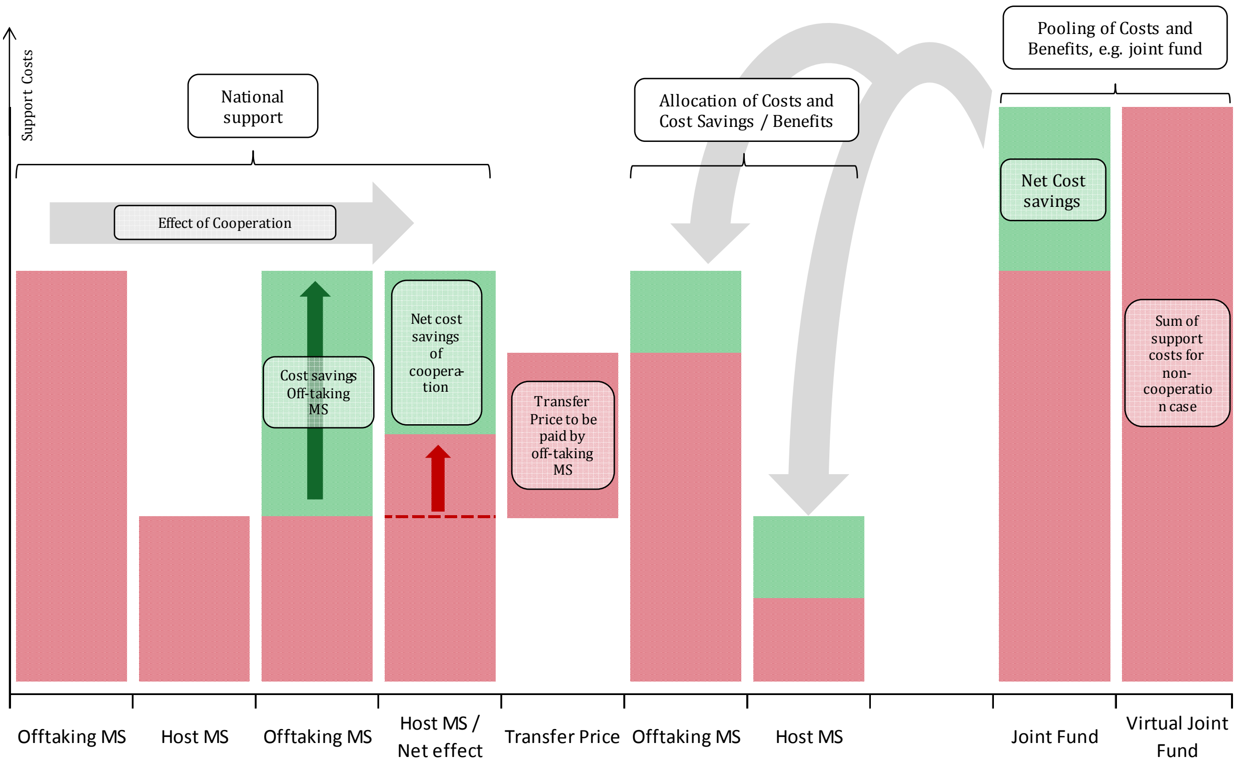

Figure 12: Allocation of costs and benefits under different institutional setups.

In principle, both approaches described above work in the same way if indirect costs and benefits are included. Then benefits are accounted against costs and the net benefit is allocated between all involved Member States. However care has to be taken with regards to some particular aspects of including indirect effects. One question is if benefits that are in general subjective and uncertain can be fully accounted against costs. Furthermore, extending the scope to account for indirect costs and benefits also implies that care has to be taken to avoid "double allocation" of costs and benefits. For instance some effects may already be compensated for through other channels, such as the inter-TSO compensation mechanism. However, the latter aspects are an accounting problem and can in principle be solved through redesigning and adapting the overall institutional setup, for instance by merging compensation approaches. In practice however this may be difficult as different actors are concerned with different compensation schemes.

The important take away from the discussion above with regards to allocation rules is that no matter which effects are included in the end each sharing rule has to allocate the gains from cooperation (in the example above net cost savings), either explicitly as in the case of pooling costs and benefits or implicitly be setting some transfer price.

Variants of allocation rules

Variant I: Harmonised sharing of costs

For this variant a "full harmonisation" with regards to the resulting (support) costs for RES expansion takes place. The arising expenditures are equally distributed among all participating Member States in accordance with their national RES targets – independent from where the actual RES deployment takes place. For establishing the financial transfer a joint fund may be a suitable option. This fund would be fed by 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 expansion. The local benefits of RES are neglected in this approach, because only (support) costs are taken into consideration.

Variant II: Harmonised sharing of costs and benefits

This approach can be described as a full harmonisation of both the resulting costs as well as the benefits of RES support. In contrast to variant I, only an agreed share of the total support costs occurring at cluster level is equally distributed among all cluster countries in accordance with national RES targets. The remaining part of the costs, representing the local benefits, has to be borne, by the Host Member State – i.e. where RES deployment actually takes place. Again, in order to establish the financial transfer, a common fund may be a suitable option.

Variant III: Harmonised sharing of cost savings

In this approach also the total (support) costs are shared between all cluster countries. The guiding idea is that each country will increase its net benefit, by receiving a share in the total cost-savings that can only be realised by cooperation. The cost savings are determined by comparing the sum of the stand-alone (non-cooperation case) costs for all cluster countries to the joint costs of compliance, the delta represents the realised cost-savings. It is suggested that those savings are allocated equally among the cluster countries, reflecting the view that those gains can only be achieved by cooperation. Deducting the allocated benefit from the "stand-alone" costs of non-cooperation defines the absolute value in costs each country has to pay. However, it is also thinkable that the cost-saving are allocating according to a different criterion than equal shares, e.g. in proportion to the benefits received, targets, etc.

Variant IV: The Shapley Value

This method is based on the marginal contribution principle. The assumption is made that each player has joined the common group in some identifiable order. Furthermore it is assumed that all possible orders for entering the group up are equally likely. If a group of players has already signed up the additional cost/benefit of including the next player to arrive determines his marginal contribution. When the marginal contributions of each player are determined for every possible sequence of joining and averaged, the result is the Shapley Value. Marginal contribution can both refer to costs and benefits and thus allocating either of them also determines the allocation for the other.

Variant V: Average premiums for RES surplus

This approach describes a methodology to share the cost for RES support between the involved

Member States solely for the surplus/deficit (that is the volume of RES-E production that is reallocated compared to the non-cooperation case) of RES-E production. Cross-border exchange takes place only for the country-specific deployment of new RES installations which is not needed for target compliance in host Member State. Therefore, average premiums arising for the support of new RES installations in the exporting country are used for pricing. These can also be considered as the minimum value of a transfer price the host Member State would expect to achieve.

Variant VI: Marginal premiums for RES surplus
Similar to variant V, the cost sharing methodology is applied solely for the surplus/deficit of RES-E production. In contrast to approach I, however, the price (per unit of RES-E generation) used for cross-border exchange is determined by the residual RES-E generation that is not required for the domestic target fulfilment in the host Member State (which would be the economic ideal). Thus, as an indication for the marginal option either the support level for the marginal technology option at cluster level is taken or the average premium of the residual basket of RES technologies is applied for price setting. Casually speaking, this represents a sort of marginal pricing.

Variant VII: Negotiated premiums for RES surplus
Again a cross-border monetary exchange occurs only for surplus/deficit of RES-E production. The basic idea behind this approach is that average premiums and marginal premiums form some intuitive lower and upper boundaries to the solution space for negotiations. The Host Member state would perceive a transfer price below its marginal / average premium to be unfair, because it would subsidise the Off-taking Member State. The Off-taking Member State would perceive a transfer higher than its average / marginal premium to be unfair because than it would not gain any benefit from cooperation at all.

The functioning of the allocation rules is illustrated through the stylised examples below. Figure 13 is used to illustrate the functioning of variants V-VII. Imagine the Host Member State has large and cheap generation potential based on hydro power and onshore wind. On the one hand the Off-taking member state has limited potentials and the marginal technology for target compliance is a rather cost-expensive option such as solar photovoltaic. Now the question is what would be the effects of cooperation – that is, the reallocation of renewable electricity generation – on the marginal compliance costs. In this stylised example the host Member State deploy some additional onshore wind generation to be transferred to the off-taking Member State. On the other hand the off-taking Member State can comply with some target / trajectory without deploying additional, high cost photovoltaic generation at less valuable sites and therefore reduce its marginal costs. The delta (δ) between these two values defines the space of solutions for negotiating the transfer price. A practical and seemingly fair (in case of 2 Member States) solution would be to pick the transfer price that is in the middle (here indicated in orange) between both marginal values. In some cases however picking the marginal premium might not be the most appropriate and robust indicator. For instance when the Member States envisage a more balanced, dynamically-oriented deployment of RES-E technology options that does not necessarily reflect a least-cost approach in terms of marginal costs. In this case the weighted-average premium might be a more plausible indicator. It can simply be constructed for each Member State by weighing each marginal technology-specific premium with its corresponding share in production (relative fraction on the horizontal axis), whereby the different weights (α,β,γ) sum up to one (α+β+γ=1). In the same way as for marginal premiums, also in the case of weighted-average premiums the delta between the Member States defines the space for possible solutions. Also in this case to pick the transfer price that lies in the middle seems plausible.

In case of a joint project where the off-taking Member State is already financing the additional RES-E generation in the host Member State this would reduce the transfer price it would have to pay to the off-taking Member State by this amount (In the illustration below the marginal onshore wind generation would already be financed by the off-taking Member State). The payment would now amount to the off-taking Member States share in the cost savings, which corresponds to half of the grey shaded bar (δ) in the illustration above.

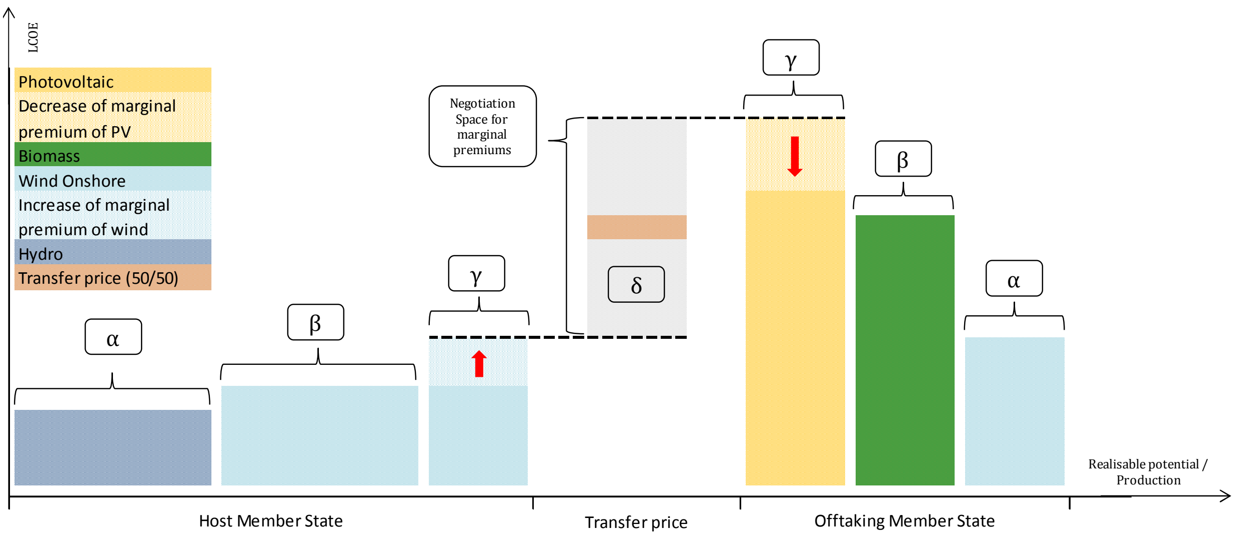

Figure 13: Transfer price setting based on marginal premiums

Figure 12 in section 9.1.7 is used to illustrate the functioning of variants I-IV. In these approaches all (support) costs (and benefits) are pooled in a joint fund. These then need to be compared against the costs of each Member State acting own (non-cooperation baseline). Variants I-IV from above either allocate the joint costs or the joint benefits, whereby an allocation of benefits also always determines the allocation of costs (by subtracting the allocated benefits from the initial costs in the non-cooperation case.) and the other way around. The derived cost shares can then be adapted by accounting for the indirect costs and benefits if desired.

A solution that always provides incentives for cooperation – in case of two Member States – is to share the net benefits (net cost savings in the example) equally. This solution is implemented by variants III and IV. In case of more than two Member States cooperating only variant IV can guarantee to implement a solution that provides incentives in terms of net benefits received.

One main distinguishing feature that can be identified for proposed variant presented in this work is whether the cost allocation method is applied solely to the surplus (that is the amount of energy that is exchanged virtually between the member states) or alternatively to the full costs (that correspond to the entire RES-E production, not just the volumes that are exchanged). Both variants have pros and cons. Pooling the full costs also strengthens the idea of cooperation, as the value through cooperation can only be created when countries come together and act jointly, while assigning a monetary value to surpluses rather emphasises the idea of trading between Member States. Furthermore, finding transfer prices that make sense can become very complex when the cooperation is between more than two Member States.

However, for practical reasons a method based on the surplus might be desirable. A method based on full harmonisation requires the countries to agree on a (hypothetical – in case of acting alone) cost baseline, in order to calculate the benefit of cooperation. Indicators as required for the approaches based on surplus, such as average or marginal premiums, are regularly and transparently published as market indicators.[16] If variants I+II are restricted to allocate support costs they have the same information requirements as approaches that allocate surpluses. Thus they can be seen as a hybrid between the ex-ante and ex-post perspective.

9.2 Annex 2: Short characterisation of the Green-X model

The model Green-X has been developed by the Energy Economics Group (EEG) at the Vienna University of Technology under the EU research project "Green-X–Deriving optimal promotion strategies for increasing the share of RES-E in a dynamic European electricity market" (Contract No. ENG2-CT-2002-00607). Initially focussed on the electricity sector, this modelling tool, and its database on renewable energy (RES) potentials and costs, has been extended to incorporate renewable energy technologies within all energy sectors.

Green-X covers the EU-27, and can be extended to other countries, such as Turkey, Croatia and Norway. It allows the investigation of the future deployment of RES as well as the accompanying cost (including capital expenditures, additional generation cost of RES compared to conventional options, consumer expenditures due to applied supporting policies) and benefits (for instance, avoidance of fossil fuels and corresponding carbon emission savings). Results are calculated at both a country- and technology-level on a yearly basis. The time-horizon allows for in-depth assessments up to 2020, accompanied by concise outlooks for the period beyond 2020 (up to 2030).

The Green-X model develops nationally specific dynamic cost-resource curves for all key RES technologies, including for renewable electricity, biogas, biomass, biowaste, wind on- and offshore, hydropower large- and small-scale, solar thermal electricity, photovoltaic, tidal stream and wave

[16] In certain cases, in particular when the volume of cooperation is large, also identifying the hypothetical marginal premium of the off-taking Member State might pose a (negotiation) challenge. Therefore choosing the weighted average premium might be the more balanced and robust indicator.

power, geothermal electricity; for renewable heat, biomass, sub-divided into log wood, wood chips, pellets, grid-connected heat, geothermal grid-connected heat, heat pumps and solar thermal heat; and, for renewable transport fuels, first generation biofuels (biodiesel and bioethanol), second generation biofuels (lignocellulosic bioethanol, biomass to liquid), as well as the impact of biofuel imports. Besides the formal description of RES potentials and costs, Green-X provides a detailed representation of dynamic aspects such as technological learning and technology diffusion.

Through its in-depth energy policy representation, the Green-X model allows an assessment of the impact of applying (combinations of) different energy policy instruments (for instance, quota obligations based on tradable green certificates/guarantees of origin, (premium) feed-in tariffs, tax incentives, investment incentives, impact of emission trading on reference energy prices) at both country or European level in a dynamic framework. Sensitivity investigations on key input parameters such as non-economic barriers (influencing the technology diffusion), conventional energy prices, energy demand developments or technological progress (technological learning) typically complement a policy assessment.

Within the Green-X model, the allocation of biomass feedstock to feasible technologies and sectors is fully internalised into the overall calculation procedure. For each feedstock category, technology options (and their corresponding demands) are ranked based on the feasible revenue streams as available to a possible investor under the conditioned, scenario-specific energy policy framework that may change on a yearly basis. Recently, a module for intra-European trade of biomass feedstock has been added to Green-X that operates on the same principle as outlined above but at a European rather than at a purely national level. Thus, associated transport costs and GHG emissions reflect the outcomes of a detailed logistic model. Consequently, competition on biomass supply and demand arising within a country from the conditioned support incentives for heat and electricity as well as between countries can be reflected. In other words, the supporting framework at MS level may have a significant impact on the resulting biomass allocation and use as well as associated trade.

Moreover, Green-X was recently extended to allow an endogenous modelling of sustainability regulations for the energetic use of biomass. This comprises specifically the application of GHG constraints that exclude technology/feedstock combinations not complying with conditioned thresholds. The model allows flexibility in applying such limitations, that is to say, the user can select which technology clusters and feedstock categories are affected by the regulation both at national and EU level, and, additionally, applied parameters may change over time.

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