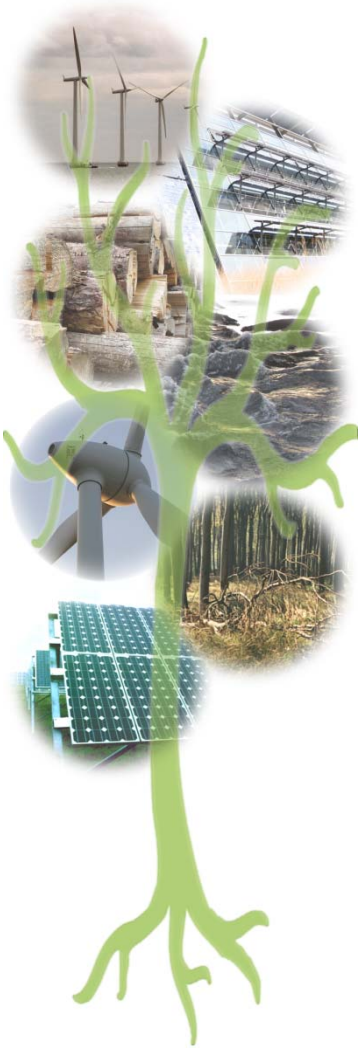
Design and impact of
a harmonised policy for
renewable electricity in Europe



D2.1 Report

# Key policy approaches for a harmonisation of RES(-E) support in Europe

## - Main options and design elements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## *The* beyond2020 *project*

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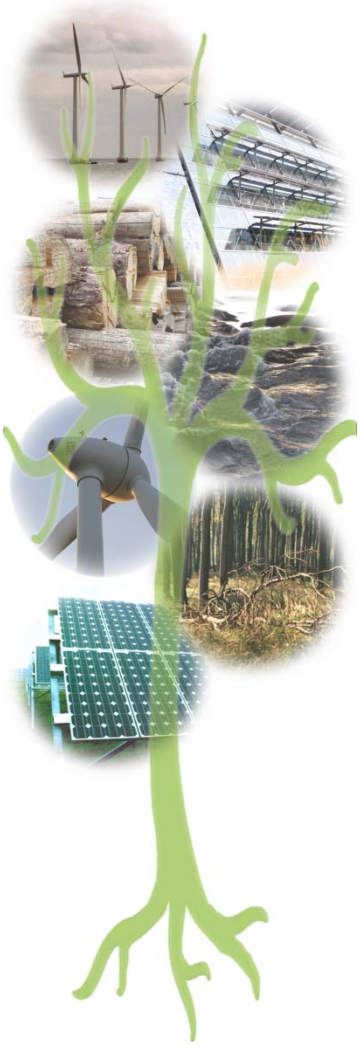
# The beyond*2020* project *at a glance*



With Directive 2009/28/EC the European Parliament and Council have laid the grounds for the policy framework for renewable energies until 2020. **Aim of this project** is to **look more closely** *beyond 2020* by designing and evaluating feasible pathways of 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** will comprise a detailed elaboration of feasible policy approaches for a 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, no further dedicated RES support besides the ETS. A thorough impact assessment will be 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, focussing on strategic impacts as well as political practicability and guidelines for juridical implementation. Aspects of policy design will be assessed in a broader context by deriving prerequisites for and trade-offs with the future European electricity market. The overall assessment will focus on the period beyond 2020, however also a closer look on the transition phase before 2020 will be taken.

**The final outcome** will be a fine-tailored policy package, offering a concise representation of key outcomes, a detailed comparison of pros and cons of each policy pathway and roadmaps for practical implementation. The project will be 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*

*focuses on the elaboration of feasible pathways for a possible harmonisation of RES(-E) support in Europe beyond 2020.*

*The aim of the inception phase is not to propose one precise design of each policy instrument, but to open the spread of feasible design options for the later impact assessment. This will involve both the design of the policy instrument itself as well as the definition of other important aspects such as the general electricity market design, the timing of harmonisation, the technology and the geographical coverage, the conditioned long-term RES targets for 2030 and beyond, etc…*

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Intelligent Energy for Europe

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## Template

# 1 Introduction

This report represents the first outcome of the inception phase (work package 2) of the beyond*2020* project. The inception phase shall provide the conceptual basis for the detailed follow-up analysis in all subsequent work packages, comprising:

- the conceptual elaboration of feasible policy approaches for a harmonisation of RES(-E) support in Europe, involving several policy paths, which are defined according to different degrees of harmonisation and policy instruments.
- the definition of evaluation criteria for the subsequent impact assessment from a theoretical viewpoint, discussing and contrasting economic theory and practical applicability.

*This report* focuses on the elaboration of feasible pathways for a harmonisation of RES(-E) support in Europe. The aim of the inception phase is not to propose one precise design of each policy instrument, but to open the spread of feasible design options for the later impact assessment. This will involve both the design of the policy instrument itself as well as the definition of other important aspects such as the general electricity market design, the timing of harmonisation (i.e. by 2021 or earlier / later), the technology (i.e. some or all RES-Electricity technologies, or even extended to specific RES-Heat options) and the geographical coverage (i.e. EU27 or also extended to third countries such as the MENA region, Norway and Switzerland), the conditioned long-term RES targets (at both EU and national level) for 2030 and beyond etc…

Pathways are defined at two levels. A first level involves degrees of harmonisation, i.e., at which administrative level the decisions on instruments and design elements are taken and whether there are national RES-E targets in addition to a European target. On a second level, there are some components of the pathways that need to be harmonised: Framework conditions, instruments, design elements, use of cooperation mechanisms and cost-allocation alternatives. Combining all these components under different degrees of harmonisation results in a broad set of different pathways.

Accordingly, this report is structured as follows. A description of the methodology is provided in the next section. Section 3 describes the different degrees of harmonisation considered in this report. Section 4 is dedicated to identify and discuss several framework conditions which might be harmonised. Section 5 provides a detailed discussion of a key component of the pathways: the design elements of different instruments. The pathways are described in section 6.

# 2 Methodology

In order to define the policy pathways, an extensive literature review, including work already performed by the members of the research team, as well as a stakeholder consultation (as part of WP8) and a consortium-internal cross-check has been performed.

The literature on the analysis of the design elements of RES-E support schemes is relatively recent, possibly because, in the past, the focus has been on the abstract comparison between instruments (mostly, quotas with Tradable Green Certificates (TGCs) and Feed-in tariffs (FITs)). Three main types of contributions in this literature are worth mentioning.

First, some contributions have already identified different design elements in RES-E support schemes (quotas with TGCs and FITs) in the EU or in the rest of the world and have analysed their advantages and drawbacks. Some of these contributions have been the result of EU-funded projects, in some of which BEYOND 2020 partners have participated. Relevant references in this context include Klein et al (2008, 2010), Mendonza et al (2010), IEA (2008), Ragwitz et al (2007).

On the other hand, the German Federal Ministry for Environment, Nature Conservation and Nuclear Safety (BMU) has a very useful database in the context of this report which provides details on the design elements of the RES-E support in the different EU Member States, with regular updates[1]. Country profiles are also provided in the RE-Shaping project, which are used for this report (Teckenburg et al 2011).

Finally, case studies of the design of RES-E policies in specific countries also provide relevant insights on those design elements. Contributions in this category include, among others, Kaldellis (2011), Kiviluoma (2010), del Río (2008), Jones (2006), KEMA (2008), Beaudoin et al (2009), Couture et al (2010), Yatchew and Baziliauskas (2011), Lasee (2010), Rickerson et al (2007), Rickerson et al (2008), Deutsche Bank (2009), Haugwitz (2008), Pegels (2010) and Nersa (2009).

[1] See http://www.res-legal.de/en/search-for-support-scheme.html

# 3 Degrees of Harmonisation

Harmonisation can be defined as a top-down implementation of common, binding provisions concerning the support of RES-E throughout the EU (Bergmann et al 2008). However, harmonisation admits many possibilities on what needs to be harmonised and how, along a continuum from "Full" to "Minimum" harmonisation, depending on the combination of "what" options (i.e., targets, support scheme, design elements, support level) and "how" options (i.e., whether decisions are taken at EU or MS level).

In order to keep the discussion on the pathways manageable, we consider four alternatives, as illustrated in the following table. With this aim to be useful for the definition of pathways, we focus on several critical aspects, i.e, whether there are Member State targets in addition to the EU-wide target, at what administrative level the decision on design elements (and, particularly, support level) is taken (EU or MS). A brief description of the different alternatives follows[2]. We have considered four major degrees of harmonisation. Obviously, there might be other possibilities within the spectrum of alternatives but we believe that the ones selected cover major aspects and possibilities for harmonisation[3].

**Table 1 Degrees of harmonisation considered in this report.**

| Degree of harmonisation | MS targets | Support scheme | Decision on design elements | Decision on support level |
|---|---|---|---|---|
| **Full** | No | EU-wide | EU | EU |
| **Medium** | No | EU-wide | EU | EU (plus additional MS support) |
| **Soft** | Yes | Same instrument used in MS, not uniform | MS (some imposed by EU) | MS |
| **Minimum** | Yes | MS decision. | MS (some imposed by EU) | MS |

- *Full harmonisation* involves the setting up of EU-wide targets (no MS targets), an EU-wide support scheme, harmonisation of framework conditions and harmonisation of the design elements of the support scheme selected. There is a very limited role to be played by MS. Full harmonisation involves harmonisation of the level of support, harmonisation of support schemes and harmonisation of the legal framework as a whole, including regulatory issues. An EU-wide equalisation of the costs of support takes place. The focus on Full harmonisation is justified because this is the long-term aspiration of the European Commission. As observed by Guillon (2010), the European Commission has repeatedly mentioned that harmonisation remains a long-term goal (European Commission 2001, 2005, 2008). While Full harmonisation remains a long-term aspiration, lower degrees of harmonisation are also possible and it is very difficult at this stage to tell what will be the final degree of harmonisation. Thus, we also consider softer degrees of harmonisation.

[2] For a discussion on different degrees of harmonisation, see Bergmann et al (2008) and Guillon (2010).

[3] In particular, an alternative which has not been discussed is the possibility to combine an EU-wide support level (as in Full and Medium harmonisation) with MS targets (as in Soft and Minimum harmonisation).

- *Medium harmonisation* would be very close to Full harmonisation. There is also one EU-wide instrument and EU support level, but countries may provide additional (albeit limited) support for specific technologies, either within the EU-wide support scheme (i.e., additional remuneration based on local benefits under feed-in tariffs or premiums) or as an additional instrument to the EU-wide support scheme (i.e., investment subsidies or soft loans). The later option would be more feasible in the case of quotas with TGC or tendering schemes since it would be very difficult or even impossible for MS to provide additional support directly incorporated into an EU-wide TGC or tendering scheme. Countries may be willing to provide additional support taking into account the local benefits of RES-E. It should be taken into account that having additional support per country would mean that the EU target may be exceeded (since the EU-support level is set to reach those targets). Alternatively, the EU-level may be set taking into account the amount of RES-E MS are willing to have and may inform the Commission on the level of support and amount of RES-E they would like to promote. The level of EU-wide support would be set interactively. Another option would be to have (indicative) national targets and use art 6 cooperation mechanisms (statistical transfers) to redistribute the additional RES-E capacity across countries. But no MS targets has been assumed in this scenario because an EU-wide support scheme with a single support level would render MS targets meaningless.
- *Soft harmonisation*. This harmonisation alternative would be closer to Minimum harmonisation than to Full harmonisation. There is an EU-wide target, but also national targets consistent with the EU target. Countries have to implement domestically the support scheme that has been decided at EU level. However, countries may use whatever design element they deem best and support levels may differ across countries[4]. There might be some design elements imposed at the EU level.
- On the other extreme of the spectrum, under *minimum harmonisation*, EU-wide targets as well as national targets are set by the EU. MS decide on both the type of support scheme that they apply as well as its design elements. MS may set whatever support level they deem better. There might be minimum design elements set by the EU (authorisation procedures and obligation to support different technologies).

Although clearly not a goal of the European Commission, the Soft harmonisation scenario is a kind of reference scenario. Its relevance is also related to the finding that significant efficiency gains can be achieved by strengthening the existing national policies (Resch et al 2007).

[4] There is no possible combination of the medium and soft alternatives, since having national targets and a support level decided at EU level does not make sense, because there is no possibility for countries to do anything to reach those targets, i.e., they can not change the support level to reach those targets. National targets only make sense if countries have an instrument in their hands to reach them (i.e., support levels).

# 4 Framework and other conditions of support

In addition to design elements, there are some "framework conditions", unrelated to the instrument chosen, which have a role to play in the harmonisation process. Bergmann et al (2008) distinguish between "preconditions" and "framework conditions". The former encompass binding targets, a common liberalised power market, true competition and a level playing field and harmonised planning procedures. Framework conditions are defined as those aspects for RES-E support that are either outside the support system itself or on aspects that may be designed similarly irrespective of the type of system applied (op.cit., p.133). The former include grid access procedures, permit procedures, the existence of long term, binding targets or investment security. The latter include aspects like the kinds of technologies supported, the duration of support, or the differentiation of support according to technology and time of commissioning. Given the pre-eminence given to design elements in this report, however, the latter are addressed in the section on design elements, i.e., they are not considered as "framework conditions". Some framework conditions are unrelated to support schemes (i.e., they are outside the support scheme), whereas others are generically related to support schemes, i.e., common to all support schemes (aspects designed similarly irrespective of the type of system applied).

In addition, there are other aspects which do not fall under framework conditions thus defined: issues of cost-allocation and use of cooperation mechanisms.

Decisions on framework conditions may be taken at the EU or MS level. The harder the degree of harmonisation, the more likely they will be decided at EU level. We thus consider the following framework and other conditions summarised in Table 2.

**Table 2 Framework and other conditions relevant in the harmonisation process.**

| List of relevant conditions (harmonisation process) |
|---|
| Targets |
| Geographical coverage |
| Sectoral coverage |
| Eligibility of plant in other countries |
| Authorisation procedures |
| Grid access conditions |
| Distributions of grid connection costs |
| Use of secondary instruments |
| Cost allocation (burden sharing) |
| Use of cooperation mechanisms |

- *Targets* are decided at EU level, as in the current Directive. However, there might also be MS targets, according to the principle of subsidiarity. The existence of MS targets opens up different possibilities in the choice of design elements, such as the use of cooperation mechanisms. Regarding the timing of those targets, both 2030 and 2050 are considered. 2030 is regularly used as a target date in many energy model simulations (including the IEA World Energy Outlook, IEA 2010a), while 2050 is explicitly considered in the EU Roadmap and also in some model simulations (IEA Energy Technology Perspectives, IEA 2010b). Under Full and Medium harmonisation, targets

are set at EU level and there is only an EU-wide target. Under Soft harmonisation, the EU-wide target coexists with national targets set by the EU.

- *Geographical coverage*. Although foreign plants might be eligible (usually with condition of reciprocity) geographical coverage in this project is also set at EU level. Since this project deals with the "design and impact of a harmonised policy for renewable electricity in Europe", we assume that the current EU-27 is included in the analysis. This affects all degrees of harmonisation. Eligibility of plants in other countries creates complexity for designing and monitoring the system (e.g. production level, electricity price, quality criteria).
- *Cooperation with third countries*. In particular imports (to the EU) of biofuels and solid biomass as well as renewable electricity (RES-E) will be considered in the overall assessment. More precisely, for Green-X modelling feasible import volumes will be defined. For imports of RES-electricity from North Africa a simplistic assumption may serve well. For instance this shall mean to assume that in accordance with study XY, Z% of EU needs for RES-E will come from North Africa, resulting from simplistic assumptions related to cost-supply options for the MENA region.
- *Sectoral coverage* is also set at EU level. Similarly to the previous point, since this project sets a focus on renewable electricity, the RES-heat and RES-transport sectors will not be considered in full detail. The detailed definition of policy options will be prominently discussed for RES-electricity. Note however that the overall assessment is not constrained to that – also RES-heat and RES in transport will be included in the assessment. Thereby, for support of RES-heat a similar approach shall be applied as discussed for RES-electricity, reflecting the gradual shift from a national to a more European approach within the assessed policy options. It remains vague how to deal with the policy framework for biofuels in the transport sector where a high degree of harmonisation is already applicable today. It may serve well to apply similar assumptions for the future development under all policy options, assuming no explicit sectoral target beyond 2020 but a continuation of previous European efforts to achieve the transition to a more sustainable use of energy in the transport sector.
- *Eligibility of plants in other countries* should be decided at EU level but is only relevant as long as there are national targets and national RES-E support schemes but is obviously not relevant when an EU-wide support scheme is implemented, i.e., with *Full* and *Medium harmonisation*. The decision is relevant under *Soft harmonisation* or in the case of Minimum harmonisation. In these latter two options, countries may allow to have foreign plants eligible for domestic support (if allowed by the EU).
- *Non-economic barriers* include administrative barriers related to the granting of permits and grid-access conditions. A mitigation of these currently unevenly distributed constraints appears crucial to achieve a level playing field for RES in Europe. Thus, granting permits and grid-access conditions would be made uniform at the EU level under the *Full* and *Medium* degrees of harmonisation. It would involve the setting of some minimum EU standards in the other two degrees of harmonisation for example, by setting a maximum time limit over which permits should be granted (all administrative levels). This should provide a homogenous (and short) lead time for RES-E investors all over Europe. Regarding the second element, priority access to the grid should be enforced at EU level.
- *Distribution of grid connection costs*. A crucial aspect is how the grid connection costs are distributed. There are basically three alternatives: deep connection charging, shallow connection charging and super-shallow connection charging. Only the lat-

ter two are favourable for RES-E plants (Guillon 2010, Klein et al 2010) and, thus, either one or the other should be implemented. This should also be harmonised across the EU in all harmonisation degrees.

- *Use of secondary instruments by MS*. Secondary instruments (investment subsidies and fiscal incentives) may be used by MS to either a) provide additional support for specific technologies (additional to the EU or MS support) or b) to support specific technologies which are not supported by the EU or MS scheme. In order to avoid distortions between MS, the possibility to use secondary instruments should be decided at EU level. Under *Full harmonisation*, neither possibility (a and b) would be allowed. Under *Medium harmonisation*, MS could provide additional (albeit limited) support (option a) and support for technologies which are not supported by the EU-wide scheme (option b) in case they are eligible for support (EU decision). Support by secondary instruments is allowed in the case of a *Soft and Minimum harmonisation*.

The decision on the application of a given framework condition (i.e., what administrative level is responsible for the decision) might be different under different degrees of harmonisation, as shown in Table 3.

**Table 3 Framework conditions in dependence of the degree of harmonization**

| Degree of harmonisation | MS targets | Eligibility of plants in other countries | Authorisation procedures | Enforcement of grid priority access | Decision on distribution of grid connection costs | Secondary instruments by MS |
|---|---|---|---|---|---|---|
| **Full** | No | Not applicable | EU | EU level | EU | N |
| **Medium** | No | Not applicable | EU | EU level | EU | Yes (limited) |
| **Soft** | Yes | Possible | MS - with minimum EU standards | MS level - with minimum EU standards | EU or MS | Yes |
| **Minimum** | Yes | Possible | MS - w /o minimum EU standards | MS level - w/o minimum EU standards | EU or MS | Yes |

## 4.1 Cost allocation (burden sharing)

Different alternatives exist for sharing the burden of costs between MS[5]. However, a crucial distinction here is between on the one hand Full and Medium harmonisation and, on the other, Soft and Minimum.

In these later two cases, there are MS targets. Each country either applies its own instrument (Minimum harmonisation) or sets the support level (among other design elements) within an EU-imposed support scheme in order to fulfil their national RES-E target. There is no requirement to share the cost burden in these two cases. Countries set whatever support level they deem best to support their RES-E resources. If countries set whatever support level they

[5] Transfer costs for consumers/society refer to the direct premium financial transfer costs resulting from the consumer to the producer due to the RES-E policy compared to the reference case of consumers purchasing conventional electricity on the power market. This means that these costs do not consider any indirect costs or externalities (environmental benefits, change of employment, etc.).

want, a redistribution of the costs (burden sharing) is not needed[6]. Of course, some MS may not comply with their targets and some may overcomply. In principle, and only for the surplus/shortage of RES-E (i.e., only for the country-specific deployment of new RES-E installations which is not needed for target fulfilment in the country of origin), a methodology for the country-specific allocations of the resulting transfer cost could be devised. This could take the form of average premiums for surplus or marginal premiums for surplus, as argued in Resch et al (2008). But, since the trade of surplus/shortages is likely to be the result of bilateral negotiations, prices for sales/purchases would be determined bilaterally and cannot be known beforehand. They fall within the range of the marginal costs of the last unit needed by the exporting country to comply with its target (lower bound) and the last unit needed by the importing country to comply with its target. But it is simply impossible to tell ex-ante what the resulting price from those transactions will be. All in all, as mentioned above, burden sharing would not be appropriate in these two cases, since countries fulfil their targets purely at the national level, but costs would have to be borne elsewhere.

In contrast, under Full and Medium harmonisation, there are no national targets, only an EU-wide target and the issue of who pays for renewable energy sources deployed all over Europe exceeds national borders. A common fund fed by European consumers or taxpayers is needed in this case. How consumers and taxpayers contribute to this fund is a crucial issue. The common fund needs to be agreed between countries. Two alternatives for burden sharing are discussed: “equal payment” and “proportional payment”.

Under equal payment, all the consumers (or taxpayers) pay the same amount of support (either in their electricity bills or their taxes): the EU-wide support level. This means that the total costs of support of RES-E across Europe are divided by the amount of total generation in the EU (€/kWh) and electricity consumers pay an add-on in their electricity bills which accounts for the support being provided. All consumers pay the same amount all over Europe per kWh of electricity consumed. In other words, transfer costs are equally distributed among all countries (consumers/taxpayers) independently from the location of RES-E deployment. The fund would be fed as an additional change by taxpayers or electricity consumers in their electricity bills, as it is currently done at national level. For example, if the total costs of support are 200000M€ annually and there are 3500 TWh of electricity consumed in the EU, all European electricity consumers would have to pay 5.7€cents/kWh in their electricity bills, regardless of whether more RES-E has been deployed in their countries or not (i.e., independently of where the RES-E is actually being generated). This approach puts the emphasis on the EU-wide benefits of RES-E support.

Under proportional payment, electricity consumers (or taxpayers) pay according to the amount of new RES-E generation in their country (i.e., proportionally to the renewables deployed in their country). This approach, where support is proportionally shared between all countries in line with the national RES-E exploitation, takes into account the local benefits of RES-E, although not the negative environmental externalities of RES-E deployment. Therefore, this approach puts the emphasis on the national benefits of RES-E support. An example will help to clarify how the burden is shared with this approach. The share of new electricity generation from renewables in a Member State is 15% (of all RES-E generation in the EU) in a given year. The total costs of support across the EU is the same as in the example mentioned above, i.e., 200000M€/year, thus, 0.15*200000 means that the burden shared by the country

[6] Resch et al (2008) discuss five alternatives for sharing the burden under three different cases (country-specific support, partial harmonisation and full harmonisation). However, the authors consider that, under harmonisation (whether partial or full), there is an EU-wide support level and national targets. This combination is excluded in this report, where there are either national targets and no EU-support level (Soft and Minimum) or there is an EU-wide target, no national targets and an EU-wide support level (medium and Full harmonisation options).

would be 30000M€. Assume also that total electricity consumption in the country amounts to 200TWh. Then, consumers would pay 30000M€/200TWh = 15€cents/kWh. Obviously, countries with a large share of RES-E will argue about the importance of the "EU benefits" of RES-E deployment whereas country with a low share of RES-E will prefer the proportional payment approach.

Both equal and proportional payment can be applied in the Full and Medium harmonisation alternatives. However, in the Medium harmonisation alternative, this approach should be applied for the EU-wide support, but the costs of the additional support provided by each country should fall on the country providing the support. Thus, in the Medium harmonisation option, consumers would have two types of costs: the EU-wide support (calculated according to the equal or proportional payment) and the additional, country-specific support.

## 4.2 Use of cooperation mechanisms

Regarding the use of *cooperation mechanisms* (see Box 1), joint projects between Member States and third countries (art. 9 of the RES Directive) could be used in all cases. However, this is not the case with cooperation mechanisms between MS. Joint support schemes (art. 11) are irrelevant in all cases, since the support schemes of the different countries are the same (except under Minimum harmonization). However, statistical transfers between Member States and joint projects between Member States (articles 6 and 7) may be used under the soft harmonisation alternative, i.e., when there are targets for MS, although not with full harmonisation (since there are no MS targets).

**Box 1 Cooperation mechanisms (according to the RES Directive).**

*Article 6*

*Statistical transfers between Member States*

*Article 7*

*Joint projects between Member States*

*Article 9*

*Joint projects between Member States and third countries*

Under full harmonisation, with EU wide targets and a uniform support scheme applied all over the EU, there is no role for cooperation mechanisms except for joint project between MS and third countries (art.9). The other cooperation mechanisms would not have a role to play since there are no national targets and nationally differentiated support levels. This is also the case with Medium harmonisation.

In contrast, the use of all cooperation mechanisms is possible under Soft harmonisation. Although the same support scheme is prescribed for all MS, countries may decide on the support levels and other design elements in order to comply with their national target. This opens the door for "where"-flexibility to achieve the national target at lower cost, as provided by the cooperation mechanisms. Similarly, all cooperation mechanisms may be used under minimum harmonisation.

**Table 4 Cost allocation and use of cooperation mechanisms in dependence of the degree of harmonization**

| Degree of harmonization | Cost allocation | Role of cooperation mechanisms |
|---|---|---|
| **Full** | Equal or proportional payment. | Art 9 |
| **Medium** | Equal or proportional payment. | Art 9 (6 with national targets) |
| **Soft** | No equalisation scheme of costs is required | All (art 6, 7, 9 and 11) |
| **Minimum** | No equalisation scheme of costs is required | All (art 6, 7, 9 and 11) |

# 5 Design elements and options

## 5.1 The instruments

RES-E promotion has traditionally been based on three main (primary) mechanisms: feed-in tariffs (FITs), quotas with tradable green certificates (TGCs) and tendering (see del Río and Gual 2004, Ragwitz et al 2007, Schaeffer et al 2000 and Huber et al 2004 for further details).

- *Feed-in tariffs* are subsidies per kWh generated paid in the form of guaranteed premium prices and combined with a purchase obligation by the utilities. The costs are usually borne by consumers. The most relevant distinction is between fixed feed-in (FITs) and fixed premium (FIP) systems. The former provides total payments per kWh of electricity of renewable origin while, in the later case, a payment per kWh on top of the electricity wholesale-market price is granted (Sijm 2002). Both have their pros and cons. While FIPs are usually considered more market compatible, FITs provide greater certainty for investors.
- *TGCs* are certificates that can be sold in the market, allowing RES-E generators to obtain revenue. This is additional to the revenue from their sales of electricity fed into the grid. Therefore, RES-E generators benefit from two streams of revenue from two different markets: the market price of electricity plus the market price of TGCs multiplied by the number of kWh of renewable electricity fed into the grid (Schaefer et al 2000). The issuing (supply) of TGCs takes place for every MWh of RES-E, while demand generally originates from an obligation. Electricity distribution companies must surrender a number of TGCs as a share of their annual consumption. Otherwise, they will have to pay a penalty. The TGC price results from the interaction of supply and demand and depends on the level of the quota (Q) and the marginal costs of RES-E generation ($MC_{RE}$). The expected TGC price ($P_{TGG}$) covers the gap between the marginal cost of renewable electricity generation at the quota level and the price of electricity ($P_e$). $P_e$ and $P_{TGG}$ move in opposite directions: An increase in $P_e$ reduces the TGC price accordingly.
- *Tendering.* The government invites RES-E generators to compete for either a certain financial budget or a certain capacity of RES-E generation. Within each technology band the cheapest bids per kWh are awarded contracts and receive the subsidy (Schaeffer *et al.*, 2000). The operator pays the bid price per kW h. A fund financed by a levy on electricity consumers or taxpayers covers the difference between this bid price and the market price of electricity.

## 5.2 Common design elements

It is well-known from the literature on RES-E support schemes that the success of RES-E promotion is as much an issue of choosing the appropriate instruments as it is of including suitable design elements. Thus, the focus on design elements is justified.

It is assumed that these design elements, which have proven their relevance from a national perspective could also be relevant in a EU harmonisation perspective. The EU focus will possibly reduce or enhance the relevance of some of those design elements.

Some design elements are common to different instruments, although the specific form this may take may differ between instruments. Other design elements are clearly instrument-specific. This subsection discusses the former, whereas the latter are discussed in the next subsection.

- *Eligibility of plants (new vs. existing).* Only *new plants* are eligible. The aim of support schemes is mainly to promote new capacity. The harmonised support scheme should not apply to existing capacity. However, following the principle of non-retroactivity, existing plants would be promoted under current (national) RES-E support schemes until these are phased-out (i.e., until the guaranteed period for support ends).
- *Constant or decreasing support level during support period.* Support for existing plants may be greater at the start of the period and be reduced over time (either an annual percentage reduction or a stepped reduction after some years) or support may be constant over time. All in all, the terms and conditions of this reduction should be known beforehand.
- *Eligibility of technologies* (i.e., which technologies are included or excluded) is also an EU prerogative as it is currently the case with the RES Directive, where the eligible technologies are defined. We also assume that these are the technologies included.
- The *duration of support* is a crucial element in all instruments which should be homogenous at EU level (in order to avoid distortions between MS). The specialised literature shows that long (but not too long) duration periods of between 15 to 20 years provide low risks for investors and, thus, comply with the effectiveness and efficiency criteria (low risk premiums make projects more bankable and reduce the financial costs of the project). Duration in a TGC scheme refers to the period over which plants may expect to receive certificates. Long-term contracts in TGC schemes are assumed (making this instrument closer to a tender scheme). With FITs, duration of support refers to the period over which the plants will receive the premium or the tariff.
- *Cost burden of RES-E support.* The cost burden for RES-E support may fall on either electricity consumers or taxpayers (i.e., the public budget)[7]. This should be decided at EU level. However, since the costs of the main instrument in the EU MS fall on consumers, this is also assumed here. Furthermore it needs to be decided, whether an equal distribution among consumers or an uneven distribution is used.
- *Technology-specific support.* A similar support level might be provided for all technologies (regardless of their generation costs) or support may be modulated according to those costs. The manner in which support is provided to specific technologies is clearly very different under different support schemes. Thus, a more detailed discussion of this design element will be provided under the heading "instrument-specific design elements".
- *Size-specific support level.* Support may be differentiated according to the size of the installation, taking into account that, generally, the generation costs (€/MWh) of larger installations are lower since they benefit from economies of scale and that governments may want to promote small scale installations for a number of reasons (decentralised generation and social acceptability).

[7] Eventually, RES-E support could also be financed by all energy consumers, as with the Green cent proposals in Spain.

- *Location-specific support.* Support level might be modulated according to the location of the plant (e.g. built-in, stand alone), with greater support levels provided for plants deployed in places with greater costs. At first, this may seem at odds with economic efficiency, since installations would not be promoted where generation costs are minimised. However, this is not always the case, since, if the good sites are limited, the producer surplus could be excessive. All in all, this disincentive may be eliminated by making the differential support (support levels minus support costs) still greater at places with the best renewable resource. The rationale behind location-specific support is to avoid concentration of renewable energy projects in a few locations.

Some of the aforementioned common design elements mentioned may take different forms under different support schemes. The following table shows these commonalities and differences and provides a brief assessment of each design element.

**Table 5 Common design elements under different support schemes and brief assessment**

| Design element | FIT | FIP | TGC | Tendering | Assessment |
|---|---|---|---|---|---|
| **Eligibility of plants (new vs. existing).** | Only new plants commissioned after a specific date are eligible for support | | | | In most cases only new plants are eligible, with some grandfathering or transitional arrangements for the existing plants that are not competitive |
| **Flow of support (constant or decreasing support level during support period)** | FIT level constant during the duration of the support or "front loading", i.e. reductions of FIT over time | FIP level or sum of FIP + electricity price (in case of sliding premium) constant during the duration of the support or "front loading", i.e., reductions of FIP over time | Constant support over time or more TGC per MWh generated in the first years of operation or for a fixed quantity of generation, and less TGC/MWh thereafter or equal number of TGCs per MWh generated over time. | Constant support over time or pre-established % reduction over time (previous to the bidding procedure) | Given the capital-intensity and high up-front costs of RES-E plants, providing greater support levels at the beginning of their lifetime ("front-loading") helps their financing compared to the same overall amount of support constantly granted over time. In practice, this might however create a complex system that lacks of transparency and understandability. For supply driven RES-E, increasing weather and revenue risk. |
| **Eligibility of technologies** | Decided at EU level. Current Directive | | | | The Directive includes a sufficiently broad definition of renewables eligible for support |
| **Duration of support** | Period when support is guaranteed (e.g.15,20,25 years) | | | | The longer the duration the more certainty to the investors |
| **Cost burden of RES-E support (taxpayers vs. consumers)** | FIT systems can be funded by public budget or charge on electricity bills | FIP systems can be funded by public budget or charge on electricity bills | Cost of TGC system usually borne by electricity consumers via charge on electricity bill but may also be funded by the public budget. | Public budget or electricity bill | Consumer financed support is generally considered more stable than budget financed support. |

**Table 5 (continued) Common design elements under different support schemes and brief assessment**

| Design element | FIT | FIP | TGC | Tendering | Assessment |
|---|---|---|---|---|---|
| **Technology-specific support** | FIT is differentiated across technologies to reflect technology-specific generation costs. The alternative is to have a uniform fixed tariff for all technologies | FIP is differentiated across technologies to reflect technology-specific generation costs. The alternative is to have a uniform premium for all technologies | Banding can be implemented through carve-outs or through credit multipliers. Under carve-outs, targets for different technologies exist, leading to a fragmentation of the TGC market, with one quota for the mature and another for the non-mature technologies. Under credit multipliers, more TGCs are granted per unit of MWh generated for immature technologies compared to mature technologies.<br>The alternative is no use of carve-outs or credit multipliers, such as in the Swedish and Polish TGC schemes. | Banding | Technological neutrality leads to static efficiency, but technology specific support allows for technology diversity, which could be superior in a long-term horizon.<br>In TGCs, carve-outs may lead to narrow markets (i.e., it narrows the tradable volume within each sub-quota) if implemented for one technology in one country, but may be interesting if implemented at EU level. Credit multipliers may lead to the problem of "net neutrality"/TGC vs. electricity accounting. In the 2007 reform of the U.K. RO, the U.K. Department for Business, Enterprise & Regulatory Reform (BERR) decided to implement credit multipliers rather than carve-outs (Bergmann et al 2008). |
| **Size-specific support level.** | FIT level modulated according to the plant size. Smaller FIT for large-scale and higher tariffs for small-scale plants.<br>Only installations below a certain capacity threshold would receive the support (stepped FIT) | FIP level modulated according to the plant size. Smaller premiums for large-scale and higher premiums for small-scale plants.<br>Only installations below a certain capacity threshold would receive the support | Small-scale installations receive more TGCs than large-scale installations<br>Only installations below a certain capacity threshold are eligible to receive TGCs | Size-differentiated tendering procedures.<br>Instrument mostly for large scale RES | Stepped tariffs have their pros and cons (see Klein et al 2010, Ragwitz et al 2007).<br>Size limits have pros (encouraging small generators) and their cons (lower economies of scale) |
| **Location-specific support level** | FIT level modulated according to the location of the plant (stepped FIT) | FIP level modulated according to the location of the plant. | Different number of TGC according to the location of the plant. | Pre-approval of sites. Location-specific support is the result of the bidding procedure. | Stepped tariffs have their pros and cons (see Klein et al 2010, Ragwitz et al 2007). |

Source: Own elaboration based on BMU (2011), Ragwitz et al (2007), European Commission (2008), del Río (2008, 2010), Haas et al (2004), Mendonca and Jacobs (2009), Kaldellis (2011), Kiviluoma (2010), Jones (2006), KEMA (2008), Beaudoin et al (2009), Couture et al (2010), Yatchew and Baziliauskas (2011), Lasee (2010), Rickerson et al (2007), Rickerson et al (2008), Deutsch Bank (2009), Haugwitz (2008), Pegels (2010), Nersa (2009) and Michell et al (2011).

Note: * Y = yes; N = no. ** Except hydro <10MW. Plant size usually determines support level.

## 5.3 Instrument-specific design elements

Instruments have different design elements. The review of the literature leads to several design elements of FITs, FIPs, tendering and TGCs, which could be relevant to consider in the harmonisation of RES-E support in the EU.

### 5.3.1 Feed-in tariffs (FITs) and Feed-in premiums (FIPs)

**Table 6 FIT and FIP design elements and brief assessment**

| Design element /alternative | Description | Brief assessment |
|---|---|---|
| **Common to FITs and FIPs** | | |
| **Support tied / not tied to electricity price** | Support may or may not be linked to the electricity price | Experience with support tied to electricity prices (Spain 2004-2007, Germany and Denmark in the 90s) shows that it leads to uncertainty on support levels over time (either large increase as in Spain or reduction as in Germany and Denmark) |
| **Support level adjustment methods (new plants)** | Periodic revisions.<br>Degression. Reductions over time in support levels for new plants. Degression rates: % reduction of support per year.<br>Capacity-based adjustments. | All have their pros and their cons. |
| **Cost-containment mechanisms** | Some elements may help to control costs: limits on generation eligible for support, capacity limits, cap on total costs, etc. | All have their pros and their cons. |
| **Purchase obligation** | Obligation imposed on grid operators or suppliers to purchase green electricity (in Spain, Czech Rep. and Slovenia this does not apply under the premium option). | Market compatibility vs. certainty for investors. |
| **Forecast obligation** | Forecast obligation is decided at EU level. This design element is particularly suitable for fluctuating RES but possibly only under the less market-compatible FIT option | The forecast obligation leads to a better management of the electricity system. |
| **FIT-specific** | | |
| **Demand orientation** | This is set at the EU level for non-fluctuating RES (i.e., higher support level for RES-E fed during periods of peak demand for electricity). | Useful to adapt electricity generation to electricity demand, but only for non-fluctuating RES. Higher administrative costs. |
| **FIP-specific** | | |
| **Cap price** | Support is capped (electricity price + premium). | A cap limits consumer costs. |
| **Floor price** | A floor ensures a minimum support level (electricity price + premium). | A floor limits risks for investors |

Source: Own elaboration based on BMU (2011), Ragwitz et al (2007), European Commission (2008), del Río (2008, 2010), Haas et al (2004), Mendonca and Jacobs (2009), Kaldellis (2011), Kiviluoma (2010), Jones (2006), KEMA (2008), Beaudoin et al (2009), Couture et al (2010), Yatchew and Baziliauskas (2011), Lasee (2010), Rickerson et al (2007), Rickerson et al (2008), Deutsch Bank (2009), Haugwitz (2008), Pegels (2010), Nersa (2009) and Michell et al (2011).

Note: * Y = yes; N = no. ** Except hydro <10MW. Plant size usually determines support level.

FITs and FIPs have some common design elements, whereas others are FIT or FIP specific. Table 6 (above) provides a description of the main design elements in FITs/FIPs. The last col-

umn briefly discusses the pros and cons of each option, according to the assessments made in the theoretical and empirical literature.

The following table (Table 7) illustrates which design element of FITs/FIPs is applied in which country.

**Table 7 Implementation of FIT/FIP design elements in EU and non-EU countries***

| Country | | Fixed tariff (FIT) / Premium (FIP) | Techno-specific support | Link to electricity price | Costs to consumers? * | Degression | Cap / Floor | Max. plant size** | Capacity cap | Duration | Cost-containment | Reduction for existing plants |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| EU | **Bulgaria** | FIT | Y | Y | Y | N | N | N | N | 15-25 | N | N |
| | **Denmark** | FIP | Y | N | Y | N | Y (cap) | N | N | 20 | N | Y (premium is reduced after 10 years) |
| | **Germany** | FIT | Y | N | Y | Y (flexible) | N | N | N | 15-20 | Registry | N |
| | **Estonia** | FIT and FIP | N | N | Y | N | N | 100MW | N | 12 | Cap on generation eligible for support | N |
| | **Finland** | FIT | Only elect. from peat eligible | N | Y | N | N | N | N | - | Maximum annual amount of support | N |
| | **France** | FIT | Y | N | Y | Y | N | 12MW, Solar: 3kWp | N (annual cap only for solar) | 15-20 | Eligibility for PV support suspended | N |
| | **Greece** | FIT | Y | N | Y | Y | N | N | N | 20-25 | 20-25 | N |
| | **Ireland** | FIP | Y | N | Y | N | N | N | N | 15 | N | |
| | **Italy** | FIT | Y | N | Y | N | N | 1MW (0.2 MW for wind) | N | 15 | N | N |
| | **Latvia** | FIT | Y | N (link to gas prices) | Y | N | N | N (max. generation hours eligible). | N | 20 | Cap on generation eligible for support | Y (tariff decreases after 10 years for non-solar) |
| | **Lithuania** | FIT | Y | N | Y | N | N | N (max. generation hours eligible). | N | Lifetime of plant | N | N |
| | **Luxembourg** | FIT | Y | N | Y | Y | N | Biomass: 5MW, solar: 1MWp… | N | 15 | N | N |
| | **Malta** | FIT | Only solar PV eligible | N | Y | N | N | N | N | Lifetime | N | N |
| | **Netherlands** | FIP | Y | N | N (taxpayers) | N | N | N | N | 15 (12, biomass) | Total amount of subsidy (first-come-first-served) | N |
| | **Austria** | FIT | Y | N | Y | Y | N | N | N | 13 (15, biomass) | Total amount of subsidy (first-come-first-served) | N |
| | **Portugal** | FIT | Y | N | Y | N | N | Y (except wind) | N | 12-25 | N | N |

**Table 7 (continued) Implementation of FIT/FIP design elements in EU and non-EU countries***

| Country | | Fixed tariff (FIT) / Premium (FIP) | Techno-specific support | Link to electricity price | Costs to consumers? * | Degression | Cap / Floor | Max. plant size** | Capacity cap | Duration | Cost-containment | Reduction for existing plants |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| EU | **Slovakia** | FIT | Y | N | Y | Y (unless project is co-funded by the government) | N | Y | N | 15 | N | N |
| | **Slovenia** | FIT and FIP | Y | N | Y | Y (only for PV) | N | 5 MW (tariff); 125 MW (premium) | N | 15 | N | N |
| | **Spain** | FIT and FIP | Y | N | Y | N (improper degression for PV). | Y | Y | Y (solar PV, other: revisions when targets are met) | 20-28 | (*cupo* system, see text) | Y (support is reduced after 20 years) |
| | **Czech R.** | FIT and FIP | Y | N | Y | N (very simple) | N | Wind: 20 MW; solar: 30 kW | N | 20-30 | N | N |
| | **Hungary** | FIT | Y (limited disaggregation) | N | Y | N | N | N | N | Pay-off period | N | N |
| | **Cyprus** | FIP | Y | N | Y (tax on elect.) | N | N | N | N | Lifetime | N | N |
| **Non-EU** | | FIT: Ontario, Kenya | Flat FITs: California (currently), British Columbia, Ontario until 2006, and New Brunswick. | N.A. | Costs to taxpayers: South Korea | Gainesville (Florida, only for PV), Switzerland, South Korea. | Cap price: Kenya. | California (1.5 MW), Kenya (variable), Ontario (10 MW for solar, 50MW for hydro), Minnesota (20 MW, proposed). Gainesville (10kW) Vermont (2.2MW), Tanzania (10MW), Thailand (10MW). | South Korea (solar, 1300MW), California (250MW), Vermont (50MW), Gainesville (Florida, 4MW), Nova Scotia (100MW), South Africa, Kenya (wind at 150MW, biomass at 200MW and hydro at 500MW). | Vermont (5 years). 7 years: Israel and New South Wales (Australia), 7-10 years: Thailand, Western Australia (10), 15-20 years: South Korea, South Africa, Ontario, Vermont and Gainesville (Florida), | N.A. | N.A. |

Source: del Río (2011), based on BMU (2011), Ragwitz et al (2007), European Commission (2008), del Río (2008, 2010), Haas et al (2004), Mendonca and Jacobs (2009), Kaldellis (2011), Kiviluoma (2010), Jones (2006), KEMA (2008), Beaudoin et al (2009), Couture et al (2010), Yatchew and Baziliauskas (2011), Lasee (2010), Rickerson et al (2007), Rickerson et al (2008), Deutsch Bank (2009), Haugwitz (2008), Pegels (2010) and Nersa (2009).

Note: * Y = yes; N = no. ** Except hydro <10MW. Plant size usually determines support level.

### 5.3.2 Quotas with TGC schemes

**Table 8 Design elements in TGC schemes and brief assessment**

| Design element /alternative | Description | Brief assessment |
|---|---|---|
| **Target (absolute / relative)** | Under a quota with TGCs, the RES-E target may be set in either relative terms (as a percentage of electricity demand) or in absolute quantities (in TWh). | A relative quota may lead to a greater or a lower absolute amount of RES than an absolute target because the level of electricity demand can not be predicted. The predictability is lower under relative targets. Energy efficiency measures may contribute to the fulfilment of the relative target (which is not the case under an absolute target).<br>There is no unambiguously preferred alternative, but relative targets are considered for the purpose of this project, since targets in the EU have been set in relative terms, both in Directive 77/2001/EC and Directive 28/2009/EC. |
| **Banding** | Banding can be implemented through carve-outs or through credit multipliers. The former have been implemented in Italy and U.K. Carve-outs have been more common in those states in the U.S. which have implemented renewable portfolio standards (RPS). In the initial discussion of banding in the U.K. the use of carve-outs was considered but credit multipliers were finally adopted. Under carve-outs, targets for different technologies exist, leading to a fragmentation of the TGC market, with one quota for the mature and another for the non-mature technologies. Under credit multipliers, more TGCs are granted per unit of MWh generated for immature technologies compared to mature technologies.<br>The alternative to banding is no use of carve-outs or credit multipliers, such as in the Swedish and Polish TGC schemes. | Banding allows for technology diversity, which could be superior in a long-term horizon. Carve-outs may lead to narrow markets (i.e., it narrows the tradable volume within each sub-quota) if implemented for one technology in one country, but may be interesting if implemented at EU level. Credit multipliers may lead to the problem of "net neutrality". In the 2007 reform of the U.K. RO, the U.K. Department for Business, Enterprise & Regulatory Reform (BERR) decided to implement credit multipliers rather than carve-outs (Bergmann et al 2008). But no alternative is unambiguously preferred. |
| **Minimum prices** | Minimum TGC prices guaranteed to ensure a minimum level of revenue to the investors[8]. | A floor limits risks for investors and reduces financing costs. |
| **Maximum TGC prices (penalties)** | An appropriate penalty is set above the marginal costs of the marginal technology which sets the TGC price. | A maximum price (penalty) discourages non-compliance and caps the costs of support. Wiser et al. (2010) show that low penalties in some U.S. RPS has led to low effectiveness. This is a crucial design element in any quota with TGC scheme. |
| **Banking** | Banking refers to the possibility to use TGCs issued in one specific year to comply with RES-E targets in a future year. | Banking would increase flexibility and positively affect the overall efficiency of support. |
| **Borrowing** | Borrowing refers to the possibility to use the TGCs to be issued in a future year to comply with RES-E targets in a previous year. | Although borrowing would increase when flexibility, increasing the efficiency in promotion, it may also lead to chronic non-compliance problems. |

[8] In Sweden, where this minimum price is applied (also in Belgium), it has build-in declines over time and has been phase-out entirely in 2008 (Wang 2006).

**Table 8 (continued) Design elements in TGC schemes and brief assessment**

| Design element /alternative | Description | Brief assessment |
|---|---|---|
| **Guaranteed headroom** | This measure was introduced in 2009 in the U.K. RO. It was aimed at addressing the ROC price "cliff edge" problem. Instead of an annual target, the obligation for a period is set at a level based on expected renewable generation plus a further proportion (an additional 8%, or 10% from April 2011) of the ROCs expected to be issued in the relevant period (Woodman and Mitchell 2011). | The guarantee of the RO requiring more ROCs than probable generation is designed to avoid the risk of ROC prices crashing as the gap between generation and the RO target is narrowed (Woodman and Mitchell 2011). The guaranteed headroom reduces the uncertainty for investors (Woodman and Mitchell 2011, Wood and Dow 2011), but might contradict the overall principle of pre-determining the demand for RES-E and increase the complexity of designing the overall system. |
| **Destination of the proceeds from the penalty** | The proceeds from the penalty may be redistributed to the suppliers who have fulfilled their quota, such as has been the case in the U.K. or to cover administrative costs (as planned in the U.K., see Wood and Dow 2011). | Both have their pros and their cons. A redistribution to those who have fulfilled their quota is an incentive for complying. |
| **Obligated party** | Either electricity suppliers (U.K.) or generators (Italy). | In most TGC schemes electricity suppliers are the obligated party. |

Source: Own elaboration based on Ragwitz et al (2007), European Commission (2008), del Río (2008), Nielsen and Jeppesen (2003), Mendonca and Jacobs (2009), BMU (2011), Woodman and Mitchell (2011), Wood and Dow (2011) and Michell et al (2011). Note: * This measure was introduced in 2009 in the U.K. RO. It was aimed at address the ROC price "cliff edge" problem. Instead of an annual target, the obligation for a period is set at a level based on expected renewable generation plus a further proportion (an additional 8%, or 10% from April 2011) of the ROCs expected to be issued in the relevant period (Woodman and Mitchell 2011).

Table 8 (above) provides a description of the main design elements in quotas with TGC schemes. Complementary to this, the following table (Table 9) discusses which design element of quotas with TGCs is applied where in the EU.

**Table 9 Design elements of quotas with TGCs in EU countries**

| Design element | Belgium | Italy | Poland | Romania | Sweden | U.K. |
|---|---|---|---|---|---|---|
| **Target (absolute / relative)** | Relative<br>Differs per region.<br>Flanders: from 4.8% in 2009 to 13% in 2020<br>Walloon: from 3% in 2003 to 12% in 2012 (RES-E and CHP).<br>Brussels: from 2% in 2004 to 3.25% in 2012 | Relative<br>2007 to 2012: the quota increases by 0.75%.<br>Quota for 2012: 7.55%<br>From 2012 onwards, the quota will linearly decrease until becoming equal to 0 in 2015 | Relative<br>Quota goes from 10.4% in 2010 to 12.9% in 2017.<br>A new draft version of this regulation gives the following obligations for green certificates for years 2018-2020: 2018 – 13.4%, 2019 – 13.9%, 2020 – 14.4%. | Relative<br>Quota from 10% in 2011 to 20% in 2020 | Relative<br>Quota obligation per MWh of electricity sold or consumed: from 0.179 in 2011 to 0.008 in 2035 | Relative<br>Quota goes from 3% in 2003 to 12.4% in 2012. |
| **Involved technologies*** | W, S, G, BG, BM, H, W<br>Special requirements for biomass. Hydro (capacities of up to 10MW) | W, S, G, BG, H, BM | W, S, G, BG, BM, H. | W, S, G, BG, BM, H | W, S, G, BG, BM, H, WV | W, S, BG, BM, G, H |
| **Definition of TGCs** | 1 MWh | 1 MWh | 1 MWh | 1 MWh | 1 MWh | 1 MWh |
| **Area of application** | Only electricity generated in Belgium is eligible for support. However, the grid operators may satisfy their quota obligation by presenting TGCs for electricity generated outside Belgium, if these were issued under conditions similar to the conditions applied in Belgium and mutual recognition is basically possible | N.A. | The Act does not stipulate that certificates can be traded on an international basis. | Certificates may be traded on the international market only if the applicable national quota for green certificates has been met | Currently, the electricity certificates system applies only to electricity produced in Sweden. However, Norway and Sweden have agreed on a joint green certificates market from 1 January 2012 onwards. | N.A. |
| **Credit multipliers** | No | Yes (since 2008). W (Off) x 2 | No | No (credit multipliers pending EC approval) | No | Yes (sine 2009) |
| **Carve-outs** | No | No | No | No | No | No |
| **Minimum prices** | Minimum payment, differentiated per technology<br>System operators are obliged to purchase certificates from producers for the established minimum price. | <10MW,<br>-Collection by GSE (the body in charge of supporting RES)<br>-Prices defined by AEEG as hourly zonal prices increased by standard losses<br>-Minimum prices guaranteed for the initial 2000 MWh for plants under 1MW. | No | Yes. During the years 2008-2025 the transaction value of a green certificate will be at least 27 Euros | No | No |

**Table 9 (continued) Design elements of quotas with TGCs in EU countries**

| Design element | Belgium | Italy | Poland | Romania | Sweden | U.K. |
|---|---|---|---|---|---|---|
| **Maximum TGC prices (penalties). Buy-out price** | 125 €/MWh in Flanders and 100 €/MWh in Brussels and Walloon. | Sanctions have not been specified and remain undefined*. | Yes. Penalty is 130% of "substitution fee", which might be paid instead of handing TGCs.<br>2010 penalty: 90.2€/MWh | Maximum price: During the years 2008-2025 the transaction value of a green certificate will be at maximum 55€.<br>Penalty: if a supplier fails to meet the annual quota, he will be obliged to purchase the missing certificates at a higher price of 110€ each | 150% of the weighed, average certificate value during the applicable obligation period | On 1 April 2009, the buy-out price was set at 37.19 GBP per MWh. Each year, this buy-out price rises or decreases with the retail price index. For the period 2011-2012, the buy-out price was set at 38.69 GBP per MWh.<br>If a supplier fails to satisfy his quota obligation, he shall make a "late payment". The late payment is the sum of the buy-out price plus interest of 5 percentage points above the base rate of the Bank of England |
| **Banking.** | Yes (within the year). In Flanders, TGCs are issued monthly and should be submitted once a year, whereas the Walloon system is based on quarters. | Yes. Banking of TGC is allowed for 3 years. | Yes, unlimited | No?? | Yes | Yes, allowed for one year. In any year, banked ROCs can only be used to meet a maximum of 25% of a supplier's obligation. |
| **Borrowing.** | No | No | No | No | No | No |
| **Size limits** | Hydro <10 MW | No, but different treatment (<10MW, > 10MW) | Not applicable | Hydro < 10 MW | Hydro < 1.5MW | > 5MW. From April 2010, plants under 50kW will no longer qualify for support under the RO, but are instead eligible for support under the recently introduced FIT scheme (see below). Maximum size limits are in place for specific technologies. |
| **Existing plants eligible** | Yes | No | Yes | Yes | Yes. Existing power plants were included in the system from the start. Since the 2006 revision, however, the support period for these plants is limited to 2012 or 2014. | No (in general) |

**Table 9 (continued) Design elements of quotas with TGCs in EU countries**

| Design element | Belgium | Italy | Poland | Romania | Sweden | U.K. |
|---|---|---|---|---|---|---|
| **Guaranteed headroom or price-regulation mechanism** | No | Yes ** | No | Yes*** | No | Yes. The targets were originally based on a "headroom" of 8% up to 2015/16. The headroom was increased to 10% in April 2011 following concerns that RES-E will meet the RO targets before 2015/16, resulting in the ROC price crashing. Targets will therefore now be set on an annual basis prior to the start of the obligation period. |
| **Duration of support** | 10 years (exc. solar PV and wind off-shore in Flanders, 20 years). | 15 years (12 for plants commissioned before 2008). Initially: 8 years | Lifetime | Lifetime | 15 years or 2035 | 20 years (projects accredited under the RO before 26 June 2008 will receive ROCs until 2027 at the latest (or project end date) |
| **Destination of the proceeds from the penalty.** | Not applicable | Not applicable | Funds from substitution fees constitute an revenue for the National Fund for Environmental Protection and Water Management that only supports RES development. | The penalties are allocated to Grid Operators, DSO and TSO. | Not applicable | The regulatory authorities collect the buy-out payments in a fund and then distribute it amongst all electricity suppliers that have satisfied their quota obligation. The proportion a supplier receives bears to the number of his ROCs. In addition, the buy-out payments are used to fund administration costs. |
| **Obligated party** | Electricity suppliers | Producers and importers of electricity(≥100GWh) | electricity generators and suppliers | Electricity suppliers | Electricity suppliers | Electricity suppliers |
| **Funding** | Electricity consumers | Electricity consumers | Electricity consumers | Electricity consumers | Electricity consumers | Electricity consumers |

Source: BMU (2011), Teckenburg et al (2011), Verhaegen et al (2009), Nielsen and Jeppesen (2003), Heinzel and Winkler (2010), Woodman and Mitchell (2011), Wood and Dow (2011), Allan et al (2011), Mitchell et al (2011).

Notes: * W= wind, H = hydro; BG = biogas, BM = biomass; G = geothermal, S = solar, WV = wave.

### 5.3.3 Tendering

Several design elements specific for tendering are worth considering, see Table 10.

**Table 10 Design elements in tendering schemes and brief assessment**

| Design element /alternative | Description | Brief assessment |
|---|---|---|
| **Aim** | Tenders may be used either to grant procurement rights or to set support levels. In both cases tenders may be combined with FITs/FIPs. | No unambiguously preferred alternative. |
| **Organisation of the tender** | There are several alternatives to organize the tendering procedure, including descending-clock and sealed-bid | Both alternatives have advantages. |
| **Deposit/guarantee /Penalty for non-compliance** | Winners of the bidding procedure who fail to deploy the project have to pay a penalty. | This mitigates the risk of not deploying the project after the bidding procedure. |
| **Deadlines for building the project** | Another alternative to discourage non-compliance is to have deadlines for building the project. | This would be more effective if combined with penalties for non-compliance. |
| **Timing of tendering rounds** | Regularly scheduled tendering rounds vs. intermittent, unscheduled tendering rounds. | Intermittent rounds lead to stop-and-go deployment. |
| **Bands** | A single band may be implemented for all technologies or there might be technology-specific bands. | Technology-specific bands promote technological diversity. |
| **Recycling of penalties** | Proceeds may be recycled to successful project developers, to cover administrative costs or another alternative | There is no unambiguously preferred alternative. |

Source: Own elaboration.

The following table (Table 11) discusses which design element of tendering is (or was) applied where in the EU or elsewhere.

**Table 11 Design elements of tendering in EU countries**

| Country | Aim | Organisation | Penalty | Deadline | Timing | Band | Recycling | Remarks |
|---|---|---|---|---|---|---|---|---|
| **Ireland (AER)** | Tender to set support level | Pay as bid | No | Not applicable | Not applicable | Yes | Not applicable | Ceased to be operational in 2002 |
| **U.K. (NFFO)** | Tender to set support level | Strike price until 3rd round. Pay-as-bid since. | No | Grace period in NFFO 5 | 1990, 1991, 1994, 1997, 1998 | Yes | Not applicable | Ceased to be operational in 2006 |
| **France (EOLE)** | Tender to set support level | Pay-as-bid | Not applicable | Not applicable | Not applicable | Only wind initially, other RES>12MW since 2000 | Not applicable | Ceased to be operational in 2006 |
| **France (PPI)** | Tender to set support level | Strike price | Yes | Yes | Not applicable | Yes | Not applicable | |
| **Denmark** | Tender to grant procurement rights | Pay-as-bid | Yes | Yes | Long-term plan for the targeted capacity increase | Only off-shore | Not applicable | |
| **Italy** | Tender to set support level | Not applicable | Not applicable | Not applicable | Periodical tenders | Yes | Not applicable | Operational since 2013 |
| **Latvia** | Tender to grant procurement rights | FIT | Not applicable | Not applicable | Periodical tenders (annual) | Yes | Not applicable | |
| **Lithuania** | Tender to set support level | Pay-as-bid | Not applicable | Not applicable | Not applicable | Yes | Not applicable | |
| **The Netherlands** | Tender to set support level | Pay-as-bid to receive the subsidy. | Yes | Yes | Not applicable | Offshore | Not applicable | The support provided for the winners is fixed in the budget, the best offers (cost per kWh) are granted subsidy until the budget is gone. |
| **Portugal** | Support levels (wind and biomass 200-2008)<br>Procurement rights (solar PV and small hydro). | Not applicable | Not applicable | Not applicable | Not applicable | Not applicable | Not applicable | |

Source. Own elaboration from Teckenbourg et al (2011), Ruokonen (2010), Gipe (2006) ADEME (2001), Menanteau et al (2002), Finucane (2005), Mitchell et al (2006), Mitchel and O´Connor (2004).

## 5.4 Concluding remarks

Not all those design elements have the same degree of relevance for the purposes of this study. In TGCs, a crucial distinction is between uniform quotas and banding (through carve-outs or credit multipliers). In FITs, a similar distinction is between uniform FITs (technology-neutrality within renewable energy technologies) and technology-specific FITs (allowing for the deployment of different technologies). An even more crucial choice in FITs is between fixed tariffs and premiums. Accordingly, these design elements provide the justification for the initial and main distinction between pathways (see next section).

On the other hand, the poor assessment of some design options rules out their use. For instance, this is the case with support linked to the electricity price in FIT schemes or with borrowing in TGC schemes. Therefore, these alternatives should not be considered in the pathways. On the other side of the spectrum, there are some design options which are crucial, such as penalties in quotas with TGC schemes. In the middle, these are also alternatives for which no unambiguous score on its assessment can be given and/or which may be relevant on a national context but not so much in an international one. Simulations with different possibilities may give insight on their final relevance. In addition, the multi-criteria assessment carried out in WP6 will tell whether or not these are so relevant for different stakeholders.

# 6 Policy pathways

Combining the degrees of harmonisation with the instruments leads to several policy paths for a harmonisation of RES(-E) support in Europe. Banded and unbanded TGCs, premium and fixed FITs are currently widespread instruments in the EU MS. Tendering schemes are not widespread, but there is a trend in some countries to use them for large scale RES projects. Unbanded TGCs were initially adopted in the U.K. and Italy but concerns about the lack of incentives for the deployment of less mature technologies led to a shift to banded TGCs. Unbanded TGCs are still present in Belgium, Poland, Romania and Sweden. A uniform quota is still proposed by those arguing in favour of inter-technology competition (i.e., competition between different renewable energy technologies to meet the target, even if this means technologies with different maturity levels). However, it is widely acknowledged that this technology neutrality would involve the dominance of mature technologies without allowing immature technologies to penetrate the market. Since the costs of immature technologies (partly) depend on their diffusion, this would mean that their costs would make them unattractive for adoption since these technologies will be needed in the future to comply with RES-E (and $CO_2$) targets cost-effectively, their advancement along their learning curve (through diffusion) is required, which calls for technological diversity and, thus, justifies a banded TGC.

These policy paths are defined in more detail below. Taking into account the aforementioned policy paths and the design elements, their combination may lead to several alternatives for the design of the pathway. In this section we consider the possible combinations in greater depth. Recall that the aim of this inception phase is not to propose one precise design of each policy instrument, but to open the spread of feasible design options for the later impact assessment.

Accordingly, 15 policy pathways are proposed, taking into account the main RES-E support instruments (TGCs, FITs and tendering), their main design elements and different degrees of harmonisation. Within those policy packages, further choices have to be made regarding some relevant design elements and the role of MS. The following table summarises the pathways considered in this project. The rest of this section provides further details on each pathway.

**Table 12 Overview on proposed policy pathways**

| *Instrument* | | **FIT** *Fixed (Feed-in) tariff* | **FIP** *Feed-in premium* | **QUO** *Quota with TGC* | **QUO** banding *Quota with banded TGC* | **ETS** *(no dedicated support for RES)* | **TEN** *Tendering for large-scale RES* | **Reference** *(national RES support)* |
|---|---|---|---|---|---|---|---|---|
| *Degree of harmonisation* | *Characterisation* | | | | | | | |
| **Full** | • One instrument<br>• EU target<br>• Burden sharing Yes / No | 1a | 2a | 3a | 4a | 5 | 6<br>Sensitivity to 7 (national support, but harmonisation for selected technologies) | 7<br>• National targets<br>• Co-operation mechanism: w/o increased cooperation<br>• w/o minimum design standards for support instruments (i.e. with minimum design standards represents a case of **Minimum Harmonisation**) |
| **Medium** | • EU target<br>• One instrument<br>• Additional (limited) support allowed | 1b | 2b | 3b | 4b | | | |
| **Soft** | • National targets<br>• One instrument<br>• MS can decide on various design elements incl. support levels | 1c | 2c | 3c | 4c | | | |

## 6.1 Pathway 1a: Fixed (feed-in) Tariff in the case of full harmonisation

### 6.1.1 Main features (brief description)

In this pathway, an EU-wide instrument is applied based on fixed-tariffs, with a support level set at EU level. Tariffs can be technology-specific or a single support level may be set for all technologies. In both cases they are set in a manner which allows the achievement of the EU target. There are no national targets and the leeway for Member States to decide on design elements is extremely limited.

Main choices in this pathway are taken at the EU level and mostly refer to the design elements of the fixed-tariff instrument (see below). Agreement between the different Member States concerning the sharing of the financial burden may or may not be reached. Finally, the use of cooperation mechanisms is ruled out (given the existence of an EU-wide support space and the lack of national targets). This is so except for article 9 cooperation mechanisms (joint projects with third countries). These can be carried out in order to comply with the EU target as long as the renewable electricity generated in the third country is consumed in the Community.

### 6.1.2 Design choices

Relevant decisions in this regard can be grouped in three categories. Some design choices are common to other instruments, whereby other design elements are common to both fixed-premiums (pathway 2) and fixed tariffs (pathway 1) and, yet, others are specific to fixed-tariffs.

#### *Design choices common to other instruments.*

- Duration of support.
- Plant size limits.
- Financial burden falling either on consumers or taxpayers.
- Technologies eligible for support.
- Flow of support (greater support in the first years vs. constant support over time).
- Stepped 1: size-specific support level.
- Stepped 2: location-specific support level.
- Technology-specific support.

Regarding these design choices, we rule out two options: 1) that support is provided to existing plants (since the aim of the support scheme is to encourage new capacities); 2) that plants in a country are eligible for support in another country, since this does not seem to be a realistic option, given that the benefits and costs of renewable energy are local, i.e., it would not be politically feasible to incur the costs without also having the benefits of promotion (only in the soft and minimum harmonisation options, one exception being the cooperation mechanisms).

#### *Design choices common to fixed-premiums*

- Cost-containment mechanisms (generation-based support, cap on technology deployment (capacity) eligible for support and cap on total support costs).
- Support adjustments (periodic revisions; degression; cap-based adjustments).
- Purchase obligation.
- Forecast obligation.

In this case, we rule out one design option (support tied to electricity prices), since it has clearly been shown to be worst-in-class.

*Design choices specific to fixed-tariffs.*

- Demand orientation

**Template 1. (Pathway 1a) Fixed (feed-in) Tariff in the case of full harmonisation**

| Design choices common to other instruments | | | | | | | | Design choices common to fixed-premiums | | | | Design choices specific to fixed tariffs | Burden sharing | Art. 9 coop. mech. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Duration of support** | **Plant size limits** | **Financing actors** | **Technologies eligible for support** | **Flow of support** | **Size-specific support level** | **Location-specific support level** | **Technology-specific support** | **Support level adjustments**** | **Cost-containment*** | **Purchase obligation** | **Forecast. obligation** | **Demand orientation** | | |
| 20-16 years<br><br>15-11 years<br><br>≤ 10 years | Y<br><br>N | Consumers<br><br>Taxpayers | Current RES-E Directive<br><br>Other | Constant<br><br>Decreasing | Y<br><br>N | Y<br><br>N | Y (technol-ogy-specific tariffs)<br><br>N (single tariff) | PR<br><br>D<br><br>C | GEN<br><br>CAP CAP<br><br>CAP COST | Y<br><br>N | Y<br><br>N | Y<br><br>N | Y<br><br>N | Y<br><br>N |

Abbreviations:

Y = Yes; N = No

* GEN = Generation-based support; CAP-CAP = Cap on technology deployment eligible for support; CAP-COST = Cap on total support costs.

** PR = Periodic revisions; D = Degression; C=Cap-based adjustments.

## 6.2 Pathway 2a: Fixed (feed-in) Premium in the case of full harmonisation

### 6.2.1 Main features (brief description)

In this pathway, an EU-wide instrument is applied based on fixed premiums, with a support level set at EU level. Premiums can be technology-specific or a single premium may be set for all technologies. In both cases they are set in a manner which allows the achievement of the EU target. There are no national targets and the leeway for Member States to decide on design elements is extremely limited.

Main choices in this pathway are taken at the EU level and mostly refer to the design elements of the fixed-premium instrument (see below). Agreement between the different Member States concerning the sharing of the financial burden may or may not be reached. Finally, the use of cooperation mechanisms is ruled out (given the existence of an EU-wide support space and the lack of national targets). This is so except for article 9 cooperation mechanisms (joint projects with third countries). These can be carried out in order to comply with the EU target as long as the renewable electricity generated in the third country is consumed in the Community.

### 6.2.2 Design choices

Relevant decisions in this regard can be grouped in three categories. Some design choices are common to other instruments, whereby other design elements are common to both fixed-premiums (pathway 2) and fixed tariffs (pathway 1) and, yet, others are specific to fixed-premiums.

#### *Design choices common to other instruments.*

- Duration of support
- Plant size limits
- Financial burden falling either on consumers or taxpayers
- Technologies eligible for support
- Flow of support (greater support in the first years vs. constant support over time)
- Stepped 1: size-specific support level
- Stepped 2: location-specific support level
- Technology-specific support

#### *Design choices common to fixed-tariffs*

- Premium adjustments (periodic revisions; degression; cap-based adjustments)
- Cost-containment mechanisms (generation-based support, cap on technology deployment (capacity) eligible for support and cap on total support costs)

#### *Design choices specific to fixed-premiums.*

- Cap
- Floor

**Template 2. (Pathway 2a) Fixed (feed-in) Premium in the case of full harmonisation**

| Design choices common to other instruments | | | | | | | | Design choices common to fixed-tariffs | | Design choices specific to fixed premium | | Burden sharing | Art. 9 coop. mech. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Duration of support** | **Plant size limits** | **Financing actors** | **Technologies eligible for support** | **Flow of support** | **Size-specific support level** | **Location-specific support level** | **Technology-specific support** | **Support level adjustments**** | **Cost-containment*** | **Cap** | **Floor** | | |
| 20-16 years<br>15-11 years<br>≤ 10 years | Y<br>N | Consumers<br>Taxpayers | Current RES-E Directive<br>Other | Constant<br>Decreasing | Y<br>N | Y<br>N | Y (technology-specific premiums)<br>N (single premium) | PR<br>D<br>C | GEN<br>CAP CAP<br>CAP COST | Y<br>N | Y<br>N | Y<br>N | Y<br>N |

Abbreviations:

Y = Yes; N = No

* GEN = Generation-based support; CAP-CAP = Cap on technology deployment eligible for support; CAP-COST = Cap on total support costs.

** PR = Periodic revisions; D = Degression; C=Cap-based adjustments.

## 6.3 Pathway 3a: Quota with tradable green certificates (without banding) in the case of full harmonisation

### 6.3.1 Main features (brief description)

Initially, TGC schemes were implemented in a technological-neutral manner, since this was deemed one of the main features (and advantages) of the scheme, avoiding winner-picking. Unbanded TGCs mean that one TGC is granted per MWh of RES-E generation, regardless of the technological maturity and costs of the renewable energy generation technology.

In this pathway, an EU-wide instrument is applied based on a quota with TGCs, but without banding, i.e., no special treatment for higher costs or immature technologies is implemented in the form of credit multipliers or carve-outs. Thus, one TGC is granted per MWh of RES-E generation, regardless of the technological maturity and costs of the renewable energy generation technology. The interaction of the supply and demand (EU target/quota) sides in the TGC market leads to an EU-wide TGC price, which is the same for all technologies and countries and which allows the achievement of the EU target. There are no national targets and the leeway for Member States to decide on design elements is extremely limited.

Main choices in this pathway are taken at the EU level and mostly refer to the design elements of the TGC instrument (see below). Agreement between the MS concerning the sharing of the financial burden may or may not be reached. Finally, the use of cooperation mechanisms is ruled out (given the existence of an EU-wide support space and the lack of national targets). This is so except for article 9 cooperation mechanisms (joint projects with third countries). These can be carried out in order to comply with the EU target as long as the renewable electricity generated in the third country is consumed in the Community.

### 6.3.2 Design choices

Relevant decisions in this regard can be grouped in two categories. Some design choices are common to other instruments, whereby other design elements specific to quotas with TGCs. Unbanded quota with TGCs is a more general case of banded-TGC schemes in that all design elements of unbanded TGC are common to both pathways but, in contrast to the banded TGC pathway, in the unbanded quota with TGCs pathway there are neither credit multipliers nor carve-outs.

There are some design elements for which we do not consider a choice between alternatives. These are relative quota (vs. an absolute quota), existence of a penalty (vs. non-existence) and no borrowing. In the EU context, given that RES-E targets are defined in relative terms in the RES Directive, absolute targets are not relevant. On the other hand, the existence of penalties is a sine-qua-non for the appropriate functioning of the scheme, as clearly shown by the empirical literature. There is virtually no quota with TGC scheme in the world where penalties are absent. Finally, although borrowing is a theoretical alternative, and one with advantages in terms of “when” flexibility for fulfilling targets, it seems too problematic regarding the effectiveness criteria. Furthermore, no TGC scheme in the world has implemented this design option.

#### *Design choices common to other instruments.*

- Duration of support
- Plant size limits
- Financial burden falling either on consumers or taxpayers
- Technologies eligible for support

## *Design choices common to banded quota with TGC scheme*

- Minimum TGC prices
- Banking
- Guaranteed headroom
- Recycling of proceeds from the penalty. Two alternatives are possible: proceeds may be given back to suppliers or they may be used to cover administrative costs).

**Template 3.** **(Pathway 3a) Quota with tradable green certificates (without banding) in the case of full harmonisation**

| Design choices common to other instruments | | | | Design choices common to banded TGCs | | | | Burden sharing | Art. 9 coop. mech. |
|---|---|---|---|---|---|---|---|---|---|
| **Duration of support** | **Plant size limits** | **Financing actors** | **Technologies eligible for support** | **Minimum TGC prices** | **Banking** | **Guaranteed headroom** | **Distribution of proceeds from penalty** | | |
| 20-16 years | Y | Consumers | Current RES-E Directive | Y | Y | Y | Suppliers | Y | Y |
| 15-11 years | N | Taxpayers | Other | N | N | N | Administrative costs | N | N |
| ≤ 10 years | | | | | | | | | |

Abbreviations:
Y = Yes; N = No

## 6.4 Pathway 4a: Quota with banding and tradable green certificates in the case of full harmonisation

### 6.4.1 Main features (brief description)

In this pathway, an EU-wide instrument is applied based on a quota with tradable green certificates, but with banding, i.e., higher costs or immature technologies receive a special treatment (greater support) in the form of credit multipliers or carve-outs. Under credit multipliers, there would be a single TGC price in the EU for all technologies, although the more expensive, most immature technologies, receive more TGCs per MWh of electricity generated. Under carve-outs, there would be several EU-wide TGC markets (one per technology) and, thus, different TGC prices depending on the technology. In both cases, the EU-wide target would be achieved, although it is more difficult with credit multipliers, since the amount of RES-E does not coincide with the number of TGCs in the market and this can not be predicted a priori, since it depends on the reaction of market actors.

Still, there are no national targets and the leeway for Member States to decide on design elements is extremely limited. As in pathway number 3, main choices in this pathway are taken at the EU level and mostly refer to the design elements of the TGC instrument (see below). Furthermore, agreement on the number of TGCs granted to each technology (credit multipliers) and the quotas given to each technology (carve-outs) should be reached.

Agreement between the MS concerning the sharing of the financial burden may or may not be reached. Finally, the use of cooperation mechanisms is ruled out (given the existence of an EU-wide support space and the lack of national targets). This is so except for article 9 cooperation mechanisms (joint projects with third countries). These can be carried out in order to comply with the EU target as long as the renewable electricity generated in the third country is consumed in the Community.

### 6.4.2 Design choices

Relevant decisions in this regard can be grouped in three categories. Some design choices are common to other instruments, whereby other design elements are common to banded quotas with TGC schemes and, yet, others are specific to banded-TGC schemes.

#### *Design choices common to other instruments.*

- Duration of support.
- Plant size limits.
- Financial burden falling either on consumers or taxpayers.
- Technologies eligible for support.
- Flow of support (greater support in the first years vs. constant support over time).
- Stepped 1: size-specific support level.
- Stepped 2: location-specific support level

#### *Design choices common to unbanded quota with TGC scheme*

- Minimum TGC prices.
- Banking.
- Guaranteed headroom.
- Recycling of proceeds from the penalty (given back to suppliers or to cover administrative costs).

### *Design choices specific to banded quota with TGC scheme (mutually exclusive)*

- Implementation of credit multipliers.
- Implementation of carve-outs.

**Template 4.** **(Pathway 4a) Quota with banding and tradable green certificates in the case of full harmonisation**

| Design choices common to other instruments | | | | | | | Design choices common to banded TGCs | | | | Design choices specific to banded TGCs | | Burden sharing | Art. 9 coop. mech. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Duration of support** | **Plant size limits** | **Financing actors** | **Technologies eligible for support** | **Flow of support** | **Size-specific support level** | **Location-specific support level** | **Minimum TGC prices** | **Banking** | **Guaranteed headroom** | **Dist. of pro-ceeds from penalty** | **Credit multipliers** | **Carve-outs** | | |
| 20-16 years | Y | Consumers | Current RES-E Directive | Constant | Y | Y | Y | Y | Y | Suppliers | Y | Y | Y | Y |
| 15-11 years | N | Taxpayers | Other | Decreasing | N | N | N | N | N | Administrative costs | N | N | N | N |
| ≤ 10 years | | | | | | | | | | | | | | |

Abbreviations:
Y = Yes; N = No

## 6.5 Pathway 5: ETS only – no dedicated support for RES

The EU ETS pathway is a (very unrealistic) sort of "reference scenario" in which there is no RES-E support and renewable electricity generation technologies are only promoted through the impact of the carbon prices stemming from the EU ETS, which could have some impact on the more mature technologies (i.e., wind on-shore) but it is unlikely to positively affect the immature technologies. This scenario involves some assumptions about how the EU ETS will develop after 2020. Although it is relatively clear that the EU ETS will continue after 2020, it is highly uncertain what the targets and the specific design of the instrument will be. Beyond the fact that allowances will be auctioned to the electricity sector, little is known. This means that carbon prices in such circumstances are highly uncertain which, in turn, also means that the impact of the EU ETS on renewable electricity is also difficult to foretell beyond 2020. The Energy Roadmap 2050, based on modelling work with the PRIMES model, provides some useful hints, however, in the 2050 horizon (including the level of carbon prices, which will be used to build this pathway[9]. In addition, the publication EU energy trends to 2030 will be considered.

[9] In this document, carbon prices start increasing from around 50€/tCO2 to between 50€ and more than 300€, depending on the scenario.

## 6.6 Pathway 6: Tendering for large scale RES (in the case of national RES support)

### 6.6.1 Main features (brief description)

Under this pathway, an EU-wide tendering scheme for large scale RES (i.e., above a given size threshold) coexists with national support schemes for the rest of project sizes (i.e., below the threshold). The tendering scheme is assumed to be technology-specific. Bidding leads to competition among bidders resulting in a (low) bid price. A centralised EU bidding procedure is organized, whereby bidders bid for locations all over Europe (€/MWh). Sites might be pre-approved by national authorities. The amount of capacity provided for bidding is compatible with the attainment of the EU target (which is not based on capacity, but on share), but the share of the EU target which is met by large projects has to be decided. Again, there are no national targets and the leeway for Member States to decide on design elements is extremely limited.

Main choices in this pathway are taken at the EU level and mostly refer to the design elements of the instrument (see below). Agreement between the different Member States concerning the sharing of the financial burden may or may not be reached. Finally, the use of cooperation mechanisms is ruled out (given the existence of an EU-wide support space and the lack of national targets). This is so except for article 9 cooperation mechanisms (joint projects with third countries). These can be carried out in order to comply with the EU target as long as the renewable electricity generated in the third country is consumed in the Community.

### 6.6.2 Design choices

Relevant decisions in this regard can be grouped in three categories. Some design choices are common to other instruments, whereby other design elements are specific to tendering.

#### *Design choices common to other instruments*

The design elements which have been implemented in previous instruments can also been implemented here:

- Duration of support
- Plant size limits
- Financial burden falling either on consumers or taxpayers
- Technologies eligible for support
- Flow of support (greater support in the first years vs. constant support over time)
- Technology-specific support (technology bands vs. no bands)

However, size-specific support is not relevant here, since, by definition, this instrument applies only for large projects. Location-specific support (additional to the level provided by the bidding procedure) is deemed trivial, since it would be internalised by bidders in their bids. The effective and efficient functioning of the instrument would be favoured by the pre-approval of sites at the MS level.

#### *Design choices specific to tendering*

- Organisation of the tender (descending-clock, sealed-bid, other)
- Deposit/guarantees/Penalty for non-compliance
- Regularly scheduled tendering rounds (vs. intermittent, unscheduled tendering rounds).
- Deadlines for building the project
- Proceeds may be recycled to successful project developers, to cover administrative costs or another alternative

**Template 5. (Pathway 6) Tendering for large scale RES (in the case of national RES support)**

| Design choices common to other instruments | | | | | | Design choices tendering-specific | | | | | Burden sharing | Art. 9 coop. mech. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Duration of support** | **Plant size limits** | **Financing actors** | **Technologies eligible for support** | **Flow of support** | **Technology-specific support** | **Organisation of the tender** | **Deposit/ guarantee/ penalty** | **Timing of tendering rounds** | **Deadlines** | **Recycling of proceeds** | | |
| 20-16 years<br>15-11 years<br>≤ 10 years | Y<br>N | Consumers<br>Taxpayers | Current RES-E Directive<br>Other | Constant<br>Decreasing | Bands<br>No bands | Descending clock<br>Sealed-bid<br>Other | Y<br>N | Regularly scheduled<br>Intermittent, unscheduled | Y<br>N | Back to suppliers<br>Administrative costs<br>Other | Y<br>N | Y<br>N |

Abbreviations:
Y = Yes; N = No

## 6.7 Pathway 7: Reference case – strengthened national RES support

This case is one of having strengthened national RES support with cooperation between MSs. In general there are national targets and there is no harmonisation of either framework conditions or design elements beyond those already harmonised by the current RES Directive. One variant under this policy pathway may however include the use of minimum design standards for RES support instruments. This would represent a case of *minimum harmonization* – i.e. where the choice on the support instruments is left to the MSs but minimum design standards need to be respected.

This pathway will serve as reference for the assessment of harmonization options. The rationale behind this pathway lies also on previous findings that some harmonization options may not result in an increase of (economic) efficiency but that significant efficiency gains can be already achieved by strengthening the existing national policies. (Resch et al 2007). In other words, improving existing support schemes may provide greater efficiency gains than harmonisation. Cooperation mechanisms (all types) may be used by MS, as it is currently the case. The use of such mechanisms may however either be strong or weak.

## 6.8 Pathway 1b & 1c: Fixed (feed-in) tariff (FIT) in the case of medium / soft harmonisation

There are two possibilities here. Either (technology-specific) support levels are set by the EU, with additional support granted by the MS for specific technologies (medium scenario) or it is the MS who sets these levels (soft scenario).

- *Medium harmonisation:* In this case, there are no national targets. The FIT pathway under the Medium harmonisation remains quite similar to the Full harmonisation option (pathway 1a). The design elements are the same. The difference is that, since the deployment of renewable energy technologies is expected to bring several local benefits, Member States may provide support for specific technologies which is additional (albeit limited) to the minimum level set by the EU, i.e., a "national tranche" of the support for specific technologies is defined. This may lead to RES-E generation higher than the EU target. In order to avoid this (or at least mitigate it), the EU target could be set interactively, taking into account the amount of RES-E generation that countries expect (would like) to support.
- *Soft harmonisation:* In Soft harmonisation, and in contrast to Full or Medium harmonisation, there are national RES targets in addition to the EU target. These targets are consistent with the EU target, i.e., the addition of these targets leads to the EU target, as it is now the case with the RES Directive. Still, there is only one instrument (FIT). MS may define their national targets and may set the support levels to reach those targets (with a FIT). The design elements are the same than under pathway 1, but the difference now is that it is both the EU and MS who decide on those design elements. There are different design choices but decision on this is taken at EU level. MS may also provide additional support. This would make some countries exceed their targets. As long as there are national targets and different support levels across countries, there is a role to be played by art. 7 and 11 cooperation mechanisms, in addition to art. 9.

  Whereas in *medium harmonisation*, the EU decides on all design elements, in the case of *soft harmonisation*, MSs have some leeway to define some design elements, while other key design elements, which may lead to distortions across countries if defined differently, are set at EU level. In particular, although not necessarily, EU and MS may decide on the following design elements:

  - EU: Duration of support, financing actors, technologies eligible for support, technology-specific support, purchase obligation.
  - MS: Plant size limits, support levels over plant lifetime, size-specific support level, location-specific support level, cost-containment, forecast obligate, demand orientation, tariff adjustments.

**Template 6.** **(Pathway 1b) Fixed (feed-in) Tariff in the case of medium harmonisation**

| Design choices common to other instruments | | | | | | | | Design choices common to fixed-premiums | | | | Design choices specific to fixed tariffs | Burden sharing | Art. 9 coop. mech. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Duration of support** | **Plant size limits** | **Financing actors** | **Technologies eligible for support** | **Flow of support** | **Size-specific support level** | **Location-specific support level** | **Technology-specific support** | **Support level adjustments**** | **Cost-containment*** | **Purchase obligation** | **Forecasting obligation** | **Demand orientation** | | |
| 20-16 years<br><br>15-11 years<br><br>≤ 10 years | Y<br><br>N | Consumers<br><br>Taxpayers | Current RES-E Directive<br><br>Other | Constant<br><br>Decreasing | Y<br><br>N | Y<br><br>N | Y (technology-specific tariffs)<br><br>N (single tariff) | PR<br><br>D<br><br>C | GEN<br><br>CAP CAP<br><br>CAP COST | Y<br><br>N | Y<br><br>N | Y<br><br>N | Y<br><br>N | Y<br><br>N |

Abbreviations:

Y = Yes; N = No

* GEN = Generation-based support; CAP-CAP = Cap on technology deployment eligible for support; CAP-COST = Cap on total support costs.

** PR = Periodic revisions; D = Degression; C=Cap-based adjustments.

**Template 7.** **(Pathway 1c) Fixed (feed-in) Tariff in the case of soft harmonisation**

| Design choices common to other instruments | | | | | | | | Design choices common to fixed-premiums | | | | Design choices specific to fixed tariffs | Burden sharing | Coop. mech. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Duration of support** | **Plant size limits** | **Financing actors** | **Technologies eligible for support** | **Flow of support** | **Size-specific support level** | **Location-specific support level** | **Technology-specific support** | **Support level adjust-ments**** | **Cost-containment*** | **Purchase obliga-tion** | **Forecast. obligation** | **Demand orientation** | | |
| 20-16 years<br><br>15-11 year<br><br>≤ 10 years | Y<br><br>N | Consumers<br><br>Taxpayers | Current RES-E Directive<br><br>Other | Constant<br><br>Decreasing | Y<br><br>N | Y<br><br>N | Y (technol-ogy-specific tariffs)<br><br>N (single tariff) | PR<br><br>D<br><br>C | GEN<br><br>CAP CAP<br><br>CAP COST | Y<br><br>N | Y<br><br>N | Y<br><br>N | Y<br><br>N | Art. 7<br><br>Art . 9<br><br>Art 11 |

Abbreviations:

Y = Yes; N = No

* GEN = Generation-based support; CAP-CAP = Cap on technology deployment eligible for support; CAP-COST = Cap on total support costs.

** PR = Periodic revisions; D = Degression; C=Cap-based adjustments.

## 6.9 Pathway 2b & 2c: Fixed (feed-in) Premium in the case of medium / soft harmonisation

Similar to fixed feed-in tariffs, there are two possibilities for feed-in premiums: Either (technology-specific) premiums are set by the EU, with additional support granted by the MS for specific technologies (medium scenario) or it is the MS who sets these levels (soft scenario).

- *Medium harmonisation:* In this case, and similarly to the case of a fixed feed-in tariff, all decisions with respect to the design elements are taken at EU level.
- *Soft harmonisation:* Although not necessarily, EU and MS may decide on the following design elements:
  - EU: Duration of support, financing actors, technologies eligible for support, technology-specific support,
  - MS: Plant size limits, flow of support, size-specific support level, location-specific support level, cost-containment, tarif adjustments, cap and floor.

**Template 8.** **(Pathway 2b) Fixed (feed-in) Premium in the case of medium harmonisation**

| Design choices common to other instruments | | | | | | | | Design choices common to fixed-tariffs | | Design choices specific to fixed premium | | Burden sharing | Art. 9 coop. mech. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Duration of support** | **Plant size limits** | **Financing actors** | **Technologies eligible for support** | **Flow of support** | **Size-specific support level** | **Location-specific support level** | **Technology-specific support** | **Support level adjustments**** | **Cost-containment*** | **Cap** | **Floor** | | |
| 20-16 years | Y | Consumers | Current RES-E Directive | Constant | Y | Y | Y (technology-specific premiums) | PR | GEN | Y | Y | Y | Y |
| 15-11 years | N | Taxpayers | Other | Decreasing | N | N | N (single premium) | D | CAP-CAP | N | N | N | N |
| ≤ 10 years | | | | | | | | C | CAP-COST | | | | |

Abbreviations:

Y = Yes; N = No

* GEN = Generation-based support; CAP-CAP = Cap on technology deployment eligible for support; CAP-COST = Cap on total support costs.

** PR = Periodic revisions; D = Degression; C=Cap-based adjustments.

**Template 9.** **(Pathway 2c) Fixed (feed-in) Premium in the case of soft harmonisation**

| Design choices common to other instruments | | | | | | | | Design choices common to fixed-tariffs | | Design choices specific to fixed premium | | Burden sharing | Coop. mech. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Duration of support | Plant size limits | Financing actors | Technologies eligible for support | Flow of support | Size-specific support level | Location-specific support level | Technology-specific support | Support level adjustments** | Cost-containment* | Cap | Floor | | |
| 20-16 years | Y | Consumers | Current RES-E Directive | Constant | Y | Y | Y (technology-specific premiums) | PR | GEN | Y | Y | Y | Art.7 |
| 15-11 years | N | Taxpayers | Other | Decreasing | N | N | N (single premium) | D | CAP-CAP | N | N | N | Art. 9 |
| ≤ 10 years | | | | | | | | C | CAP-COST | | | | Art. 11 |

Abbreviations:

Y = Yes; N = No

* GEN = Generation-based support; CAP-CAP = Cap on technology deployment eligible for support; CAP-COST = Cap on total support costs.

** PR = Periodic revisions; D = Degression; C=Cap-based adjustments.

## 6.10 Pathway 3b & 3c: Quota with tradable green certificates (without banding) in the case of medium / soft harmonisation

- *Medium harmonisation:* In this case, countries may provide additional support, but not within the quota with TGC mechanism because this is an EU mechanism over which countries can not introduce elements (i.e., they have no control over the main design elements, which are decided at EU level). Complementary instruments may provide this additional albeit limited support and it is probably the appropriate manner to promote the more costly/less mature technologies. All decisions with respect to the design elements are taken at EU level (including the penalty level).
- *Soft harmonisation:* In this case, there are several TGC schemes (one per MS), with some design elements decided at EU level, the most likely to create distortions across countries if they differ: penalty, minimum TGC prices, duration of support, financing actors, technologies eligible for support and banking. MS could decide on plant size limits, support levels over plant lifetime, size-specific support level, location-specific support level, guaranteed headroom and distribution of the proceeds from the penalty

  Countries may provide additional support, but not within the TGC scheme, since this is not possible once a national target has been set.

  An obvious alternative is that the EU and national targets are set interactively. The EU sets a target, distributes this target across countries according to certain parameters (GDP, resource potentials and achieved potentials). Then those MS willing to have a higher share (taking into account the local benefits) inform the Commission, which then adjusts the national targets accordingly (not the EU target, which remains the same).

  Another possibility would be to have a buy-out price which is higher than the buy-out price which clears the market (i.e., intersection of the national quota and the marginal cost curve for RES-E generation). However, this would not guarantee that a higher amount than the target is reached.

  The more simple alternative would be to promote such additional capacity outside the TGC scheme, i.e., through additional instruments.

  In this case, given the existence of national targets and national support levels, all cooperation mechanisms may be used.

**Template 10.** **(Pathway 3b) Quota with tradable green certificates (without banding) in the case of medium harmonisation**

| Design choices common to other instruments | | | | | | | Design choices common to banded TGCs | | | | Burden sharing | Art. 9 coop. mech. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Duration of support | Plant size limits | Financing actors | Technologies eligible for support | Flow of support | Size-specific support level | Location-specific support level | Minimum TGC prices | Banking | Guaranteed headroom | Distribution of proceeds from penalty | | |
| 20-16 years | Y | Consumers | Current RES-E Directive | Constant | Y | Y | Y | Y | Y | Suppliers | Y | Y |
| 15-11 years | N | Taxpayers | Other | Decreasing | N | N | N | N | N | Administrative costs | N | N |
| ≤ 10 years | | | | | | | | | | | | |

Abbreviations:
Y = Yes; N = No

**Template 11.** **(Pathway 3c) Quota with tradable green certificates (without banding) in the case of soft harmonisation**

| Design choices common to other instruments. | | | | | | | Design choices common to banded TGCs | | | | Burden sharing | Coop. mech. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Duration of support | Plant size limits | Financing actors | Technologies eligible for support | Flow of support | Size-specific support level | Location-specific support level | Minimum TGC prices | Banking | Guaranteed headroom | Distribution of proceeds from penalty | | |
| 20-16 years | Y | Consumers | Current RES-E Directive | Constant | Y | Y | Y | Y | Y | Suppliers | Y | Art. 6 |
| 15-11 years | N | Taxpayers | Other | Decreasing | N | N | N | N | N | Administrative costs | N | Art. 7 |
| ≤ 10 years | | | | | | | | | | | | Art. 9 |
| | | | | | | | | | | | | Art. 11 |

Abbreviations:
Y = Yes; N = No

## 6.11 Pathway 4b & 4c: Quota with banding and tradable green certificates in the case of medium / soft harmonisation

- *Medium harmonisation:* This case is similar to pathway 3b, but under this policy pathway the EU-wide TGC scheme uses banding to provide technology-specification of financial support, i.e., there are either carve-outs or credit multipliers. The design elements are those of pathway 4a.
- *Soft harmonisation:* Similarly, this case reproduces pathway 3c with a difference: banding is allowed. Although not necessarily, EU and MS may decide on the following design elements:
  - EU: Duration of support, financing actors, minimum TGC prices, technologies eligible for support, banking, existence of credit multipliers or carve outs, but countries decide on the specifics (number of TGCs per MWh of generation for a specific technology)
  - Ms: Plant size limits, support levels over plant lifetime, size-specific support level, location-specific support level, guaranteed headroom, distribution of proceeds from penalty, carve-outs and credit multipliers

**Template 12.** **(Pathway 4b) Quota with banding and tradable green certificates in the case of medium harmonisation**

| Design choices common to other instruments. | | | | | | | Design choices common to banded TGCs | | | | Design choices specific to banded TGCs | | Burden sharing | Art. 9 coop. mech. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Duration of support** | **Plant size limits** | **Financing actors** | **Technologies eligible for support** | **Flow of support** | **Size-specific support level** | **Location-specific support level** | **Minimum TGC prices** | **Banking** | **Guaranteed headroom** | **Distribution of proceeds from penalty** | **Credit multipliers** | **Carve-outs** | | |
| 20-16 years | Y | Consumers | Current RES-E Directive | Constant | Y | Y | Y | Y | Y | Suppliers | Y | Y | Y | Y |
| 15-11 years | N | Taxpayers | Other | Decreasing | N | N | N | N | N | Administrative costs | N | N | N | N |
| ≤ 10 years | | | | | | | | | | | | | | |

Abbreviations:
Y = Yes; N = No

**Template 13.** **(Pathway 4c) Quota with banding and tradable green certificates in the case of soft harmonisation**

| Design choices common to other instruments | | | | | | | Design choices common to banded TGCs | | | | Design choices specific to banded TGCs | | Burden sharing | Coop. mech. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Duration of support** | **Plant size limits** | **Financing actors** | **Technologies eligible for support** | **Flow of support** | **Size-specific support level** | **Location-specific support level** | **Minimum TGC prices** | **Banking** | **Guaranteed headroom** | **Distribution of proceeds from penalty** | **Credit multipliers** | **Carve-outs** | | |
| 20-16 years | Y | Consumers | Current RES-E Directive | Constant | Y | Y | Y | Y | Y | Suppliers | Y | Y | Y | Art 7 |
| 15-11 years | N | Taxpayers | Other | Decreasing | N | N | N | N | N | Administrative costs | N | N | N | Art 9 |
| ≤ 10 years | | | | | | | | | | | | | | Art 11 |

Abbreviations:
Y = Yes; N = No

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