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





D6.1 Report

Multi-criteria Decision Analysis

- Assessing policy pathways for renewables support in the EU after 2020

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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 longterm 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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<u>This report</u> focuses on the comprehensive assessment of policy pathways regarding the possible harmonisation of RES(-E) support schemes in the EU after 2020. The analysis is based on outputs from previous work in the beyond 2020 project.

The assessment puts its focus on a multi-criteria decision analysis, but includes qualitative analysis on overarching issues as well.

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1 Introduction

This report covers the analysis and results obtained in work package 6 of the beyond2020 project. The core objective of this work package was to perform an integrative evaluation of policy pathways regarding the (non-)harmonisation of renewables support in the EU after 2020.

Work package 2 identified a range of possible policy pathways along with performance criteria to assess them. Work packages 3-5 produced detailed quantitative and qualitative data and assessments on each policy pathway. The integrative evaluation conducted in this report is based on the outputs generated in these previous work packages, and references to the relevant beyond2020 publications will be made throughout the text. Additionally, work package 6 addresses some specific issues which have not been dealt with in the previous work packages. Overall, the aspects covered in work package 6 can be summarised as follows:

- Assessment of the policy pathways' theoretical concepts and their practicability
- Analysis of the policy pathways' compatibility with European policy strategies and other issues (European long-term climate strategy, innovation policy, industrial policy, and effects on neighbouring countries)
- Multi-criteria decision analysis (MCDA) of the policy pathways, based on the quantitative and qualitative outputs from previous work packages.

This report focuses on the third point, the MCDA. However, it also covers parts of the second point, namely the interactions with innovation and industrial policy, and effects on neighbouring countries. The compatibility with the long-term European climate strategy is covered in a separate document (D6.1b). The first point is also discussed in a separate paper (D6.1a).

Box 1 Related beyond2020 deliverables contributing to the comprehensive assessment of policy pathways in work package 6

- D6.1a: Contextualising the debate on harmonising RES-E support in Europe A brief preassessment of potential harmonisation pathways
- D6.1b: Interactions between EU GHG and Renewable Energy Policies how can they be coordinated?
- D6.2: Multi-criteria decision aid tool integrating the gathered information on policy options (not publicly available)

D6.1a and D6.1b can be downloaded from www.res-policy-beyond2020.eu

This report is structured as follows: Chapter 2 introduces the methodology for the MCDA. This includes both the MCDA method itself as well as the use of input data, and the methodology for collecting and processing input data for criteria weighting and for evaluating the socio-political acceptability criterion. Chapter 3 shows the results, both for the criteria weighting and socio-political acceptability analyses, as well as for the overall MCDA. Chapter 4 addresses interactions with other policy areas. Chapter 5 provides conclusions and recommends policy pathways to be detailed further in work package 7 of the beyond2020 project.



2 Methodology and Input Data

This chapter summarises the methodology used for the multi-criteria analysis of different policy pathways against a defined and limited set of decision criteria. The analysis on interaction with other European policies and targets was done qualitatively, based on literature research and expert discussions. For the comprehensive analysis and comparison of policy pathways, resulting in preference rankings for different stakeholders, the PROMETHEE method was used. This method, as well as its application in this specific case, will be detailed in the following sections.

2.1 The PROMETHEE method

Most of our decision making is somehow of a multi-criterial nature, be it with regard to complex policy decisions or just everyday choices such as what to have for lunch. We usually face a range of alternative options amongst which we have to identify our most preferred one. Real-life decision problems rarely take into account only one criterion, and there is usually no one option which performs best with regard to all criteria. Multi-criteria methods were thus developed to overcome a central problem of the optimisation methods usually applied in classical operations research. These classical methods aim to optimise with respect to one criterion, often a comprehensive profit-index or cost-index, by defining an objective function, subject to constraints, which is then maximised or minimised (Figueira et al., 2005). Furthermore, classical operations research relies on a number of assumptions which in reality often do not hold, such as the transitivity of decision maker preferences, full comparability of alternatives, and clearly quantifiable data to base the decision on (Oberschmidt, 2010).

For decision problems in which not only direct costs, but also non-monetary aspects need to be considered, one possibility is to apply macroeconomic benefit models which take into account externalities. For such an assessment, non-monetary values such as environmental quality, political acceptability or health effects have to be expressed in monetary units. This makes all aspects of the decision problem easily comparable but is often an undertaking of great practical difficulty. Multicriteria decision methods avoid the difficulty of monetarisation of non-monetary dimensions common in macro-economic benefit models, and are also better suited to deal with problems where the common assumptions of classical optimisation models do not apply. They are designed to handle quantitative and qualitative information, and can also be used to support group decisions (Zimmermann and Gutsche, 1991). They are therefore adequate for the assessment of energy policy decision problems with multiple objectives.

In the beyond2020 analysis, the PROMETHEE method (Brans et al., 1986) is applied, which is one of several methods using an outranking procedure to assist multi-criterial decision making. PROMETHEE has been applied in a wide range of subject areas. Behzadian et al. (2010), in a comprehensive review of PROMETHEE-focused publications, find that of 195 application-based papers analysed, 47 were in the field of environment management, 28 in hydrology and water management, and 25 in business and financial management. Other common fields of application were chemistry, logistics and transportation, energy management, manufacturing and assembly, and to a lesser extent social topics. The scope includes investment or strategy decisions on company level, as well as local or national policy decisions.



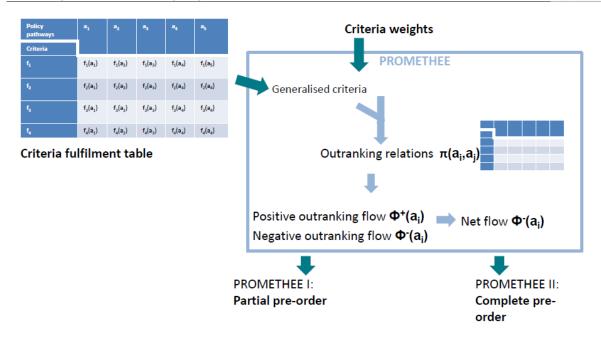


Figure 1 Schematic illustration of the PROMETHEE method

Source: Own illustration based on Brans et al. (1986) How to select and how to rank projects: The PROMETHEE method.

The PROMETHEE method requires two main categories of inputs:

- A selection of alternatives (in our case: policy pathways), criteria by which to assess them, and the corresponding data on each policy pathway's performance with regard to each criterion. This information is summarised in Table 3, the criteria fulfilment table.
- Information on the decision makers involved, and the weights they allocate to each criterion. This data reflects the subjective opinions of decision makers.

In addition, preference functions must be defined along with suitable threshold values which determine how the differences between alternatives enter the overall decision. Based on this input, PROMETHEE provides preference rankings of policy pathways for each decision maker. Decision makers' rankings can finally be aggregated into a group ranking. The aim of the analysis is <u>not</u> to find the final and "correct" ranking of pathways. The inputs are partly subjective, relying on qualitative data gathered from interviews, and the model cannot simulate the full extent of factors going into human decision making and political negotiations. The idea is rather to provide a comprehensive view of the decision problem, to illustrate the ideas and positions held by stakeholders, and to assess which policy pathways might provide room for compromise due to their being acceptable to a variety of stakeholders with very different views.

PROMETHEE results in one partial pre-order (PROMETHEE I) and a complete pre-order (PROMETHEE II) of policy pathways. PROMETHEE I contains more detailed information, also showing incomparabilities between policy pathways, while PROMETHEE II forces all pathways into one strict preference order.

The analysis was carried out using a software tool developed at Fraunhofer ISI by Hirzel (2013), as well as an excel tool developed especially for the beyond2020 analysis (D6.2).



2.2 Inputs to PROMETHEE

2.2.1 Pathways, criteria, and criteria fulfilment

The basis for the multi-criteria analysis was laid in work package 2, where possible policy pathways for the post-2020 period, including feasible design options, were defined. In addition, a set of relevant assessment criteria was identified through extensive literature research and expert discussions.

Box 2 beyond2020 deliverables from work package 2 providing the structural framework for the multicriteria decision analysis.

- D2.1: Key policy approaches for a harmonisation of RES(-E) support in Europe
- D2.2: Assessment criteria for identifying the main alternatives advantages and draw-backs, synergies and conflicts

Both reports can be downloaded from www.res-policy-beyond2020.eu

Table 1 summarises the policy pathways identified for further analysis in work package 2. They are structured along two dimensions: i) The degree of harmonisation, defined as full, medium, soft, minimum, or none, and ii) possible support instruments they can be combined with. This structural framework results in 16 possible policy options.

Table 1 Policy pathways assessed in beyond2020. Source: D2.1 Del Río et al.(2012a)

Degree of harmonisatio	FIT (feed-in tariff)	FIP (feed-in premium)	QUO (quota system with uniform TGC)	QUO banding (quota system with banded TGC)	ETS (no dedicated RES support)	TEN (Tendering for large scale RES)		
<u>Full</u>	•EU target •One instrument		1a	2 a	3a	4a	5	6 Sensitivity to 7 (national support, but
Medium	•EU target •One instrument •Additional (limited) sup	•One instrument •Additional (limited) support allowed •EU & National targets			3b	4b		harmonisation for selected technologies)
<u>Soft</u>					3c	4c		
<u>Minimum</u>	•With minimum design standards for support instruments	targets upport instruments targets •Cooperation		7d Ref erence: national RES support with strong coordination - with minimum design standards				
<u>None</u>	•No minimum design standards for support instruments	mechanism (with or without increased cooperation)	7 Ref erence: national RES support with moderate cooperation - with out minimum design standards					



Table 2 Overview of assessment criteria, indicators, and data sources. Source: Based on D2.2 Del Río et al.(2012b)

Criterion	Brief characterisation	Indicator used in MCDA
Effectiveness	Ability of a policy pathway to achieve a given RES target. In this analysis, a RES target of 31.2% in 2030 is assumed.	
Static efficiency (Cost-effectiveness)	Minimisation of generation costs and minimisation of policy support costs. Transaction costs (whether they fall on private or public entities) and other costs (costs of grid reinforcement and extension and back-up costs) should also be taken into account.	plants installed between 2021- 2030 Or, alternatively
Dynamic efficiency	The ability of a policy pathway to stimulate long-term learning effects and thus cost reductions for RES technologies.	
Equity	Distributive impacts of a policy pathway. These are possible either between consumers and producers or between energy consumer groups within Member States, or between Member States. In this analysis, the distributive impacts (costs and benefits) between Member States are assessed.	Member States of "international- ised" support expenditures - the difference of actual support ex- penditures and the fictitious ex-
Environmental and economic effects	RES-E deployment triggered by RES-E policy has unavoidable local impacts of a different nature: socio-economic, environmental and otherwise.	 GHG emissions avoided due to RES
Socio-political acceptability	Attractiveness of a policy pathway to national policy makers. This is critically affected by (and affects) the social acceptability of a pathway by the electorate. The criterion has some overlaps with the (perceived) performance of a pathway regarding equity, environmental and economic effects, and static efficiency.	very unlikely to be politically acceptable in my country"; 5 = "this pathway is very likely to be politically acceptable in my country") Data source: Semi-structured inter-
Legal feasibility	This criterion refers to the extent to which the EU has competence to legislate a given pathway (legal basis) and whether the policy pathway complies with EU primary and secondary law.	cult/impossible to implement; 10 = easy to implement)



Table 2 summarises the assessment criteria alongside which the policy pathways are analysed. They were identified in work package 2 and further specified regarding measurable indicators. Data sources were mostly quantitative data produced by TU Vienna's Green-X model, as applied in work package 4, as well as qualitative legal assessments conducted in work package 3. Data on sociopolitical acceptability was collected in interviews as part of work package 6 and will be described in more detail in section 3.1 of this report.

Box 3 beyond2020 deliverables from work packages 3, 4, and 5 contributing criteria fulfilment data

- D3.1: Potential areas of conflict of a harmonised RES support scheme with European Union law
- D3.2: Legal requirements and policy recommendations for the adoption and implementation of a potential harmonised RES support scheme.
- D4.2: Cost-benefit analysis of policy pathways for a harmonisation of RES(-E) support in Europe
- D5.1: Review report on interactions between RES-E support instruments and electricity markets
- D5.2: Assessment report on the impacts of policy pathways on future electricity markets

Reports can be downloaded from www.res-policy-beyond2020.eu

Table 3 provides a summary of criteria fulfilment values as used in the PROMETHEE analysis. As described in the results section, several variations of the decision problem are analysed, with varying input data. The values shown here correspond to the full range of 16 pathways under the consumer perspective variation.



 Table 3
 Criteria fulfilment (data as used in the consumer perspective variation)

Criterion	FIT (full) 1a	FIT (medium) 1b	FIT (soft) 1c	FIP (full) 2a	FIP (medium) 2b	FIP (soft) 2c	Tech-neutral quo- ta (full) 3a	Tech-neutral quo- ta (medium) 3b	Tech-neutral quo- ta (soft) 3c	Banded quota (full) 4a	Banded quota (medium) 4b	Banded quota (soft) 4c	ETS 5	Tender 6	Minimum harmoni- sation 7d	No harmonisation 7
Effectiveness (share of targeted 2030 RES volumes in %)	100.00	100.03	100.02	100.04	100.08	100.17	100.03	100.11	100.11	100.03	100.06	100.13	46.25	100.07	100.06	100.68
Static efficiency (bn €)																
average annual support expenditures 2021-2030	33.80	33.54	33.34	37.69	37.47	37.88	44.17	44.01	43.14	39.73	39.49	39.80	18.26	34.55	38.53	43.93
average annual generation costs 2021- 2030	13.41	13.50	13.31	14.02	14.06	14.41	11.16	10.50	10.07	13.38	12.80	12.32	0.02	13.31	14.54	15.34
Dynamic efficiency																
Portfolio Diversity (Hirschman- Herfindahl-Index)	0.142	0.142	0.138	0.140	0.138	0.135	0.162	0.163	0.161	0.145	0.146	0.144	0.259	0.135	0.135	0.130
Decrease in investment cost (%)	9.4	9.4	9.3	9.3	9.3	9.3	8.2	8.2	8.1	9.5	9.5	9.4	6.1	9.3	9.3	9.4
Equity (standard deviation)	0.0009	0.0010	0.0014	0.0010	0.0010	0.0011	0.0010	0.0009	0.0020	0.0010	0.0009	0.0016	0.0000	0.0011	0.0010	0.0008
Environmental and economic effects																
Avoided GHG emissions (bn €)	13.89	13.90	13.74	14.65	14.67	14.56	14.55	14.52	14.49	14.33	14.36	14.35	6.25	14.03	14.58	14.33
Avoided fossil fuel imports (bn €)	67.45	67.63	67.14	69.59	69.70	69.66	68.80	68.86	68.97	68.85	69.11	69.28	27.49	67.67	69.94	69.46
Socio-political acceptability																
(mean score of 8 respondents, scale 1-5)	0.00	0.00	2.16	0.00	0.00	3.25	0.00	0.00	2.00	0.00	0.00	2.04	2.46	0.00	3.88	3.38
(number of respondents who gave a "1")	5	4	4	4	3	0	4	3	3	4	3	3	2	2	0	1
Legal feasibility (rated 0-10)	0	0	6	0	0	6	0	0	6	0	0	6	10	0	8	10



2.2.2 A methodology to assess the socio-political acceptability of policy pathways

The socio-political acceptability criterion refers to the political acceptability of a given policy pathway to the political decision makers in Member States. This aspect is very difficult to quantify. The political discussion is dynamic and decision makers' positions change frequently as Member States undergo new national elections, communicate with other Member States, or are influenced by the policy discussion in Brussels. Nevertheless, this criterion cannot be ignored in this overall assessment, as resistance from political and societal actors is a very relevant factor in real decision making. Elected representatives of Member States are expected to vote negatively on legislative proposals by the Commission which are not acceptable in their home country. This can result in the rejection of certain policy pathways, even if they perform well in the other assessment criteria.

The criteria report D2.2 (del Río et al., 2012b) describes the socio-political acceptability criterion as related to equity, static efficiency, and environmental and economic effects. Social acceptability and political acceptability are combined into one criterion, as it is assumed that the preferences of the electorate translate into preferences and actions of elected politicians. In addition, there may be historical preferences for certain policy pathways in some Member States.

To assess the socio-political acceptability of policy pathways, 9 national decision makers (or alternatively, experts on the current national discussion) were interviewed, providing positions for the UK, Poland, Netherlands, Germany, Finland, Denmark, Slovenia, Ireland, and Italy. They were asked for a rating of each pathway on a scale from 1 ("very unlikely to be politically acceptable in my country") to 5 ("very likely to be politically acceptable in my country"), which all except the Finnish respondent were able to provide. Spanish decision makers were approached for an interview, but due to ongoing internal discussions were not in a position to communicate an official opinion. In addition to the interviews, 14 Member States replied to the Commission's Green Paper consultation on a 2030 framework for climate and energy policies (see Table 6), which in many cases also provided an indication on their opinion regarding the (non-)harmonisation of RES support. Furthermore, other public statements by Member States regarding the 2030 target discussion support the assessment.

2.2.3 Criteria weighting methodology

Criteria weighting vectors represent the subjective importances which decision makers allocate to each criterion. After stakeholder mapping through literature research and expert judgment, the identified stakeholder groups' weighting vectors were assessed by the following procedure:

- i) A criteria weighting questionnaire was developed and disseminated at beyond2020 events. Eighty-three responses were received. Although the sample is not meant to be representative, the survey served to identify any stakeholder groups or aspects missed so far.
- ii) Detailed semi-structured interviews were conducted with eight respondents from seven stakeholder groups, covering the range of opinions contributing to the policy debate. The interviews included filling in and discussing the criteria weighting questionnaire, but focused on the motivation and convictions behind the allocated weights, as well as respondents' views on the stakeholder landscape, the policy discussion, and their preferred pathways.
- Publicly available material such as position papers and public consultation responses serve to back up the interview results and provide views of other stakeholders not interviewed.



The first version of the survey still asked respondents to allocate weights to the criteria by allocating 100 points to the most important one and correspondingly less points to the less important ones. This weighting method is frequently used in connection with MCDA. The resulting weighting vectors contain information not only on which criterion is more important than another, but also tell us <a href="https://www.much.com/much.co

Originally, the *socio-political acceptability* criterion had two sub-criteria, and this original criteria set was also the version presented in the questionnaire. At a later stage, it became clear that one of the two sub-criteria could not be assessed separately from the *legal feasibility* criterion. This sub-criterion was thus dropped from the analysis. We must therefore remember that the questionnaire respondents had something slightly different in mind when providing the rank/weight for the *socio-political acceptability* criterion, as they were assuming two sub-criteria.

Finally, the quantitative and qualitative information provided by stakeholders serves to create "typical" decision maker types with corresponding weighting vectors. These prototypes can be seen as exaggerated versions of real decision makers, used to illustrate rather extreme views. The PROMETHEE analysis is carried out for each decision maker prototype to compare their preference rankings regarding the policy pathways.

2.3 Preference functions and threshold values

In the PROMETHEE method, the values of each policy patway regarding each criterion are compared to find an indicator of preference. This is done with the help of a preference function which can contain threshold values expressing different degrees of preference (Tsoutsos et al., 2009). For instance, if a decision maker feels that a very small difference in a criterion (of up to x units) between two policy pathways will not affect his preference, this can be taken into account by setting an appropriate preference function and threshold value. Six standard types of preference function, also called generalised criteria, are provided in the PROMETHEE method (Brans et al., 1986). These are enough to cover the vast majority of realistically occurring decision problems. One of the six generalised criteria must be chosen for each assessment criterion.

In our case, the type 1 indifference function (usual criterion) was chosen for *effectiveness*. This simple preference function only distinguishes between strict preference and indifference. This seems a suitable choice for the effectiveness criterion, as the 2030 RES target either is or is not achieved. All other assessment criteria are treated with the type 6 indifference function (Gaussian criterion) for this analysis. Type 6 enables a continuous move from indifference to weak, then strong, and finally, strict preference. It is suitable for continuous data as available for the assessment criteria here. S-values were defined according to the methodology specified in Queiruga et al. (2008).



2.4 Variations and Sensitivities

To indicate the robustness of the results, the MCDA was carried out with variations on

- Two alternative indicators for the *static efficiency* criterion: i) support costs and ii) generation costs. This leads to two different views we call the consumer perspective and the broader system perspective. The underlying reasoning is explained at the beginning of section 3.3.
- Criteria weighting vectors, using *walking weights* sensitivity testing. This is covered and explained in section 3.3.1.



3 Results

The following sections describe three groups of results:

- The results of the stakeholder analysis regarding socio-political acceptability of policy pathways, for which the methodology was described in section 2.2.2. These results in turn serve as input for the multi-criteria decision analysis (MCDA);
- the results of the stakeholder analysis regarding criteria weights, for which the methodology was described in section 2.2.3. These results are also needed as input for the MCDA;
- and finally, the actual MCDA, using the PROMETHEE method as it was specified in section 2.1.

3.1 Socio-political acceptability of policy pathways

With the Commission's Green Paper consultation on a 2030 framework for climate and energy policies in summer 2013 and the subsequent Communication "A policy framework for climate and energy in the period from 2020 to 2030" (COM(2014)15 final) on 22 January 2014, the policy discussion regarding renewables at the time of writing focuses on future targets, namely on the question of whether a GHG emission target for 2030 will suffice to achieve long-term decarbonisation objectives, or whether additional sub-targets will be needed (i.e. RES, energy efficiency). The policy pathways analysed in beyond2020 are based on the assumption that the EU will set a 2030 RES target, which then is or is not split up into national targets, depending on harmonisation degree. The sole exception is pathway 5 (ETS-only), which would automatically be implemented in case of the absence of a 2030 RES target. Thus, it can be assumed that for all Member States which argue against a separate RES target, pathway 5 is the preferred pathway, while for those supporting a RES target, it is not immediately clear which of the remaining policy pathways they find most politically acceptable. At the time of writing, many Member States were preoccupied with the 2030 target discussion, and not all of them had a clear position on which (non-)harmonisation model they would prefer in case of a RES target. However, most interviewees were able to identify some general tendencies in their own country, depending, amongst others, on the current political situation. For some Member States, the choice of instrument is a decisive factor, while others are more flexible in this regard, but have strong views regarding the degree of harmonisation.

Germany is one of those Member States where the debate on (non-)harmonisation of support schemes seems most evolved. For the past legislative period, however, the country faced some difficulties finding clear positions on European climate and energy policies. The two Ministries for Economic Affairs and for the Environment were both responsible for the Energiewende, but headed by ministers from different parties - the Liberal Democrats (FDP) and the Christian Democrats (CDU/CSU), respectively. Frequent disagreements between the two houses led to Germany not being a pro-active player in favour of ambitious European climate and energy policies. With a newly elected government coalition (Christian Democrats and Social Democrats) in power since late 2013, both houses are now headed by Social Democrat (SPD) ministers. What's more, areas of competence are being redistributed and clarified, with the newly re-named Ministry for Economic Affairs and **Energy** now being the main responsible for the *Energiewende*. For this analysis, the interview was conducted under the previous government still, with a respondent who worked for the Environment Ministry at the time. The respondent described his own ministry's position regarding the beyond2020 pathways, and also speculated about the opposing views of the other ministry. However, the recent competence and staff shifts between the two ministries give rise to the assumption that the former Environment Ministry position may now be more widely acceptable politically, also for



the Ministry for Economic Affairs and Energy¹. The German respondent argues against harmonisation, saying that the ambitious *Energiewende* cannot be successfully implemented in a harmonised system where all details have to be agreed upon by 27 Member States. The German support scheme has been rather successful in the past. However, other Member States have individual framework conditions, which warrant individual support schemes. In addition, the respondent points out the practical political difficulties he would anticipate under a harmonised support scheme: Member States have conflicting interests, leading to any harmonised system being based on the lowest common denominator, rendering it ineffective and inefficient. When setting harmonised support levels, he expects, for instance, a "horse trade between PV and biomass countries, with PV countries accepting high biomass support only if they in turn get one cent more support for PV, and things like that." The German respondent states that his ministry supports no or minimum harmonisation (pathways 7d and 7) and already has some clear ideas as to which framework conditions should converge in the future: "To prevent lobbyism, we favour Europe-wide cost maps with a transparent methodology, and with a uniform degression formula. Support levels should not be set in parliaments, so lobbying is more difficult."

Respondents from other Member States also point out the differing framework conditions in Member States and thus the better political acceptability of low degrees of harmonisation, such as respondents from Denmark and Ireland.

The UK clearly positioned itself against a RES target in 2030, both in the official response to the Commission's Green Paper consultation on a 2030 framework for climate and energy policies, as well as via public statements by UK politicians (Harvey, 2013). There is a clear political preference for pathway 6 (ETS-only), based on the conviction that renewables should be in competition with each other as well as with other decarbonisation technologies such as CCS and nuclear power. This would ensure maximum efficiency, in the sense of lowest carbon abatement costs. The UK interview respondent indicates that, in case there will be a RES target, the UK preference would be for full harmonisation, as this is expected to best ensure the creation of an internal market for investors. Harmonised support levels in all Member States would avoid subsidy competition. Medium or soft harmonisation, with a harmonised instrument but freedom for Member States to influence support levels, is not politically acceptable. Poland, on the other hand, shares with the UK its preference for no RES target, and thus for pathway 6 (ETS only). However, the Polish interview respondent stresses that the situation of Poland is unique: "For example the cost of credit is totally different for countries which are out of the [Euro] zone, for example Poland." In case of a RES target, a harmonised scheme would thus not be politically acceptable in Poland. Based on his experience and contact with other Member States, the respondent speculates that a majority of them would find high degrees of harmonisation unacceptable for the same reason.

Often, acceptability of a given policy pathway is linked to the developments observed in other Member States. Some Member States have an informal leadership role and shape the perception in other countries. Especially respondents from smaller Member States are prepared to follow strong groups or alliances of other Member States.

For instance, the Dutch respondent makes clear that full or medium harmonisation is politically more attractive in the Netherlands than minimum harmonisation (Reference pathway 7), but "I think these [reference pathways] are the fallback options if all else fails. If there is a majority for this in Europe, then we would probably support it."

Regarding the choice of support instrument, trends set by other Member States are monitored and bottom-up convergence of other Member States' support schemes does not go unnoticed:

[.]

¹ For instance, the new minister for economic affairs, Sigmar Gabriel, appointed Green politician Rainer Baake as State Secretary for Energy. The minister has also pushed for a 2030 RES target on European level, a move which his predecessor would have been strictly opposed to.



"If you look at developments, then of course the Netherlands, the UK, Germany, everybody is shifting towards FIP." according to the respondent from the Netherlands. "We are seeing that the current trend is that many European countries are moving from FITs to FIPs. I think this kind of harmonisation is good." said one respondent from Italy. Of course, applying the definitions used in beyond2020, the respondent was referring to bottom-up convergence rather than top-down harmonisation.

Some Member States have stronger preferences than others regarding the support instrument. The Dutch respondent explains that any instrument will be judged by its effectiveness and efficiency in RES deployment. If a harmonised scheme could be expected to be effective and efficient, the choice of instrument is secondary. The UK, too, has a stronger position on harmonisation degree than on the instrument applied. However, as the UK quota scheme is just being phased out, a harmonised quota is seen as less politically attractive.

Respondents from Germany, Denmark, Finland, and Ireland report a clear political preference for feed-in systems, although there may often be disagreement between different players within the respective country. While the German case has been detailed above, the Danish respondent remarks that ministries for economic affairs might in general be more open to schemes which put greater risk on RES investors, such as quota schemes.

Several respondents opposed to harmonisation state that they, in contrast to harmonisation proponents, are acting in the true interest of the energy transition. This implies that harmonisation proponents have no real interest in the successful deployment of renewables, but instead are trying to maintain the status quo with its structures favourable for large incumbents.

Table 4 provides an overview of the positions of 19 Member States regarding harmonisation and the 2030 target discussion preceding it. The table combines publicly available information, such as published statements and consultation responses, with the more detailed information gleaned from the interviews in case of the UK, Poland, Netherlands, Germany, Finland, Denmark, Slovenia, Ireland, and Italy.

Table 4 Positions of selected EU Member States on 2030 RES targets and on harmonisation of support schemes. Sources: Interviews with national respondents, publicly available responses to Commission Green Paper consultation on a 2030 framework for climate and energy policies, and other publications.

01 PC	ionotions.
Member State	Position
UK	RES target not desirable, only an ambitious CO2 target, as communicated in response to Commission Green Paper consultation on a 2030 framework for climate and energy policies in summer 2013.
	In case of RES target, a fully harmonised support scheme is desirable, as it creates an internal market for investors and avoids subsidy competition, according to UK interview respondent.
Poland	RES target not desirable, according to response to Commission Green Paper consultation.
	In case of RES target: National framework conditions are unique, high degrees of harmonisation are therefore not politically acceptable. Minimum harmonisation is most likely to be acceptable, according to Polish interview respondent.
Czech Repub- lic	RES target not desirable, according to response to Commission Green Paper consultation.
Romania	RES target not desirable, according to response to Commission Green Paper consultation.
Finland	A possible RES target should be moderate and non-binding, according to response to Commission Green Paper consultation.
	Minimum or soft harmonisation preferred, expected to improve efficiency. RES mix and security of supply must be controlled nationally, according to Finnish interview respondent.
Cyprus	A possible RES target should be non-binding, according to response to Commission Green Paper consultation.



Estonia	RES target is acceptable if "EU-level action in these areas provides substantial added value",
	according to response to Commission Green Paper consultation.
Netherlands	In case of a RES target, a harmonised scheme is desirable. The choice of instrument is secondary, according to Dutch interview respondent.
Slovenia	Harmonisation discussion has not been prominent so far. Harmonisation of design principles seems acceptable, but not higher harmonisation degrees, according to Slovenian interview respondent.
Spain	Unclear position in response to Commission Green Paper consultation.
Germany	Signed a joint ministerial letter together with other Member States addressed to Energy Commissioner Günther Oettinger and Climate Commissioner Connie Hedegaard sent December 2013, calling for a "robust" 2030 RES target (Neslen, 2014). The word "binding" was not used in the letter.
	High degrees of harmonisation are not politically acceptable. Minimum harmonisation is politically attractive, for instance on methodology and processes of support level setting.
France	Signed the ministerial letter to Commissoners Oettinger and Hedegaard calling for 2030 RES targets (Neslen, 2014).
	"an EU target for renewable energy accompanied by a partial harmonisation of support mechanisms could allow a better integration of energy on the renewable electricity market and optimising their development within the European Union" according to response to Commission Green Paper consultation.
Italy	Signed the ministerial letter to Commissoners Oettinger and Hedegaard calling for 2030 RES targets (Neslen, 2014).
	Full harmonisation is not acceptable, according to Italian interview respondents.
Portugal	Signed the ministerial letter to Commissoners Oettinger and Hedegaard calling for 2030 RES targets (Neslen, 2014).
	Strong preference for improved cooperation mechanisms, according to response to Commission Green Paper consultation. This implies political preference for lower harmonisation degrees.
Austria	Signed the ministerial letter to Commissoners Oettinger and Hedegaard calling for 2030 RES targets (Neslen, 2014).
Denmark	Signed the ministerial letter to Commissoners Oettinger and Hedegaard calling for 2030 RES targets (Neslen, 2014).
	No or minimum harmonisation preferred, as each Member State has individual framework conditions. General trend in Denmark against Europeanisation, according to Danish interview respondent.
Belgium	Signed the ministerial letter to Commissoners Oettinger and Hedegaard calling for 2030 RES targets (Neslen, 2014).
Ireland	Signed the ministerial letter to Commissoners Oettinger and Hedegaard calling for 2030 RES targets (Neslen, 2014).
	No clear position on harmonisation, the debate has not been prominent in Ireland recently, according to Irish interview respondent.
Lithuania	Favours RES target, and argues for better use of cooperation mechanisms and encouragement of regional convergence, according to response to Commission Green Paper consultation.

The input data used in the PROMETHEE calculation is based on the opinions of the 8 interviewees from the UK, Poland, the Netherlands, Germany, Denmark, Slovenia, Ireland, and Italy, who assessed each pathway on a scale from 1 ("very unlikely to be politically acceptable in my country") to 5 ("very likely to be politically acceptable in my country"). These interviews are not meant to be representative. Each Member State has its own motives and reasoning. However, some common themes and general tendencies can be observed in the interview data and are qualitatively supported by public statements of Member States who were not interviewed.



Table 5: Mean (Ø) and standard deviation (σ) of national decision makers' rating of policy pathways

Support instrument Degree of harmonisation	ե	FIP	QUO	QUO banded	ETS	TEN
<u>Full</u>	1a ∅= 1.50 σ= 0.76	2a ∅= 2 σ= 1.2	3a ∅= 1.71 σ= 1.2	4a ∅= 1.50 σ= 0.76	5 Ø= 2.46 σ= 1.46	6 Ø= 2.41 σ= 1.31
<u>Medium</u>	1b ∅= 1.88 σ=1.13	2b Ø= 2.54 σ= 1.46	3b Ø= 1.88 σ= 1.13	4b ∅= 1.66 σ= 0.72		
<u>Soft</u>	1c ∅= 2.16 σ=1.42	2c Ø= 3.25 σ= 1.13	3c ∅= 2.00 σ= 1.2	4c ∅= 2.04 σ= 1.16		
<u>Minimum</u>	7d Ø= 3.88 σ= 1.13					
<u>None</u>	7 Ø= 3.38 σ= 1.51					

On average, pathway 7d (minimum harmonisation) received the most points from the interviewees (\emptyset =3.88, out of a possible 5), followed by pathway 7 (non-harmonisation), pathway 2c (FIP-soft), pathway 2b (FIP-medium), and pathway 5 (ETS).

The standard deviations give an indication as to how much variation there is between the degrees of political acceptability in each Member State. There are some clear losers: pathways 1a (FIT-full), 4a (Quota-banded-full), and 4b (Quota-banded-medium) receive low average ratings (\emptyset), without much disagreement (low σ -values) between respondents. In contrast, the two options at the opposite ends of the spectrum, namely pathway 5 (ETS-only) and 7 (non-harmonisation) have high average ratings but also the highest standard deviations, indicating a high level of disagreement. This finding is not surprising and is supported by the qualitative information from other sources detailed above. Member States show highly varying political acceptability for a single CO₂ target and the resulting ETS-only pathway. Among those Member States which agree with a 2030 RES target, binding or otherwise, many call for better coordination, convergence, or partial harmonisation, which in the beyond2020 framework corresponds best with minimum or soft harmonisation. With few exceptions, there is much agreement on high degrees of harmonisation not being politically attractive.

3.2 Decision makers and criteria weights

3.2.1 Stakeholder groups

A variety of stakeholders are involved in the policy discussion regarding RES financing mechanisms beyond 2020. As the decision concerns a legislative process on EU level, the directly involved stakeholders are naturally the EU legislative bodies: (i) the European Commission, mainly via its Directorate General for Energy, the Directorate-General for Competition, and the Directorate-General for Environment; (ii) the European Parliament with its 754 members; and (iii) the Council of the European Union, in which the 27 EU Member States meet in different configurations, always represented by those ministers responsible for a given topic. While the Commission has the right of initiative regarding the proposal of new legislation, the latter two EU bodies vote on these proposals.



Further stakeholder groups are involved indirectly in the policy making process. The following groups were identified in the harmonisation discussion:

- RES industry
- Conventional energy industry
- NGOs
- Energy intensive user industry
- Grid operators
- Electricity traders

Some stakeholders belong to more than one category. For instance, many large utilities still own a large fleet of conventional power plants, but are also increasingly investing in renewables.

3.2.2 Shared objectives

The interviewed stakeholders' statements as well as contributions in beyond2020 workshop discussions indicate that all stakeholders share one ultimate objective, at least as far as this is stated in their public statements. This ultimate objective is the long-term decarbonisation of the European economy, and consequently, of the energy sector. Some stakeholders push this to a stronger extent than others, but even industry user associations such as businesseurope, who usually stress the importance of maintaining European economic competitiveness, do not openly question the need for a long-term European climate policy.

The disagreement regarding future climate policies, then, is not a question of "if" but of "how". How ambitious should short- to medium-term decarbonisation targets be? Which decarbonisation technologies will be needed, and in which timeframes? Which instruments are best suited to incentivise deployment of these technologies? How should the costs be distributed intra- and intergenerationally? Are certain technologies (for instance, RES) important enough in the long term to warrant special treatment in the short to medium term?

This report focuses on RES policies after 2020, but of course stakeholders' attitudes towards these is determined by how they answer the underlying questions; what they think is the best way to reach the ultimate objective of decarbonisation. The following sections shall describe firstly stakeholders' publicly stated preferences for certain RES policy pathways. Secondly, stakeholders' statements regarding the importance of assessment criteria shall be analysed.

3.2.3 Stated preferences for policy pathways

Many stakeholders, especially those in close touch with political discussions in Brussels, already have a more or less detailed position regarding which policy pathway they would prefer. A great number of organisations have communicated their opinions on whether there should or should not be a separate RES target for 2030, and some already have more detailed opinions on harmonisation and support scheme design.

As mentioned in the previous chapter, within the analytical framework of beyond2020, all policy pathways presuppose the existence of a RES target for 2030, with the exception of pathway 5 (ETS-only). This means that those stakeholders who are against a 2030 RES target are thus in favour of pathway 5, while for the other stakeholders, the position on harmonisation is not so clear. The positions of Member States regarding the 2030 RES target are included in the overview of table 4. Table 6 provides an overview of selected stakeholder positions other than Member States, as stated in the publicly available responses to the Commission's Green Paper consultation on a 2030 framework for climate and energy policies in summer 2013. This overview is not meant to be complete, as the Commission received around 600 responses in total. The selection of stakeholders shows that, unsurprisingly, the RES industry as well as environmental NGOs tend to be in favour of a RES target. In



contrast, the energy intensive consumer industry tends to favour a single GHG emission target. Regarding the conventional energy industry, Eurelectric, representing the electricity industry on European level, favours a single CO_2 target, and equally do the large utilities Vattenfall, E.on, Statkraft, and some others. Their opinion is shared by the European associations representing the oil, gas (OGP, Eurogas), and nuclear (FORATOM) sectors.

Table 6 Selected stakeholder positions on the 2030 target discussion according to their responses to the Commission's Green Paper consultation on a 2030 framework for climate and energy policies, summer 2013

Single GHG emissions	target	GHG emissions target and RES target			
⇒ Policy pathwa	y 5	⇒ Choice between various policy pathways			
IETA CEMBUREAU Eurelectric, Vattenfall, E.on, Statkraft and other utilities Eurogas FORATOM OGP National Grid (UK) businesseurope	can be so ondary RI al RES to companie cooperations.	imary GHG target supported by sec- supported by sec- ES target. Nation- targets to be ac- ed by increased ion. EZ - unclear posi- ther yes nor no EX - unclear posi- ther yes nor no	s target; and y players Association of er Industries, ke München,		

Opinions among the large incumbents are not as homogenous as one might expect: BDEW (German Association of Energy and Water Industries), EnBW, Stadtwerke München, DONG Energy, and EDP all communicated their preference for a 2030 RES target. Many of them have made significant investments in RES in recent years, adjusted their strategies accordingly, and thus have an interest in the sector's further development. Interviewees from other stakeholder groups generally assume that the big utilities would push for an ETS-only approach, or at least full harmonisation. For instance, one German respondent expects some big utilities active in Germany to support a European RES target for strategic reasons:

"They have realised that Germany will definitely go through with the Energiewende. And if they are forced to participate in this, they want their competitors in other countries to also participate, otherwise they will suffer a competitive disadvantage. So they want a RES target, and as instrument they want a quota."

Among those utilities who clearly mention harmonisation or convergence in their consultation responses, the opinion is usually phrased more softly:

Generally, the option of further developed, nationally customised support systems should be maintained, while EnBW does not reject a later coordination or convergence on European level. [...] it is possible to design national support systems in a way which is compatible with the internal market." - EnBW response to Green Paper consultation

"To guarantee a cost-efficient development of RES, the Group recommends a progressive inclusion of mature renewable technologies into the market and a progressive convergence of RES support schemes across member states for non mature technologies." - GDF Suez response to Green Paper consultation

"The European Commission should [therefore] promote the continuous convergence of support systems more strongly." - BDEW response to Green Paper consultation



One German energy utility respondent, seeing himself rather more as part of the RES industry, expresses preference for a Europeanised system.

Of those stakeholders in favour of a 2030 RES target, there are more or less clear opinions on which harmonisation degree they would prefer:

According to their Green Paper response, EEX favours a European RES target and national targets, but emphasises the need for coordination of national policies to avoid unwanted international spill over effects. Regional policies, similar to the coupled electricity markets of Benelux, France, Austria and Germany are suggested. In the beyond2020 framework, this could be categorised as minimum or soft harmonisation.

"EU-wide targets should be set to maximise the efficiency of target achievement.[...] In addition, national targets should be defined at EU level." - EEX response to Green Paper consultation

"[...]new generation capacity can be build where it is most efficient. This also implies the strengthening of cooperation between member states. The existing promising initiatives should be strengthened further [...]" - EEX response to Green Paper consultation

Europex, in its Green Paper response, states that high degrees of harmonisation are desirable, even before 2020. They suggest a gradual phase-in of a harmonised quota scheme alongside national schemes.

"Europex considers an EU-wide market-based mechanism, namely a tradable green certificate scheme based on national quota, to be the most cost-effective instrument for RES deployment." - Europex response to the Green Paper consultation

NGOs and the RES industry tend to oppose high harmonisation degrees, and for similar reasons. The NGO interview respondent argues clearly against harmonisation, due to the differing framework conditions and the single energy market not having been realised yet. A certain level of coordination regarding design standards, or maybe even minimum harmonisation, could be desirable.

"About that premature harmonisation; if you have one instrument across all of the EU, and you have all of these barriers still existing, then what is going to actually happen is that it is not going to be developed in the right places, and you don't have the right market signals." - NGO respondent

EREC argues for minimum harmonisation, and already has clear ideas as to which framework conditions should be harmonised: support level calculation methodology, technology cost calculation methodology, IRR calculation methodology, and data reporting.

The respondent from DG Competition stated that the only assessment criterion relevant for them is compatibility with the internal market. Apart from this, they have no stake in the harmonisation discussion. This position led, in autumn 2013, to DG Competition putting forward a draft General Block Exemption Regulation in which tendering schemes (national, but open to all bidders from EEA countries) would have received favourable treatment.



3.2.4 Weighting of Criteria

Regarding the 2030 target discussion, the above section on stated pathway preferences shows that stakeholders are clearly divided into two camps. A main assumption in this multi-criteria decision analysis is that this disagreement is caused by some aspects of a future support scheme being more or less important to certain stakeholders. These differing preferences should manifest themselves in differing weights allocated by stakeholders to different assessment criteria. Table 7 gives an overview of the weights calculated from the information provided by the eight interview respondents. These figures should be considered indicative only. The qualitative information provided in the following sections gives a more complete picture of their underlying motivations, and of additional factors which could not be represented by the questionnaire methodology. Nevertheless, the standard deviations give an idea as to how much disagreement there was regarding a given criterion.

Table 7 Mean (ø) and standard deviation (σ) of weights allocated to criteria by interview respondents.

ECC L'	٦	
Effectiveness		
ø= 18.5%		
σ= 0.121		
Static Efficiency		
ø= 21.8%		
σ= 0.105		
Dynamic Efficiency	Portfolio diversification	ø= 11.4%
Ø= 21.4%		σ= 0.017
Ø= 21.4% σ= 0.069	Technology learning	ø= 10.1%
0-0.007	reclinology learning	$\sigma = 0.056$
		0 0.030
Equity		
ø= 8.2%		
σ= 0.06		
Environmental and economic effects	GHG emissions avoided	ø= 6.6%
- 11 20/		σ= 0.027
Ø= 11.3% σ= 0.045	Fossil fuel imports avoided	ø= 4.7%
0-0.043	Tossii ruei iiripoi ts avoided	$\sigma = 0.017$
		0-0.017
Socio-political acceptability		
ø= 11.3%		
σ= 0.059		
Legal feasibility	1	
ø= 7.4%		
σ= 0.037		



3.2.4.1 Clusters of and interrelations between criteria

One respondent describes how he clusters the criteria in his mind into two categories: He considers effectiveness, efficiency, and legal feasibility to be "hard" factors, while the remaining criteria are "soft". If the "hard" factors seem favourable for a given policy pathway, the "soft" factors will follow. Several other respondents use this terminology of "hard" and "soft", but there is some disagreement about whether soft criteria are really less important:

"...on the other hand, if you don't have public acceptance from the beginning, then the rest is no use."

Similarly, respondents do not necessarily assign the same criteria to the two categories. For instance, there is some disagreement as to how "hard" the *legal feasibility* criterion really is:

"What's legal and what's not can change, you know." NGO respondent

"Legal feasibility is the most difficult one. I either rank it very low, because I assume it as given, or very high, because if [a pathway] is not legally feasible under EU law, then it cannot be implemented." RES industry respondent

Regarding interrelations, the beyond2020 criteria report (D2.2, del Río et al., 2012b) dedicates its chapter 5 to a qualitative overview of relationships such as possible synergies and conflicts between the assessment criteria. Table 8 shows the summary of this assessment.

In a multi-criteria decision analysis, strong correlations between criteria should ideally be avoided in order to obtain a meaningful result. On the other hand, the criteria must cover all relevant aspects of the decision problem. The selection of assessment criteria in beyond2020 was made with this trade-off in mind.

Several respondents mentioned a relationship between the *equity* and *socio-political acceptability* criteria, interpreting the latter to be the more subjective criterion, depending more on perceptions than on hard facts. Similarly, some respondents see interrelations between these two criteria and *static efficiency*.



From (columns) /to (rows)	Effectiveness	Cost- effectiveness	Dynamic efficiency	Equity	Local impacts	Social acceptance	Political feasibility	Legal feasibility
Effectiveness						(indirect effect through political feasibility)	Regulatory stability as a result of politi- cal feasibility fa- vours deployment	
Cost- effectiveness			Innovation positively influences cost- effectiveness (tech- no-cost reductions)				Regulatory stability results in lower risk premium	
Dynamic efficiency	Market creation leading to learning effects and private R&D							
Equity					Local impacts have equity effects some of which are difficult to predict			
Local impacts	Deployment leads to local impacts		Creation of a local industry and impacts upstream the innovation process (technology diversity).				Indirectly through impact of political feasibility on effec- tiveness	
Social acceptance		Greater consumer costs reduce social acceptance		Distributive impacts of the support scheme affects social acceptance	Benefits of RES-E deployment results in social acceptance			
Political feasibility		High consumer costs make continuation of support scheme unlikely		Inequitable schemes are politically unfea- sible in the long- term	Greater local bene- fits make the con- tinuation of support politically feasible	Social acceptance is a crucial element of political feasibility		If the instrument is not legally feasible it can not be political feasibility. Not the other way around.
Legal feasibility								

Table 8 Illustrating the interactions between criteria. Source: D2.2 (del Río et al., 2012b)



3.2.4.2 Effectiveness

Effectiveness measures the degree to which a given renewables target is achieved in each policy pathway. As described in Table 2, a renewables target of 31.2% in 2030 was assumed in all pathways except pathway 5 (ETS only). Effectiveness is the one criterion which draws the widest range of opinions in both the stakeholder survey and the interviews, as it was assigned any rank between 1 (most important) and 7 (least important). The standard deviation shown in Table 7 is correspondingly high.

There is one group of stakeholders who assign a very low importance to the effectiveness criterion because they argue that a RES target is not necessary at all. Thus, even though the weighting methodology in the survey did not permit them to assign a weight of zero to this criterion, their qualitative statements indicate that this is actually their opinion. This group includes parts of the energy industry as well as energy-consuming industries. The underlying assumption is that if GHG emissions are not avoided due to RES, they will be avoided somewhere else in the system due to the overall GHG emissions target. The question of how much RES deployment is incentivised in a given policy pathway is therefore irrelevant.

Among those stakeholders who favour, or at least do not oppose a 2030 RES target, the effective-ness criterion receives mixed weightings. The NGO respondent explains that wide-scale RES deployment is a prerequisite for achieving learning effects, economies of scale, and thus the long-term success of RES. Having a target and achieving it is the best way of ensuring such wide-scale deployment. The respondent also expects pathways with lower harmonisation degrees to perform better with regard to *effectiveness*. The RES industry respondent, whose stated preference for policy pathways point in the same direction, ranks the criteria according to a different logic: Dynamic efficiency is the ultimate long-term goal and ranks highest, while *static efficiency* and *effectiveness* are means to achieve this goal, and are thus ranked second and third. One energy industry respondent is generally in favour of having a RES target, but only assigns a medium rank to it. He further points out that it is also not desirable to overachieve a given target, citing the German experience with PV as an example where effectiveness was much better than planned, resulting in high support costs.

3.2.4.3 Static Efficiency

Cost arguments have strongly dominated the harmonisation debate from the start, and have been thoroughly analysed (see Gephart et al. (2012) for an overview of studies). The term "costs", as used in the policy discussion on RES support, can refer to generation costs or support costs, either short- or long-term, depending on the speaker and context. Stakeholders often do not clearly distinguish between these cost categories. However, stakeholders arguing for a cost-minimising approach to RES support often mention the high burdens on energy consumers. This implies that they are referring to support costs in this context.

"We are really concerned about the cost and the price impact of the existing way of supporting renewables. Of course renewables will have to continue to play a growing role in the energy mix in Europe. No doubt. But Europe cannot afford the price it pays now, and the impact it has on industry at large." - European industry respondent

Technology-neutral support schemes are sometimes brought forward as a way to minimise "costs", and in this case the speaker is usually referring to generation costs. A fully harmonised technology-neutral quota (here: pathway 3a) featured prominently in discussions about harmonisation in the past for this reason. Numerous authors have since argued that a technology-neutral approach may minimise overall generation costs, but only leads to lower overall support costs if the respective cost-potential-curves are rather flat, i.e. if the desired target can be achieved solely using RES installations with very similar generation costs. In case of a steep curve, overall support costs would



actually be higher than necessary (see Bofinger, 2013 for a theoretical explanation; Gephart et al., 2012 for an overview of studies on the topic). Similarly, the "best sites" argument brought forward by many stakeholders also focuses on minimising generation costs:

"So far, considerable efficiency benefits have remained unused which would have resulted from a use of geographically especially suitable regions [...]." - BDEW response to Green Paper consultation

Higher harmonisation degrees would lead to RES installations being built at the best sites, in theory. Of course, in a technology-specific scheme, lower generation costs would also result in lower support costs. A common counter-argument to "best sites", however, is that resource availability is not the only, nor even the most important factor for an investor when choosing a site for a RES installation:

"And then of course if you just happen to have a country that has an awful planning system and it takes forever to get something built, [...] you end up having no renewables in those sorts of areas, as renewables will go where it is easiest." - NGO respondent

Generation costs, and as a consequence also support costs are also influenced by the administrative and political risks investors face at a given location.

The *static efficiency* (*cost-effectiveness*) criterion has not only played an important role in the harmonisation debate, but now also features very prominently in the argumentation of those stakeholders in favour of a single GHG emissions target.

"Static efficiency is definitely our priority. I am against this soviet style planning; the Commission loves targets and always wants to introduce targets [...]. This is the usual method for a government or a public authority to confirm afterwards that you've done this or done that. But we think cost-efficiency considerations have been lost in the course of this discussion. [...] It is our opinion that we could achieve similar results with much less money. This is a political learning curve [...]" Energy industry respondent

As a result, the *static efficiency* criterion tends to receive high weightings from most stakeholders, especially from parts of the conventional energy industry as well as electricity consumers. Even though on average, stakeholders who clearly favour ambitious RES deployment paths (NGOs and RES industry) clearly allocate less weight to this criterion, they still acknowledge its relevance, often ranking it in the medium range instead of very low. This is due to an assumed strong link between costs, their distribution, and social and political acceptability:

"I think the debate becomes sort of about your static efficiency question, and also about the equity question. You know, who is paying for the renewables support, and who is benefiting,..." - NGO respondent

Even stakeholders who are very concerned about *static efficiency* acknowledge that investments in the energy sector are necessary for decarbonisation, even though they should not be unnecessarily high.

"In any case, no matter which scenario we choose, it will be expensive, that's for sure. An energy transition costs lots of money. I personally think, and I am not the only one, that this is a slope we climb, we have done that in the past, these are learning curves, in a way. You have to climb the hill, and afterwards you have a different system which offers benefits, also for Europe as a [production] location." - Energy industry respondent

Stakeholders from either camp stress the need to create a binding, reliable framework to provide security for investments. In case of a RES target, investment security decreases support costs.



3.2.4.4 Dynamic Efficiency

As described in Table 2, *dynamic efficiency* in this analysis is measured by two sub-indicators: the diversity of the RES technology portfolio in 2030, and a technology-learning index which expresses the decreasing investment expenditures per unit of renewable energy produced.

This criterion is given the highest weight on average, both across all survey respondents as well as across the 8 interviewees, and with rather little disagreement between them. The rather high standard deviation shown in Table 7 is due to one outlier.

"I'd say the development of technologies is most important, independently of target achievement." - RES industry respondent

"It is obvious that we need big investments to start off the learning curve. And then we can talk about instruments, and about fair distribution." - Conventional energy industry respondent

A common explanation for the mostly high ranking is that long-term cost reductions and a diversified RES portfolio, will lead to achievement of the ultimate objective of decarbonisation. Respondents mostly agree on this. However, there are some disputes on how static efficiency can be improved. The energy industry respondent stresses that *dynamic efficiency* is especially important for immature RES technologies, and sees no trade-off with *static efficiency*, which applies more to mature RES technologies. To this end, R&D support for immature technologies is most appropriate to drive technology learning, while a RES target is not needed and market-pull instruments such as feed-in laws or quota schemes can be gradually phased out to let mature RES compete in the market. The RES industry and NGO respondents believe that a 2030 target will ensure the wide technology deployment that is a prerequisite for technology learning. A 2030 target is therefore desirable even if it comes at the cost of lower *static efficiency* in the time frame 2020-2030. The RES industry and NGO respondents also differentiate between mature and immature technologies, but seem to have a different opinion as to the degree of maturity at which support should cease for a given technology. They argue that a level playing field for RES (even mature ones) has still not been achieved due to a variety of market barriers.

Some stakeholders say that they do value *dynamic efficiency* highly, in the sense of technology learning, but that they are not necessarily interested in high RES portfolio diversity as an end in itself. Technology-neutral support, in their opinion, ensures fair competition between technologies. Separating these two sub-indicators was not originally foreseen in the questionnaire methodology, but these respondent's qualitative statements indicate that this is what they actually mean.

3.2.4.5 Equity

This criterion is one with which the respondents associate different concepts. In the multi-criteria analysis, we define equity as the extent to which benefits and costs of RES deployment differ across Member States. This is the most appropriate definition for our specific purpose, given data availability and the concrete research question. However, equity might also be defined as the extent to which benefits and costs are distributed among different consumer groups. Says one NGO respondent: "...and that brings us to the heavy energy users, because I think they actually benefit a lot from renewable energy users due to the decreasing wholesale electricity prices across Europe."

One respondent mentioned that the equity criterion was difficult to rank because this problem does not exist yet in reality, and it is difficult to estimate how serious equity effects would really be. Possibly because *equity* has not yet been an aspect which has been widely discussed in the political debate so far, this criterion receives rather low rankings from the interview respondents, and tends to get medium to low rankings from all survey respondents as well. One of the few exceptions is the interview respondent from a municipal utility, who states that equity is an important criterion for them, as they feel responsible for ensuring that the citizens of their municipality get what they pay for.



3.2.4.6 Environmental and Economic Effects

Environmental and economic effects are represented by two sub-indicators: Firstly, the GHG emissions and secondly, the fossil fuel imports avoided due to RES installed in the analysed time frame (2021-2030). The interview respondents report some difficulty in ranking this criterion, which is probably why it gets rather mixed weights from the survey respondents overall.

Regarding avoided GHG emissions, several interview respondents indicate that under the current energy and climate framework, the GHG target and the RES target interact with each other and should in the future be better aligned. One respondent wonders whether avoided GHG emissions should even appear in the list of criteria, because achievement of the environment objective "should be outside of the evaluation, it is kind of the headline of it all." While it is true that, as mentioned before, the ultimate objective is decarbonisation, the question of how much decarbonisation should come from RES rather than from other technologies is still hotly debated. As one beyond2020 workshop participant argued, under a GHG emissions target with a functioning ETS, RES deployment will have no effect on how many emissions are avoided overall. Whatever is not avoided due to RES will be avoided somewhere else in those sectors included in the ETS. This is one of the main arguments used against a 2030 RES target. One common counter-argument from proponents of a RES target is that the effective functioning of the ETS in the future is questionable, judging from the experience so far. Furthermore, even in case of a 2030 RES target, the design of the support scheme(s) can have an effect on where the RES installations are built, which conventional capacities they replace, and thus which amount of GHG emissions is avoided.

Regarding fossil fuel imports, one energy utility respondent mentions that his company has taken precautions against having to buy natural gas on international markets, and that this sub-criterion is thus not relevant for him. All of the interview respondents, and the majority of all survey respondents indicate that avoided GHG emissions are more important than avoided fossil fuel imports, no matter how much weight they put on the overall criterion.

The respondent representing the energy user industry indicates that he would have liked to see additional cost impacts of RES on industry, including possible job losses and other negative effects. While this would indeed be an interesting aspect to cover, the necessary data for this analysis are not available in beyond2020.

3.2.4.7 Socio-Political Acceptability

This criterion takes into account the political attractiveness of a given policy pathway. Several respondents mention that they see strong links to other criteria. However, while other criteria cover the "actual" values a given policy pathway takes, the *socio-political acceptability* criterion depicts a more subjective aspect. The same costs or environmental effects may be more or less politically acceptable in different Member States, depending on the individual willingness to pay, the way the issue has been communicated to the electorate and to politicians, or because of historical preferences for certain instruments or technologies.

"Equity and socio-political acceptability are related in my opinion, because a system will be accepted if the distribution is fair. But I would place acceptability higher, the subjective feeling..." - RES industry respondent

"And then, there's politics. We have to see this pragmatically. Some things are slowed down or become impossible because of elections, or due to strategic publications and decisions." - Energy utility respondent

This criterion tends to get medium to low rankings from the interviewees as well as from all survey respondents, with some exceptions.



3.2.4.8 Legal Feasibility

As mentioned in section 3.2.4.1, some respondents found it quite difficult to rank the *legal feasibility* criterion, as it is difficult to judge how hard a constraint legal requirements really are. Even the legal analysis (D3.1 and D3.2) does not give an absolutely clear answer to this question, as there are different possibilities to interpret the relevant legal texts.

However, most respondents, both in the survey and in the interviews, chose to allocate a rather low rank to this criterion. How important a respondent assumes this criterion to be is probably linked to his or her training. Many of the survey and interview respondents have a technical or economics background which may have led to their focussing on the more familiar criteria. However, some interview respondents also believe that the legal framework is a "soft" factor which can be adapted when necessary:

"This is the softest issue of all. Even when it is written down as hard, these are things that can be changed later on with a certain consensus." - Energy utility respondent

Other respondents do think that the legal framework could become a very hard constraint under certain circumstances. In the analysis, this issue is taken into account by running two varieties of the PROMETHEE calculation. In the first variety, the legal aspects are assumed to be a soft factor which can be adapted if a policy pathway is really attractive. All policy pathways are thus included in the calculation. In the second variety, the legal framework is assumed to be a hard constraint, and all pathways with questionable legal feasibility are eliminated from the analysis. The PROMETHEE calculation is then carried out with a short-list of only those pathways which are legally feasible.

3.2.4.9 Decision maker prototypes

The multi-criteria decision analysis will be conducted with differing weighting vectors, representing the preferences of different decision maker types. Their weightings will result in different preference rankings of policy pathways. It is important to emphasise that the objective of the analysis is not to identify the one "correct" preference ranking or to predict political decisions taken for or against a given pathway. The idea is rather to explicitly link stakeholders' policy preferences to the importances they (implicitly) assign to criteria. The analysis shows which criteria cause the biggest disagreement and which pathways could offer potential for compromise. For this purpose, three decision maker prototypes are created, representing rather extreme positions in the spectrum of opinions:

- The Cost-concerned: This type puts most emphasis on the costs incurred due to the deployment of RES. The concern with costs in the short/medium term is expressed in the high weight allocated to static efficiency, while a strong interest in long-term cost reductions results in a high weight being put on dynamic efficiency. This decision maker is in favour of a single GHG emissions target, and the effectiveness criterion is therefore irrelevant. In his opinion, any GHG emissions not avoided by RES will be avoided somewhere else in the system due to the ETS.
- The Environmentalist: This type puts most emphasis on the short- and long-term development of RES, which is expressed in high weights allocated to the effectiveness and dynamic efficiency criteria. This type also believes that the contribution of RES is needed in the EU's overall GHG emission reduction efforts, already in the short/medium term. This leads to a significant weight put on environmental effects (GHG emissions).
- The Pragmatic: This type is most concerned about whether a pathway is politically feasible and politically acceptable.

The three prototypes are based on the ranking/weights provided by questionnaire respondents, as well as the qualitative interview data summarised above. Sensitivities are carried out in the multi-criteria analysis by varying the weighting vector of the three prototypes.



Table 9 Decision maker prototypes and their weighting vectors

		The	The	The
		Cost-Conscious	Pragmatic	Environmentalist
Effectiveness				20%
Static efficiency		45%	20%	
Dynamic effi- ciency	Portfolio Diversity	15%	10%	25%
	Technology Learning	15%	10%	15%
Equity		15%		5%
Environmental and economic effects	avoided GHG emissions			25%
	avoided fossil fuels	10%		10%
Socio-political acceptability			30%	
Legal feasibility			30%	

3.3 Preference rankings of policy pathways

This section shows the preference rankings produced by the PROMETHEE model on the basis of above-mentioned input data. As mentioned earlier, the cost argument has been dominant in the policy discussion, with stakeholders alternating between or mixing different definitions of "costs", depending on the angle from which the problem is viewed. These definitions do have implications on the policy discussion (del Río and Cerdá, 2014). To take into account these different perspectives, two versions of the multi-criteria analysis are conducted and compared:

- Consumer perspective: Burdens on energy consumers are frequently mentioned by stake-holders when discussing costs, usually with reference to the competitiveness of European energy-intensive industry, equity concerns, and excessive burdens on poorer private house-holds. Therefore, a consumer perspective is taken here, focussing on financial burdens in the form of support costs to RES, or in the form of higher electricity and GHG certificate prices in case of the ETS-only pathway. Specifically, the indicator for the *static efficiency* criterion in this case is defined as the average annual <u>support costs</u> incurred by new RES generation plants from 2021-2030. The ETS pathway is a special case in this respect. It results in very low support costs to RES, due to very few RES being deployed. However, this leads to the average electricity market price being higher than in the other pathways. In addition, the GHG certificate price under this pathway will be higher than under the pathways with well-coordinated emissions and RES targets. These two effects constitute financial burdens on consumers and are taken into account here.
- Broader system perspective: A different interpretation of "costs" centres on the equimar-ginality principle, and subsequently a minimisation of generation costs. Some economists would also use the term "welfare perspective" for this case. In past policy discussions, proponents of a technology-neutral approach to RES support have usually based their argumentation on this cost interpretation. In contrast to the above consumer perspective, this perspective does not take into account distributive effects between buyers and sellers of ener-



gy in the form of producer rents. In our analysis of this perspective, the indicator for the *static efficiency* criterion is defined as the average annual generation costs of new RES generation plants from 2021-2030.

Data for all other criteria remains the same under both perspectives. Most economists will probably consider the broader system perspective more relevant. However, we will put more emphasis on the consumer perspective in the following analysis, for the simple reason that the impact of support costs on consumers is such a dominant factor in the policy discussion. It can be expected that considerations regarding support costs, not generation costs, will be what drives future policy decisions regarding renewables.

Some special provisions are taken regarding the way the *legal feasibility* and the *socio-political feasibility* criterion interact: As shown in Table 3, a number of pathways receive zero points ("difficult/impossible") in the *legal feasibility* assessment, meaning that unanimity in the European Council would be required to implement this pathway. If under the *socio-political feasibility* criterion, one or more Member State respondents have indicated that this same pathway would be "highly unlikely to be politically acceptable in my country" (score: 1), then unanimity cannot be achieved and the pathway cannot be implemented. In the PROMETHEE calculation, this is taken into account by penalising all such pathways with an overall score of zero for the *socio-political acceptability* criterion.

Unanimity in the Council is theoretically possible, but rather unlikely. As explained in section 3.2.4.8, two varieties of the PROMETHEE analysis are provided to take account of this fact. Figure 2 demonstrates the resulting PROMETHEE I preference ranking if the policy pathways with low *legal feasibility* are considered possible and the full range of pathways is therefore included in the analysis. Figure 3, in contrast, shows the ranking if unanimity in the Council is considered so unlikely as to be virtually impossible, and all pathways with low *legal feasibility* are excluded from the analysis. This affects all pathways under full and medium harmonisation (FITful-1a, FITmed-1b, FIPful-2a, FIPmed-2b, QUOful-3a, QUOmed-3b, QUBful-4a, and QUBmed-4b)), as well as the tendering pathway (TEN-6) which foresees harmonised tenders for large-scale installations.

3.3.1 The consumer perspective

The ranking of all 16 pathways is given in Figure 2, with the positive and negative (Φ, and Φ) flows provided for each pathway. These flows result in a ranking of pathways in a PROMETHEE I partial pre-order. The figure shows that quota schemes, both technology-neutral and banded, at full or medium harmonisation (pathways QUOful-3a, QUOmed-3b, QUBful-4a, and QUBmed-4b) tend to rank low for all decision maker prototypes. Even the Environmentalist and the Cost-Conscious, who both do not take into account legal feasibility in their weighting, agree on this. This means that even if these pathways were legally feasible, they are still unlikely to be preferable for any decision maker. Regarding the ETS (5) pathway, it is not surprising that it ranks last for the Environmentalist, who finds effectiveness and dynamic efficiency very important. For the Pragmatic, this pathway ends up in the middle range, while for the Cost-Conscious, it is incomparable. In the PROMETHEE I partial pre-order, incomparabilities arise if a pathway does very well in one criterion, but very poorly in another. The Cost-Conscious put a lot of emphasis on static efficiency, and some on equity, in both of which ETS (5) is the best-performing pathway. However, dynamic efficiency also has significant weight, and ETS (5) performs rather poorly here. Under PROMETHEE II, the pathways can be forced into a complete pre-order which ignores such incomparabilities. In this case, the Cost-Conscious ends up with ETS (5) as the top-ranking pathway. The full- and medium-harmonised FIT pathways (FITful-1a, FITmed-1b) also get top rankings. This may seem surprising at first, but these two pathways are characterised by good performance under the static efficiency, equity, and dynamic efficiency criteria, all valued highly by the Cost-Conscious.



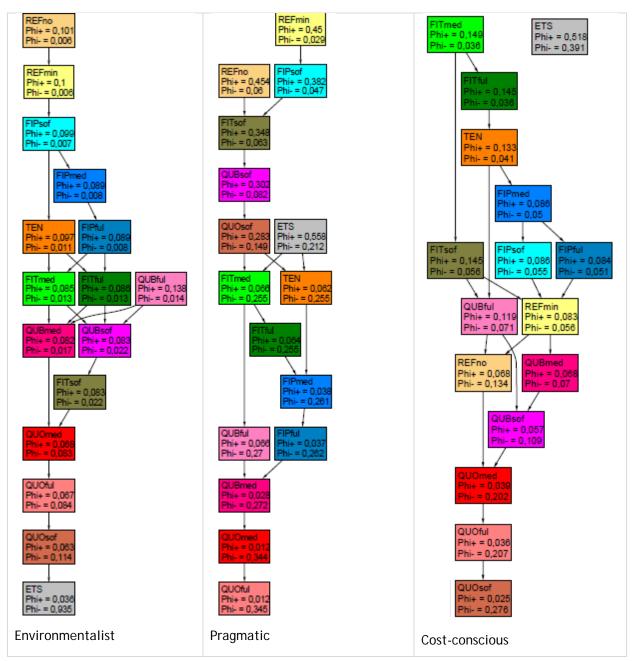


Figure 2 Consumer perspective: PROMETHEE I (partial pre-order) with the full range of pathways and three decision maker prototypes. ETS pathway takes into account other consumer costs.

In a next step, all legally questionable pathways are excluded from the analysis. The PROMETHEE I ranking of only the short-listed legally feasible pathways in Figure 3 show that the Environmentalist and the Pragmatic end up with the same three top-ranking pathways: no harmonisation (REFno-7), minimum harmonisation (REFmin-7d), and a FIP under soft harmonisation (FIPsof-2c). The ranking for the Cost-Conscious looks different, with ETS (5) and a FIT under soft harmonisation (FITsof-1c) ranked at the top. FIPsof (2c) comes in third, however. It seems that under a consumer perspective, this is a pathway which offers potential for compromise between the three very different stakeholders.

PROMETHEE also allows to model group decisions. We use an algorithm by Macharis et al. (1998) to produce a combined ranking of the three decision makers. It is possible to assign weights/voting rights to the decision makers to express possible power imbalances between them. However, we do not attempt to quantify such power relations here. Instead, it is assumed that the three decision makers are equally strong and their views contribute a third each to the group decision. In the



PROMETHEE II complete pre-order for the group, minimum harmonisation (7d) ranks at the top, followed by non-harmonisation (7) and FIPsof (2c).

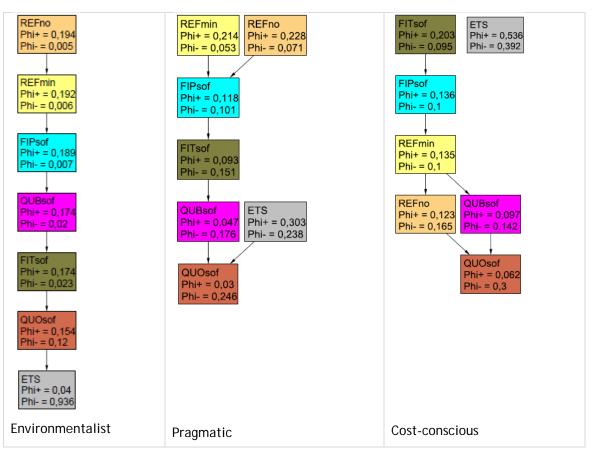


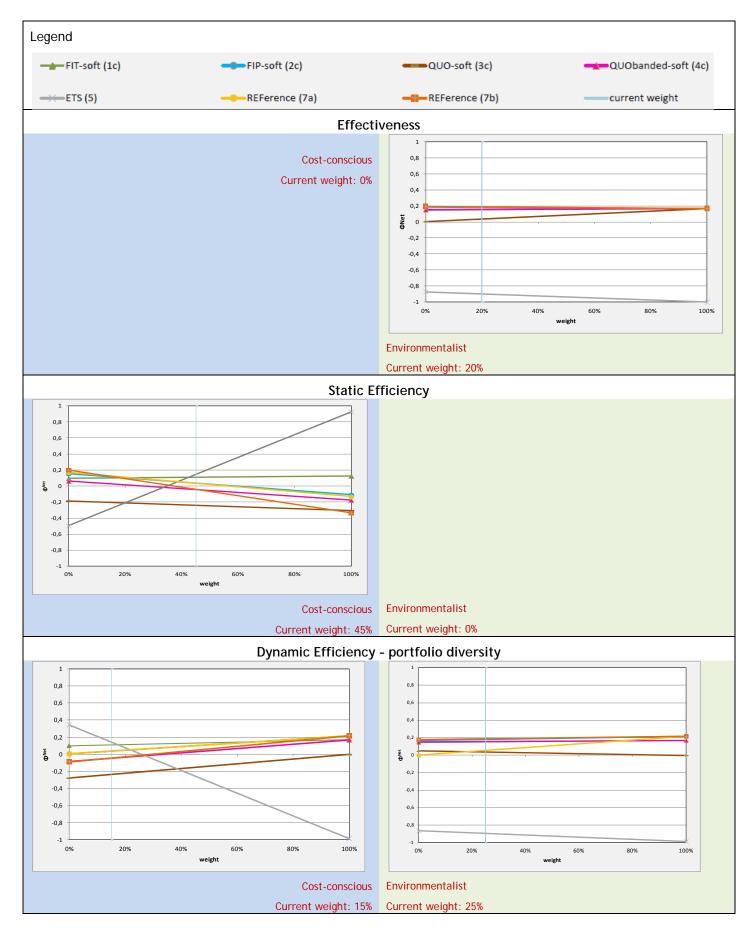
Figure 3 Consumer perspective: PROMETHEE I (partial pre-order) with only legally feasible pathways and three decision maker prototypes. ETS pathway takes into account other consumer costs.

Of course, the criteria weighting vectors used for the three decision makers are an attempt at quantifying subjective preferences which are hard to quantify. One should therefore keep in mind that the results might look different if the weighting vectors were changed. A walking weights sensitivity analysis is shown below to illustrate how PROMETHEE II preference rankings would vary if the weights of criteria were shifted. Each graph shows the effect of varying the weight of one given criterion from 0% to 100% while leaving the weight of the other criteria constant in relation to each other. The net flow (Φ_0) is shown on the y-Axis. The higher the Φ_0 value, the more preferable the pathway. The sensitivity analysis therefore yields a different picture for each decision maker. For simplification, only the Environmentalist and the Cost-Conscious are shown here, for those criteria where the allocated weight was not zero.

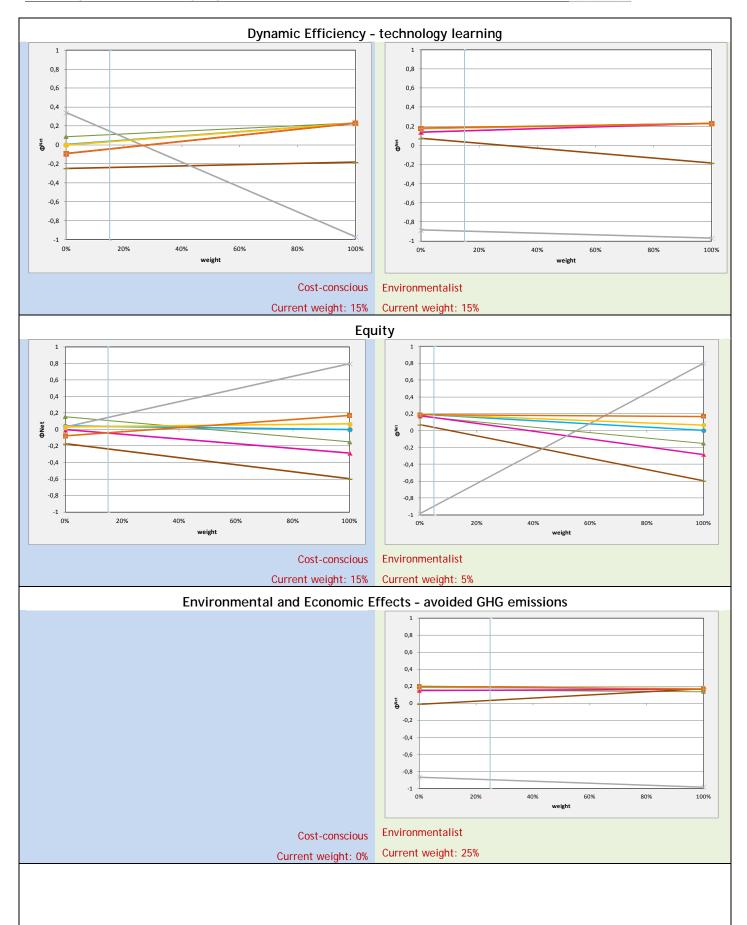
Figure 4 shows that if the *effectiveness* criterion were varied between 0% and 100%, this would not have a big effect on the Environmentalist's ranking. Minimum harmonisation (7d), closely followed by no harmonisation (7) are always the top-ranking pathways. The ETS (5) pathway always has the lowest ranking, no matter which weight the *effectiveness* criterion takes. The Cost-Conscious does not view this criterion as relevant and has allocated zero weight to it.

Static efficiency is the most important criterion for the Cost-Conscious, with 45%, which makes ETS (5) the most preferred pathway. If the criterion's weight increased, this does not change. However, if the weight is moved to any less than 44.2%, ETS (5) loses its top rank. The Environmentalist does not view this criterion as relevant and has allocated zero weight to it.











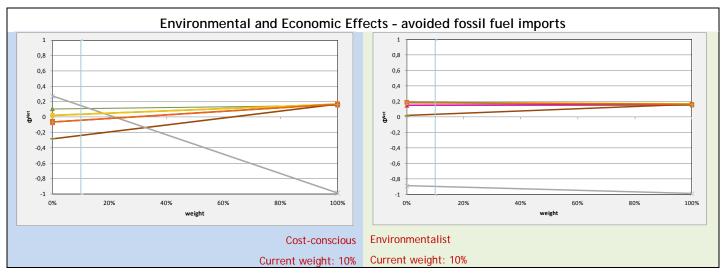


Figure 4 Walking weights sensitivity testing for the Cost-Conscious and the Environmentalist

Dynamic efficiency is very important to both decision makers. For both sub-criteria (portfolio diversity and technology learning), the result is stable for the Environmentalist. Non-harmonisation (7) always stays the most preferred pathway, no matter how the *dynamic efficiency* weights are varied. For the Cost-Conscious, an increase in the weights of currently 15% would result in ETS (5) losing its top ranking position – at a weight of around 17.5% in case of both sub-criteria.

The ETS (5) pathway performs best in the *equity* criterion. If the weight is shifted from currently 5% for the Environmentalist to around 62%, non-harmonisation (7) would be replaced by ETS (5) as the top-ranking pathway. In case of the Cost-Conscious, the weight of equity criterion is reduced from the current 15% to 11.6%, FITsof (1c) becomes the most preferable pathway.

The Environmental and Economic Effects criterion also has two sub-criteria, avoided GHG and avoided fossil fuels. For the Cost-Conscious, the first one is not relevant. He puts a weight of 10% on the second, resulting in ETS (5) being the most preferred pathway. If the weight is increased to 12.7%, FITsof (1c) moves to first place in the preference order. The Environmentalist takes both sub-criteria into account. Non-harmonisation (7) and minimum harmonisation perform very similarly in both sub-criteria, but with the current weight setting, 7d is preferred. The two pathways switch places at a weight of 46.2% for avoided GHG emissions, and at 60% for avoided fossil fuels.

Overall, the walking weights sensitivity testing shows that the results for the Environmentalist are rather stable. Weights would have to be shifted substantially to arrive at a different preference ranking. The low ranking of the ETS (5) pathway is especially clear. The Cost-Conscious, on the other hand, reacts more sensitively to changes in his weighting vector. He tends to put more weight onto those criteria in which the ETS (5) pathway performs well. As this pathway is a rather extreme pathway with very good performance in some and very bad performance in other criteria, it often changes from worst- to best-ranked pathway as a given criterion is shifted. The Cost-Conscious' weighting vector just about leads to a preference for the ETS (5) pathway. However, if the weight on static efficiency were just a bit lower, or the weights on the dynamic efficiency sub-criteria just a bit higher, FITsof (1c) would rank first.



3.3.2 The broader system perspective

Only the short-list version of the PROMETHEE I ranking is shown in figure 5. The ranking for the Environmentalist looks exactly like it does in the consumer perspective above, as this decision maker puts zero weight on the *static efficiency* criterion. A switch in focus from (short- to medium-term) support costs to generation costs therefore does not affect his preference ranking. For the Pragmatic, non-harmonisation (7) and minimum harmonisation (7d) are most preferred. The ETS (5) pathway is incomparable, but would come in third if forced into a complete pre-order under PROMETHEE II. Similarly, ETS (5) is incomparable for the Cost-Conscious decision maker, but would be the topranking pathway in PROMETHEE II, followed by minimum (7d) and no harmonisation (7d).

Pathways 7d and 7 are thus always among the three most preferred pathways for all decision makers. Contrary to the consumer perspective, the picture is not so clear for FIPsof (2a). When looking at the PROMETHEE II complete ranking, this pathway is in third place for the Environmentalist, fourth for the Pragmatic, and only fifth for the Cost-Conscious.

A group assessment - assuming that all three decision makers have equal strength in influencing the decision - would result in non-harmonisation (7) ranked first, followed by minimum harmonisation (7d) and FIPsof (2a).

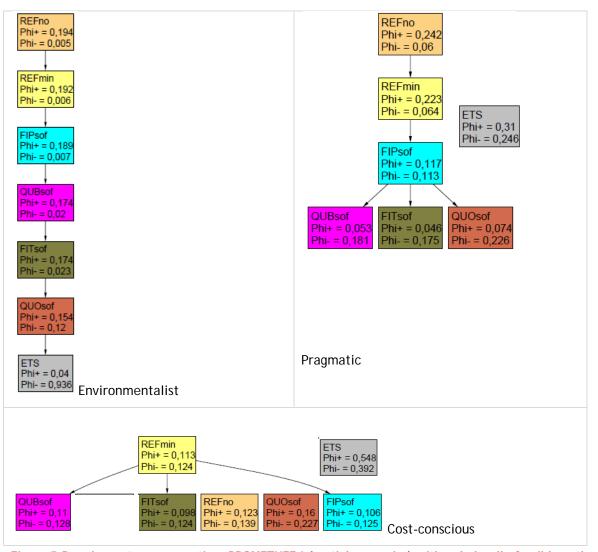


Figure 5 Broader system perspective: PROMETHEE I (partial pre-order) with only legally feasible pathways and three decision maker prototypes.



4 Interactions with other policy areas

This chapter covers overarching issues related to harmonisation, which could not be meaningfully quantified for each pathway within beyond2020. They are therefore not included in the MCDA, but are nevertheless relevant. The harmonisation of RES(-E) support affects and is affected by other European policies and strategies, including:

- Long-term European climate policy
- Innovation policy
- Industrial policy
- Relations to third countries regarding RES-E imports

While the first topic is covered in a separate document (D6.1b - see Box 1 for an overview), the latter three shall be detailed in the following sections.

4.1 Innovation policy

Innovation in renewable energy technologies is a main element to achieve renewable energy targets beyond 2020 in an effective and cost-effective manner. Obviously, this requires a combination of policies. In particular, in addition to the deployment support provided under the 16 beyond2020 policy pathways, a targeted support for innovation (R&D) is needed. Exploring the interaction between deployment support and other innovation policies is the aim of this section.

4.1.1 Technological change

Technological change involves several stages, with feedback loops between them. Technological change is a complex process with several stages. The first stage, research and development, is typically followed by a gradual move into demonstration projects or prototypes. The subsequent commercialisation phase provides market experience to tailor the product to consumer demand, explore smart ways of manufacturing the product and accumulating experience and production scale to reduce costs. This can ultimately generate the right conditions for widespread deployment and diffusion of the product (Neuhoff and Dröge, 2009).

According to the linear model of technological change, technologies subsequently pass from one stage to another but without interactions between stages (Kline and Rosenberg, 1986). In contrast, the systemic model of innovation stresses the relevance of feedback loops between stages (Rip and Kemp, 1998). For example, post-adoption technical challenges stimulate innovative activity (Taylor et al., 2005). Together with R&D investments, learning effects are an important source of technological change. These take place mostly in the diffusion stage and involve the acquisition of new skills, technology or processes during the production process (learning by doing) and technological advances that occur during utilization of the product (learning by using) (Popp, 2006).

A multitude of instruments are applied to stimulate innovative activity. A traditional classification of instruments in the economics of innovation survey is that between technology-push and market-pull policies. The former influence the supply of new knowledge, whereas the later affect the size of the market for a new technology (Taylor, 2008). Although this classification has been deemed simplistic, it is quite illustrative and agrees to some extent with the classification of environmental policy and technology policy measures. The former subsidise technology development directly, e.g. through public R&D funding, while the later create indirect incentives for investments in technology development by creating markets for emerging technologies. It is commonly acknowledged now that neither is sufficient and both are helpful for innovation to occur (Neuhoff and Dröge, 2009)(Bürer and Wüstenhagen, 2009).



4.1.2 The triple externality problem and the plea for policy mixes

From an economic point of view, whether policies should be implemented depends on the types of market failures they are expected to correct. Two main market failures to low-carbon technologies in particular have been considered in the literature, often referred to as the "double externality problem" (Rennings, 2000)(Fischer and Newell, 2008; Jaffe et al., 2005): an environmental and a technological externality. A third group would encompass market failures not included in those two categories. To these market failures, undisputed among economists, one can be added: positive externalities in deployment.

The environmental externality refers to firms not having to pay for the damages caused by their GHG emissions which, in turn, results in a low incentive for low-carbon technological innovation. While a carbon price is an appropriate instrument to internalize the negative environmental externalities related to CO2 emissions, it is unlikely to address the other externalities (i.e., market failures) in the innovation process.

There is a technological externality which is related to spillover effects enabling copying of innovations, which reduces the gains from innovative activity for the innovator without full compensation. In other words, firms are unable to fully appropriate their R&D. Basic research has especially high spill-over rates. This "innovation externality" does not only relate to R&D, but also to demonstration (del Río, 2011).

In addition, there is a (positive) deployment externality. This is related to the increased deployment of a technology which results in cost reductions and technological improvements due to learning effects and dynamic economies of scale (Stern, 2007). Even companies that did not invest in the new technologies themselves can benefit from these insights and produce the new technology at low costs. Although investors can partially capture these learning benefits, e.g. using patents or their dominant position in the market (Neuhoff and Dröge, 2009), the initial investor does not capture all these learning benefits. Thus, investments in the new technology will stay below socially optimal levels. Learning is certainly a source of innovation and cost reductions but it does not come freely. It is the result of previous investments. Note that this implies circularity: diffusion is endogenous to the level and evolution of costs, but costs are also affected by the degree of diffusion.

The relevance of the innovation externality is very high in the first stages (i.e., R&D) and decreases as we move downstream in the innovation process, i.e., to the diffusion stage where technologies are already mature. In contrast, the environmental externality is relatively more important in the diffusion stage. Thus, it seems clear that in the initial and final stages, instruments should predominantly tackle the innovation and environmental externalities, respectively. Between those two extremes, there is the so-called "valley of death" (International Energy Agency (IEA), 2008; Taylor, 2008), a term that highlights that it is difficult for some technologies in the post-demonstration stage to reach commercialisation as a result of their higher costs compared to their higher-carbon competitors. The deployment externality usually plays a major role in this intermediate stage of the innovation process, i.e., for technologies which have passed demonstration but are in the precommercialisation, and even in the initial phase of commercialization, and for which a large cost reduction potential with increased diffusion exists.

Accordingly, the role of government changes along the low-carbon technology pipeline. Indeed, insights from the economics of innovation shows that the role of government is often most effective when it combines "supply-push" support (i.e., focus on R&D and technology standards) with "demand-pull" instruments (i.e. a focus on influencing the market through economic incentives, such as those described in the beyond2020 policy pathways). To determine the appropriate support instrument for each technology, its specific characteristics have to be taken into account, including its maturity level, costs, potentials for cost reductions and main sources of technological change (i.e., whether R&D or learning effects from deployment dominate). The value of technological diversity is greatest in the first stages of the technological change process, when technological uncertainty is high. Instruments in this case should aim to put technologies on the shelf (Sandén and Azar, 2005).



In later stages (diffusion), standardisation due to competition is more appropriate, i.e., once technologies are already on the shelf, an instrument should be applied to allow their selection and diffusion. Governments should be as neutral as possible at this stage. A price signal creates competition between mature technologies, ensures that the cheapest are selected, and reduces the risk of "picking winners". In contrast, creating competition between immature technologies may be counterproductive and lead to a premature selection (Sandén and Azar, 2005). Some of the controversy around future RES support is caused by stakeholders' different perceptions on whether most RES technologies (and which) have already reached this diffusion stage and should thus be exposed to full technology competition. In the MCDA, the dynamic efficiency criterion includes a sub-criterion on technological diversity, which is to be maximised. The underlying assumption is that RES overall are still at an earlier stage where "putting technologies on the shelf" is important.

4.1.3 Synergies and complementarities between innovation and diffusion policy instruments

While it is obvious that a combination of deployment and R&D is needed, the question remains as to the appropriate balance between the two.Learning-by-doing and R&D investments are two main sources of technological change. The former refers to repetitious manufacturing of a product leading to improvements in the production process and costs reductions in the technologies. Both factors allow technologies to improve their quality and reduce their costs and are complementary in addition to carbon prices (Bosetti et al., 2011). Some authors argue that, with respect to some technologies (mostly solar PV), too much public support has been dedicated to deployment and less than what would have been socially optimal has been devoted to R&D (Frondel and Ritter, 2010). There seems to be a widespread consensus that past and current levels of public (and private) investments in renewable energy R&D are too low to address energy-related concerns, including climate change (Mitchell et al., 2011).

The bulk of public R&D expenditures in renewables in IEA countries is currently dedicated to solar PV (about 35%, 542 million USD in 2010) and wind (about 30%, 424 million USD)(IEA, 2012). Expenditures on CSP, ocean, geothermal, hydro and bioenergy are very similar (in the range of 101-130 million USD each)(IEA, 2012). These R&D expenditures are clearly lower (in fact, a very small fraction) than expenditures on deployment, i.e., compare those figures with the US\$ 66 billion of global subsidies to renewable power world-wide (IEA, 2011a).

Some economists are skeptical about the existence of a deployment externality and, thus, they only justify a carbon price and R&D support and, thus, are critical direct deployment support (see, e.g., (Frondel and Ritter, 2010, 2008)). However, R&D spending without the acquisition of experience through deployment that involves learning will make the technology harder to implement on a wide scale (Sagar and van der Zwaan, 2006). To the best of our knowledge, there is no study indicating the optimal share of funds that should be dedicated to either R&D support or deployment support in order to encourage the greatest technology cost reductions per € of support.

In addition, both deployment and R&D have been treated as if they were isolated from each other when in reality they interact in complex ways. There are positive feedbacks between the two. RD&D leads to cost reductions, make the technologies more attractive for potential adopters, encourages diffusion and, thus, reinforces advancements of technologies along their learning curves (Watanabe et al., 2000)(Anna Bergek and Jacobsson, 2010). Learning effects as a result of deployment reduce costs and promote diffusion, leading to more dynamic markets for renewable energy technologies. In turn, market creation makes RD&D investments in those technologies more attractive. Indeed, empirical studies have shown that private RD&D investments are an important side-effect of deployment policies (Lee and Lliev, 2009; Watanabe et al., 2000)(Johnstone, N et al., n.d.), in a context of relatively modest and stagnant direct public RD&D support in renewable energy technologies (IEA, 2008 b) (Ek and Söderholm, 2010). Private RD&D account for a large share of total RD&D in the RES-E sectors. Of course, there might also be conflicts. Deployment may crowd out private R&D. For



example, according to Hoppmann et al (2013), FITs incentivized German firms to shift resources towards new production capacities and away from long-term R&D.

Capturing those interactions is key to identify the overall innovation effects or innovation dimensions of different policies. As explained above, two important dimensions govern the innovation landscape, technological diversity and competition. A policy affecting one of those innovation dimensions also influences others. Figure 6 depicts this basic model.

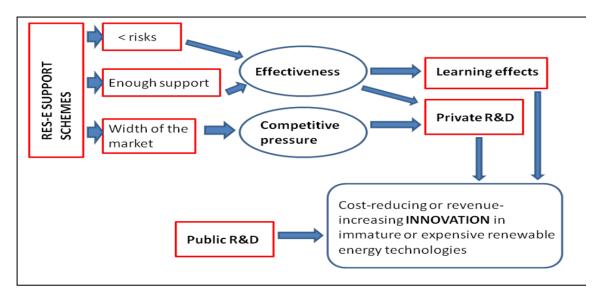


Figure 6 Illustrating our model of the innovation effects of RES-E deployment instruments. Source: Own elaboration

The creation of a market for the most immature / most expensive technologies leads to a greater degree of technological diversity, since the penetration of the mature ones is easier. Obviously, RES-E support schemes influence effectiveness in the deployment of those technologies by providing enough support, i.e., support levels for immature or expensive technologies which are above their costs and reasonable risks for investors. The policy risks might be related to the instrument. For example, revenue risk is generally greater with TGCs than with FITs, since in the first case the revenue stream depends on the uncertain and sometimes volatile TGC price. But they may also be unrelated to the instrument. For example, constantly changing the support scheme or main design elements of the scheme would result in policy instability which is certainly not attractive for investors. As mentioned above, the existence of a market (effectiveness in deployment) is crucial to allow technologies to exploit their cost-reduction potentials through learning effects. But it is also very important in order to induce private R&D investments, both due to demand-pull (existence of a market in which innovators can sell their products) and supply-push (existence of profit margins which can be reinvested in innovation) factors. Both learning effects and private R&D are a main driver of innovation and cost reductions.

Competitive pressure is also a main determinant of innovation activity and it can also be induced to a greater extent by some instruments. While the literature on RES-E support schemes has traditionally argued that TGC schemes and auctions provide more competitive pressure to reduce costs, this pressure is not totally absent with FITs, particularly under some FIT designs such as degression. An incentive to increase the production efficiency is also present under FITs. Competitive pressure is thus a driver of private R&D and, thus, innovation.



Table 9 summarises the results of a systematic review on national RES-E support schemes and their innovation effects. The results are structured according to support instrument. Harmonisation degrees are not taken into account. Given that no instrument fulfils all the innovation dimensions and that the literature argues in favour of instrument combinations to support technologies with different maturity levels, with FITs for the immature, more expensive technologies, and TGCs for the mature ones (IEA, 2011b)(Midttun and Gautesen, 2007)(International Energy Agency (IEA), 2008), we may ask whether a combination of deployment instruments is desirable from the perspective of innovation effects.

Previous research has shown that a combination of demand-pull (deployment instruments) and supply-push policies (public RD&D) are more effective in promoting innovation than just one type of policy on its own (Mickwitz et al., 2008). Thus, public RD&D investments are needed in addition to a RES-E support policy since the former generate variety in the system while the later help to select among the different options (Foxon and Pearson, 2008; Vollenbroek, 2002). Even FITs are no substitutes for public R&D investments, given existing market failures in R&Dinvestments. In particular, although deployment policies induce private R&D generally, they are unlikely to promote basic and applied science. They are likely to promote incremental innovation. Only technology-push support (public R&D support) is able to incentivise non-incremental innovation (Peters et al 2011, Nemet 2009). Thus, public R&D should be combined with deployment incentives.

Finally, some of the drawbacks of the deployment instruments with respect to specific innovation effects/dimensions can be mitigated with the use of different design elements, not different instruments. Indeed, only looking at instruments is not enough to analyse the innovation effects of RES-E support, since their impact is mediated by their design elements. Both the RES-E literature (International Energy Agency (IEA), 2008) and the innovation literature (Rogge et al., 2011) have argued so. However, space limitations prevent us from discussing the innovation effects of FIT and TGC design elements. This is a fruitful area for future research. An initial attempt has been made by (del Río, 2011).

To sum up, taking into account the stylised model shown above, it can be argued that FITs and, to a lesser extent, FIPs are more likely to induce innovation as a side-effect of deployment than quotas with TGCs, mostly as a result of market creation. The main impact of TGCs on innovation is likely to be felt through the competition dimension. However, competitive pressures to reduce the costs of the technologies and/or to increase their productive efficiency are also present in FITs and FIPs. Whether they are present to a larger or a smaller extent than with TGCs is an empirical issue worth researching in the future.



Table 10 Empirical findings of the literature on RES-E support with respect to different innovation dimensions

Instrument	Diversity	R&D investments	Learning effects	Technological competi-	Risks
				tion	
FITs	*Technological diversity. FITs have led to a diversified renewable energy technology portfolio in Spain, Denmark and Germany (del Río González, 2008) (Lipp, 2007). FITs are easily differentiated by maturity level, costs, project size, location and resource quality. *Diversity of project sizes in the above countries. FITs have caused a fast shift towards distributed resources and smaller-scale systems installed by smaller firms (Mendonça, 2010).	The greater effectiveness of FITs in spurring diffusion is likely to feedback positively into R&D investments, as shown by Rogge et al (2011) for Germany. The creation of a local RES-E market encourages a local industrial base and, in turn, facilitates R&D investments by local manufacturers. A lower risk for investors is translated to equipment/technology manufacturers (Mitchell et al., 2006). Most manufacturers of repossible tackpalaries.	FITs have shown generally effective to increase renewable capacity, both in the EU and Canadian provinces (Lipp, 2007)(Lauber, 2004)(Gan et al., 2007)(Ragwitz et al., 2007)(International Energy Agency (IEA), 2008; Menanteau et al., 2003)(Meyer, 2003)(Sawin, 2004)(Mulder, 2008) (Ferguson-Martin and Lilly 2011)	Butler (Butler and Neuhoff, 2008) empirical analysis among equipment suppliers in the U.K. revealed that, at the time of their survey, there was stronger competition among turbine producers and constructors under the FIT than under tendering or TGCs.	Lower risks of FITs. Finding based on several methodolo- gies, mostly inves- tors' surveys (Euro- pean Commission, 2008) (Bürer and Wüstenhagen, 2009) (Klessmann et al., 2008) (Ernst & Young, 2010; Masini and Menichetti, 2012) (Lipp,
	*Diversity of actors. As project revenue streams were certain under the German FIT, project developers engaged the affected community early in the process (Butler and Neuhoff, 2008). The majority of investments by large incumbents have been earmarked for conventional technologies (Rogge et al., 2011). FITs set no restrictions on eligibility or capacity, meaning that both large-scale investorowned utilities and smaller businesses and individual homeowners can take advantage of them (Sovacool, 2010).	facturers of renewable technologies are from countries with FITs (Denmark, Germany and Spain). These countries have been the most successful at creating sizable, stable markets for wind power (Lewis and Wiser, 2007)(Beise and Rennings, 2005; Meyer, 2007). In 2000-2002, they were home to eight of the ten biggest wind turbine manufacturers in the world. In contrast, a competitive renewable energy industry was not developed in the UK (Finon and Menanteau,	Hill, 2011). Nevertheless, RES-E capacity expansion has been modest in Greece and Italy (before adopting TGCs) (Rowlands, 2005). Papineau (2006) shows large and (statistically) significant estimates for learning effects in wind and solar technologies in countries with FITs (Denmark and Germany). Similar findings from (Söderholm and Klaassen,	Haas et al (2011) find that, regardless of the instrument, there is an incentive for equipment manufacturers to manufacture better and cheaper equipment in order to increase profits.	2012) (Lipp, 2007) (Butler and Neuhoff, 2008; Mitchell et al., 2006). Surveyed investors have a clear and strong preference for FITs.
	FITs in Germany have provided an incentive to build renewable energy "all over the country, in varying sizes and configurations, owned by a variety of people and institutions, even in low resource areas". FITs promote diversification of technologies, locations and ownership. More than 90% of the 430,000 solar panels installed under the German	Johnstone et al (n.d.) show that FITs encourage R&D investments in immature, high-cost technologies (solar), while TGCs encourage R&D investments in more mature tech-	2007).		



		FIT, for example, are owned by homeowners and cooperatives instead of electric utilities and independent power providers (Sovacool, 2010).	nologies (wind). Jänicke (2012) shows that FITs in Germany led to a large increase in renewable technology patents after 1998. Lee et al (2009) argue that renewable technology patenting by country is also a response to shifts in market conditions and the timing of their take-off may also reflect the impact of policy incentives such as feed-in tariffs in key wind markets. However, these authors do not show a clear relationship between the patent assignees and the type of support scheme implemented in the countries.			
Quotas TGCs	with	a) Technology diversity. The cheapest technologies are privileged over expensive ones (solar, off-shore wind, wave and tidal)(Lipp, 2007)(Johnstone, N et al., n.d.)(Butler and Neuhoff, 2008)(Haas et al., 2011)(Mitchell and Connor, 2004)(Gan et al., 2007)(Fouquet and Johansson, 2008; International Energy Agency (IEA), 2008; Ragwitz et al., 2007)(Elliot, 2007). * U.K.: only wind on-shore, landfill-gas and some biomass have been promoted (Butler and Neuhoff, 2008)(Mitchell et al., 2006) (Allan et al., 2011; Grubb, 2008). * Sweden: Investments in new plants restricted to on-shore wind and biomass cogeneration (Wang, 2006)(Jacobsson et al., 2009). Of the electricity production that received TGCs in 2008, 64% was	Producer surpluses are not directed to innovation in immature technologies. Significant rents are reaped in TGC schemes by investors in mature technologies (U.K., Flanders and Sweden)(Verbruggen, 2009))(A Bergek and Jacobsson, 2010; Jacobsson et al., 2009). But these rents have not rewarded successful entrepreneurs developing and applying immature technologies (Bergek and Jacobsson 2010). Little demand has not stimulated industry creation in immature technologies in the U.K., Sweden and Flanders (Jacobsson et al., 2009).	In the EU, TGCs have been less effective than FITs (European Commission, 2008) (International Energy Agency (IEA), 2008). Some studies have compared the UK (TGC) and the German (FIT) models, showing a lower effectiveness of the former (Butler and Neuhoff, 2008; Lipp, 2007; Mitchell et al., 2006). The UK ROC has not delivered deployment at expected levels (Wood and Dow 2011). The data shows a low effectiveness of the Swedish TGC scheme both in terms of installed capacity and generation (Wang 2006, Jacobsson et al	Butler and Neuhoff (2008) and Toke (2007) empirical analyses question the supposed competition benefits of TGCs. The former point out that FITs maintain competitive pressures in the manufacturing industry. TGCs have led to higher profit margins than FITs (IEA 2008c, EC 2008) and, thus, a lower pressure to reduce costs and lower competition than expected. Verbruggen (2009) argues that the Flanders TGC scheme has led to excess profits, discourag-	Ample evidence of the higher risks of TGCs with respect to FITs (Butler and Neuhoff, 2008; Lipp, 2007) (Mitchell et al., 2006) (European Commission, 2008) (Bürer and Wüstenhagen, 2009) mostly related to volatile TGC prices. Analysis of historical. TGC prices for states in the US shows wide variations (Wiser et al., 2011) (Mendonça, 2010) (Sovacool, 2010). Large fluctuations of TGC prices
		from biofuel-fired plants, 5.5% from CHP plants burning peat, 13% from wind and 17% from hydro. The other technologies did not receive any TGCs at all (Swedish Energy Agency 2009). The current	Patent analysis suggests that FITs encourage private R&D investments in immature, high-cost technologies	2009). In 2007, the target was 25.6 TWh and actual generation reached 15.9	ing generators from find- ing the least-cost solu- tions. In addition, the	in Sweden (Swedish Energy Agency, 2009).



	quota obligation in 2016 will probably be fully met	(solar), while TGCs encourage R&D	TWh (Jacobsson et al	exclusion of small compa-	
	by biomass and on-shore wind (Anna Bergek and	investments in mature technologies	2009).	nies from participating	Quantity risks have
	Jacobsson, 2010).	(wind)(Johnstone, N et al., n.d.).		has, in some cases, weak-	Quantity risks have
		However, Lee et al (2009) do not		ened market competition	been associated to
		show a clear relationship between	Ineffectiveness in Australia	in the US (Sovacool 2010).	TGC schemes (stop-
	* In Flanders, most of the RES-E was delivered from	the patent assignees in wind and	and Japan. In Australia, the		go investment
	bio-waste and biomass exploited by incumbents	solar and the type of support	annual target of 14,400		cycles) (Prest,
	(Verbruggen, 2009)(Jacobsson et al., 2009)	scheme.	GWh in 2011 only consists		2009)(Baratoff et
	(voisi aggon, zoo), (casossos et an, zoo)		of 1900 GWh of new gener-		al.,
			ation (Valentine, 2011),		2007) (Mendonça,
	* Texas: only deployment of wind energy has been		although the MRET may		2010).
	encouraged (Schmalensee, 2009)(Langniss and		have been successful at		
	Wiser, 2003).		arresting a long-term de-		
	W13C1, 2003).		cline in RES-E (Buckman		
			and Diesendorf, 2010). In		
	* Colifornia A manton tookunlariaal diyansity, than		2007, Japan was only half		
	* California. A greater technological diversity than		its national target of 2010		
	in other RPS. Of the 7000MW of contracts for re-		(IEA, 2007).		
	newable generation between 2002 and 2007: 53%		(1271, 2007).		
	(wind), 23% (solar), 12% (geothermal), 7% (biomass)				
	and 1% (hydro and ocean(Schmalensee, 2009).		In contrast, the effective-		
			ness of RPS in the U.S. is		
			unclear. Yin and Powers		
	* Other US states. Wind is the dominant renewable		(2010) find that US state		
	technology deployed. State experience in support-		RPS programs have had a		
	ing solar energy with RPS programs is mixed (Wiser		statistically significant and		
	et al 2011).		positive impact on in-state		
			renewable energy devel-		
			opment. Menz and Vachón		
	*Japan: The RPS has not promoted technological		(2006) show that states		
	diversity (Valentine 2010, Takase and Suzuki 2011).		with an RPS exhibited		
	The dominant technology has been low-cost waste-		larger expansion in wind		
	fired power from existing power plants, with wind		capacity between 1998 and		
	power also a significant fraction. Ineffective to		2003 than states without an		
	support solar PV (Takase and Suzuki 2011)		RPS. The Texas RPS target		
			for 2005 was met several		
			years early (Butler and		
	* Australia. Only the most mature technologies		Neuhoff, 2008). Several		
	(hydro, on-shore wind and bagasse) have been		case studies show that RPS		
	promoted (Kent and Mercer, 2006)(Buckman and		can be effective in promot-		
1	Diesendorf, 2010). Solar electricity: only 1.4% of		ing wind capacity additions		
			ing wind capacity additions		



Tendering/	the 35,484,013 TGCs created by 2008 (Buckman and Diesendorf, 2010). Apart from case studies, other methodologies (i.e., modelling simulations) point in the same direction. Voogt and Uyterlinde (2006) and Nogee et al (2007) show, respectively that an EU-wide and a US federal RPS would not promote technological diversity (particularly solar technologies) and that wind and biomass would dominate. b) Diversity of actors. A diversity of actors is not promoted: large utilities and incumbents have been favoured and small actors are discouraged from participating in Flanders (Verbruggen 2009), Sweden (Jacobsson et al., 2009)(Anna Bergek and Jacobsson, 2010) and the UK (Mitchell et al., 2006)(Verbruggen, 2009)(Woodman and Mitchell, 2011)(Wood and Dow, 2011). This is partly a result of the larger investment risks and transaction costs of the instrument for small actors. The three largest producers accounted for 21% of certificate-entitled production in Sweden (Swedish Energy Agency 2009). The TGC scheme in the UK poses price, volume and balancing risks that only large, integrated energy companies have overcome (Mitchell et al., 2006). In the US, RPS have been found to favour vertically integrated generating companies and big electric utilities that can handle large-scale investments (Sovacool, 2010). Small renewable energy producers may face barriers under an RPS due to the significant transaction and administrative costs and risks involved in participating in the TGC market((van der Linden et al., 2005)(Mendonça, 2010)).	Producer surplus: In the U.K. NFFO,	(e.g., (Fan et al., 2005)(Chupka, 2003)(Bird et al., 2005)(Langniss and Wiser, 2003)(Schmalensee, 2009)). In contrast, Carley (2009) shows that RPS policies do not increase the share of RES-E generation. States with RPS do not have statistically higher rates of RES-E share than states without RPS policies, holding all else constant. Kneifel (2008) finds that RPS policies do not lead to an increase in renewable capacity in a state. Sovacool (2010) shows that RPS have been responsible for only one-fifth of renewables growth in the US from 1978 to 2006.	Competitive pressure has	Large asymmetry in
bidding	sive technologies were not promoted. Landfill gas, waste-to-energy and on-shore wind dominated (Reiche and Bechberger, 2004)(Lipp, 2007)(Mitchell	the fierce competition among project developers kept producers surpluses to a minimum, limited the budgets of developers and	the quantities of renewable energy generation that it had aimed for (Butler and Neuhoff, 2008; Lipp,	forced develop- ers/producers to cut their costs down. The average price paid to projects	the risks before and after the bidding procedure. Before, the risks are related



and Connor, 2004).

b) Diversity of actors

The intense price competition favoured large incumbent RES-E developers and suppliers in the UK, Ireland and France, at the expense of independent providers and small firms (Mendonça, 2010; Sovacool, 2010). Bias of the NFFO towards big industrial players. Lack of creation The priority granted by NFFO has been unable to create a big renewable lobby group in the U.K. (Agnolucci, 2007).

manufacturers, encouraged producers to adopt foreign best available technologies and did not enable them to invest major resources in R&D(Finon and Menanteau, 2008; Lewis and Wiser, 2007).

Market creation.

NFFO: tenders did not draw domestic manufacturing interest to the country (Mitchell and Connor, 2004). This also occurred in France and Ireland (Finon and Menanteau, 2008). In contrast, the tendering scheme in Quebec attracted local manufacturing, due to stringent local content requirements, labour tax incentives and a large project tender that established a sizable market (Lewis and Wiser, 2007).

Countries with tendering have not been those with greater or lower patents (Lee and Lliev, 2009). 2007) (Beck and Martinot, 2004) (Mitchell, 2000) (Edge, 2006). The incentive to bid low and the absence of an obligation to carry out the projects led to low profitability levels and discouraged the realisation of projects. Planning restrictions were also a barrior

From the 1st to the 5th round of the NFFO, the projects generating decreased and the noncompleted projects increased (Agnolucci, 2007). By 2003, only 30% of MW contracted were actually installed (Butler and Neuhoff, 2008). France's EOLE saw just 70 MW built out of 300MW contracted with 30MW were operating in 2005 (Butler and Neuhoff, 2008). Manitoba's tendering scheme shows a similar ineffectiveness (Ferguson-Martin and Hill. 2011). There is also evidence of ineffectiveness (regarding projects actually being built) in Portugal (Heer and Langniss, 2007), Peru (Cherni 2011) and Brazil (Elizondo and Barroso, 2011).

awarded contracts decreased in the U.K. during the 90s from 6.5 p/kWh to 2.71 plkWh (Haas et al., 2001)(Finon and Menanteau, 2008). However, Mitchell and Connor (2004) question whether competition was significant, at least in the earlier rounds since. 2/3 of capacity contracted in NFFO-1 was accounted for by existing facilities and the prices were agreed in advance of the bidding process.

Although Klaasen al(2005) assume that the NFFO reduced the price for wind energy, the empirical analysis by Butler and Neuhoff (2008) suggest low competition between equipment manufacturers in the U.K. compared to countries with FITs (Germany). Söderholm and Klaasen (2007) do not find evidence that tendering leads to greater competition than FITs.

to the sunk costs in case the project does not have a winning bid. This risk significantly increased capital cost in the U.K. (Butler and 2008: Neuhoff, Mitchell et al., 2006). Once bids are awarded, the scheme provides a large degree of certainty both regarding price and quantity (Langniss, 1999) (Menanteau et al., 2003; Mitchell et al., 2006).



4.1.4 The impact of different policy pathways on innovation in renewable energy technologies

This section analyses the likely innovation effects of different policy pathways. Our initial hypothesis is that innovation will be affected by the two main dimensions of policy pathways: instruments (and design elements) and governance structures, i.e., the degrees of harmonisation component/dimensions in the pathways. The impact will be felt on the innovation drivers and through the mechanisms considered in our basic model proposed in the previous section.

Crucial factors leading to innovation may be impacted by policy pathways in a different manner. As noted above, a main element is technological diversity or market creation for immature technologies, which, in turn, is influenced by lower (policy) risks (some of which are instrument related whereas others are not) and by the existence of a sufficiently high level of support for these technologies (i.e., above the costs of those immature technologies) which, on the one hand, allows technologies to penetrate the market and, on the other hand, if sufficiently high, they can lead to profit margins which can be reinvested into R&D activities. Therefore, those policy pathways which are effective are also more likely to lead to innovation in renewable energy technologies. In this context, effectiveness may be related to both the instruments (and design elements) chosen and to the degrees of harmonisation. Regarding the impact of instruments, our review of the literature shows that the innovation effects for immature, relatively more expensive technologies of technology-specific support tend to be greater than technology-neutral instruments. FITs tend to be greater innovation effects than TGCs and ETS. The reason for the greater innovation (effectiveness) impacts of FITs with respect to quotas with TGCs is twofold. First, FITs have shown to be more effective in allowing the diffusion of more immature technologies because the support provided tends to be above the costs of those technologies (sometimes, such as in the case of solar PV in some countries, much higher above), whereas quotas with TGCs have often not provided enough support for these technologies to penetrate the market.

Of course, since the specific design elements of the instruments also matter, a distinction can be made in this regard between the QUO and the QUO BANDING pathways. TGCs with banding (technology-specific design element) are likely to have greater innovation effects than TGCs without banding (technology-neutral design element) since the former are likely to be more effective in the diffusion of immature renewable energy technologies than the later. In other words, under QUO BANDING, expensive technologies are more likely to penetrate the market, since the level of support provided by either carve-outs or credit multipliers is more likely to allow them to cover the costs of the technologies than under the QUO alternative.

The innovation effects of the REF pathways regarding the support level are related to the choice of instruments at the national level, and the ranking is thus similar than before. This means that support levels for immature/expensive technologies are likely to be more favourable under the FIT than under FIPs, quotas with TGCs and banding and quotas with TGCs and no banding (in descending order). The same can be more or less expected under the TEN pathway since tendering is only used for large-scale projects.

Policy risks are a major factor influencing the deploying of renewable energy technologies. Policy risks might be related to the instrument or not. Instrument-related policy risks are mostly related to revenue uncertainty and are obviously greater under quota with TGC schemes (whether banded or not) than under FIPs and FITs, given the volatility of the TGC price. In turn, the degree of risk is lower under FIT than under FIP, since total remuneration under the later depends on the (uncertain) evolution of electricity market prices. However, FIPs are likely to be less risky in this context than

2

² However, the recent changes in FIT support (particularly for solar PV) in several EU countries (including Spain, Germany, Italy, France and the Czech Republic) suggests that FITs may also have a substantial degree of regulatory risks for investors in some countries, resulting in higher than previous capital costs for investors under such schemes (European Commission 2013).



TGCs, since at least one part of the total remuneration (the premium) is known a priori. All this suggests that the FIT and FIP pathways are likely to be more favourable for the innovation in immature technologies compared to the QUO pathways and, in turn, these are likely to be more favourable to innovation than the ETS-only pathway (i.e., without dedicated RES support), since in this case, immature technologies are unlikely to penetrate the market.

On the other hand, the degrees of harmonisation are likely to influence the factors which affect effectiveness but, in particular, the policy risks related to the stability of the policy. Policy pathways with decisions taken mostly at EU level are likely to be more stable than policy pathways with a large Member State role in decisions. Therefore, the FULL degree of harmonisation are likely to be more effective in supporting immature technologies than the MEDIUM and SOFT ones. While it is true that lower degrees of harmonisation cover national priorities in the choice of technologies to a greater extent and, thus, might be more favourable to specific technologies, this does not mean that they will necessarily be more favourable to immature, more expensive technologies. We could hypothesise that under an EU-wide support scheme, the benefits in terms of economies of scale and learning effects would be greater than under softer policy pathways, which may lead to more fragmented markets. Regarding the other policy pathways, regulatory stability can be expected to be very high for the ETS-only pathway, given its EU-wide character. The REF policy pathways are likely to be the least stable of all, since the decisions are fully or almost fully taken at the Member State level. This is also mostly the case in the TEN policy pathway, although the tendering procedure for large-scale projects takes place at the EU level.

On the other hand, competition has been identified as a main driver of innovation in so far as competitive pressure provides an incentive to different equipment suppliers to cut costs. Regarding the degrees of harmonisation, competition between technologies can be expected to be greater, the greater the degree of harmonisation, given the existence of a larger market. In other words, the innovation effects triggered by competition are likely to be higher under the FULL policy pathways than under the MEDIUM and SOFT pathways, irrespective of the instrument being used. Likewise, the REF policy pathways would result in lower degrees of competition and associated innovation effects.

Regarding the instruments, as mentioned in section 3, while it has often been argued that competitive pressure is greater under quotas with TGCs (and tendering) than under FITs, the truth is that the empirical evidence on such superiority is scant if not virtually non-existent. While quotas with TGCs may provide an incentive for cost-reducing innovation in general, FITs may provide a greater incentive for revenue-increasing innovation (i.e., productive-efficiency innovation). In addition, the existence of competition to reduce the costs of immature technologies depends on the existence of a market, and these are mostly created under FITs and FIPs rather than under quotas with TGCs. Therefore, since the results of the competitive pressure of different instruments are unclear, we assume that the innovation effects of those instruments are similar with respect to the competition driver.

The following table summarizes the above discussion. Scores are given to different aspects of the innovation effects of the policy pathways on a likert scale, where 5 stands for a very favorable impact of the policy pathway on the respective innovation effect and 1 for the least favorable impact. Two remarks are worth making. First, the scores are only meant to be illustrative and relative, i.e., the score given to a specific policy pathway under one of the dimensions should be regarded in comparison to the score given to other policy pathways. Second, the last column provides a non-weighted average of the different scores, i.e., an equal weight to diversity and competition is given.



Table 11 Scoring the innovation effects of different beyond2020 policy pathways. Source: Own elaboration

		Technolo	Technological diversity			Competitive	TOTAL
		Support level	Policy risks instru- ment- related	Regulato- ry stabil- ity	Subtotal	pressure (geographical width of the market)	
FIT	Full	5	5	5	5,0	4	4,5
	Medium	5	5	4	4,7	3	3,8
	Soft	5	5	3	4,3	1	2,7
FIP	Full	4	4	5	4,3	4	4,2
	Medium	4	4	4	4,0	3	3,5
	Soft	4	4	3	3,7	1	2,3
QUO	Full	2	2	5	3,0	4	3,5
	Medium	2	2	4	2,7	3	2,8
	Soft	2	2	3	2,3	1	1,7
QUO	Full	3	3	5	3,7	4	3,8
BANDING	Medium	3	3	4	3,3	3	3,2
	Soft	3	3	3	3,0	1	2,0
ETS		1	1	1	1	2,3	1,6
TEN	FIT	5	5	1	3,7	4	3,8
	FIP	4	4	1	3,0	4	3,5
	QUO	2	2	1	1,7	4	2,8
	QUO B	3	3	1	2,3	4	3,2
•	ith FIT	5	5	2	4,0	2	3,0
min. star ards)	nd- FIP	4	4	2	3,3	2	2,7
,	QUO	2	2	2	2,0	2	2,0
	QUO B	3	2	2	2,3	2	2,2
REF (witho		5	5	1	3,7	1	2,3
min. star ards)	nd- FIP	4	4	1	3,0	1	2,0
ĺ	QUO	2	2	1	1,7	1	1,3
	QUO B	3	2	1	2,0	1	1,5

The results show that the FITfull (1a) policy pathway is likely to have the greatest impact on innovation, followed by FIPfull (2a). On the other side of the spectrum, the ETS (5) and technology-neutral quota schemes (national, under no or minimum harmonisation) are less likely to trigger innovation in less mature or more expensive technologies in the absence of targeted R&D public support. The reason is that these pathways are less likely to favour the deployment of immature technologies, especially the first one.



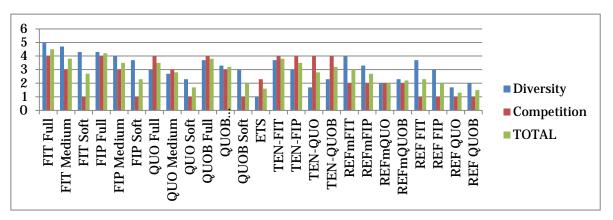


Figure 7 Illustrating the innovation effects of different policy pathways. Source: Own elaboration.

These results suggest that public R&D would make a greater contribution to innovation in renewable energy technologies, i.e., would be more necessary, under those policy pathways which are likely to lead to lower innovation effects. Under those policy pathways under which those innovation effects are more likely, it is mostly because private R&D investments are incentivised to a greater extent. In so far as private and public R&D are substitutable, and assuming that a total amount of R&D (i.e., public + private) is needed, a lower level of private R&D investment may be offset by public R&D support. Or, put it differently, assuming such substitutability, more innovation-friendly policy pathways come with an important side-effect in addition to the benefits of RES-E deployment itself. Those policy pathways would mean less public R&D funds are required.

However, this conclusion should be softened because the extent to which public and private R&D are complementary or substitutable is certainly not a closed issue. It is highly likely that they are less substitutable and more complementary in the intermediate stages of the innovation process. Public R&D is certainly much required in the first stages of such process, in which private companies are less likely to invest, given the large spillovers and small short-term benefits at theis stage (i.e, basic science to private R&D to a large extent). The existence of (positive) externalities in those initial stages makes public investment in R&D much needed.

4.2 Industrial policy

The issue of equity has already been addressed as part of the MCDA. There, the equity criterion was defined as imbalances of costs and benefits between <u>Member States</u>. However, the term equity is also often associated with the distribution of costs and benefits between different income groups, or between private households and industry. On the one hand, it is desirable to distribute the cost burden evenly between these groups. On the other hand, many Member States see the international competitiveness of their domestic industries in danger if they are exposed to higher energy prices. The interrelation between RES(-E) support and industrial policy is the topic of this section.

Some EU Member States provide reductions in electricity prices and related taxes for producing companies and energy-intensive industry through exemptions from related charges. The main argument behind such national policy often relates to the negative impact of higher electricity costs upon EU companies' international competitiveness. By means of exemptions, electricity prices are kept low for selected types of companies and prevent the emigration of enterprises from that country, thus avoiding a negative impact upon the economy and employment.

Across selected EU Member States, different criteria and indicators are used for reduced contributions by, and exemptions for, energy-intensive industries from a wide range of related taxes and



payments, such as: electricity taxes, environmental taxes, renewable energy payments and contributions, co-generation, etc (Department for Business, Innovations and Skills UK, 2013)(Fraunhofer ISI, 2013)(Arepo, 2012)(Department for Business, Innovations and Skills UK, 2012). The indicators used include:

- total electricity consumption at industrial branch level [Total GWh per year];
- electricity demand intensities at industrial branch level [Turnover or Value added, €/GWh];
- the voltage level of the network connection at industrial level;
- identification of electricity-intensive production processes;
- the peak load at industrial branch level, the individual production at company level, the stage of introduction of energy management systems, etc.

Factors that affect international competitiveness of EU companies are to be considered from a country-specific perspective, since it is important to take into account their access to natural resources, the level of development, and the degree of industry specialization of the country (or countries) in question (Bardt, 2011)(Jochem et al., 2012)(Graichen et al., 2008)(Zimmermann et al., 1999).

If these industries were not to be supported by governments, several issues could appear: for instance, if raw material is to be transported to production sites (such as for the metal industries), taxes and high labour costs would be reflected in the production costs, and environmental regulations have an effect upon products by increasing their production costs. As a consequence, industries tend to emigrate to countries where conditions increase their competitiveness (e.g. textile and leather production, aluminium, etc.) (Jochem et al., 2012)(Fraunhofer ISI, 2013)(Graichen et al., 2008)(Department for Business, Innovations and Skills UK, 2012).

It is important to recall the fact that environmental regulations and high energy prices applied to energy-intensive industries do influence their competitiveness in a negative manner, but on the other hand these prices and regulations tend to create the need of the industry to improve the efficiency of their products and advance technologically (Jochem et al., 2012). Furthermore, international competitiveness is not affected by increasing costs in one particular country, but by the relative changes in production and energy costs in comparison to other countries' production costs changes (Bardt, 2011)(Jochem et al., 2012)(Zimmermann et al., 1999).

For instance, a BIS study of energy policy costs faced by energy-intensive industries in a sample of OECD countries found that "[t]he energy-intensive industrial sectors in the EU generally have significantly higher costs of energy and climate change policies per tonne of product in the 2015 and 2020 milestone years of this study, compared to the countries in this study that are outside the EU. These are largely driven by direct and indirect EU ETS costs as well as renewable policy costs (mainly UK, Italy and Denmark) and energy policy costs (mainly Germany and France)" (ICF, 2012).

Competitiveness is defined by the IEA as "the capacity of companies to maintain or grow their market shares form an international perspective". Several factors affect the competitiveness of companies in an international context; these include, for instance: (I) Client proximity, (II) Labour costs, (III) Energy prices including taxes and subsidies, (IV) Energy intensity, (V) Transport costs, (VI) Product quality, (VII) Integrated production, (VIII) Research and Development, (IX) Qualification of Labour opportunities, and (X) Access to capital markets (Jochem et al., 2012)(Fraunhofer ISI, 2013)(Zimmermann et al., 1999). The degree of competitiveness in any given market depends upon the market structure, the number and size of participants and the way(s) in which these actors are interconnected vertically and horizontally (Jochem et al., 2012)(Fraunhofer ISI, 2013).

The effect of these factors is not always possible to quantify: for example, the effect of R&D and labour specialization on the innovation capacity of companies to develop high quality products, which differentiation will be crucial in international markets (and have an indirect impact upon international competitiveness), beyond price competition. Other factors influence international competitiveness, such as the positioning of new suppliers on the market, substitution with other



products as well as the capacity to negotiate with suppliers and producers (Jochem et al., 2012)(Fraunhofer ISI, 2013).

The main conclusion is that several factors (not all of them quantifiable) have an effect upon the international competitiveness of companies and, as a factor of production, electricity costs and demand have an effect depending upon the energy intensity of the industry measured against turn-over, production value or value added vs. international competitiveness.

Companies and governments could partially identify the required "advantages" for a business to perform better than competitors, and creating these advantages at EU level is what leads to reduced costs (Fraunhofer ISI, 2013) (Department for Business, Innovations and Skills UK, 2012). Furthermore, the increase in efficiency with electricity-related energy efficiency measures, rendered partially profitable by higher energy costs, contributes to enhancing the image of companies and reducing energy-related costs (Jochem et al., 2012). However, these investments are also related to reinvestment cycles and can also be connected to missing investments in production capacities.

Several indicators have been developed by different organizations and authors (Fraunhofer ISI, 2013)(Jochem et al., 2012) with the aim of "measuring" the degree of international competitiveness at sector, company or branch level, taking into account the effect of production factors (e.g. electricity costs). These include: (I) market shares (production or revenue), (II) production volumes, (III) relative trade shares, (IV) trade intensity, (V) global market price, and (VI) learning rates [4].

For future policy proposals with the objective of deriving exemptions and privileges for EU energy-intensive industries, an elaborated set of criteria and indicators are necessary in order to identify those companies affected by energy or climate policy measures in relationship to their international competitiveness position. Initially, indicators such as the trade intensity or world prices for selected products appear to lead towards the desired identification, combined with consideration for (among others) electricity intensities indicators of the companies or industrial branches due to reduced transaction costs for authorities and reduced manipulation data for companies (Fraunhofer ISI, 2013).

However, more in-depth analysis and interaction is needed, in particular with the impact which this concern with the position of EU energy-intensive industries is likely to have upon other emerging policies such as the Energy Efficiency Directive. On the one hand, there is the objective of enhancing energy efficiency; on the other, exemptions might motivate increased energy consumption, which result in inconsistency with the desired energy efficiency targets.

Initial analysis concerning the criteria for setting up the conditions and data required by EU energy-intensive industries suggests that possible exemptions – e.g. for renewable energy contributions, energy taxes, peak loads, etc. – should be gradually introduced (Fraunhofer ISI, 2013). This should be done not only based on the electricity consumption and intensities of branches and their trade intensities, but should be adjusted and complemented with: (I) the recognition of the implementation by EU energy-intensive industries of energy consumption monitoring schemes and programmes, leading towards identifying profitable energy efficiency potentials, (II) the implementation of profitable Energy Efficiency Measures with TIR over 10% and with amortization times over 3-5 years, and (III) the introduction and maintenance of energy management systems, which have increased the efficiency of production and services. Taking into account these actions by industry will not only promote the incentive to claim exemptions, but will also provide impulses to become more competitive with positive economic effects at EU level as well.

4.3 Interactions with third countries

Imports of renewable electricity from neighbouring non-EU countries into EU Member States are expected to play a bigger role after 2020. The effects of (non-)harmonisation within the EU on third countries shall be analysed here. Estimates on these effects are characterised by far-reaching un-



certainties. Nevertheless, a first qualitative assessment is attempted in Table 9. Eight criteria were identified which have relevance for countries interested in exporting RES-E to the EU. The Middle East and North Africa (MENA) region is used as an example here, but similar effects can be expected on other neighbouring countries as well.

It would not make sense to apply the eight criteria to the full range of 16 pathways for a qualitative assessment, as they would not be clearly distinguishable. In the pathway definition of work package 2 (D2.1), the relations with third countries were not covered and the relevant design features were therefore not specified. In order to make this analysis meaningful, five of the pathways were selected which cover the whole range of harmonisation degrees. They were modified to include features which result in interesting implications for third countries. The means of including installations in third countries were also further specified. These pathways therefore do not perfectly correspond with those shown in table 1 of this report:

- Banded quota scheme under full harmonisation (QUOBfull 4a): In this policy pathway, an EU-wide quota scheme with tradable green certificates (TGC) is in place. Cost bands are defined and a specific banding factor is allocated to each technology. RES-E importers from 3rd countries participate in the supply side of the EU TGC market. The same banding factors apply.
- FIP scheme under full harmonisation with tendering (similar to FIPfull 2a): In this policy pathway, small RES-E installations are not included in support schemes, but are still economically attractive to a certain degree due to the possibility of net metering. For large RES-E installations, an EU-wide tendering scheme is in place. Imports from 3rd countries are also tendered.
- FIP scheme under medium harmonisation (similar to FIPmed 2b): In this policy pathway, an EU-wide FIP scheme is in place for all technologies, and for projects of all sizes. Minimum support levels for each technology are prescribed by the EU, but may be topped up by member states due to national interests. Imports from 3rd countries receive the standard EU premium.
- FIP scheme under soft harmonisation with tendering (similar to FIPsoft 2c): In this policy pathway, an EU-wide FIP scheme for small installations is in place. For large installations, the EU prescribes a tendering scheme. Support levels and design elements both for FIP and tender are up to the Member States, subject to minimum design standards. Imports from 3rd countries are tendered by individual Member States.
- Bottom-up policy convergence with minimum design standards (similar to no/minimum harmonisation 7d/7): In this policy pathway, a diverse portfolio of support systems prevails, as member states have free choice of their support schemes. However, support systems do converge bottom-up due to policy learning and the diffusion of best practice. Import regulations for 3rd countries are as diverse as national support schemes.



Table 12 Implications of harmonisation on RES-E imports from third countries

Implications for RES-E imports from 3 rd countries	Banded Quota scheme (TGC), full harmonisation	Feed in premium (FIP) com- bined with tender, full harmonisation	Feed in premium (FIP), medium harmonisation (uniform support with possible add-ons by MSs)	Feed in premium (FIP) combined with tender, soft harmonisation (MS specific targets, design elements & support levels)	Policy convergence (possibly with harmonised minimum design standards) but no further harmonisation
Degree of harr	nonisation: strong		medium		minimum / none
Potential overall demand for RES-E imports from 3 rd countries in terms of EU RES-E deficit / non-compliance with EU RES targets	? Uncertain, the actual demand for imports depends on the defined level of the EU quota and whether it is effective enough to incentivize sufficient exploitation of European RES resources.	? Uncertain, the actual demand for RES-E imports from 3 rd countries depends on the effectiveness of the European support scheme and whether it can sufficiently incentivize the exploitation of EU RES resources to meet the defined target. Generally, the overall volume of demand in a scheme combined with a tender is restricted by the tendered volume.	Characteristics of the European Support scheme and whether it can sufficiently incentivize the exploitation of EU RES resources to meet the defined target. Individual MSs might decide to particularly push RES deployment which would lead to a lower demand for RES-E imports from 3rd countries.	Concertain and MS-specific, actual demand for RES-E imports from 3rd countries depends on the effectiveness of the MSs' individual support scheme design, RES potentials and whether the defined MS targets can be met by exploitation of the national resources (or through cooperation with other MS) alone. Generally, the overall volume of demand in a scheme combined with a tender is restricted by the tendered volume.	?? Uncertain and MS-specific, potentially high demand from individual MS which do not meet their national RES targets (also not through cooperation with other MSs).
Revenue flow	Revenue = electricity price + TGC price	Revenue = electricity price + premium (determined through tender procedure)	Revenue = electricity price + EU wide standard premium	Revenue = electricity price + MS specific premium (determined through tender procedure)	Depending on support scheme which is individually defined by the MSs (feed in premium, quota, feed in tariff, tender)
RES-project financing & investment risks	Financing risk in a quota system is generally higher due to the lack of predictability of the certificate price.	O/+ Medium financing risk, revenue largely depends on development of electricity market price.	+ Medium to low financing risk, revenue largely depends on development of electricity mar- ket price; still the EU-wide pre- mium guarantees at least mini- mum revenues.	O/+ Medium financing risk, revenue largely depends on development of electricity market price; the EU-wide design guidelines guarantee at least continuity of the support.	O/+ Depending on MS policy. The attractiveness of support levels may vary among MSs; assumed convergence of MS policies towards best practice would imply more risk conscious policy design in the future.



Complexity of transaction process	Limited complexity since direct contract partner is EU (RES imports count directly towards EU targets). Disadvantages may emerge due to lengthy decision making processes on EU level.	Limited complexity since direct contract partner is EU (RES imports count directly towards EU targets. Disadvantages may emerge due to lengthy decision making processes on EU level.	+ Limited complexity since direct contract partner is EU (RES imports count directly towards EU targets. Disadvantages may emerge due to lengthy decision making processes on EU level.	Medium complexity, contract partner is the MS but overall framework for the cooperation is provided by the EU.	High complexity if bi- or multi- lateral agreements between a 3 rd country and single or several MSs on project-by-project basis are assumed. Potentially, individual MS could develop simplified cooperation schemes or a standardized framework for cooperation could be developed; this would facilitate the cooperation in the longterm but would require high initial effort.
Choice of RES- technologies	Flexible, deployment of diverse technology portfolio is possible; also less mature technologies can be applied through definition of favourable banding factors for these technologies. Generally: Under premium and quota systems dispatchable RES technologies (e.g. CSP with storage, biomass) have an advantage, since they can adapt production to the market price fluctuations.	++ Very flexible assuming a technology specific premium; the level of the premium can be differentiated between several technologies and different design options within one technology. Tenders can be designed to promote specific technologies, to focus on specific geographical regions or project sites.	++ Very flexible assuming a technology specific premium; the level of the premium can be differentiated between several technologies and different design options within one technology.	++ Very flexible, assuming MS specific tender design and technology specific support. Tenders can be designed to promote specific technologies, to focus on specific geographical regions or project sites.	Depends on negotiation (support scheme design, technology preferences, support levels) of individual MSs with 3 rd countries. Flexible depending on MS technology preferences.
Eligible project sizes (as a result of administrative barriers and level of investment risk)	L Limited level of complexity of administrative procedures (authorization on EU- level not on MS-level) but assumedly still dominance of larger projects since the financing risk under a quota scheme might be too high for developers of smaller projects.	L/M Limited complexity of administrative procedures (authorization on EU- level not on MS-level) facilitates participation of smaller projects but lower predictability of the revenue might pose a too high risk for smaller projects. Depending on tender design (e.g. project -specific vs. volume tender) deployment of more	L/M Limited complexity of administrative procedures (authorization on EU- level not on MS-level) facilitates participation of smaller projects, but lower predictability of the revenue might pose a too high risk for smaller projects.	L High administrative effort (negotiations on MS-level) and higher financing risks related to insecurities in MS's policy developments (MS specific support levels) might hinder participation of smaller projects Depending on tender design (e.g. project -specific vs. volume tender) deployment of more	Depending on MSs support framework. Probably dominance of large projects due to higher uncertainty and related financing risks and high administrative effort (negotiations on MS-level and on project-by-project basis, assuming that a super-ordinate framework for cooperation is lacking).



Grid constraints	A high level of harmonisation might foster creation of RES hot spots within Europe. This could aggravate grid congestions and imply a lack of transmission capacities for desert power.	diverse portfolio possible (vol- ume tender with smaller pro- jects). A high level of harmonisation might foster creation of RES hot spots within Europe. This could aggravate grid congestions and imply a lack of transmission capacities for desert power. Grid constraints might, however, be mitigated through geograph- ical specifications in calls for tenders.	A medium level of harmonisation might still foster creation of RES generation clusters in Europe. This could aggravate grid congestions and imply a lack of transmission capacities for desert power. Grid constraints might be mitigated through mobilization of 'non-hot spot potentials' based on MS specific support-add ons.	diverse portfolio possible (volume tender with smaller projects). Under soft harmonisation RES generation will be distributed rather evenly across Europe. This might reduce grid constraints but the lack of a pan-European RES strategy might also imply limited coordination of cross-border infrastructure development and a lack of capacities for desert power imports.	The lack of a pan-European RES strategy towards imports from 3 rd countries might also aggravate grid-planning issues. If no harmonized approach exists in terms of RES-imports it is possible that also the coordination of European infrastructure development is limited and capacities for desert power import are lacking.
Overall competitiveness of RES - E imports from 3 rd countries (desert power) under the scheme	Desert power might be economically very competitive compared to European RES-E generation depending on the fact whether the comparatively high financing risks implied by a quota system can be tackled.	++ The advantages of an EU-wide harmonized tendering approach in combination with the comparatively low financing risk entailed by the EU premium scheme, might lead to a maximum of competitiveness of desert power under this scheme. This applies in particular if tenders are organized jointly for projects in 3 rd countries and European projects.	The possibility for individual European MSs to create additional incentives for domestic RES-E generation could reduce not only the competitiveness but also the overall demand for RES-E imports from 3rd countries.	? The ability of 3 rd countries to compete in the European RES-E market would strongly depend on the individually defined support levels and tender criteria as well as on the administrative burden associated with the participation in the respective and possibly combined Member States' support schemes.	? The overall competitiveness of desert power under a non-harmonized European RES-E support scheme depends on the individually defined support schemes and levels for domestic and 3 rd country RES support and is subject to a multitude of uncertainties. Possibly, very favorable conditions for single projects in 3 rd countries could be created by individual MSs. However, a fragmented EU approach probably won't favor large-scale and long-term RES deployment for export in 3 rd countries.



5 Conclusions

In reality, and considering the current 2030 target discussion, the decision for a RES support policy pathway will not be taken in one step. With the decision for or against a separate RES target, the course will be set for either the ETS (5) pathway or a dedicated RES policy which could look like one of the remaining 15 beyond2020 pathways. The ETS (5) pathway is therefore, not surprisingly, the pathway that causes the most disagreement. While it is the most favoured pathway for some stakeholders, it is completely unacceptable to others. The 2030 target decision will be taken based on more and different criteria than those used in this analysis, which exceed the scope of this report but are treated in D6.1b. Here, we shall focus on the remaining pathways in case the decision for a RES target is taken.

It follows from the preference rankings shown in sections 3.3.1 and 3.3.2 that minimum harmonisation (7d) and FIPsoft (2c) offer the most potential for compromise between the three decision maker prototypes. Non-harmonisation (7) is also among the top-ranking pathways for the Pragmatic and the Environmentalist, and therefore also in the group ranking. However, this pathway is not attractive at all to the Cost-Conscious decision maker. We have to keep in mind that the group ranking, as mentioned above, assumes equal strength of the three decision maker prototypes in influencing the preference ranking. It does not mimic the power structures and sideline negotiations which determine real compromise finding between interest groups. It is therefore better to concentrate on the individual preference rankings here instead of the group ranking.

A further argument against non-harmonisation (7) is that, given the evolution of the political debate in past years, a mere continuation of the status quo seems unlikely. There are many voices, including those strictly in favour of more RES deployment, which call for some alignment of framework conditions and design features (minimum harmonisation).

The main conclusion from the MCDA in chapter 3 is therefore to focus on a more detailed elaboration of the pathways FIPsoft (2c) and minimum harmonisation (7d) in work package 7.

Chapter 4 takes a broader view and assessed the interactions of harmonisation pathways with other European policies. With regard to innovation policies, it is shown that not only the deployment instruments specified in the beyond2020 pathways are relevant to incentivise innovation, but that they must be complemented by R&D policies. As the innovation potentials under different (non-)harmonisation pathways differ, effective R&D policies become all the more important where deployment instruments are less appropriate to incentivise innovation. Nevertheless it could also be shown that technology specific RES policies show a higher performance regarding dynamic efficiency.

With regard to industrial policies, factors determining international competitiveness, apart from energy prices, are listed and criteria are laid out to assist in a useful mechanism to determine which industries/firms should be exempt from sharing the burden of RES support. They include (I) the recognition of the implementation by EU energy-intensive industries of energy consumption monitoring schemes and programmes, leading towards identifying profitable energy efficiency potentials, (II) the implementation of profitable Energy Efficiency Measures, and (III) the introduction and maintenance of energy management systems.

Concerning the effects of (non-)harmonisation on neighbouring countries, relevant criteria include the potential overall demand for RES-E imports into the EU as well as the relative generation costs/support costs of EU-domestic RES-E versus imported RES-E, the complexity of the transaction process if a third country wants to sell RES-E to an EU Member State, the attractiveness of the scheme for different RES technologies and project sizes, and possible grid constraints.



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<u>This report</u> focuses on the comprehensive assessment of policy pathways regarding the possible harmonisation of RES(-E) support schemes in the EU after 2020. The analysis is based on outputs from previous work in the beyond 2020 project.

The assessment puts its focus on a multicriteria decision analysis, but includes qualitative analysis on overarching issues as well.