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WP 9 Report on policy assessment of instruments to internalise environment related external costs in EU member states, via promotion of renewables

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1. Introduction

This report presents the results of work package 9 within the CASES (Cost Assessment of Sustainable Energy Systems) project. Work package 9 (WP 9) contains an "Assessment of Policy Instruments to Internalize Environment-Related External Costs in EU Member States, Via Promotion of Renewables". Work package 9 is related to the second policy objective of the CASES project which is to evaluate policy options for improving the efficiency of energy use, taking account of the full cost data which has been assembled in the first part of the CASES project. The other work packages related to this objective are WPs 8, 10 and 11. Work packages 8, 9 and 10 share a common methodology.

WP 9 pursues two main objectives. The first is to assess policy instruments to internalize externalities in EU member states via the promotion of renewable energy. The second objective is to investigate stakeholders' preferences for those policy instruments through a stakeholder workshop which is organized together with WPs 8, 10 and 11.

There are four participants to the work package 9: Fondazione Eni Enrico Mattei (FEEM), National Technical University of Athens (NTUA), Risoe Laboratories (RISOE) and University of Flensburg (UFLENS).

The organization of the report is based on the description of work. Chapter 2 follows with a synopsis of policy instruments corresponding to task 9.1. The analysis of policy instruments (task 9.2) is covered in chapter 3. Chapter 4 deals with the linkages between policy instruments (task 9.3) and chapter 5 with their social and fiscal implications (task 9.4). Policy recommendations are given in chapter 6 followed by a conclusion. This introduction will give an overview on the concept of external costs and their connection to renewable energies.

External costs are defined as non-market disadvantages (or advantages) experienced by third parties, e.g. households, the public or coming generations. (Bartmann, 1996, p. 36) Those advantages or disadvantages are not taken into account in private costs calculations. The sum of private costs and external costs is called social costs or full costs. In the following the discussion is restricted to negative external effects of energy production. By not taking those effects into account the price of the production causing the effects is too low and consequently the quantity produced is too high. Consideration of the external costs could be achieved by internalizing those costs, meaning to include the external costs in the market and price mechanisms. (Krewitt and Schlomann, 2006, p. 5) If the producer was forced to consider the external costs, the supply curve would shift. The produced quantity would be reduced and the price increased. Because different energy production technologies cause diverse external effects the relative prices of the technologies and hence the merit order would also change. In the CASES project latest results on external costs have been assembled.

All internalization strategies are based on the assumption that individuals' preferences and production functions are known and constant, complete information on damages and polluters is available and markets are functioning and competitive. Furthermore the external effects may not be irreversible or even globally destructive because in those cases reaching far into the future static approaches will inevitably fail. (Bartmann, 1996, p. 43f)

Several political instruments have been proposed to achieve internalization of external costs. The optimal instrument for internalization creates no distortions on the market. Furthermore it should be efficient and fair, minimize costs and uncertainty and have low administrative costs. (Longo and Markandya, 2005, p. 17) The first best option is always a tax in the amount of the external costs or an equivalent quantity regime with certificate trading. Instruments that support or disburden environmentally friendly technologies like instruments for the promotion of renewable energies or combined heat and power production are the second best options as they can establish indirect internalization. (Krewitt and Schlomann, 2006, p. 6) Other possible instruments are the standard-price approach, charges, and negotiations. (Bartmann, 1996, p. 43)

Promotion instruments for renewable energies can be justified by the differences in external costs between renewable and conventional energy production technologies. The external costs of renewable energy production are generally lower than those of conventional energy production. Thus renewable energies are highly disadvantaged by the present prices which do not include external costs. According to the Community Guidelines on State Aid for Environmental Protection financial support up to 0.05 €/kWh can be seen as compensation for external costs. (Hohmeyer, 2001, p. 4) Different analyses have shown that the differences in external costs outweigh the extra costs of renewable energy sources, except for technologies which so far have very high production costs like photovoltaic. (Krewitt and Nitsch, 2003, p. 540; Krewitt und Schlomann, 2006; Hohmeyer, 2001) However the promotion of renewable energies can only remunerate the reduced external costs. Promotion of renewables can adjust the relative prices between renewable and conventional technologies but it does not bring prices to their full cost level. Thus full internalization cannot be achieved.

On the other hand one has to keep in mind that the promotion of renewables is not solely based on the objective of internalization. Even if internalization is attained better by other instruments like emission taxes there are good reasons for the promotion of renewable energies. In the proposal for a new directive on the promotion of the use of energy from renewable sources (European Commission, 2008) the need to further promote the use of renewable energies is justified by their contribution to "climate change mitigation through the reduction of greenhouse gas emissions, sustainable development, security of supply and the development of a knowledge based industry creating jobs, economic growth, competitiveness and regional and rural development". (p. 2)

Having substantial shares of renewable energy sources in the energy mix will enhance the diversity of production and reduce the import dependency of energy production as usually domestic renewable resources are used. The security of supply is thereby greatly increased. Furthermore decentralised renewable energy plants are often situated in regions with lower economic activity and can provide additional sources of income and employment both for highly qualified and less qualified employees.

There is also a rationale for promoting renewable energies from the perspective of resource economics. Resource economics deals with the optimal allocation of resources over time. In traditional resource economics present generations are favoured over future generations due to the discounting of future utilities. From an efficiency perspective there are two rules for the depletion of exhaustible resources. The resource has to be completely depleted over the time horizon. And the growth rate of the marginal productivity of the resource has to be equal to the marginal productivity of capital (interest). That means that at every point in time with one unit of the resource the same present value is gained. The second rule is called the Hotelling rule. (Bartmann, 1996, p. 60; Hensing et al, 1998, p. 29) The level of the present value is determined by several parameters, one of them being the possibility for perfectly substituting the resource in the long-term. Bartmann, 1996 describes the substitution of the resource with an inexhaustible backstop technology. For its development high capital assets are necessary. The substitution takes place in three phases. In the first phase only the exhaustible natural resource is used. The Hotelling rule demands a substitution of the resource with capital. During a transitional period the resource stock tends to zero and the backstop technology steps in. Finally the resource is completely depleted and only the backstop technology used. (p. 62) The resource must be depleted at the exact point in time when the shadow price of the resource reaches the costs of the backstop technology. (Hensing et al, 1998, p. 32) In reality the future costs of the backstop technology are not known and can furthermore be influenced by current research and development activities. By lowering the costs for backstop technologies also the equilibrium price development of the resource is lowered. That means that the industry which is exploiting the conventional resource has no incentive to develop backstop technologies as this devaluates their resource stock and benefits only the consumers. For that reason there is from an economic perspective too little private commitment for backstop technologies and their development has to be ensured by public support. (Hensing et al, 1998, p. 38)

Also the requirements of sustainable development demand that resource rents from the use of depletable resources are completely invested in the development of backstop technologies to keep the stock of resource capital functionally constant. (Hohmeyer, 2001, p. 16)

2. Synopsis of policy instruments

In this chapter an overview on the possible promotion instruments for renewable energy will be given. First generic policy instruments are described and defined. Those generic instruments will later be used in the analysis. In the second part of the chapter some examples of implementation of those instruments in EU member states will be shown.

Classification of instruments

Generally environmental policy instruments can be classified in command and control measures, economic instruments and voluntary initiatives. Command and control measures prescribe a certain technology or a certain standard. The obliged actors have no room for flexibility. Those instruments will not be covered in the following.

Economic instruments provide economic incentives to reach the desired level of renewable energy. They can be distinguished in two different approaches. Price based instruments regulate the price producers of renewable energy receive. The quantity which is supplied depends on the production cost curve of renewable energies. Fixed feed-in tariffs and fixed premium systems are price based instruments. The other approach is to set the quantity of renewable energy and let the price be determined by the market. A green quota with tradable green certificates and the tender system are examples of quantity based instruments. In theory price and quantity based instrument can reach the same results. In practice the choice of instrument in a specific situation depends on what information is given and what exactly is intended by the instrument.

Generic policy instruments

For all instruments there are several different possibilities of designing the instrument. To take account of the influence the choice of design has on the performance of the instrument, for most instruments more than one design variant has been defined. In those cases a base case with certain specifications was set. Additional variants differ from the base case only in one characteristic which is also denoted in their name. In the following the different instruments will be explained and the definitions used for the analysis will be given.

Feed-in tariff

All renewable electricity fed into the grid is remunerated with a fixed tariff which is paid instead of the electricity price. Grid access for renewable electricity is guaranteed. Usually the feed-in tariff is paid by the grid operators and collected from the electricity consumers. If there are several regional grid operators the sums paid to renewable operators are balanced between them.

Base Case:

- Financing: Renewable energy operators receive the tariff from the grid operators. The costs are passed on proportionally to the electricity suppliers and onward to all electricity customers.
- Development: Tariffs are regularly adjusted according to specific criteria. For example, the tariffs are indexed to a specific parameter like the inflation rate or the production costs of renewable energy plants.
- Specificity: For each renewable energy technology or for groups of technologies a specific tariff level is fixed.
- Hardship: There is no special hardship clause that caps the burden for energy intensive industries.

Additional to the base case the following design variants have been defined. They differ from the base case only in the described characteristic, all other design specifications are as in the base case. In the following and for all other instruments only the differences to the base case are listed.

Tax financed: Renewable energy operators receive the tariff from a public institution. It is financed from the tax base.

Constant over time: No change in tariffs is foreseen.

Decreasing over time: The tariffs for new plants are reduced by a fixed amount or percentage in a certain time frame, e.g. 2% every year.

Same for all technologies: For all renewable energy technologies the same tariff level applies.

Hardship clause: The contribution of energy-intensive industries is restricted to a certain amount or share of the electricity bill.

Fixed premium

All renewable electricity fed into the grid is paid a premium that comes additionally to the electricity price, which the renewable energy operators realise on the electricity market. Usually the feed-in premium is paid by the grid operators and collected from the electricity consumers. If there are several regional grid operators the sums paid to renewable operators are balanced between them.

Base Case:

- Financing: Renewable energy operators receive the premium from the grid operators. The costs are passed on proportionally to the electricity suppliers and onward to all electricity customers.
- Development: Premiums are regularly adjusted according to specific criteria. For example, the premiums are indexed to a specific parameter like the inflation rate or the production costs of renewable energy plants.
- Specificity: For each renewable energy technology or for groups of technologies a specific premium level is fixed.
- Hardship: There is no special hardship clause that caps the burden for energy intensive industries.

Tax financed: Renewable energy operators receive the premium from a public institution. It is financed from the tax base.

Constant over time: No change in premiums is foreseen.

Decreasing over time: The premiums for new plants are reduced by a fixed amount or percentage in a certain time frame, e.g. 2% every year.

Same for all technologies: For all renewable energy technologies the same premium level applies.

Hardship clause: The contribution of energy-intensive industries is restricted to a certain amount or share of the electricity bill.

Tendering System

For the installation of new renewable electricity capacity an auction is held. Deadlines for project implementation and meaningful penalties for non-compliance are in place.

Base Case:

- Financing: The financial support for renewable energy operators is financed by a mark-up paid by all electricity customers.
- Form of support: The tenderers present a bid over a fixed compensation per kWh for the production.
- Specificity: For each renewable energy technology or for groups of technologies a separate auction is held.

Tax financed: The financial support for renewable energy operators is financed from the tax base.

Auction over lowest premium: The tenderers present a bid over a fixed premium per kWh, paid on top of the electricity price, which the operators realise on the market.

Auction over lowest subsidy: The tenderers present a bid over an investment subsidy for the installation of the renewable energy plants.

No technology banding: Auctions are not technology-specific.

Tradable Green Certificates

A group of agents in the energy supply chain is obligated to have a certain quota of renewable electricity in their portfolio. Compliance is demonstrated by presenting renewable energy certificates. Those certificates are tradable. They can be traded together with the physical electricity or as a separate commodity. For non-compliance with the quota obligation penalties are imposed.

Base Case:

- Development: Increasing quota
- Obligation: The obligation is placed on electricity producers.
- Specificity: There is one renewable quota which comprises all renewable energy technologies.
- Validity: Certificates can be banked for the following commitment periods but missing certificates may not be borrowed from the following commitment periods.
- Price: The price of certificates is determined freely by supply and demand. Neither price cap nor floor is fixed.

Constant Quota: A constant quota is fixed for a certain time period.

Obligation on consumers: The obligation is placed on electricity consumers.

Obligation on retailers: The obligation is placed on electricity retailers.

Technology specific quotas: For each renewable energy technology or for groups of technologies there are separate quotas.

Banking and borrowing: The generated certificates can be banked for the following commitment periods and missing certificates can be borrowed from the following commitment periods.

Neither banking nor borrowing: All certificates have to be generated and used in the current commitment period.

Price cap and floor fixed: There is a price cap for the certificate price in the form of a fixed penalty price for non-compliance with the quota obligation as well as a minimum certificate price.

Only price cap in form of penalty: There is a price cap for the certificate price in the form of a fixed penalty price for non-compliance with the quota obligation.

Investment subsidies

Based on investment costs: The subsidy is based on the total investment costs, e.g. 70% of the investment.

Based on investment costs and efficiency of production: The subsidy is not only based on the investment costs, but takes also the plant efficiency into account.

Favourable changes in the existing tax system – Taxation Incentives

Lower VAT rates for renewable electricity: For the electricity from renewable energy a lower VAT rate applies.

Favourable depreciation possibilities: For the depreciation of renewable energy plants special favourable rules apply.

Exemption from energy or environmental taxes: Renewable electricity is exempt from environmental or energy taxes put on conventional electricity.

Implementation of policy instruments in Europe

All members of the European Union are required by directive 77/2001 on the Promotion of Electricity produced from Renewable Energy Sources in the internal electricity market to increase the share of renewable electricity in the national production to a certain level set for 2010. The choice of instruments and promotion schemes is left to the member states and so every country has adopted its own specific approach. In the following section the support measures of some member states shall be described exemplarily.

In the United Kingdom the renewable energy policy consists of four key support measures. The main mechanism is the Renewable Obligation (RO) which was introduced in 2002. (Department for Business Enterprise and Regulatory Reform [BERR], 2008, p. 6) An obligation is placed on licensed electricity suppliers to have an increasing share of renewable electricity in their electricity sales. Alternatively they can pay a penalty or buy-out price. Generators of renewable electricity receive a renewable obligation certificate (ROC) for every MWh they generate. They sell those certificates to the electricity suppliers to generate additional income. The suppliers demonstrate with those certificates their compliance with the obligation. Renewable electricity generation has increased significantly since 2002 to about 4.4% of total electricity generation compared to 1.8% in 2002. Additional to the support through the renewable obligation electricity from renewables is exempt from the Climate Change Levy. An expanded support programme including capital grants and an expanded research and development programme have also been introduced. (p. 2) According to BERR, 2008 the planning is currently one of the most significant barriers to the deployment of renewable energy. (p. 7)

Also in Italy renewable electricity is supported by a quota system. Since 2002 large producers and importers of electricity are obliged to feed into the grid a minimum quota of renewable electricity. Initially the quota was set at 2%. It will increase in the future. The grid manager issues green certificates to the renewable electricity producers. The green certificates constitute the proof of fulfilment of the quota obligation. They can be sold on a parallel market separate from the physical electricity. Failure to comply is sanctioned with limited access to the general electricity market. Furthermore renewable energy is favoured by priority in dispatching. (Republic of Italy, 2006, p. 13ff)

In Portugal in addition to fixed prices paid to renewable electricity public tenders were used to increase the deployment of renewable energies. In 2005 a public call for tenders for the supply of 1800 MW of wind energy capacity was published. For electricity production from biomass a public call for tenders was published in 2006. (Portugal, 2007, p. 4f)

In 2006 a new support system for renewable electricity was introduced in the Czech Republic. It grants all renewable electricity the right to be connected to the grid. Producers of renewable electricity can choose between minimum feed-in tariffs and green bonuses (surcharges on the market price of electricity). For plants already in operation the level of support is granted for 15 years. (Czech Republic, 2007, p. 19)

In Germany renewable electricity is supported by fixed feed-in tariffs, regulated since 2000 in the Renewable Energy Law. Differentiated tariffs are set for different technologies and scales of production plants. The tariffs are financed via a mark-up on the electricity price and collected and distributed by the grid operators. Tariffs for new plants decrease every year by a fixed percentage. The German promotion instrument led to a significant increase in the use of renewable energy for electricity production. (Government of the Federal Republic of Germany, 2007, p. 4f)

3. Analysis of policy instruments

Methodology

In the following the methodology used for the analysis of policy instruments is described. The procedure is also shown in the following flow chart where the contributions of the researchers and the stakeholders can be observed. This methodology is used in work packages 8 and 9.

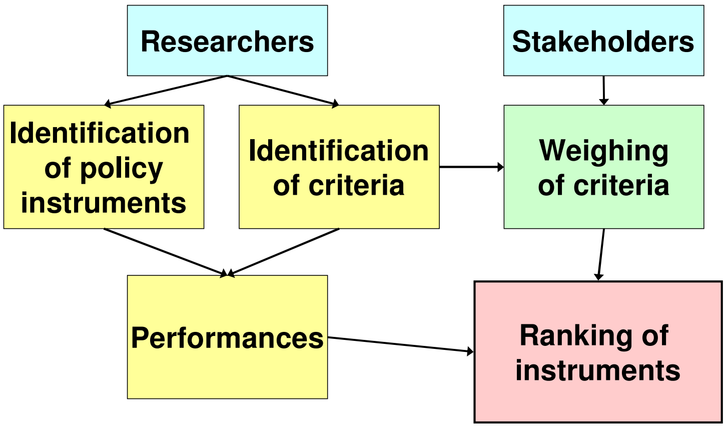

Figure 1 Procedure of policy assessment

In a first step a number of generic policy instruments were identified and selected for the analysis. As described already in the preceding chapter for each policy instrument a base case with certain design specifications has been defined. In many cases other alternative variants have been defined in addition to the base case to take into account the influence that the design of an instrument has on the performance.

A number of criteria have been identified and defined. All policy instruments for the promotion of renewable energy will be evaluated against those criteria. The criteria used in the analysis will be explained in the next section.

The performance of the instruments with regard to the different criteria has been evaluated. For that purpose a literature review has been carried out. Practical experiences with implementing the instruments that have been gained so far were also taken into account. For each criterion every instrument has received a score ranging from 1, denoting the lowest performance, to 5 denoting the highest performance. The scores in each criterion were given by keeping the definition of the criterion in mind and trying to relate the instrument to the criterion. Also care was taken to adequately indicate different performances of the instruments with the given scores.

The instruments, criteria and the scores were inserted in the MCDA tool developed in work package 11. This tool was used to elicit stakeholder preferences during the stakeholder workshop, held in Bruges on April 23rd 2008. During the workshop the stakeholders were presented with the definitions of instruments and criteria. They were then asked to weigh the different criteria based on the importance they attach to them. The used the ratio weights and the level weights method for weighing. The tool automatically calculates a ranking of instruments from the scores of the instruments and the weights of the criteria. Each stakeholder observes a different ranking based on his or her weights. From the data of all stakeholders an overall ranking can be generated.

Criteria for the evaluation

In this section the criteria which were used for evaluating the policy instruments will be listed and defined. In total ten criteria were used which evolve around the concept of sustainable development. The following figure gives an overview on the criteria.

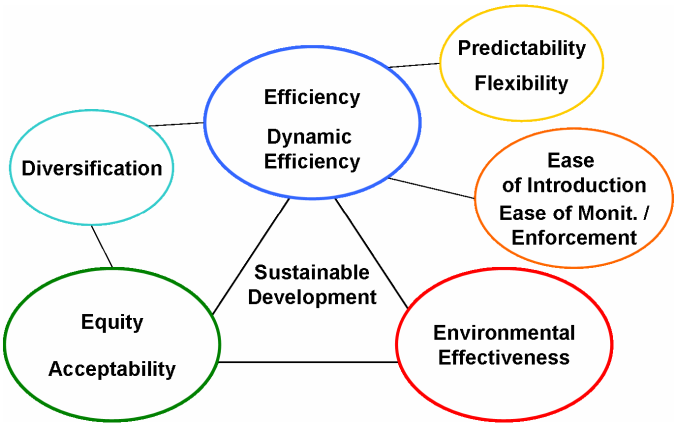

Figure 2 Criteria for the evaluation of policy instruments

Effectiveness to increase RES

The extent to which the policy instrument achieves the stated objective of increasing the share of renewable energies in the electricity production within a specified time period

Cost-Efficiency

The extent to which the policy instrument achieves the stated objective at the lowest possible cost for economic actors (businesses, households and government), within a specified time period and with a high degree of certainty. The relevant cost components are: costs needed to bring about the stated objective of the action, e.g. costs of abatement technologies, and the compliance costs (resources needed to comply with the monitoring and general administrative requirements) incurred by economic agents and regulatory costs incurred by the regulator.

Flexibility

The extent to which the policy instrument will retain its effectiveness under a range of changing environmental, economic, technological and social conditions. That is, will the instrument automatically adjust or, if not, how easily will the policy instrument, once implemented, be modified to accommodate changes?

Predictability

The extent to which the policy instrument provides power generators with a stable incentive ('carrot' or 'stick'), of known duration. An instrument with a high degree of predictability should reduce 'market risk', so that generators feel confident enough to modify their investment plans and to innovate and reduce costs in response to the policy instrument.

Dynamic Efficiency

The extent to which the policy instrument provides continuing incentives for innovation and diffusion that will lead to improved performance - in environmental quality or cost – through the development and adoption of new environmentally cleaner and economically more efficient practices or technologies

Equity

The extent to which the policy instrument does not yield disproportionate burdens or benefits – financial or environmental – to particular groups, or unduly limit the options of future generations.

Ease of introduction

The extent to which the policy instrument is relatively easy to implement, and does not require significant changes – by either government or generators – to existing legal, managerial, and technological (e.g. IT) systems. If new legislation is necessary, how feasible is it? Are the informational requirements for setting the policy instrument manageable?

Ease of monitoring and enforcement

The extent to which reliable compliance monitoring and enforcement can be implemented at an acceptable cost. Monitoring and enforcement costs will depend on the informational requirements and the institutional and human resource requirements.

Diversification

The extent to which the policy instrument will lead to a diversified electricity generation system, by encouraging investment in a range of technologies, at different scales and at geographically dispersed sites.

Acceptability

The extent to which the policy instrument is understood by the public, acceptable to generators, and sellable to decision-makers in government. If an instrument has been used with any success in the past, political resistance may be low. The acceptability of an instrument will also depend on whether it avoids negative and creates positive impacts in other important policy areas (e.g. employment).

Scoring of the instruments

Effectiveness to increase renewable energy production

Feed-in tariff

The actual increase in deployment of renewable energies depends very much on the level of the tariff. The tariff has to ensure the economic viability of renewable electricity projects including satisfactory return on investment. Some producer surplus also has to remain with the renewable energy producers so that they are able to invest in research and development. If the tariff is set sufficiently high substantial investments into renewable electricity projects can be promoted. (Resch et al, 2005, p. 54)

Feed-in tariff (FIT) systems implemented in several countries have proved very favourable for increasing the share of renewably produced electricity. Fixed feed-in tariffs provide the investors with security concerning the price they receive for the electricity and all produced electricity will be compensated. The only insecurity left concerns the electricity production in cases of volatile energy sources like wind energy and solar energy. The thus created investment security contributes to effectiveness in increasing the deployment of renewable electricity. FIT systems have proved very effective in attracting investments in wind power in Denmark, Spain and Germany (Morthorst et al, 2005, p. 31)

Of course for the effectiveness of the scheme it is a precondition that barriers to the implementation of renewable electricity projects are removed and favourable framework conditions are in place. In some countries that have been running FIT systems there has been no significant increase in the share of renewable electricity. Belgium, Norway and Sweden have been running FIT systems that did not contribute much to renewable energy deployment (Morthorst et al, 2005, p. 31)

Another aspect of effectiveness has to be taken into account when evaluating the instruments. The criterion effectiveness includes the extent to which the policy instrument achieves the stated objective within the specified time period, and with a high degree of certainty. As feed-in tariffs are a price regime only the tariffs are fixed and the amount of renewably produced electricity is left to the market. It is hence very difficult to predict the renewable electricity production resulting from the feed-in tariff system. A certain amount of renewable energy can only be reach by trial and error with a feed-in tariff system. The assurance that the objective will be met is weaker under the tariff system than under comparable quantity regimes. However a sharp increase of renewables could be achieved in countries with feed-in tariffs, not in those with a renewable quota. (Ringel, 2006, p. 9ff)

In the following table the scores of all the variants of the feed-in tariff can be seen. Here and in all the following tables in this chapter a green cell indicates that the variant has the highest score of all instruments while a pink colour indicates that the variant has received the lowest score of all instruments. Frequently the highest and lowest score were assigned more than once.

Alternatives	EFFECT
Fixed feed-in tariff - Base Case	5
Fixed feed-in tariff - Tax financed	4,7
Fixed feed-in tariff - Constant over time	4,5
Fixed feed-in tariff - Decreasing over time	4,5
Fixed feed-in tariff - Same for all technologies	4
Fixed feed-in tariff - Hardship clause	5

Table 1 Feed-in tariff - Effectiveness

Base Case: In the base case the tariffs are collected and distributed by the grid operators and financed by the electricity consumers. There is no limit on the budget and thus on the effectiveness of the scheme. The tariffs are regularly adjusted to factors like the inflation rate, the production costs of renewable energies and other drivers and can therefore maintain a stable environmental effectiveness. If tariffs are set for each technology specifically so that profitability can be reached the conditions for reaching an ambitious quantity goal are optimal. The base case reaches an overall score of 5.

Tax financed: The environmental effectiveness of a tax financed system may be impaired as there is usually a limited budget foreseen. When the budget is exhausted there might not be follow-up financing or at least some uncertainty slowing the development of renewable energies. In this case less renewable energy will be produced than in the case of financing by the electricity consumers. For that reason the score of the tax financed variant is with 4.7 lower than that of the base case.

Constant over time: Constant tariffs basically guarantee a continuing environmental effectiveness. However the effect could be reduced due to inflation. Changes in the costs of renewable energy plants are also not taken into account. This variant provides less environmental effectiveness than the adjusted tariffs in the base case therefore the score is 4.5.

Decreasing over time: If tariffs for new plants are reduced over time one should take care that the reduction is not faster than the rate of cost reductions achieved by the renewable electricity generators in order to retain the environmental effectiveness. When a certain decrease is fixed ex ante this will only by chance represent the real development. There is the risk of decreasing the tariffs to fast. Also for this variant the environmental effectiveness will be lower than in the base case and the score is 4.5.

Same for all technologies: The effect of uniform tariffs on the deployment of renewables depends on the level of the tariff. When the tariff level is based on the costs of the cheapest technologies all others will not be supported and the achieved renewable energy will be lower. If the tariff level for all technologies is based on the most expensive one the deployment of renewables will be the same as with differentiated tariffs but there will be economic consequences. This tariff level is however not likely and therefore a lower environmental effectiveness can be expected from uniform tariffs and the score is 4.

Hardship clause: The introduction of a hardship clause that limits the burden on energy-intensive industries has no influence on the environmental effectiveness. The score for this variant is therefore the same as for the base case.

Fixed Premium

The fixed premium is paid to renewable operators on top of the electricity price which they realize on the market. The sum should be fluctuating around the level of the fixed tariff. It can be assumed that the fixed premium has the same environmental effectiveness as the feed-in tariff.

Alternatives	EFFECT
Fixed premium system - Base Case	5
Fixed premium system - Tax financed	4,7
Fixed premium system - Constant over time	4,5
Fixed premium system - Decreasing over time	4,5
Fixed premium system - Same for all technologies	4
Fixed premium system - Hardship clause	5

Table 2 Fixed Premium System - Effectiveness

Base Case: The score for the base case of the premium system is the same as for the feed-in tariff. It is 5.

Tax financed: For the tax financed premium the same as for the tax financed feed-in tariff applies. The score is here also 4.7.

Constant over time: Also for the constant premium the argument is the same as for the tariff and the score is the same with 4.5.

Decreasing over time: The score for a premium system with a fixed decrease is also 4.5. As in the case of the feed-in tariff the environmental effectiveness is lower than in the case of regularly adjusted premiums.

Same for all technologies: Paying the same premium for all technologies will exclude the more expensive technologies. As in the case of the feed-in tariff the deployment of renewables will be lower with a uniform premium. The score is 4.

Hardship clause: As the introduction of a hardship clause has no influence on the environmental effectiveness the score is the same as in the base case.

Tendering system

When a tender is held for a certain renewable energy capacity, there will be winning bids exactly for the auctioned capacity. The inherent problem of the tender system is that frequently not all of the winning bids are realized. Winning projects often do not obtain the required permissions for implementation.

For the environmental effectiveness it is very important to set deadlines for the project implementation and meaningful penalties for non-compliance. The lack of deadlines and penalties could easily result in a poor compliance by the winning participants. This would severely impair the environmental effectiveness.

The produced energy from contracted projects depends on the annual operation hours. They vary between the different renewable energy technologies. If the tender is not technology-specific the resulting electricity production can only be roughly estimated.

Overall the tender system has a lower environmental effectiveness than feed-in tariff and premium system.

Alternatives	EFFECT
Tendering System - Base Case	3,5
Tendering System - Tax financed	3,5
Tendering System - Auction over lowest premium	3,5
Tendering System - Auction over lowest investment subsidy	3
Tendering System - No technology banding	3,5

Table 3 Tendering System - Effectiveness

Base Case: The base case is optimally designed with regard to effectiveness. It contains no barriers to implementation. However due to inherent limitations of the tender system, as explained above, the score of the base case is 3.5.

Tax financed: The tax financed system has the same effectiveness as the base case. In the case of auctions for a fixed capacity a limited budget does not impair the effectiveness.

Auction over lowest premium: When the winner auf the auction is awarded with a fixed premium instead of a feed-in tariff the same environmental effectiveness can be expected. The score is hence the same as in the base case.

Auction over lowest investment subsidy: If the winner of the tender gets an investment subsidy which does not depend on production there is no incentive for efficient and effective production of renewable electricity. The environmental effectiveness, that means the produced renewable electricity, is very likely lower in this case. The score is 3.

No technology banding: As the auction is held over a certain capacity the decision on technology banding will not change the overall procured capacity and with that the produced amount of electricity. The score is the same as in the base case.

Tradable green certificates

The environmental effectiveness of a tradable green certificate system depends mainly on the level of the quota. It should be fixed to an ambitious but achievable rate. With a quota for renewable electricity the share that will be produced can be fixed with great certainty, provided that meaningful penalties are in place. However the absolute quantity of renewable electricity depends on the overall electricity production or demand. If the electricity production or demand is decreasing the renewable electricity production could also decrease and still fulfil the quota. In general tradable green certificates are considered as ecologically effective and timely. (Ringel, 2006, p. 10)

Penalties for non-compliance with the quota are very important to guarantee the environmental effectiveness. When no penalties are in place the environmental effectiveness is severely reduced.

Alternatives	EFFECT
Tradable green certificates - Base case	5
Tradable green certificates - Constant quota	4,7
Tradable green certificates - Obligation on consumers	5
Tradable green certificates - Obligation on retailers	5
Tradable green certificates - Technology specific quotas	5
Tradable green certificates - Banking and borrowing	4,7
Tradable green certificates - Neither banking nor borrowing	5
Tradable green certificates - Price cap and floor fixed	4,3
Tradable green certificates - Only price cap in form of penalty	4,3

Table 4 Tradable green certificates - Effectiveness

Base Case: With an increasing quota the renewable electricity production will gain shares at the expense of conventional electricity production. Depending on the rate of increase of the quota, a large growth of renewable electricity can be achieved. In the base case borrowing of certificates is not allowed so that renewable electricity production cannot be postponed to the future. The certificate price is not restricted and hence does not limit the effectiveness of the promotion scheme. The well designed tender system has the same effectiveness as the feed-in tariff and the premium system. The assigned score is 5.

Constant quota: With a constant quota the development of renewable electricity is coupled to the development of total electricity production or demand. The absolute renewable electricity production could increase but there will be no change in the structure of electricity production. The environmental effectiveness is lower as in the base case and the score is 4.7.

Obligation on consumers: The choice on which actor in the supply chain the obligation is placed has no influence on the amount of renewable electricity produced. The environmental effectiveness is the same as in the base case.

Obligation on retailers: As stated above there is no deviation from the base case.

Technology specific quotas: Whether there is one uniform quota or several technology specific quotas will not change the environmental effectiveness as the overall quantity of produced renewable electricity is fixed. The score is the same as in the base case.

Banking and borrowing: When banking and borrowing are allowed the obligors have the possibility to borrow certificates from the next commitment period. That means they use certificates for their fulfilment for which there is not yet correspondent renewable electricity produced. Even if the quota system stays in place and the missing renewable electricity is produced in the next commitment period the short-term environmental effectiveness is impaired. Also it might be environmentally desirable to have the renewable electricity production as soon as possible. This cannot be guaranteed when allowing borrowing. The score is with 4.7 lower than that of the base case.

Neither banking nor borrowing: When neither banking nor borrowing is allowed the environmental effectiveness is the same as in the base case.

Price cap and floor fixed: If a price cap is in place the environmental effectiveness of the scheme is lower as the obligors have the possibility to buy out of the obligation at the cap price. For that reason the score is reduced to 4.3.

Only price cap in form of penalty: In this case the same argument applies. A price cap will reduce the environmental effectiveness and the score is again 4.3.

Investment subsidies

Alternatives	EFFECT
Investment subsidies - Based on investment costs	3
Investment subsidies - Based on investment costs and efficiency of production	4

Table 5 Investment subsidies - Effectiveness

Based on investment costs: When a fixed subsidy is given to newly installed renewable energy plants additional investments will be motivated. However as the subsidy is based on the investment sum there is no incentive to efficiently produce as much renewable energy as possible. This leads to a medium score of 3 for this variant.

Based on investment costs and efficiency of production: When the support is not only based on the investment but also on the efficiency of the plant, there is an incentive for efficient renewable energy production and the environmental effectiveness of the scheme will be higher. This variant receives a higher score of 4.

Taxation incentives

Alternatives	EFFECT
Lower VAT rates for renewable electricity	3
Favourable depreciation possibilities	2
Exemption from energy or environmental taxes	4

Table 6 Taxation Incentives - Effectiveness

Lower VAT rates: A lower VAT rate for renewably produced electricity is a tax reduction which directly benefits renewable electricity producers by the amount of tax saved. This financial incentive will lead to additional renewable energy production, however less to than in the case of exemption from energy or environmental taxes. The score for this instrument is 3.

Favourable depreciation possibilities: The least environmental effectiveness of all instruments can be expected from depreciation regulations. This measure will hardly motivate additional investment in renewable energies. With a 2 the lowest score of all instruments is assigned.

Exemption from energy or environmental taxes: When renewable energy is exempt from energy or environmental taxes renewable producers receive the saved amount to compensate for their additional costs. Depending on the level of the taxes this exemption can bring a substantial quantity of renewable energy into the market. This instrument thus has a high score of 4.

Cost-efficiency

Feed-in tariff

For a long time it has been assumed that pricing schemes like the fixed feed-in tariff and the premium system have lower cost-efficiency than quantity regimes. However recent research suggests that this is not generally the case and that the financial support may have been lower under the German feed-in tariff scheme than under the British Renewables Obligation (RO). Grotz and Fouquet, 2005 show that the prices per kWh for wind electricity are not cheaper in quota systems than in pricing systems. They give 13 €ct/kWh as the Italian certificate price and 9.6 €ct/kWh for the UK certificate price for 2003. Tariffs in the Netherlands (9.2 €ct/kWh), Germany (6.6 – 8.8 €ct/kWh) and France (8.4 €ct/kWh) have been all below this level. (p. 20)

Toke, 2004 points out that when comparing the British certificate prices with the German feed-in tariff one has to keep in mind, that e.g. wind energy tariffs are reduced in a second stage based on the achieved production. Furthermore electricity prices are generally higher in Germany than in the UK. And the average wind speed in Germany is much lower than in the UK. (p. 19) Toke, 2004 compared the support per kW, calculated with average capacity factors for Germany and the UK. For the Renewables Obligation in the UK he obtained a payment of £ 121.33 and for the feed-in tariff in Germany £ 88.91. However this is at least partly due to other reasons beside the form of support scheme. The tax regime in Germany allows the deduction of private investments in renewable energy. This makes investment in renewable energies for wealthy people cheaper than in the UK. (p. 22)

According to Butler and Neuhoff, 2004 the remuneration under the German support system will be lower than the certificate prices under the RO only until approximately 2012. (p. 15) Also Elliot, 2005 expects prices of the German and the British support schemes to converge in the long run. (p. 1)

This empiric evidence leads to a higher cost-efficiency score for the feed-in tariff and the premium system than for the quantity based mechanisms. Still the score for the feed-in tariff is in the medium range because not automatically only the cheapest production units are employed.

Alternatives	COST-EFF
Fixed feed-in tariff - Base Case	3,7
Fixed feed-in tariff - Tax financed	3,7
Fixed feed-in tariff - Constant over time	3
Fixed feed-in tariff - Decreasing over time	3,3
Fixed feed-in tariff - Same for all technologies	4
Fixed feed-in tariff - Hardship clause	3,3

Table 7 Feed-in tariff - Cost efficiency

Base Case: Automatic adjustment to the real development of costs of renewable energy is more favourable than ex ante fixed reduction.

With varying tariffs for different technologies not only the cheapest technology will be promoted. That means that higher tariffs will be paid to technologies which are less mature and have higher generation costs. This will increase the overall compensation that has to be paid and reduce the cost-efficiency. On the other hand the specific tariffs will reduce the producer surplus for some of the producers. For a given renewable electricity target the necessary uniform feed-in tariff is determined by the most expensive technology needed to fulfil the target and also less expensive technologies will be compensated with this tariff. With specific tariffs the less expensive technologies receive a lower tariff and hence the producer surplus that can be gained with those technologies is lowered. This effect will reduce the total amount of support needed for a specific target. However as the production cost curve for renewable energy is not known in practice tariffs will not correspond directly to a quantity target.

When no hardship clause is implemented the burden is allocated evenly to all customers. There is an incentive for all consumers to reduce their demand as reaction to the mark-up. The overall score of the base case is 3.7.

Tax financed: The cost efficiency of the system, that means relation between the achieved renewable electricity production and the costs of the system is the same regardless of the source of financing. The score for this variant is therefore the same as for the base case.

Constant over time: Assuming that the production costs of renewable electricity will decrease in the future (learning curves, economies of scale) constant tariffs would continually increase the producers' surplus. Constant tariffs also provide no incentives to reduce costs. The cost-efficiency is therefore lower than in the base case with regularly adjusted tariffs. The score is 3.

Decreasing over time: In order to reach a certain renewable energy target with minimum costs the tariff should be regularly decreased. Decreasing tariffs put pressure on the operators of renewable energy plants to reduce the production costs. However the feed-in tariff with a fixed predetermined decrease is not as cost-efficient as the base case because it is not based on the real development of costs and prices but on an ex-ante assumption that may not materialize. The score is with 3.3 higher than that of constant tariffs but lower than that of the base case.

Same for all technologies: If a uniform tariff for all renewable energy technologies is based on the cheapest options, this alternative will allow renewable production to lower costs than with varying tariffs. In this case only the cheapest and most cost-effective technology will be employed. The cost-efficiency of the system will be higher than in the base case with specific tariffs and a score of 4 has been assigned.

Hardship clause: The overall efficiency of the scheme is lower when some consumers are exempt from paying the compensation. This leads to higher burdens of the other customers. Furthermore the effect of demand reductions due to the compensation of renewable energy will be lost in the privileged consumer group. The score is with 3.3 lower than in the base case.

Fixed premium

The fixed premium has the same cost-efficiency as the feed-in tariff. The extra cost of the system is in both cases the amount paid on top of the electricity price no matter whether this is realized separately or together in one tariff. The scores given to the feed-in tariff are therefore for all variants the same as in the case of the feed-in tariff.

Alternatives	COST-EFF
Fixed premium system - Base Case	3,7
Fixed premium system - Tax financed	3,7
Fixed premium system - Constant over time	3
Fixed premium system - Decreasing over time	3,3

Fixed premium system - Same for all technologies	4
Fixed premium system - Hardship clause	3,3

Table 8 Fixed premium system - Cost efficiency

Base Case: The argument related to the feed-in tariff is valid also here. The base case is scored with 3.7.

Tax financed: The source of financing has no influence on the cost-efficiency. The score is the same as for the base case.

Constant over time: As explained above the constant premium is less cost-efficient than the regularly adjusted premium. The score for this variant is 3, the same as for the constant feed-in tariff.

Decreasing over time: A fixed decrease is more efficient that constant premiums but less optimal than the adjustment of premiums based on the real development of drivers. The score of this variant is accordingly with 3.3 in between the others.

Same for all technologies: This is the most efficient variant of the premium system. In this case only the most competitive technologies are used and the overall costs are minimized. This variant scores 4.

Hardship clause: Again this variant has a lower score than the base case because the costs are not strictly allocated based on electricity consumption. The score for this variant is 3.3.

Tendering system

In general a tender guarantees that only the most competitive project are realised. Furthermore, apart from the unknown outcome of the auction, the winners of the tender have high revenue predictability. The costs are not increased by risk premiums for economic uncertainty.

Alternatives	COST-EFF
Tendering System - Base Case	3,5
Tendering System - Tax financed	3,5
Tendering System - Auction over lowest premium	3,5
Tendering System - Auction over lowest investment subsidy	3
Tendering System - No technology banding	4,5

Table 9 Tendering System - Cost efficiency

Base Case: In the base case there are technology-specific auctions. Within each technology band the only most competitive technologies are accepted, but overall also less mature technologies are included, implying higher total costs for the renewable electricity production. For this reason the score of the base case for efficiency is 3.5.

Tax financed: The tax financed system has the same costs. Only the source of the financing is different but the cost-efficiency is the same as in the base case.

Auction over lowest premium: As explained before the cost-efficiency of a tariff system and a premium system are the same and hence also in the tender system there is no difference between the base case and a system with premiums.

Auction over lowest investment subsidy: When a subsidy on investment is paid the incentive for high reliability of the plants and efficient production is weaker. This results likely in a lower production of renewable electricity and reduced cost-efficiency as the output that can be achieved with a certain input of financing is lower. The score is only 3 for this variant.

No technology banding: The cost-efficiency is higher when there is no technology specificity. Thereby it is assured that the most competitive technologies are used for the fulfilment of the objectives and minimum compliance costs are created. For this reason this variant of the tender receives with 4.5 the highest score.

Tradable green certificates

The design of a green quota allows in theory to reach a given environmental standard with minimum costs. A fixed quota by itself is not economically efficient but via the fulfilment with tradable certificates economic efficiency is guaranteed. (Ringel, 2006, p. 11)

However as explained above empiric evidence has indicated that so far the certificate prices under quota systems implemented in Europe were higher than the tariffs paid under pricing schemes. For that reason the scores for the tradable green certificate system are slightly lower than for the price based instruments.

Alternatives	COST-EFF
Tradable green certificates - Base case	3,3
Tradable green certificates - Constant quota	3,3
Tradable green certificates - Obligation on consumers	3,3
Tradable green certificates - Obligation on retailers	3,3
Tradable green certificates - Technology specific quotas	3
Tradable green certificates - Banking and borrowing	3,7
Tradable green certificates - Neither banking nor borrowing	3,3
Tradable green certificates - Price cap and floor fixed	3,3
Tradable green certificates - Only price cap in form of penalty	3,7

Table 10 Tradable green certificates - Cost efficiency

Base Case: If there is only one quota for all renewable electricity, it will be achieved with the technologies that have the lowest costs. There is a high degree of cost efficiency. However since only banking of certificates is allowed and not borrowing there is no inter-temporal efficiency. The most competitive technologies will be used for fulfilment but maybe not at the most competitive point in time. According to Morthorst et al, 2005 the base case would be ideal in that there is neither price cap nor floor and the penalty set sufficiently high so that it does not have a price controlling influence. (p. 40) Still due to the practical experiences related above the score for the base case is only 3.3.

Constant quota: Whether the quota is constant or increasing changes the environmental output but not the costs per output and hence the same score as for the base case applies.

Obligation on consumers: The cost-efficiency of the system does not depend on who is obliged to present certificates. Therefore for this variant the same score as for the base case was assigned.

Obligation on retailers: The same is also valid here. There is no deviation from the base case.

Technology specific quotas: With technology-specific quotas not only the least expensive technology will be promoted and applied but also other more expensive technologies. The cost-efficiency is lower. Furthermore there is the risk that the separated certificate markets, e.g. for PV, have a very low liquidity. (see Morthorst et al, 2005, p. 42) This variant receives a lower score for cost-efficiency than the base case. It is 3.

Banking and borrowing: A system which allows banking and borrowing has higher cost-efficiency because the actors can chose freely at which point in time they make their investment in order to fulfil the quota. Renewable electricity will be produced at the time when it is most cost-efficient. The score of this variant is 3.7.

Neither banking nor borrowing: It can be assumed that costs for renewable energy will decrease in the future. For this reason banking of certificates will not significantly increase the cost efficiency of the scheme. The score for this variant is the same as for the base case.

Price cap and floor fixed: In this variant the effects of price floor and price cap are compensating each other. With a price cap the costs are limited but with a floor they are not allowed to fall as much as they might without. Overall the cost efficiency can be estimated to be comparable to that of the base case.

Only price cap in form of penalty: When a price cap is implemented in the system the overall costs are limited. The cost-efficiency of this variant is therefore higher than that of the base case and a score of 3.7 is assigned.

Investment subsidies

Alternatives	COST-EFF
Investment subsidies - Based on investment costs	2
Investment subsidies - Based on investment costs and efficiency of production	3

Table 11 Investment subsidies - Cost efficiency

Based on investment costs: The cost efficiency of investment subsidies based only on the investment costs is rather low. This scheme gives no incentives to maximise the output and this impairs also the cost-efficiency. The score for this instrument is 2.

Based on investment costs and efficiency of production: When the subsidy is also based on the efficiency of production the cost-efficiency increases. However it is lower than for instruments where the support is solely based on the output. This variant achieves therefore only a score of 3.

Taxation incentives

Alternatives	COST-EFF
Lower VAT rates for renewable electricity	3,5
Favourable depreciation possibilities	3
Exemption from energy or environmental taxes	3,5

Table 12 Taxation Incentives - Cost efficiency

Lower VAT rates: Tax exemptions have medium cost efficiency comparable to that of the price based instruments. In both cases renewable energy operators receive more than the conventional electricity price per kWh and depending on the level a certain amount of renewable electricity will be produced. This instrument has a score of. 3.5.

Favourable depreciation possibilities: Favourable depreciations regulations have slightly lower cost efficiency. The costs of the scheme are small but also the achieved renewable energy production is small. The support does not directly act on the production. This instrument gets a score of 3.

Exemption from energy or environmental taxes: The cost efficiency for this instrument is the same as for lower VAT rates. In both cases renewable electricity is exempt from taxes. Also for this instrument the score is 3.5.

Flexibility

Feed-in tariff

Under fixed price systems the financial support is not automatically adjusted to changing economic conditions such as the costs of finance or changes in the production cost of wind power. The system is hence rather rigid. (Morthorst et al, 2005, p. 32; Resch et al, 2005, p. 54)

Alternatives	FLEX
Fixed feed-in tariff - Base Case	3
Fixed feed-in tariff - Tax financed	2,5
Fixed feed-in tariff - Constant over time	2
Fixed feed-in tariff - Decreasing over time	2,5
Fixed feed-in tariff - Same for all technologies	3
Fixed feed-in tariff - Hardship clause	3

Table 13 Feed-in tariff - Flexibility

Base Case: Compensations paid by all electricity consumers are easier to modify and adjust to changed parameters, because the public budget is not involved. Furthermore with regularly scheduled adjustments the flexibility of the feed-in tariff will be highest. The base case receives a score of 3.

Tax financed: When the feed-in tariff is financed from the tax base the decision-making process needed for changes and modifications will be more complicated and lengthy because the public budget is affected. This variant receives with 2.5 a lower score in flexibility.

Constant over time: Constant tariffs are less flexible than tariffs which are regularly adjusted. To adapt the constant tariffs to changes in the economic parameters a new governmental or legislative initiative is needed. Constant tariffs represent consequently the least flexible variant with a score of 2.

Decreasing over time: Tariffs that are decreased over time according to a fix pattern are also not flexible to short-term changes of economic parameters. However a reduction of the production costs of renewable electricity is already anticipated with this design. This variant ranges between the base case and constant tariffs with regard to flexibility and receives a score of 2.5.

Same for all technologies: Having uniform tariffs for all technologies does not change the flexibility of the system. The score for this variant does not differ from the base case.

Hardship clause: The introduction of a hardship clause has no influence on the flexibility of the scheme. This variant has the same score as the base case.

Fixed premium

The fixed premium system has a higher flexibility than the feed-in tariff system because only the premium part of the revenues for renewable operators is fixed. The electricity price automatically adjusts to changes of economic parameters.

Alternatives	FLEX
Fixed premium system - Base Case	4
Fixed premium system - Tax financed	3,5
Fixed premium system - Constant over time	3
Fixed premium system - Decreasing over time	3,5
Fixed premium system - Same for all technologies	4
Fixed premium system - Hardship clause	4

Table 14 Fixed premium system - Flexibility

Base Case: In the base case tariffs are regularly adjusted to changes. This ensures a high flexibility of the system. The score for the base case is 4.

Tax financed: The tax financed variant of the premium system is considered less flexible because every adjustment will have to go through a more complicated legal process. This variant has a lower score of 3.5.

Constant over time: Constant premiums represent the least flexible variant. No changes whatsoever are taken into account. This variant receives a lower score of 3.

Decreasing over time: This variant is more flexible than constant premiums but less favourable than regularly adjusted premiums. The score of 3.5 is not as high as that of the base case.

Same for all technologies: As in the case of the feed-in tariff uniform premiums have the same flexibility as technology-specific premiums and there is thus no difference to the base case score.

Hardship clause: Also limiting the burden of energy-intensive industries does not change the flexibility of the system.

Tendering system:

The tender system is also rather inflexible. Once the auction is over, prices are fixed and will not be adjusted again. However the results of the auction are based on the bids and hence take into account all relevant parameters.

Alternatives	FLEX
Tendering System - Base Case	3

Tendering System - Tax financed	2,5
Tendering System - Auction over lowest premium	3,5
Tendering System - Auction over lowest investment subsidy	2,5
Tendering System - No technology banding	3

Table 15 Tendering System - Flexibility

Base Case: In the base case the support is financed by the electricity consumers. This makes the scheme more flexible than a tax financed variant. The feed-in tariff that is paid is less flexible than a premium. On the whole the score for the base case is 3.

Tax financed: As already explained in the cases of the feed-in tariff and the premium system a tax financed system has a lower flexibility than a system which is financed by all electricity consumers. The flexibility of this variant is with 2.5 lower than that of the base case.

Auction over lowest premium: Before the higher flexibility of the premium system compared to the tariff system was described. Based on this argument the system with an auction based on a premium has a higher flexibility than a system with an auction based on a feed-in tariff. The score is 3.5.

Auction over lowest investment subsidy: The investment subsidy is the least flexible form of support. It is not automatically adjusted to economic parameters and it does not change with the amount of produced energy. This variant has a score of 2.5.

No technology banding: Technology banding does not change the flexibility of the system. The score for this variant is the same as for the base case.

Tradable green certificates

The quota is a very flexible instrument. The price of green certificates is automatically adjusted to changes in the price level, costs of renewable electricity and other economic effects. Ideally the electricity price and the certificate price will add up to the long-term marginal costs of renewable electricity production. (Morthorst et al, 2005. p. 41)

In principle the renewable energy quota is inherently sun setting. However if all renewable energy technologies are included in the same quota the certificates will still have a positive value when some of the technologies are already competitive and would not need support any longer. (Morthorst et al, 2005, p. 42)

Alternatives	FLEX
Tradable green certificates - Base case	4,7
Tradable green certificates - Constant quota	4,7
Tradable green certificates - Obligation on consumers	4,7
Tradable green certificates - Obligation on retailers	4,7
Tradable green certificates - Technology specific quotas	4,3
Tradable green certificates - Banking and borrowing	5
Tradable green certificates - Neither banking nor borrowing	4,7
Tradable green certificates - Price cap and floor fixed	4,3
Tradable green certificates - Only price cap in form of penalty	4,3

Table 16 Tradable Green Certificates - Flexibility

Base case: The base case is designed so that high flexibility is reached. The price is not limited in any way. The only restriction included is the prohibition of borrowing certificates from future commitment periods. The overall score of the base case is 4.7.

Constant quota: Whether the quota is constant or increasing does not change the flexibility of the scheme. The score for this variant does not differ from the base case.

Obligation on consumers: On which actor in the supply chain the obligation is put also has no influence on the flexibility of the quota system. The same score as for the base case is assigned.

Obligation on retailers: As explained for the preceding variant there is no difference to the base case.

Technology specific quotas: Specific quotas are less flexible than one overarching quota because the choice of technology used for fulfilling the quota is no longer left to the obligors but prescribed by the quotas. The flexibility score for this variant is 4.3.

Banking and borrowing: When banking and borrowing of certificates is allowed the flexibility for the obligors in fulfilling the quota is highest. They can not only decide freely on the type but also on the time of their investment. This variant receives with 5 the highest score of all instruments.

Neither banking nor borrowing: For the obligors of the system this design variant provides less flexibility in fulfilling the quota. The score of this variant is lower than that of the previous one. A 4.7 is assigned.

Price cap and floor fixed: When price cap and floor are fixed the price of the green certificates is not allowed to only form based on supply and demand. The price cannot freely adapt to any changes but is confined to a corridor. This limits the flexibility of the system. The score is reduced to 4.3.

Only price cap in form of penalty: Also this variant provides less flexibility than the base case because the price is not allowed to increase freely based on costs. The score for this variant is also 4.3.

Investment subsidies

Alternatives	FLEX
Investment subsidies - Based on investment costs	2
Investment subsidies - Based on investment costs and efficiency of production	3

Table 17 Investment subsidies - Flexibility

Based on investment costs: Investment subsidies are fixed based only on the investment costs. This support will not adjust to any change of parameters. It has a low flexibility score of 2.

Based on investment costs and efficiency of production: This variant of the investment subsidy is a bit more flexible because it takes the efficiency of electricity production into account. It receives a score of 3.

Taxation incentives

Alternatives	FLEX

Lower VAT rates for renewable electricity	4
Favourable depreciation possibilities	4
Exemption from energy or environmental taxes	4

Table 18 Taxation Incentives - Flexibility

Lower VAT rates: The flexibility of tax exemptions is quite high. VAT is paid as a percentage of the electricity price. The benefit hence adjusts automatically to changes in economic parameters like the development of prices and the costs of production. If the costs of production which affect conventional and renewable production equally increase also the economic benefits through saved VAT increase. However changes in the costs of renewables which are not reflected in the electricity prices will not be incorporated with this scheme. The overall score for flexibility is 4.

Favourable depreciation possibilities: Also the benefits from depreciation regulations will change with the level of costs and prices. The same score of 4 is assigned to this instrument.

Exemption from energy or environmental taxes: For the exemption from energy and environmental taxes the same argument as for the exemption from VAT applies. This instrument consequently receives the same score of 4.

Predictability

Feed-in tariff

The reduction of risks for investors is very important to make a support mechanism effective. Lowering the risk reduces the costs of capital and thereby increases the economic efficiency of the system. For the operators this effect is the same as raising the level of compensation. The feed-in tariff provides lower risk (higher security) for investors than other support mechanisms. This enables the renewable energy generators to finance more easily through the capital market. (Mitchell et al, 2006, p. 300ff) The higher reliability for investors is given because the price paid per kWh is known beforehand.

Since the total price received by the electricity producers is fixed, the compensation that has to be paid on top of the electricity price depends on the level of the electricity price. This feature of the feed-in tariff system makes it impossible to predict level of support per kWh. If electricity prices rise above the level of the tariff the support is even negative. (Morthorst et al, 2005, p. 30)

Alternatives	PRED
Fixed feed-in tariff - Base Case	5
Fixed feed-in tariff - Tax financed	5
Fixed feed-in tariff - Constant over time	5
Fixed feed-in tariff - Decreasing over time	5
Fixed feed-in tariff - Same for all technologies	5
Fixed feed-in tariff - Hardship clause	5

Table 19 Feed-in tariff - Predictability

For all variants of the feed-in tariff the same score for predictability has been assigned. As the tariffs are guaranteed for existing plants and only change for new plants the development of the tariff level does not change the predictability of the system. Neither do issues of financing like the source of financing or the involvement of energy-intensive industries.

Fixed premium

The predictability of the premium system for investors is lower than that of the feed-in tariff. This is due to the fact that in this system only the premium is fixed but the level of the electricity price fluctuates and can not be known exactly by the investors. The overall revenue they receive is therefore not known beforehand as in the case of the feed-in tariff.

Alternatives	PRED
Fixed premium system - Base Case	3
Fixed premium system - Tax financed	3
Fixed premium system - Constant over time	3
Fixed premium system - Decreasing over time	3
Fixed premium system - Same for all technologies	3
Fixed premium system - Hardship clause	3

Table 20 Fixed premium system - Predictability

Also in this case there is no difference between the variants of the premium system. All variants receive a score of 3.

Tendering system

The predictability for the winners of the tender is quite high. They contract the produced electricity for the level of support corresponding to their bid. The uncertainty in this system is which bid and at what level will win the tender. Investors that start planning renewable energy projects, make a calculation and place a bid can never be certain of success. The incurred costs are lost for all but the winners of the tender. This kind of risk can only be taken by larger companies and discourages public cooperatives.

Alternatives	PRED
Tendering System - Base Case	4
Tendering System - Tax financed	4
Tendering System - Auction over lowest premium	3
Tendering System - Auction over lowest investment subsidy	4
Tendering System - No technology banding	4

Table 21 Tendering System - Predictability

Base Case: In the base case the winner of the auction receives a fixed price per kWh corresponding to his bid. This provides a high predictability for investors. The score for the base case is 4.

Tax financed: There source of financing is not relevant for the predictability of the system.

Auction over lowest premium: The predictability of this variant is 3, lower than that of the base case. When a premium is contracted instead of a fixed tariff operators have to sell their produced electricity on the electricity market. Due to the fluctuating electricity price this part of the revenue is less predictable and this reduces the overall predictability of the scheme.

Auction over lowest investment subsidy: A fixed investment subsidy has the same predictability as the feed- in tariff.

No technology banding: Whether there is a uniform auction or several technology-specific auctions does not change the predictability of the system. There is no deviation from the base case.

Tradable green certificates

The predictability of the certificate trading scheme is quite low. Renewable operators have to operate on two different markets, the electricity market and the certificate market. On both markets they face fluctuating prices with unknown future development. Investors, facing decreasing production costs for renewable energy, have no security that they will be able to compete with new plants in the future. Overall the predictability of the tradable green certificate scheme is lower than of the other instruments.

Alternatives	PRED
Tradable green certificates - Base case	1,7
Tradable green certificates - Constant quota	1,7
Tradable green certificates - Obligation on consumers	1,7
Tradable green certificates - Obligation on retailers	1,7
Tradable green certificates - Technology specific quotas	1,7
Tradable green certificates - Banking and borrowing	1,3
Tradable green certificates - Neither banking nor borrowing	1,3
Tradable green certificates - Price cap and floor fixed	2
Tradable green certificates - Only price cap in form of penalty	1,7

Table 22 Tradable green certificates - Predictability

Base case: According to Morthorst et al, 2005, the banking of certificates will eliminate price fluctuations in the certificate market and thus increase the reliability for investors. It is the basis for long-term certificate purchase contracts. (p. 42) However without any restrictions on the price, like cap or floor, the predictability is a bit lower. The overall score for the base case is 1.7.

Constant quota: The constant quota has the same predictability as a quota with a known increasing course. The score is the same as for the base case.

Obligation on consumers: The predictability of the scheme does not depend on who is obliged to fulfil the quota. The score is the same as for the base case.

Obligation on retailers: Likewise for this variant there is no change to the base case.

Technology specific quotas: Splitting the quota in several technology-specific quotas will reduce the liquidity of the separate markets. If the markets are not liquid enough the certificate price will not be stable thus increasing the uncertainty for investors. (Rio, 2005) On the other hand smaller markets may be easier to predict. On the whole the predictability is assumed to be comparable to the base case.

Banking and borrowing: On the one hand banking and borrowing is supposed to smooth out the price fluctuations of green certificates because shortages can be avoided. On the other hand renewable energy operators will have less security of selling their certificates if the obliged parties have the possibility to borrow certificates. The latter effect is estimated to outweigh in this case. The score for this variant is 1.3.

Neither banking nor borrowing: Also this variant has a score of 1.3 because without the possibilities of banking and borrowing the market is very unstable.

Price cap and floor fixed: With a price cap and a floor the price of green certificates is limited in both directions. This reduces the price uncertainty for investors and increases somewhat the predictability. The score for this variant is higher than for the base case. A score of 2 is assigned.

Only price cap in form of penalty: A price cap on the certificate price only limits the revenue for investors. By itself the price cap will not increase the predictability of the scheme. The score is the same as in the base case.

Investment subsidies

Alternatives	PRED
Investment subsidies - Based on investment costs	5
Investment subsidies - Based on investment costs and efficiency of production	5

Table 23 Investment subsidies - Predictability

Based on investment costs: Investment subsidies are a very predictable instrument. Renewable energy producers receive the support upfront so they do not have any financial uncertainty. The score for this instrument is 5.

Based on investment costs and efficiency of production: Basing the subsidy also on the efficiency of production does not change the predictability. Also in this case the producer receives the support when installing the plant and has no further uncertainty. This variant also has a score of 5.

Taxation incentives

Alternatives	PRED
Lower VAT rates for renewable electricity	3
Favourable depreciation possibilities	3
Exemption from energy or environmental taxes	3

Table 24 Taxation Incentives - Predictability

Lower VAT rates: The relative benefit of lower VAT rates is very predictable as it does not change. The absolute financial benefit depends however on the price level. For this instrument the score is 3.

Favourable depreciation possibilities: For depreciation regulations the same applies. The exact financial benefit is not known. Also this instrument receives a medium score of 3.

Exemption from energy or environmental taxes: Also in this case of tax exemption like in the case of lower VAT rates the absolute financial benefit is not known exactly. The same score of 3 is assigned to this instrument.

Dynamic Efficiency

Feed-in tariff

Fixed feed-in tariffs do not create competition between renewable electricity producers because there is no restriction to receiving the tariff. There is hence no competitive necessity to reduce costs below those of the competitors on the level of operators. Competition is however created between the manufacturers of renewable electricity equipment. (Resch et al, 2005, p. 54) This competition is an incentive to reduce the investment costs of renewable energy plants. On the other hand a fixed feed-in tariff gives no incentive to renewable electricity producers to adjust their production to the demand. (Resch et al, 2005, p. 22) Also by itself it provides no incentive to develop renewable energy plants with favourable grid and balancing behaviour.

Alternatives	DYN-EFF
Fixed feed-in tariff - Base Case	4
Fixed feed-in tariff - Tax financed	3,8
Fixed feed-in tariff - Constant over time	3,3
Fixed feed-in tariff - Decreasing over time	4
Fixed feed-in tariff - Same for all technologies	3,8
Fixed feed-in tariff - Hardship clause	3,8

Table 25 Feed-in tariff - Dynamic efficiency

Base Case: If the criteria underlying the regular adjustment of tariffs include the costs of renewable energy technologies, the base case will provide incentives for cost reductions. When also currently more expensive technologies are promoted with higher tariffs for those technologies like in the base case the dynamic efficiency of the whole system is higher. Cost reductions are initiated also in renewable energy sectors that are presently less mature but might become cost-efficient contributors in the future. The overall score for the base case is 4.

Tax financed: When the feed-in tariff is financed from the tax base and not via a mark-up by electricity consumers the scheme does not provide incentives for reduced consumption or efficiency increase. For this reason the dynamic efficiency of this variant is lower than that of the base case. The score is 3.8.

Constant over time: Constant tariffs provide no incentive for cost reductions and technology development. Their dynamic efficiency is low. A score of 3.3 is assigned.

Decreasing over time: Tariffs which are decreased by a specified rate force the renewable electricity producers to reduce the costs of production in the future. They provide an incentive for technology development and innovation. They dynamic efficiency is comparable to that of the base case and the same score is given.

Same for all technologies: When the same tariff is applied for all technologies only those renewable energy technologies which are already today most cost-efficient will be promoted and cost reductions will be achieved only in those sectors and not for other less mature technologies. The dynamic efficiency of this system is lower than that of the base case. The score is 3.8.

Hardship clause: When the financial burden on energy-intensive industries is limited incentives for energy efficiency increase are lower than in the base case. Consequently the dynamic efficiency of this variant is lower and receives a lower score of 3.8.

Fixed premium system

The dynamic efficiency of the fixed premium system is higher than that of the fixed feed-in tariff. With the premium system renewable operators are forced to enter the electricity market and via the electricity price there is an incentive to adapt the production to the demand. This system brings renewable electricity closer to the market than a system of feed-in tariffs.

Alternatives	DYN-EFF
Fixed premium system - Base Case	5
Fixed premium system - Tax financed	4,8
Fixed premium system - Constant over time	4,3
Fixed premium system - Decreasing over time	5
Fixed premium system - Same for all technologies	4,8
Fixed premium system - Hardship clause	4,8

Table 26 Fixed premium system - Dynamic efficiency

Base Case: The dynamic efficiency of the base case is high because different technologies in different stages of maturity are promoted. Also premiums are regularly adjusted so that there are incentives for technology improvements and cost reductions. This optimal design of the instrument leads to a score of 5 for dynamic efficiency.

Tax financed: The tax financed variant of the premium system does not relate the amount each person or company has to pay for the support of renewable energy to the amount of electricity consumed. This variant provides hence no incentives for demand reduction. The dynamic efficiency is lower and receives a score of 4.8.

Constant over time: Constant tariffs have a lower dynamic efficiency than the base case. They provide no incentive for accelerated cost reductions. The score for this variant is 4.3 and so lower than that of the base case.

Decreasing over time: When premiums are decreased according to a fixed pattern cost reduction are already anticipated in the scheme. This provides an incentive for producers of renewable energy equipment and operators to meet the set pathway. The dynamic efficiency is as high as in the base case.

Same for all technologies: When a uniform premium is paid to all technologies only the most competitive branches will benefit. The dynamic efficiency of the whole system is thus lower. Technologies at early stages of maturity will not be brought closer to the market. The score for this variant is 4.8.

Hardship clause: Analogous to the feed-in tariff system also in this case the hardship clause variant receives a lower score. This is due to the fact that costs for the financing of the system are not strictly attached to energy consumption. For energy-intensive industries incentives for efficiency increase and demand reductions are lower with this variant. The resulting score is 4.8.

Tendering system

When renewable capacity is tendered there is a tough price competition among the renewable electricity producers. This gives strong incentives for innovations and cost reductions. But also in this case competition is not extended to the operation phase.

Alternatives	DYN-EFF
Tendering System - Base Case	4
Tendering System - Tax financed	3,7
Tendering System - Auction over lowest premium	4
Tendering System - Auction over lowest investment subsidy	3,7
Tendering System - No technology banding	3,7

Table 27 Tendering System - Dynamic efficiency

Base Case: The base case provides high dynamic efficiency. With the allocation of the extra payments to all electricity consumers and the resulting increase of electricity costs there is an incentive for electricity saving and efficiency increases. By holding different auctions for different technologies many branches are prompted to innovations. The score for the base case of the tender system is 4.

Tax financed: Like in the case of feed-in tariff and premium system also the tax financed variant of the tender system has a lower dynamic efficiency because of the reduced incentives for energy efficiency and demand reductions. A score of 3.7 is assigned.

Auction over lowest premium: When the winners of the tender receive a premium on top of the electricity price they are forced to compete on the market and to adapt their production to market conditions. Incentives for technological and cost improvements are high. This variant receives a score of 4.

Auction over lowest investment subsidy: The payment of a fixed investment subsidy provides no incentives for efficient and effective electricity production. The dynamic efficiency of this variant is lower than for the other forms of support. A score of 3.7 is given.

No technology banding: When uniform tenders are held only the most competitive technologies will be able to take part and only for those branches the scheme will provide incentives for innovation. This variant has consequently a lower score of 3.7 than the base case.

Tradable Green Certificates

A green quota puts a constant price pressure on the producers of renewable electricity. This leads to a high dynamic efficiency. Contrary to the price-based instruments the green quota introduces competition not only among the renewable energy manufacturers but also among the operators of renewable energy plants. This will promote innovations and cost reductions not only in the production but also in the operation of renewable energy plants. (see also Morthorst et al, 2005, p. 41)

Operators of renewable energy plants have to enter the electricity market. This provides incentives for adapting the renewable energy production to the demands of the market. Production management and system services of renewable energy plants will be stimulated.

Alternatives	DYN-EFF
Tradable green certificates - Base case	4,8
Tradable green certificates - Constant quota	4,5
Tradable green certificates - Obligation on consumers	4,8
Tradable green certificates - Obligation on retailers	4,8
Tradable green certificates - Technology specific quotas	5
Tradable green certificates - Banking and borrowing	4,5
Tradable green certificates - Neither banking nor borrowing	4,8
Tradable green certificates - Price cap and floor fixed	4,5
Tradable green certificates - Only price cap in form of penalty	4,5

Table 28 Tradable green certificates - Dynamic efficiency

Base case: The renewable quota will promote innovations and cost reductions, however only in the renewable electricity branches that are competitive enough to be used for the fulfilment of the quota. But the overall dynamic efficiency is very high and scores 4.8.

Constant quota: A constant quota will not promote development of renewable energy above a certain specified level. This will give only little incentive for further technology development. The score is with 4.5 lower than that of the base case.

Obligation on consumers: The dynamic efficiency is the same regardless on which actor in the supply chain the obligation is put. The score of this variant does not differ from the base case.

Obligation on retailers: As explained above there is no difference to the base case.

Technology specific quotas: Technology-specific quotas will promote not only the cheapest renewable electricity technology but also other currently more expensive technologies. This will increase dynamic efficiency as costs reductions in several different technologies are supported. This variant receives a 5, the highest score of all instruments.

Banking and borrowing: The dynamic efficiency is lower when borrowing is allowed because operators are not forced to actively press ahead with cost reductions. Instead they are allowed to postpone investment and hope for cost reductions in the future. The score for this variant is 4.5.

Neither banking nor borrowing: When neither banking nor borrowing is allowed the dynamic efficiency is the same as in the base case. The score is 4.8.

Price cap and floor fixed: When a price cap is fixed the revenue for renewable energy producers is limited. This may exclude currently more expensive technologies and also it may limit the possibilities for research and development within the renewable energy industry. The score for this variant is a bit lower than the base case. It is 4.5.

Only price cap in form of penalty: When only a price cap is set the score is reduced for the same reasons. It is also 4.5.

Investment subsidies

Alternatives	DYN-EFF

Investment subsidies - Based on investment costs	3
Investment subsidies - Based on investment costs and efficiency of production	4

Table 29 Investment subsidies - Dynamic efficiency

Based on investment costs: Investment subsidies which are solely based on the investment costs provide little incentive for costs reductions and technological improvements. Also because the subsidy is irrespective of production there is no incentive for efficiency. The score for this variant is 3.

Based on investment costs and efficiency of production: This variant has a higher dynamic efficiency because the subsidy is not only based on the investment costs but also on the efficiency of production. This provides incentives for increasing the efficiency. The score 4 for this variant is in the range of that of the feed-in tariff.

Taxation incentives

Alternatives	DYN-EFF
Lower VAT rates for renewable electricity	4
Favourable depreciation possibilities	3
Exemption from energy or environmental taxes	4

Table 30 Taxation Incentives - Dynamic efficiency

Lower VAT rates: Lower VAT rates give financial support per kWh. There is hence an incentive for efficient production and the dynamic efficiency is comparable to that of the feed-in tariff scheme. The score for this instrument is also 4.

Favourable depreciation possibilities: Supporting renewable production with depreciation possibilities provides no incentives for efficient production. The score 3 is the same as for the first variant of the investment subsidies.

Exemption from energy or environmental taxes: The case of exemption from energy or environmental taxes is also comparable to that of the feed-in tariff. Also this variant of taxation incentives receives a score of 4.

Equity

Feed-in tariff

The feed-in tariff can generally achieve high equity. This promotion system encourages broad public participation thus giving many people the chance of benefiting from the scheme.

Alternatives	EQU
Fixed feed-in tariff - Base Case	5
Fixed feed-in tariff - Tax financed	4,7
Fixed feed-in tariff - Constant over time	5
Fixed feed-in tariff - Decreasing over time	5
Fixed feed-in tariff - Same for all technologies	4,7

Fixed feed-in tariff - Hardship clause	4,3

Table 31 Feed-in tariff - Equity

Base Case: Compensation paid by all electricity consumers, without exemption for energy-intensive industries, will be more in line with the polluter-pays-principle. This is bound to be perceived as a fair distribution. However the compensation is distributed as an equal share of the electricity consumption. Only the amount of electricity consumed is relevant for the burden of each customer and not the type of electricity consumed. There is hence no relation to the external costs caused by each customer. When diversified tariffs are paid more different technologies are promoted and the compensation is spread on more renewable energy branches. Overall the score for the base case is 5.

Tax financed: The financing of the compensation from the tax based would correspond to the principle of the common burden of the environmental damage. The share of each citizen is determined by his tax base, consumed goods, income and other factors and not by his contribution to the environmental problem. This would be perceived as a less fair allocation of costs than the financing by electricity consumers. The score is lower than that of the base case with 4.7.

Constant over time: The development of the tariff level will not affect the equity of the promotion scheme. The score is the same as for the base case.

Decreasing over time: Likewise tariffs with a fixed decrease receive the same score.

Same for all technologies: Uniform tariffs have a lower score for equity of 4.7. This is due to the fact that uniform tariffs do not take the differences between different technologies into account. Technologies in different stages of maturity are treated equally.

Hardship clause: The decision on whether there is an exemption from the contribution for energy-intensive industries will have an effect on the perceived equity of the system for the stakeholders. The conclusions however could be very different and depend on the subjective definition of equity. Energy-intensive industries will favour an exemption or a limitation, because otherwise they feel overly burdened because of their dependency on energy. Private consumers might judge this design as unfair. They feel that the burden lies solely on the "small customers" while large companies are protected by politicians. Here we assign a lower value for equity to account for the majority of customers. The score for this variant is 4.3.

Fixed premium

The performance of the fixed premium system in achieving equity is comparable to that of the tariff system. Also in this scheme many people can participate resulting in spread out benefits.

Alternatives	EQU
Fixed premium system - Base Case	5
Fixed premium system - Tax financed	4,7
Fixed premium system - Constant over time	5
Fixed premium system - Decreasing over time	5
Fixed premium system - Same for all technologies	4,7
Fixed premium system - Hardship clause	4,3

Table 32 Fixed premium system - Equity

Base Case: The base case has a score of 5 for equity. In this case the premiums are financed by all electricity consumers based on electricity consumption. Large energy consumers are not exempt from the costs. This is a very fair allocation of costs. Furthermore in the base case via technology specific premiums many different technologies are promoted thus leading to benefits in a large range of renewable energy industries.

Tax financed: As in the case of the feed-in tariff the tax financed premium system achieves less equity than the base case because the costs are not allocated based on the electricity consumption. This variant has a score of 4.7.

Constant over time: Constant premiums have the same score in equity as the base case.

Decreasing over time: Also in the case of decreasing premiums there is no change to the base case.

Same for all technologies: Uniform premiums will benefit fewer different technologies than specific tariffs. Technologies in different stages of maturity will be treated equally. The equity of the scheme is lower for this variant. It reaches a score of 4.7.

Hardship clause: The argument here is the same as in the case of the feed-in tariff. The score for equity is lower because the financial burden is not distributed equally based on the electricity consumption. The score for this variant is 4.3.

Tendering system

A tendering system has a lower equity than feed-in tariff or premium system. Because of the upfront investment for entering the tender this promotion instrument discourages broad public participation. The revenue gained after winning the tender is very predictable but still participation will mainly be restricted to larger companies.

Alternatives	EQU
Tendering System - Base Case	4
Tendering System - Tax financed	3,5
Tendering System - Auction over lowest premium	4
Tendering System - Auction over lowest investment subsidy	4
Tendering System - No technology banding	3

Table 33 Tendering System - Equity

Base Case: The base case of the tendering system is well designed with regard to equity. The financing is allocated based on electricity demand and via technology banding different renewable energy technologies are supported. The equity score for the base case is 4.

Tax financed: As already explained for the case of the feed-in tariff a tax financed system will be perceived as less equal because the financial burden is not connected to the electricity consumption, the source of the environmental problem. The score for this variant is lower than for the base case. A 3.5 is assigned.

Auction over lowest premium: The form of support does not have an influence on the equity of the instrument. For that reason the score for this variant is the same as for the base case.

Auction over lowest investment subsidy: The same applies also here. There is no difference to the base case.

No technology banding: Tendering without technology banding has a lower performance in the criterion equity because the benefits of the scheme are not equally distributed but concentrated in the one or few most competitive branches. Hence the score for this variant is only 3.

Tradable green certificates

Also the tradable green certificate scheme is not very participatory. The high uncertainty inherent to the instrument will discourage small private investors. The benefits of the scheme may hence well be confined to large companies.

Alternatives	EQU
Tradable green certificates - Base case	3,5
Tradable green certificates - Constant quota	3,5
Tradable green certificates - Obligation on consumers	3,5
Tradable green certificates - Obligation on retailers	3,3
Tradable green certificates - Technology specific quotas	3,8
Tradable green certificates - Banking and borrowing	3,5
Tradable green certificates - Neither banking nor borrowing	3,8
Tradable green certificates - Price cap and floor fixed	3,3
Tradable green certificates - Only price cap in form of penalty	3,3

Table 34 Tradable green certificates - Equity

Base case: One quota for all renewable technologies will lead to the deployment of the most competitive technologies first. Less mature technologies will not enter the market. This raises the question of fairness of competition between technologies at different stages of development. (see Rio, 2005, p. 1248) Because of this characteristic the base case receives only a score of 3.5.

Constant quota: The choice between a constant quota and an increasing quota does not affect the equity of the promotion instrument. The score is the same as for the base case.

Obligation on consumers: The obligation of consumers seems from an equity point of view equal to the obligation of producers. The score for this variant does not differ from the base case.

Obligation on retailers: The obligation of retailers seems less fair than the other two alternatives. As they neither produce nor consume electricity and only act as traders they are not directly "polluters" which are supposed to be responsible. This variant has a lower equity score of 3.3.

Technology specific quotas: Technology-specific quotas achieve a higher equity because the benefits of the promotion scheme are more evenly spread. The score for this variant is 3.8.

Banking and borrowing: The banking and borrowing variant receives a lower score than the variant where both are excluded. When banking, borrowing or both are allowed inter-temporal equity is impaired. No longer are equal efforts requested in all commitment periods but efforts can be postponed to a later point in time, thus possibly delegating them to coming generations. This variant has a score of 3.5.

Neither banking nor borrowing: This variant implies a higher inter-temporal equity. The quota has to be fulfilled in every commitment period so that efforts cannot be postponed. The score for this variant is 3.8.

Price cap and floor fixed: The price cap limits the price the obligors of the quota have to pay for the certificates and at the same time the price and hence the revenue the renewable operators receive. The price is no longer solely based on the costs. This seems an unfair distribution of risk within the scheme. The variant achieves a score of 3.3.

Only price cap in form of penalty: For this variant the same reasoning applies. Also a score of 3.3 is assigned.

Investment subsidies

Alternatives	EQU
Investment subsidies - Based on investment costs	4
Investment subsidies - Based on investment costs and efficiency of production	5

Table 35 Investment subsidies - Equity

Based on investment costs: Investment subsidies can reach quite high equity as they benefit all kinds of renewable energy technologies, scales and types of ownership. However because the subsidy is not based on production the support is a bit detached from the environmental benefit. The overall score for this variant is 4.

Based on investment costs and efficiency of production: This variant receives a higher score of 5 because the financial support is linked to the efficiency of production.

Taxation incentives

Alternatives	EQU
Lower VAT rates for renewable electricity	5
Favourable depreciation possibilities	4
Exemption from energy or environmental taxes	5

Table 36 Taxation Incentives - Equity

Lower VAT rates: Lower VAT rates can be justified with the lower environmental impact of renewable energy. Insofar this taxation incentive achieves a high degree of equity and has thus a score of 5.

Favourable depreciation possibilities: Depreciation possibilities have less potential of high equity because they are not directly related to the renewable energy production. This instruments has a score of 4.

Exemption from energy or environmental taxes: The equity achieved with this instrument is very high. Renewable electricity has much lower environmental impacts than conventional energy. Consequently it is very much in favour of equity to exempt this type of energy from energy or environmental taxes. The score for this instrument is 5.

Ease of introduction

Feed-in tariff

One advantage of the feed-in tariff system is its simple setup. (Morthorst et al, 2005, p. 31) There is only once the need for introduction of the framework and decision on the tariff level. But still there will be the necessity for lengthy discussions and also political opposition from conventional energy producers.

Alternatives	E-INT
Fixed feed-in tariff - Base Case	3,5
Fixed feed-in tariff - Tax financed	2,5
Fixed feed-in tariff - Constant over time	3,5
Fixed feed-in tariff - Decreasing over time	3,5
Fixed feed-in tariff - Same for all technologies	4
Fixed feed-in tariff - Hardship clause	3,5

Table 37 Feed-in tariff - Ease of introduction

Base Case: A system that is financed by the electricity consumers is easier to set up than a tax financed system. On the other hand technology specific tariffs are more complicated because for each technology a different tariff level has to be fixed. The overall score for the base case is 3.5.

Tax financed: A tax financed system will be more difficult to implement because it has to compete with other public projects for scarce public resources. For that reason the score for this criterion is 2.5.

Constant over time: Whether the tariffs are constant or changing over time has no influence on the introduction of the scheme. The score is the same as for the base case.

Decreasing over time: As explained above the decrease of tariffs has no influence on the ease of introduction.

Same for all technologies: Uniform tariffs will be easier to introduce because only one tariff level has to be set and not different tariff levels for each technology. There is hence only one decision to take and one does not have to try to capture all the differences between technologies. The score is with 4 the highest of all feed-in tariff variants.

Hardship clause: The implementation of a hardship clause does not change the ease of introduction of the system.

Fixed premium system

The ease of introduction of a fixed premium system is comparable to that of a feed-in tariff system.

Alternatives	E-INT
Fixed premium system - Base Case	3,5
Fixed premium system - Tax financed	2,5
Fixed premium system - Constant over time	3,5
Fixed premium system - Decreasing over time	3,5
Fixed premium system - Same for all technologies	4
Fixed premium system - Hardship clause	3,5

Table 38 Fixed premium system - Ease of introduction

Base Case: Also in this case the base case gets a score of 3.5. The financing from all electricity consumers is in favour of ease of introduction but the technology specific premiums make the introduction more complex.

Tax financed: Also in the case of the premium system the tax financed variant is more difficult to implement because it affects the public budget. A score of 2.5 is assigned.

Constant over time: The development of the premiums in the course of the promotion scheme has no influence on the ease of introduction. The score for this variant is the same as for the base case.

Decreasing over time: For the introduction of the scheme, premiums with a fixed decrease cause the same effort as tariffs which are regularly adjusted, like in the base case.

Same for all technologies: For this variant the score is with 4 the highest because uniform premiums are easiest to introduce. In this case only one premium level has to be agreed on and not several specific levels.

Hardship clause: A hardship clause does not lower the ease of introduction of the scheme. The score is the same as for the base case.

Tendering system

Also the tendering system has quite a simple set-up. It can be started with a call for bids. Also in this case the political process necessary for the introduction will provide the most barriers.

Alternatives	E-INT
Tendering System - Base Case	3,5
Tendering System - Tax financed	3
Tendering System - Auction over lowest premium	3,5
Tendering System - Auction over lowest investment subsidy	3,5
Tendering System - No technology banding	4

Table 39 Tendering System - Ease of introduction

Base Case: In the base case several different technology specific tenders have to be set up. This makes it a bit more complicated than holding only one tender. The score for the base case is 3.5.

Tax financed: As in the case of the preceding instruments, the tax financed system is more difficult to implement and receives a lower score of 3.

Auction over lowest premium: The form of support does not affect the ease of introduction of the scheme. The score is the same as for the base case.

Auction over lowest investment subsidy: Also in this case there is no change to the performance of the base case.

No technology banding: Auctioning without technology banding is easier to implement because only the overall desired capacity has to be fixed and one or more overarching auctions held. Having several technology specific auctions as in the base case makes the implementation more complex. Consequently this variant receives with 4 the highest score of the tender system.

Tradable green certificates

The tradable green certificate scheme is more complex to implement than the previous instruments. Besides the political discussion process common to all promotion schemes in this case a system for trading the green certificates has to be implemented. Certificates have to be defined and a national registry has to be set up.

Alternatives	E-INT
Tradable green certificates - Base case	3
Tradable green certificates - Constant quota	3
Tradable green certificates - Obligation on consumers	2,5
Tradable green certificates - Obligation on retailers	3
Tradable green certificates - Technology specific quotas	2,5
Tradable green certificates - Banking and borrowing	3
Tradable green certificates - Neither banking nor borrowing	3
Tradable green certificates - Price cap and floor fixed	3
Tradable green certificates - Only price cap in form of penalty	3

Table 40 Tradable green certificates - Ease of introduction

Base case: In the base case only one quota has to be monitored and enforced and the number of producers is manageable. The overall score for the base case is 3.

Constant quota: The development of the quota makes no difference to the ease of monitoring and enforcement.

Obligation on consumers: The obligation of consumers is very complicated as the number of consumers is much higher than the number of producers. This highly increases the complexity of the system. The score for this variant is 2.5. This is among the lowest of all instruments.

Obligation on retailers: There is no change to the monitoring and enforcement complexity when electricity retailers are obliged instead of producers.

Technology specific quotas: Technology-specific quotas are more difficult to monitor and enforce because the issued certificates have to be technology-specific. Also the compliance with each separate quota has to be monitored for every obligor. The score for this variant is 2.5, also among the lowest of all instruments.

Banking and borrowing: The possibilities for banking and borrowing are not relevant for the ease of introduction of the scheme. This variant has the same score as the base case.

Neither banking nor borrowing: Consequently also the score for this variant is the same.

Price cap and floor fixed: Also the price formation does not affect the ease of introduction. This variant does not differ from the base case.

Only price cap in form of penalty: The same reasoning applies here.

Investment subsidies

Alternatives	E-INT
Investment subsidies - Based on investment costs	5
Investment subsidies - Based on investment costs and efficiency of production	4

Table 41 Investment subsidies - Ease of introduction

Based on investment costs: The ease of introduction for the investment subsidies is very good. No extra institutions have to be set-up, not even a legislative process is required. This variant receives a high score of 5.

Based on investment costs and efficiency of production: The ease of introduction is a bit lower for this variant of the investment subsidies because additional provisions for controlling the efficiency of the plants have to be made. This variant has a lower score of 4.

Taxation incentives

Alternatives	E-INT
Lower VAT rates for renewable electricity	4
Favourable depreciation possibilities	4
Exemption from energy or environmental taxes	4

Table 42 Taxation Incentives - Ease of introduction

Lower VAT rates: All taxation incentives are fairly easy to introduce. They only require small changes to the tax legislature. For this reason all variants get a score of 4 for ease of introduction.

Favourable depreciation possibilities: As explained above a score of 4 was assigned.

Exemption from energy or environmental taxes: The same applies also here.

Ease of monitoring and enforcement

Feed-in tariff

For the execution of a feed-in tariff system the amount of electricity needs to be measured and the collection and distribution of funds organized. This could be done by the transmission grid operators in case the payments are collected from the electricity consumers. The transmission system operators have knowledge of the electricity flows within their network. If the electricity is fed into the distribution grid the transmission system operators have to be notified by the distribution system operators of the quantities. The organisation of the payments could also be handled by a public institution, either a new institution or an existing one whose competencies are amended. According to Resch et al, 2005 the resulting transaction and administration costs of a feed-in tariff system are low. (p. 54)

Alternatives	E-MON
Fixed feed-in tariff - Base Case	4
Fixed feed-in tariff - Tax financed	4
Fixed feed-in tariff - Constant over time	4,5
Fixed feed-in tariff - Decreasing over time	4
Fixed feed-in tariff - Same for all technologies	4,5
Fixed feed-in tariff - Hardship clause	4

Table 43 Feed-in tariff - Ease of monitoring and enforcement

Base Case: For the base case the ease of monitoring and enforcement is estimated to a score of 4. The monitoring for technology-specific tariffs is a bit more complex than for uniform tariffs. Also when tariffs for new plants are adjusted different tariffs are paid to plants of different age.

Tax financed: For the monitoring and enforcement the source of financing is not relevant. The score for this variant is the same as for the base case.

Constant over time: The ease of monitoring and enforcement of constant tariffs is higher because they are not adjusted to changes. The same tariffs are paid to old and new plants. This makes the settlement easier. The score for this variant is 4.5.

Decreasing over time: A tariff scheme with a fixed decrease has the same monitoring and enforcement effort as the base case with regular changes of the tariff level. In both cases different tariffs are paid to old and new plants. The score for this variant is also 4.

Same for all technologies: This variant has a higher ease of monitoring and enforcement because there is only one tariff level for all technologies. The score for this variant is 4.5.

Hardship clause: When a hardship clause is implemented there is no change to the ease of monitoring and enforcement of the system. The score is the same as for the base case.

Fixed premium system

The ease of monitoring and enforcement of the premium system is the same as for the tariff system. The execution differs only in the level of the tariff/premium. For that reason the scores assigned to the fixed premium system are the same as for the tariff system.

Alternatives	E-MON
Fixed premium system - Base Case	4
Fixed premium system - Tax financed	4
Fixed premium system - Constant over time	4,5
Fixed premium system - Decreasing over time	4
Fixed premium system - Same for all technologies	4,5
Fixed premium system - Hardship clause	4

Table 44 Fixed premium system - Ease of monitoring and enforcement

Base Case: Also for the premium system the base case receives a score of 4 like in the case of the feed-in tariff. The reasons for this are the technology specific premiums and the adjustment of premiums for new plants.

Tax financed: Analogous to the feed-in tariff also in the case of the premium system the source of financing is not relevant for the monitoring and enforcement.

Constant over time: As in the case of the feed-in tariff the constant tariffs receive a higher score of 4.5 in ease of monitoring and enforcement.

Decreasing over time: When premiums for new plants decrease according to a fixed pattern different premiums are paid to old and new plants. The ease of monitoring and enforcement is the same as in the base case.

Same for all technologies: Differentiated premiums have higher monitoring and enforcement complexity than uniform premiums. Consequently the ease of monitoring and enforcement is higher for this variant. A score of 4.5 is given.

Hardship clause: As in the case of the feed-in tariff this variant does not deviate from the base case.

Tendering system

The ease of monitoring and enforcement of the tender system is comparable to that of feed-in tariff and premiums system. For the tender system all variants have the same monitoring and enforcement costs. The score is 4 for all variants.

Alternatives	E-MON
Tendering System - Base Case	4
Tendering System - Tax financed	4
Tendering System - Auction over lowest premium	4
Tendering System - Auction over lowest investment subsidy	4
Tendering System - No technology banding	4

Table 45 Tendering System - Ease of monitoring and enforcement

Tradable green certificates

The green quota is a more complex instrument than payment mechanisms. Not only the production of renewable energy has to be metered and certificates issued for every MWh but also all traffic in those certificates has to be registered. The variants of the tradable green certificate system receive consequently lower scores than the other instruments.

Alternatives	E-MON
Tradable green certificates - Base case	2,7
Tradable green certificates - Constant quota	2,7
Tradable green certificates - Obligation on consumers	2,3
Tradable green certificates - Obligation on retailers	2,7
Tradable green certificates - Technology specific quotas	2,3
Tradable green certificates - Banking and borrowing	2,7
Tradable green certificates - Neither banking nor borrowing	3
Tradable green certificates - Price cap and floor fixed	2,7
Tradable green certificates - Only price cap in form of penalty	2,7

Table 46 Tradable green certificate system - Ease of monitoring and enforcement

Base case: Because of the uniform quota the ease of monitoring and enforcement is higher than with technology-specific quotas. The obligation of producers is comparably easy to monitor and enforce. The overall score for the base case is 2.7.

Constant quota: A constant quota has the same ease of monitoring and enforcement as the increasing quota of the base case.

Obligation on consumers: When the obligation is put on consumers the ease of monitoring and enforcement will be lower because the number of obligors is much higher. Also they are very heterogeneous with large and small companies and a very large number of private households.

Monitoring the compliance of each household is extremely complex. Thus the score for this variant is with 2.3 the lowest of all instruments.

Obligation on retailers: The ease of introduction of this variant is comparable to the base case where the obligation is put on the producers.

Technology specific quotas: With several specific quotas different certificates have to be treated separately and the complexity of monitoring and enforcement increases. The score for this variant is 2.3.

Banking and borrowing: When additional to banking also borrowing is allowed the score is the same as in the base case. There are no additional costs for this variant.

Neither banking nor borrowing: When neither banking nor borrowing is allowed the ease of monitoring and enforcement is a bit higher because the commitment periods will be completely separated. There is no need to keep track of certificates across different periods. The score for this variant is 3.

Price cap and floor fixed: Restrictions which are put on the price do not change the ease of monitoring and enforcement of the scheme. The score is the same as for the base case.

Only price cap in form of penalty: Also in this case there is no change and the variant has the same score.

Investment subsidies

Alternatives	E-MON
Investment subsidies - Based on investment costs	5
Investment subsidies - Based on investment costs and efficiency of production	4

Table 47 Investment subsidies - Ease of monitoring and enforcement

Based on investment costs: Investment subsidies based on investment costs have very low monitoring and enforcement costs. Once the subsidy is disbursed there are no further requirements. The score for this instrument is consequently 5.

Based on investment costs and efficiency of production: For this variant the monitoring and enforcement efforts are somewhat higher because the efficiency of production as one of the bases of the subsidy has to be monitored. This variant receives a score of 4.

Taxation incentives

Alternatives	E-MON
Lower VAT rates for renewable electricity	4
Favourable depreciation possibilities	3
Exemption from energy or environmental taxes	4

Table 48 Taxation Incentives - Ease of monitoring and enforcement

Lower VAT rates: The tax exemptions are comparable to the feed-in tariff in their monitoring and enforcement costs. Therefore lower VAT rates are equally scored 4.

Favourable depreciation possibilities: The monitoring for this instrument is somewhat more complex because it involves checking the accounting of renewable energy operators. This variant receives a lower score of 3.

Exemption from energy or environmental taxes: Also this case is comparable to lower VAT rated and the feed-in tariff. The same score of 4 is given to this variant.

Diversification

Feed-in tariff

The feed-in tariff has the potential of achieving very high diversification. Several different technologies can be promoted and small private investors as well as large companies can take part. Thereby small scale decentralised as well as large scale projects will be supported.

Alternatives	DIVERS
Fixed feed-in tariff - Base Case	5
Fixed feed-in tariff - Tax financed	5
Fixed feed-in tariff - Constant over time	5
Fixed feed-in tariff - Decreasing over time	5
Fixed feed-in tariff - Same for all technologies	3
Fixed feed-in tariff - Hardship clause	5

Table 49 Feed-in tariff - Diversification

Base Case: Specific tariffs as in the base case will promote several diverse renewable technologies and lead to a higher diversification of production. The score for this variant is 5.

Tax financed: The source of financing does not affect the diversification of the promotion instrument and thus the score for this variant does not differ from the base case.

Constant over time: The development of the tariffs over time also has no influence on the diversification of the scheme. This variant receives the same score as the base case.

Decreasing over time: Also in this case there is no change compared to the base case and the same score is assigned.

Same for all technologies: A uniform tariff will only promote the cheapest renewable energy technologies. This will result in more uniformity and concentration of production and not in technology diversification. The score of this variant has to be significantly lower than that of the base case. A score of 3 is assigned.

Hardship clause: When a hardship clause is included in the scheme the diversification of the instrument does not change. This variant has the same score as the base case.

Fixed premium system

The premium system has the same potential of achieving high diversification as the feed-in tariff system. Also in this case different technologies and projects with different scales will be supported.

Alternatives	DIVERS
Fixed premium system - Base Case	5
Fixed premium system - Tax financed	5
Fixed premium system - Constant over time	5
Fixed premium system - Decreasing over time	5
Fixed premium system - Same for all technologies	3
Fixed premium system - Hardship clause	5

Table 50 Fixed premium system - Diversification

Base Case: The base case of the premium system with technology specific premiums promotes diversity of technologies. This variant receives a score of 5.

Tax financed: As already explained the source of financing has no influence on the diversification of the instrument. There is no deviation from the base case.

Constant over time: Also the development of the premiums has no influence on the diversification. The score is the same as in the base case.

Decreasing over time: The same argument applies here. There is no change compared to the base case.

Same for all technologies: If the premiums are the same for all technologies the diversification of the scheme is much lower than with differentiated premiums. Uniform premiums will only promote the most competitive technologies and not several diverse technologies. A score of 3 is assigned to this variant.

Hardship clause: Limiting the burden on energy-intensive industries with a hardship clause will not affect the diversification of the scheme. The score is the same as for the base case.

Tendering system

The tender system can also lead to technology diversity. However due to the set-up of the scheme small scale project developers are not encouraged to participate. This will result in concentrated large-scale projects.

Alternatives	DIVERS
Tendering System - Base Case	4
Tendering System - Tax financed	4
Tendering System - Auction over lowest premium	4
Tendering System - Auction over lowest investment subsidy	4
Tendering System - No technology banding	2

Table 51 Tendering system - Diversification

Base Case: Technology banding as foreseen in the base case will lead to more diversification, because it obligatorily includes a variety of technologies. The score for the base case is 4.

Tax financed: The tax financed variant differs from the base case only in the source of financing. This has no influence on the diversification of the instrument.

Auction over lowest premium: The form of support that is paid to the winners of the tender also has no influence on the diversification of the scheme. The score is the same as for the base case.

Auction over lowest investment subsidy: The same argument holds also for this variant. There is no difference to the base case.

No technology banding: Uniform auctions will lead to less diversity as only the least expensive technologies will succeed. The pressure to offer the lowest price will result in larger projects and consideration of only the most favourable sites. This will lead to increased regional concentration of projects. The diversification in all aspects is considerably lower and a score of 2 is assigned.

Tradable green certificates

A quota tends to be an instrument that attracts mainly large companies. Because of the higher uncertainty regarding quantity and price compared to the feed-in tariff there is less participation of small companies and private owners. Projects will be larger and more concentrated.

Alternatives	DIVERS
Tradable green certificates - Base case	3
Tradable green certificates - Constant quota	3
Tradable green certificates - Obligation on consumers	3
Tradable green certificates - Obligation on retailers	3
Tradable green certificates - Technology specific quotas	4
Tradable green certificates - Banking and borrowing	3
Tradable green certificates - Neither banking nor borrowing	3
Tradable green certificates - Price cap and floor fixed	3,5
Tradable green certificates - Only price cap in form of penalty	3

Table 52 Tradable green certificates - Diversification

Base case: In a single quota the cheapest technologies will be used for fulfilment. Depending on the level of the quota this can be only one technology that by itself is able to fulfil the target or more technologies that are equally cheap or are used because the potential of the cheapest technology is exhausted. The diversity is lower than with specific quotas. The score for the base case is set to 3.

Constant quota: The choice between constant and increasing quota changes only the amount of renewable energy produced but not the diversity of production. The score does not differ from the base case.

Obligation on consumers: The diversification of the instrument does not depend on who is obliged to fulfilment. This variant does not differ from the base case in diversification.

Obligation on retailers: Also for this variant there is no difference to the base case.

Technology specific quotas: With technology specific quotas the diversity will be higher as there is participation of several technologies, also the less mature and cheap ones, guaranteed. This variant provides the highest diversification within the tradable green certificate system. It receives a score of 4.

Banking and borrowing: The flexibility of obligors to bank and borrow certificates has no influence on the diversification of the scheme.

Neither banking nor borrowing: As explained above there is no deviation from the base case.

Price cap and floor fixed: When a floor is fixed all renewable operators which sell green certificates can calculate with a minimum price. This will encourage also other investors than large companies and increase the diversity of the kind of projects realized. This variant has a higher score of 3.5.

Only price cap in form of penalty: When only a price cap is in place the same effect cannot be expected. The diversification will be the same as in the base case.

Investment subsidies

Alternatives	DIVERS
Investment subsidies - Based on investment costs	4
Investment subsidies - Based on investment costs and efficiency of production	4

Table 53 Investment subsidies - Diversification

Based on investment costs: With the investment subsidy many different renewable energy technologies and project scales can be supported. This instrument thus has a high diversification potential. The score for this criterion is 4.

Based on investment costs and efficiency of production: This variant has the same diversification potential and also receives a score of 4.

Taxation incentives

Alternatives	DIVERS
Lower VAT rates for renewable electricity	3
Favourable depreciation possibilities	3
Exemption from energy or environmental taxes	3

Table 54 Taxation Incentives - Diversification

Lower VAT rates: Lower VAT rates provide the same financial benefit to all renewable energy technologies and do not specifically support a variety of technologies. This will result in only the most competitive technologies being applied. For that reason the diversification score for this instrument is 3, the same as for uniform feed-in tariffs.

Favourable depreciation possibilities: The same reasoning applies to the depreciation regulations. Also here only the most competitive technologies will benefit. The same score of 3 is assigned.

Exemption from energy or environmental taxes: This case is comparable to lower VAT rates and consequently receives the same score of 3.

Acceptability

Feed-in tariff

The payment of feed-in tariffs will allow private persons, small co-operative groups and small companies to participate. (Resch et al, 2005, p. 54) The broader public participation will significantly increase the acceptability of the scheme and of renewable energy in general.

Alternatives	ACC
Fixed feed-in tariff - Base Case	4,8
Fixed feed-in tariff - Tax financed	4,3
Fixed feed-in tariff - Constant over time	4,5
Fixed feed-in tariff - Decreasing over time	4,5
Fixed feed-in tariff - Same for all technologies	4,3
Fixed feed-in tariff - Hardship clause	5

Table 55 Feed-in tariff - Acceptability

Base Case: When the feed-in tariff is paid by all electricity consumers it does not burden the public budget and can not be classified as a subsidy. This could potentially increase the overall acceptance of the instrument. On the other hand some consumers might not be willing to pay a surcharge to their electricity bill and prefer finance from the tax base. Different renewable energy technologies are supported in the base and consequently the overall acceptance will be higher. More branches and interest groups are involved to form a broader coalition in favour of the instrument. The public acceptability will be higher when no hardship clause is implemented and there are no exemptions for large producers but the acceptability to the industry sector will be very low without special hardship clauses. The overall score for the base case is 4.8.

Tax financed: The political acceptance for the instrument might be lower when public funds have to be invested for the financing. For that reason a lower score of 4.3 is given.

Constant over time: When the tariffs paid to renewable energy operators are kept constant there is no relation to the development of costs. Over time tariff levels may be perceived as too high and this will lead to a lower acceptance of the promotion scheme. A lower score of 4.5 is assigned.

Decreasing over time: As in the case of the previous variant, also tariffs with a fixed decrease are not connected to the real development of costs. The acceptance for this variant will be lower therefore it has a score of 4.5.

Same for all technologies: When there is a uniform tariff only the least expensive renewable energy technologies will be used. Hence development is confined to one branch. This will lead to lower acceptance than with varying tariffs. The score is with 4.3 lower than that of the base case.

Hardship clause: Alleviation of the burden of energy-intensive industries will increases the acceptability of the promotion scheme to the industry sector. It might reduce the acceptability to the public but the overall score for this variant is 5.

Fixed premium system

The principle and lay-out of the fixed-premium system are comparable to that of the feed-in tariff system and also the amount of money spent is comparable. For that reason the acceptance of the fixed premium system is comparable to that of the feed-in tariff system.

Alternatives	ACC
Fixed premium system - Base Case	4,8
Fixed premium system - Tax financed	4,3
Fixed premium system - Constant over time	4,5
Fixed premium system - Decreasing over time	4,5
Fixed premium system - Same for all technologies	4,3
Fixed premium system - Hardship clause	5

Table 56 Fixed premium system - Acceptability

Base Case: For the premium system the same arguments as related above in the case of the feed-in tariff apply. Financing by electricity consumers and technology-specific premiums increase the acceptability but a missing hardship clause will reduce the acceptability to the industry sector. The overall score for the base case is 4.8.

Tax financed: As in the case of the feed-in tariff the acceptance for the tax financed variant is lower because public funds have to be mobilized and will not be available for other public projects. The variant receives a score of 4.3.

Constant over time: For the constant premium the same argument as for the constant tariff holds. The acceptance is lower than for the base case and is scored at 4.5.

Decreasing over time: Again the score for this variant is the same as for the feed-in tariff because a premium with a fixed decrease has a lower acceptance than a premium which is regularly adjusted to new developments. The score for this variant is 4.5.

Same for all technologies: The uniform premium will promote only the most competitive technologies so the benefits will be more concentrated than in the case of technology-specific premiums. This will reduce the acceptance of the scheme to 4.3.

Hardship clause: When the burden on energy-intensive industries is alleviated the acceptability of the scheme for the industry will be a lot higher. The score for this variant is 5.

Tendering system

Participation in an auction entails considerable preparation costs without a guarantee of getting the project. This excludes small companies and private investors from participating as they will not be able to cope with such stranded costs. Participation of only large companies will reduce the public acceptance.

The forced cost reductions for winning an auction will force developers to devise large projects on the most favourable sites. This will lead to a concentration of projects in some areas which will prove very difficult for the acceptance of renewable energy.

All this explains why the tendering system leads to a lower acceptance of the scheme and of renewable energy in general.

Alternatives	ACC
Tendering System - Base Case	4
Tendering System - Tax financed	3,5
Tendering System - Auction over lowest premium	4
Tendering System - Auction over lowest investment subsidy	4
Tendering System - No technology banding	3

Table 57 Tendering system - Acceptability

Base Case: For the base case the acceptability will be higher than for a variant without technology banding because several different branches will benefit. The score for the base case is 4.

Tax financed: The tax financed system has a lower acceptance than the base case which is financed by electricity consumers. The reasons for this have already been stated for the feed-in tariff and the fixed premium. A lower score of 3.5 is assigned.

Auction over lowest premium: As explained above a fixed premium and a fixed feed-in tariff lead to the same acceptability. This variant has consequently the same score as the base case.

Auction over lowest investment subsidy: Also the payment of subsidies will lead to the same acceptability as for tariffs and premiums.

No technology banding: When there is no technology banding the promotion scheme achieves a lower acceptability because only one or few most competitive branches can benefit. The score for this variant is 3.

Tradable green certificates

A green quota tends to attract larger projects that are carried out by larger and more experienced companies. There will be less public involvement and privately owned renewable plants. This will lead to a lower acceptance of the renewable energy development than would be achieved with a more participatory system.

Alternatives	ACC
Tradable green certificates - Base case	3,3
Tradable green certificates - Constant quota	3,3
Tradable green certificates - Obligation on consumers	3
Tradable green certificates - Obligation on retailers	3,3
Tradable green certificates - Technology specific quotas	3,5
Tradable green certificates - Banking and borrowing	3,5
Tradable green certificates - Neither banking nor borrowing	3,3
Tradable green certificates - Price cap and floor fixed	3,5
Tradable green certificates - Only price cap in form of penalty	3,3

Table 58 Tradable green certificates - Acceptability

Base case: The score of the base case for acceptability is 3.3. Due to the uniform quota the acceptability is a bit lower than with technology specific quotas.

Constant quota: Whether the quota is constant or continually increasing is a matter of political decision but will not affect the acceptability of the scheme.

Obligation on consumers: When the obligation is put on the consumers the acceptance will be lowest. The complexity of the system will be high and consumers will feel unfairly burdened even though they will bear the costs in any case. This variant receives with 3 the lowest score of all instruments.

Obligation on retailers: There will be no difference in acceptability when the obligation is put on the retailers compared to the obligation of producers. The same score of 3.3 is assigned.

Technology specific quotas: Technology specific quotas will increase the acceptability of the system. With this variant more different technologies are promoted and the benefits will be more widespread. Also with different technologies there will be no geographical concentration of all plants but different plants will be located in different areas. A score of 3.5 is assigned for this variant.

Banking and borrowing: When banking and borrowing of the certificates is allowed the acceptance of the obligors will be higher because they have more flexibility in the fulfilment of the quota. Therefore a higher score of 3.5 is given to this variant.

Neither banking nor borrowing: The acceptance will be lower when no temporal flexibility in the form of banking or borrowing is granted. The score for this variant is 3.3.

Price cap and floor fixed: When there is a price floor the risk for investors is lower. In this case also smaller project developers can take part and this will increase the acceptability of the scheme. This variant has a score of 3.5.

Only price cap in form of penalty: Setting a price cap for the green certificate price will not change the acceptability of the instrument. The score is the same as for the base case.

Investment subsidies

Alternatives	ACC
Investment subsidies - Based on investment costs	4,5
Investment subsidies - Based on investment costs and efficiency of production	4,5

Table 59 Investment subsidies - Acceptability

Based on investment costs: The investment subsidies will reach a high acceptability because the scheme is easy to understand and many people can benefit from it. The score for this variant is 4.5.

Based on investment costs and efficiency of production: A different base for the subsidies will not change the acceptability significantly. The score for this variant is the same.

Taxation incentives

Alternatives	ACC
Lower VAT rates for renewable electricity	4
Favourable depreciation possibilities	4
Exemption from energy or environmental taxes	4

Table 60 Taxation Incentives - Acceptability

Lower VAT rates: Taxation incentives for promoting renewable energy will not draw a lot of public attention. However tax exemptions to remunerate the environmental benefits of renewable electricity production will be widely acceptable. This variant therefore receives a score of 4.

Favourable depreciation possibilities: This case is comparable to that of lower VAT rates although depreciation regulations are very technical and will not be understood by the broad public. Also here the score is 4.

Exemption from energy or environmental taxes: For this instrument the same score as for lower VAT rates is given. Also in this case the reasoning behind the support will be well understood and acceptable.

Evaluation of workshop results

The workshop was held on April 23rd 2008 in Bruges, Belgium. In total three exercises were carried out. Here the results of the exercise dealing with instruments for the promotion of renewable energy will be evaluated. This exercise had the aim to weigh different criteria that can be used to evaluate instruments for the promotion of renewable energy. From the weighing of criteria and the performances of the instruments a ranking of instruments was calculated. In total 28 stakeholders participated in the exercise dealing with instruments for the promotion of renewables. The ratio method for the weighing of criteria was applied by all 28 stakeholders and the level method by 24 stakeholders.

Average ranking of criteria

Both in the ratio and in the level method environmental effectiveness has the highest average weight. Also in both weighting methods diversification came out with the lowest average weight. The following table shows the average weights of criteria for the ratio method and the level method.

Ratio Method		Level Method	
Environmental Effectiveness	18%	Environmental Effectiveness	14%
Cost-Efficiency	16%	Cost-Efficiency	14%
Dynamic Efficiency	11%	Dynamic Efficiency	11%
Predictability	10%	Equity	10%
Equity	9%	Predictability	10%
Flexibility	9%	Flexibility	10%
Ease of Monitoring and Enforcement	8%	Ease of Introduction	9%
Ease of Introduction	8%	Ease of Monitoring and Enforcement	9%
Acceptability	6%	Acceptability	8%
Diversification	5%	Diversification	6%

Table 61 Average weights of criteria

The ranking of criteria is almost the same regardless of the method used. The only changes are due to small deviations in the decimals which are not shown in the table. Environmental effectiveness and costs are at the top of the list. In the level method results cost-efficiency is weighed almost equal to environmental effectiveness. Dynamic efficiency as the next criterion also has a very high position. Predictability, equity and flexibility are in the middle of the list. Predictability and flexibility act in different directions. Policy instruments which are very predictable tend to be less flexible and vice versa. Some stakeholders have put an emphasis on one or the other but many have attached a similar weight to flexibility and predictability. The administrative criteria ease of monitoring and enforcement and ease of introduction are in the lower middle both with the same weight. Contrary to equity which is in the upper middle acceptability receives a low average weight. The least important criterion according to stakeholders' weighting is the diversification of policy instruments. Having different renewable energy technologies in the market seems to be no objective by itself if not contributing to the environmental effectiveness.

Comparing the results of the ratio and the level method one can see that the level method weights are more evenly spread reaching only from 6% to 14%, while the weights from the ratio method are a bit more dispersed from 5% to 18%. In some cases the weights of a certain stakeholder differ very much between the ratio method and the level method.

Final ranking of instruments

In the following table for each instrument the average ranking position across all stakeholders is shown. With both ratio weighing and level weighing the base case of the fixed premium system and the base case of the feed-in tariff are at the top of the instrument ranking. Using the level method the premium system has a slightly better position than the feed-in tariff. There is a clear favour for the price based instruments over quantity regimes. This becomes obvious when looking at the first column of the table where the instrument type is shown. The first choices all belong to premium system or feed-in tariff system. Supporting renewable energy with favourable depreciation regulations is the least favourable option. This support element should be used rather in addition to other promotion instruments. The variants of the quota system and the tender system are mainly found in the lower part of the list. The investment subsidy which is based on the efficiency of renewable energy plants is the 11th instrument of the list. It ranks higher than the quantity based instruments. The best instrument from the category taxation incentives is the exemption of renewable energies from energy and environmental taxes.

Instrument Type	Instrument Variant	Ratio Method	Level Method
FPS	Premium System – Base Case	2	1
FIT	Feed-in tariff – Base Case	2	2
FPS	Premium System – Hardship	4	4
FIT	Feed-in tariff – Hardship	5	4
FPS	Premium System – Decreasing	7	6
FIT	Feed-in tariff – Uniform	7	7
FPS	Premium System – Uniform	7	7
FIT	Feed-in tariff – Decreasing	8	6
FPS	Premium System – Tax financed	8	10
FIT	Feed-in tariff – Tax financed	9	10
IS	Investment Subsidy – Eff	12	10

FPS	Premium System – Constant	12	12
FIT	Feed-in tariff – Constant	13	12
TI	Energy & Environmental Taxes	13	14
TGC	Quota – Neither banking nor	17	19
TGC	Quota – Base Case	18	20
TI	VAT	19	16
TS	Tender – Base Case	19	17
TGC	Quota – Banking and borrowing	19	21
TGC	Quota – Retailers	19	22
TS	Tender – Premium	21	18
TS	Tender – No technology banding	22	22
TGC	Quota – Specific	22	23
TGC	Quota – Constant	24	25
TGC	Quota – Consumers	24	26
IS	Investment Subsidy – Inv Costs	25	23
TS	Tender – Tax financed	26	26
TGC	Quota – Price cap	26	28
TS	Tender – Subsidy	27	26
TGC	Quota – Cap and floor	27	27
TI	Depreciation	31	31

Table 62 Final ranking of instruments

FPS – Fixed premium system, FIT – Feed-in tariff, IS – Investment Subsidy, TI – Taxation Incentives, TGC – Tradable Green Certificate System, TS – Tender System

The average ranking in table 62 is calculated by adding the rank orders of the instruments of all the stakeholders and dividing by the number of stakeholders. This explains that not all ranking places are taken and that often instruments have the same average ranking positions.

The result is rather surprising in its clearness. It does not fully reflect the predetermined choices of the stakeholders but is based on their weighing of criteria. The first two criteria environmental effectiveness and cost-efficiency do not lead to a clear favour for the price based instruments. For dynamic efficiency scores are highest for the quota system but also good for the premium system. The fourth and fifth criteria predictability and equity are clearly in favour of price-based instruments while the next, flexibility, favours the quantity based schemes. Overall this weighing results in the price based instruments reaching much higher rankings than the quantity based instruments.

In the following figure the instrument ranking is shown graphically.

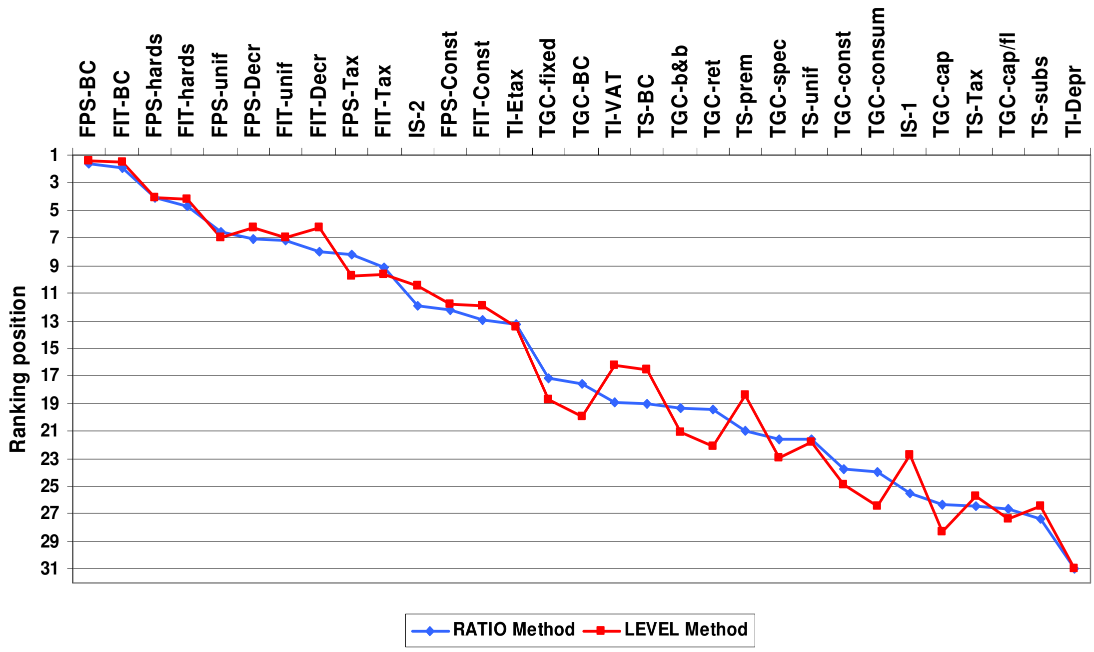

Figure 3 Average ranking of the instruments

Table 62 and figure 3 show the average rankings of all instruments which are representative for the whole group of stakeholders. In the next figure it is shown for how many stakeholders an instrument appeared among the top 10 and the top 5 instruments. Here we can see that individual results can differ significantly from the average even though the overall consensus is quite high. But for example the TGC variant with obligation on retailers appeared twice in the top 10 list while the average ranking position was only 19. For the level method these results are very similar.

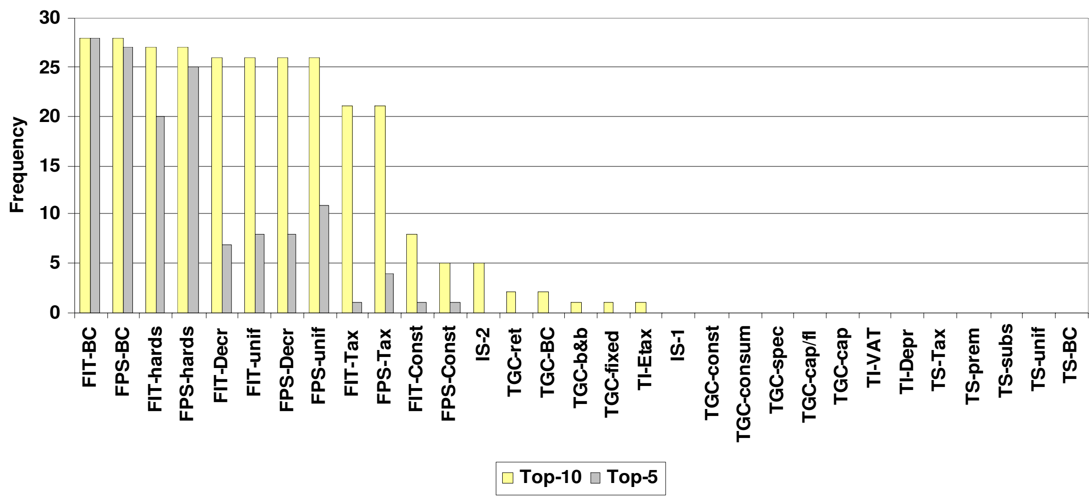

Figure 4 Number of appearances in the top 10 and top 5 places in the ratio method

Design of the instruments

In the following table the ranking order of the feed-in tariff variants is shown. It can be seen that the base case configuration reaches the highest place. Constant tariffs, but also a tax financed system, are the least favourable options.

	Ratio Method	Level Method
Feed-in tariff - Base Case	2	2
Feed-in tariff – Hardship clause	5	4
Feed-in tariff - Uniform	7	7
Feed-in tariff - Decreasing	8	6
Feed-in tariff - Tax financed	9	10
Feed-in tariff - Constant	13	12

Table 63 Feed-in tariff variants

As can be seen in the next table for the premium system the order of the variants is almost the same. Only the order of decreasing and uniform premiums is changed.

	Ratio Method	Level Method
Premium System - Base Case	2	1
Premium System – Hardship cl.	4	4
Premium System - Decreasing	7	6
Premium System - Uniform	7	7
Premium System - Tax financed	8	10
Premium System - Constant	12	12

Table 64 Premium system variants

For the quota system the base case is not the best option but the quota system without banking and borrowing. However the variants with neither banking nor borrowing, the base case and the banking and borrowing variant are quite close together. Price restrictions with a price cap or price cap and price floor are the worst options and also at the bottom of the whole instrument list.

	Ratio Method	Level Method
Quota - Neither banking nor	17	19
Quota - Base Case	18	20
Quota - Banking and borrowing	19	21
Quota - Retailers	19	22
Quota - Specific	22	23
Quota - Constant	24	25
Quota - Consumers	24	26

Quota - Price cap	26	28
Quota - Cap and floor	27	27

Table 65 Quota variants

For the tender system the base case is the best configuration. In this case the premium variant ranks lower than the feed-in tariff variant. The investment subsidy for the winners of the tender is the least favourite option.

	Ratio Method	Level Method
Tender - Base Case	19	17
Tender - Premium	21	18
Tender - No technology banding	22	22
Tender - Tax financed	26	26
Tender - Subsidy	27	26

Table 66 Tender system variants

Sensitivity analysis

During the workshop, after the stakeholders had completed a basic scenario with weighting of the criteria they were given the opportunity to specify sensitivity analysis scenarios with alternative weights for the criteria.

In the following figure the differences between the basic scenario and the sensitivity analysis scenario can be seen. There are only few changes of the order of criteria. For the ratio method the criterion equity is given more importance in the sensitivity analysis scenario. It is on the fourth position before predictability. Flexibility has lost in importance and ends up in the second to last position. Also in the level method analysis the criterion flexibility is given less weight in the sensitivity analysis scenario. The organisational criteria ease of introduction and ease of monitoring and enforcement receive significantly higher level weights in the sensitivity analysis scenario. They take up the fourth and fifth ranking position for the level method analysis while there is no change in the ratio method.

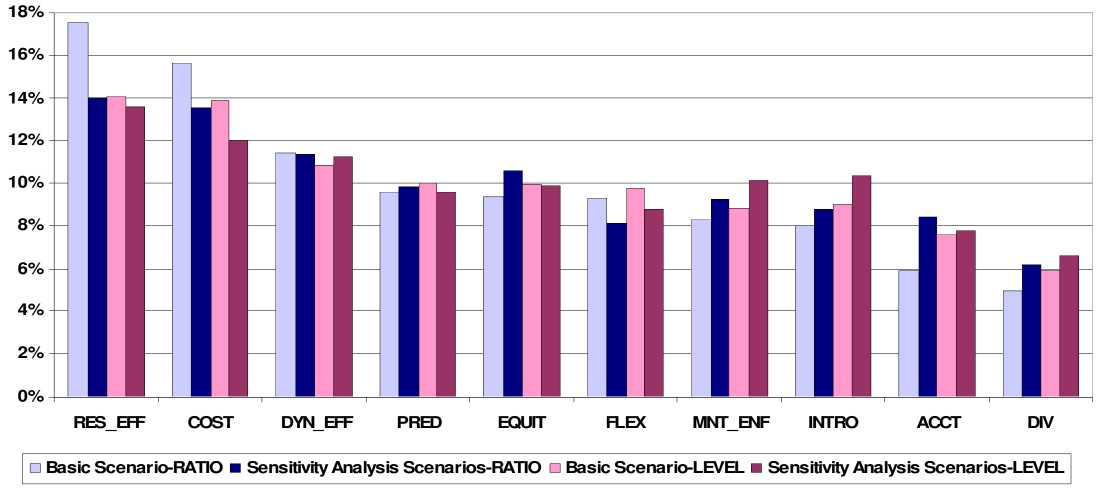

Figure 5 Weights of the criteria in the basic and sensitivity analysis scenario

It is obvious that in general in the sensitivity analysis scenarios the weights are more evenly dispersed on the different criteria. The six most important criteria have almost all gotten lower weights in the sensitivity analysis scenario and the four least important criteria have received higher scores. This effect is more striking in the ratio method than in the level method where the weights are already in the basic scenario slightly more spread out.

The changed order of criteria results in slightly different average ranking positions of the instruments but the general tendency of results is the same. The same instruments are in the top 10 of the average ranking and also the least favourite instrument is again the improved depreciation. While some instrument variants appear in reversed order in the ranking this does not change the distinct favour of the price based instruments.

Conclusion

The workshop has led to valuable insights both on the methodology used and on the subject. This experience has shown that stakeholders are very interested in participating in such a workshop. However some time should be invested to really make everybody familiar with the tool and to make all the processes clear. When the stakeholders are asked to provide input they request to be given detailed information.

When confronted with the ranking of instruments some stakeholders felt that this result did not represent their opinion. There can be different reasons for this. The ranking of the instruments is based on the weighing of criteria and on the performance of the instruments with regard to the criteria. The weighing was controlled by stakeholders. The performances on the other hand were supplied by the CASES partners involved in the workshop. This approach was supposed to make the procedure more transparent and to prevent stakeholders from picking the obvious choice of instrument without reflecting. However if stakeholders fundamentally disagree with the performances they will likely also disagree with the final ranking that results from their weights. During the workshop stakeholders had the possibility to review and change the performances but due to lack of time and the large number of instrument variants and criteria stakeholders had little chance to use this option.

Another reason that the final ranking did in some cases not reflect the real opinions of stakeholders could be that stakeholders base their choice of instrument at least partly on criteria which were not included in the exercise. Nonetheless no other criteria appeared in the discussion and the list was already quite extended. Stakeholders may base their spontaneous choice of instrument on the situation of their special institution and which instrument will benefit them more. In this case the outcome should differ from the predetermined opinion of the stakeholders and this should be an incentive for everyone to reflect their opinion. It may also be the case that the weights which the stakeholders assigned to the criteria during the exercise do not reflect their predetermined opinion. Here either stakeholders were induced by the tool to appear for example more environmentally friendly than they really are or their predetermined assumptions were short-sighted and should be revised.

Certainly a group of 30 stakeholders is too small to provide representative opinions, however a tendency can be seen regarding the importance of different criteria for the performance of promotion instruments. If a consensus can be reached on the criteria, the choice of instruments can be conducted in a more objective and transparent way.

4. Analysis of linkages to emission trading

Introduction

Low consumer prices, emission reduction and increased production of renewable energy are among the goals pursued by energy policy. These objectives are not independent from each other as renewable energy sources produce much less emissions than conventional energy sources while still having higher production costs. Regulatory instruments affect each other and hence the realization of the different objectives. (see also Jensen and Skytte, 2003, p. 63f) On the one hand policies for emission reduction will favour the use of renewable energies. On the other hand instruments to promote renewable energies will reduce emissions and both policies are expected to increase consumer prices in the short-term.

Besides understanding the impact of single isolated policies more and more attention has recently been paid to the interaction of different instruments that are applied in parallel in the energy sector. The European emissions trading scheme and national instruments for the promotion of renewable energies act upon overlapping groups of actors. Sijm and van Dril, 2003 indicate that the indirect interactions between the target groups of emission trading and renewable support schemes are “manifold, significant and complex” (p. 13).

Several analyses have been carried out to study the effects of the interaction of diverse policy instruments.

Green quota and emission trading

Many have focused on the interaction of tradable green certificates and emissions trading. When those two instruments are in place three different markets exist. Renewable electricity producers are active on the green certificates market and the electricity market. Conventional producers are active on the electricity market and the emission permits market. (see also Jensen and Skytte, 2003, p. 65)

Jensen, Skytte, 2003 have analyzed the interaction of green certificates and emission permits in different case studies in an analytical paper. They see the two instruments to some extent as substitutes for each other and investigate the separate attainment of each of the goals by either one of the instruments or both instruments and the simultaneous attainment of both goals with both instruments. (p. 66) Hindsberger et al. 2003 have analysed the effect of co-existing instruments in an international context with a quantitative model. They argue that some consequences cannot be assessed only on theoretical grounds. (see p. 86) BALMOREL, a numerical model covering the Baltic Sea region, is used for the analysis. BALMOREL is a one period static model with possibilities of investment in new production technologies. It maximises the sum of consumers' surplus and producers' surplus and incorporates environmental and energy constraints. The reproduced markets, the electricity market, the emission permits market and the green certificate market, have different geographical extensions within the model. (p. 87)

For their calculations Hindsberger et al, 2003 defined 30 different combinations of emission goals and renewable energy goals. They discovered that the electricity spot price decreases with higher renewable targets. (p. 90) The promotion of renewables leads to replacement of the marginal production unit and hence to a reduction of the wholesale price of electricity. (Rathmann, 2007, p. 342f) Also Unger and Ahlgren, 2005 came to similar conclusions when analyzing the effects of a Nordic TGC market on the electricity and CO_2 market with MARKAL. They affirm that the introduction of a green quota reduces the wholesale electricity price. (p. 2157) When a green quota is introduced consumer costs and consumer price can increase or decrease. On the one hand the wholesale power price is lowered but on the other hand there are additional costs from the use of renewable energy. The overall effect is ambiguous. (Jensen and Skytte, 2003, p. 67) Likewise Unger and Ahlgren, 2005 discovered the effect of a green quota on the retail electricity price to be ambiguous depending on the level of the quota. When the reduction in wholesale price outweighs the costs of the green certificates the retail price will be lower than without the quota. (p. 2157)

Hindsberger et al, 2003 show that a rising green quota increases the price of green certificates but decreases the price of emission allowances. (p. 90f) The latter effect is discovered also by Unger and Ahlgren, 2005. (p. 2157)

Amundsen and Nese, 2005 have analyzed an integrated tradable green certificate market with an analytical model. They argue that a percentage requirement for green electricity has an indeterminate effect on the quantity produced as the overall consumption may change at the same time. (p. 8)

The emission trading causes an unambiguous increase of consumer prices because the costs of the marginal production unit are increased. (Jensen and Skytte, 2003, p. 67) The European Emission Trading increases the electricity price by the costs of purchasing allowances where the emissions exceed the allocation and the opportunity costs of the allocated permits. (Rathmann, 2007, p. 342f) Also Hindsberger et al discovered that the electricity spot price increases with lower emission limits. If ambitious targets are adopted for both emissions and renewable energies the price is the same as without goals. Stronger emission limits increase the price of emission allowances but have virtually no influence on the price of green certificates. The aggregate costs tend to increase with an increasing green quota and a decreasing emission constraint. (p. 88ff) Contrary to those findings NERA, 2005 expects the emission trading scheme to lower the green certificate price. By increasing the wholesale price for electricity the emission constraint lowers the cost gap and thus the green certificate price for a given quota. (p. 27)

Reinaud, 2003 points out that emission trading by itself will not lead to increased renewable energy production but other policies are needed for this purpose. (p. 9) Amundsen and Nese, 2005 claim furthermore that if the green quota is combined with emission trading harsher emission constraints will lead to a decline in green electricity generation because the green certificate price is reduced more than the wholesale price is increased. This would lead to outcomes contrary to the purpose of both policy instruments. (p. 10f) Also NERA, 2005 point out that when a green quota is set relative to total production by reducing overall electricity consumption emission trading will reduce also the renewable generation compared to a situation without emission trading. (p. 28)

The interaction of the two instruments makes it possible to use both instruments for the emissions goal or the renewable goal. A certain share of renewable energy can be reached by setting a green quota but also by setting the emission cap below a certain level. However Jensen and Skytte, 2003 establish that in order to reach the renewable goal and minimise consumer prices it is always optimal to apply only the green quota compared to the emissions cap or a combination of both instruments. (p. 68f) The solution is not as clear-cut for the emissions goal. It depends on the effect of the green quota. When the green quota is negatively correlated to the consumer price it is optimal to use the green quota to achieve the emissions goal. However when the green quota is positively correlated to the consumer price it is optimal to use the emission quota. A combination of both instruments will not lead to any advantages. (p. 69)

When attempting to simultaneously reach both goals it can happen that one goal envelops the other. In that case the argument is the same as before with only one goal. Otherwise neither goal alone is sufficient to fulfil both. Here again the solution depends on the effect of the green quota. When the green quota is negatively correlated to the consumer price it is optimal to set the green quota high enough to reach both goals. In case of positive correlation it is optimal to set both quotas to their respective goals. Regulating only through the emission quota is never the favourable choice. (Jensen and Skytte, 2003 p. 69f)

Bräuer et al, 2000 have carried out a theoretical analysis of the co-existence of certificate markets. They assume a situation where renewable energy producers can operate on the green certificate market as well as on the emission permit market and distinguish closed and open co-existence. Closed co-existence means that renewable energy producers do not participate in the electricity trade while in open co-existence they operate also on the electricity market. (p. 3)

Although in closed co-existence renewable energy producers do not operate on the electricity market there are still interactions between the certificate markets. Due to the green quota additional renewable electricity is being produced and other low priced emission reduction measures are not needed any more. Emission reductions are provided “for free” by renewable energy production as their additional costs are covered by the green certificate price. The price of CO_2 permits drops. For renewable energy producers there is no change compared to isolated examination of the two markets. (p. 8f)

In open co-existence the price for green certificates is reduced by the price of emissions permits. The price of emission permits is already included in the electricity price which renewable energy producers can realize on the market. The buyers of green certificates benefit from reduced prices. The price of emission permits is the same as in the case of closed co-existence. (p. 10f) With regard to the CO_2 target there is a twofold support for renewable energies which goes to the expense of reductions through rational energy use. (p. 12)

Also Morthorst, 2001 analyzed the interaction between the separate markets by focusing on the green certificate market. When only the green certificate market exists in addition to the electricity spot market the long-run marginal costs of renewables can be broken down into the spot market electricity price, the value of achieved CO_2 reductions and the costs for achieving the renewable energy target. The price of the green certificates is equal to the value of emission reductions plus the costs for the renewable target. When those certificates are traded internationally the buying country pays a price which is higher than the costs of the renewable energy target while the value of the CO_2 reduction remains in the selling country. This results in a bias for domestic renewable capacity expansion. (p. 349f)

When the green quota is combined with an emission permit scheme based on grandfathering the costs of CO_2 reduction will be partly included in the electricity spot market price. In this analysis it is assumed that only the costs actually paid are included in the electricity price and the value of the grandfathered permits is not. In this case the price for green certificates will fall to some extent but the national value of the CO_2 reduction is still considerably higher than the increase of the electricity spot price. Countries importing green certificates still have to pay a higher price for achieving renewable energy targets than the home country. (Morthorst, 2001, p. 351) However the European Emissions Trading has shown that the value of emission permits has been completely included in the electricity price even though they were granted for free to the electricity producers.

There would hence be no difference to the combination of a green quota with an emission permit scheme based on auctioning. In this case the electricity price increase is equal to the price of the permits and hence to the national value of CO_2 reductions. (Morthorst, 2001, p. 351f) The price of green certificates will fall to level of additional costs to achieve the renewable energy target and importing countries will now pay the same for achieving the renewable energy target than the home country. Trade in certificates will hence be equal to domestic implementation. (p. 352f)

The calculations of Unger and Ahlgren, 2005 show that a green quota obligation would change the Nordic-Continental trade patterns. Biomass combustion would dominate the certificate scheme in the short run but also investment in non-renewable energy plants would be affected. Also Hindsberger et al, 2003 found out that strong renewable goals with, as well as without, strong emission constraints will motivate investments in wind power, biomass and waste-fuelled technologies in Denmark, Finland, Germany and Sweden. Furthermore the results indicate that under strong emission and renewable energy goals Denmark and Finland will produce an electricity surplus while Germany and Sweden will be importers. (p. 92)

Morthorst, 2003 analyzed the interactions between an international green certificate market and an international emission trading scheme with a small three-country model. According to his results an increasing renewable quota eases the situation for the conventional power industry. For that reason the emission cap has to take into account the required renewable energy production and both quotas should be adjusted in a coordinated manner. (p. 79f)

Feed-in tariff and emission trading

The interaction of feed-in tariffs and emissions trading has received fewer attention that that of green certificates and emissions trading. However a detailed analysis has been carried out by Rathmann, 2007. He shows that by reducing CO_2 emissions the promotion of renewable energy reduces the CO_2 price and consequently also the wholesale price for electricity. The wholesale price is further reduced because the additional renewable electricity will replace the marginal production unit. For the retail price there is on the one hand an increase through the fee for the support of renewables and on the other hand a reduction through reduced wholesale prices. For Germany the results show that the retail price is lower than it would be without support of renewables. Consumers gain from the reduction and the benefit for those consumers exempt from the renewable support fee is even higher. (p. 347) A rough estimation for the EU indicates that electricity prices would be almost 30 €/MWh higher without additional renewable electricity production in line with directive 2001/77/EG. The net electricity price reducing effect persists as long as the CO_2 abatement cost curve has a slope higher than 0.04 (€/t)/(Mt/a). (p. 348) This interaction between additional renewable energy production and the CO_2 price would not exist if emission reductions caused by renewables were taken into account ex ante in the national allocation plans. This would maintain the climate protection effect of the renewable support scheme in addition to that of the emission trading thus keeping both instruments independent of each other. (p. 343) In order to reduce the effect of the emission trading on the electricity price ex post allocation of emission rights based on benchmarks would be more favourable because it reduces the opportunity costs for electricity producers. (p. 348)

Common policy suggestions

Sorrell and Sijm, 2003 point out that in theory every instrument which interacts with emission trading increases abatement costs while not providing any additional emission reductions. The rationale for introducing other instruments must hence be other policy objectives besides emission reductions or their contribution to overcoming market failures. (p. 434)

In order to reach additional emission reductions through the promotion of renewable energy planned renewable energy production has to be taken into account in the national allocation plans and the emission cap has to be reduced accordingly.

Providing CO_2 allowances for renewable production and thus creating fungibility between the emission trading and the renewable promotion scheme is not desirable according to NERA, 2005. (p. 20f) By linking the emission trading to CO_2 reduction measures within the EU problems of double counting arise. This could lead to exceedance of the emission cap.

5. Social and fiscal implications of policy instruments (Roberto Porchia, FEEM)

This chapter aims to review the literature to analyse the social and fiscal implications of different internalisation instruments, mainly focusing on the impacts on the most vulnerable groups in society and on the fiscal burdens created by some instruments working through positive incentive schemes on the basis of government payments.

The social implications of internalisation policies are assessed with respect to their impact on income redistribution, and with respect to the access to energy for vulnerable groups. However the impacts of energy policies cover a wide range of economic aspects, including competitiveness, employment, growth and the change of industrial structures, which have strong social consequences on poor and vulnerable groups. Indirect impacts of policy are not included in this analysis.

Feed-in tariff and Fixed premium

Under these schemes the State regulates the price for renewable electricity fed into the grid at a level, which is higher than the achievable market prices. The state guarantees the grid access for renewable energy and pays the difference between the market price and the fixed price (feed-in tariff) or a premium on top of electricity price. Since these instruments don't directly influence the final cost of electricity for households, their social impact is limited. The social impact is given by the amount paid by the State, instead of alternative social use of the collected revenue. Countries with severe budget constraints may face difficulties to pay for relatively high tariffs.

A limit of FITs is that they guarantee prices for developers, but would not provide certainty on the amount of renewable electricity that such a tariff would deliver. A disadvantage is that particular quantity targets cannot be achieved with certainty, and that regulated prices may lead to certain inefficiencies that could possibly be avoided by more competition-oriented instruments.

Premiums regard usually all renewable energy technologies together; this has negative impacts by discouraging development of the less mature technologies. There is no reason why this should necessarily be so, as targets for different renewable energy sources can be differentiated. This would involve some judgement by government as to which technologies hold the most promise.

Hence the effects of these instruments on economic efficiency and on the technological mix as well as the influence of these instruments on the environment and the social impact depend on the skill of the policy maker and their motivations. (Madlener and Stagli, 2005) and (Winkler, 2005)

Tendering

Mainly independent power producers are invited by the regulator to compete on a price for contracts to supply RES-E within a certain limited capacity quota for each technology. Then the authority ranks the received bids and the lowest bids within each technology band are accepted in preference. The marginal bid is therefore most expensive and sets the final price paid for the whole band.

This instrument is not specifically designed to achieve a reduction of the adverse environmental and social impacts. The social impact depends on which and how many of the technologies can successfully compete in the market, and whether or not higher economic efficiency of a particular technology corresponds with a lower adverse environmental and social impacts. (Madlener and Stagli, 2005)

This instrument gives an incentive to reduce costs for renewables technologies, which is much stronger in this system than under feed-in tariff and fixed premium. It has advantages in using the tendering process to promote competition among renewable electricity technologies, without having to make a selection in advance. In practice, however, the institutional capacity to administer the tendering process may be a major constraint. (Winkler, 2005)

Tradable green certificates

Under a TGC system, renewable electricity is sold at market prices of conventional electricity. The additional cost incurred in producing with renewable technologies is covered by the sale of certificates in a dedicated market for green certificates. Certificates are bought by electricity suppliers or, alternatively, the consumers, who are obliged to purchase a certain amount of certificates according to their total annual electricity sales or consumption.

Verbruggen shows a social welfare loss arising with the introduction of TGC in the case of certificates purchased by the supplier (Verbruggen, 2004). If the supplier must process a quota of RES-E equal to k% of his sold volume, certificates are sold at price pc per kWh of RES-E and the full certificate price is paid by the end-users, then the power price increases by kp_c. As is shown in the Figure 1 below, depending on the price elasticity of demand at S_0 consumption will decrease from q_0 to q_n with some of the consumer surplus converted into support payments for RES-E and some social welfare loss. The kp_c price increase could also be interpreted as the payment for transiting from the present non-sustainable system to a sustainable system. Then, p_0+kp_c should be considered as the 'right' price, under this interpretation social welfare is increased by avoiding external costs of non RES-E and in the long run no welfare loss is indicated.

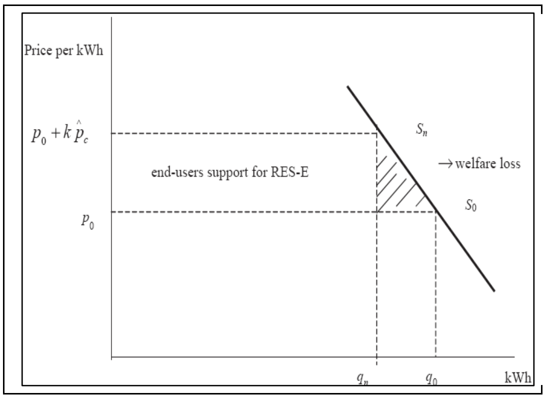

Figure 6 Welfare loss under a Tradable Green Certificates scheme

Investment subsidies and tax incentives

To promote production of RES-E and to make renewable technologies less expensive than the industrial cost, government could subsidise investment in these technologies by introducing lump sum subsidies or tax incentives. As consequence costumers should buy RES-E at the same price as electricity produced by traditional technologies. The instruments have no direct impact on household income or on household access to electricity. However the social effects of these instruments depend on how the revenue to finance subsidies is collected. In Fischer and Richard, 2008 investment subsidies are associated with a fossil-based output tax. This tax raises revenue, as does the emissions price if it is implemented through emissions taxes or auctioned permits. Price increases affect producers and consumers in relation to supply and demand elasticities. The investment subsidies require outlays of public funds; taxpayers support the renewable energy producers, while electricity consumers and fossil producers are held harmless. The standards involve no net revenue change, implicitly earmarking the net costs of these policies back to consumers and producers. The net effects on economic surplus depend on the magnitude of the efficiency loss in the process.

Carbon tax

To induce producers to invest in renewables technologies governments may introduce a tax on the quantity of carbon dioxide (CO_2) emitted by producing electricity.

Vehmas carried out a review of the existing research, which focused on the distributive impacts of carbon/CO_2 taxes, measured across different income groups (Vehmas et al., 1999). The analysis showed that according to OECD studies carbon taxes are generally regressive, but less than expected. On the other hand, the effects of carbon taxes on income distribution and employment are not widely analysed; however in the literature of ecological tax reform employment effects are often expected to be positive. If this is the case, distributive impacts of carbon taxes can be favourable also for low-income groups. Then the final social impact could be positive.

A different conclusion was reached by Oladosu in an examination of the income distribution impacts of a carbon tax in the Susquehanna River Basin (SRB) Region of the United States (Oladosu, 2007). By utilizing a computable general equilibrium model she finds that the aggregate impacts of a $25/ton carbon tax on the regional economy are negative but modestly so. Results are summarised in the Table 1. The impact is around one-third of 1% reduction in Gross Regional

Product (GRP) in the short-run and double that amount in the long-run. However, unlike many previous studies, she finds that the carbon tax is mildly progressive as measured by income bracket changes, per capita equivalent variation, and Gini coefficient changes based on expenditure patterns. The dominant factors affecting the distributional impacts are the pattern of output, income and consumption impacts that affect lower income groups relatively less than higher income ones, an increase in transfer payments favoring lower income groups, and decreased corporate profits absorbed primarily by higher income groups.

The Gini coefficient and the Theil index results represent single parameter measures of the changes in income inequality among income groups due to the carbon tax. The calculations are based on expenditures rather than income (because the former is considered a more consistent metric), and are expressed as percentage changes over the benchmark. These indexes declined by around 0.15% in both the short and long run, indicating the tax is mildly progressive, which is consistent with the relative per capita welfare effects.

Short- and long-run welfare effects of a $25/ton consumption carbon tax: government expenditure of tax revenue

	Units	$0K–$5K	$5K–$10K	$10K–$15K	$15K–$20K	$20K–$30K	$30K–40K	$40K–$50K	$50K–$70K	>$70K	Overall
Short run											
Per capita income	(%Δ)	0.36	0.37	0.37	0.36	−0.37	−0.42	−0.42	−0.64	−0.66	−0.44
Utility	(%Δ)	0.94	0.21	0.29	0.22	−0.28	−0.15	−0.18	−0.22	−0.12	−0.06
Eq. variation per capita	$Δ	−5.50	−24.39	−46.01	−63.11	24.14	25.67	31.60	79.44	169.65	24.82
Gini coefficient	(%Δ)	–	–	–	–	–	–	–	–	–	−0.15
Theil index	(%Δ)	–	–	–	–	–	–	–	–	–	−0.14
Long run											
Per capita income	(%Δ)	−0.27	−0.26	−0.25	−0.25	−0.96	−1.04	−1.04	−1.27	−1.30	−1.06
Utility	(%Δ)	−0.40	−0.11	−0.09	−0.06	−1.08	−0.67	−0.71	−0.56	−0.33	−0.51
Eq. variation per capita	$Δ	2.48	13.47	14.85	19.32	94.90	115.81	128.85	207.32	456.75	121.49
Gini coefficient	(%Δ)	–	–	–	–	–	–	–	–	–	−0.16
Theil index	(%Δ)	–	–	–	–	–	–	–	–	–	−0.15

Table 67 Welfare effect of a $25/ton consumption carbon tax

Instruments to reduce negative social effects of electricity-policies

To adjust negative social effects of internalisation policies, alternative mechanisms are available to ensure electricity supply to vulnerable groups. The reference for this analysis is the review of alternative instruments in utility pricing carried out by the World Bank (World Bank, 2000). The instruments identified are the following:

1. No disconnection of households who do not pay their utility bills.
2. Price subsidies to all households.
3. "Lifeline" rates with two or three blocks, which size varies with household circumstances.
4. Price discount for certain categories of customers.
5. A 'burden limit' so that households are only required to pay a certain percentage of their disposable income for the service. The share not paid by the household is paid by the state.
6. Other "earmarked cash transfers" are cash payments for the payment of the utility bill, whose amount is based on some household income targets. It can be calculated by considering the minimum income for households after the payment of electricity.
7. "Non earmarked cash transfers" paid by the State to poor households allow them to reach a certain level of income. Under this scheme it is not required to spend the money on a specific item.

The conclusion from the evaluation of these instruments is that, the absolute best system cannot be identified; however, some options are generally preferable to others from a socio-economic point of view. For example price discounts do not result in high coverage or good targeting. Similarly a policy of not disconnecting non-payers provides negative incentives not to pay and provides financial problems to the utility. For this reason it should be used with extreme care. The options of burden limits or cash transfers may not be affordable in some of the poorer European countries, since they are expensive for the state. On the other hand the use of lifeline rates can get round the problem of state funding of the subsidy. This instrument can provide an affordable basis for social protection and access to energy for the poor if the target group is not too large. (Markandya and Streimikiene, 2003) and (Menne and Markandya, 2005)

Conclusions

This literature review analysed the social and fiscal implications of different internalisation instruments, via promotion of renewables. The instruments assessed are feed-in tariff, fixed premium, tendering, tradable green certificates, investment subsidies, tax incentives and carbon tax.

The social impact of *Feed-in tariff and Fixed premium* is not clear, it depends on the skill of the policy maker, on their motivations and the criteria used to collect revenue to finance these instruments.

The social impact of *Tendering* depends on the quantity and on the type of technologies that compete in the market, and whether or not higher economic efficiency of a technology corresponds to a lower social impact.

The analysis showed that a social welfare loss arises with the introduction of *Tradable green certificates*.

Investment subsidies and Tax incentives have no direct impact on household income or on household access to electricity. However the social effects of these instruments depend on how the revenue to finance subsidies is collected.

Carbon taxes are generally regressive, but less than expected. On the other hand employment effects are often expected to be positive. If this is the case, distributive impacts of carbon taxes can be favourable also for low-income groups. Then the final social impact could be positive.

6. Policy recommendations

Improvement of instruments

From the ranking of the different instrument design variants conclusions can be drawn on the optimal specifications of instruments. For the feed-in tariff and the fixed premium system the variant with financing through a mark-up on the electricity price is clearly superior to the tax financed variant. The same is also valid for the tender system. In any case the costs of the promotion schemes should be allocated to the electricity consumers. Financing from the tax base is not a preferred option. For the tradable green certificate system this source of financing is already inherent to the scheme.

The results from the workshop show clearly that tariffs and premiums which stay constant over a longer period of time also for new plants are not a good option. The best alternative would be to regularly adjust tariffs and premiums based on the development of certain predetermined influence factors. Tariffs and premiums with a fixed annual decrease are not as beneficial but still preferable to the constant version. In the case of the tradable green certificate system the continually increasing quota is more favourable than the constant quota.

For the feed-in tariffs, the premiums and the tender system technology-specific promotion is the best choice. Uniform tariffs and premiums and tenders without technology banding reach lower ranking positions. For the tradable green certificate system the situation is different. In this case technology specific quotas are less favourable than a quota system with only one overarching quota. This is due to the fact that specific quotas cause many organizational problems which are easier to handle with price based instruments and in the tender system. Also, having only one quota will not lead to less renewable energy production as in the case of the feed-in tariff system and the premium system.

For the feed-in tariff system and the premium system variants with a hardship clause for energy-intensive industries have been evaluated. In both cases the base case without the hardship clause proved to be superior. However both variants were quite close to each other. If more importance is attached to political acceptability the variant with hardship clause might be the preferred choice.

In the tradable green certificate system the quota obligation can be put on electricity producers, retailers or consumers. The obligation of producers reached a higher ranking than the obligation of retailers though both variants are close together. Obligation of consumers is the least preferred choice. That is not surprising because this variant has high organizational complexity. As a rule the obligation of consumers should be avoided. Putting the obligation on producers would be the best choice.

The design variant with prohibition of both banking and borrowing is the most preferred choice for the quota system. It is followed by the based case which allows banking and the variant where both banking and borrowing are allowed. There is a clear tendency that greater effectiveness and predictability is preferred over flexibility even though all three options rank very close together.

As regards price restrictions both a price cap only and price cap and price floor reach very low rankings. Letting the certificate price form freely based on supply and demand is unambiguously the best design choice.

Framework Aspects

When discussing different instruments for the promotion of renewable energy one has to keep in mind that those instruments can only be successful in a favourable political and legal environment. Creating encouraging framework conditions is at least as important as the choice of instruments.

Morthorst et al, 2005 (p. 31) and Dinica, 2006 (p. 464ff) point out that stable conditions and the risk / profitability characteristics of the scheme rather than the support system itself determine the investment behaviour and hence the success of diffusion. Long-term and sufficiently ambitious targets should be set and only new capacities considered for any change of the instrument. (Ragwitz et al, 2006)

Besides a reliable political framework well-functioning planning and permission regulations and adequate grid conditions are main determinants for attracting investments. (Morthorst et al, 2005, p. 31) In this context several aspects have to be considered. Which permits are needed, how many authorities are involved and what are the authorisation procedures? In which cases is an environmental impact assessment required? In which form are stakeholders involved in the process? The whole process should be designed as simple as possible so that the time needed to obtain all permits and the investment needed for studies and permits are minimized. Also the details of the process should be made transparent to all relevant actors. Provisions for grid-connection should be defined in a non-discriminating and transparent way. (Ragwitz et al, 2006)

Some countries have successfully employed detailed planning for the integration of renewable energy plants, e.g. wind power plants, in regional and local spatial planning. One main benefit of detailed planning is the greater certainty for developers and financiers. The planning is separated from the rush of the project development and once the planning is in place project development is simpler. On the other hand detailed planning is costly and time-intensive and may delay project development by several years. (Resch et al, 2005, p. 8f)

The deduction of investments in renewable energy from taxable income is also a very important framework aspect and a precondition for significant investments.

Suggestions for an integrated EU policy

In the proposal for a directive on the promotion of the use of energy from renewable sources (COM 2008/19 final) the European Commission encourages the introduction of a system of guarantees of origin which can be issued, transferred and cancelled electronically. Guarantees of origin shall be issued not only for electricity produced from renewable energy sources but also for heating and cooling from renewable energies. Member states shall mutually recognise their guarantees of origin. Designated bodies shall maintain national registers of guarantees of origin. Member states can transfer guarantees of origin to other member states and also persons in different member states may trade. Furthermore the proposed directive addresses administrative procedures, planning, construction and information and training to support the development of renewable energy.

From the experiences that have been gained with practical implementations of promotion instruments in the members of the European Union it can be seen that in many cases the situation for renewable energies can be enhanced simply by improving the framework conditions without a fundamental change of instrument. Munoz et al, 2007 even assume that more than two-thirds of the cost reduction potential of harmonization can be attributed to the optimization of national support schemes. (p. 3105f) It would hence be important to set clear guidelines for creating simple and transparent procedures for planning, permission acquirement, and grid connection. Positive experiences of some member states should be conferred to other member states by however not ignoring national situations and traditions.

Some concepts have been proposed for harmonized European promotion schemes. Mostly European harmonization is connected with tradable green certificates as it is widely doubted that a system of feed-in tariffs can be made compatible with a single liberalised European electricity market. A harmonized European green quota system would require harmonized quotas constructed on a single European aim. Green certificates would be recognised mutually and ideally traded European wide. However national aims of diversifying energy sources would not be considered with a European quota. (See Ringel, 2006, p. 12ff)

Munoz et al, 2007 on the other hand propose a harmonized European feed-in premium system which is based on a modular premium paid on top of the electricity price. (p. 3108ff) They suggest that the premium is not constant but set separately for each technology and country However the composition of the premium is harmonized. It consists of investment costs, some grid services, a political incentive and an additional non-harmonized component to account for national priorities. The grid services element compensates renewable energy plants when they provide grid services. This could be extended to other decentralised production units as well. The political incentive element would be linked to the EU targets and signal the degree of political willingness. It is the same across all member states for generation of the same kind. Guaranteed grid access and priority transmission are assumed for this scheme.

To date, bearing in mind the possibilities for improvement within chosen promotion schemes there seems to be no compelling argument for prescribing the same promotion instrument for all member states. Countries with different traditions regarding renewable energy production, public involvement and political intervention are bound to choose different approaches. This is not per se a drawback but can offer the chance for every country to find the promotion scheme which can best promote renewable energies under local conditions. Combining national policy instruments with a harmonized, favourable and transparent framework is the best way forward at the moment.

Analysis of hidden costs of implementation

(Xianli Zhu, Kristian T. Jakobsen, Kirsten Halsnæs, UNEP Risoe Centre, Risoe DTU)

Introduction

Work Package 9 of the CASES project focuses on the impacts that different policies have on the use of different types of energy among EU-25 countries. As part of the activities under this Work Package, Risoe is expected to perform an analysis of the hidden costs of the implementation of different policy instruments for the internalisation of net external benefits of renewables. Hidden cost is not a concept well-covered in existing literature and studies on the costs of policy implementation are rare. This report will start with a review on existing studies about hidden costs and policy implementation costs, give some analysis on the process and component of policy implementation, and finally consider the implementation costs through 2 case studies.

As discussed in other Work Packages of the CASES project, compared with fossil fuel-based electricity generation, electricity generation from renewable sources tends to be of lower external costs and social costs. Multiple policy instruments could be adopted to promote the development of electricity generation from renewable sources, including policies for technology development and the actual deployment of renewable-based electricity generating systems.

The private costs of renewable electricity generation tend to be higher than those of fossil fuel-based electricity generation. To overcome market failure, government policies are necessary to offer some economic incentives, be it in the form of public subsidies, tax reductions, or green certificate, to make electricity generation a competitive investment option for private investors.

The process and components of policy implementation

The process of policy implementation

Policy intervention generally involves two major components: policy formulation and implementation. The first step is mainly policy design, possibly involving some legislation or public consultation.

Implementation is one of the key steps of the public policy cycle.The success of a policy depends on both the policy formulation and the implementation. Different policy design and implementation could lead to the following four major types of results.

- Sound policy, well implemented → success.
- Sound policy, badly implemented → failure.
- Bad policy, well implemented → success (but rarely).
- Bad policy, badly implemented → compound failure

To its minimum, implementation usually involves three elements: organisation, interpretation, and application (http://www.geocities.com/~profwork/pp/implement/index.html).

Organization: Establish and staff a new agency or assign authority to an existing agency and personnel. This delegates the responsibility of implementation to a specific grouping. Often, the agency is given a program specified in the legislation. As discussed above, the organization, whether public or private, that is responsible for implementation is probably far away and the actual implementation is done at the local level. This poses a serious dilemma of social distance: those making policy are not those implementing programs.

Interpretation: Translate legislation intent into operating rules and guidelines. This is very tricky and ambiguity can be ruinous. Ultimately, the judiciary may become involved and the legislators may need to later clarify their ends and means.

Application: Not just the dedication of resources to doing the job but also the coordination of a new initiative or agency with ongoing operations. Note that cross-purposes, competition and jealousies, and cooperation may be at play.

The components of policy implementation costs

According to the IPCC (2001), the implementation costs of climate mitigation policies depend on:

- Financial market conditions;
- Institutional and human capacities;
- Information requirements;
- Market size and opportunities for technology gain and learning; and
- Economic incentives applied (grants, subsidies, and taxes).

It concluded that 'a framework to assess implementation costs thus includes the costs of project or policy design, institutional and human capacity costs (management and training), information costs, and monitoring costs. The costs of resources involved should, in each case, be based on economic opportunity costs.

OECD classified implementation costs related to policies into three basic groups:

- Direct costs to government, including all lower levels of government - the cost of delivering a service or of administering a regulatory system;
- Compliance costs for business and citizens affected - administrative and paperwork (operating) costs and capital costs;
- Indirect costs to the economy in general, such as environmental and social effects or reduced competition, innovation and investment.

The Hidden Costs of Policy Implementation and their Measurement

Term of Hidden Costs in Existing Literature

Hidden cost is not a term widely used in economics. However, in some journal articles and books, it is used to analyze the costs of side effects, indirect costs, or even external costs that are not explicit or often neglected in decision-making. For example, T. Cuff (2005) used 'hidden costs' to estimate the costs related to some side-effects that economic development had on men height, Marshall and Guskiewicz (2003) take sports and recreational injury to estimate the hidden costs of a healthy lifestyle, van Leeuwen et al (2006) used hidden cost to refer to the indirect costs to employers because of absence and reduced productivity due to employees suffering chronic diseases, Belanger C and Gagnon L (2002) concluded in their research that 'since the useful capacity of wind power during peak periods is very low, the development of wind power clearly has hidden costs in terms of additional backup capacity. There are also authors that use 'hidden cots' to refer to life cycle costs, to differentiate it from the market costs that are most widely used in economic decisions, like H. Paul Barringer (2003), Gerald Rebitzer and Stefan Seuring (2003).

The hidden costs of policy implementation

The standard dictionary definition of the term implementation is simply: To put into effect according to some definite plan or procedure.

Within the public policy cycle, implementation is defined as public policy implementation and consists of organized activities by government directed toward the achievement of goals and objectives articulated in authorized policy statements.

When estimating the social costs of different policies or targets for promoting electricity generation from renewable sources, most studies focus on the costs directly related to the electricity generation from renewable sources, be it undertaken by the private sector (in case of mandatory regulatory requirement) or by the whole society (high electricity prices or some other forms of taxes). Such estimates or assessments are mainly based on local renewable energy resource availability, estimates about annual operating hours of renewable electricity plants, and the current and future costs of relevant renewable electricity generating technologies. Such costs are mainly technological costs, which are related to the construction and operation of the renewable energy power plants and usually included in enterprises' operation accounting and decision making.

The implementation of the different policy instruments, be it cap and emission trading or subsidies, also involve some costs, e.g. costs to change existing rules and regulations, the establishment or adjustments to relevant infrastructure (making grid more compatible with the fluctuations or changes in electricity generation from renewable sources), as well as training and education of the personnel and organizations involved in policy implementation and those which are affected by the policies. The level of such costs depends on a wide variety of factors, like policy instrument design and the social and economic context, public sector efficiency. For a policy to be successful there needs to be some form of planning, monitoring, verification, and compliance arrangements. In this report, hidden costs are defined as the costs associated with policy instrument implementation, including the costs of putting a policy into place and keeping it functioning.

In Climate Change 2001 – Mitigation (IPCC, 2001), the hidden costs associated with climate policy implementation are expressed as 'implementation costs'. The IPCC definition of implementation costs are 'the more permanent institutional aspects of putting a programme into place and are different to those costs conventionally considered as transition costs. The latter, by definition, are temporary transition costs.

In an OECD report about agricultural policies (2007), the costs related to policy implementation are referred to as 'administration cost', or policy-related transaction costs. 'Agricultural policies, like all government policy, incur transaction costs – the cost of designing, implementing and evaluating the measure involved. Policy-related transaction costs are defined as the costs arising from designing, implementing and evaluating agricultural policies at all stages of the policy process, covering actions and interactions between and within government agencies, private organisations and programme participants.'

In this report, the OECD definition (2007) will be followed, e.g. the hidden costs of policy implementation is taken as policy-related transaction costs, covering the costs incurred by governments in gathering information, planning and designing policies, collecting revenue, and implementing, checking, and monitoring the outcomes of policies.

Figure 1 offers an illustration about the detailed activities involved during different stages of policy implementation. Some of these activities are within the government agencies, some are in the domain of policy making, while some may involved the services provided by contracted agencies and also the participation by enterprises that are expected to benefit from relevant renewable energy supporting policies or schemes.

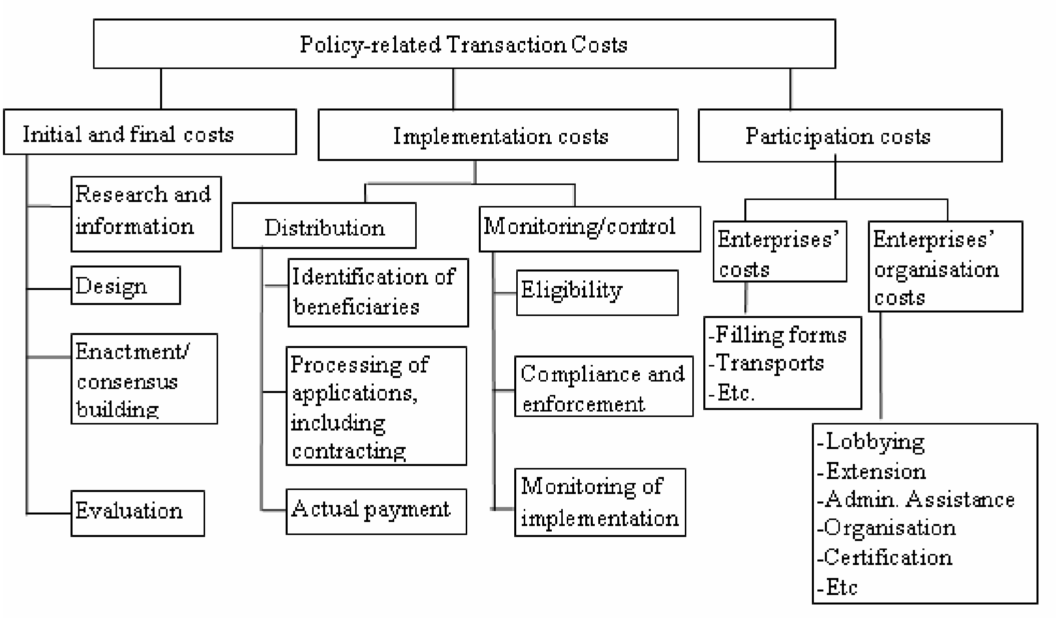

Figure 7 Overview of policy implementation and participation costs

Source: Adapted by the author based on OECD (2007)

The Methods for Hidden Cost Comparison and Estimation

As part of the social costs related to policy implementation, the administration costs of different policy options need to be considered for optimal policy instrument selection. Hence, it is necessary to measure them and make such results available to support policy making.

Even among OECD countries, there is no systematic monitoring and disclosure of the administration costs of different policy instruments, and to get the full information, many elements would need to be defined separately.

Players involved in policy administration

Usually, the implementation of a public policy involves three major types of actors: government agencies that are in charge of policy implementation, the targeting groups of the policy-enterprises that are engaged in generating electricity from renewable sources, and contracted agencies such as organisations doing the verification and auditing on the data submitted by power plants generating electricity.

Information requirements for the measurements

To estimate the administration costs of different policies, some information will be needed for each policy. For the implementing government agencies, two main types of costs are involved in policy implementation: labour costs and operational expenditures. For most countries, although data about aggregate administration budget of each government organ is available, in most countries the costs of each policy administration is not split into the cost for each policy or scheme. Especially each government organ is often involved in the implementation of multiple policies and schemes, and policy implementation in many cases involves government agencies at different levels. The methods of estimating and allocating policy-related transaction costs depend on the institutional framework for policy implementation, the type of policy, and data availability.

Such data could be collected through questionnaire, extracting data about the personnel and policy budget of relevant implementing agencies, and survey on the costs to benefiting enterprises and contracted agencies through sampling survey.

The set-up phase, e.g. the introduction phase, of a new policy tends to involve a large amount of costs, spending on policy design, institutional framework establishment, and training of relevant personnel. This is the one-off cost and should be allocated over the whole term of the policy. Hence, the allocation of this part into each year could be lower for policies lasting a longer period.

This level of policy implementation costs also depends on the number of enterprises to be benefited, the homogeneity or diversity of these enterprises, as well as the monitoring and compliance check and verification.

OECD (2007) summaries a few principles to reduce the implementation costs of policies:

- Consider the policy-related transaction costs during policy designing and make a trade-off between precision and implementation costs;
- Design the programs or schemes in way to reduce information asymmetry, hence the control costs;
- Limit the number of policies of the same purpose and do not change them too frequently;
- Make policy-related transaction costs transparent and monitor them;
- Learn from the past and other policy implementation experiences;
- Build on existing institutions if possible.
- Reduce the number of agencies involved in implementation;
- Contract out some routine administration activities through tendering to reduce costs;
- Use information technologies (data base, on-line monitoring and reporting etc).

Renewable energy policies and their implementation

Renewable energy development is a process of technology research, development, and deployment. It depends both on the speed of technology progress and the creation and market development. Market demand and attractive investment returns attract enterprises to invest in renewable energy technology development and project investment. The expansion of the market could generate scale effects and accumulate experiences, contributing to technology progress, which in turn further lower the technology barriers and risks, leading to further market expansion.

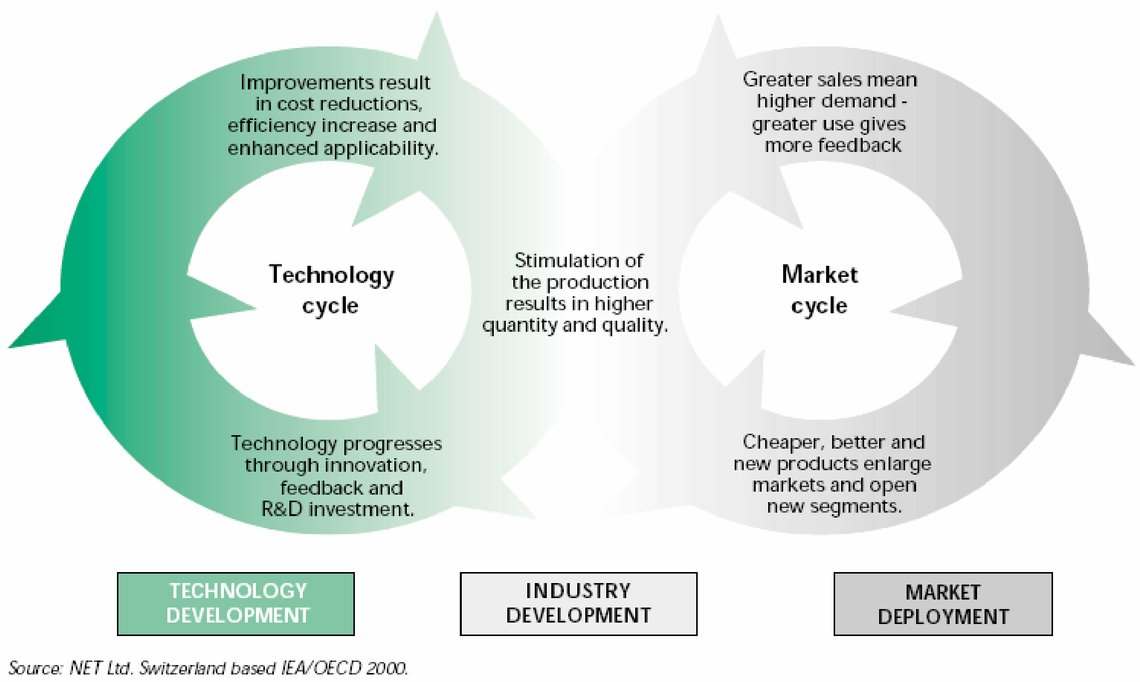

Figure 8 Virtuous Cycle in a Supportive Policy Environment

Source: OECD/IEA, 2004, Renewable Energy - Market & Policy Trends in IEA Countries, page 58

Supportive policies could be targeted at facilitating any step of the process. Based on the target stage of policy intervention, policies for renewable energy development could be classified into three major steps (OECD/IEA, 2004).

- Research and Innovation Policies that support the development of new and improved technologies;
- Market Deployment Policies that underwrite the cost of introducing technologies into the market to improve technical performance and to encourage development of an industry;
- Market-Based Energy Policies that provide a competitive market framework, and may internalise externalities in terms of energy security, environmental protection and economic efficiency.

Policy instruments are mechanisms to induce desired change .Based on the way or the contents of the intervention, basically three types of policy instruments could be identified. Such categorization also applies to the policy instruments for supporting electricity generation from renewable sources (OECD, 2001):

- regulatory instruments: including rules, prohibitions, licenses, etc.;
- financial instruments: including subsidies, taxes and tax deductions, user fees, certain types of budgetary expenditure;
- informational instruments: including advertising campaigns, information booklets, or use of the Internet.

Electricity generation from renewable sources often involves higher private costs than electricity from fossil based generating facilities. Hence, despite the multiple external benefits the renewables could produce, private investors, in the pursuit of maximization of their own economic benefits, will not opt to invest in electricity generation from renewable sources. In reality, renewable energy development faces three major types of barriers: costs and pricing ones, legal and regulatory ones, as well as market barriers.

A wide range of different policies could be adopted to address these barriers. They could be policies directly aimed at realising certain renewable energy targets, or as a measure to realise emission greenhouse gas reduction targets, to improve energy security, or increase the competitiveness of the power sector. Table 68 (Beck and Martinot, 2004) offers an overview of various types of renewable energy policies and the barriers they are mainly used to eliminate.

Policy	**Explanation**	**Major barriers adressed**
Renewable Energy Promotion Policies		
Price-setting and quantity-forcing policies	Mandates prices to be paid for renewable energy, or requires a fixed amount or share of generation to be renewable	High costs, unfavourable power pricing rules, perceived risks
Cost reduction policies	Reduces investment costs through subsidies, rebates, tax relief, loans, and grants	High costs, perceived risks
Public investments and market facilitation activities	Provides public funds for direct investments or for guarantees, information, training, etc. to facilitate investments	Transaction costs, perceived risks, lack of access to credit, information, and skills
Power grid access policies	Gives renewable energy equal or favourable treatment for access to power grids and transmission systems	Independent power producer frameworks, transmission access, inter-connection requirements
Emission Reduction Policies		
Renewable energy set-asides	Allocates, or sets aside, a percentage of mandated environmental emissions reductions to be met by renewable energy	Environmental externalities
Emissions cap and trade policies	Allows renewables to receive monetary credit for local pollutant emissions reductions	Environmental externalities
Greenhouse gas mitigation policies	Allows renewables to receive monetary credit for GHG emissions reductions	Environmental externalities
Power Sector Restructuring Policies		
Competitive wholesale power markets	Allows competition in supplying wholesale generation to the utility network and eliminates wholesale pricing restrictions	May heighten barriers of high costs, lack of fuel price risk assessment, unfavorable power pricing rules
Self-generation by end users	Allows end-users to generate their own electricity and either sell surplus power back to the grid or partly offset purchased power	May reduce barrier of interconnection requirements, but heighten barriers of high costs, lack of fuel price risk assessment

Privatization and/or commercialization of utilities and perceived risks	Changes government-owned and operated utilities into private or commercial entities	May reduce barrier of subsidies, but heighten barriers of high capital costs
Unbundling of generation, transmission and distribution	Eliminates monopolies so that separate entities provide generation, transmission, and distribution	May provide greater incentives to self-generate, including with renewable energy
Competitive retail power markets	Provides competition at the retail level for power sales, including “green power” sales	May reduce barriers of high costs, lack of information, transaction costs
Distributed Generation Policies		
Net metering	Values renewable energy production at the point of end-use and allows utility networks to provide “energy storage” for small users	Unfavourable power pricing rules
Real-time pricing	Values renewable energy production at the actual cost of avoided fossil fuel generation at any given time of the day	Unfavourable power pricing rules
Capacity credit	Provides credit for the value of standing renewable energy capacity, not just energy production	Unfavourable power pricing rules
Interconnection regulations	Creates consistent and transparent rules, norms, and standards for interconnection	Interconnection requirements, transaction costs

Table 68 Summary of Renewable Energy Policies and Barriers
Source: Renewable Energy Policies and Barriers, Fred Beck and Eric Martinot, in Encyclopaedia of Energy, Cutler J. Cleveland, ed., Academic Press/Elsevier Science, 2004, page 3-6

Supporting schemes for electricity from renewable sources among EU Countries

EU is a lead in renewable energy development and many EU countries have been supporting the development of electricity generation from renewable sources through various schemes. The most common renewable energy policies in EU countries which contributed the most to renewable energy development during the 1990s and early 2000s are: (a) direct equipment subsidies and rebates, net metering laws, and technical interconnection standards in the case of solar PV; (b) investment tax credits, production tax credits, and European electricity feed-in laws in the case of wind; (c) grid-access and wheeling policies supporting independent power producers and third party sales in the case of biomass and small hydro power.

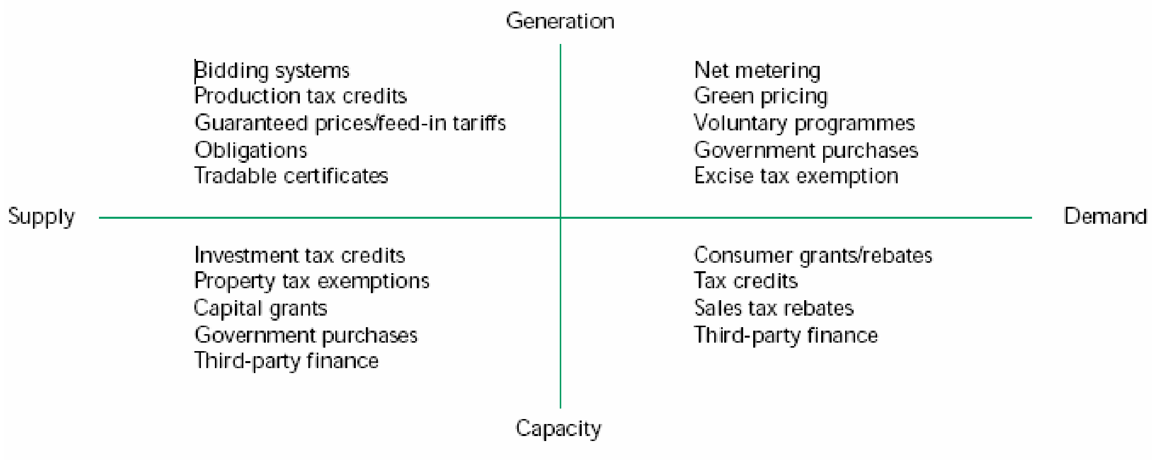

Figure 9 Market Deployment Policy Instruments

Source: OECD/IEA, 2004, Renewable Energy - Market & Policy Trends in IEA Countries, page 85

However, there still exists a wide variety of barriers to the development of electricity generation from renewable sources among EU countries. As part of the OPTRES project, a questionnaire-based survey was conducted to identify barriers to the development of renewables-based electricity generation among EU-25 countries. The major barriers identified are:

Category	Barriers
Administrative barriers	High number of authorities involved
	Lack of coordination between different authorities
	Long-lead times to obtain the necessary permits
	RES insufficiently taken into account in spatial planning
	Low awareness of benefits of RES at local and regional authorities
Grid-related barriers	Insufficient grid capacity available
	Procedure of grid connection is not fully transparent
	Objectiveness is not fully guaranteed
	Cots of grid connection
	Long lead time to obtain authoritisation for grid connection
Social barriers	Opposition from local public and local authorities
	Low awareness of benefits of renewable energy sources
	Invisibility of the full costs of electricity from non-renewable sources
Financial barriers	Lack of trust among banks or investors
	Low predictability of capital subsidies and cash flows

Table 69 Major barriers to the development of renewable energy production

Barriers to the Development of Renewables-based Electricity Development in EU-25, Source: Ragwitz M. et al, OPTRES, Assessment and Optimisation of Renewable Energy Support Schemes in the European Electricity Market, 2007z

There are several major different types of technologies for electricity generation from renewable sources. Due to different technological features, they are face different kinds of barriers. Table 70 is the results of an IEA study on the existing key barriers faced by different renewable technologies in IEA countries and the policy instruments to eliminate these barriers.

	Technical barrier		Cost barriers		Cost-effective, but facing other barriers
	R&D	Demonstration	Deployment	CO_2 reduction incentive	Regulation/ Information/Other
Power Hydro (small & large)				X	X
Biomass	x	x	x	X	
Geothermal	x	x	x	X	
Wind (onshore & offshore)		x	X	X	X
Solar photovoltaics	X	X	X	X	
Concentrating solar power	x	X	X	X	
Ocean energy	X	X	X	X	

Table 70 Barriers of different technologies

Note: X denotes a barrier that is important today, while x denotes a barrier that is less important but still significant, Source: Energy Policies of IEA Countries -2006 Review, IEA, 2007, page 187

Two case studies on the implementation costs of renewable energy polices

This section will analyze two cases where options within the area of renewable energy have experienced a boom in certain countries due to mechanisms that have lowered or eliminated the hidden costs. The cases will focus on passive houses in Germany as well wind energy in Denmark.

Case 1: Passive housing in Germany

Passive Houses are buildings in which the space heat requirement is reduced by means of passive measures to the point at which there is no longer any need for a conventional heating system; the air supply system essentially suffices to distribute the remaining heat requirement. The broad definition of a Passive House is:

"A Passive House is a building, for which thermal comfort can be achived solely by postheating or postcooling of the fresh air mass, which is required to fullfill sufficient indoor air quality conditions - without a need for recirculated air." (Feist, 2006)

In other words, the term "Passive House" covers a construction standard[1] which assures that buildings have a comfortable indoor climate without needing a conventional heating system.

[1] The Passive House construction standard is a refinement of the low-energy house which sets the energy consumption below 75 kWh/(m2a) compared to 100 kWh/(m2a) in the German standard from 1995.

The first Passive House buildings were built in Darmstadt, Germany, in 1990, and occupied the following year. Since then, more than 6,000 Passive House buildings have been constructed in Europe, most of them concentrated in Germany and Austria (The International Passive House Conference, 2007).

The main principle behind a Passive House is to reduce investments through energy efficient design e.g. reducing heat demand by extensive insulation, heat recovery and passive solar gains among others. In order to ensure a comfortable indoor climate all year round without using a conventional heating system, it is necessary to reduce the building's annual space heat requirement to 15 kWh/(m2a) by using the means mentioned above (Feist et al, 2001).[2] Furthermore, the total primary energy consumption for heating, hot water and electricity cannot exceed 120 kWh/(m2a). It should be noted that the Passive House approach differs from a "Zero Energy house" by allowing a small energy demand in contrast to the "Zero Energy house" which does not allow for any energy demand. This is due to the high construction cost traditionally associated with building a "Zero Energy house".

Building a Passive House is usually associated with higher construction costs in relation to insulation, air tightness etc. compared to standard buildings, but on the other side savings can be made from the simpler heating system. Calculations based on 13 projects including 212 dwelling have shown that it is around 10 percent more expensive to build a Passive House compared to a standard house, but in some cases the costs were almost identically e.g. in the case of a project in Gothenburg, Sweden where the building standards are already very energy efficient (Feist et al, 2001). It is also expected that the construction costs for Passive Houses can be lowered when construction companies have gained more experience in building such houses.

The Passive House Institute states that when you take the annual energy savings coupled with certain tax advantages (German Eco-Supplement) and special interest rates offered under a Passive House promotion program[3] into account, the construction of Passive Houses is more economical than conventional construction. However, in order to properly assess how economically the construction of Passive Houses is it is necessary to look at the extra building costs together with the savings from the lesser energy demand.

Audenaert et al (2008) have looked at the economics behind building passive houses in Belgium and this example can be used to verify if Passive Houses are more economical than standard as well as low-energy houses. The study finds that the costs of building a Passive House is 16 percent higher than the costs associated with a standard house i.e. significantly higher than the average of 10 percent from the German projects. The costs associated with building low-energy house are found to be only around 4 percent higher. The study concludes that within a 20 years time span the construction of a Passive house is only economically feasible compared to standard type houses if the energy prices grow with more than 10 percent annually given the present energy costs.[4] The study also shows that when the Passive Houses are compared to low-energy houses, the energy costs need to grow with more than 15 percent annually if the construction of Passive Houses shall be economical attractive. This result differs from the statement of the Passive House Institute on the economical feasibility of the Passive Houses, but the main reason is probably the main difference in the construction costs for Passive Houses in Belgium and Germany. Another reason could be the source of heat as some German houses use electricity for generating heat and a shift away from electricity would mean much higher energy savings as electricity is the most expensive heating source.

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2 Specified for buildings in climatic conditions similar to Central Europe.

3 In April 2006 the interest rate was set at 2.1 percent (KFW- Förderbank).

4 The study only looks at gas as the source of heat and it uses a mean gas price of 0.04€/kWh as the benchmark. If other and more expensive sources are more commonly used for heating the energy savings will of course be larger making Passive Houses more attractive.

All in all, this review shows that the increase in numbers of Passive Houses in Germany are partly due to the fact that the country has been a first-mover on this market and has therefore initiated a number of government research projects on building such houses in the past. These projects have made it possible for German entrepreneurs involved in passive house construction to drive down the building costs by a learning-by-doing process and to be therefore economically efficient in constructing such buildings compared to other countries. This is shown by the difference in the construction costs for this type of buildings in Germany and Belgium where the added costs amounted to 10 percent of the buildings costs associated with a standard house in Germany while the added costs are estimated to be 16 percent in Belgium. The process of reducing costs due to a learning-by-doing process is also called "technological learning" and refers to the phenomenon that the cost of a technology decreases as the cumulative installation of the technology increases (see e.g. Argote and Epple, 1990 and Klaassen et al, 2005). On the other hand, it is not obvious if the subsidies in form of tax advantages and special interest rates offered in Germany are more advantageous compared to other countries and the direct effects of these instruments are therefore difficult to access. However, the aggregate effect of the lower building costs together with the different subsidies offered in Germany has been so significant that the construction of passive houses has been much more numerous in Germany compared to other EC-countries. This seems to suggest that these mechanisms have been able to cover both direct extra costs as well as any hidden costs. Finally, it is expected that the building costs related to passive houses will continue decrease in Germany resulting in similar building costs for passive houses and standard houses (The International Passive House Conference, 2007).

Case 2: Wind energy in Denmark

Denmark has been involved in the development of wind turbines for the production of electricity since the middle of the 1970s where a coordinated R&D programme was initiated covering all energy areas including wind energy. Since then Denmark has been a pioneer country in the area of wind energy development and has obtained one of the largest capacities in the EC regarding wind energy with around 3,000 Megawatt (MW) covering almost 17 percent of the gross electricity consumption (Danish Energy Authority, 2008).

The main increase in capacity happened from 1994 until around 2003 where the capacity increased from around 500 MW to the present level.[5] The increase in this period was mainly due to a significant increase in the number of privately solely owned wind mills while the increase of capacity by power companies as well as co-operatives was insignificant in the same period (Morthorst, 1999). However, in order to get an understanding of which mechanisms were responsible for the boom in the installment of privately owned wind turbines this paper will analyze the relevant mechanisms implemented in the Danish energy sector.

As mentioned before, the Danish government initiated a R&D program in 1976 which covered the whole energy sector and from 1976 to 1995, 10 percent of the total energy research program was spent on wind energy projects. An investment subsidy was introduced in 1979 and offered 30 percent of the total investment cost for the installation of wind turbines that were approved by a test station (Klaassen et al, 2005). The combination of the R&D program and the investment subsidies led to the development of reliable small wind turbines and the focus was to support the operators rather than the manufacturers in order to stimulate the market introduction. Therefore, the private engagement was the main driving force

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5 2007 was actually the first year since 1977 where Denmark experienced a decrease in the wind energy capacity dropping from 3,136 MW in 2006 to 3,125 MW in 2007 (European Wind Energy Association, 2008)

up until the mid-1980s where the Danish Government made an agreement with the utilities to develop wind power within the established electricity system. This led to a significant increase in the number of wind turbines owned by power companies up until around 1994 (Morthorst, 1999).

The main mechanism introduced was a long-term agreement on fixed feed-in tariffs and functioned as a partial refund of the energy and environmental taxes levied on electricity consumption. It consisted of the payment of a guaranteed tariff that was paid to wind turbine operators by the energy supply companies for selling electricity to electricity companies (Klaassen et al, 2005). The idea behind such a scheme is that the economics of wind turbines are highly dependent on stable and long-term agreed payments for the electricity produced due to the high fixed cost, low running costs and long life time associated with the construction and operation of wind turbines (Morthorst, 1999).

For privately owned wind turbines, the following conditions were implied by the feed-in tariff

- All electricity produced from the wind turbines were bought by the electricity companies. The owner's own electricity consumption was bought from the utilities at normal rates.
- The buy-back rate was equal to 85 percent of the consumer electricity price in the distribution area where the turbine was located.
- The Government subsidized the production from wind turbines and could be seen as the refund of the energy and environmental taxes on the private consumption of electricity (Morthorst, 1999).

The introduction of such a scheme has proved to be an important factor in the development of the wind turbine capacity e.g. in the three countries with the largest wind turbine capacity in Europe namely Spain, Denmark and Germany. While the introduction of feed-in tariffs had an almost immediate effect on the development of the capacity in Spain and Germany, it did not have the same immediate effect in Denmark. The explanation could be differences in the taxation of earnings because in 1994 the tax conditions for privately individually owned turbines were improved (Morthorst and Jensen, 1994) and linked with the better cost effectiveness of wind turbines this led to the boom of individually owned wind turbines in Denmark.

Morthorst (1999) analyzes how the profitability of wind turbines affects the capacity development using Denmark as an example. The paper shows that before 1994 only private turbines owned by co-operatives were having a positive net internal rate of return (NIRR)[6] while individually owned turbines did not experience the same profitability.[7] After the tax reform in 1994 the individually owned turbines shifted over to having a significant positive NIRR while the jointly owned turbines had a sharp decrease in profitability. The paper then looks at if there is a significant relationship between the profitability and the capacity development i.e. if stakeholders respond to high NIRRs by building more turbines. For the co-operatively owned turbines the relationship is at best weak, but for individually owned ones the article finds a strong relationship between capacity development and profitability. The article concludes that if there is an expected NIRR higher than 5 percent for the individually owned wind mills there will be an expansion of capacity. On the other hand, the data shows that with a NIRR below 5 percent the expansion of privately owned turbines will be minimal as the NIRR-level of 5 percent can be seen as a risk-premium covering unexpected changes in life time of the turbine (e.g. reduction in subsidies, changes in tax condition etc.).

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6 The NIRR is found by deducting the discount rate after tax with the internal rate of return after tax.

7 The article focuses only on private turbines as it states that the turbines constructed by the power companies are mainly put in place by request from the Danish Government and therefore do not respond to market incentives as it is the case for privately owned turbines.

In relation to hidden cost the analysis in Morthorst (1999) suggests that a NIRR above 5 percent will cover any unexpected changes, but also any other hidden costs in relation to establishing wind turbines in Denmark. Klaassen et al (2005) also concludes that the R&D policy in Denmark has been one of the most successful so far while the capacity promoting subsidies have been very effective pointing towards that these initiatives have been able to cover any relevant hidden costs of constructing and managing wind turbines.

Conclusion

A wide variety of schemes, programs, and policy instruments could be applied to encourage the development of electricity generation from renewable sources. Unexceptionally, the implementation of these policies, in addition to involving the social costs calculated under the CASES project, itself also causes some administration costs to implementing government agencies, contracted agencies, as well as the enterprises covered under such schemes.

Most cost-benefit analyses about renewable energy development are based on the technological cost and the costs incurred by government agencies and participating enterprises are often neglected in such analyses. However, to compare the different policy options, such implementation costs need to be considered as they may be significant under some circumstances.

In this report, the hidden costs of policy implementation for promoting electricity generation from renewable sources, have been defined as the policy-related transactions costs over the life-cycle of policy implementation: from policy design, to implementation, and evaluation.

Although there is some research about how the assessment of such costs could be carried out, the policy-related transaction costs are not systematically studied and there are few existing data about the level of such costs for the implementation of different renewable energy supporting schemes among EU countries. Due to time and resource limits, this research could not carry out a survey about the implementation costs of different renewable energy supporting schemes in different EU countries. Some general analysis indicates that such costs often depend on a wide variety of national circumstances and the different combinations of such policy instruments. The two case studies illustrate that the general rules about effective regulation: public awareness improvement, harmonization among different government measures on similar activities and market players, as well as effective elimination of barriers in both technology development and deployment and market condition improvement are important for the successful outcomes of renewable energy supporting schemes and also to lower the overall policy implementation costs.

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