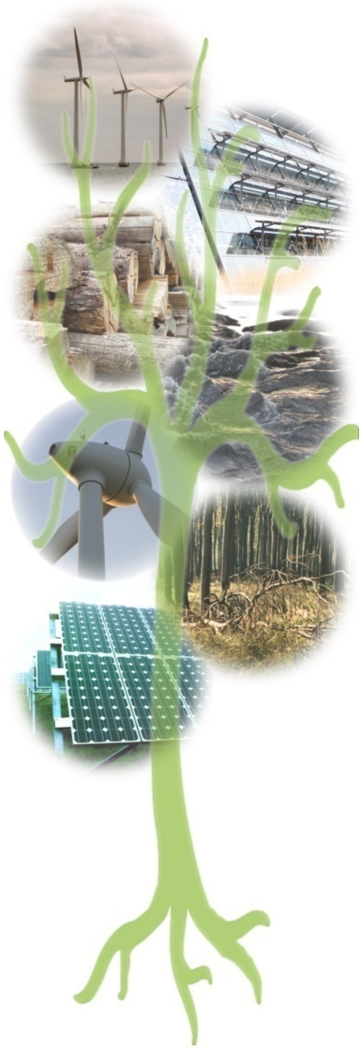
Design and impact of
a harmonised policy for
renewable electricity in Europe



Report (D6.1b)

Interactions between EU GHG and Renewable Energy Policies – how can they be coordinated?

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The beyond*2020* project *at a glance*

With Directive 2009/28/EC, the European Parliament and Council have laid the grounds for the policy framework for renewable energies until 2020. The **aim of this project** is to **look more closely *beyond 2020*** by designing and evaluating feasible pathways for a harmonised European policy framework for supporting an enhanced exploitation of renewable electricity in particular, and RES in general. Strategic objectives are to contribute to the forming of a European vision of a joint future RES policy framework in the mid- to long-term and to provide guidance on improving policy design.

The work comprises a detailed elaboration of feasible policy approaches for possible harmonisation of RES support in Europe, involving five different policy paths: i.e. uniform quota, quota with technology banding, fixed feed-in tariff, feed-in premium, or no further dedicated RES support besides the ETS. A thorough impact assessment is undertaken to assess and contrast different instruments as well as corresponding design elements. This involves: a quantitative model-based analysis of future RES deployment and corresponding cost and expenditures based on the Green-X model; and a detailed qualitative analysis, focusing on strategic impacts, as well as political practicability and guidelines for juridical implementation. Aspects of policy design are assessed in a broader context by deriving prerequisites for and trade-offs with the future European electricity market. The overall assessment focuses on the period beyond 2020; however, a closer look is also taken at the transition phase before 2020.

The final outcome will be a finely-tailored policy package, offering a concise representation of key outcomes, a detailed comparison of the pros and cons of each policy pathway and roadmaps for practical implementation. The project is embedded in an intense and interactive dissemination framework consisting of regional and topical workshops, stakeholder consultation and a final conference.

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This report

systematically assess the arguments against and in favour of having separate targets and policies for RE and GHG emissions reductions. Furthermore, the arguments for and against implementing support instruments for renewable electricity (RES-E) in addition to the EU Emission Trading Scheme (ETS) are analysed and options how to coordinate ETS and RES-E support are explored.

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Executive summary

In the current debate about a European climate and energy policy framework for 2030 some critics argue that the coexistence of separate EU targets and policies for renewable energy (RE), energy efficiency and greenhouse gas (GHG) emissions reduction is undesirable and even counterproductive, and should therefore be discontinued after 2020.

In this paper we systematically assess the arguments against and in favour of having separate targets and policies for RE and GHG emissions reductions. Furthermore, we analyse specifically the arguments for and against implementing support instruments for renewable electricity (RES-E)[1] in addition to the EU Emission Trading Scheme (ETS) and explore options how to coordinate ETS and RES-E support.

We conclude that the coexistence of GHG and RE policies and targets is clearly justified. Well-coordinated targets and policies will be capable of reaching both the GHG emission reduction target and the RE deployment targets in an effective and efficient manner.

The key arguments for the coexistence of separate EU targets and policies for renewable energy and GHG emission are:

- With respect to their common goal to reduce GHG emissions, the combination of a GHG and RE deployment target can be justified due to three different market failures: the environmental externality, the innovation externality and the deployment externality.
- Renewables policies address more objectives than GHG mitigation. RE deployment, in addition to GHG reduction, also contributes to non-GHG policy goals such as avoidance of local environmental effects, a lower dependence on fossil fuels imports, industrial policy, job creation and regional development. These other objectives would not be met effectively and efficiently by a policy that focuses on GHG only.
- In principle, these arguments justify both the coexistence of policy instruments and targets. Policy instruments are needed to reach policy targets and make them meaningful. Vice versa, a target defines the ambition and pathways for the use of policy instruments. Due to their different objectives, both GHG and RE targets and policy instruments are needed, but the question arises how to make them coherent.

Looking specifically at the pros and cons of combining the EU ETS and RES-E support instruments, the main argument for an ETS-only approach is that dedicated RES-E support increases the costs of complying with a given ETS target, as higher-cost abatement technologies are forced into the market, while the total number of CO_2 allowances remains the same. In other words, the cost-effectiveness of the EU ETS in meeting its (short-term) CO_2 target is decreased. However, the promotion of RES-E is likely to be cost-effective for the long-

[1] We do not look into heat and transport policies in this paper. RES-E has the most significant influcence on ETS. Also, the *beyond2020* project focuses within the discussion of harmonisation of RE support schemes on the electricity sector. RES-E.

term 2050 decarbonisation target that requires the use of more expensive and innovative technologies (dynamic efficiency, at least for the power sector).

From the perspective of promoting renewables cost-effectively, there are mainly two arguments why dedicated RES-E support instruments and RE targets are needed: Firstly, if properly designed, they limit the investment risk for RES-E installations compared to an ETS-only approach, thus reducing their capital costs and the respective support costs for consumers. Secondly, dedicated RE targets are needed for coordinating supply chain and infrastructure investments. Supporting RES-E deployment trough dedicated RES-E support instruments is clearly more cost-effective than promoting it through ETS. This finding is supported by the modelling results of the *Beyond2020* project.

The other key argument against dedicated RES-E policies is that the resulting RES-E deployment lowers CO_2 emission allowance prices in the ETS, which benefits conventional fossil-fuel generation and prevents industry from innovating ("green promotes the dirtiest"). However, such negative impact can be avoided by coordinating the targets and trajectories between both instruments. This leads us to the question: how can they be coordinated? The basic answer is that the amount of CO_2 emissions expected to be reduced with RES-E deployment needs to be taken into account when setting the CO_2 cap under the ETS. If this is done, then the negative effects of RES-E support on the CO_2 emission allowance price can be fully mitigated. Already the EU energy and climate package in 2008 considered the renewables targets in the ETS cap setting, even though it was disputed whether the assumptions and modelling results were correct. Claims that renewables were the main driver of the currently low CO_2 emission allowances prices can therefore be refuted, even more as other factors like the economic crisis and the large inflow of international offset credits clearly explain the price effect. However, the projection of future RES-E generation and translation into a consistent ETS cap is always linked to a number of uncertainties. Uncertainties arise with regard to the projection of the RES-E growth and technology mix, its CO_2 displacement effect, and its ETS eligibility (depending on whether centralised or decentralised RES-E plants will be built). These uncertainties might justify some *dynamic* adjustments of the original trajectories.

In principle, ETS and RES-E trajectories can be coordinated *ex ante* or *ex post/dynamically*. From the ETS perspective, *ex ante* coordination is clearly preferable, as *ex post* adjustments will reduce the credibility of the ETS. However, one might consider transparent *dynamic* adjustment mechanisms that would become effective in cases where there are major deviations from the original projections. Adjustments for coordinating RES-E deployment and the ETS cap can be implemented both within the ETS and within the RES-E support instruments through specific design elements. Some flexibility in the RES-E growth trajectory is important, however, as a strict yearly trajectory would be difficult to achieve and could obstruct RES-E market growth patterns.

When discussing uncertainties affecting ETS, one should acknowledge that there are more severe uncertainties affecting the CO_2 prices in the ETS than those related to RES-E growth. For example, the recent economic crisis has created a large number of surplus allowances (among other factors) and led to a discussion on a structural reform and *ex post* adjustment of the ETS that would stabilise CO_2 prices of the ETS. This discussion is very relevant for RES-E, as stabilising CO_2 emission allowance prices is crucial for the effectiveness and efficiency of RES-E support. Low CO_2 allowances prices will increase the need for RES-E support and lead either to high support payments or to reduced RE growth.

1. Introduction

In the 2009 Climate and Energy Package, the 20-20-20 EU targets for greenhouse gases (GHG) reduction, energy efficiency and renewable energy (RE) were formulated and embedded. Currently, only the EU's Emission Trading Scheme (ETS) is set to continue after 2020. Until 2027, its cap will decrease by 1.74% annually.[2] Most Directives that are part of the Package foresee a post-2020 update. For instance, the Renewable Energy Directive anticipates an agreement on a post-2020 policy package by 2018. But many stakeholders – not the least the European Commission itself – are urging that there is a need to have clarity much earlier than that. The main reason for this is that investors need certainty in order to plan their investments. Project lead times are long and capital investments in energy technologies may have a return on investment well beyond 2020.

A broad debate on a post-2020 policy framework has already begun, starting from the 2050 Roadmaps published by the European Commission in 2011, and more recently developed by the published Green Paper and subsequent consultations. At the moment this debate is divided and the discussion revolves around the question whether the current approach for 2020 should be continued until 2030 – that is, through similar policy frameworks guided by more stringent separate targets – or whether other approaches would be more appropriate. Currently, there are several Member States that have openly objected to setting (binding) EU renewables targets for 2030 and instead advocate a more technology-neutral approach in the form of a carbon-only target, with the ETS as the main instrument. The consequences of the ongoing economic crisis, the resulting budgetary problems of Member States and concerns about the (short-term) affordability of energy dominate the political debate to a large extent.

This paper systematically assesses the arguments against and in favour of having separate EU targets for renewable energy and GHG emissions reductions as well as implementing support policies for renewable electricity (RES-E)[3] in addition to the EU ETS. It concludes that the coexistence of dedicated policies and targets for GHG reductions and for renewables is necessary, despite their partial redundancy. Moreover, it provides recommendations on how to design ETS and renewable energy/electricity targets and policies for 2030 in such a way that they are consistent and actually reinforce each other.

Methodologically, three different streams of the literature on the interaction between emissions trading (ETS) and RES-E support schemes can be discerned (del Río 2007). One focuses on the theoretical interactions resulting from the simultaneous application of both instruments (see Jensen and Skytte (2002, 2003), Skytte (2006), Boots (2003), Morthorst (2000a+b, 2001, 2003), Del Río *et al*. (2005), Braathen (2011), Boots *et al* (2001), Pethig and Wittlich (2009), Lecuyer and Bibas (2011) and Fischer and Preonas (2010). Another stream of the literature

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[2] This reduction rate is insufficient in light of the EU's long-term ambition to reduce its GHG emissions by at least 80% by 2050, compared to 1990 levels.

[3] Since among all energy sectors the electricity sector has the most significant influence on the ETS a focus is put in this analysis on RES-E support.

analyses the possible interactions in several countries, using case studies (see Sorrell 2003a+ b; Walz and Betz 2003; Boemare and Quirion 2003; Sijm 2003; Mavrakis and Konidari 2003, del Río 2009). Finally, recent contributions have used different types of modeling tools for the analysis of the interactions in specific countries and regions (Linares *et al.* 2008 for Spain, Böhringer and Rosendhal 2009 and Abrell and Weigt 2008 for Germany, de Jonghe *et al.* 2009 for Benelux, France and Germany, Palmer *et al* 2011 for the U.S. and Tsao *et al.* 2011 for California).

A common finding of the different approaches is that the coexistence of ETS and RES-E support schemes may lead to conflicts either in terms of redundancy or negative interaction regarding the cost-effectiveness of GHG abatement ('redundancy' refers to the use of two instruments to achieve one goal). Other authors argue that multiple policy objectives and market failures justify the dual approach (e.g. Sijm 2003, Morthorst 2003, del Río 2007, de Vos *et al*. 2013). Furthermore, the possibility of coordinating both targets (the CO2 cap under the ETS and RES-E generation as a result of RES-E support) is disregarded in many of the policy interaction studies and will be further investigated in this paper.

The paper is structured as follows: Section 2 elaborates on different criteria by which to judge the effects of policies and policy interactions. In section 3, a typology of interactions and the main justifications for the coexistence of policy instruments for GHG mitigation and renewable energy are presented, after which the paper elaborates on interactions between the EU ETS and support for renewable electricity (RES-E) in section 4. More specifically, section 4 addresses the pros and cons of an ETS-only approach and how coordination of renewables targets and the ETS can improve effectiveness and efficiency. In section 5 the main conclusions are elaborated.

2. Criteria to judge the effects of policies and policy interactions

Policy mixes can be assessed according to different criteria, which correspond to explicit or implicit policy objectives. In the policy debate, however, those criteria are often kept implicit rather than being openly discussed. In order to make the criteria used in this paper transparent, this section briefly elaborates each of them. We have chosen the following criteria, which are commonly used in structured assessments of policies (see del Río *et al.* 2012 for further details): effectiveness, cost-effectiveness, dynamic efficiency, equity, environmental and economic effects and socio-political feasibility.

Note that we will not systematically apply all of these criteria to the policy options discussed in sections 4 and 5. Instead, the criteria will be referred to where useful to explain the reasoning behind different arguments that are brought forward in the policy debate.

2.1 Effectiveness

One main criterion by which to judge the success of RES-E support schemes or GHG mitigation instruments is the extent to which instruments are effective in triggering RES deployment or GHG emissions reductions. An instrument is said to be effective if it is able to achieve a given RES-E or GHG target.

2.2 Cost-effectiveness

Cost-effectiveness (also referred to as static efficiency) generally refers to the achievement of a given RES-E or GHG target at the lowest possible cost to society (macro-economic efficiency). Environmental Economics sets a clear criterion for cost-effectiveness in reaching a target: i.e. the equimarginality principle, which refers to static efficiency and welfare gains. Cost-effectiveness is attained when an instrument encourages proportionally greater RES-E deployment (GHG emissions reductions) by those firms and installations with lower RES-E deployment (emissions abatement) costs, and lower RES-E deployment (GHG emissions abatement) by companies with higher deployment (abatement) costs. This leads to an equalisation of the marginal costs of either RES-E deployment or of GHG emissions reductions across firms/plants (equimarginality). In the RES-E realm, the extent to which an instrument encourages the choice of technologies, sizes and places which minimise generation costs is thus a key aspect. This would lead to a minimisation of generation costs across firms/countries.

While part of the literature has focused on the minimisation of the generation costs (see, e.g., Borenstein 2011, Schmalensee (2011), among others), some have discussed the need to reduce the overall policy costs for consumers or taxpayers. Thus, the costs of support should also be taken into account, although, in economic terms, this is a strictly distributional issue. RES-E support is, in the end, generally paid by electricity consumers via their electricity bills. Therefore, cost-effectiveness in this context can be defined as supporting a given amount of RES-E at the lowest possible consumer costs. In this case, the aim should be to minimise the revenues for producers to sufficient and appropriate levels: that is, to trigger deployment while avoiding excessive producer rents.

2.3 Dynamic efficiency

Dynamic efficiency refers to the ability of an instrument to generate a continuous incentive for technical improvements and costs reductions in renewable energy technologies or in other GHG mitigation technologies: that is, an incentive positively to influence technological change processes in the medium and long term. This is a key benefit of early investments in renewable energy technologies because, while RES-E is not a cost-effective means of reducing GHG emissions today, it may be more so in the future. For this to happen, investments need to happen now to accelerate its development and thus cost reductions. In contrast to the cost-effectiveness criteria, which are much more concerned with the short-term perspective, dynamic efficiency is a fundamental aspect with regard to a problem that is related to a long-term perspective, such as climate change. Future targets regarding GHG emissions and renewable energy are unlikely to be less ambitious than today and, thus, technological change will continue to be a key element in both realms.[4]

In contrast to cost-effectiveness, dynamic efficiency has an intertemporal perspective on costs. Those RES-E support instruments which favour the commercialisation of expensive technologies in niches tend to lead to quality improvements and cost reductions; this will allow for renewable energy technologies to comply with more ambitious renewable energy and emissions reduction targets at reasonable costs in the future. If currently expensive mitigation technologies have a large cost reduction potential with increased diffusion (as shown by several studies for energy technologies: see for example IEA 2010), then supporting them today would lead to welfare benefits in terms of inter-temporal mitigation efficiency (i.e. cost-effectiveness in the medium and long term).

The impact of RES-E support schemes upon innovation in renewable energy technologies has several dimensions: diversity; R+D; learning effects; and competition (see Del Río *et al* 2012 for further details):

- diversity refers to the extent to which an instrument favours the deployment of different technologies;
- R&D refers to the extent to which a RES-E support instrument encourages private R&D by firms. In turn, this is the result of a supply-push and a demand-pull effect. The former occurs because the deployment instrument creates a producer surplus (profit margin) which is reinvested in R&D. The demand-pull relates to the fact that the

[4] The need for a large-scale deployment of renewables to reduce CO_2 emissions is common in the projections made with simulation models. For example, according to projections made by IEA in its 2008 report on energy technology perspectives (IEA 2008b), by 2050 the increased use of renewables would contribute 21% to CO_2 emission reductions in the BLUE map scenario (the one compatible with 450ppm concentration levels) with respect to the reference scenario.

deployment instrument creates the perspective for a market for the technology, which investors in R&D need to sell their technologies;

- effective instruments should establish learning effects: the advancement of technologies along their learning curve (e.g. through improved production processes, integrated supply chains);
- finally, the extent to which an instrument favours competition between RES-E generators and renewable energy technology suppliers leads to greater innovation.

If there is a time dimension involved, whereby at least one of the targets in the policy mix has a long time horizon, then a relevant aspect is whether the combination leads to accelerated innovation processes which may allow for one or two targets to be achieved (effectiveness) or for doing so at a lower cost (cost-effectiveness). For instance, in the ETS-RES-E support combination, it has been argued that the latter instrument is a source of innovation and cost reductions in mitigation (renewable energy) technologies which might allow more stringent GHG targets to be set in the future or reach whichever target is set at lower costs. Compared to a purely static perspective, the dynamic efficiency criteria would allow greater costs in the short term if this were to mean much lower (discounted) costs in the long term.

2.4 Equity

Even if an instrument leads to net benefits for society as a whole, it is highly likely that there will be “winners” and “losers”. The distributive impacts upon consumers, citizens, sectors, firms or countries should be considered when designing climate or renewable energy policies at any level (global, European, national or regional). The social acceptance of a given policy depends to some extent upon how those distributive impacts are handled. Distributive concerns are related to winners and losers, both within countries (consumers, producers and taxpayers) and between countries: i.e. who pays for and who benefits from a given instrument or design element. In particular, it should be identified whether a given instrument leads to a concentration of the costs of RES-E promotion or GHG emissions abatement in a limited number of countries. While minimisation of the total costs of complying with RES-E or GHG targets is part of the cost-effectiveness criterion, compliance costs may fall disproportionately upon countries with lower GDP per capita. As argued by Caproset *al*. (2008) for the case of compliance with EU GHG targets, this result was considered by the European Commission to be inconsistent with the equity and fairness criteria which have been set as basic policy principles by the EU.

2.5 Environmental and economic effects

The deployment of RES-E projects may bring positive effects for the countries where they are located. Those potential positive effects of RES-E deployment can be related to two categories: environmental and economic effects. The former refers to reduction in GHG emissions and local pollutants,[5] while the latter concerns avoided fossil fuel consumption, which positively affects the trade balance (exports minus imports). Other co-benefits are usually mentioned, including net job creation, industry creation and exports of renewable energy technology equipment. Finally, it is important to take into account that environmental impacts are not necessarily positive, but may also be negative (for instance, regarding visual aspects or land use).

2.6 Socio-political feasibility

The implementation of a policy or instrument which meets all of the aforementioned criteria may still not be socially acceptable and, thus, not politically feasible. While a politically salient rationale, this aspect captures the attention of very few economists, who prefer to focus instead on economic efficiency (Fischer and Preonas 2010). Social rejection may be related to a broader discourse in a society (i.e., civil society is against the deployment of renewables or against deployment support) or it may have a local character (the so-called 'NIMBY' syndrome).

Likewise, social acceptability is related to the existence of real or perceived local environmental and socioeconomic benefits for specific countries. It may also be related to other criteria. For example, an expensive policy is unlikely to be socially acceptable to the general population (consumers or taxpayers).

The (perceived) social acceptability of RES-E policies at the country level can be assumed to translate into a preference of national policy-makers for a specific instrument. Indeed, the political feasibility of a given instrument is related to equity concerns, environmental and economic effects and social acceptability, which may result in significant conflicts with interest groups. Thus, political feasibility deserves separate consideration. Political feasibility depends upon: the distribution of the costs of reaching the targets; and awareness of potential local benefits.

The social acceptability and, thus, political feasibility of the policy mix is directly related to both (perceived) impacts on equity and cost-effectiveness. An expensive policy combination is unlikely to be socially acceptable.[6]

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[5] Although GHG emissions have a global character, EU countries have a 2020 GHG emission target and they are also operating under the continuation of the Kyoto Protocol: i.e., there is a local dimension in those GHG targets.

[6] An additional criterion was defined in the beyond2020 project (legal feasibility). However, it is not included here because our discussion does not focus on juridical aspects in depth.

3. Interactions and justifications for the coexistence of policy instruments and targets for GHG mitigation and renewable energy[7]

3.1 A typology of policy interactions

The coexistence of policy instruments may lead to negative interactions (i.e., conflicts) or positive ones (either complementarity or synergistic effects). According to Konidari and Mavrakis (2007), interactions between instruments might be positive (when the performance of one or both examined instruments against a criterion increases because of their coexistence) or negative (when the combined policies lead to negative impacts that would not have occurred by either alone). However, there is no consensus on the terms and definitions of conflicts, complementarities and synergies in the literature on interactions. In general, we could argue that instruments lead to conflicts, complementarities or synergies with respect to one criterion when the addition of one instrument to another leads to reductions, adds fully or magnifies the impact of the combination of both instruments (del Río 2013). The type of interaction affects the evaluation result and, therefore, the success of the policy mix.

Obviously, conflicts refer to evaluation criteria and can be assessed either in qualitative or quantitative terms.

3.2 The need for the coexistence of different instruments

Del Río 2007 and Morthorst 2003 show that there are no fundamental problems of double regulation, double coverage or double crediting in the interaction between GHG and renewable energy policy.

There are basically two reasons that justify policy mixes from an economic point of view: (1) the existence of a multitude of objectives, which cannot be achieved with only one instrument. This provides the basic and main justification for having a RES-E deployment instrument in addition to a GHG mitigation instrument (ETS);[8] and (2) the existence of different market failures that will impede reaching one policy goal.

1) *A multitude of objectives*

Starting with policy goals, these are adopted by governments with the acquiescence and/or influence of electoral majorities. In the climate and energy realm these goals may take into account the three "traditional" dimensions of the sustainability of energy systems: i.e.,

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[7] This and the following section heavily draw from del Río (2013).

[8] Sijm (2003) argues the there are three potential rationales for supplementary policies to ETS: to improve the design of the ETS, to correct market failures that reduce the static/dynamic efficiency of ETS, and to meet other policy objectives besides CO_2 efficiency. Examples of this first category would include RES-E support for sectors not covered by the CO_2 emissions reduction program.

environmental sustainability (GHG mitigation), security of energy supply (diversification of energy sources) and economic sustainability (a competitive energy system: i.e., affordable energy).[9] Governments do not only have goals restricted to this area: there are other relevant goals – including employment and industrial development, regional and rural development, and the promotion of innovation – which have to be taken into account when assessing the coexistence of different instruments.

Both policy fields have a common goal (GHG emissions reductions) but RES-E deployment has also other goals, which are complementary to GHG reduction[10]. Arguably, the most relevant in the EU context is the diversification of energy sources leading to lower fossil fuel dependence and the promotion of a secure energy supply. The argument is that, by promoting a diverse mix of policies to increase the share of RES-E, governments can help to shield themselves from volatilities in the global fossil fuel markets. Moreover, in the EU, the availability and regional concentration of fossil-fuel reserves and resources is regarded as problematic from a geostrategic perspective (Matthes 2010). RES-E is considered to be a useful strategy for reducing vulnerability by decreasing the imports of fossil fuels. This goal is even mentioned seven times in the current RES Directive (Directive 28/2009/EC). But the Directive also mentions others, including: promoting technological development and innovation, and providing opportunities for employment and regional development, especially in rural and isolated areas (see also EC 2012a).[11] This is not only the case in the EU, but also in other OECD countries.[12]

However, several authors question the economic rationale behind additional objectives such as energy security or creating employment. Fischer and Preonas (2010) note that, in the absence of an emissions cap, subsidies for RES-E effectively displace fossil energy sources and offer environmental benefits. However, the magnitude of those benefits may be smaller than expected, if the marginal generation source displaced is relatively clean compared to the average: e.g. if more natural gas-fired generation is displaced compared to coal. Pethig and Wittlich (2009) state that, while the argument that security of energy supply can be improved through reducing dependence upon imports of fossil fuels is plausible, they are not aware of studies demonstrating rigorously that the way the market system copes with that challenge is unsatisfactory.

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[9] See, for example, EC (2012a).

[10] GHG mitigation targets may also have other goals in practice but in a pure interpretation they only aim to reduce GHG emissions,

11 Sorrell and Sijm (2003) note the potential for an "early mover advantage," by which strong, early renewables support could spur the development of viable industries with significant export potential. One additional rationale is to mitigate other non-CO_2 externalities associated with electricity generation from fossil sources, such as sulphur dioxide, nitrous oxide, and mercury emissions (Fischer and Preonas 2010).

[12] Recent legislation in both chambers of the U.S. Congress has sought to create a similar "package" of federal policies to reduce emissions and stimulate renewables production. The House and Senate bills share the same goal: "to create clean energy jobs, achieve energy independence, reduce global warming pollution and transition to a clean energy economy" (Fischer and Preonas 2010).

An additional critique is that there might be other alternatives to RES-E deployment which may achieve the non-GHG targets in a more effective and/or cost-effective manner. The most prominent alternative is energy efficiency. However, almost all scenarios include a prominent role for RES-E deployment in achieving the GHG and non-GHG goals in the mid- and long term. Therefore, their potential contribution to those goals, and particularly to the security of energy supply, should not be disregarded (del Río 2009).

2) Market failures

Combinations of instruments to attain the same goal may also be justified because each instrument tries to tackle different market failures or to remove different barriers. From an economic point of view, which policies should be implemented depends upon the goals to be attained and the market failures that they aim to correct. Understanding the existing market failures and existing policies is thus important for assessing the effectiveness and efficiency of additional policies (Palmer *et al*. 2011). In the climate mitigation/renewable energy policy realms, we may speak of a "threefold externality problem"; each aspect justifies the implementation of an instrument which tackles a different externality (del Río 2010).[13]

i. the *environmental externality* refers to firms not paying for the damage caused by their GHG emissions which, in turn, results in a low incentive for low-carbon technological innovation (Lee *et al*. 2009);
ii. the *innovation externality* is related to spill-over effects enabling the copying of innovations, which reduces the gains to the innovator from its innovative activity where it does not receive full compensation for that activity,[14] meaning that private actors will autonomously conduct less R&D than what is needed overall. This is a particularly serious problem in the realm of energy technologies.[15] The technological externality relates not only to R&D, but also to demonstration;[16]

[13] Other market failures may exist, including informational problems and market power. However, we have focused on the three which we deem most relevant for the justification of the coexistence of CO2 mitigation (ETS) and RES-E support policies

[14] Due to positive spillovers, the overall economic value to society of a research effort often exceeds the economic benefits enjoyed by the innovating firm. Three relevant distinct flows of spillovers justifying public intervention can be distinguished: (1) Spillovers occur because the working of the market for an innovative good creates benefits for consumers and other non-innovating firms (market spillovers). (2) Spillovers occur because knowledge created by one firm is typically not contained within that firm, and thereby creates value for other firms and their customers (knowledge spillovers). (3) The performance of interrelated technologies may also depend on each other, and as a result each firm improving one of these related technologies would create economic benefits for other firms and their customers (networks spillovers)(European Commission 2009).

[15] Historically, research and development in the energy sector has been lower than that in product-driven industries (Grubb *et al.* 2008). Technology spill-overs in the energy sector are large, making it harder for private sector agents to recover the full benefits of innovation and breakthrough (Neuhoff *et al.* 2009).

[16] The size and complexity of demonstrating these technologies, which often includes complex planning and infrastructural support, make it difficult for the private sector to independently finance demonstration (Lee *et al.* 2009).

iii. the increased deployment of a technology which results in cost reductions and technological improvements due to learning effects and dynamic economies of scale may result in a positive *deployment externality* (Stern 2006).[17] Even companies that did not invest in the new technologies may benefit and produce the new technology at lower costs. Although investors can partially capture these learning benefits – e.g. using patents or their dominant position in the market (Neuhoff *et al* 2009) –, the initial investor does not capture all of these learning benefits. Thus, investments in the new technology will remain below socially optimal levels.[18]

Notwithstanding these points, some have criticised the existence of this deployment externality and, thus, use it as a basis to argue against deployment support. A particularly vehement and oft-cited critique is that of Frondel *et al* (2010), which is based on two statements: (1) no support should be provided to more expensive technologies as this would stifle innovation; and 2) R&D is the only way to reduce the costs of technologies. However, we will show that these claims can withstand neither theoretical nor empirical scrutiny.

Regarding the first claim, Ragwitz *et al.* 2007, IEA 2008a and Resch *et al* 2009 have consistently shown that, from an inter-temporal perspective, ambitious RES-E deployment targets can only be attained cost-effectively by simultaneously (i.e. not sequentially) promoting different technologies. Huber *et al.* (2007) show that, due to learning effects, a higher intermediate RES-E target generates higher costs of RES-E support over the period 2006–2010, but results in lower costs for society over the whole period from 2006 to 2020. The higher RES-E interim target implies that high-cost technologies are developed earlier. Learning effects suggest that it is cheaper in the medium term to provide significant investment early on in order to drive renewable technologies rapidly down their experience curves and reduce costs quickly, rather than to reduce the costs of technologies relatively slowly through more gradual introduction (Rickerson *et al.* 2007, Huber *et al*. 2004, 2007).

Second, Frondel *et al.* (2010) argue that little innovation stems from deployment support and from advances along the learning curve, citing Nemet (2006). While Nemet (2006) argues that the main cost reductions in solar PV technology stem from the lab (i.e., R&D), he does not deny the importance of technological learning through deployment. The complementary role that demand-pull (i.e., support for RES deployment) and supply-push (i.e., public support for

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[17] Since the 1970s, the costs of energy production from all technologies have fallen systematically through innovation and economies of scale in manufacture and use (apart from nuclear power). Technologies such as solar energy and offshore wind all show much scope for further innovation and cost-reduction (Anderson 2006). The extent of those reductions depends on the maturity of the technology. The costs of the more mature technologies, including geothermal, hydropower and onshore wind power, are assumed to fall less than those of new technologies (IEA 2009).

[18] Learning is certainly a source of innovation and cost reductions but it does not come freely. It is the result of previous investments. Note that this implies circularity: diffusion is endogenous to the level and evolution of costs, but costs are also affected by the degree of diffusion. Greater deployment accelerates technological progress and provides economies of scale in manufacturing the associated equipment. The extent of the reductions depends on the maturity of the technology. The costs of the more mature technologies, including geothermal, hydropower and onshore wind power, are assumed to fall less than those of new technologies (IEA 2009).

R&D) play is well established in the economics of innovation literature. Both public support and private R&D investments are needed, and they reinforce each other. The latter simply do not happen if private R&D investors do not perceive that there will be a market for their products. In the RES-E realm, this market is created by public policies through deployment support. This can be illustrated by the strong market growth of PV that was triggered by the feed-in tariffs in Germany, Spain and other European countries, and which has led to cost reductions of more than 65% since 2006 (BSW 2013). In fact, deployment support policies play a very relevant role, not only in tackling the innovation externality, but in addressing the deployment externality as well.

Thus, the main justifications for having a RES-E deployment instrument in addition to a GHG mitigation instrument are that: (1) the existence of multiple objectives (GHG reduction, security of supply, economic development, environmental benefits, etc.) cannot be achieved with one instrument; and (2) different market failures will impede reaching the policy goal of decarbonisation by a single instrument that focuses on GHG reduction only.

These arguments justify both the coexistence of policy instruments and targets. Policy instruments are needed to reach policy targets and make them meaningful. Vice versa, a target defines the ambition and pathways for the use of policy instruments. Due to their different objectives, both GHG and RE targets and policy instruments are needed, but the question arises how to make them coherent.

4. Assessment of the interaction between ETS and RES-E support

While the last section discussed the interaction of GHG and RE policy in general, this section will look more specifically at the pros and cons of combining the EU ETS and renewable electricity support instruments.

4.1 Arguments in favour of an ETS-only approach

Many authors have concluded that the interaction between the EU ETS and support for renewable electricity is negative (e.g. Abrell and Weigt (2008), Braathen (2011), Fisher and Preonas (2010). Böhringer and Rosendhal (2009), De Jonghe *et al.* (2009), Lecuyer and Bibas (2011), Pethig and Wittlich (2009), Tsao *et al.* (2011) and Palmer *et al.* (2011)).They argue that adding a RES-E support instrument to an already existing ETS is neither efficient nor effective, given that RES-E is an expensive way to tackle CO2 emissions and, since there is a CO_2 allowance cap, RES-E deployment does not have any effect on total CO_2 emissions reductions.

However, this argument fails to consider that RES-E support instruments have other goals in addition to CO_2 emissions mitigation, and, thus, that such coexistence can be justified on those grounds (see section 3). In turn, an ETS cannot achieve both targets (CO_2 and RES-E deployment) cost-effectively. Using an ETS to reach an RES-E quota leads to higher consumer costs than using RES-E deployment instruments for that purpose, due to the strong emissions restriction needed to increase RES-E deployment with an indirect mechanism such as an ETS (Jensen and Skytte 2003, Fisher and Newell 2008, Huber *et al* 2004).

The arguments for an ETS-only approach without RES-E support policies need some further explanation. There is a broad agreement that, since CO_2 emissions are covered by a cap in an ETS, no additional reduction of CO_2 emissions as a result of supplementary RES-E promotion policies can take place. The following figure illustrates the impact of RES-E support on CO_2 emission allowance prices, when the RES-E target and ETS cap are not coordinated. The figure shows the CO_2 abatement costs of different technologies (T1 to T5), where T4 and T5 can be assumed to be renewable energy technologies (RETs). There is an ETS cap set at Q0. Before RES-E was promoted, the cap was achieved with technologies T1, T2 and (part of) T3, with a CO_2 price in the ETS of p0. When RETs are promoted, the CO2 cap with the non-RETs technologies effectively shifts to the left and the CO_2 price in the ETS is reduced accordingly (to p1).[19]

[19] According to Rathmann (2007), assuming a short position of the EU-ETS of 70Mt/a and a linear CO2-abatement cost curve, the current CO2-price is 27% lower than it would be without additional RES-E.

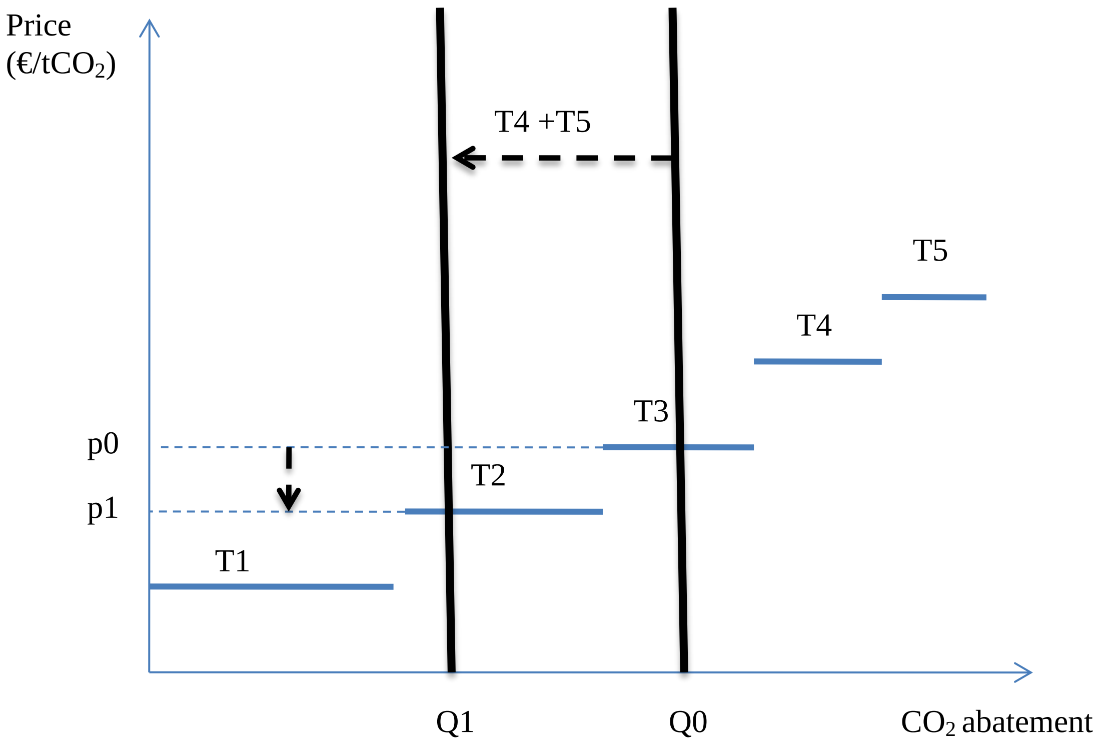


Figure 1 - Illustrating the CO_2 price reduction effect as a result of RES-E promotion
Source: Own elaboration

Since higher-cost abatement technologies are allowed to take part in the power generation mix than would be the case without RES-E promotion, the costs of complying with a given ETS target increase – i.e., the cost-effectiveness of meeting the ETS CO_2 target – would be eroded (see e.g. Böhringer and Rosendahl 2009, Abrell and Weigt 2008, Unger and Ahlgren 2005). As explained above, this reasoning only refers to cost-effectiveness regarding the achievement of the short-term ETS target. For a long-term decarbonisation target that requires the use of more expensive and innovative technologies, the assessment might be different (dynamic efficiency).

Furthermore, Böhringer and Rosendahl (2009) argue that "green promotes the dirtiest": i.e., that the RES-E generation as a result of deployment policies results in lower CO_2 prices which benefit conventional fossil-fuel generation. This means that RES-E support leads to an increased production from the most CO_2-intensive power generation technologies (typically coal power) as compared to an ETS alone. In addition, this lower price decreases investments in, and/or innovation efforts aimed at, low emission technologies in sectors and segments covered by the ETS, e.g. in industry (Matthes 2010).[20]

[20] All in all, the low CO_2 prices in the EU ETS are not fundamentally related to RES-E deployment, but to lenient targets and the economic crisis (Ellerman 2013).

For some authors, these arguments call into question the need to adopt RES-E support policies (e.g. Pethig and Wittlich (2009), who argue that "if it is true that expanding green energy comes without intrinsic benefits other than its emissions reducing side effect, demands for abolishing green energy support schemes are valid"). However, the above outlined argumentation completely neglects the point that CO_2 prices will not necessarily be reduced if the RES-E and ETS targets are properly coordinated. In other words, CO_2 prices are reduced by RES-E support policies only if the design of the ETS does not take into account existing RES-support policies and deployment targets.

4.2 Arguments in favour of dedicated RES-E support instruments and targets

Section 3 explained the need for GHG and RE policy mixes, due to the multitude of objectives of RES deployment and different market failures of GHG-only policy instruments like the ETS. Looking more specifically from the perspective of developing renewables, there are several arguments why dedicated RES-E support instruments and RES targets are needed (see Piria *et al*. 2013, de Vos *et al*. 2013, Klessmann *et al*. 2013).

Since RES-E technologies are typically characterised by high capital and low operational costs, RES-E investors need a relatively predictable stream of income in order to invest in renewables and be confident of recovering their costs. The EU ETS (as it is designed today) does not provide such investment certainty, as CO_2 prices are volatile and influenced by many external factors. This finding is supported by the modelling results of the Beyond2020 project (see Resch *et al* 2012): the "ETS only" scenario results in significantly less RES-E deployment than all other policy scenarios. More precisely, the high level of uncertainty leads to high risk premiums on the RES-E investments, thus increasing the cost of capital and making the RES-E projects expensive. This reduces the competitiveness of RES-E compared to other GHG mitigation options, even for low-cost RES-E technologies, and leads to lower RES deployment and/or higher policy costs than in the case of dedicated RES-E support.

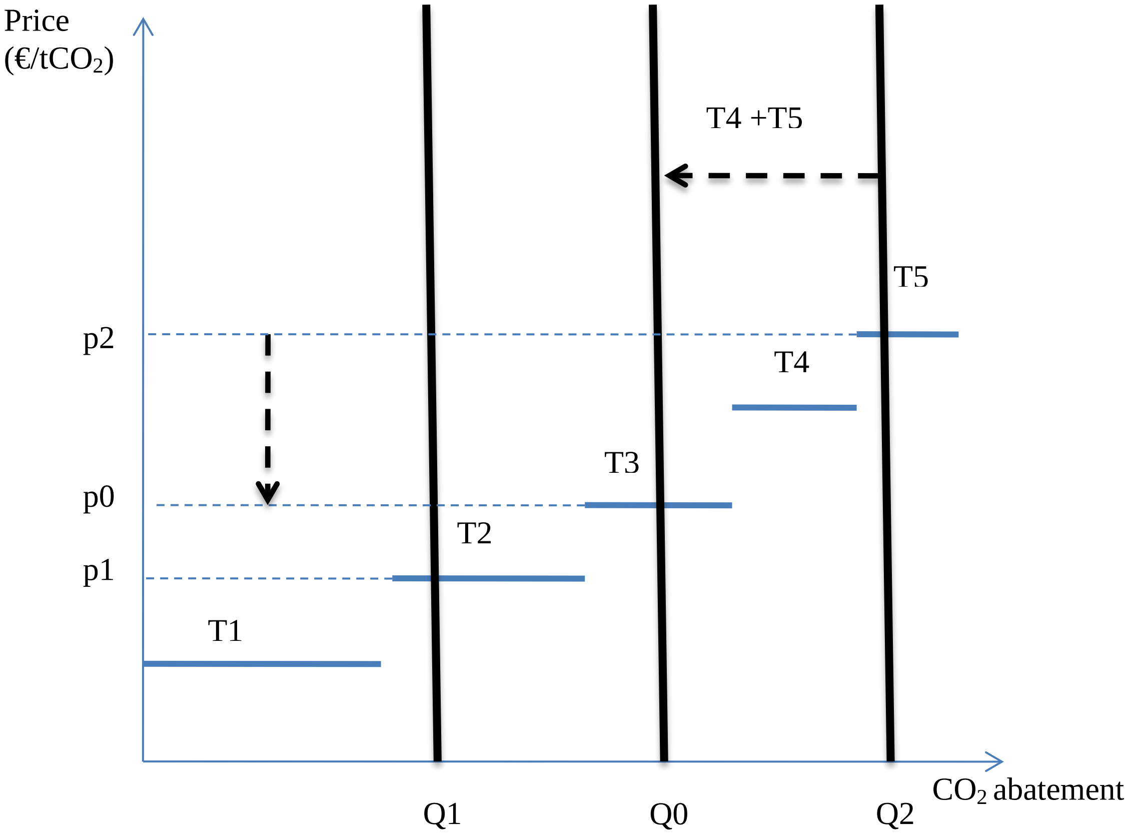
Dedicated RES targets and policies are also needed to encourage the necessary supply chain investments and infrastructure planning (Piria *et al*. 2013, Neuhoff 2013).

4.3 How coordination of ETS and RES-E support can improve their effectiveness and efficiency

As mentioned above, the predominant perspective on the interactions between ETS and RES-E support is based on the idea that if RES-E support is added to an ETS, the reduction in the price of allowances will have negative impacts upon its cost-effectiveness. However, the negative impact can be limited by coordinating the target shares between both instruments, so that the amount of CO_2 emissions expected to be reduced with RES-E deployment is taken into account when setting the CO_2 cap under the ETS[21] (in other words: in order to keep the same price level, the ETS cap is made more stringent than it would be without RES-E support). If this is done, then the negative effects of RES-E support upon the CO_2 price can be fully mitigated. As we will explain below, however, the precise projection of future RES-E generation and translation into a consistent ETS cap might not be fully achieved in practice.

It should be noted that Europe currently does not have RES-E targets but gross final energy targets for RE, thus including RES-E, renewable energies for heating and cooling (RES-H) and renewables in transport (RES-T). However, the expected RES-E target shares are laid out in the National RE Action Plans (NREAPs) of the Member States. In case this approach is continued beyond 2020, the ETS cap could be adjusted once the NREAPs are available. The RES-E share has the most substantial effect on ETS but RES-H in industry could have an effect as well.

Graphically, the expected CO_2 reductions as a result of RES-E deployment of technologies T4 and T5 (compare figures 1 and 2) would result in an initially more stringent target of Q2 instead of Q0 and the price reduction due to such deployment would reduce the price to p0 instead of p1: i.e., the CO_2 target of the ETS is set while also taking the RES-E target and its expected impact into account.



[21] However, this requires a projection which RES-E generation will fall under the ETS and which will occur in the non-ETS sectors. Only the RES-E share that is covered by the ETS should be taken into account in the ETS cap setting. Decentralised RES-E generation usually does not fall under the ETS.

Figure 2 - Illustrating the coordination of the CO2 target and RES-E deployment Source: del Río (2013)

Of course, in the case of a combination of an ETS and RES-E support there will still be a lower cost-effectiveness (according to the so-called equimarginality principle) in achieving the CO_2 target of the ETS than in the case when only an ETS is used to achieve this target. But these extra costs can be interpreted to be the costs of achieving the non-CO_2 benefits plus the dynamic efficiency benefits of RES-E deployment. Thus, the cost-effectiveness of reaching the long-term GHG reduction target (-80% to -95% for the EU by 2050) is likely to improve when compared with an 'ETS only' approach, at least in the power sector (in the industry sector it is likely to stay unchanged). Also, it is important to recall that we do not assume that two instruments (ETS and RES-E support) try to achieve one target (CO_2 emissions), but rather that a multitude of goals are pursued by using those two instruments (CO_2 emission reduction and RES-E deployment, taking into account the non-CO_2 benefits of RES-E deployment). The challenge, therefore, is not to choose between different policy instruments designed to achieve the same target, but rather to choose a mix of instruments to fulfil two targets.

The solution, then, is to use appropriate RES-E deployment instruments (and support levels), and to combine them with other instruments of industrial policy, rural and regional policy (etc.), to achieve those benefits linked to RES-E deployment at the lowest possible cost. The existence of those interactions suggests the need for an integrated approach to climate and energy policy. Lecuyer and Bibas (2011) conclude that the objectives should be tuned together, and instrument levels should be defined taking into account all other instruments. On the other hand, the consistency of different policy targets and instruments can only be a guiding principle, not a strict requirement, as pointed out by Neuhoff (2013): "[t]he requirement of 100% consistency would limit the opportunities for political compromise – e.g. through flexibility on timing, sectoral scope, or process, that might be necessary to gain agreement on transformational policy."

Of course, due to uncertainty of how much CO_2 reduction an additional amount of RES-E will create, adjusting the emissions reduction target adequately, and in a sufficiently timely fashion, is a challenge (Skytte 2006, p.9). A baseline has to be defined for the emissions that would have been produced if RES-E had not been deployed, which is always subject to major uncertainties: it requires an assessment of the CO_2 content of the kWh that RES-E technologies displace, which depends upon the merit order (i.e. the last production capacity required to fulfil the demand at every moment). These elements typically differ from one country to another (Philibert 2011). Also, there are some uncertainties regarding the RES-E technologies that will be applied, depending upon the technology specificity of the RES-E support instrument, and on the actual RES-E growth path that will be achieved, which might differ from the original projections.

Another complexity is the allocation of future RES-E generation to the ETS and the non-ETS sectors. Only the RES-E share that falls under the ETS should be taken into account in the ETS cap setting. Decentralised RES-E generation usually does not fall under the ETS but displaces fossil generation options that fall under the ETS.

Further issues may arise around the unequal trajectories towards reaching the ETS and RES-E targets[22]. Also the implications for the industry sector need special consideration, as the latter is more vulnerable to high or volatile carbon and electricity prices[23] than the power sector (this issue will not be further investigated here since this is done within another subtask of the *beyond2020* project).

Therefore, the question arises: how are we to reflect these uncertainties in the target-setting and instrument design? In principle, targets can be coordinated *ex ante, ex post* or via a *dynamic approach.* From the ETS perspective, *ex ante* coordination is clearly preferable, as *ex post* or *dynamic* adjustments will reduce the credibility of ETS. In practice, transparent mechanisms for dynamic adjustments of the ETS CO_2 constraint trajectory might still be required for major deviations. Furthermore, adjustments of RES-E support are likely to be needed to steer RES-E growth according to the envisaged trajectory. This will be further explained below.

According to the Impact Assessment modelling of the European Commission (2008a+b), the 2020 targets for GHG, RE and energy efficiency were coordinated *ex ante* and also reflected in the ETS cap setting. However, this was only an approximation. Furthermore, the consistency of the targets was controversial at that time and questioned e.g. by Höhne *et al*. (2008), who calculated that the ETS cap would need to be more stringent in order to reflect the EU renewables and energy efficiency target (see also the updated assessments of the target and ETS consistency by Höhne *et al*. 2011).

As the future RES development will always be linked to some uncertainty, one could think about an *dynamic* correction mechanism that adjusts the ETS cap to the actual RES development, in cases where the RES deployment substantially deviates from the original projections. If the *dynamic* correction mechanisms are known beforehand and based on objective criteria rather than arbitrary decisions, the credibility of the ETS could still be preserved under such a setting. Note that dynamic approaches are also commonly used for target setting in energy efficiency policy making: since energy efficiency targets are commonly

[22] Even when RES-E targets and the ETS cap are aligned, the different trajectories towards reaching the RES-E and ETS targets may increase the volatility of CO_2 allowances prices. While the reduction of the ETS cap follows a fixed yearly schedule, the RES-E trajectory is more flexible. The renewables directive 2009/28/EC defines binding national RES targets for 2020 (overall gross final energy, not RES-E) but the trajectory for reaching these targets is an indicative minimum trajectory. The breakdown in RES-E shares is only provided by the NREAPs, as mentioned above. From the RES policy perspective, such flexibility seems recommendable for the future as well, as most of the RES-E support instruments applied in Europe (including quota schemes) do not steer RES-E growth precisely on a yearly basis.

[23] Increasing shares of (fluctuating) RES decrease average electricity spot market prices but make them more volatile: prices will be low in hours of high RES-E feed-in and higher in other hours. If industry can adapt their demand to this pattern, they will benefit from this development, but this might not always be the case. Another issue is whether industry is burdened with the RES-E surcharge that increases electricity prices for consumers. Currently energy-intensive industry is exempted from this surcharge in all European countries but these exemptions are under discussion in some Member States.

defined in comparison to a baseline, several countries (e.g. UK, Italy) apply the concept of defining a *dynamic baseline* (cf. Sorrel 2009) rather than sticking to an initially set static one within their energy saving obligation schemes in order to ensure the “additionality” of savings (cf. Suna 2013). On the other hand, the RE target achievement can also be enforced on the RE policy side, e.g. by regularly monitoring the progress in RE development (as currently done under the renewables Directive) and fine-tuning the policy framework to achieve the RE targets. For RES-E support instruments, different design options are available to steer RES-E growth (e.g. quotas, caps, “breathing” caps, auctions, etc.; we will not discuss their pros and cons here). Most of these design elements aim at limiting RES-E growth, while – from the perspective of meeting the predefined targets and being consistent with the ETS cap – it is also important to achieve the targeted RES-E growth. The latter can be managed through effective RES-E support scheme design and the removal of non-economic barriers (see e.g. Klessmann *et al*. 2011 and Ragwitz *et al*. 2012). Some flexibility in the RES-E growth trajectory is important, however, as a strict yearly trajectory would be difficult to achieve and could obstruct RES-E market growth patterns.

One should be aware, however, that uncertainties regarding RE development are by far not the highest uncertainty in the ETS cap setting process. The current surplus of allowances in ETS, which mainly results from the economic crisis that substantially reduced energy demand and from the large number of international credits, show the difficulty in making *ex ante* projections of energy consumption and CO_2 emissions, especially under changing economic framework conditions. Against this background, European stakeholders are currently discussing different options for a structural reform of the EU-ETS that would increase and stabilise CO_2 prices: e.g. adjusting the CO_2 target or introducing a linear reduction factor, retiring allowances, or introducing a carbon floor price (see European Commission 2012b for their description, advantages and drawbacks; for a discussion of different reform options to get on track to meet the 2° target, see also Höhne *et al*. 2013).

The current problems of the EU-ETS also have implications for RES-E support. Without a structural reform of the EU-ETS that ensures higher CO_2 emission allowance prices in the future and thus internalises part of the external costs of climate change, RES-E support instruments will remain under high cost pressure. Since RES-E support instruments aim to pay RES-E investors the difference between the cost of RES-E and the electricity market price, low CO_2 prices will increase the need for RES-E support and either lead to high support payments or to reduced RES growth. A well-functioning ETS with meaningful CO_2 prices is thus a precondition for effective and efficient RES support policies.

5. Conclusions

In this paper we systematically assessed the arguments against and in favour of having separate targets and policies for RE and GHG emissions reductions. Furthermore, we analysed specifically the arguments for and against implementing support instruments for renewable electricity [24] in addition to the EU Emission Trading Scheme and explore options how to coordinate ETS and RES-E support.

We conclude that the coexistence of GHG and RE policies and targets is clearly justified. Well-coordinated targets and policies will be capable of reaching both the GHG emission reduction target and the RE deployment targets in an effective and efficient manner.

Negative impact can be avoided by coordinating the targets and trajectories between both instruments. This means that the amount of CO_2 emissions expected to be reduced with RES-E deployment needs to be taken into account when setting the CO_2 cap under the ETS. If this is done, then the negative effects of RES-E support on the CO_2 emission allowance price can be fully mitigated. However, the projection of future RES-E generation and translation into a consistent ETS cap is always linked to a number of uncertainties. Uncertainties arise with regard to the projection of the RES-E growth and technology mix, its CO_2 displacement effect, and its ETS eligibility (depending on whether centralised or decentralised RES-E plants will be built). These uncertainties might justify some *dynamic* adjustments of the original trajectories.

In principle, ETS and RES-E trajectories can be coordinated *ex ante* or through a *dynamic* approach. From the ETS perspective, *ex ante* coordination is clearly preferable, as *dynamic* adjustments will reduce the credibility of the ETS. However, one might consider transparent *dynamic* adjustment mechanisms that would become effective in cases where there are major deviations from the original projections. Adjustments for coordinating RES-E deployment and the ETS cap can be implemented both within the ETS and within the RES-E support instruments through specific design elements. Some flexibility in the RES-E growth trajectory is important, however, as a strict yearly trajectory would be difficult to achieve and could obstruct RES-E market growth patterns.

[24] We do not look into heat and transport policies in this paper. RES-E has the most significant influcence on ETS. Also, the *beyond2020* project focuses on the electricity sector within the discussion of harmonisation of RE support.

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