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Belgian Implementation of the ExternE Project

Environmental External Costs of Fuel Cycles: A Policy Case Study on Electricity Taxation

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Table Of Contents

I Introduction

The ExternE project developed a methodology for the quantification of externalities from different power generation technologies. Under the Joule II program the methodology has been applied to a number of fuel cycles in 8 EU Member States and in Norway. A number of case studies are carried out in these countries, using the external cost data generated by the project. This paper presents the results of a policy case under the Belgian implementation of ExternE. The objective of this case study is to provide some insight into ExternE damage costs for the Belgian electricity sector in relation to the design of electricity taxes. Special reference is made to electricity taxes in proposals on the taxation of energy at the European level. Some thought is given on how to bridge the distance between damage cost research and political decision making in the area of energy taxation.

Developing this type of case studies is also part of a broader endeavour as worded in the chapter 40 of Agenda 21 ("Information for decision making"), which calls for, among other elements, the collection of multi-sectoral information and the use thereof in decision processes. According to Agenda 21 special attention in that respect is to be paid to the transformation of existing information into a form that is useful to decision making and policy planning.

Reliable data on external costs of electricity generation could be a useful input into the design of electricity taxes. ExternE data on external environmental costs of fuel cycles in the Belgian power generation sector are presently available under the Belgian ExternE implementation. Economic theory on external costs (environmental or other) states that these costs should be accounted for in market prices to ensure a proper allocation of resources and to achieve maximum social welfare. Taxation is a possible instrument to ensure that external costs of electricity production are internalised in electricity end-user prices.

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. Although a straightforward application of full cost pricing is impossible, some research is available on how to “correct” external damage costs to obtain second-best cost “adders” applicable in real-life situations. This means that the optimal (from the point of view of society as a whole) “adders” may well differ from the level of the damage costs. No attempt is made here to transform ExternE damage costs into optimal electricity tax levels, although research in the area would be interesting.

Although "optimal" tax rates may substantially differ from damage costs, by way of an illustration, a comparison is made between damage costs and proposed European electricity tax rates. Proposed European tax rates include the 1992 proposal on a CO_2 / energy tax and the more recent proposal on the restructuring of the Community framework for the taxation of energy products in the EC. Such an “at a glance” comparison may put the order of magnitude of the external damage costs in perspective. The 1997 proposal on the restructuring of the Community framework for the taxation of energy products extends the minimum rate system for mineral oils to other energy products, including to electricity. The proposal includes a consumption tax on electricity, with initially low rates. Though such a consumption tax does not allow differentiating tax rates in accordance with damage specific to the different input fuels in power generation, it may offer a number of possibilities to integrate ExternE damage cost data. The proposal leaves Member States the possibility to impose, in addition to the electricity tax, a (non-harmonised) tax on inputs in electricity generation. The level of such a non-harmonised input tax could be modulated according to the external damage costs of the different input fuels. The proposal also leaves Member states the possibility to refund the revenues of the consumption tax to producers using renewable sources. The modalities of such a subsidy could take environmental external costs into account.

II Environmental policy and external damage costs of electricity generation in Belgium

A. Environmental policy in the electricity sector

Belgium is committed to sustainable development since the Rio Agreements. No full consensus exists up to now as to the steps which should be taken to implement the Agenda 21, but the careful use of scarce energy resources and the reduction of harmful emissions by the electricity sector are no doubt among the major concerns. The electricity sector in Belgium was responsible for 27% of Belgian SO_2 emissions, 15% of NO_x emissions[1] (in 1993), and some 19% of CO_2 emissions[2] (in 1994).

In October 1991, central electricity producers agreed with the government on a SO_2 and NO_x emission reduction scheme for the period 1993-2003, based on 1980 emissions. Based on the 1988 EC Large Combustion Plant Directive, the agreement applies the "bubble" concept whereby a reduction is imposed on the total emissions of the sector. For SO_2, a reduction of emissions with 75% by 1998 compared to their 1980 level was agreed (with a target value of -77,5%) and a reduction of 80% by 2003 (with a target value of -85%).

For NO_x, a reduction of 40% by 1998 compared to emissions in 1980 was agreed as well as stabilisation of the emissions at that level until 2003 (with a target value for 2003 of -45%). The agreement also includes supply of power plants without flue gas de-sulphurisation with low sulphur fuels (maximum 1%) and the introduction of measures to reduce the NO_x emissions in existing plants. The sector has already largely met the agreed SO_2 and NO_x reduction objectives[3]. SO_2 emissions decreased with 80% from their level of 352.000 tons in 1980 to 68.781 tons in 1996. NO_x emissions in 1980 were at 87.010 tons and decreased with 42% to 50.623 tons in 1996. Dust emissions decreased with 75% from their level of 23.730 tons in 1980 to 5.884 tons in 1996.

1. Figures taken from the Belgian Communication under the Long Range Transboundary Air Pollution (LRT AP) Convention, 1995. The electricity sector includes power generation, combined heat and power (CHP) installations and urban public heat systems.
2. First Belgian National Communication on Greenhouse Gases, January 1997, Chapter 2: Inventory of emissions.
3. Electrabel, SPE, 1997.

Regarding global warming, the Belgian government, during its Council of ministers of 6 June 1991, has committed itself to reduce Belgian CO_2 emissions with 5% from their 1990 level by the year 2000. In 1996, Belgian power plants emitted 22.555 Kt CO_2. Emissions were down with 29% from their 1980 level of 31.604 Kt and have been relatively stable since 1990. Increasing electricity demand drives development of the emissions. Electricity demand grows faster than the demand for alternative energy products. The sector's national investment plan for 1995-2005[1] foresees future emission growth will have to be limited by a planned increase in combined heat and power generation (CHP), the introduction of new STAG plants and by actions to reduce demand. Nuclear electricity can only play a limited role in the reduction of CO_2 emissions. The increase of nuclear capacity is restricted to small production increases of existing units and the recent introduction of the Chooz B nuclear plant.

With respect to demand control, the 1995-2005 investment programme puts forward demand-side management (DSM) measures that should top off 8 TWh (or 8%) of total electricity demand as projected by the BVEO / CGEE[2], the Board of electricity producers, in 2005[3]. Demand is projected to grow from some 74 TWh in 1995, with 2,7% annually, to some 88,5 TWh in 2005. During 1996, 200 Mio BF (around 5,2 Mio ECU) was spent on a programme for rational energy use in production. This annual amount will increase to 450 Mio BF (or 11,5 Mio ECU) by 2005. During 1996, financial means that became available through tariff reform measures in distribution were reserved for rational energy use measures in distribution.

1. Beheerscomité van de Elektriciteitsondernemingen / Comité de Gestion des Entreprises de l'Electricité (BCEO / CGEE), Nationaal uitrustingsprogramma inzake de middelen voor productie en transport van elektriciteit 1995-2005. Samenvatting en toelichting (National equipment plan on production and transport of electricity), 17 November 1995.
2. BCEO / CGEE: Beheerscomité van de Elektriciteitsondernemingen / Comité de Gestion des Entreprises de l'Electricité.
3. With respect to end use savings, several studies have in recent years estimated the existing potential for electricity savings. These studies show the under-exploitation of an important potential for economically efficient energy savings, primarily in the use of electricity. A technical-economic study by Econotec ("Contribution du Modèle EPM à l'estimation des mesures fiscales et non-fiscales prévues dans le Programme Belge de Réduction des Emissions de CO_2", Econotec, September 1996) estimated the existing **economic** electric energy saving potential (at prevailing 1995 energy prices) at 1.899 MWh in 2000 rising to 4.119 MWh in 2005 (2,6% and 5,7% respectively of 1996 net electricity production in Belgium). A study by STEM ("CO_2-Emissie Vermindering door Elektriciteitsbesparing", STEM, November 1995) estimated the **economic** saving potential at 13% to 19% of consumption in 2000 and at 21% to 31% in 2005. A 1994 study by CES ("Energie en Milieu in het federaal België", CES, KU-Leuven, March 1994) considers a saving potential of 3,5% of total final consumption in **2000** (under a policy scenario including a CO_2 / energy tax) and of 14,1% (under a scenario including a CO_2 / energy tax and an extensive package of additional measures designed to reach Belgium's CO_2 emission reduction commitment for 2000).

B. External environmental damage costs

The Belgian ExternE project has measured external costs for a number of reference plants, based on 1995 emissions (table 1). Damage costs used in this chapter refer to the data using a 3% discount rate for fossil fuels, and a 0% discount rate and a time horizon of 10.000 years for damages from the nuclear cycle. The damage costs measure residual damage, i.e. damage remaining after the application of current environmental policy. Some of the environmental effects have not been quantified, although they may be high, such as thermal discharge of the coal plant.

Total annual damage resulting from the Belgian power production in 1995, based on a relatively low damage estimate for global warming (18 ECU / tonne of CO_2), amounts to 2256 Mio ECU. Total damage represents some 1,2% of 1995 GDP.

TABLE 1 - Summary of Belgian "ExternE best estimate" damage costs of electricity fuel cycles, 1995
(3% discount rate, 0% discount rate and 10.000 year horizon for nuclear)

(mECU/kWh)	Coal non-retrofit	coal retrofit	natural gas	nuclear (open cycle)	Nuclear (closed cycle)
Front End					
	0,72	0,72	0,07	3,62	3,54
Production					
SO_2	51,84	5,16	0,01		
NO_x	42,51	9,31	2,74		
TSP	2,30	2,44	0,00		
Ozone	4,20	0,86	0,26		
Other	3,56	0,33	0,08		
Public health				0,37	0,37
Occupational health, noise	0,27	0,27	0,04	0,04	0,04
Major accidents				0,00	0,00
Global warming					
Low (18 ecu/ton CO_2)	17,30	17,90	7,40	0,09	0,08
High (46 ecu/ton CO_2)	44,30	45,80	18,80	0,23	0,20
total					
Low global warming	122,70	37,00	10,60	4,12	4,03
High global warming	149,70	64,80	22,00	4,26	4,15

Source: VITO.

III Full cost pricing

Full cost pricing refers to the pricing of commercial goods - such as electric power - that would include into the final prices faced by the end-user not only the private costs of inputs, but also the costs of the externalities created by their production[1]. Full cost pricing refers to the reflection into final prices of all externalities, environmental or other. In this text, we will use full cost pricing to refer to external environmental costs from the electricity sector.

Competitive markets maximise economic welfare if all costs of production are accounted for in prices. When prices do not include all costs of production, e.g. when some environmental impacts are not accounted for, this leads to inefficiencies. This is so because in the absence of additional measures, private actors do not take these costs into account. The objective of full cost pricing then is to reduce the emissions of CO_2, SO_2, NO_x and PM to the extent that effects on morbidity, mortality and production are fully included in the final price through appropriate instruments. There are theoretical reasons to suggest welfare benefits from the imposition of full cost pricing. The internalisation of external costs increases total welfare by reducing negative impacts on health, materials, and the environment. If the full costs are calculated correctly, the losses in producer and consumer surplus and environmental rents are more than offset by the increases in quality of life and the reductions in health and maintenance costs.

What are the appropriate instruments to internalise the damage costs? The case of a Pigouvian tax is that a tax equal to the marginal damage caused by an external activity would result in a situation where the marginal damages are equated to the marginal costs of abatement. In this way, fully optimised use of resources is achieved, by undoing the misallocation of resources caused by the existence of the external effects. Possible instruments to internalise external environmental costs are emission taxes, full cost adders[2], or the trading of emission permits. The height of the tax, the fee, the adder or the price of the permit reflects the external costs. When added to the private cost of production "full cost pricing" would be achieved. The reflection of full costs should have an effect on the choice of fuels and on the production technology used, and on electricity demand.

The theoretical benefit of full cost pricing has been illustrated by a number of empirical studies. Jan Keppler and Tom Kram[3] discuss two case studies, for the

1. Jan Keppler and Tom Kram, July 1996.
2. Adders act as a surcharge to internalise external costs in the planning of additional investment in the electricity sector, or in dispatch decisions of electric utility systems. The adder represents an amount per unit of emission, that is added hypothetically to the private costs when considering capacity planning (“investment planning adder”) or when planning operation of the plants (“dispatch adder”). Although the adders are not actually charged, they can significantly influence investment or dispatch decisions.

Netherlands and Italy, where the application of full cost adders for the pollutants SO_2, NO_x and particulate matter would result in substantial reductions of these emissions. The damage costs used were taken from the ExternE project. The results were measured against a hypothetical base case in which existing emission control policies were discontinued. The full cost adders did not include damage for CO_2, but the authors also discuss the impact of full cost pricing for the regional pollutants on CO_2. The link between full cost adders and the greenhouse effect is thus indirect in their study. The effect on CO_2 emissions can vary depending on the time frame and the energy system in question, and the resulting CO_2 emission reductions in the two cases considered can range from less than 1% to 10%. A study on the Belgian electricity sector is that of S. Proost and J. Van Rompuy[1]. They show that the welfare advantages to be expected from an emission charge or tradable permit system are potentially high (see further, point 1.1.3).

The availability of environmental damage costs such as in the ExternE project would allow for an "economic textbook" application of a Pigouvian tax. However, in practice there are a number of limitations to the application of full cost pricing.

A first problem has to with the existence of clearly established dose-impact relationships and the possibility to satisfactorily express the impact on welfare in monetary values (the existence of clear preferences). A case in point is the damage related to nuclear accidents, that have a low probability to occur but with a real risk to result in high damages when they occur. Such "high damage – low probability" events make it difficult to express clear preferences. Another example is the global warming problem. The structure of the problem, the relationships between causes and effects are complex and therefore it is difficult to express clear preferences with respect to it. In consequence, a Pigouvian approach seems to be difficult to apply concerning environmental externalities of nuclear power generation and global warming. The framework can more safely be applied where externalities are best quantitatively established, i.e. for a number of regional pollutants such as SO_2, $NO_{x,}$ and particulate matter.

Secondly, the economic theory that provides the basis for full cost pricing assumes a competitive market. A competitive electricity market implies that electricity demand is steered by efficient pricing, meaning marginal cost pricing. The ideal tariff should vary with time, place, and reliability of supply. In reality, however, tariff mechanisms have not been fine-tuned to reflect marginal production costs. If the electricity market is not competitive but characterised by monopolistic behaviour, prices may be higher than would have been the case in a competitive market. Full cost pricing could imply further electricity price increases, thereby worsening the existing distortions and increasing economic costs. The possibility of welfare losses linked to full cost pricing in the presence of pre-existing distortions is not imaginary. In Belgium, as in other parts of Europe, the electricity industry is heavily regulated and the benefits of full cost pricing must be balanced against the possible exacerbation of existing distortions.

A third reason why the application of full cost pricing is not straightforward in practice is that it can have perverse effects when it does not apply across all fuels.

3. Jan Keppler and Tom Kram, July 1996.
1. S. Proost and J. Van Rompuy, 1996.

When price of electricity increases compared to the prices of close substitute energy products, unwanted substitution of primary fuels for purchased electricity may occur, resulting in welfare reduction (this is the so-called "piecemeal problem"). To some extent, this is one of the issues that the European Commission tries to address in its recent proposal on the restructuring of the Community framework for the taxation of energy products. The proposed restructuring extends the existing excise tax systems for mineral oils to the entire range of energy products, including electricity. The objective of this proposal is not only to diminish distortions between countries but also between different types of fuels.

A more practical problem linked to full cost pricing is that the imposition of the full costs in one country could make its electricity more expensive in comparison to another. This could lead to increased imports (of possibly higher emitting electricity production from countries that do not impose full costs). If the imposed taxes are high it could also cause competitiveness problems for the country's industry. The problem is certainly true for a small country like Belgium, where short distances to foreign electricity producers do not impose unacceptable losses in transmission. Referring again to the Commission proposal on the taxation of energy products, the imposition of minimum tax rates throughout the EU would to some extent address the problem of distortions of competition stemming from the application of different tax structures and rates throughout the Community. To the extent however that the tax rates in the Commission proposal do not imply the application of full costs, and if Member States want to impose higher taxes than the minimum, as the proposal would allow them to, they may find that their room of manoeuvre remains rather limited.

The level of uncertainty linked to damage cost estimates, the existence of other distortions and other more practical problems, mean that the problem is not as simple as to merely impose a Pigouvian tax in accordance with the size of the damage costs. It is therefore not surprising that full cost pricing in the sense discussed here has rarely been applied in practice.

One possible way forward would be to extend the theory so that it can better deal with real world situations. Burtraw e.a.[1] have provided a normative model for appropriate consideration of external damage costs in the resource planning and dispatch decisions of public utilities. The efficient policy, in the context of pre-existing emission regulation, considers the role of deviations from marginal cost pricing in electricity pricing and the possibility of customer bypass of the utility grid. They conclude that the second-best optimal adder for a power generation technology will depart from the marginal damage related to it due to the economic inefficiency associated with second-best rate of return economic regulation and due to the opportunity to bypass the electricity grid.

Alternatively, one could leave the theoretical framework of welfare maximisation behind and settle for a less ambitious frame of thought. In this approach, one would rather concentrate on the achievement of certain environmental objectives, which are determined politically, with minimum cost. In principle economic instruments should result in lower economic costs than command and control instruments. In reality, emission reductions have mostly been achieved through regulation, whereby abatement levels were set at politically determined levels.

1. Dallas Burtraw, Winston Harrington, Alan J. Krupnick and A. Myrick Freeman III, 1995.

These instruments have often significantly reduced emissions, but they do not necessarily have the welfare effect of full cost pricing. So far, when economic instruments were introduced, they have not been designed in order to internalise damage costs. Tax and charge levels were set with specific emission reduction or revenue collection objectives in mind.

Even if full cost pricing may be a too ambitious objective, a Pigouvian tax can help in increasing welfare and combat some of the higher damages[1]. In addition, it has been argued to insert the paradigm of static optimisation into a larger framework that calls for the management of change of structural parameters in a dynamic perspective[2]. The parameters involved include technological parameters, the degree of competition, the form of regulation, and preferences to the extent that they are amenable to policy action. Under the dynamic approach, the optimal policy instrument depends on the situation at hand.

If the possibilities for the application of full cost pricing should be considered in a dynamic context, then one important issue is the gradual liberalisation of electricity markets in the European Community. In this paper, the effect of the move towards “re-regulated” electricity markets is not considered in detail, but it is clearly of importance in its effects on environmental issues in the electricity sector and also in its effect on the possibilities for the application of certain types of environmental policy instruments. With respect to the first element, the direct effect of market liberalisation on the environmental impact of electricity production, the belief is widely held that it may result in a more widespread use of smaller, less capital-intensive generation units, meaning natural gas fuelled units. A more widespread use of natural gas as input fuel would generally mean a decrease in the harmful emissions of electricity production. With respect to the changed room of manoeuvre for governments to apply certain types of instruments in a liberalised setting, it appears that the applicability of taxation instruments is not endangered, but rather reinforced. A general argument in this respect is that a taxation type of instrument fits in well in a liberalised market, where governments could prefer a more “at arm-length” policy approach towards the electricity sector, refraining from other measures which would require more intimate control over the sector. It can also be noted that liberalisation in time could lead to much more competitive electricity markets. This may render the assumption behind full cost pricing on the existence of competitive markets somewhat less heroic and render the application of the theory somewhat less problematic.

1. Nick Eyre, 1996.
2. J. Keppler, 1996; Nick Eyre, 1996.

IV ExternE data on external costs and economic instruments for full cost pricing

External damage cost estimates could be used to set charge rates for emissions. Emissions of important pollutants (SO_2, NO_x, particulate matter, and CO_2) would be charged per ton of pollutant. A major advantage of setting charge rates in this way is certainly the high environmental efficiency that can be expected. Compared to other possible economic instruments, there is a direct link between the damage and the charge rate, and the tax weighs more heavily on the more polluting technologies and fuels. Producers, when trying to minimise costs, receive a strong signal to adjust technological and fuel choices towards more environmentally friendly alternatives.

The welfare advantages to be expected from such a charge are potentially high. Using a dynamic partial equilibrium model of the Belgian electricity market, S. Proost and J. Van Rompuy[1] compare the imposition of a generalised emission tax (levied on central and de-central producers) to the present situation where existent emission regulation is maintained. They conclude that when emission taxes equal to the marginal environmental damages, as obtained earlier in the EC ExternE project, are imposed, important welfare gains can be achieved. Present regulation essentially includes the 1988 Large Combustion Plant Directive, supplemented with a sector agreement between the central electricity producers and the authorities, that limits total emissions of SO_2 and NO_x for the period 1993 to 2003. There are no regulated limits on CO_2 emissions.

Investment or dispatch adders can also be expected to raise welfare. Investment or planning adders act as a surcharge to internalise a cost per unit of emission. When added hypothetically to the private costs during the planning process, adders serve as shadow prices that result in the selection of new resources that better minimise total social costs. Similarly, dispatch adders would act as a potential tax to internalise a cost per unit emission into decisions about the operation of individual power plants. Up to now no utility has used dispatch adders but studies have shown that such adders would result in substantial and immediate benefits.

Investment adders, on the contrary, have been used by several public utilities in different states in the US. A problem with their application is that in the short and medium run they may have a perverse outcome. Although inclusion of the adders in investment decisions results in the addition of clean capacity to existing

1. S. Proost and J. Van Rompuy, 1996.

capacity, emissions increase because the newer plants tends not to be called into operation because of their higher production costs. To be effective, such adders should in the short and medium run be complemented with some other emission limiting mechanism, e.g. dispatch adders.

ExternE damage costs, expressed per tonne of pollutant, could be used as emission charge rates. Figure 1 gives emission charge rates using ExternE damage cost estimates for the coal, natural gas, and nuclear fuel cycles. In comparison, corresponding rates that would have resulted from the application of a CO_2/energy tax, as proposed in 1992 by the European Commission, are pictured. The rates of the tax were not set in accordance to external damage cost estimates, but they provide some base of reference to appreciate the level of emission charges that would result from Belgian ExternE damage cost estimates. The CO_2/energy tax is set at 3$/barrel during the first year of implementation, and gradually increases to 10$/barrel. After that, the tax rate remains constant in real terms. 50% of the tax was to be based on the energy content of the fuels and the other 50% on the their energy content. For electricity, the carbon part of the tax is levied on the inputs in electricity generation, while an energy tax rate of 2,1 ECU/MWh is defined, increasing to 7 ECU/MWh in the last year of introduction of the tax. The latter part, the energy tax, is the only tax that is levied on electricity produced from non-fossil sources. The objective of the CO_2/energy tax was to provide an incentive to reduce CO_2 emissions (carbon part of the tax) and to increase energy efficiency (energy part).

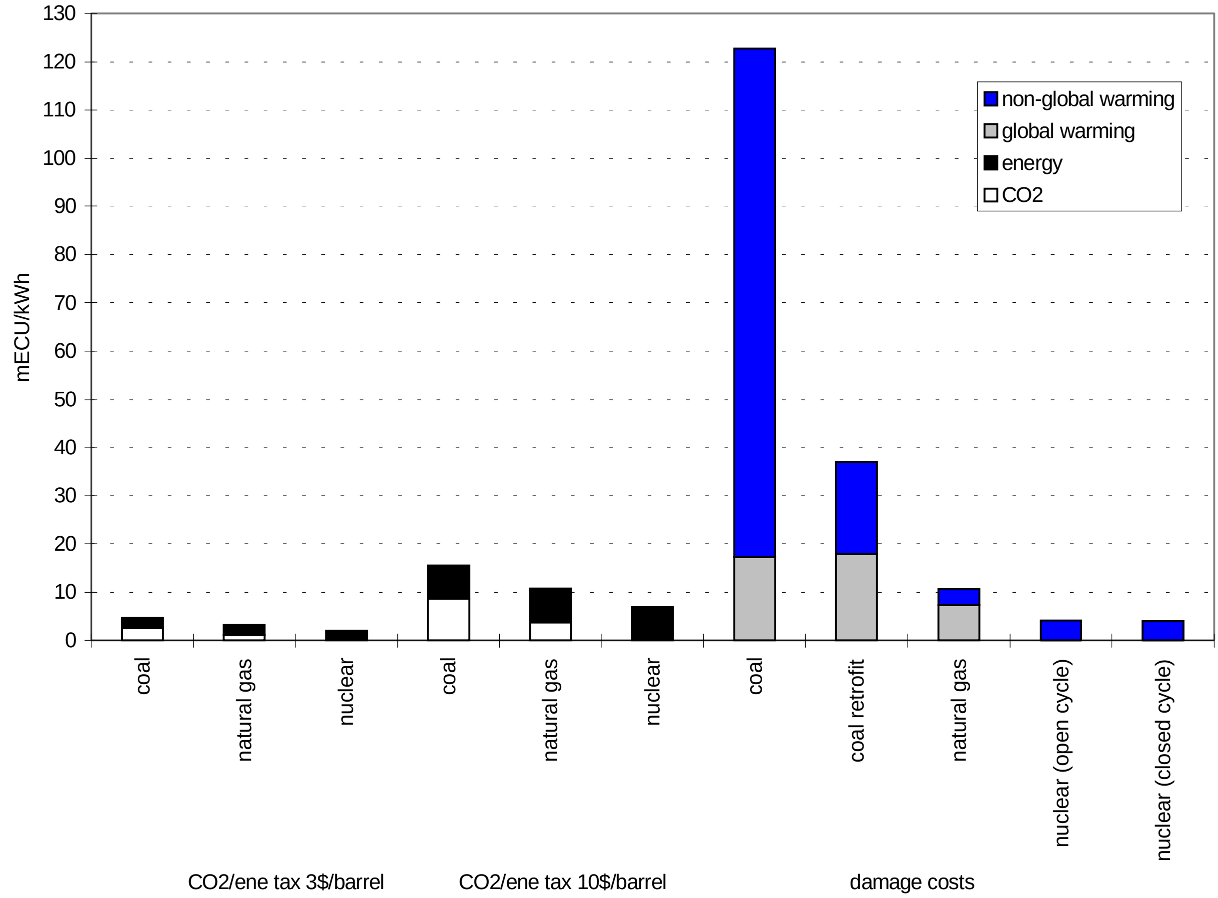
The 1992 CO_2/energy tax rates would not have attained the level of the marginal external damage costs. This does not necessarily mean that the proposed rates were too low, or non-optimal. As reasoned above, “mapping” damage costs straight into tax levels is not necessarily the best solution from a welfare point of view. It can also be noted from figure 1 that, for fossil fuel based generation (coal and natural gas), the carbon part of the CO_2/energy tax is somewhat lower than ExternE global warming damage for Belgian coal and gas plants. The CO_2/energy tax for nuclear electricity, on the contrary, would have been higher than Belgian ExternE damage costs for the nuclear fuel cycle. One of the reasons for the inclusion of an energy part in the CO_2/energy tax, which is the only tax on electricity from nuclear sources, was to reduce the risk of increasing distortions on the European electricity market. Without the energy part of the tax, the tax burden imposed on countries with strongly diverging power generation structures, e.g. due to different shares of nuclear power in total electricity production capacity, would have been very unequal.

Emission charges in line with damage costs would result in the highest charge for coal plants (retrofitted or not) and the lowest for nuclear plants. Although the CO_2/energy tax was not designed to explicitly take the emission of specific pollutants into account, except for CO_2, it would also have resulted in a certain differentiation of its impact per type of fuel, similar to an emission charge. The reason of course is that the CO_2/energy tax was to be based partly on the carbon content of the input fuels. However, the differentiation of the tax burden over different fuels would be less outspoken than in the case of an emission charge, even in a case of an emission charge in a situation where all coal based plants are retrofitted (see figure 1).

One problem with the application of an emission charge lies in the regional scale of the acidification problem and the international scale of global warming. The majority of the damages provoked by Belgian electricity producers occur outside of the boundaries. In these circumstances, without international agreement or co-ordination of a tax or charge system, national authorities have no incentive to set charge rates at levels corresponding to damage costs. On the contrary, if Belgium unilaterally decides to implement emission charges, an effective charge may hurt its own industry. This is even more the case with the advent of the internal market for electricity where large industrial consumers can shop around for power. Moreover, although in principle such a charge is not in contradiction with the internal market, border tax adjustments may in practice render the application of a national instrument difficult[1]. The transboundary nature of the environmental problem and the rather limited room for manoeuvre of individual Member States to develop strong environmental policy initiatives within the internal market seem to call for an internationally co-ordinated or common instrument.

1. The imposition of the charge (or a replacing levy) on imported electricity and the de-taxation of exported electricity within the internal market in principle do not pose a problem. Duties with similar effect as customs duties on imports or exports are allowed if they are part of a general tax system, which should then be applied without discrimination on the basis of the origin of the products and according to objective criteria. Products from another country should not bear a heavier tax burden than domestic products. Levying an emission charge on imported electricity requires that emissions from the production of imported electricity are known, which may be problematic. A replacing levy could be imposed, e.g. based on average emission rates for the exporting country, but such a levy could be contrary to WTO rules.

FIGURE 1 - ExternE marginal damage costs *(3% discount rate, except 0% for nuclear, 10.000 year horizon for nuclear, global warming: 18 ECU/tonne CO_2)* **and a CO_2/energy tax.**



Source: Federal Planning Office, using ExternE data from VITO.

With respect to regional air pollutants, a European approach for a co-ordinated or common economic instrument such as emission charges are not on the table for the moment. In the proposal on a EU strategy to combat acidification of March 1997, the European Commission encourages Member States to use economic instruments to meet proposed national emission ceilings in a cost-effective way, without making concrete proposals for the co-ordination of an economic instrument at the European level. The emphasis of the adopted strategy is on further regulation. Main elements of the strategy include the establishment of national emission ceilings for each acid rain pollutant, the ratification of the UN protocol on further reductions of sulphur emissions, the proposal for a directive limiting the sulphur content of heavy fuel oils, and a review of the Large Combustion Plant Directive (Dir. 88 / 609 / EC).

With respect to the formulation of an answer to the global greenhouse challenge, and the reduction of CO_2 emissions and other greenhouse gases, industrialised "Annex 1" countries are expected to set new emission reduction targets for the period after 2000 at the Kyoto Conference in December 1997. The discussion within the EU on how to meet possible new objectives and on (internationally co-ordinated) policy instruments to achieve them will take place during 1998. Meanwhile, many industrialised countries, including Belgium, are unlikely to reach CO_2 emission reduction targets set for the year 2000.

The only European proposal for an economic instrument in the energy domain is the 1997 proposal for the restructuring of the Community framework for the taxation of energy products. This is discussed in the next point.

V The European Commission's proposal on the restructuring of the Community framework for the taxation of energy products in the EC

The European Commission recently adopted a proposal for a Directive that widens the scope of the Community minimum rate system, presently limited to mineral oils, to all energy products. This proposal presents a consistent framework of taxation for the energy sector, while allowing Member States the flexibility to charge more than the minimum tax rates. The proposal is intended to reduce the existing distortions of competition in the internal market for energy. In addition, the proposal gives the Member States the flexibility to differentiate the rates of taxation on the basis of environmental criteria, while complying with the minimum rates.

The proposal for a Directive includes within its scope all energy products: apart from the mineral oils already covered by the existing European system on minimum excise duty rates, these are chiefly coal, natural gas and electricity. As regards electricity, the proposal provides for the taxation of output at the final consumption stage. Member states are also authorised to refund to the producer the tax paid by the consumer where they wish to encourage the use of renewable energy sources.

The proposed rates are intended to lead to a closer approximation of national rates in three two-year stages. A low level is set for newly taxed products, such as electricity, which will bear rates of 1 mECU/KWh (as from 1-1-1998), 2 mECU/KWh (as from 1-1-2000) and 3 mECU/KWh (as from 1-1-2002). The minimum level of taxation for the last stage, as from 2002, are put forward as target rates and will need to be confirmed as binding in a subsequent proposal from the Commission.

Energy products used as inputs in electricity production are exempted from the imposition of minimum rates. The proposal leaves open the possibility for Member States to tax these products, in order to achieve environmental objectives. If Member States decide to implement such (non-harmonised) input taxes on energy products used in electricity production, then these taxes do not count in order to attain the defined minimum rates for electricity.

Although the main objective of this proposal is to take a step forward in the harmonisation of energy tax rates and the realisation of the internal energy market, the proposed tax structure clearly has a number of environmental objectives as well. While specific tax rates are defined for each product and type of use, rates overall are defined in relation to the energy content of products[1]. This can be considered as a development from the 1992 proposal on a CO_2/energy tax, which contained a carbon component besides an energy component. In contrast to the CO_2/energy tax proposal, the recent 1997 proposal does not have a carbon component, but it leaves room for Member States to adopt higher rates than the minima, in order to come closer to a fiscal structure accommodating environmental impacts.

The proposed electricity tax is an output tax, levied on the amount of electricity used. Compared to an emission charge (or to an input tax as a proxy for an emission charge), an output tax has a less direct relation to the pollution generated and its effectiveness is considered to be lower compared to that of an emission charge. The output tax is imposed after technological and fuel choices have already been made and so does not affect them. The output tax on electricity can have an impact on pollution levels through a reduction in the general demand level for electricity. The advantage of this approach is that it can easily be implemented and that tax collection is straightforward. Moreover, the destination principle, whereby energy products traded within the Community are taxed in the country where consumption takes place, is respected in a straightforward way.

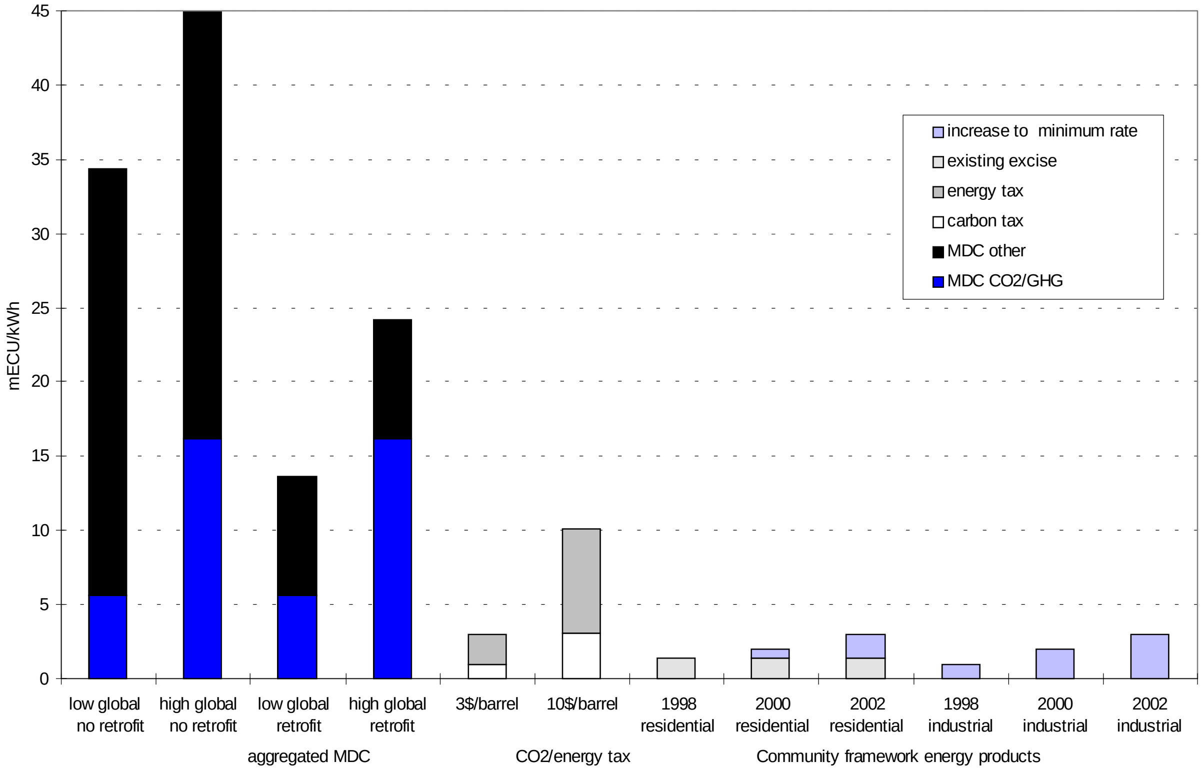
We consider two alternative policy scenarios for compliance in Belgium with the proposed European tax rates[2]. A first scenario is that Belgium applies the minimum rates. A second scenario would be for Belgium to introduce higher rates than the minimum rates, e.g. to consider the European rates as additional to the existing Belgian rates, at least in the residential and the transport sector. Rates for industry are kept at the minimum level in this second scenario, for reasons of international competitiveness.

Figure 2 pictures the first alternative. Existing taxes (except VAT) must be taken into account for attainment of the defined minimum rates. In Belgium, a "special contribution on energy" was introduced as of 1-8-93. For low voltage electricity this levy amounts to 1,375 mECU/KWh (0,055 BF/KWh) while high voltage electricity bears a zero rate. For residential and commercial electricity use, therefore, the existing rate is already higher than required in the first phase of the European proposal. The existing rate of 1,375 mECU/KWh will need to be raised by 0,625 mECU/KWh on 1-1-2000 and by 1,625 mECU/KWh on 1-1-2002 in order to attain the proposed minimum rates. For industry, currently bearing no excise taxes, increases equal minimum rates, except when exemptions or reductions apply. Electricity used in chemical reduction processes or in electrolytic and metallurgical processes is exempted from the tax. Member States may furthermore apply partial or total reductions in the tax amount on the part of a company’s energy costs, not linked to transport, that exceeds 10% of its total production costs.

In the alternative scenario, Belgium could decide to set tax rates higher than the proposed European minimum rates. Figure 3 pictures the decision to apply minimum rates for residential users on top of existing rates. For industrial users, minima would still apply in this option. Also in this option electricity tax rates would remain far below aggregated damage per KWh.

1. For motoring fuels, rates have traditionally been much higher than implied by their energy content.
2. Stéphane Willems, Nadine Gouzée, August 1997.

FIGURE 2 - ExternE aggregated marginal damage cost for Belgium and proposed European electricity tax rates.
Alternative I: adherence to proposed minimum rates.

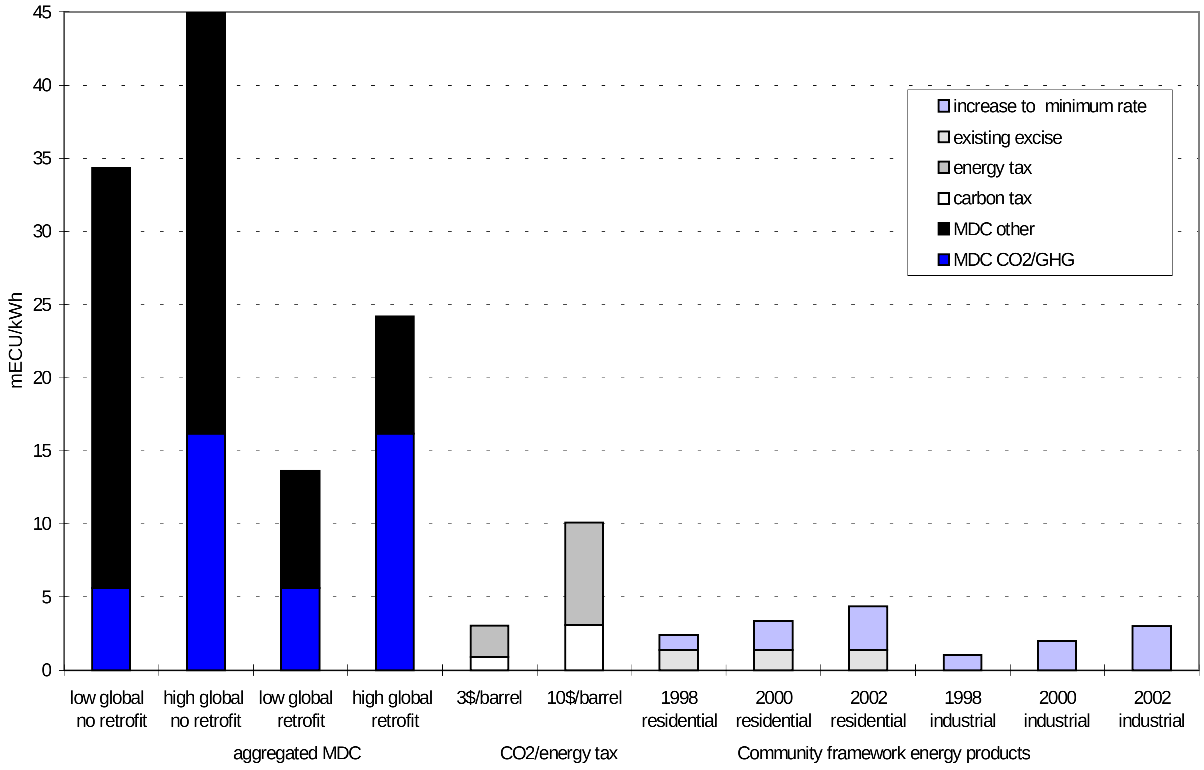


Source: Federal Planning Office, using ExternE data from VITO.

The proposed minimum rates for electricity, going from 1 mECU/KWh to 3 mECU/KWh in three phases, remain far below the aggregated damage cost for the Belgian power sector, which amounts to 34,35 mECU/KWh (assuming global warming damages of 18 ECU/tonne CO_2). Even acknowledging that the externality that should "best" be used to internalise damage may substantially differ from ExternE damage figures, the risk that the proposed electricity tax levels would result in economic costs seems small. The proposed European rates are not fixed in accordance with environmental damage costs, but are rather set in line with the general philosophy behind the proposal, which is to offer a harmonised tax structure with low rates for newly taxed products.

Important information in the Belgian ExternE damage costs relates to the substantial differentiation of damages resulting from different types of plants and input fuels. This suggests that a policy of internalisation of external damage cost should take these variations properly into account, if it is to produce welfare benefits. A drawback of the electricity output tax compared to the CO_2/energy tax (and certainly compared to an emission charge) is that it does not vary with the type of input fuel. Nevertheless, the European proposal leaves Member States the possibility to levy additional taxes on inputs, but such a variant has not been included in Figure 2. The possibility of setting the rates for such additional, non-harmonised, input taxes in accordance with external damage costs can be considered.

FIGURE 3 - ExternE aggregated marginal damage cost for Belgium and proposed European electricity tax rates.
Alternative II: higher than minimum rates.



Source: Federal Planning Office, using ExternE data from VITO.

VI Conclusion

Although the availability of data on external environmental damage cost should allow for the application of full cost pricing theory, in practice this is not straightforward. The theoretical framework behind the internalisation of external costs relies on a number of assumptions that are hardly met in reality, e.g. the existence of clear preferences and the existence of competitive markets. In the presence of distortions on electricity markets, setting tax rates equal to marginal external damage costs no longer necessarily leads to welfare maximisation.

Having this limitation in mind, in this paper, aggregated residual damage levels and damages for individual Belgian reference plants were compared to tax rates following from the European Commission proposals on a CO_2/energy tax and, more recently, on the restructuring of the Community framework for the taxation of energy products in the EC. On the whole, proposed tax levels remain lower than the damage costs. Although this does not necessarily imply that the proposed tax instruments are “non-optimal”, the risk of setting too high tax levels in the recent proposal on the restructuring of energy taxation appears limited.

Both total aggregated damages resulting from power generation as well as marginal damage resulting from specific fuel cycles, especially coal, are high. The state of affairs seems to suggest two possible ways to proceed, which do not exclude each other but should rather be pursued in parallel. One option would be to continue research on how the theoretical framework on full cost pricing could be extended in order to take more realistic, “second best” options into account. Interesting in this respect should be to investigate how external damage costs should be corrected in order to provide “optimal” levels for the application of economic instruments such as environmental taxes. The design of environmental taxation instruments has to consider a number of elements that have to do with the effectiveness, practicability, income distribution issues, etc. Calculating “theoretically correct” tax levels could provide a useful input into such a policy design process.

A second option would be to look for more pragmatic ways to insert knowledge on external damage costs in energy taxation policy at the European level. The height of external damage costs measured in the ExternE project are substantial and even if the theory cannot be applied in a straightforward way, the potential welfare gains to be expected from levying emission charges or setting energy taxes in accordance with the measured damage levels cannot be ignored. There seem to be a number of opportunities for such an approach. One possibility would call for greater attention in the European proposal for evidence on the high level of the externalities in general and on the strong differences between damages caused by types of plants in particular.

When setting energy taxes for environmental purposes, a balance must be struck between economic efficiency and ease of implementation of the tax from a fiscal point of view. The environmental damage associated with different input fuels (and technologies) is widely different, suggesting that the welfare loss of not reflecting them in tax rates may be substantial. In the proposed European electricity tax, however, the balance has been struck appears to be more in favour of fiscal practicability, to the detriment of economic efficiency. Setting a consumption tax allows to respect the country of destination principle and at the same time simplifies levying of the tax. However, the potential cost in terms of welfare is high. The tax renders electricity mildly more expensive, which may somewhat reduce demand. This strategy may not be very effective given the generally low price elasticity of electricity demand. The high potential for providing an incentive towards more environmentally friendly fuels and towards more energy efficiency at the generation or supply stage is ignored. The environmental damage associated with different input fuels (and technologies) is widely different, suggesting that the welfare loss of not reflecting them in tax rates may be substantial. These arguments would call for taxation on inputs or at the production stage, which renders respect of the country of destination principle more complex. The question is then how a balance can be found between the environmental effectiveness and economic efficiency, on the one hand, and the practicability of an EC wide taxation system, on the other. This trade-off was also felt at the time the CO_2 / energy tax was under discussion, when several options were suggested according to which electricity production would be taxed on the basis of substitute values for the inputs in electricity generation[1]. Several variations can be imagined with respect to a taxation system based on such substitute values, resulting in varying compromises between practicability and economic efficiency.

One option would be to choose the substitute values close to the inputs into generation for each individual producer. The tax paid by each producer would be based on the external damage caused per unit produced during a past period, e.g. one year. The tax for the producer is the equivalent of a “deferred” production tax, expressed in terms of a consumption tax. National fiscal authorities would need to define in advance the level of the tax for each producer, based on ExternE costs. De-taxation and re-taxation of intra-community trade in electricity would be relatively straightforward, as since the tax per unit of traded electricity is exactly known, and re-taxation in the importing country would be equal to detaxation in the exporting country, using the same rates. The main advantage of this system is that electricity produced is almost completely taxed in function of the damage that it provokes. The economic efficiency thus approaches very much that of a tax solely applied at the production stage. However, such a system risks to impose an administrative burden on fiscal authorities. It also leads to different tax levels for what end-users consider the same product (but which in essence is not, in terms of environmental damage).

Failing a reconsideration of European energy taxation and the tax rates therein more along the lines of external cost evidence, the application of the European proposal, supposing it is accepted, in individual Member States still seems to offer other possibilities to take into account our improved knowledge on the damage of electricity generation. Theoretical difficulties with the application of the internalisation framework in taxes notwithstanding, the strong variation of damage costs levels by fuel type suggests society is to gain from the reflection of

1. European Commission, May 1992.

these discrepancies into economic instruments. An adequate policy instrument should reflect this and by way of illustration, two possibilities are put forward in relation to the proposal.

- The proposed taxation framework includes a consumption tax on electricity and allows Member States to supplement the output tax with a (non-harmonised) tax on the inputs used in electricity generation. If Member States decide to implement such an input tax, the rates for it could be set in accordance with external damage costs. Setting of the rates in this way would provide a powerful incentive to producers to switch towards more environmentally friendly inputs or technologies.
- The proposal also allows Member States to refund to electricity producers the revenues from the electricity produced form renewable energy sources. Subsidisation criteria could take into consideration the external costs of the renewable sources in question.

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