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WP 8 Report on assessment of policy instruments to internalise environment related external costs in EU member states, excluding renewables

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1. Introduction

This report describes the results of work package 8 on the "Assessment of Policy Instruments to Internalize Environment-Related External Costs in EU Member States, excluding renewables". One of the objectives of the CASES project 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 9, 10 and 11. Work packages 8, 9 and 10 share a common methodology.

WP 8 first objective is to assess policy instruments to internalize externalities in EU member states, excluding renewables. The second objective is to investigate stakeholders' preferences for those policy instruments through a stakeholder workshop which is organized together with WPs 9, 10 and 11.

It is certainly not the intention of this WP to define policy instruments for a more sustainable and efficient energy use *by excluding renewables*. The reason for having a separate analysis "excluding renewables" is that some policy instruments mainly have an impact on non-renewable technologies or technologies using non-renewable fuels. Although WP8 mainly deals with non-renewable sources and their price mechanisms, it has been decided not to distinct the scope of WP8 and WP9 pure on a technology basis (i.e. non-renewable versus renewable energy): a policy instrument may directly target both technologies within a Member State (e.g. an energy tax may have differentiated rates or exemptions depending on the technology / fuel). Therefore, we proposed to use a distinction based on policy instruments.

The organization of the report is based on the description of work. Chapter 2 follows with a synopsis of policy instruments corresponding to task 8.1. The analysis of the extent to which policy instruments succeed to internalize external costs (task 8.2) is covered in chapter 3. Chapter 4 deals with the linkages between policy instruments (task 8.3) and chapter 5 with the analysis of the policy instruments (task 8.4) including the validation of the instruments by stakeholders. An extra technology analysis is performed and shortly described in chapter 6. Policy recommendations and conclusions are given in chapter 7.

2. Synopsis of policy instruments

This paragraph gives an overview of policy instruments to internalize environment related external costs. Both existing (EU and the different EU Member States) and new policies are listed. Policy instruments focusing only on promoting renewable electricity production are not discussed (see WP9 report).

2.1. Classification of instruments

For the purpose of this report, policy instruments have been chosen that directly have an impact on the use of classical energy production, mainly using fossil fuels or nuclear technology. Although WP8 mainly deals with non-renewable sources, it has been decided not to distinct the scope of WP8 and WP9 pure on a technology basis (i.e. non-renewable versus renewable energy): a policy instrument may directly target both technologies. The distinction is also not on the basis “promoting” versus “non-promoting”. After all, if all externalities would be internalised, investments will be triggered and technologies with a low social cost will be promoted. In that case, a price on emitting GHG can be a strong incentive for the development of renewable energy.

Generally environmental policy instruments can be classified in command and control measures, economic instruments and voluntary initiatives (V. Oikonomou; C. J. Jepma 2007).

Legal or regulatory instruments, where governments can set legal requirements on power companies, industry and households with financial penalties for non-compliance.

Economic instruments are also called *market based instruments* (MBI) and according to (EEA, 2005) MBI can be classified into five main types:

1. Tradable permits that have been designed to achieve reductions in pollution (such as emissions of CO2) or use of resources (such as fish quotas) in the most effective way through the provision of market incentives to trade
2. Environmental taxes that have been designed to change prices and thus the behaviour of producers and consumers, as well as raise revenues.
3. Environmental charges that have been designed to cover (in part or in full) the costs of environmental services and abatement measures such as waste water treatment and waste disposal.
4. Environmental subsidies and incentives (in this report only in the context of reducing existing subsidies for energy use with fossil and nuclear).
5. Liability and compensation schemes that aim at ensuring adequate compensation for damage resulting from activities dangerous to the environment and provide for means of prevention and reinstatement.

Organizational measures include negotiated and voluntary agreements.

Experience in recent years shows that the question of 'which instrument is best' has changed to 'which mix of instruments is best', both in terms of using Market Based Instruments alongside other environmental measures such as regulations and in terms of using MBIs to meet environmental objectives in combination with economic and social objectives e.g. environmental tax reform and subsidy reform.

2.2. Abolish distorting subsidies

Environmental subsidies and incentives have been designed to stimulate development of new technologies, to help create new markets for environmental goods and services including technologies, to encourage changes in consumer behaviour through green purchasing schemes, and to temporarily support achieving higher levels of environmental protection by companies (V. Oikonomou; C. J. Jepma 2007). Tradable green certificates is often wrongly categorised under the “subsidising” policies. It is rather a combination of standardization and introducing tradable permits.

Some argue that there would not be any need for subsidies in the presence of a fully functioning market system in which all externalities are internalised (EEA 2005). However, subsidies can help create markets, and speed the development of markets and technologies, but they can also slow market development and encourage 'lock-in' to existing systems. They can be a catalyst and at the same time a brake, encouraging increased efficiency, or hindering it — depending on their design, objective and to what they are applied.

From a broad economic perspective, it could be argued that subsidies are inefficient and would not be needed if the external costs of all activities were internalised. In some respects, therefore, one can see the application of some subsidies, for example those introduced for environmental purposes, as attempting to rectify market failures. Subsidies become inefficient if their existence leads to overproduction of the subsidised product, or if it creates 'economic rents', in other words undue profits for individuals or parts of the sector. The latter occurs when the subsidy is no longer needed or larger than the incremental support needed — in other words, above the needed threshold. Even green subsidies should be temporary, otherwise they can effectively slow the development of innovative technologies.

If environmental externalities are better internalised, there will be more of a level playing field for technologies and there should be less need for pro-environmental subsidies. We are, however, far from the point where externalities are fully internalised, and the ideal objective, of prices reflecting all costs including external ones, still seems an unachievable ideal, despite rhetorical support.

A serious hampering for an efficient energy use are subsidies for energy use. Those subsidies are large mainly in developing countries, but also in Europe and they keep energy prices artificially low. Worldwide, the energy use would decrease with 13% and the CO2 emissions with 16% if subsidies for energy use would be abolished (The World Bank/Oxford University Press, 2003).

Also in the EU, energy use is strongly subsidised, according to (EEA, 2004). Because there is no consensus on a clear definition of energy subsidies, the EEA looked to both direct and indirect support mechanisms. The so called "on-budget" subsidies are sums that are categorized as government expenses. "Off-budget" support are fiscal exemption, preferential market entry etc.. The minimum estimates of the EEA for the total subsidies for energy use in the EU in 2001 amount to 29,2 miljard EUR. The biggest part (82%) goes to non-renewable energy, mainly fixed fuels (coal) and to natural gas and oil. The lowest share of energy subsidies is provided to nuclear power. However, the EEA report states that these figures "exclude the potential cost of not having to pay full-liability insurance cover for a critical nuclear accident or fuel incident since commercial and State liabilities are limited by international treaty" (EEA, 2004).

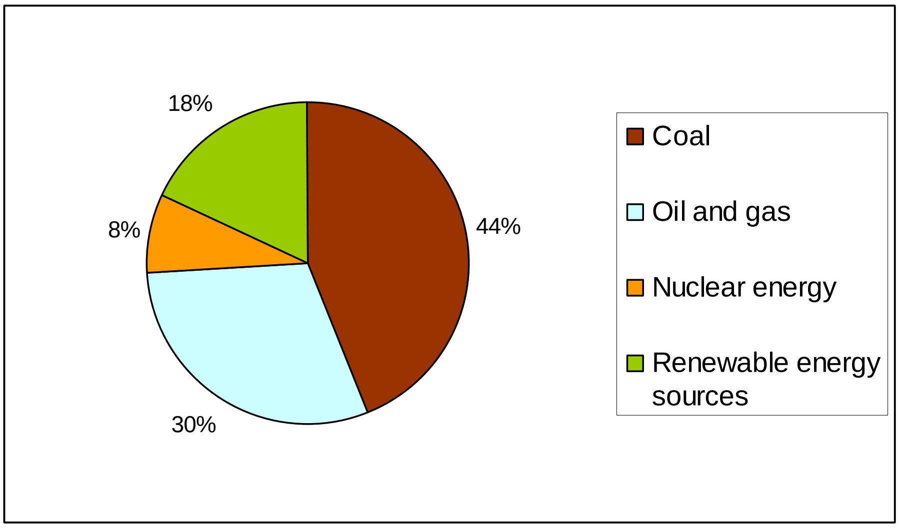

Figure 1: Subsidies for energy use (EU-15, 2001). Source EEA (2004).

Historically, energy subsidies existed in order to support the development of public sector industries. These have gradually been privatised and so subsidies in the oil and gas sectors are far less common than they used to be. Coal subsidies still exist in a number of countries such as Germany and, to a lesser extent, Spain, and even in the United Kingdom. These were launched to support a key industrial sector and now remain, often to support employment in areas with few alternatives, and also, as in Germany, to ease the restructuring process. Nuclear power also benefits from direct subsidies, transparent payments (e.g. the UK's non-fossil fuel obligation), and other subsidies, which are less transparent, including the use of guarantees and limiting liability (e.g. in case of accident, and guarantees for waste disposal and decommissioning).

A reform of the current practice of energy subsidisation is high on the political agenda as specifically mentioned in the sixth environment action programme of the EU, especially with respect to reforming subsidies that have considerable negative effects on the environment. Subsidies for fossil fuels, for example oil and coal, pose greater threats to the environment in general than support schemes for renewable energies that are often portrayed as environmentally beneficial, although the full range of impacts, including indirect effects, should be taken into account.

Energy subsidies for fossil fuels are likely to continue to decline, and there will be increasing pressure to phase out those that remain, for example those on coal. Nuclear subsidies are likely to remain for the foreseeable future due to the expensive nature of the industry and the need for government support in the form of guarantees and limiting liability in the case of accidents, waste disposal and liabilities. The longer-term market price development of oil and efforts to continue to include external costs in prices will prove to be major determinants of the market penetration of renewable forms of energy, in addition to the need for financial support.

If environmental externalities are better internalised, there will be more of a level playing field for technologies and there should be less need for pro-environmental subsidies. We are, however, far from the point where externalities are fully internalised, and the ideal objective, of prices reflecting all costs including external ones, still seems an unachievable ideal, despite rhetorical support.

2.3. EU Emissions Trading

Tradable permits that have been designed to achieve reductions in pollution (such as emissions of CO2) or use of resources (such as fish quotas) in the most effective way through the provision of market incentives to trade (EEA, 2005). Certificates or marketable (tradable) permits/quotas are, among others, emissions trading schemes, White, Green and Combined Heat and Power (CHP) Certificates. For emissions trading schemes, the basic principle is that any increase in emission from a given source must be offset by a decrease in emissions of an equivalent quantity. For example, when a statutory ceiling on pollution levels is fixed for a given area, a polluting firm can set up a new facility or expand its activities only if it does not increase the total pollution load. The firm must therefore buy "rights" or allowances to pollute from other firms located in the same control area, which are then required to abate their emissions by an amount equal to additional pollution emitted by the new activity (V. Oikonomou; C. J. Jepma 2007).

Cap and trade system (Wikipedia). A central authority (usually a government or international body) sets a limit or cap on the amount of a pollutant that can be emitted. Companies or other groups are issued emission permits and are required to hold an equivalent number of allowances (or credits) which represent the right to emit a specific amount. The total amount of allowances and credits cannot exceed the cap, limiting total emissions to that level. Companies that need to increase their emissions must buy credits from those who pollute less. The transfer of allowances is referred to as a trade. In effect, the buyer is paying a charge for polluting, while the seller is being rewarded for having reduced emissions by more than was needed. Thus, in theory, those that can easily reduce emissions most cheaply will do so, achieving the pollution reduction at the lowest possible cost to society.

An emission cap and permit trading system is a quantity instrument because it fixes the overall emission level (quantity) and allows the price to vary. One problem with the cap and trade system is the uncertainty of the cost of compliance as the price of a permit is not known in advance and will vary over time according to market conditions.

2.4. EU Emissions trading, Allowance allocation

Three basic approaches have been used in past programs to allocate allowances to sectors/facilities (NERA 2007) (1) "Grandfathering"—allocating on the basis of historical emissions. (2) "Benchmarking"—allocating on the basis of some emission rate (per unit of input or output) and (3) "Auctioning"—requiring the purchase of allowances.

Grandfathering and benchmarking are both systems with free allocation. The primary difference between auctioning and free allocation of allowances is in terms of their impacts on income distribution. Under auctioning the allowance revenues go to the public authorities, whereas with free allocation the value of the allowances goes to the installations covered under the ETS (European Commission 2008).

The opportunity cost of an allowance is identical in both cases. The adverse macroeconomic impacts of introducing a greenhouse gas emissions constraint through auctioning in the EU ETS sectors can be partly offset by returning the allowance revenues to the economy. Obviously, the method chosen by Member States to recycle these revenues in the economy is important to determine the scale of this offsetting effect. Direct transfers to households improve private consumption, but could have less impact on employment. Reduction of labour taxes could generate benefits for employment and reducing corporate taxes could decrease the direct impact on the sectors affected. Full auctioning of allowances imposes an additional financial cost on firms, in particular energy-intensive ones if these are unable to pass through the cost of allowances due to exposure to intense competition from outside the EU (European Commission 2008).

The allocation of permits among industries has been the subject of a debate (next 3 paragraphs: Longo A.; Markandya A., 2005). Permits could be allocated to companies on the basis of their historical output of emissions (grandfathering) or they could be auctioned. The usual argument to support grandfathering is that while inefficient, is it provides greater political control over the distributional effects of regulation (Stavins 1997).

On the other hand, Cramton and Kerr (2002) argue that an auction is preferred to grandfathering because it reduces tax distortions and the need for politically contentious arguments over the allocation of rents, provides more flexibility in distribution of costs and greater incentives for technological innovation.

An important difference between permits that are auctioned by the government and permits that are issued for free is that with free permits the polluter pays only the abatement cost, but with auctioned permits the polluter must also pay the remaining damage at the new emission level, as pointed out by Desaigues and Rabl (2001). The difference in cost to the polluter is very large: a factor of three or more as can be seen from the results of Rabl et al. (2004).

Should prices go up with free allocation ?

In theory, the energy efficiency policy and the fuel choice of companies is independent of the allocation system of emission rights. After all, emission rights have a similar price in both cases:

Allocation system with auctioning:

Buying emission rights is a way for the company to make it possible to emit CO_2. The company pays for the remaining emissions thus a real price has to be paid for the emissions.

Allocation system with grandfathering (free allocation):

Using emission rights is a way for the company to make it possible to emit CO2. An alternative is to make the plant more efficient, to reduce specific emissions and sell rights on the market. The opportunity cost of using emission rights is the price of emission rights on the market.

The opportunity cost is the cost incurred by choosing one option over the alternative. When an asset can be freely traded, its opportunity cost is equal to the market price. In this case, the assets are emission rights. The opportunity cost of emission rights is the price of the emission rights:

It can not be lower than the market price:

if the cost of reducing emissions is lower than the market price, the company will sell emission rights on the market.

It can not be higher than the market price:

the opportunity cost can not exceed the cost of buying emission rights on the market.

No matter what allocation system is used, companies include in their investment calculations a (shadow) price on emitting greenhouse gases. This economic theorem is used in optimisation models to simulate the effect of EU-ETS by introducing a shadow price on emitting greenhouse gases.

Does emission trading with free allocation fully internalise external costs ?

As already mentioned, the opportunity cost of an allowance is identical in both cases and so the prices should be equal. Some however argue that external costs are not fully internalised because no price has to be paid for the external costs from the free allocated emission quota (Torfs R; De Nocker L. 2005). One could wonder whether as a result of windfall profits the incentives for companies to reduce emissions are smaller?

It is widely accepted (NERA 2007) that under "idealized" conditions, the decision to adopt one of these three major alternatives would affect neither the cost savings from emissions trading nor the ability of the program to cap emissions from program participants; under these conditions, the allocation of allowances is assumed to become "just" a distributional issue. Moreover, because of a belief that giving out allowances for free in the EU ETS (generally through grandfathered rather than benchmarked allocations) has lead to "windfall profits" for some recipients—notably electricity producers—that are inconsistent with a "polluter pays" principle, some commentators have argued for a "simple solution" of auctioning all allowances and, indeed, New York and some other RGGI states have proposed 100 percent auctioning of allowances. But these two simple propositions—that all allocation alternatives achieve the same aims (other than distributional effects) and that allocating allowances for free leads to inequitable outcomes—ignore a host of “real world” complexities. The report comes to following conclusions:

1. Leakage (e.g., increase in GHG emissions outside the EU ETS or RGGI due to uneven international GHG regulation) has the potential to undermine both environmental and cost-effectiveness objectives.
2. Allocating allowances for free (rather than auctioning) can allow policy makers flexibility to reduce leakage and achieve other aims.
3. Auctioning might reduce the overall cost of meeting the cap and provide revenue that could in theory be used to improve the efficiency of the tax system or pursue other aims.
4. Allocating allowances to new entrants (and confiscating allowances for facilities that shut down) tends to increase overall compliance costs but would likely lead to lower electricity and other product prices in the long run.
5. “Windfall profit” characterizations tend to be simplistic and potentially misleading.
6. The relative “fairness” of benchmarking and grandfathering depends upon the criteria for “fairness.”
7. Empirical estimates of the percentage of allowances that would need to be allocated for free to make affected sectors/companies “whole” (e.g., reimburse for stranded costs) vary widely among studies and within a given study.
8. Uncertain empirical information regarding cost burdens and other impacts makes it difficult to quantify the nature of the tradeoffs among different aims in choosing among allocation alternatives.
9. The relative importance of all of these complexities can differ for different sectors, suggesting that the “optimal” allocation approach could be different for different sectors.
10. Timing tends to change both the impacts of the program and, in some cases, the importance of various aims and thus increases complexities; but the time dimension also provides

Ecofys investigated the impact of (Ecofys 2008) of using output based benchmark as a rule for allocation in the so called IFIEC method. The IFIEC method “limits the CO_2 costs of electricity production to the actual costs of achieving a clean production level, as determined by a benchmark. This is different from the methods of auctioning and grandfathering in which the full costs (either real costs or so-called opportunity costs) of all CO2 emissions are passed through into the electricity price. As a result, application of the IFIEC method reduces electricity costs for end-users in the order of, on average, 10-30% of industry’s electricity bills and 5-20% of household bills. Within EU-ETS, the IFIEC method provides the same environmental incentives as auctioning and better incentives than the current system of grandfathering, provided that a single (not fuel-specific) benchmark is used for all electricity producers under EU-ETS. The lower electricity prices that result from the IFIEC approach, however, reduce the incentive for some low-carbon measures to be implemented outside EU-ETS.“

Not everybody is convinced of the advantages of a benchmark based system. A summary of advantages and disadvantages is also given in (NERA 2007):

	Emissions-Based grandfathering	**Benchmarked Allocation**	**Auctioning**
Advantages	Relatively simple; provides continuity Compensate for "stranded costs"	May be perceived as fairer May address competitiveness impacts and emissions leakage *if updated*	May be perceived as fairer Provides government revenues that can be used for various purposes
Disadvantages	May over-compensate Uncertain effects	May over-compensate Benchmarking complicated May reduce scheme cost-effectiveness (assuming updating)	May under-compensate May exacerbate competitive impacts and emissions leakage.

2.5. Emissions trading, safety valve

Safety valve, is a hybrid of the price and quantity instruments. The system is essentially an emission cap and tradable permit system but the maximum (or minimum) permit price is capped. Emitters have the choice of either obtaining permits in the marketplace or purchasing them from the government at a specified trigger price (which could be adjusted over time). The system is sometimes recommended as a way of overcoming the fundamental disadvantages of both systems by giving governments the flexibility to adjust the system as new information comes to light. It can be shown that by setting the trigger price high enough, or the number of permits low enough, the safety valve can be used to mimic either a pure quantity or pure price mechanism. China uses the CO2 market price for funding of its Clean Development Mechanism projects, but imposes a safety valve of a minimum price per tonne of CO2.

2.6. Taxes (excluding VAT)

Full cost pricing would require that external (environmental or other) costs be accounted for in market prices of economic goods to ensure a proper allocation of resources and to achieve maximum social welfare. Emission charges/taxes stand for direct payments based on measurements or estimates of quantity and quality of pollutant discharged.

There are two recognised approaches to internalising environmental costs through the application of a tax (EEA 2005).

1. *Pigouvian tax.* The tax is set at the level that internalises all the environmental costs, i.e. the costs of environmental damage (also called externalities or external costs), into the price. To guarantee this, the tax rate must be equal to the marginal social costs and the marginal social benefit that result from the activity that emits an additional unit of pollution (see OECD, 2001). This approach is referred to in the literature as a Pigouvian tax after Pigou who developed the rationale for environmental taxation (Pigou, 1932).

2. *Baumol-Oates tax.* The tax is set at a level which is estimated to be sufficient to achieve a given environmental objective (40). This approach can be traced back to Baumol (1972) and Baumol and Oates (1971).

The preferred approach — based on theoretical economic considerations — is the first (the Pigouvian) approach: this way of taxing (in a perfect market) results in the most efficient use of resources. However, full internalisation of external costs is difficult to achieve in practice because the value of environmental damage is generally not known. The more pragmatic Baumol–Oates approach is therefore generally used, meaning that, if the environmental target is given, environmental taxes can be used to achieve this target effectively, again resulting in the most efficient use of resources. They also provide incentives for technological improvements and increased efficiency in the long run (dynamic efficiency).

Environmental tax reform (EEA 2005)[1]

Environmental tax reform (ETR) is the term used for changes in the national tax system where the burden of taxes shifts from economic functions, sometimes called 'goods', such as labour (personal income tax), capital (corporate income tax) and consumption (VAT and other indirect taxes), to activities that lead to environmental pressures and natural resource use, sometimes called 'bads'. This redistribution of tax burdens across the economy should provide appropriate signals to consumers and producers and lead to a better functioning of markets and increased welfare, as it moves society towards a more sustainable development path.

What is an environmentally related tax ?

OECD gives a definition (Trofs R.; De Nocker L. 2005) "… environmentally related taxes are defined as any compulsory, unrequited payment to general government levied on tax-bases deemed to be of particular environmental relevance. Taxes are unrequited in the sense that benefits provided by government to taxpayers are not normally in proportion to their payments. …. The name, or the expressed purpose, of a given tax is not a criterion….The focus is instead on the potential environmental effects of a given tax, which is determined by the tax impacts on the producer and consumer prices in question, in conjunction with the relevant price elasticities."

Does VAT internalize ?

Sometimes, it is argued that VAT already internalizes a part of the externalities. VAT is the most important tax on electricity in many MS. In (Torfs R.; De Nocker L. 2005) it is argued that because VAT is a general tax for all products and services, VAT does not give price signals and

[1] Environmental fiscal reform (EFR) is a broader concept that includes reform of environmentally harmful subsidies.

does not internalize at all. When comparing taxes with environmental impact, one should not take into account VAT. Only when there is a (partial) exemption for VAT, it have to be included and sometimes it is called a subsidy.

2.7. Electricity tax based on technology mix

Product charges/taxes are applied to products that create pollution either when they are manufactured, consumed or disposed of (V. Oikonomou; C. J. Jepma 2007).. Product charges/taxes are intended to modify relative prices of products and/or finance collection and treatment systems. One practical form of product charges/taxes is tax differentiation leading to more favourable prices for "environmentally friendly" products and vice versa (e.g., car sales differentials as on fuel efficiency, existence of catalytic converter, compliance with emission standards and tax differentiation between leaded and unleaded fuel).

2.8. Performance based command and control

Command and control measures prescribe a certain technology or a certain standard. In general, legal or regulatory instruments is when governments can set legal requirements on power companies, industry and households with financial penalties for non-compliance. They are traditional main pillars of environmental policy. Examples include appliance, vehicle and building standards (on energy use or emissions), land and other resource management codes and standards for technology (e.g., a renewable portfolio standard in electricity requires that a minimum percentage of electricity is produced by renewable technologies).

2.9. Voluntary agreements

Organizational measures include negotiated and voluntary agreements. They are commitments undertaken by power producers or industries in consultation or negotiation with a public authority and are usually recognized by that agency; they are expected to have a high degree of effectiveness if they are combined with other policies. These agreements can take many forms concerning the degree of bindingness (e.g., legally non-binding press statements to legally binding covenants). They include a wide range of issues, such as a decrease in energy consumption or phasing in of low sulphur petrol.

2.10. Implementation of policy instruments in Europe

Following documents are of interest for a better understanding of future implementation of policy instruments:

- The EU Green Paper on European Strategy for Sustainable, Competitive and Secure Energy SEC(2006)317;
- The Green Paper on energy supply security COM(2000)769;

- The Commission's new Green Paper on energy efficiency COM (2005) 265;
- Directive2001/77/EC on the promotion of electricity produced from renewable energy sources in the internal electricity market (RES-E Directive);
- 2004/8/EC Directive on the promotion of cogeneration. European Commission. (2008).
- Proposal for a Directive of the European Parliament and of the Council on the promotion of the use of energy from renewable sources. Brussels, 23.1.2008, COM 2008

Energy taxation directive

As a result of Directive 2003/96/EC, several EU Member States are required to introduce new taxes on coal, natural gas and electricity, where such taxes have not previously been levied (EEA 2004 see OECD/EEA database and EEA, 2000) and some have to increase existing taxes on mineral oil products. The consequences for individual Member States differ considerably, with some Member States not being obliged to introduce or increase any energy taxes and others being required to do so. Generally, the impact on the new EU Member States is significant. The directive represents an achievement in harmonising environmental and fiscal policies. However, tax rates in some Member States, for example on mineral oils, are significantly above the minimum, while those in others are around the minimum. Hence, large differences in tax rates still exist, so the practical impact of the directive on harmonising rates has been to ensure that countries cannot reduce taxes below a minimum level.

The future of market based instruments

The adoption of the EU directive on restructuring the Community framework on taxation of energy products in 2003 may trigger developments in energy taxation at the EU Member State level. It took six years of negotiation and amendment to adopt this directive, and it can be seen as a reflection and confirmation of unilateral processes leading towards a better (though far from full) internalisation of the external costs of the use of fossil fuels. For example, the introduction of the energy and electricity tax in Germany and the climate change levy in the United Kingdom illustrate the relevance and need for environmental taxes in environmental policy.

Fiscal measures are difficult to implement at EU-level, because for the voting of new fiscal regulation, unanimity is needed thus a consensus between all MS.

The European Parliament adopted, by 479 votes to 53 with 5 abstentions, a resolution on the Green Paper on market-based instruments (MBIs) for environment and related policy purposes (European Parliament 2008).

"…It stresses that the polluter pays principle enables a real price to be set by including in the product price the cost of cleaning up pollution and repairing damage caused by production."

"…Members regret the absence of an in-depth analysis on the merits of differentiation between market-based instruments targeted at the consumer as opposed to the producer level."

"…they also criticise the fact that the Green Paper concentrates mainly on atmospheric pollution and global warming, and by and large disregards the other negative impacts of production and distribution processes and consumption patterns on the environment."

"…parliament recognises that a failure to internalise environmental costs is tantamount to subsidising environmentally harmful activities. It points out that the existence of a large number of Environmentally Harmful Subsidies (EHS) in EU Member States aggravates pollution and seriously undermines the polluter pays principle. The reform of EHS must not be limited to the CAP. In this area the transport sector, particularly road transport, requires specific, determined action. The Commission is asked rapidly to propose a roadmap for the abolition of EHS in accordance with the European Council's decision on the review of the sustainable development strategy."

"Principles: Parliament points out that the polluter pays principle is one of the pillars of EU environment policy, but that its implementation leaves a lot to be desired in most Member States. Members take the view that the move towards sustainable development and a carbon-free economy requires a combination of deterrent instruments (e.g. taxes, fees) and incentive instruments (e.g. trading schemes). They stress that the development of instrument mixes will help to optimise the use of MBIs, which can contribute greatly to achieving the goals of the Lisbon agenda. Social consequences resulting from the implementation of MBIs should be compensated for by specific policy measures such as floor prices, rate reductions, subsidies etc. for low-income households. Parliament considers it also necessary to adopt measures aimed at penalising excessive consumption. It states that Community market-based measures cannot be limited to emission permit or emission quota trading schemes and that other possible schemes need to be envisaged, such as the introduction of a carbon tax, as well as a reduction in subsidies for fossil fuels.

Instruments: the Commission is called to strengthen the EU ETS by establishing a progressively tightening cap and extend it to all first-tier emitters as the main means of achieving the 2020 GHG reduction targets. Parliament stresses the urgent need for a revision of the EU ETS in order to address effectively the shortcomings experienced during the trial period, including the windfall profits of companies due to the assets acquired from the allocation of CO2 quotas free of charge (for instance the large electricity producers). It emphasises that the strong endorsement of the polluter pays principle in the EU Sustainable Development Strategy implies that the EU ETS should be primarily based on auctioning of the emission permits and on a total emissions cap that is consistent with the EU 2020 reduction target of 30%, including quantitative limits and qualitative requirements for the use of Clean Development Mechanism / Joint Implementation (CDM/JI) project credits."

In (European Parliament 2008), one also can read "The EU…recalls that the energy tax directive foresees that, under certain conditions, taxation can be fully or partially replaced by alternative market-based instruments, including, in particular, the EU-ETS" (p. 18)

"….stresses the need to apply better regulation principles to the use of Market Based Instruments and to avoid overlapping and complex instruments; supports the amendment of Council Directive 2003/96/EC of 27 October 2003 restructuring the Community framework for the taxation of energy products and electricity1 ("Energy Taxation Directive") in such a way as would ensure that participants in the EU ETS do not pay twice for their emissions, through both trading and taxation" (p. 21)

"…calls for Market Based Instruments revenues to be reinvested in programmes which support environmental goals and mitigate any impact on competitiveness and any social impact; believes that EU ETS auction revenues could be a key source of EU funding in the future;" (p 21)

The impact assessment of the EU ETS review (European Commission 2008) concludes that the preferred long term option is full auctioning with free allocation taking place during a transitional period based on harmonised EU-wide rules, and taking into account progress in reaching an international agreement to avoid net carbon leakage and for those installations in energy intensive sectors exposed to international competition.

3. Do policy instruments internalize external costs ?

What is the extent to which different policy instruments succeed to internalize external costs ? When producing electricity, a power plant may emit pollutants that are transported in the atmosphere and then when inhaled can create a health risk or after deposition can disturb ecosystems. The power plant operator has no incentive to account for this damage, when making decisions. His duty is to respect the emission thresholds imposed by environmental regulation, but not the avoidance of further small risks and damages. The damages occurring thus are external effects, i.e. not taken into account by the person or institution causing the effects. These external costs are not accounted for by the decision maker; thus they should be internalised by using appropriate instruments, e.g. a tax (Bickel P.; Friedrich R., 2005).

Environmental economics theory (Proost S.; Rousseau S., 2007) states that if there is a large number of polluters (causing external costs) and victims (exposed to pollution), full internalisation of external costs is not evident. In the ideal solution, there exists an optimal level of pollution when the marginal cost of reducing the pollution equals total environmental damage. This theorem is fundamental because accepting the existence of an optimal pollution level means accepting that some pollution remains, depending on the external costs and the costs for reducing the emisisons. The reason is that reducing (overall) social costs is not the same as minimising the external costs. The second theorem says that pollution is reduced in a cost minimal way when the marginal cost of pollution reduction is equal between the source of emissions. A policy is said to be cost efficient when this theorem is fulfilled.

So what should be the objective of the policy instrument ? When the objective is to fully internalise external costs, the only condition to be fulfilled is that consumer prices have to reflect full social cost. Internalizing as such can be the objective, although it does not tackle a specific environmental problem and although it is not common to have such a “vague” objective. It will be clear from the report that it is not always easy to fulfil this condition in many cases. When producers are facing an extra cost for the externalities, the supply curve will shift, the quantity of production and consumption will reduce and the price will increase. Many people wonder whether it is sufficient that prices go up and consumption has somewhat lowered. This report assumes that full internalisation is the first best solution resulting in a pollution level as close as possible to the optimal level and achieved in a cost efficient way. The theory behind full cost pricing, however, cannot easily be applied, as it relies on strict assumptions that are not easily met in reality. Assumptions made include the existence of clear preferences and the existence of competitive markets, which in reality are only partially or not met. The difficulty to apply the full cost pricing in practice has led to the adoption of a less ambitious objective than that of welfare maximization.

A policy objective does not necessarily have to match with the principles of full internalisation. For some policy objectives, the principles of full internalisation can’t be met with any policy instrument because the assumptions behind the objective are simply in contrast with the theory of lowest social cost. For the assessment of the policy instruments (chapter 5), a specific policy objective is chosen for the participation exercise with the stakeholders. It has been shown that not everybody is convinced that full internalization is the correct or the only correct condition for sustainable electricity production.

3.1. Lower social cost versus full internalization

Within the context of policy instruments evaluation, it is important to be able to distinguish real internalizing effects and effects caused by decreasing total or average external costs. When investment decisions are made, e.g. about which power plant technology to use or where to site a power plant, it is evident that it would be of interest for society to take environmental and health impacts into account and include the external effects into the decision process, i.e. to internalise external costs. To support the decision process, the social costs of the investment alternatives, i.e. the sum of internal and external costs, can then be compared. If decisions are to be taken now, but the consequences of the decisions reach decades into the future, the possible future costs have to be estimated (Bickel P.; Friedrich R., 2005).

Policy instruments that fully internalise external costs differ from policy instruments that aim at lowering the social costs: (1) it is possible that the level of the remaining emissions is too low or too high than (in economical terms) the social optimum and (2) no price has to be paid for the external costs from the remaining emissions in contrast to the principle of the polluter pays principle. An overview of advantages and disadvantages is given in (Proost S.; Rousseau S. 2007):

Emission tax = marginal damage	Correct choice of emission reduction technologies. Consumption pays the marginal social cost.
Subsidy equal to marginal damage	Correct choice of emission reduction technologies. Too large consumption because the product is sold much below marginal social cost.
Product tax	No incentive to switch to cleaner technology Too small consumption.
Technological standard	Correct choice of emission reduction technologies. Too large consumption because the product is sold below marginal social cost.

3.2. A consumer price equal to social cost versus full internalization

The best way of internalising these costs is via imposing taxes that are equal to the external costs, so that prices reflect the true costs and tell the ecological truth. However, as it is often not feasible to fix a different tax for each individual case, averaged external costs for classes of goods, sites or activities are used to determine the tax to be imposed (Bickel P.; Friedrich R., 2005).

The problem with averaged external costs for classes of goods is that there is no possibility to switch to the technology of choice and benefit from this. Having a consumer price equal to the social cost because for example there is an electricity tax equal to the external cost of electricity production, does not necessarily mean that external costs are fully internalised. It is a product tax based on the average electricity production and thus averaging the effects in the retail market does not give proper price signals to the consumer.

(EEA 2005) "If the prices of non-renewable energy are not increased where applicable by internalizing its external costs and abolishing subsidies, the price of renewable energy must be reduced. In theoretical terms, inefficiency is countered with inefficient measures."

3.3. Low external cost versus low social cost technologies

Often, it is argued that renewable technologies are in favour of non-renewable technologies because the external costs are lower. Why operating aid is based on the difference with external costs and don't we use the concept of social cost for the comparison ?

(EEA 2005) The provisions in the guidelines for support for renewable energy are based on calculations of external costs and follow a practical approach. "Member States may grant operating aid to new plants producing renewable energy that will be calculated on the basis of the external costs avoided. These are the environmental costs that society would have to bear if the same quantity of energy were produced by a production plant operating with conventional forms of energy. They will be calculated on the basis of *the difference between, on the one hand, the external costs produced and not paid by renewable energy producers and, on the other hand, the external costs produced and not paid by non-renewable energy producers.* At any event, the amount of the aid thus granted to the renewable energy producer must not exceed EUR 0.05 per kWh[2]."

[2] Cfr also community guidelines on state aid for environmental protection (COM 2001/C37/03)

4. Policy linkages with emission trading

The goals is to analyze the effect of combining policies and to analyse the linkages between different policies. Important insights have been acquired on the connections and overlaps between different policies. It was found very important to make good estimates of overlaps between ETS and other EU or local policies. Since policies focus on different groups, the evaluation of the overlaps will be different for the different sectors.

4.1. Overlapping effects

Overlapping effects occur when the effects of two or more policy measures can not be simply aggregated (Duerinck J. et al. 2008). The combined effect of two or more measures is not always the sum of the individual effects. Various policies have been defined at national or EU level that affect GHG emissions from the electricity sector and industry.

The EU-ETS interacts with policy measures at domestic level:

- the promotion of electricity from renewable energy – by means of financial mechanism, tax deductions or regulatory policies
- the promotion of cogeneration – by means of financial mechanism or regulatory policies
- improving energy efficiency in the industry such as benchmark agreements, voluntary branch agreements
- reducing electricity consumption by end-use sectors

A common practice is to look at the CO_2 trading price as an opportunity cost, regardless of the allowances allocated in ETS, and to model the interactions of a CO_2 price with financial or regulatory mechanisms of domestic policy measures. A CO_2 price will make the use renewable energy and CHP more profitable and will also enhance other domestic measures to improve energy efficiency.

It can theoretically be shown that other policy instruments from sectors covered by EU-ETS might have significant effects on the emission trading price, distribution of emissions reduction, distribution of efforts. However, *as long as there is an emission trading price then other policy instruments have no effect on total GHG emissions with a cap and trade emission trading is enforced at EU-level.*

4.2. Combining the EU-ETS and instruments for non-renewable energy sources

When combining taxes with EU-ETS there is consensus that the effects or additive and that sector should only be subject to one system (Sijm J 2003). “If the EU ETS results in higher electricity prices, it could be considered to reduce the taxes onelectricity consumption by small-scale end-users proportionally in order to avoid double taxation of these end-users. Energy users should pay for carbon emissions, whether through taxation or emissions trading. For each target group, only a single instrument should be used for carbon pricing. Therefore, sectors participating in the EU ETS should not be subject to national or EU carbon/energy taxation."

"Of the different Community market-based instruments existing in the field of energy, transport and environment, energy taxation is, perhaps, the most cross-cutting with impacts in all three areas and directly interacting with all other instruments" (European Parliament 2008).

The review of the Energy Taxation Directive would allow these aspects to be taken into account by clarifying the aspects covered by harmonised energy taxation. In practice, the explicit identification of an environmental element in the minimum levels of taxation (differentiating between greenhouse gas and non-greenhouse gas emissions) would enable energy taxation to complement other market-based instruments better at EU level.

The EU ETS currently applies to emissions from certain combustion and industrial installations, while energy taxation applies instead to fuel uses of energy , while leaving the most energy intensive sectors (currently covered by EU ETS) outside its scope in an important number of cases. The Commission considers that this rule could be explored further to see whether sectors covered by EU ETS could be excluded from the scope of the environmental element of the Energy Taxation Directive to the extent that their greenhouse gas impact is adequately addressed by EU ETS (in other words so that the relevant environmental elements of the minimum levels of taxation would not be applicable to them, while the energy based element would remain as well as other environmental elements). On the contrary, for situations when certain operators do not participate in emission trading due to small size or other considerations, the environmental counterpart of the minimum levels of taxation would ensure a more widespread application of the polluter pays principle. These rules could effectively apply both to the industrial sector and to aviation.

Excluding the environmental impacts addressed by EU ETS from the scope of the Energy Taxation Directive might be a viable solution that could also resolve the problem of potential overlap between the two instruments while ensuring that the remaining objectives of energy taxation are observed. Such a solution could also avoid difficulties stemming from the differing features of EU ETS (uniform price across the EU that however varies over time) and energy taxation (different prices reflecting the freedom of Member States to set tax rates above the minima as they see fit, that tend, however, to be rather stable over time). However, any move towards such a solution merits further in-depth analysis, especially if the EU ETS is significantly broadened in scope.

Whichever the solution, it needs to be seen in a global perspective. There is an increasing global recognition that environmental protection needs to be integrated into economic decisions in order to ensure long term sustainable development. This will lead to an extended application of MBI by national authorities and their use should be promoted at the global level. The EU should actively engage in dialogue with other countries, to promote the use of market-based instruments that allow policy objectives to be met in a cost-effective way.

But as long as this is not the case and the EU and third countries apply different levels of carbon taxation or other methods of reducing greenhouse gas emissions (such as the ETS), it is important to provide the necessary incentives to encourage the EU's trading partners to undertake effective measures to abate greenhouse gas emissions. The feasibility of all policy measures for this purpose should be analysed. This has already led to the beginning of a debate on the application of carbon equalisation mechanisms, such as border tax adjustments. At the same time, it is recognized that this approach is subject to legal and technical constraints, which need to be further examined."

4.3. Combining the EU-ETS and MS renewable energy objectives

Few literature is found on the modelling of the impact of a combination of policy measures. CASES WP9 final report gives a good overview of existing literature, but not many have quantitative results on the impact of overlap. A report is in preparation (Nijs W.; Van Regemorter D. 2008) in which the impact is calculated of the renewable objective of Belgium, given a climate policy, both in terms of cost and change in the energy system in 2020. In this study, the effect can be seen of a MS facing the EU-ETS and meanwhile having a national policy for green electricity and heat production and introducing biofuels. In the policy assessment it can be seen how the energy system reacts on the policy combination, taken into account the interaction between different technologies and also the interaction of the use of electricity with other energy vectors.

The objective of (Nijs W.; Van Regemorter D. 2008) is to examine the impact for Belgium of the EU-objectives for climate change and renewable energy for 2020. For climate change, a distinction is made between the ETS sectors with the emission trading system at EU level and the non ETS sectors with targets at country level. The EC proposes an EU target for the ETS with auctioning of the permits and a burden sharing between countries for the non ETS sectors to reach the overall 20% reduction target. The specific targets for Belgium are for the non ETS sectors a reduction of 15% CO2eq in 2020 compared to 2005 and a renewable target share of 13% in 2020. The cost of reaching this target and its implications for the energy system are evaluated with the Belgian MARKAL/TIMES model. It has benefited from the development of TIMES and the associated software VEDA within the EU research project NEEDS.

General assumptions of the study:

- Partial equilibrium model in TIMES
- Macroeconomic background for Belgium derived with GEM-E3
- Only CO_2 emissions
- Energy prices ~ POLES july 2007
- Discount rate 4%, time horizon 2050
- 12 time slices so fluctuating electricity demand is modelled correctly
- Reference = no policy measures except Kyoto target, nuclear phase-out

Some conclusions; the addition of a renewable energy and biofuel target above the climate policy:

- Does not impose an excessive cost for Belgium.
- Increases the total additional cost in 2020 with 46%; after 2020 the yearly additional costs are reduced as the climate target alone induces already a higher share of renewables.
- Increases the total additional cost over the entire horizon with 8%
- Accelerates the reduction of CO_2-emissions but after 2030 the difference is small with the situation with only EU-ETS.
- Induces different technology choices compared to CO2 target only (CCS vs wind and biomass)
- Marginal cost of renewable target decreases over time because of the assumed CO_2 policy, except for a stringent target of more than 17%.
- Although in two scenarios CO_2 emissions and system cost are the same, having an endogenous CO2 price lowers the marginal cost of a renewables target.
- 13% RE target is higher than the share of RE induced by the climate constraint only in 2020.
- Biofuels significant contribution in reducing non-ETS emissions; the cost efficient share of biofuels is larger than 10%
- Impact of CCS and Cogeneration is important
- A policy targeted only on RE alone is not enough for the climate target.

In (Sijm 2003) it is concluded that "the operational linkages and interactions between emissions trading and renewable energy policies in general, and between the markets for power, green certificates and emission allowances in particular, are quite intricate and sometimes complicated. Overall, however, there seem to be no major problems or conflicts between the operation of the EU ETS and the Dutch support policies for renewable electricity. On the contrary, the operation of the instruments seems to be mutually reinforcing in the sense that obtaining the operational target of one instrument enforces the achievement of the target of the other. The only problem might be the double or over-stimulation of existing producers of renewable energy."

5. Assessment of policy instruments

The goal of the analysis of policy instruments is to:

- construct a list of criteria and performances of the different policy instruments to those criteria as a basis for the Multi-Criteria Decision Analysis exercise described in this paragraph.
- determine stakeholders preferences for specific policy instruments to internalize external costs.

A case study has been chosen and policy instruments are validated by the stakeholders. This workshop of WP8-11 (23rd of April) is organized by VITO; WP8, 9 and 11 contributed with respect to the content of the workshop. Three MCDA exercises have been performed during the workshop, one for technology assessment and two with policy objectives:
MCDA 1: "How to define sustainable technologies ?"
MCDA 2: "How to increase the penetration of renewable electricity production ?"
MCDA 3: "How to produce low carbon electricity in a sustainable way ? "
Paragraph 5.3 describes the results of MCDA 3.

5.1. Why stakeholder participation is important

In a rational model of interaction between policy and science a fully quantified set of criteria would be fine, there would be perfect information or a limited and manageable uncertainty related to the overall costs, including the impacts on welfare that have been expressed in costs. In this situation a policy maker 'absorbs' the scientific information and includes values and political aspects before deciding on policy measures or options. In what is sometimes called a 'post-normative' society, this linear feed forward of information is no longer valid. Energy and climate problems are too complex and uncertain to fit in such a rational model, with disagreement between scientists and with outspoken opinions outside the scientific community influencing the political debate. Stakeholder involvement, and even better stakeholder participation early in the policy process is seen as a way to overcome part of these issues. Stakeholder participation does not solve the issues of complexity and uncertainty, but can create a common basis, a common understanding of the imperfect knowledge. It opens the policy debate and encourages transparency. A very straightforward approach is multi-criteria analysis. At least one goal of the workshop was to create a little bit more confidence and transparency.

The inclusion of 'soft' values, qualitative aspects of risk associated with certain technologies, certain energy scenarios or policy choices should be made possible. Therefore it is proposed to include non-monetised criteria in the 'techno-economical' assessment of electricity production in Europe.

5.2. 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.

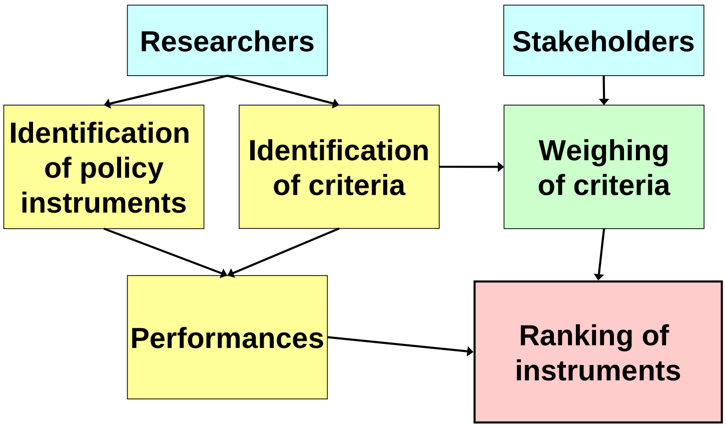

Figure 2 Procedure of policy assessment

In a first step a number of generic policy instruments were identified and selected for the analysis. 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 qualitative 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.

5.3. Case study: how to produce low carbon electricity in a sustainable way ?

The third exercise for the stakeholders was a case study: "How to produce low carbon electricity in a sustainable way ?". In this MCDA a number of policy measures have been evaluated on their ability to decrease greenhouse gas emissions from electricity production in a sustainable way. The selection of instruments is based on the ranking of criteria. The base case of the policy instruments always assumes renewable promotion at MS level and assumes that apart from greenhouse gas policy, there is an appropriate policy for the reduction of NOx, SOx and PM. All scenario's represent a situation in 2020 with policies implemented at EU-level or implemented in all Member States of the EU.

Null scenario (NULL):

A null scenario is defined as a scenario without extra specific CO2 policy on top of the policies agreed upon until 2007. It is assumed that no efficient emission trading system is used in 2020.

EU-emission trading (ETS)

EU-emission trading is assumed as it is proposed by the EC with full auctioning. Full auctioning implies that the sector has to buy all emission rights from an exchange market organised by Member State governments.

It is assumed that the emissions of the electricity sector have reduced with 20 % compared to 1990. In the base case, Clean Development Mechanisms are possible up to 1/3th of the reduction amount. The price of an emission right is determined by all aspects influencing the market in- and outside the electricity sector and in- and outside the EU. Auction rules and procedures are important drivers.

Carbon tax (C-tax)

The policy is a tax on the basis of the emitted CO2. All power plants are obliged to pay a tax in proportion to the emitted CO2. The level of the tax is 43 €/ton in the base case. This corresponds to the commitment of EU to reduce the CO2 emissions with 20%, in the assumption that it is not possible to make use of Clean Development Mechanisms (European Commission 2008).

Electricity tax(E-tax)

E-tax assumes a policy with a tax on the basis of the mix of electricity production technologies and a certain carbon value. Producers selling electricity (or consumers buying electricity) have to pay a tax up to the level of the average emitted CO2 of the power plants of the producer selling the electricity. In the base case, 43 €/ton CO2 is assumed for the calculation of the electricity tax. It is assumed that the electricity demand is not too elastic and that the tax burden comes down to the consumer.

Performance based Command and control (C&C)

Performance based command and control. The GHG emissions of all electricity plants are limited up to 80 % of the average CO2 level in 1990, with a correction for the growth of electricity consumption. As a result, the level is determined by the future electricity production and the target of CO2 emissions.

Voluntary agreement(VOL)

In a voluntary agreement, the electricity sector engages for a certain percentage of reduction in their CO2 emissions.

5.4. Base case

For most policy instruments, there is a base case which is characterized by certain design specifications. Additionally to the base case there are alternative design variants for the policy instrument. The alternatives differ from the base case only in one specification which is also indicated in their name. Everything else is identical to the base case. For the scenario's NULL, ETS, C-tax and E-tax, following assumptions apply:

Base Case:

- Non-CO2 externalities: it is assumed that apart from other policies, there is an appropriate policy for the reduction of NOx, SOx and PM.
- Renewable electricity: this policy path does include today's efforts for renewable electricity production. It is assumed that the promotion of renewable electricity is preformed at Member State level.
- Nuclear: there is no difference with current policies. Nuclear electricity is allowed and used for about 30 % of the electricity production in EU.
- CCS: Carbon capture and storage is possible in this scenario. Since this is the null scenario, no CCS will be chosen.
- Social tariffs: it is assumed that in the base case, no efficient social tariffs are used.

5.5. Variants

Generic variants

The differences to the base case are:

Non-CO2 externalities:	No policy for NOx, SOx and PM; it is assumed that there is no separate policy for the reduction of NOx, SOx and PM.
Renewable electricity:	No promotion of renewables: it is assumed that in contrast to the base case, no promotion of renewable electricity is performed at Member State level.

Nuclear	Nuclear electricity is prohibited.
CCS	Carbon capture and storage not allowed.
Social tariffs	It is assumed that an appropriate policy is pursued so more vulnerable groups in society face lower electricity prices.

Specific variants:

EU-ETS -30 % GHG reduction	This scenario only differs from the base case in the strength of the target.
EU-ETS -no CDM restriction	In contrast to the base case, there is no CDM restriction.
EU-ETS -Free Emission Rights Grandfathered	The electricity producers receive allowances for free. This term refers to the allocation based on emission levels in the past, typically determined as an average of recent years (reference or base period).
EU-ETS -Free Emission Rights Benchmark (Output based)	Free allocation can also be based on a technological standard or benchmark, expressed as unit CO2 per unit output (MWh of electricity production). The level is determined by the future electricity production and the target of CO2 emissions.
CO2 tax > 50 €/ton	This scenario only differs from the base case in the strength of the tax. It is assumed that the tax induces a reduction of 30% of the emissions.
Electricity Tax based on technology mix and a carbon price > 50 €/ton	This scenario only differs from the base case in the strength of the tax.

5.6. Criteria for the evaluation

Quantitative criteria (as a percentage)

Effective to decrease GHG (compared to 1990).
The extent to which the policy instrument achieves the stated objective of decreasing greenhouse gases by the electricity sector within a specified time period. The numbers correspond to estimated CO2-equivalent emissions, relative to the emissions of 1990.

Effective to decrease GHG in EU (compared to 1990)
The extent to which the policy instrument achieves the objective of decreasing EU-greenhouse gases within a specified time period. The numbers correspond to estimated CO2-equivalent emissions, relative to the emissions of 1990.

Private Cost (compared to base case, no extra CO2 policy)
Costs needed to decrease GHG emissions, e.g. the use of low carbon technologies, compliance costs and regulatory costs (relative to the cost in a scenario without extra specific CO2 policy).

Non-CO2 externalities (compared to worst case)
Achieving a decrease of greenhouse gases can alter the amount of other externalities. This criterion aims at grouping the non-CO2 externalities: the damage of local pollutants (NOx, SOx and PM), security of supply, food supply safety…Following effects can be under "Non-CO2 external costs":

- Damage of local pollutants NOx, SOx, PM,… to human health and ecosystems
- Accidents risk
- Effects on Employment
- Security of supply & depletion of non-renewable resources (oil, gas, silicon, copper, …)
- Research and development (sunk costs)
- Income distribution
- Local ecosystem damage (however addressed and at least partly compensated within the Environmental Impact Assessment)
- Visual Intrusion

Qualitative criteria

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.

Effective to make consumer price reflect full social cost
When a price includes both the private cost and all the external costs, it is said that all externalities have been internalised. Different consumer price mechanisms exist of which average cost pricing and marginal cost pricing are the most important. If the consumer price does not differentiate on the basis of environmental externalities, the score on this criterion is low. This is for example the case when an electricity tax is used because of the mechanism of averaging the external costs.

Effective to make production cost equal to full social cost
How effective is the instrument to make the cost of producing electricity equal to its full social cost ? Full internalisation can be reached more easily at the production side since tariffs are more diverse in time and in relation to the way of production. Those diverse costs will be passed to the consumer (mostly on an average basis). The assumption of full internalisation implicates in most cases a "dynamic efficient" policy. Nevertheless, the opposite is not always true, for example in the case where prices are not as high as the total social cost.

5.7. Scoring of the instruments

Scoring policy instruments is to give performances of the different policy instruments to the criteria. This gives a matrix with on the vertical axis the policy instruments and on the horizontal axis the criteria. In a perfect world, one would have quantitative model results and data for all the environmental effects of technologies chosen by this model, given a mix of different policies. The model that assesses the technologies should take into account both the interactions between technologies (importance of grid, base load versus peak load demand) and the interactions between other energy vectors (trade offs). Policy scenarios lead to a set of technologies with environmental effects. This is showed in the scheme with the green arrows.

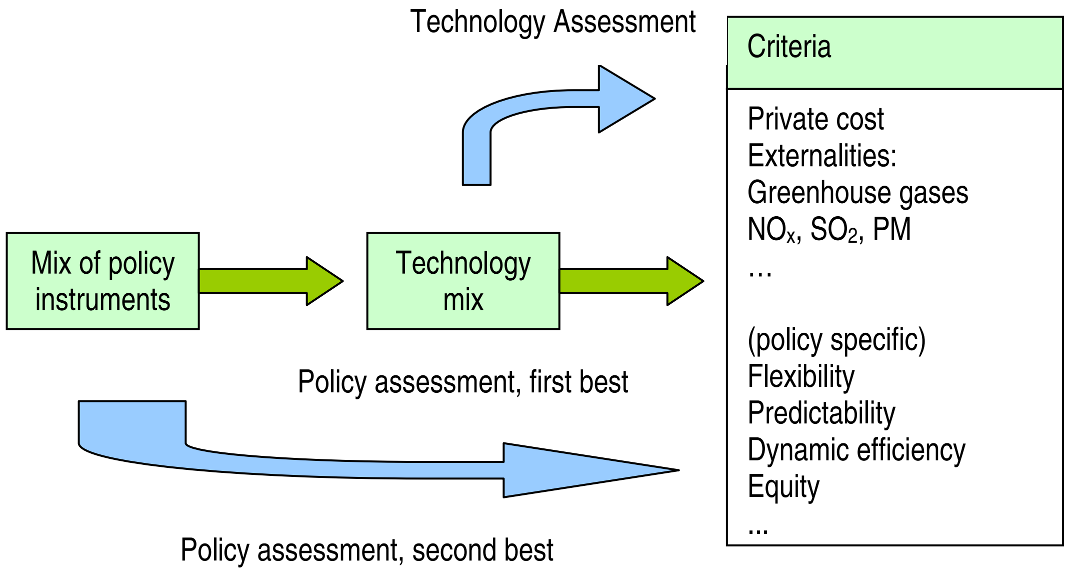

Figure 3: Scheme of assessing policy instruments (first and second best) and assessing technologies.

For the CASES workshop we did two Multi-criteria Decision Analysis that are different from the ideal approach. The technology assessment (blue arrow top), described in chapter 6, is not ideal because it is not a policy assessment. In addition, the scoring of the policy instruments (blue arrow down) was not ideal because there is not a link with a technology mix resulting from this mix of policy instruments. The reason is that not much model data and results were available for doing so.

Nevertheless, it is important for a multi-criteria analysis to have all performances of the different policy instruments. Table 1 show the performances of the policy instruments for the criteria described in chapter 5.6. Basis for this scoring was expert judgement and data from (European Commission 2008).

Table 1: Performances of policy instruments for the case study "how to produce low carbon electricity in a sustainable way ?"

Alternatives	Acr	GHG	GHG EU	PR COST	OTHER EXT	FLEX	PRED	DYN-EFF	EQU	CONS INT	PROD INT
No extra specific CO2 policy -Base Case	**NULL**	130	130	100	35	5	5	2	3	2	2
No extra specific CO2 policy -No policy for NOx, SOx or PM	**NULL noNEC**	130	130	95	100	5	5	1	3	2	2
No extra specific CO2 policy -No promotion of Renewables	**NULL noREN**	145	145	80	35	5	5	1	3	2	2
No extra specific CO2 policy -EU Green Certificate System	**NULL greenEU**	130	130	90	35	5	5	2	3	2	2
No extra specific CO2 policy -No Nuclear	**NULL noNUC**	170	170	130	35	5	5	2	3	2	2
No extra specific CO2 policy -No CCS	**NULL noCCS**	130	130	100	35	5	5	2	3	2	2
No extra specific CO2 policy -Social tariffs	**NULL soc**	130	130	100	35	4	5	2	4	2	2
EU-ETS -Base Case Full Auctioning and -20% GHG reduction	**ETS**	80	87	130	30	5	4	4	3	3	5
EU-ETS -30% GHG reduction	**ETS strong**	70	80	145	25	5	3	5	3	3	5
EU-ETS -no CDM restriction	**ETS CDM**	80	95	120	30	5	4	5	3	3	5
EU-ETS -Free Emission Rights Grandfathered	**ETS grand**	80	87	130	30	5	4	5	2	3	5
EU-ETS -Free Emission Rights Benchmark (Output based)	**ETS bench**	80	87	130	30	3	4	5	4	3	5
EU-ETS -No policy for NOx, SOx or PM	**ETS noNEC**	80	87	123	85	5	4	4	3	2	4
EU-ETS -No promotion of Renewables	**ETS noREN**	80	87	120	30	5	4	4	3	3	5
EU-ETS -EU Green Certificate System	**ETS greenEU**	80	87	115	30	5	5	5	3	3	5
EU-ETS -No Nuclear	**ETS noNUC**	80	87	150	30	5	4	5	3	3	5
EU-ETS -No CCS	**ETS noCCS**	80	87	160	30	5	4	5	3	3	5
EU-ETS -Social tariffs	**ETS soc**	80	87	130	30	4	4	5	4	3	5
CO2 tax -Base Case 43 €/ton	**C-TAX**	80	80	130	30	4	5	5	3	3	5
CO2 tax > 50 €/ton	**C-TAX high**	70	70	150	25	4	5	5	3	3	5
CO2 tax -No policy for NOx, SOx or PM	**C-TAX noNEC**	80	80	125	85	4	5	4	3	2	4
CO2 tax -No promotion of Renewables	**C-TAX noREN**	80	80	120	30	4	5	4	3	3	5
CO2 tax -EU Green Certificate System	**C-TAX greenEU**	80	80	115	30	4	5	5	3	3	5
CO2 tax -No Nuclear	**C-TAX noNUC**	80	80	150	30	4	5	5	3	3	5
CO2 tax -No CCS	**C-TAX noCCS**	80	80	160	30	4	5	5	3	3	5
CO2 tax -Social tariffs	**C-TAX soc**	80	80	130	30	3	5	5	4	3	5
Electricity Tax based on technology mix and a carbon price of 43 €/tor	**E-TAX L**	110	110	95	30	2	4	3	3	3	2
Electricity Tax based on technology mix and a carbon price > 50 €/ton	**E-TAX H**	90	90	95	30	2	4	3	3	3	2
Performance based command and control	**C&C**	80	80	130	30	2	5	2	3	3	2
Voluntary agreement to reduce GHG	**VOL**	80	80	130	30	1	5	3	3	3	2

5.8. Evaluation of workshop results

The average weights that the stakeholders have given to the different criteria is shown in Figure 4. The average weights derived by the two methods were remarkably close, especially for the middle-ranked criteria. It can be seen that the weights derived from RATIO method present a greater dispersion in comparison with the weights derived from the LEVEL method, leading to bigger deviations in the top- and bottom-ranked criteria. This is due to the relatively constrained framework of placing criteria in the LEVEL method.

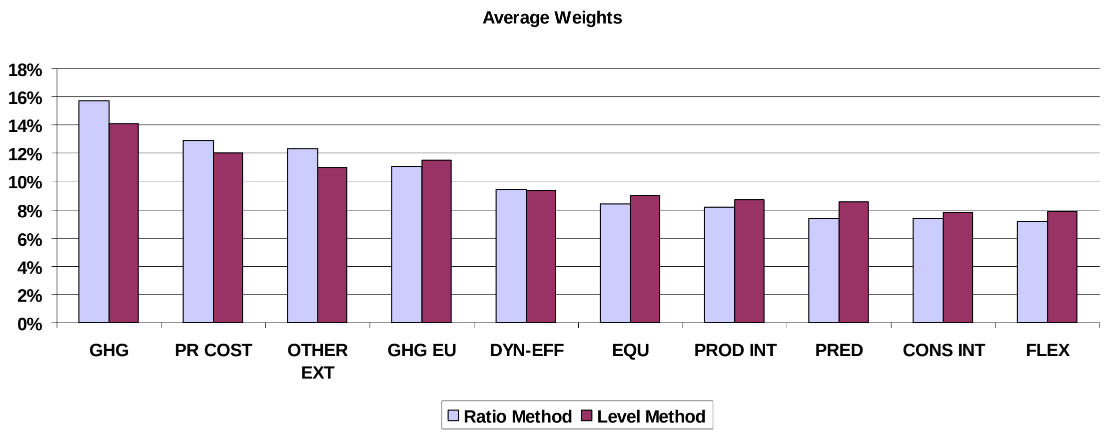

Figure 4: average weights for both the Ratio Method and the Level Method.

In the following table for each instrument the average ranking position across all stakeholders is shown. The average ranking 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 differences between average rankings of the policy instruments produced by the two weighting methods are also presented in Figure 5.

Alternatives	avg RATIO	avg LEVEL
ETS greenEU	2	2
C-TAX greenEU	3	3
C-TAX soc	3	3
C-TAX	6	6
C-TAX high	6	5
ETS soc	6	6
C-TAX noREN	7	7
ETS CDM	8	9
ETS bench	9	9
C-TAX noNUC	10	10
ETS noREN	10	11
C-TAX noCCS	13	12

ETS	13	13
ETS strong	14	15
ETS noNUC	14	14
ETS grand	15	16
ETS noCCS	17	16
E-TAX H	18	19
VOL	20	20
C-TAX noNEC	20	20
C&C	20	20
ETS noNEC	22	22
E-TAX L	22	23
NULL soc	24	23
NULL greenEU	24	24
NULL	26	25
NULL noCCS	26	25
NULL noREN	27	27
NULL noNEC	29	28
NULL noNUC	30	29

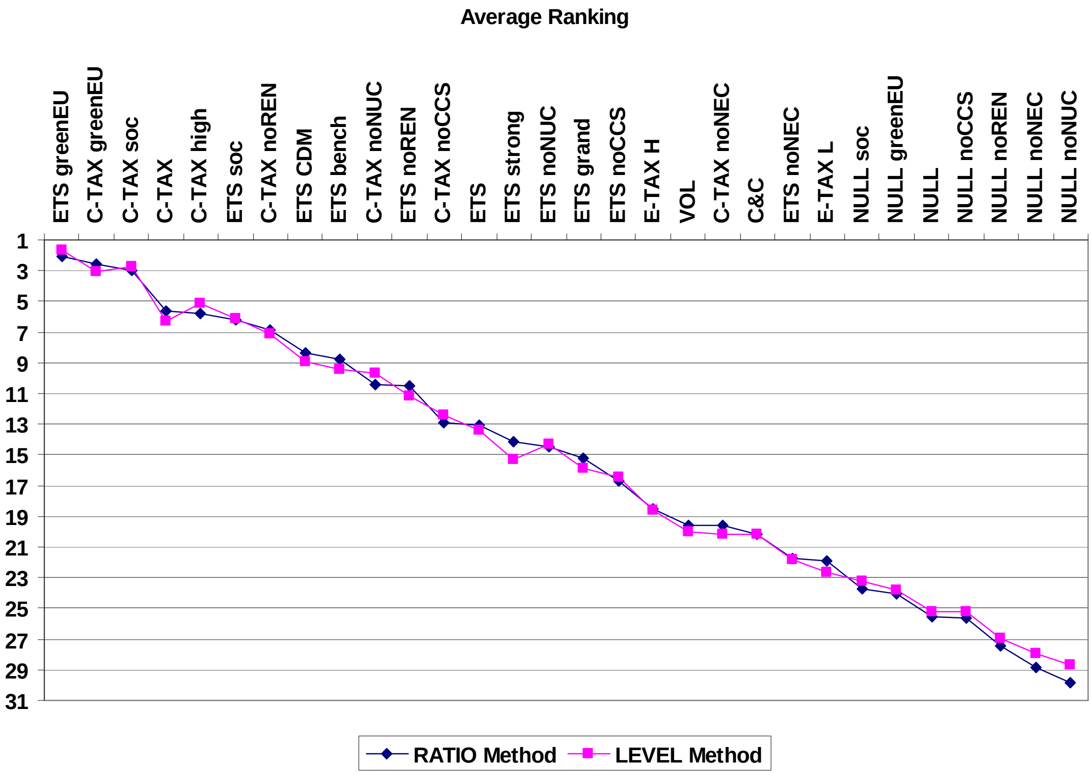

Figure 5: Average ranking of the policy instruments with the two methods.

It can be seen that the impact of the weighting method on the global score and consequently on the final ranking of policy instruments is low. This means that the observed deviations in the weights produced by the two weighting methods, were not large enough for differentiating the rank order of the examined alternatives. In other words, the ranking of policy instruments is not sensible to mean deviations of weights of 1-2%, since the produced global scores were almost identical. One can distinguish at least three groups of instruments, one group of best performing instruments (0.75-0.85), one medium group (0.5-0.65) and the bottom ranked instruments with a global score lower than 0.5. In the group of "best performing instruments", ETS

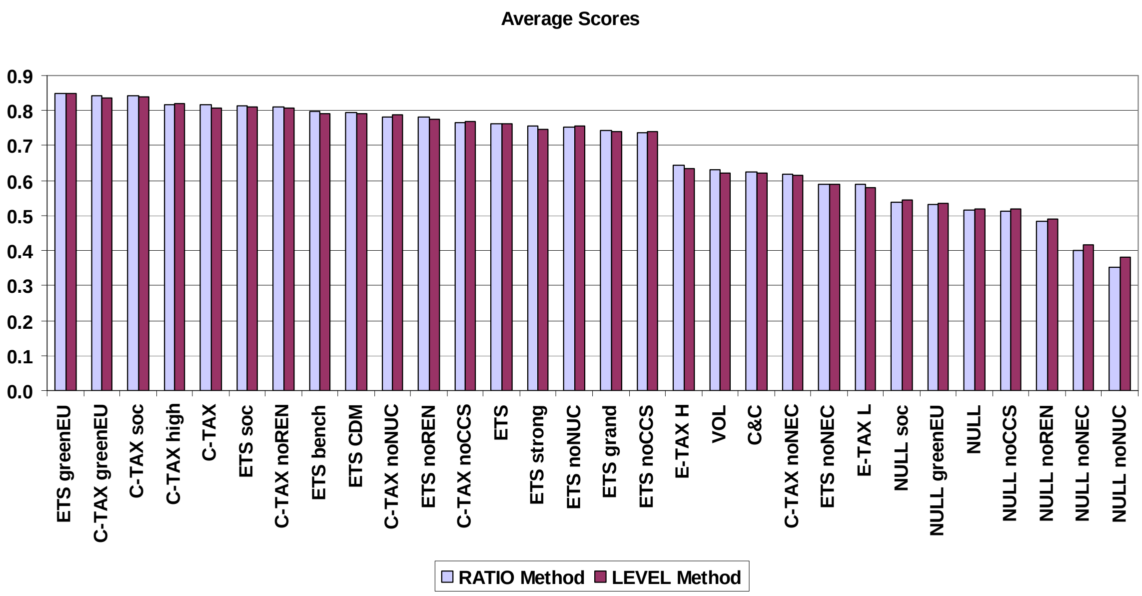

Figure 6: Average scores of the different policy instruments.

In the next figure it is shown for how many stakeholders an instrument appeared among the top 10 and the top 5 instruments. Individual results can differ significantly from the average even though the overall consensus is quite high.

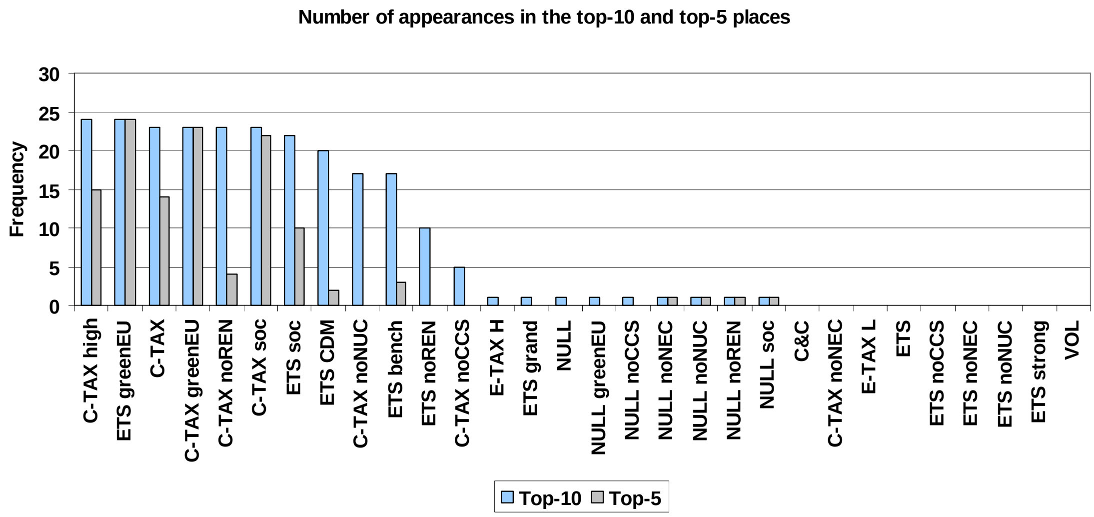

Figure 7: Number of appearances in the top-10 and top-5 places.

Design of the instruments

By looking to the ranking order of the policy instruments per group, one can see the preference on the variants compared to the base case. The example is given for the EU emission trading policies. The ranking of “grandfathered”, “noCCS” and “noNEC” are clearly not the favourites.

Alternatives	avg RATIO	avg LEVEL
ETS greenEU	2	2
ETS soc	6	6
ETS CDM	8	9
ETS bench	9	9
ETS noREN	10	11
ETS	13	13
ETS strong	14	15
ETS noNUC	14	14
ETS grand	15	16
ETS noCCS	17	16
ETS noNEC	22	22

Conclusions

The conclusions are very close to the conclusions of WP9. 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.

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.

6. Assessment of technologies

As already mentioned, in a perfect world, one would have quantitative model results and data for all the environmental effects of technologies chosen by the model, given a mix of different policies. Because this data was not available, VITO decided to do an extra MCDA exercise. The first MCDA exercise of the stakeholder workshop was focused on the assessment of electricity production technologies and is among other data, based on data of WP6. Results are described by NTUA in WP11.

7. Policy recommendations and conclusions

Following recommendations and conclusions can be made:

- Up to now, external costs are decreasing, but are not internalised.
- Few tax systems are coupled to environmental performances
- "Full internalisation" is more than "the consumer price is equal to the social cost"
- "Full internalisation" is more than "stimulating technologies with a lower total social cost" and certainly more than "stimulating technologies with a lower external cost".
- Relative prices matter, but green promotion is not enough for reducing emissions up to "optimal" level;
- Technologies with a low external cost are often not the ones with a low social cost
- Future European Emission Trading System is promising
- The interaction of tax systems with EU ETS is additive but for each target group, only a single instrument should be used.
- The interaction of promoting renewables with EU ETS is strong in the medium long term; after 2030, an assumed strict climate policy induces renewables by the high carbon price.
- There is lack of consensus about the acceptability and validity of damage cost values.
- A pan European model is needed to bridge the gap between policy instruments and the resulting technology combination with their social cost taking into account all interactions between technologies and taking into account the interaction with non-electricity energy vectors.
- The analysis of the results of the Multi-criteria Decision Analysis shows that the type of the weighting method can slightly influence the level and the dispersion of weights.
- Extra research is needed to bridge the gap between Extern-E methodology and the general concept of sustainability. Is the concept of social costs a good indicator for sustainability ?

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