

Imperial College

OF SCIENCE, TECHNOLOGY AND MEDICINE

External Cost and Environmental Policy in the United Kingdom and the European Union

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Centre for Energy
Policy and Technology

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Imperial College Centre for Energy Policy and Technology Purpose, Background and Contact Details

Purpose

The Centre was formed to study technologies and policies on energy and environment. It will be unique in the UK and internationally and brings three long-standing strengths of Imperial College to bear on modern energy and environmental problems:

- The science and technology of all aspects of energy production and use and pollution abatement.
- The analysis of the environmental impact of energy-related pollution on ecosystems and human health.
- The economic, legal and institutional aspects of energy and environmental policies.

Why the Centre Has Been Formed

The growth of the energy industry in the 20th century rested on far-reaching innovations and huge investments, with the creation of new disciplines in mining, petroleum, chemical, civil, electrical and mechanical engineering. All this required equally far-reaching investments in university education and research, and the requirements of the 21st century will be no less demanding.

Energy is in transition and change as never before – energy industries are going through rapid liberalisation, globalisation & technological development. The world market grows by an amount equal to the entire UK market *every year*, yet 2 billion people are still without modern energy. At the same time, local, regional and global pollution will need to be reduced substantially. Technological advance could bring about large reductions in pollution per unit of energy produced and consumed. But this won't happen by itself, nor will it be sufficient alone – supportive policy frameworks and more efficient resource management practises must also be developed.

There was a need to establish a university centre working at the *interface* between energy policy and technology development to provide intellectual leadership and dispassionate advice to governments, industry, the public and international organisations. Imperial College is uniquely placed to do this and this is the purpose of ICCEPT.

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The Occasional Paper Series

This series has been initiated to allow the timely dissemination of information, ideas and research developments within the wider community. Papers will be produced as and when appropriate, on all aspects of Energy Policy and Technology.

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External costs and environmental policy in the United Kingdom and the European Union
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The cover image shows the fuel channel labyrinth for a solid polymer fuel cell bipolar plate, courtesy of DaimlerChrysler AG.

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1. MAIN FINDINGS FROM PAPERS

1.1. Introduction

The purpose of this project was to investigate the current attempts to internalise external costs from energy production, distribution and use with special consideration for the role of the ExternE project in influencing policy. Our approach to assessing the policy relevance of the ExternE project is in six parts (forming six separate papers):

- To present the theoretical relationship between environmental markets (Section 2).
- To review the methods and results of the ExternE project (Section 3).
- To examine the key features of recent EU policies (a) to see what use (if any) they made of the ExternE project, (b) to contrast the differences between policies in practice and the policies that might be implied by the results of the ExternE projects, and (c) to explain the differences (Section 4).
- To examine these features for European national policies, with a special focus on CO₂ (Section 5).
- To undertake an analysis of the political-economy of environmental decision-making, and contrast this with the ‘economic ideal’ which inspired the ExternE approach (Section 6).
- To interview decision-makers in government to obtain their perspectives on the usefulness (or otherwise) of the ExternE approach (Section 7).

This chapter presents an overview. It starts by summarising some of the findings from our review of the ExternE project. This is followed by a discussion of external costs and environmental policy, including a summary of the political economy of environmental policy, the barriers to improving it and key trends in United Kingdom and European energy-related environmental policy. The final section provides some recommendations for policy and future research.

1.2. The ExternE Project

1.2.1. External Cost Estimation as a Basis for Energy-Related Environmental Policy

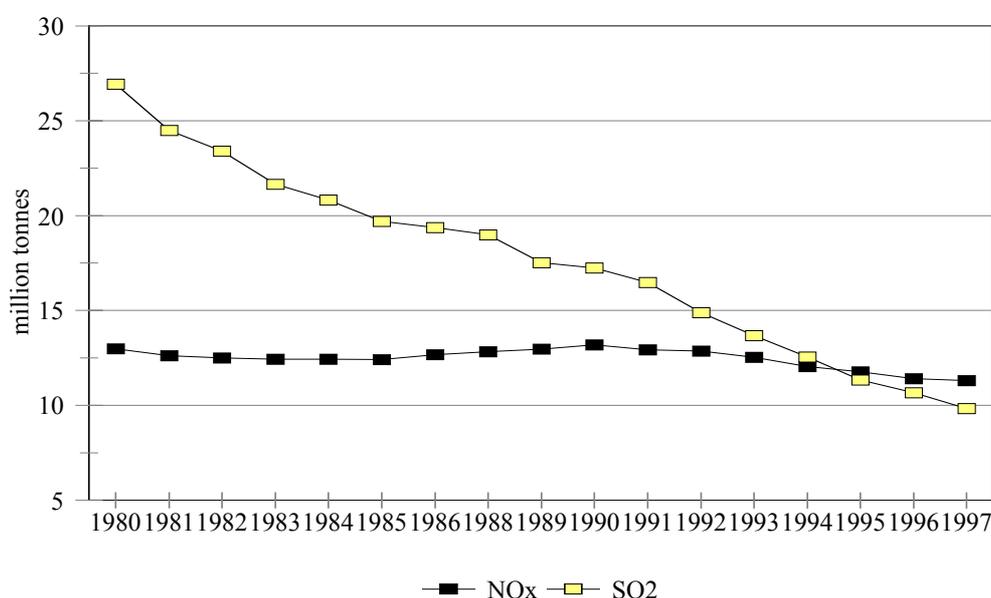
Economists’ estimates of the external costs of pollution are not the only—or even the most important—criterion for decision-making, even if they could be quantified reliably. The review of Rabl and Spadaro (2000) arrived at the same conclusion. There are several reasons for this:

- There is a long history of—and a bureaucratic preference for—policies being based on scientific evidence on environmental impact rather than economic evidence, especially where health and safety are concerned. Related to this:
- The uncertainties in the economic analysis are even greater than those of the scientific analysis. The economic analysis *begins* where the scientific analysis ends, i.e. with dose response functions of environmental impact, and adds to these the difficulties of, for example, (a) placing a ‘value’ on morbidity and mortality (‘Loss of Life Years’), (b) allowing for irreversibilities, which ExternE does not quantify, (c) intergenerational equity and the related issue of deciding on (d) the discount rate, and (e) the highly uncertain product of the probability and the costs

of calamitous events—the more extreme scenarios of global warming, nuclear accidents, and so forth.

Such factors however, which have long been known, merely limit the applicability of the ExternE approach, and do not invalidate it. The point is that economists cannot provide quantitative answers to all the questions faced by policy-makers; too many uncertainties and moral and other dilemmas remain unresolved. But policies have to be made nevertheless. The approach of ExternE thus needs to be seen for what it is, a useful basis for the estimating external economic costs of pollution, using the best methods we so far have at our disposal. They are a useful input to policy—even if they are, and cannot be expected to be, the only input.

Figure 1.1. European Union Air Pollution Emissions (1980-1997)



1.2.2. Some Strengths of ExternE Results

Several results that have emerged stand up to scrutiny and are consistent with experience. We would especially highlight the results in relation to local and regional pollution, and to near term issues such as acid deposition:

- The local and regional damage costs of coal plant, with the older coal plant being more damaging than the new. For new base-load coal plants these average around 0.032 Euros per kWh for SO₂ plus NO_x, having declined substantially with FGD and low-NO_x boilers in recent years, and 0.003 per kWh for particulates, the problem having been virtually eliminated through ESPs. (These are the figures quoted by Rabl and Spadaro 2000).
- The relatively low local and regional damage costs for gas fired plant, being around 0.011 Euros per kWh for NO_x.
- The very clear finding on the large variations in external costs between sites.
- That the methodology is well suited to the analysis of site-specific problems.

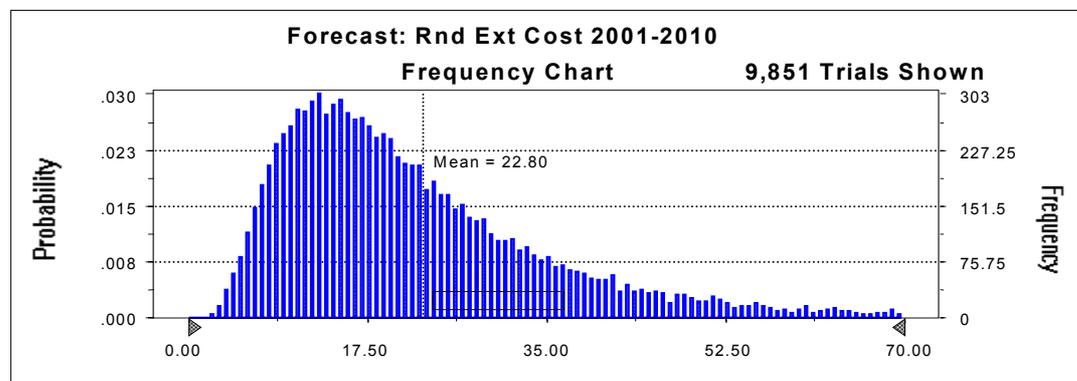
With the possible exception of NO_x , however, the local and regional external costs arising from the combustion of fossil fuels are in the process of being internalised in the policies of most European countries, as we can infer from the trends in emissions shown in Figure 1.1. However, where countries have not so far internalised the costs, the ExternE project points to the importance of doing so, and somehow regulating or pricing the emissions accordingly.

1.2.3. Some Weaknesses of ExternE Results

In other respects the results will be questioned—in relation to climate change and nuclear power in particular. As regards climate change:

- The external costs need to be linked to accumulations rather than emissions.
- Irreversibilities are also neglected.
- The external costs are not confined to Europe.
- Available estimates are much wider than the results of applications of the method have so far suggested. (See Figure 1.2. Even this figure understates the range of possibilities ahead, since Tol's review shows that current estimates involve a large number of assumptions and 'guesstimates'. What is the external cost? Is it 29 Euros per tonne, as ExternE estimates? \$2/tonne, the lower of the range in figure 1.2, or \$75/tonne, or \$220/tonne? We still do not know. What can be said is that the available estimates point toward a tightening of climate change policies, rather than a weakening, as do of course political pressures.)

Figure 1.2. Probability Distribution Function of the Marginal External Costs of Carbon Dioxide Emissions for the Period 2001-2010 (in $\$/\text{tC}$), at a 5% discount rate.



The figure shows the distribution up to 3 standard deviations about the mean; the full range of estimates is \$2 to \$225/ ton C. Source: Anderson and Papathanasiou (2000) based on a review by Tol (1999)

For nuclear power some allowances for the risks arising from radiation have been made, and on current evidence are realistic. However low the probability of nuclear accidents might be, the long-term disposal of radioactive wastes, possible misuses of fissile material and irreversibilities more generally will all loom large in the analysis of future policies, whatever one's personal or corporate position might be. Divergences between the public's perceptions of risks and the 'rational' estimates of industry and government are likely to be another factor that will lead to divergences

between the policies that ‘rational’ economic analysis might put forward and the decisions of government. That ExternE is not able to address such question will necessarily limit its applicability—even though, as noted above, many useful results have emerged and should be used in the analysis of current policies.

1.2.4. Complexities with Climate Change Policy

With respect to climate change policies, the focus is more likely to be on targets, offset programmes and technology policies than on the use of estimates of external costs as a basis (say) for estimating penalties or taxes on fossil fuels. Our reviews of EU and country policies uniformly point to such policies—especially in the case of renewable energy and (in France) nuclear power. Partial exceptions are the Scandinavian countries and Holland, where modest carbon taxes have been introduced alongside technology policies. This is a perfectly valid response to the situation, and can be defended by reference to the value of creating options and reducing the costs of responding to climate change. The policy has an ‘*option value*’, a concept familiar from the financial markets, and a *positive externality*, since it will reduce the costs to future generations of responding to climate change (as mentioned in the stakeholder interviews).

1.2.5. The Uses of the ExternE Project

The ExternE project has performed a valuable function in showing concretely what is meant by external cost, and the importance of internalising such costs in the pricing system. Only a few years ago, environmental policies used exclusively command and control methods and were based on piecemeal political compromises with some assistance from scientific arguments rather than any economic rationale. Today, where appropriate, policy-makers are willing to use the more flexible market-based instruments and be guided, to some extent, by economic criteria. Economic evaluations of environmental damage, such as the ExternE project, have enabled policy-makers to more solidly ground their decision-making process, as well as to improve the effectiveness of their activities.

Nevertheless, there remains much misunderstanding about the concept, and of its translation into policy. For example, certain countries are still proposing to tax kWh or energy instead of pollution. Electricity—indeed energy—is widely and wrongly seen as a ‘bad’ not a ‘good’, and the wrong quantities are being taxed on environmental grounds.

1.3. External Costs and Energy-Related Environmental Policy

1.3.1. Environmental Quality and the Policy-Maker

The policies that have been discussed throughout this report are the result of market failing to reflect the true costs of pollution. Scientific evidence, such as the ExternE project, confirms that energy production, distribution and use impose costs on society. These costs generate a willingness to pay for environmental quality, which can depend on, for example, income, the perceived cost of improving the environment, preferences, information, education and awareness, and political opportunities. ‘Suppliers of environmental quality’, that is, the polluters have few incentives to

avoid pollution and, therefore, choose to pollute as long as the costs to the companies are positive. This market failure generates the need for environmental regulation.

‘Suppliers of environmental regulation’, that is, the politicians and their civil servants, respond to political and other incentives (from the public and pressure groups) by introducing (or delaying - if discouraged) environmental legislation. These legislations generally takes the form of environmental standards, technological requirements or market-based instruments and, in the case of energy-related environmental quality, leads producers and consumers in the markets for energy, energy technology and environmental pollution permits to incur costs associated with environmentally damaging activities. The resulting adjustments in these markets shift the supply curve for environmental quality, reflecting to some extent the public requests for reductions in environmental pollution. Shifts in the demand and supply curve for environmental quality will in the long run lead to changes in the levels of environmental quality and the costs of achieving them.

1.3.2. Barriers to Improving Energy-Related Environmental Policy

The barriers to using ExternE and other information to internalise the external costs of energy identified were the predisposition (sometimes ideologically based) of politicians and civil servants’ to prevailing practices and approaches, lack of information, lack of awareness of the process about how to internalise the costs, and the existence of powerful pressure groups creating obstacles to internalising external costs. At the same time, there are powerful pressures from the NGOs and, often from the public, to move to new policies. The outcome is rarely if ever based on the simple calculus of cost-benefit analysis.

At the EU level, the Commission generally leaves it to individual countries to select methods of achieving the standards agreed upon. This dichotomy between EU level standard setting and member state level means of achieving the standards may reduce the ability to fully internalise external costs. There was evidence from discussion with the stakeholders that awareness of the ExternE project was minimal despite its value in energy-related environmental policy.

Policy-making is often a process of muddling towards a solution. Economists (in association with epidemiologists) propose estimates of external costs of energy systems. Some might see these estimates as providing an exact science to adjusting market distortions related to the environment. Politicians and civil servants take this information and add it to a long list of other elements (scientific or not) in order to take a decision on the standards and means of achieving them. Where known, the ExternE methodology and results have been criticised. The criticisms and the uncertainty about specific values of external can be used to delay the internalisation process, despite the debate being about a detail (about the appropriate figure to choose) rather than about the nature of the process.

Imposing additional costs on economic activities in order to ensure internalisation is unpopular to the polluters that need to pay. Agents upon which these costs are imposed will invest considerable resources in trying to sway policy decisions away from internalisation. This will reduce the likelihood of governments imposing the full external cost, if at all. In practice, the decision is a political compromise.

1.3.3. Trends in Energy-Related Environmental Policy

The value associated with air and atmospheric quality has generated a demand for energy-related environmental policy. Its effectiveness has been limited by many factors, including beliefs, information, pressure groups and bureaucracy. Over a period of centuries, environmental policy has evolved as a result of changing forces within society. For example, as early as the fourteenth century, authorities were banning coal use because its smoke was a 'nuisance' (Clapp 1996). In the early modern era, there were those that said it was associated with 'respiratory' problems. Generally, legislation failed to be introduced or, where it was, it failed to be enforced. Part of the reasons was the importance of coal use for the industrialising economy. Concerns for health were certainly the drivers for reforms in the nineteenth century, which gradually managed to disperse air pollution. Today, those health problems are being incorporated into estimates of external costs, such as the ExternE project. So, throughout history, there has been an element of scientific and economic evidence in influencing environmental policy-making.

There are also some signs that the quality of the policy-making process is improving:

First, environmental problems are not going away and are becoming a greater priority. Effectively, the demand for environmental legislation has risen. This puts increasing value on politicians' supporting reform. This continued growth can be associated with increasing awareness and acceptability of environmental issues, a rising income level (thus, willing to pay more for environmental quality), and (in the current state of economic growth) other issues (such as unemployment and crime) are lower. In times of economic recession, however, there might be a small declining demand for environmental legislation. Nevertheless, environmental issues are increasingly on governments' agendas.

Second, in the last few years, it appears that regulators, industrialists and environmental movements are increasingly willing to accept the concept of market failure and the internalisation of external costs. Although some might disagree, scientific objectives, which have historically been key to environmental problems, are being incorporated within economic models of social welfare optimisation. Environmental policy should, therefore, be a more unifying approach, linking scientific and economic concerns, and able to compare them on equal terms, through monetary valuation. And, while this attempt leads to its own problem, since many feel they are not comparable, economic valuation does provide a new tool for policy-makers to control environmental pollution.

Third, the improvements in the ExternE project itself have helped reduce opposition. One reason is that scientists, although not having resolved the methodological controversies, have accepted more maturely that some of these problems are philosophical problems that should be set aside. In addition, the epidemiologists and economists have developed better approaches to the valuation of mortality and the measurement of climate change impacts, and a greater understanding and openness about the limitations of the results.

Fourth, the pressure groups opposed to the internalisation process are smaller. Powerful companies are claiming to make strong commitments to reducing environmental damage and are less willing or able to hinder the introduction of environmental legislation. Thus, opposition to such legislation is weaker. Also, as more support the green lobbies, the weight of opposition is less powerful.

For some years, there has also been a growing recognition by industry that environmental regulations frequently generate new business opportunities, and this too has been a force for more constructive market-based policies. Some market-based instruments are becoming more favourably received on this account. For example, the introduction of tradable permits is quite popular with industrialists. In general, permits to pollute are grand-fathered and not requiring permit-holders to pay for them. Also, permit allocation negotiations and knowledge of the permit market create a barrier to entry in the wider market (e.g. electricity generation). Thus, permits are attractive to industry. Partly as a result of the support for these measures and partly to avoid the uncertainties associated with estimating external costs, there has been a move in the last few years away from the direct use of external costs (such as in taxation) towards quantity-based economic instruments, principally tradable permits and certificates. Such an approach may reduce the need for estimates of external costs, and yet reflect the value of taking them into account.

Fifth, this has been related to the role civil servants play in ensuring the smooth running of legislation. That is, they now appreciate the wider value of internalisation, appreciate the personal gains from its introduction and have a better understanding of how to create incentives for all involved to no longer oppose legislation. The upshot is that, while there are still substantial barriers to the introduction of external costs, they are falling. Any attempts to accelerate and improve the process would need to focus on these four key components: ideological barriers, informational limitations, pressure groups and bureaucratic friction.

Lastly, mention should be made of innovations in environmental policy that relate to the development of technologies and practices to solve environmental problems. In reviewing policies in EU countries (Chapters 4 and 5), it is noticeable that a complex array of policies are being developed to support environmental innovations directly—tax incentives for new technologies, regulatory requirements and targets, premium prices for ‘clean’ energy technologies, support for R&D, and so forth. Thus the instruments of environmental policy are no longer focussed exclusively on the negative externalities of pollution, but now pay attention to the positive externalities of innovation—for example, those associated with new and renewable technologies. In this respect, civil servants are ahead of the academics, and of the ExternE exercise. We believe that this trend in policy should continue, and that future studies of the external costs of pollution, and of the marginal costs of abating it, need to look far more critically at the scope for innovation for reducing costs, to estimate the positive externalities of innovation..

1.4. Recommendations on the Internalisation Process and the Use of ExternE

As stated above, this project sought to investigate efforts to internalise external costs from energy production, distribution and use with special consideration for the role of the ExternE project in influencing policy. Some recommendations from this study are:

1. The ExternE approach is proving to be a good basis for the study of some kinds of external costs, and we recommend its continued use. It is a means of improving the rigour of policy analysis when and where the relevant information is available. However:
2. The limitations of the method and approach should also be recognised. The method is not well suited for handling problems where uncertainties are large. In climate change studies, for example, we do not know the magnitude of the external costs within two or more orders of magnitude. The same is true of attempts to assess the external costs of low probability events such as nuclear accidents or radiation leakages. However, uncertainties are part of the problem, and we need to estimate the variance and any asymmetries in the frequency distribution of possibilities, as well as the mean values of external costs. Among other things, the analysis of uncertainties and risks will point to the use of alternative instruments of policy, such as those required to explore options and develop new technologies to address an environmental problem.
3. Further efforts are required to improve stakeholder understanding of economic principles and their use in environmental policy-making, including the problems posed by uncertainty. Related to this:
4. Stakeholders, particularly those reluctant to see reform associated with the internalisation process need to be made aware of the potential benefits to them. A rising awareness of the advantages to once-dissenters of the gains of tradable permit schemes and positive externalities is clearly apparent and should continue in an attempt to minimise conflict and enable the pace of reform to accelerate.
5. There remains much scope to improve communication between policy-makers and (natural and social) scientists. The ExternE project is an example of where further dialogue is needed. Civil servants need to play the role of facilitators – for example, explaining how external cost estimates are going to be used, what assumptions lie behind them, what are their strengths and weaknesses. At the same time, scientists (not least economists) need to recognise that their job does not end with the production of numbers, but how they might be used.
6. In the resolution of environmental problems, the contribution of innovation, and of policies to support it directly, needs more attention, especially in areas such as climate change policy. Perhaps the main innovation in environmental policy in recent years has been the recognition of the value of technology policies to enable industry to respond to environmental concerns in a cost-efficient way. A study of the positive externalities of innovation would be an important development of the ExternE project.

The economic approach to decision-making is only one tool among many for the formulation of policy. Consequently, the results of past and future ExternE project may never serve as the direct determinant of taxes imposed on consumer suggested by economic textbooks. Nevertheless it will serve a useful role in informing policymakers of the *economic* costs of pollution. Policymakers will inevitably need to weigh factors that the approach is still not well placed to cope with, risk and uncertainty being one.

1.5. Future Research

We suggest the following areas for future research:

The first is on *uncertainty and risk*. As noted, the estimates of costs and, especially the benefits of pollution abatement, often cannot be estimated within very broad limits.

The second is to examine *the consequences of uncertainty for environmental policies*—what new instruments are needed? What is the option value of reducing uncertainty?

The third is on *the positive externalities of innovation*. We need a good basis for estimating what these externalities are—the benefits of ‘learning by doing’, for example, the value of developing technologies being developed to solve an environmental problem, and the effects of innovation-induced reductions in costs on the uptake and environmental impact of the new technologies.

The fourth is on the *policy instruments that are best suited to promote the new technologies and innovation directly*. (As noted, all EU countries are currently experimenting with a range of instruments, and what comprises the best set is unsettled.)

The fifth is to *increase our understanding of the relationships between policy-makers and scientists*. The sociology of and incentive structure within science, and the use of science by the pressure groups, the media and the public is crucial for the output produced and, therefore, the information upon which policy-makers base their decisions.

Sixth, we need more *post-evaluation of past policies* and what could be learned from them. The UK climate change levy is one example of an attempt to internalise external costs of energy use. The process has followed an unusual course and might provide many lessons about the relationship between policy-makers and pressure groups.

A starting point might be to bring together a multi-disciplinary group of analysts to consider the results from the ExternE project, the lessons learned, and issues for future research.

References

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2. THE STRUCTURE OF MARKETS RELATED TO THE ENVIRONMENT

Roger Fouquet

2.1. The Market for Environmental Quality

2.1.1. The Value of Environmental Quality

The release of pollutants into land, water or air can have considerable detrimental effects on economic agents other than those who pollute. These external effects can be estimated and a monetary value attached to them.

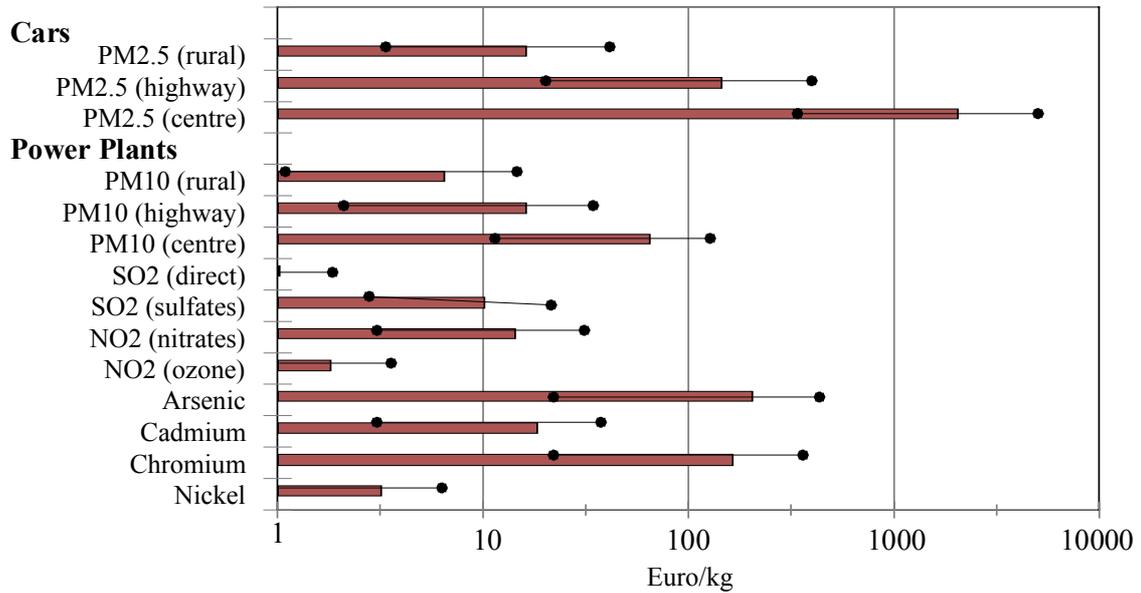
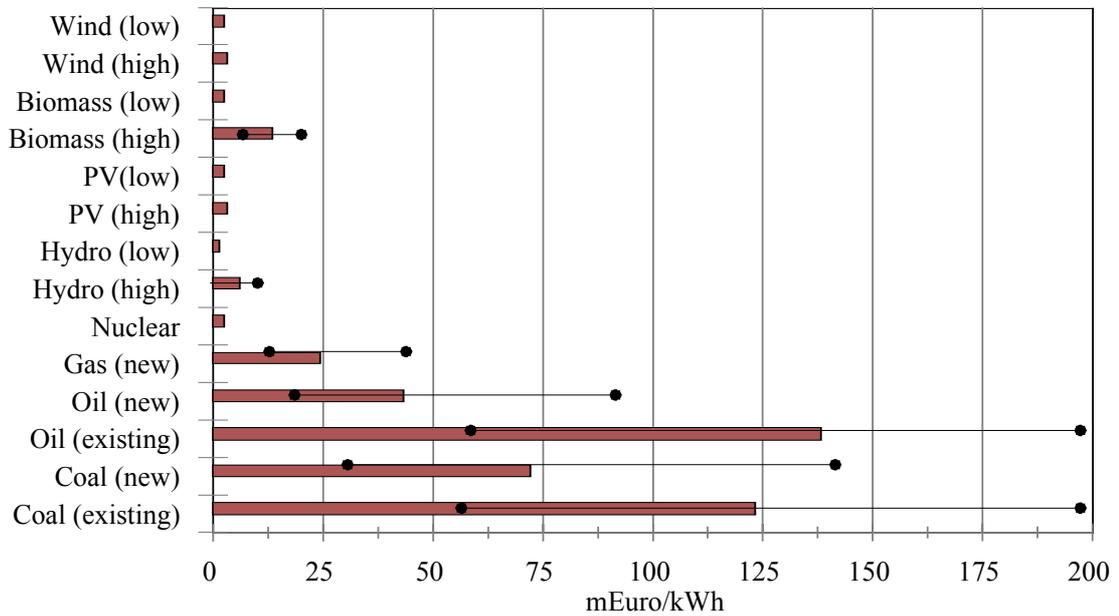
The most extensive study of evaluating the costs of air pollution in Europe was funded by the European Commission and is known as the ExternE project (Rabl and Spadaro 2000), which is discussed in more detail in the next chapter. A survey of the literature, which incorporates calculations of the dose-response function and the public's willingness to pay, does provide some indication of the damage cost in the United Kingdom associated with sulphur dioxide, nitrogen dioxide and particulates. Per kilo of emissions, particulates appear to cause the greatest damage, especially smaller particulates, because of their ability to enter deeper into lungs than larger molecules.

If these are linked to the fuel use in electricity generation, it is clear from Figure 2.1 that coal power stations are responsible for considerable external costs - estimated at around 0.07 Euros per kwh for a new station (approximately 5p per kwh). This is greater than the marginal private cost of generating electricity. New oil and gas are estimated to cause approximately 0.05 and 0.03 Euros (3 and 2 pence) per kwh, respectively. These are non-negligible figures. Naturally, these assume that companies fail to take on any internalisation of the external costs.

There was also an attempt to consider downstream impacts, particularly solid hazardous wastes, despite the uncertainty related to future waste management. These play a potentially important role in the external costs of nuclear power. The authors find that the costs could be negligible provided waste is stored in well managed leak proof facilities. If a leak does occur, the most probable outcome is toxins entering groundwater. Provided appropriate measures are taken, the authors suggest that the impacts can be contained within a local area, and stopped and corrected. Thus, the external costs (including air and atmospheric pollution) resulting from nuclear power are expected to be small in comparison to fossil fuel costs, and similar to those from renewable sources.

These low costs assume that at all stages appropriate management is pursued. The flip-side to these low external costs are high private costs incurred by the companies resulting from pursuing appropriate management. The authors add a note of caution about the external costs estimates of nuclear power. "All this assumes, of course, a mature and stable political system, with strict verification of compliance with all regulations. Low external costs do not suffice to allay concerns about accidents, long lived radioactive waste, the right to impose impacts on future generations, and risks from terrorists and rogue governments; these issues involve acceptability rather than costs." (Rabl and Spadaro 2000).

Figure 2.1. Estimates of External Costs of Energy Use (Source: from Rabl and Spadaro 2000)

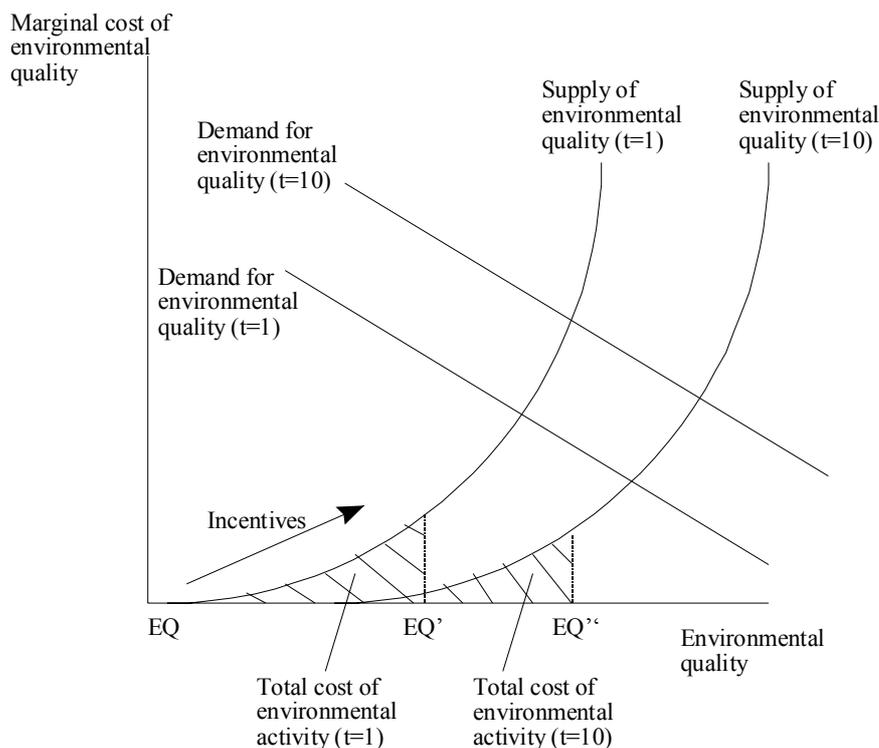


If the external costs related to air pollution and waste (as well as others from the production of fuels, such as exploration, mining, distribution and decommissioning) were incorporated into each company's cost function, then a trade-off would be made between paying taxes or permits to pollute and expenditure related to environmental (including decommissioning) liabilities.

2.1.2. The Demand for Environmental Quality

As seen above, services provided by environmental resources generate a demand for environmental quality¹. The public as a consequence is likely to be willing to pay to avoid damage to the environment and the services it provides (Maler 1996). This suggests the potential for a market for environmental quality - as shown in Figure 2.2., where the social optimal level is identified by the meeting of the demand and supply curves. Economics can provide a framework for analysing the evolution of environmental quality as partly the reflection of changing market forces.

Figure 2.2. The Market for Environmental Quality



¹ How informed are individuals about the full and long-term services the environment provides, and the reductions in quality resulting from pollution? Who controls the production and supply of information about environmental quality, damage and service provision? What incentives are the producers and suppliers of information responding to?

Through time, the related demand for environmental quality is likely to change. In Figure 2.2, this is shown by a shift to the right in the demand curve (from year $t=1$ to $t=10$). Factors that will be responsible for any changes include: increased scientific knowledge, information provision and awareness, which are likely to highlight the need for environmental quality, especially in relation to health effects and related health care costs; increased wealth (coupled with positive income elasticity for environmental quality) raise the willingness to pay for pollution abatement; modern political systems, which are more sensitive to public demands, including environmental demands; also, individual preferences or tastes, which may be culturally-based.

2.1.3. The Supply of Environmental Quality

In the market for energy, for example, the manager of a firm seeks to supply the company's products or services in order to maximise profits and satisfy shareholders (and ideally other stakeholders). It must find the output path that combines existing technology with inputs (such as labour, physical capital, human capital, materials, etc...) to minimise costs of production. According to the impact different centres of economic activity within a company have on the cost minimisation process, the manager will adjust the allocation of resources (including finances and an organisational structure) supplied to these centres.

Each company is faced with the public's demand for its products or services. The level of differentiation between its products and its nearest competitors' will determine the price elasticity of demand; greater differentiation leads to market power and ability to influence prices. Based on its degree of market power, the firm selects the level of energy production that maximises profits.

Numerous activities throughout the stages of production have by-products, such as land, water or air pollution, that influence the well-being of individuals beyond the market for energy. The supply of environmental quality can be considered a function of the amount of reduction in environmental pollution, as well as the ecosystem (e.g. land, water and air)'s ability to assimilate or disperse the pollutants. The level of supply is, therefore, a direct reflection of companies' marginal cost of reducing pollution (i.e. the cost of reducing an additional unit of pollution).

2.1.4. Failures in the Market for Environmental Quality

Because of the lack of sufficient signals and especially incentives (for example, in the form of prices) to allocate and ration resources, companies would tend to supply a level of environmental quality, where the marginal costs of abatement are equal to zero. As a result, the marginal costs of the company's production activities are greater to society than they are to the company - since the cost to society include the costs of pollution, as well as the costs of producing, say, energy. And, since the firm produces a level of energy output that ensures that private marginal costs are equal to marginal revenue (ie equal to the price, in a perfectly competitive market) in order to maximise profits, there will be a higher level of energy production and, thus, of pollution than if production had been set for social marginal costs to equal marginal revenue. In other words, the relative price ratio facing producers encourages a greater level of production than the socially optimal level. Thus, when negative externalities (such as

land, water or air pollution) exist, the firm will produce more than the socially desirable level of energy and, thus, of pollution.

Certain incentives do exist, however, to encourage firms to internalise (or, at least, reduce the external costs of their pollution). These include resource and property management, product differentiation and corporate image. Because of such incentives, companies are likely to internalise some of the externalities, reflected in Figure 2.2 in a move up the supply curve.

First, a firm is likely to be to some extent inefficient in its use of resources (energy, materials, ..). Better resource management reduces costs of production and waste or pollution at the same time. Second, the value of a company's property, for example, its land, could be reduced by poor environmental quality. The firm may, therefore, set out to minimise certain types of pollution in order to raise the value of the land and, at the same time, reduce the level of external effects of its production activities. Third, the company may realise that its product differentiation and ability to sell its product is in part dependent on the image it portrays in relation to environmental care and how employees, contractors and consumers perceive it. So, there are factors that act as a means of signalling and creating incentives for companies to alter their activities to minimise their environmental impact. Because of such incentives, companies are likely to internalise certain externalities². In Figure 2.2, the incentives are represented by the arrow, and the outcome is a higher level of environmental quality, perhaps y_e' .

In any particular year, a company will be involved in two types of internalisation activities and expenditures. While some expenditure is involved in on-going investments and processes to reduce environmental damage, many of the internalisation activities require back-end costs, such as decommissioning of installations. Aggregated together, these annual costs are equivalent to the (shaded) area under the supply curve in Figure 2.2, which is the sum of the marginal cost of abatement between y_e and y_e' . For each year (e.g. $t=10$), a company will have an expenditure on 'environmental' activities, reflected by the shaded area under that year's supply (i.e. marginal cost of abatement) curve between y_e and y_e' (when $t=10$). The net present value of the sum of all these future expenditures are considered future environmental (including decommissioning) 'liabilities' for the company, and call for provisions to be set aside to cover them.

2.1.5. Trends in Energy-Related Environmental Quality

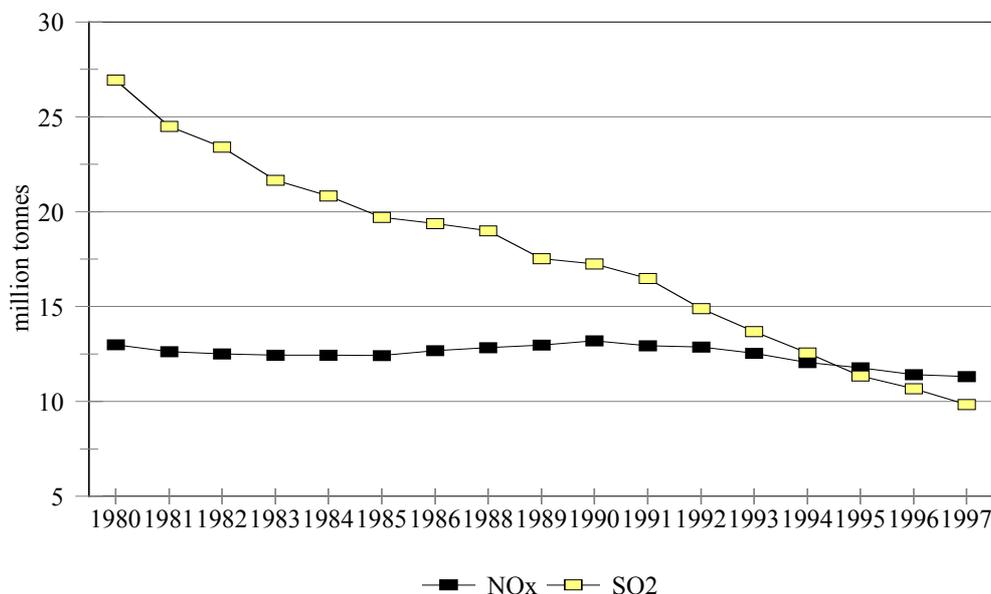
Air pollution, the generic term for noxious emissions including smoke (ie suspended particulates), sulphur dioxide, nitrogen oxides, carbon monoxide, volatile organic compounds, and heavy metals, such as lead, is arguably the greatest energy-related environmental problem in the United Kingdom's history. Smoke, which simply measures the quantity of particulate matter in the air, was the most visible type and oldest measure of air pollution. Much of the smoke originated from industrial activities, especially the iron and steel industry (eg stoking) and electricity generation. The 1960s were the start of a period of reduction in the smoke emissions. This was

² Internalisation means that the firm actually takes into account the external costs of pollution in its optimisation procedure. In certain of the examples given, the firm simply benefits by reducing the external costs without explicitly taking into account of the external costs.

because of a decline in many heavy (and energy-intensive) industries, a temporary rise in the real price of energy, the continued shift away from coal, especially associated with the use of nuclear power and then natural gas for electricity generation, and the use of petroleum for transportation.

There is a difference, however, between the national level of emissions and the local concentration of the pollutant. In the model discussed above, emissions are the level of environmental pollution and concentrations are the level of environmental quality. While the level of emissions links the fuel combustion with the pollution, concentration of an air pollutant is the crucial indicator of health damage and costs. In special cases, dramatic concentration levels have been recorded. The worst recorded case of the famous ‘pea soup’ fog occurred in early December 1952, a period of particularly cold and unfavourable meteorological conditions, smoke remained trapped throughout London and 4,000 additional deaths were reported in the city over a couple of days. This event was, however, one of the last examples of high smoke concentrations. After this event, a ban on the use of coal for domestic fires in urban areas led to declines in local air pollution. Despite examples such as the one in 1952, it is generally believed that smoke concentrations started to decline around the turn of the century. This suggests that the number of deaths from respiratory problems last century must have been very large. This century’s decline in concentrations was mainly the result of a migration of homes towards the suburbs (and, thus, a decline in the density of population in cities), an increasing use of electricity to power industrial activities, an attempt to shift industrial activities out of the cities and an increased efficiency of industrial boilers. The first three tended to disperse emissions, reducing the concentration of pollutants, and the later reduced total emissions.

Figure 2.3. Trends in Air Pollutant Emissions



The level of sulphur dioxide concentrations (as well as emissions) tended to follow the trend in smoke emissions as the sulphur content in coal is far greater than in other fossil fuels. Emissions, therefore, fell from the late 1960s. Nitrogen oxide emissions, considered more harmful to health than smoke or SO₂, result from the burning of all

fossil fuels and, therefore, have probably been rising continuously since the switch from biomass to fossil fuels hundreds of years ago. In recent years, much of the recent growth in emissions is associated with electricity generation and road transport have caused most of the emissions. Over the last ten years, greater efficiency from Combined Cycle Gas Turbines and low NO_x burners in electricity generators and catalytic convertors installed on cars have started to reduced emissions and concentrations.

Other more modern pollutants, lead, carbon monoxide and volatile organic compounds are linked to the use petroleum products especially in road transport and emissions have, therefore, risen over the last 40 years. The switch from leaded to unleaded petrol in cars has been responsible for the 70% fall in lead emissions between 1985 and 1990 and the fall continues. Also, in the last 5 years, Carbon monoxide and VOC emissions have fallen around 20% because of the use of catalytic convertors and a shift to diesel engines.

Two other types of energy-related environmental pollution are acid rain and greenhouse gases, both which follow to a large extent the trend in air pollution. Acid rain results from the dispersion by winds of sulphur dioxide and nitrogen dioxide, either directly or in clouds and, thus, acid deposition is closely related to the declining trend in the two related air pollutants. Greenhouse gases include, carbon dioxide, methane and nitrous oxide. The former is in far greater a quantity than the other two and is the main cause of concern for atmospheric pollution. Carbon dioxide is emitted in the combustion of all fossil fuels, although considerably less in the lighter fuels (eg natural gas). This means that there has been a decline in carbon dioxide emissions over the last twenty years, although at a more moderate rate than air pollution and due to potential growth in energy use in the transport sector (DTI 2001).

2.2. The Market for Environmental Quality Regulation

2.2.1. A Demand for Environmental Quality Regulation

It has been suggested above that the external costs associated with energy production, distribution and consumption are not fully taken into account, and the market for environmental quality fails to develop properly. The inability to directly signal preferences to the supply side leads to a demand for environmental legislation, which can in turn influence supply. The combination of legislation and the threat of enforcement create incentives for externality-generating agents to internalise them, and improve the supply of environmental quality, towards the optimal level where demand and supply meet.

The supply of environmental legislation can be considered a two-step process. First, government makes a proposal about the appropriate level and the institutional framework (ie instrument choice) to ensure supply side adjustments to the demand for environmental quality. Then, in parliament, a vote is made to decide whether the proposal should be accepted or rejected, possibly subject to amendments. Both the proposal and the vote can be considered the outcome of the interaction of the demand (from the public and various pressure groups) for and the supply (by policy-makers

and politicians) of environmental legislation (Keohane et al 1998)³. The difference between the proposal and the vote is that the former involves one politician (or, at least, a government) with a monopoly of legislative supply selecting a standard and/or instrument, and the latter ensures a competitive market where all parliamentary politicians supply a (nearly) homogeneous supply of support⁴. Here, we will first examine the supply of and demand for legislation, then consider briefly the proposal (by the monopolist supplier) and the voting process (in a competitive arena).

2.2.2. The Supply of and Demand for Legislation

The commodity of interest is the politician's 'support' for either a level of legislation or a type of policy instrument. What this politician seeks and those demanders can compensate him/her with is the resources for re-election: votes, as well as monetary and other contributions - this is the currency with which political support is paid for.

Politicians in general have a support supply function. Its shape depends on "(1) the opportunity cost of efforts to provide a given degree of support a policy instrument; (2) the psychological cost of supporting an instrument despite one's ideological beliefs; and (3) the opportunity cost (in terms of reduced probability of reelection) of supporting an instrument not favored by one's electoral constituency in terms of reduced probability of reelection." (Keohane 1998 p.324). The overall marginal cost function is simply the vertical summation of the three costs⁵.

Certain external factors can influence the supply function, including the preferences of the politicians' party on this particular issue and the potential for vote-trading amongst politicians. In addition, a politician's support can be swayed by lobbyists. Pressure groups will seek to influence her beliefs about the subject or about her constituents' preferences. In Figure 2.4., the point where the supply function crosses the horizontal axis, A, reflects how much support (or, in this case, opposition) the politician would have for a proposed policy. The accumulated resources for reelection would have to be greater than B to gain her support; as this point (where the supply curve crosses the vertical axis) indicates the politician's indifference between unpaid opposition to the policy and support compensated by an amount B. Where the

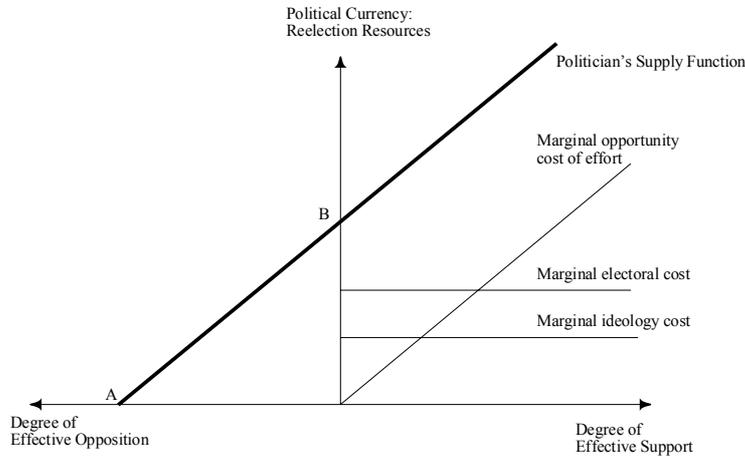
³ In Keohane et al (1996), the framework presented is to explain market for instrument choice in particular. This concept can equally be considered for level of environmental standards.

⁴ Naturally, the complexity of the supply of legislation can be increased to account of the stages of proposal (eg green paper, white paper and bill in the United Kingdom) or the different voting houses (eg House of Commons and Lords, of Representatives and the Senate, etc..).

⁵ The relationship between this politicians' output and input can be represented by a production function. It indicates the amount of effort a politician requires for a particular level of effective support. Each politician is likely to experience a different support production function according to her degree of efficiency. The efficiency might be determined by the 'capital' available to her, including the number and quality of staff members, her seniority or respect as a politician and her membership and leadership in relevant committees (Keohane 1998). It will determine the input and, therefore, the first element of the cost of political support. The following two costs are associated with the ideological and constituency costs. They can either be positive or negative costs depending on whether support is provides her with her satisfaction from an ideological perspective or from the likelihood of reelection. These costs may or may not increase with incrementally higher levels of support; if they do not, then they do not alter the shape of the combined marginal cost function.

aggregated demand for support crosses the politicians' supply function will be the equilibrium point for support (or opposition). So, if the demand curve meets the supply function above B, the policy will be supported by the politician in question.

Figure 2.4. Politician's Environmental Legislation Supply Function



Demand for political support results from individuals and firms directly seeking politicians' willingness to vote, or indirectly through the activities of pressure groups (such as environmental, consumer, worker or industry representatives). Previously, it was stated that the demand *for* environmental legislation will be equivalent to the total value of improving quality from the current state to the optimal level (ie the area under the demand curve between y_{et} and the level where the demand and supply curve meet in Figure 2.2). Individuals are affected by environmental legislation, either because of its influence on the supply of environmental quality or through indirect effects associated with the costs of products and services or on the demand for labour. An individual develops a series of demand functions for all private and public goods, including environmental standards and instruments, in order to maximise her utility given budgetary constraints. Her demand for environmental standards, say, will be a function of income and the price of relevant goods, such as ensuring political support for the desired level⁶.

A firm is affected by environmental legislation through the costs of inputs to produce. A firm seeking to maximise profits given input costs (influenced by factors such as constraints imposed by environmental legislation) will calculate the desired level of demand for each input. Thus, a firm will work out the level of environmental support (or not) demanded given the cost of ensuring support.

The public good aspect of environmental support means that individual effort and costs to influence legislation will generate small benefits. With marginal costs likely to outweigh marginal benefits, lobbying will be under-supplied by individuals, with too many hoping to free-ride. Although also victims of free-riding and subject to problems of principal-agent theory, organised pressure groups provide a supply of lobbying. Creating private (or club) benefits from membership and, thus, generating income, a group must select how to allocate its resources in attempts to lobby for

⁶ It is assumed that the utility individuals or firms derive political environmental support (or not) will be decrease with incremental increases.

various political outcomes. The interest group will have a declining demand curve, such that its marginal willingness to pay for support decreases as the total support by politicians for the subject of interest increases.

To aggregate the demand from these three groups, it is not possible to simply sum them willingness to pay horizontally, as would be done for a private good. The willingnesses to pay could be summed horizontally, although it only provides the maximum level of actual demand in the absence of free-riding; because of free-riding between individuals, firms and even interest groups, the actual demand is likely to be lower.

2.2.3. Legislative Procedures

When faced with a demand for environmental regulation, the first stage in ensuring supply is for government to propose a level of environmental quality and a means of achieving it. Led by one politician - so, as a monopoly of supplier, she faces a downward sloping demand curve - he/she makes a proposal by evaluating the information available and converging on one dominant idea. As mentioned above, crucial for demanders of regulation will be to shift this politician's supply function towards support of their preferred 'idea' or to compensate them through reelection resources. Since the latter may often be considered illegal, a competitive market between information/ideas develops where each idea is being supplied by its protagonists for its virtues. Only one will be chosen.

This creates a situation similar to those for a technology or an institution; that is, only one can survive in the market. The difference is that, for the suppliers of information/ideas, there is only one user of the idea that is important (at this stage) - the politician proposing the bill. Nevertheless, to ensure the choice, pressure groups may need others (particularly, surrounding civil servants and other members of parliament) to adopt the 'preferred' idea, increasing the probability of the proposer's adoption of the idea. As mentioned earlier, the choice of instrument depends on the perceived costs and benefits to politicians (and the civil servants) of each idea⁷.

There are increasing returns to scale from using one particular technology, institution or idea. Thus, once one takes a lead in the market, And, equally when dominance is achieved, there are likely to be lock-ins and path dependency.

Increasing evidence of the benefits (or reduced costs) of behaviour and market-based instruments in improving environmental quality will raise public awareness and, therefore, may increase the costs to politicians of not using such measures (Shogren 1998 p.558).

Once a proposal has been made, in democracies, it has to be passed through parliament. Each politician can provide the same level of support, in the form of on vote. So, the market for political support at this level can be considered competitive, since the commodity provided (ie support) is homogeneous and there are numerous

⁷ For example, increasing evidence of the benefits (or reduced costs) of behaviour and market-based instruments in improving environmental quality will raise public awareness and, therefore, may increase the costs to politicians of not using such measures (Shogren 1998 p.558).

suppliers (ie members of parliament). The equilibrium point, the meeting of the aggregate supply and demand, provides an indication of the overall degree of support for the particular issue and the marginal willingness to pay for support⁸. It, therefore, indicates the likelihood of politicians voting in its favour⁹.

Once the framework is set up, there is a need for monitoring and enforcement. This may often be provided by an environment agency, and ensures that the constraints imposed on economic agents are binding. As a consequence, the supply of environmental quality adjusts, hopefully, towards the equilibrium with the demand. The stronger is the monitoring and enforcement, the more likely the policy is going to actually influence the supply of environmental quality; without sufficient threat, supply cannot be expected to meet the demand curve.

2.2.4. The Supply of Environmental Regulation

Government can influence three key markets related to energy-environmental policy. First, the traditional approach, referred to as Best Available Technology Not Exceeding Excessive Cost (BATNEEC), tried to specify the type of technology energy users could use. More generally, the regulators can change the constraints in the market for energy technology by creating incentives to use certain pieces of more efficient equipment (either in terms of energy or environment) or by encouraging manufacturers to supply equipment of a certain standard. Second, policy can affect the market for energy. These effects can either be on the energy producers, which lead directly to high supplies of environmental quality (such as in relation to radioactive waste) or influence the user (as in standards on electricity generators that feed through to the use), or directly influence the consumers (e.g. CCL). More recently, a third market, for environmental pollution permits, has been considered open to influence. It could be argued that the lack of any regulation on pollution is a policy of allowing the supply of pollution permits to adjust (in a perfectly elastic way) to the demands for the right to pollute to ensure that the price of each permit is equal to zero. Alternatively, government can impose a fixed supply curve, according to the desired level of pollution.

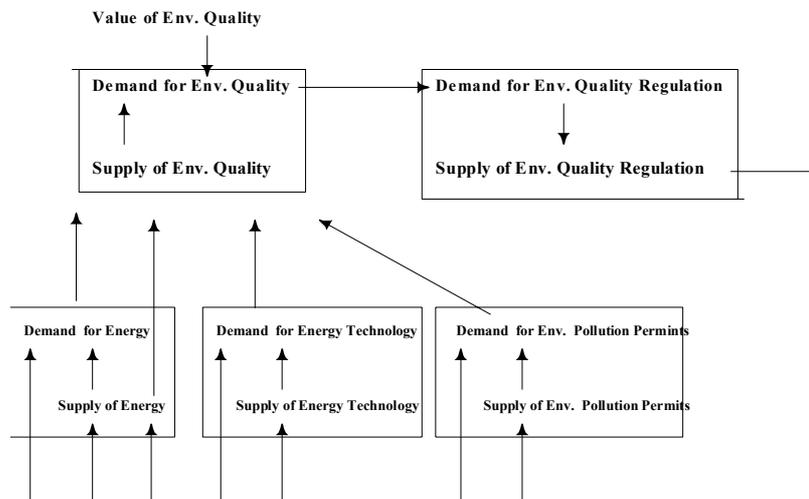
So, legislation can be introduced that requires the company to prevent or reduce the external effects, to clean-up the damage done, to compensate the victims or to minimise the risk of damage occurring. Market based incentives, such as taxes on pollutants, subsidies for using clean processes or tradable permits for the right to pollute, can be introduced that will set a cost on polluting.

⁸ The equilibrium point could fail to provide a market outcome: (a) if the politicians preference for the proposed legislation is greater than the individuals', firms' and interest groups' willingness to pay (ie the meeting of demand and supply is below the horizontal axis), then politicians will be in favour of the proposal irrespective of the demand incentives or (b) if the politicians dislike for the proposed legislation is greater than the public's maximum willingness to pay for support (ie the meeting of the two curves is to the left of the vertical axis), politicians will be against the proposal.

⁹ Because effective support is translated into a binary system ('one person, one vote'), the framework as presented cannot indicate the outcome of the vote (even if all demand and supply behaviour was known with certainty). Attempts are being made to develop the link between the degree of support into votes.

It could, therefore, be argued that the level of environmental quality and cost of achieving it reflect the (distorted) interactions of the demand for and the supply of environmental quality. If so, to anticipate future trends in pollution and companies' environmental (including decommissioning) liabilities, it would be valuable to consider how demand and supply will change and how they will interact, including the distortions. For example, rising standards of living or greater awareness of physical damage associated with certain pollutants are likely to raise public's willingness to pay for environmental quality. This will impose pressures on policy makers to introduce legislation to raise in environmental standards. Higher environmental standards are likely to lead to higher costs of either prevention or remediation - ie higher environmental liabilities. Changes in pressure groups, in the media's approach to public's concerns or in the reflection of public preferences through political processes are likely to alter legislation related to the environment. Such changes are likely to increase the incentives for companies to internalise some of the external costs and supply a higher level of environmental quality, thus, increasing the total costs of abatement (i.e. environmental liabilities). Alternatively, policy makers are moving towards more market based instruments to achieve environmental standards. These instruments can achieve similar standards as traditional 'command-and-control' measures, but at lower costs to companies. This movement may put downward pressure on environmental liabilities.

Figure 2.5. Links between the markets for environmental quality, its regulation and related markets



2.3. The Market for Environmental Information

2.3.1. Policy-Makers' Demand for Information

Most decisions related to environmental activities are made with a degree of ignorance, uncertainty or risk¹⁰. Consequently, related to each decision-making process, the agents will be receiving information. In particular, the degree of effective

¹⁰ Here, risk is when individuals know the probability distribution function, uncertainty when they do not, and ignorance when they are not aware of the issues.

support provided by politicians will be heavily influenced by their information content and sources. The producer and supplier of information will, therefore, play a key role in agents' beliefs and choices, and in determining environmental policy (See Figure 2.5).

For government to make decisions about the appropriate policies to use, they need information on the nature of environmental problems, their importance, their causes, possible solutions and the most suitable policy to tackle them (Fouquet 1997).

The first task of an environmental policy maker is, therefore, to identify the problem. The next task for environmental policy makers is to understand the cause of the problem. From an economist's perspective, this will involve finding out what factors are leading to market failures. In addition, policy decisions are constrained by the information available about the benefits and costs of environmental quality, by the technological capabilities of resource-using appliances and by the related institutional framework for generating environmental quality, such as the structure of markets or the current legislation on rights to pollute the atmosphere or air. Thus, policy makers' ability to successfully intervene in energy markets, rectify market distortions and ultimately to progress towards sustainable development depends on the quantity and quality of the information they acquire and the costs of acquiring it.

2.3.2. Characteristics of Information

“Information has three main properties that would seem to cause difficulties for market transactions: experience good (you must experience an information good before you know what it is), returns to scale (information typically has a high fixed cost of production but a low marginal cost of reproduction), public goods (information goods are typically non-rival and sometimes non-excludeable).” (Varian 2000).

Needing to experience information knowing its value means that either the supplier will have difficulty charging the desired price for the product after it has been consumed or the buyer will have difficulty placing a value on the product before it has been consumed. There are certain institutions developed to improve the buyer's ability to evaluate and the seller's ability to charge: previewing and browsing, expert reviewing and reputation.

The high fixed costs of information production and low marginal costs of its reproduction limits the potential for competitive markets. Generally, these costs are sunk, such that they are covered to production and not recoverable in case the product is a failure. Competitive markets drive prices down to marginal costs, which are virtually zero for information goods, thus, limiting the ability of buyers to cover the high fixed costs.

As a result, competitive markets for information do not exist, instead each information product works in its own differentiated market, with some similar and some different characteristics. This enables the supplier to face imperfectly elastic demand for his/her product. With some power over the pricing structure, the supplier can raise prices

above marginal costs and discriminate on the basis of price and/or quality amongst consumers¹¹. This enables him/her to recover some of the fixed costs.

Pure public goods are non-rival and non-excludable. A non-rival good, such as information, can be consumed by one person without reducing the cost of another person benefiting from its consumption - thus, the marginal costs of another person consuming are zero. For example, television programmes are non-rival because my neighbours consumption in no-way affects my costs of enjoying those programmes. A non-excludable good is one for which the costs of stopping an individual from consuming it are prohibitively high. In the example above, the 'terrestrial' television channels are effectively non-excludable, despite the threat of the 'BBC's detector vans. Excludability, limiting consumption only to paying customers, is generally made feasible by legal rights and/or technological devices.

While information is by its nature non-rival, non-excludability is a choice for society to make about whether to charge individuals or not¹². Many societies believe in the value of exclusion for the producers and suppliers of information. The principal method is copyright (or intellectual property right) laws. This at least places a legal, if not physical, barrier to copying and selling information, or piracy. Another approach is to bundle the public good with a private good; devices (such as encryption) are being developed to limit the use of the product. A further method is to use tracking devices to know who is using the product and to charge them accordingly.

2.3.3. Information Production, Supply and Use

In relation to environmental issues, physical, biological and social scientific analysis will produce the basis for much of the information. Scientists (in the broadest sense), producing information, will also be responding to incentives and subject to constraints (Stephens 1996). A research team, using its human capital (eg its knowledge, experience and skills) and equipment, will try to maximise its collective value or objectives. A researcher's objectives can come in many forms: financial reward, added knowledge and experience, reputation and prestige, power and influence, social improvement, etc.. The constraints faced are in terms of the finances and time, which can determine the size and quality of the research team and equipment available, and the opportunity costs associated with pursuing particular research rather than another potential attractive topic. The achievement of the objectives, given the constraints, will depend on 'output success', which will principally be associated with results, analysis and conclusions, and the ability to disseminate them to the widest and most prestigious fora(um?). Output success will be in large part in competition with (and to the detriment of) other scientific teams; each trying to provide the highest quality results (dependent on credibility, accuracy, etc...) at the lowest cost (perhaps reflecting the ease with which the reader can understand and use the information).

¹¹ One example of variations in quality is the delay in the provision of the information after production - hardback and paperbacks, film and videos, .. (See Shapiro and Varian 1998).

¹² Some might argue that information economy could be made into a communist society by not allowing people to charge, and information would be available freely to all. This means an incentive structure needs to be created for the producers and suppliers.

After the production of information, it needs to be supplied to interested parties. The dissemination of scientific information varies according to the reputation of the authors, the potential interest and controversy of the results, the choice of journal, etc.. Furthermore, information that supports a pressure group's position will be supplied for more widely, as there is a private/club benefit from its distribution - although not always accurately reflecting the producers views [what are the likely informational distortions between the producer and the suppliers?]. On the other hand, much research gets ignored or does not reach a wide audience because the researchers' lack the skills or resources necessary to successfully distribute their information. There is also a role for the more general media to influence what scientific information becomes important and influential. The likelihood of a particular piece of research reaching the appropriate policy-maker depends on the researchers' reputations, their contacts, efforts, the dramatic content of their results, the interest and demand from policy makers. Even if a particular piece of information reaches a policy maker, it competes with other information pieces and sources to influence decisions.

2.4. Conclusion

This chapter has represented a model of the market for environmental quality. It has sought to take account of the associated market failures and how that generates a market for environmental quality regulation. The suppliers of environmental regulation need to improve their understanding by entering the market for information, which is in part met by natural and social scientists. This information helps (or hinders) policy-makers ability to make decisions about standards and methods of achieving them. This decision-making process is inevitably a tension between political and economic forces, and it is not always the most social beneficial course of action that is followed. In our case, it is not clear how information about the marginal benefit of reducing environmental pollution, such as the ExternE project, will be used by politicians as the basis for internalising external costs or as just one of many competing pieces of information about how to act.

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3. THE EXTERNE PROGRAMME

Bauen, A., V. Karakoussis and R. Fouquet

This chapter assesses the ExternE programme. It considers the nature of energy externalities (Section 3.1.) and their assessment (Section 3.2.). It then provides an explanation of the ExternE methodology (Section 3.3.), followed by a review of early, related studies (Section 3.4.) and a summary of the latest estimates (Section 3.5.). This is followed by certain specific limitations (Section 3.6.) and a more general discussion, focussing particularly on the choice of methodology (Section 3.7.). Section 3.8. considers the difficulties of applying the ExternE project to environmental policy-making and the final section draws some conclusions.

3.1. The Externalities of Energy

The energy sector is a major source of environmental and non-environmental externalities (Table 3.1). Consideration of the externalities in decision and policy making with regard to energy is fundamental to reduce its negative impacts and move towards a more sustainable energy supply and use.

Table 3.1. Examples of Impact Categories Leading to Potential Externalities

Environmental	Non-environmental
<ul style="list-style-type: none"> • Human health • Ecotoxicity (impacts of noxious substances on flora and fauna) • Acidification • Eutrophication • Soil quality • Climate change • Amenity (e.g. noise, odours and visual impacts) • Biodiversity 	<ul style="list-style-type: none"> • Resource use • Employment • Security and reliability of supply • Effects on Gross Domestic Product • Rural development

Externalities occur at all stages of a fuel cycle¹³. The externalities of energy can be reduced by improving fuel cycles, switching between fuel cycles, a more efficient end-use of energy and reductions in energy consumption. The ultimate goal of externalities valuation is to achieve an economically efficient allocation of resources through the integration of externalities in energy prices. Given the state of the art of externalities valuation, we are still far from being able to use externalities in search of Pareto optimal solutions (admitting that markets operate perfectly!). However, the valuation of externalities (and the process of assessing externalities generally) is useful for providing an indication of damages/benefits associated with different

¹³ A fuel cycle is defined as consisting of all activities involved in the supply of thermal or electrical energy to an end user and consists of the following principal activity groups: primary fuel production and transport, conversion to heat and electricity, and electricity and heat distribution. In the case of energy supply to the transport sector, the fuel cycle consists of primary fuel production, transport and refining, fuel distribution, and conversion to mechanical power. Renewable fuel cycles, such as wind, solar and hydro, do not possess upstream fuel production and transport stage and the fuel cycle consists uniquely of conversion and transport and distribution stages. Energy saving measures could be considered as a fictitious fuel cycle in which energy instead of being generated is saved (negawatts).

energy options, for assessing trade-offs between different energy options, for ranking energy options and it can serve as a basis for the introduction of economic instruments to reflect the social costs of energy.

The 'monetary valuation of environmental externalities now seems to be the dominant paradigm in the comparative environmental appraisal of energy options' (Stirling, 1997). However, the path to assessing externalities is mined with difficulties and uncertainties.

3.2. Approaches to Externalities Assessment

The determination of the external costs and benefits of fuel cycles is characterised by three main stages: identification, quantification and monetisation of the impacts.

Two methodologies are commonly used to determine the externalities associated with fuel cycles and are based on top-down or bottom-up approaches. Most of the earlier externalities studies employ a top-down approach where generic damage costs are estimated at a national level for different impact categories (e.g. damage to forests) and are then attributed to various emissions (e.g. SO₂) to determine, based on an emissions inventory, an average external cost per unit of emission. The external cost per unit of energy is finally obtained on the basis of generic emissions from different fuel cycles (Hohmeyer, 1988; Friedrich and Voss 1993; Pearce 1995a, b; Ott, 1994). The top-down approach is generally based on highly aggregated data for damages and emissions. It may be suitable to provide a first indication of the environmental externalities of energy where sufficient data is available on the state of the environment to estimate specific impacts resulting from emissions of pollutants to the environment. It does not however allow for the assessment of the marginal effects of additional energy supply, which are usually of interest for decision making and planning purposes.

The bottom-up approach is also known as *impact-pathway approach* or *damage-function approach* (DFA) and it allows for the calculation of marginal external costs. The approach can be generally applied to all sorts of impacts for which a impact-pathway can be defined. In the case of pollutants the approach begins with determining the quantity of emissions from a defined source, then makes use of dispersion models and exposure-response functions to determine the marginal damages resulting from the emissions. The final step consists of multiplying the marginal damages by their estimated monetary value. DFA studies are site specific and the marginal external costs obtained are in principle not transferable. The application of this methodology requires large quantities of data and is time consuming. The results of past studies have shown that externalities calculated using a bottom-up approach tend to be lower than those calculated using top-down approaches. In part this difference appears to be due to the limited consideration of synergistic effects between pollutants and the adoption of linear exposure-response functions in bottom-up studies. The more recent studies use this approach (RCG/Tellus, 1995; ORNL/RFF, 1995; CEC, 1995 and 1998a).

A series of valuation techniques are used to assign monetary values to environmental impacts. *Market prices* can be used for the direct valuation of damages or benefits to commodities which are traded (e.g. damages to forests lead to the loss of timber

which can be quantified based on the price at which it is traded on the market). For environmental goods and services for which no direct market exists, economists have had to devise other valuation tools. A direct method consists of the *contingent valuation method (CVM)*, in which individuals are asked the *willingness to pay (WTP)* for improved environmental quality or the *willingness to accept compensation (WTA)* for environmental damage, creating thus a fictitious market for the goods and services considered. Non-market items can also be valued *indirectly*, by examining changes in prices of traded commodities which are linked to them. *Hedonic valuation* looks at differences in prices of market-based goods (e.g. housing prices) to determine the willingness to pay of individuals to avoid certain impacts. The *revealed preference method* infers what value individuals place on goods and services by observing their behaviour. For example, *travel-cost valuation* looks at individuals' expenditure to travel to places where a desirable environment may be experienced.

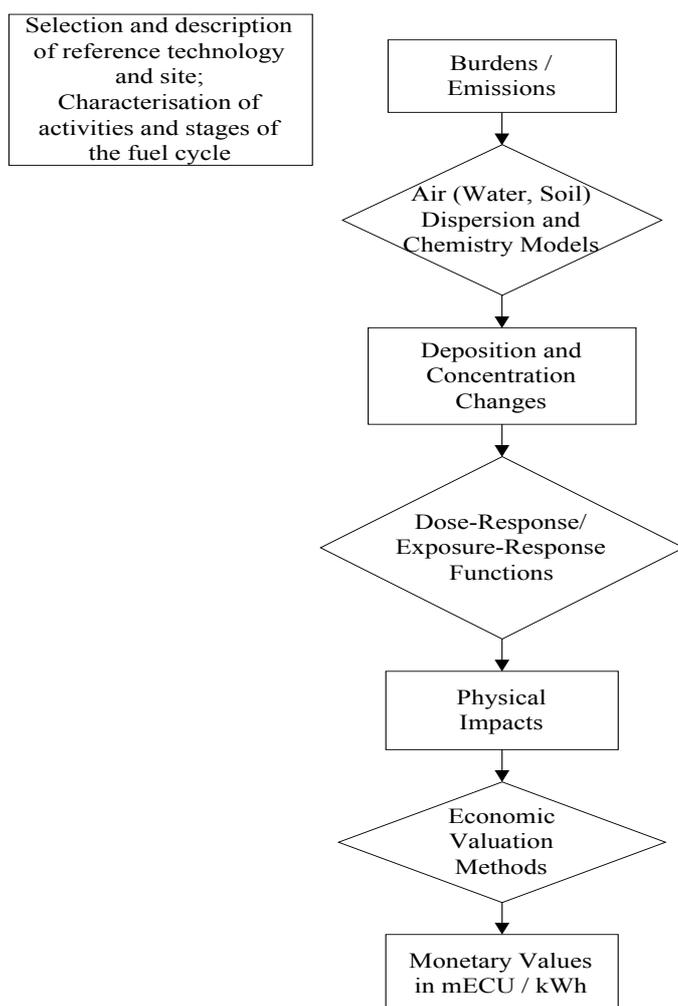
Where damage costs are difficult to determine using the above valuation techniques, or if the uncertainty of the values is judged to be too large, control costs have been proposed in some cases as a proxy for damage costs. Control costs can be determined by assessing the costs of achieving emissions reductions to specific levels (or also costs incurred for mitigating the damages). They do not give an indication of the externality but of what society would have to pay to avoid it. This may be useful in relation to impacts that are characterised by a high degree of uncertainty, as is the case with climate change.

3.3. The ExternE Methodology

The most exhaustive study to date on the external costs of energy is the ExternE project which began as a collaborative effort between the EC and the US in 1991 and of which the European side has completed a third phase in 1998 (CEC, 1995 and 1998a). The ExternE methodology (CEC, 1995) uses a bottom-up approach to determine the environmental external costs of fuel cycles (Figure 3.1). The project has been principally concerned with the determination of impacts and externalities of air emissions from conventional thermal power plants, as these are likely to cause the most significant (i.e. priority) impacts in the case of conventional fossil fuel cycles. The first step in the methodology is to provide a fuel cycle inventory and impact matrix, based on which a set of priority impacts are identified by expert judgement for further study. To determine the damages of atmospheric pollution, the dispersion and transformation of pollutants is modelled based on a short-range and long-range atmospheric dispersion model. The local atmospheric dispersion model calculates the pollution increments for one hundred 10x10km grid cells around the emission source. The regional atmospheric dispersion model calculates the pollution increments for 100x100km grid cells across Europe. The pollution increments can be translated into impacts via exposure-response functions. ExternE has selected a large number of exposure-response functions (ERFs) relating impacts to the polluting species considered (e.g. effect of exposure to particulate concentration on acute mortality). The ERFs are the result of an extensive literature survey and are mostly based on recent epidemiological studies carried out across Europe (ExternE Phase III, CEC, 1998a). It is important to note that the exposure-response functions used are linear. The economic valuation of the physical impacts is carried out, based on a database of monetary values associated with the different impacts. The monetary values are based on different valuation techniques and have been obtained through a literature survey.

The ECOSENSE software developed within the framework of the ExternE project performs the external costs calculations for short-range and long-range atmospheric pollution from point sources. ECOSENSE requires input in the form of plant characteristics and location, emissions per unit flue gas volume, and meteorological data for the short-range dispersion model. The results are provided as a range of low and high cost estimates for damages to human health, damages to forestry and crops and damages to building material.

Figure 3.1. Impact-Pathway Methodology (CEC, 1998b)



The ExternE methodology stresses three principles which are important in externality valuation. They are: transparency (i.e. clear description of method, assumptions and data used), comprehensiveness (i.e. consideration of all significant impacts and full account of their spatial and temporal effects), and consistency (i.e. allow for comparisons between different fuel cycles and sites). In addition, the project has been split into three project areas:

- **ExternE Core Project:** Focusing on developing the ExternE methodology and investigate the use of sustainability indicators; explore the policy relevance of ExternE through policy making case studies and disseminate project results.
- **ExternE National Implementation:** Aiming at implementing the ExternE methodology in all member states (and Norway) to derive comparable data covering the external costs of electricity generation. Apply the data produced to policy case studies for each member and the EU as a whole.
- **ExternE Transport:** The transport project is extending the ExternE methodology to the use of energy in the transport sector. It aimed at developing a consistent accounting framework for estimating external costs from transport and demonstrate its application through a number of case studies.

The starting point for the fuel cycle assessment is the definition of the boundaries of the system and the range of burdens and impacts to be addressed. To ensure consistency in the application of the methodology for different fuel cycles, the boundaries set in the ExternE project are very broad. The stages of the fuel cycle considered include:

- Production of construction materials
- Transport of construction materials
- Exploration of fuel
- Extraction of fuel
- Transport of fuel
- Transport of personnel
- Treatment of flue gases
- Generation of wastes and byproducts
- Further treatment of waste Removal of plant at the end of its service lifetime
- Restoration of site after closure

One of the most important features of ExternE is the site dependence of the analysis of each fuel cycle. For each stage of each fuel cycle a specific location for the powerplant and the other activities included in the scope of the study, has been selected.

The term “burden” in the ExternE project is used to describe anything that is, or could be, capable of causing impact of whatever type. The methodology considers as burdens the following:

- Solid wastes
- Liquid wastes
- Gaseous and Particulate air pollutants
- Accidents
- Occupational exposure to hazardous substances
- Noise
- Heat
- Presence of human activity (causing e.g. visual intrusion)
- Others (e.g. exposure to electromagnetic fields, availability of fissile material for non-peaceful purposes)

After identifying all possible burdens the next stage involves the identification of the potential impacts of these burdens. In doing so, many receptors that may be affected

by fuel cycle activities are valued in a number of different ways (e.g. forests are valued for timber but also for amenity, protection of the hydrological cycle, habitats etc.). At this stage it is irrelevant whether a given burden will actually cause an impact. All potential impacts of identified burdens are reported. In addition the spatial and temporal limits of the impact analysis are defined.

Table 3.2. Sustainability Indicators Framework

Sustainable Development Framework	Environment Themes	Pollutants	Impacts on	Thresholds	Indicators
Strong	Acidification/ Eutrophication	SO2 NOx N deposition Acid deposition	Natural, Semi-natural ecosystems Forests Freshwater ecosystems Fisheries	Critical Loads/Levels, Target loads, Gap closure Acid neutralising capacity (ANC)	Exceedence, Weighted exceedence Monetary value of ANC exceedence
Strong	Nuclear	Radioisotopes	Human health	Typical background radiation levels	Level exceedence
Strong	Global warming	CO2 etc.	Climate	Acceptable temperature changes	Exceedence of acceptable temperature changes
Week		PM10 SO2 O3 CO2 etc	Human health - Morbidity - Mortality Forests Materials Climate change	Current disamenity, Asset depreciation	Monetary values of disamenity and depreciation

Source: Externe, 1998, vol. 7

Having identified the range of burdens and impacts that result from the fuel cycle examined and defined the technologies under investigation, the analysis proceeds as follows:

- **Prioritisation of impacts:** From all the impacts identified priority was given to those which (according to present knowledge) will provide the greater externalities.
- **Description of priority impact pathways:** Define the link between burden and the monetary cost of the impact caused.
- **Quantification of burdens:** Collection of a vast amount of data from different sites in member states to build the inventory for all stages of the fuel cycles.
- **Description of receiving environment:** In order to identify the impacts due to the burdens under investigation in a specific area, expert assessment of the area is required. That includes meteorological conditions affecting dispersion and chemistry of atmospheric pollutants, location, age and health of human populations relative to the source of emissions, the status of ecological resources and the value systems of individuals.

- **Quantification of impacts:** Modeling of the dispersion of pollutants and use of dose-response models to assess their impact on humans and the environment.
- **Economic valuation of impacts**

Considering the increasing integration of the concept of sustainability in policy making, the ExternE project used the already existing methodology to produce a set of sustainability indicators.

3.4. Review of Externalities of Energy

The previous sections have made reference to a number of studies which have addressed the externalities of energy, and table 3.3. provides the ranges for the externalities obtained by some prominent studies since the late 1980s for different fuel cycles (the value of the externality associated with climate change impacts is given in parentheses). The review which follows provides an indication of the impacts on which valuation has focused to date, the magnitude of energy externalities, the differences in values between studies and the relative importance of different impacts.

Studies have mainly focused on the impacts of fuel cycles on human health, and these generally represent the most significant contribution to the value of the externality. In cases where estimates of damage from climate change caused by the emission of greenhouse gases are considered, they often overwhelm other externality values. The range of externality values are also wider where damages from climate change are considered because of even larger uncertainties over the impacts. Apart from the uncertainties surrounding the physical impacts of climate change, further uncertainty is added by different economic assumptions made in valuing potential damages. Typically, the level of discounting is the cause of considerable controversy and an important ethical issue. Small changes in the discount rate cause large variations in damage estimates because of the long-term effects of climate change.

Hohmeyer (1988) uses a top-down approach to value damages associated with environmental impacts of fossil fuel generation on flora, fauna, humans and materials, and considers climate change impacts. A single externality has been attributed to electricity from fossil fuels in general, expressed per unit of electricity generated. However this cost is likely in most part to be attributable to coal, in particular old coal plants, which should account for most of the damage. The external costs of nuclear energy are found to be large and are attributed to impacts on human health from normal operation and accidents and to resource depletion. Climate change accounts for just a small part of the externalities valued in this study, representing less than 1% of the estimate.

The study also considers a number of non-environmental externalities such as the depletion of non-renewable resources and government subsidies, with the first contributing between a quarter and half of the externality estimate for fossil fuels and between one third and two thirds of the value for nuclear. The externalities estimated are believed to represent only the tip of the iceberg and consideration of further externalities would further strengthen the stance of renewables. The net benefits of wind and solar energy result from economic effects such as gross value added, savings and employment.

Table 3.3. Review of Externalities of Energy [UScents/kWh]

	Hohmeyer (1988)	Friedrich and Voss (1993)	Ottinger et al. (1990)	RCG/Tellus (1995)	Masuhr and Ott (1994)	ORNL/RFF (1994)¹	Pearce (1995a, b)	CEC (1998a)
Coal	4.1 - 9.3	0.4 - 2.0	2.9 - 6.7 (1.7)	0.3	-	0.06 - 0.13	1.5 - 8.1 (0.7 - 0.8)	0.8 - 31.4 (0.5 - 18.0)
Oil	-	-	2.9 - 6.8 (1.2)	0.2	6.0 - 88.0 (3.1 - 85.4)	0.018 - 0.024	5.7 - 9.1 (0.7)	2.0 - 24.8 (0.4 - 15.8)
Gas	-	-	0.8 - 1.2 (0.79)	0.02	3.3 - 61.0 (2.2 - 59.8)	0.0013 - 0.024	0.6 - 0.7 (0.3)	0.3 - 10.5 (0.2 - 9.8)
Nuclear	10.2 - 21.9	0.03 - 0.6	3.4	0.01	0.3 - 3.0 (0.1 - 2.8)	0.022 - 0.034	0.07 - 0.5 (0.02)	0.3 - 1.0 (0.01 - 0.04)
Biomass	-	-	0 - 0.8	0.3	-	0.19	0.4 (0.04)	0.1 - 4.2 (0.08 - 0.3)
Hydro	-	-	-	-	0.2 - 1.2	0 - 0.017	0.06 (0.008)	1.0 - 0.9
Solar	<i>7.2 - 18.0</i>	0.05 - 1.2	0 - 0.5	-	-	-	0.1 (0.005)	0.08 - 1.1 (0.03 - 1.0)
Wind	<i>5.9 - 13.0</i>	0.02 - 0.4	0 - 0.1	0.001	-	-	0.02 - 0.07 (0.005)	0.05 - 0.5

Note: values in parentheses indicate contribution of climate change externality to the externality value provided

italics denote an environmental benefit

¹ Data summarised in Lee (1996)

Hohmeyer's study being one of the first studies to attempt the quantification of the externalities of energy attracted great attention, in particular because it indicated that the externalities of conventional generation are significant and similar in magnitude to the price of electricity. As a response, Friedrich and Voss (1993) carried out a similar study which resulted in much lower externalities for fossil and nuclear fuel cycles. The study rejects most of the non-environmental externalities claimed by Hohmeyer (1988) (e.g. employment), estimates the cost of utilisation of non-renewable resources as being small and possibly internalised, and estimates R&D expenditure and public subsidies as being significant externalities. R&D expenditure account for most of the externality estimate in the case of wind and solar.

The PACE study (Ottinger et al. 1990) is based on a literature review of environmental impacts based on bottom-up studies. The externalities valued refer to damages of air pollution. The damage cost of climate change impacts accounts for a large portion of the externality associated with the fossil fuel cycles. The bulk (80%) of the externality of the nuclear cycle is associated with the risk of accidental emissions. The externalities associated with renewable energy are mainly a result of toxic emissions from the manufacturing process in the case of photovoltaics, of noise in the case of wind and of atmospheric emissions in the case of biomass.

Masuhr and Ott (1994 and 1996) discuss a top-down approach applied to Switzerland. The externalities of the fossil fuel cycles account for the damages of air pollution to human health, buildings, agriculture and forestry. The nuclear energy externality accounts only for estimated deaths caused by normal plant operation. The principal externalities associated with hydropower are a result of the impairment of natural landscapes and the impacts on water systems. The externality values are based on willingness to pay surveys on conservation and biodiversity and on the valuation of the recreational function of natural landscapes. The costs of climate change are valued in terms of damage cost estimate ranges and average avoidance costs for Switzerland (damage cost estimates are shown in Table 3.3).

Pearce (1995a and b) estimates externality adders for UK power generation based on a literature review of externalities associated with different pollutants and on a range of emissions for different generating technologies. The estimates account for air pollution and climate change impacts. The climate change damage cost is based on an estimate by Fankhauser (1994). The externality adder for nuclear energy is largely a result of damage estimates for accidental emissions. The externality estimates for hydro and wind account only for damages from emissions of pollutants from equipment production and from the construction stage, and does not include - although they are mentioned - more site specific effects such as noise, landscape changes and effects on fauna which may be dominant for such generating systems.

The RCG/Tellus (1995) study, also known as the New York State Externalities Study, is based on a bottom-up approach. The study considers the impacts of air, water and soil pollution. For fossil fuel cycles, air pollution impacts are the only ones of significance. The study does not account for climate change impacts. Impacts of water pollution appear to be significant in the particular biomass case considered. The nuclear energy externalities are dominated by radiation exposure impacts from normal operation. The wind energy externalities are a result of impacts on the landscape. The externality adders calculated are lower than those obtained by the previous studies.

However, the results for the Sterling, NY, site are particularly low, and within the same study, the siting of fossil facilities (natural gas and oil) at other sites has resulted in increases in externality adders of up to a factor of eight. Ottinger (1996) has criticised the study as suffering from serious omissions and undervaluations and his criticism extends to other bottom-up studies. Also, the low health damages calculated can be explained by the low population densities exposed to the pollutants and by a lack of adequate air dispersion modelling (CEC, 1998b).

The Oak Ridge National Laboratory (ORNL) and Resources for the Future (RFF) study (ORNL/RFF, 1994) has been carried out as part of the EC/US External Costs of Fuel Cycles study, the first phase of the ExternE project (CEC, 1995). The study, based on the bottom-up approach, focuses on the impacts on human health of atmospheric emissions from power generating facilities. Like the RCG/Tellus study, the externalities calculated are significantly lower than those of other studies.

The most recent and extensive effort to value the externalities of energy is provided by the ExternE project. The third phase of the project (CEC, 1998a) has assessed the externalities of fossil, nuclear and renewable fuel cycles across the European Union member states. For the fossil fuel cycles the range of externalities is strongly influenced by the technology chosen for the case studies and by their location. For example, a similar facility sited in Sweden and in Germany is likely to present lower externality values for Sweden because of the likely lower population that may be exposed to pollution. Such site specific effects may lead to different priorities with regard to the impacts of fuel cycles at different sites. In the case of the nuclear fuel cycle, the external costs associated with the risk of accidental emissions are very small. However, the study admits that much controversy exists on how public perception of risk should be included in the analysis. Most of the damages are attributed to radioactive emissions of abandoned mill tailings and to climate change impacts of the emissions from reprocessing stages. The externalities of the biomass fuel cycles are generally lower than those of the best fossil fuel cycle considered. The external benefit obtained for hydropower reflects the Austrian case study where only benefits of protection from flooding and effects on navigation have been considered. The site dependency of externality estimates is also likely to be great for hydropower because of the strong influence of local amenity and ecological issues. The externalities of both nuclear and renewables are small, but the uncertainties over the risks associated with nuclear are much larger.

Few studies on the externalities of energy have been carried out outside Europe and the US. A study by Carnevali and Suarez (1993) assessed the effects of Argentinean energy policies of the 70s and 80s on air pollution emissions and emissions control costs. It is estimated that fuel switches avoided a capital expenditure on emissions control of over \$1.5 billion. Van Horen (1996) carried out an assessment of the externalities of coal and nuclear energy for South Africa. The externalities of coal consider mining injuries and deaths, health impacts from air pollution and climate change impacts, and they range between 0.6 and 3.4 UScents/kWh (0.16 and 0.24 UScents/kWh excluding climate change impacts). The externalities for nuclear consider exclusively fiscal subsidies and range between 0.9 and 3.1 UScents/kWh. Furtado (1996) carried out a contingent valuation study to assess the WTP to avoid environmental impacts from hydro, coal and nuclear power in Brazil (table 3.4). The study which related to three specific facilities showed public preferences to favour

hydropower, followed by coal and finally nuclear. After comparison with externalities determined in other European and US studies, Furtado found the values to be sufficiently reliable for use in cost-benefit analysis of energy generation options. However, for the facilities considered, the inclusion of the external costs considered would not have influenced their ranking based on private costs. Furtado's study is a pioneer in the valuation of energy externalities in Brazil. The study though relies on contingent valuation alone, with all impacts aggregated in a unique value, and lacks specificity with regard to technology and knowledge of actual impacts.

Table 3.4. CVM Estimates of Externalities of Energy in Brazil (Furtado, 1996)

Conversion facility	Externality [UScents/kWh]
Hydro	0.38 - 0.81
Coal	1.34 - 2.81
Nuclear	2.97 - 5.95

The review of the externalities of energy illustrates the wide range of values found in the literature. The assumptions and methods vary greatly for the different studies, and many results are strongly site dependent. However, it can generally be concluded that the externalities of energy are most likely to be significant in relation to the current price of energy. The difference in externality between fossil and renewable sources is also likely to be significant, in particular when considering CO₂ emissions. Greatest benefits of renewables appear when comparing old coal technology to wind, while the benefits are reduced when comparing natural gas to biomass, where the benefit may largely be attributed to reduced CO₂ emissions. The case of natural gas and biomass fuel cycles will be discussed in greater detail later. The range of externalities of nuclear energy is large, mainly due to difficulties in assessing the risk of nuclear accidents. Nuclear energy also presents difficulties (e.g. disposal of radioactive waste material) which lead to questioning the sustainability of the fuel cycle.

3.5. Summary of Results of the ExterneE Project

3.5.1. Results for Air Pollutants

After having looked at a review of other related study estimates the external costs of energy production, distribution and use, in this section, we consider the estimates brought together specifically under the umbrella of the ExterneE programme. The summary of the main results is presented in Table 3.5.

The highest damages per tonne of pollutant emitted belong to central European countries (France, Germany, the Netherlands, Belgium, Northern Italy) mostly because of the large population affected. The much lower damage figures presented for peripheral countries (Scandinavian, Greece) are not only due to less population affected, but also to limitations of the methodology which excludes non-European populations. The problem has partly been solved by the incorporation of Russian populations for Finland and Asian and North African populations for Greece. Given the site specific character of the methodology, results vary considerably even within the same country. A characteristic example is the case of large cities been located near incineration plants as seen in the case of France. This location produces very large damages, e.g. particulates produce damages around 57,000 ECU/t in the Paris area.

Table 3.5. Summary of Results for Air Pollutants

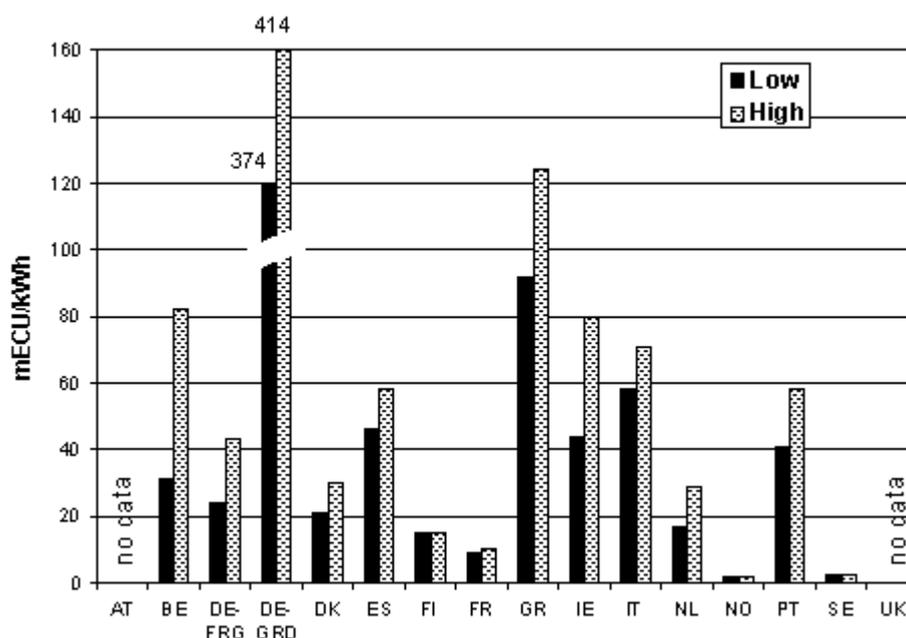
Country	SO ₂	NO _x	Particulates
Austria	9,000	9,000-16,800	16,800
Belgium	11,388-12,141	11,536-12,296	24,536-24,537
Denmark	2,990-4,216	3,280-4,728	3,390-6,666
Finland	1,027-1,486	852-1,388	1,340-2,611
France	7,500-15,300	10,800-18,000	6,100-57,000
Germany	1,800-13,688	10,945-15,100	19,500-23,415
Greece	1,978-7,832	1,240-7,798	2,014-8,278
Ireland	2,800-5,300	2,750-3,000	2,800-5,415
Italy	5,700-12,000	4,600-13,567	5,700-20,700
The Netherlands	6,205-7,581	5,480-6,085	15,006-16,830
Norway	n.a.	n.a.	n.a.
Portugal	4,960-5,424	5,975-6,562	5,565-6,955
Spain	4,219-9,583	4,651-12,056	4,418-20,250
Sweden	2,357-2,810	1,957-2,340	2,732-3,840
UK	6,027-10,025	5,736-9,612	8,000-22,917

Source: ExternE, 1998, vol. 10

3.5.2. Results for Aggregation

To facilitate policy makers to use the results of ExternE for national or European level policy analysis, a set of aggregated results was produced. Due to the number of assumptions used and the methodological difficulties in dealing with such a task, these results should be considered as preliminary, approximate figures and used as background information.

Figure 3.2. Mean Externalities of the Electricity Supply Industry in 15 European Countries



The total damages obtained were translated into an average externality for the electricity generated in each member state and presented in Figure 3.2 for comparison. Damages are higher for countries using coal and lignites more extensively and lower for those where nuclear and renewables have a larger share.

3.5.3. Results for Fuel Cycles

A summary of the results for each fuel cycle per country is presented in 3.6. Damages are expressed in mECU/kWh (this is a subtotal of quantifiable externalities).

Table 3.6. Summary of Results for Fuel Cycles

Country	Coal & lignite	Peat	Oil & orimul.	Gas	Nuclear	Biomass	Hydro	PV	Wind	Waste (ECU/t waste)
AUT				11-26		24-25	0.04**			
BE	37-150			11-22	4.0-4.7					
DE	30-35		51-78	12-23	4.4-7.0	28-29		1.4-3.3	0.5-0.6	
DK	35-65			15-30		12.14			0.9-1.6	
ES	48-77			11-22		29-52*			1.8-1.9	15-24
FI	20-44	23-51				8-11				
FR	69-99		84-109	24-35	2.5	6-7	6			67-92
GR	46-84		26-48	7-13		1-8	5.1		2.4-2.6	
IE	59-84	33-38								
IT			34-56	15-27			3.4			46-77
NL	28-42			5-19	7.4	4-5				
NO				8-19		2.4	2.3		0.5-2.5	
PT	42-67			8-21		14-18	0.3			
SE	18-42					2.7-3	0.04-7			
UK	42-67		29-47 31-52 ⁺⁺	11-22	2.4-2.7	5.3-5.7			1.3-1.5	

Source: ExternE, 1998, vol. 10

*: biomass co-fired with lignites

** : benefits not included. Benefits account for 0.78-8.3 mECU/kWh

++ : orimulsion

The main finding is that fossil fuels, especially coal, lignites and oil present the largest damages, while damages from natural gas are quite low. The lack of great variations in figures for damages between countries concerning natural gas is due to the similarities in the technologies assessed. A completely different case can be seen for biomass where variations in technology and assumptions used lead to significant variations between implementations.

Renewables and nuclear show the lowest damages. However there is still debate and great uncertainty in assessing the possibility of major nuclear accidents. The uncertainties for renewables are not expected to significantly increase the total of externalities calculated because they concern primarily impacts on human amenity and second order impacts due to atmospheric emissions and occupational accidents. These impacts, although difficult to quantify, are not believed to be significantly higher. The above fact gives an advantageous position to renewables with respect to conventional fuels (Mirasgedis and Dialouki 1998).

3.5.4. Results for Global Warming

The marginal damages calculated using base case assumptions are shown in Table 3.7. The uncertainty analysis performed showed that the range of uncertainties is very

large. Even the choice of a base case represents a subjective (and often political) view of economies and societies.

Table 3.7. Summary of Results for Global Warming

Greenhouse Gas	Damage Unit	Marginal Damage from Model			
		FUND		Open Framework	
		1 %	3 %	1%	3 %
Carbon Dioxide	ECU/tC	170	70	160	74
	ECU/tCO ₂	46	19	44	20
Methane	ECU/tCH ₄	530	350	400	380
Nitrous Oxide	ECU/tN ₂ O	17000	6400	26000	11000

Source: ExternE, 1998, vol. 8

Basis: IPCC IS92a scenario
equity weighted
no socially contingent effects
emissions in 1995-2005
time horizon of damages 2100

3.6. The Limitations of the ExternE Estimates

Most of the externalities studies carried out to date acknowledge fundamental problems due to lack of scientific knowledge, uncertainties at various stages of the valuation process, biases in valuation, differences in economic assumptions and ethical issues. However, there is also general agreement that because of omissions in the quantification of impacts, the externalities presented are in most cases believed to underestimate the actual level of externalities.

There are considerable differences between the values obtained by the studies reviewed here. They are mainly due to the variety of methodological approaches used, to differences in the impacts considered, in the emissions estimates for the fuel cycles, in the specific damages attributed to emissions and in the assumptions underlying the risk of nuclear energy, and, where climate change is considered, to the wide range of damage estimates calculated (Lee, 1996).

Most of the earlier studies, based on top-down approaches, obtain higher externality values compared to more recent studies based on impact-pathway approaches. The extent of the effects considered is also very important. For example, the inclusion of climate change damage estimates generally leads to much higher externalities being attributed to fossil fuel cycles and has a significant influence on the nuclear cycle. The consideration of non-environmental externalities may also affect significantly the externality estimates. The technologies considered in the fuel cycle are also a cause of differences in estimates. For example, noxious emissions from a coal-based fuel cycle using integrated gasification combined cycle technology (IGCC) are much lower than those from a coal-based fuel cycle using old coal fired boilers with no emissions control. Also differences in generic damage estimates or in exposure-response functions used lead to significant differences in externality estimates, and so do assumptions made with regard to the risks associated with nuclear energy, for example with regard to the probability of severe accident, releases and exposure in the case of severe accident and risk perception.

Many of the problems affecting the reliability of externality studies can be mitigated or solved through methodological refinements and improvements in scientific knowledge. Addressing the variability of results in externality studies, the US Office of Technology Assessment (OTA) stated that "many differences can be addressed through further research and analysis. Some critical agreements over methodology, however, mask deeper disputes over values, basic policy goals, and the intended role of environmental cost studies. It is unlikely that these disputes can be resolved by technical analysis or scientific research." (OTA, 1994).

There remain, however, a number of limitations associated with externalities values which raise questions about their usefulness in decision making processes. Stirling (1997) asserts that externality valuation suffers the same drawback as other aggregated quantitative techniques, that is the "failure to address the multidimensional nature of environmental appraisal".

Some important issues concern the distribution of environmental effects. They are: the predominantly local effects of certain fuel cycles as opposed to the predominantly regional and global effects of others, the question of how to deal with intragenerational and intergenerational equity (e.g. how impacts are distributed among the population and how to address long-term impacts such as climate change), and the anthropocentrism which characterises environmental valuation and which may not attribute the necessary relevance to the diversity of ecological systems.

Questions can also be raised as to the way monetary valuation addresses environmental effects in terms of severity (e.g. deaths as opposed to serious injuries), immediacy (e.g. injury as opposed to disease), gravity (e.g. the high probability of small impacts of fossil generation as opposed to the low probability of large impacts of nuclear generation), and reversibility (e.g. the irreversibility of climate change and radiation impacts as opposed to the reversibility of changes in landscape of certain renewables such as wind).

Monetary values may also give a false sense of objectivity in aggregating impacts over which those affected have different degrees of voluntariness and control (e.g. the health impacts of air pollution as opposed to the right to a pristine landscape). Monetary valuation is also undermined by issues of comprehensiveness, emphasis being mainly on more readily monetisable impacts, and by issues of reliability in the techniques used in estimating impacts and monetary values, which affect the uncertainty of externalities. These are principally due to lack of sufficient knowledge, data quality, complexity of some of the effects and diversity of empirical and theoretical models used. The variety of influences affecting the uncertainty of externalities render their treatment by orthodox probabilistic approaches a difficult task. The best way to deal with uncertainty appears to make use of ranges of values and sensitivity analysis. It is fundamental, given the current state of the valuation of external effects, to specify, at different stages of the process leading to the monetisation of the impacts, the degree of confidence in the data and models used.

3.7. Discussion of the ExternE Project

3.7.1. The ExternE Methodology

The main purpose of this discussion is to evaluate ExternE as a tool for decision making. The discussion attempts to focus on the way the ExternE results were produced and not the numerical results themselves.

At a conceptual level, the analysis attempts to identify, if possible, an ideal case where the methodology would lead to a set of results with the lowest possible uncertainty. Moving from the concept to the application, the next step is to examine the way that ExternE methodology addressed the problem and evaluate how close this approach has been to the ideal case. The main aim is to understand the reasons behind the methodological choices/assumptions made by ExternE and explore the potential for improvement. The discussion explores the ability of the methodology to adopt and incorporate change and finally highlights areas for change.

To examine the way that the issue of internalising externalities has been approached in the ExternE project, the discussion attempts to answer the following questions looking at each stage of the methodology:

- Is the methodological concept selected appropriate?
- Which are the technical problems to be faced, and is the methodology able to produce reasonable results despite them?
- Are there other reasons, apart from technical, introducing uncertainty?
- Will the validity of the results increase when technical difficulties are solved?
- How far are we from the ideal situation?
- Will the methodological framework be capable to adopt to new scientific knowledge and gradually limit current uncertainty?
- Are there functional assumptions that cannot change?

It has been considered useful to examine damages from climate change separately because from a methodological point of view there is significant differentiation between the calculation of climate change damages and the main core of the ExternE results. This is mainly because climate change is not a site specific phenomenon. In addition these calculations include the highest uncertainty due to lack of substantial scientific information and also due to a series of assumptions used, based on political and philosophical beliefs.

3.7.2. “Top down” vs. “Bottom up” Approach

The two main approaches used in externality analysis are the top down and the bottom up approach (ExternE, 1998). “Top down” analysis is highly aggregated and it is carried out at a regional or national level using estimates of the total pollutants emitted and of the damages caused. The analysis is based on national averages and neglects effects due to variations in population density and pollutant concentration. The transport of pollutants across boundaries is also neglected. The method is considered too simplistic for policy use, especially because it does not take into consideration the site dependence of the damages (Saez et al 1998). The method has been applied in early studies on externality analysis (ExternE, 1998).

The full fuel cycle methodology used in ExternE allows for detailed and spatially disaggregated analysis of pollutant damages. It follows a logical progression from characterisation of emissions through modelling of pollutant dispersion and atmospheric lifetime to determination of impacts using dose response functions and associated economic costs (Holland et al 1996). ExternE examines all stages of the fuel cycle instead of looking at “power generation”.

ExternE methodology is a powerful tool capable of incorporating change in factors influencing the analysis and update previous estimations (Saez et al 1998). An apparent example is the change implemented between the 1995 and 1998 versions of ExternE to include, between others, a better estimation of climate change effects and a more informed use of dose response functions. The methodology provides a platform for producing comparable results allowing for estimations on the significance of any introduced change.

The selection of methodological concept by ExternE has been widely accepted. Several studies on the same topic follow the same methodological approach.

The “bottom up” approach selected to be implemented in the ExternE project, was applied via the impacts pathway analysis (see Figure 3.1). This discussion examines each stage of the impact pathway analysis as it was followed in the ExternE project. To facilitate the discussion the analysis has been divided in three parts examining the concept of the methodology, the influence of the conceptual framework to the application of the methodology and the calculations of the final results.

3.7.3. The Conceptual Framework of the Methodology

The first part includes the stages of the methodology that sets the framework for the analysis. These stages are:

- Setting of boundaries,
- Identification of burdens,
- Identification of impacts and the use of valuation criteria,
- Definition of spatial and temporal limits of the impact analysis.

The boundaries in the ExternE study are widely set to incorporate differences between the technologies under investigation. Considering the purpose of the project maybe there is no scope for improvement in this stage. ExternE attempted to include in the analysis most of the upstream and downstream processes for each technology. Evidently infinite expansion of the boundaries to include all possible upstream and downstream processes is not practical as it increases complexity without adding to the reliability of the results.

Apart from the obvious burdens like solid waste and air pollutants, the definition that ExternE gives to the term burden, opens the discussion to include burdens that are generally not seen in conventional LCA (e.g. electromagnetic fields). The fact that in this stage it is irrelevant if the burden is actually capable of causing any impact, provides freedom to investigate options that were not considered in previous studies. It is common knowledge that as science progresses new mechanisms of impact generation are discovered. The methodology provides the framework to include in the assessment any new scientific evidence (e.g. some years ago venting CO₂ in the

atmosphere was considered harmless). ExternE itself broadened its scope and in the 1998 version included actual calculations on climate change impacts omitted in the 1995 version.

The identification of impacts relies on current literature, empirical knowledge and experts opinion. As long as this stage is a brain storming session aiming to identify all possible impacts despite their probability of occurrence, it provides the flexibility to integrate new evidence in the analysis. It also highlights areas for further research. Identifies weaknesses of analytical tools.

Valuation reflects current scientific knowledge but also social and economic believes of what is “worth valuing”. In some cases there is the willingness to value a commodity that might be lost (visibility losses) but there is not a sound methodological framework developed to support this valuation. Ecosystems for example are valued for productivity based on human terms.

There are some factors that are almost impossible to quantify in monetary terms (e.g. aesthetic appreciation) as they are directly linked with individual preference. This problem is not an issue of development of the methodology but simply a conflict of concepts.

The boundaries of the analysis have been defined in such a way that impacts are assessed over their full geographic and temporal range (Holland 1998). Because of the fact that the methodology assessed impacts only on European populations, the damages from emissions in peripheral countries were initially underestimated. The methodology was then modified to include damages on North African populations for the case of Greece and Russian in the case of Northern European Countries (ExternE, 1998).

The methodology has been proved adequate in setting spatial limits for the estimation of damages, to capture short and long distance dispersion of pollutants using the latest available scientific knowledge. In setting temporal limits the intention of the project was to assess impacts of pollution over their full temporal range. While the results for short term effects (e.g. chemical pollution) are based only on technical assumptions (dispersion models, chemical changes of pollutants, dose response functions etc.), the results for long term effects like those from the release of long lived radionuclides, that have to be assessed over a period of thousands of years, include assumptions on how the world might be in the future. These assumptions introduce a great deal of uncertainty that cannot be avoided, despite any scientific progress. Special attention has to be given on the interpretation of results for fuel cycles that could cause a great deal of long term effects (e.g. nuclear).

3.7.4. The Application of the Methodology

The second part looks at the application of the methodological framework developed in the previous stages and includes:

- Prioritisation of impacts,
- Description of priority impact pathway

It is evident that a study cannot assess all the possible impacts that have been identified in the previous stage. The need for prioritisation is a functional need for the study and is not a reason for exclusion. However including specific impacts in the analysis can be as controversial as excluding others. For example according to Madisson (1999), occupational health impacts and accidents have already been internalised in today's energy market and should not be counted again, a point of view argued by ExternE. There is a series of reasons for excluding an impact from the analysis:

1. *The impact is trivial.*
2. *There is lack of data or modeling capacity to assess the impact although it could be important:* In the assessment of some impact categories such as acid rain effects on forests, several types of possible impacts have been omitted due to lack of scientific or economic data (Holland 1998). The impact of NO_x via ozone has not been assessed due to the lack of a model capable to deal with the complexity of the chemical reactions involved. Damages from NO_x are attributed only to nitrates producing a potentially lower figure than it should actually be. A preliminary estimation of the damages of ozone gave an average figure for the whole of Europe of 1,5000 ECU/t of NO_x emitted.(ExternE, 1998). It would be interesting to examine how much the results would change if local ozone modeling was included (ExternE 1998). For sites near the sea, damages are expected to be smaller as most of the pollutants will fall on the sea. The effect of such a process has not been quantified.
3. *There is not a known way of assessing the specific impact:* Despite the magnitude of damages to human health it cannot be concluded that the impacts on ecosystems (including forests and fisheries) are relatively small. In many cases damages are site specific, non-linear and/or cumulative. When valuing ecological effects how should one assess impacts on non-human life which have no direct physical consequences for human beings? How important is the well being of non-human organisms? At the current state of knowledge these impacts on ecosystems cannot be assessed fully in physical terms let alone as monetary damages (Eyre 1997). ExternE did not include such impacts. Although there was some progress in developing a methodological framework for assessing impacts from visibility losses, ExternE decided to exclude them (ExternE, 1998).
4. *There is too great uncertainty surrounding the specific impact:* The externalities related with the nuclear fuel cycle are presented to be comparatively small. However there are significant issues that were not explicitly analysed or in some cases ignored. These issues ironically are those in the centre of public concern and include assessment of severe accidents, long lived radioactive waste, the right to impose impacts on future generations and risks from terrorists and rogue governments (Rabl and Spaddaro 2000, Eyre 1997). These issues are not purely technical and their assessment might reflect current political and ethical views. They tend to be more issues of acceptability than costs. For example it is more interesting to assess if our society considers acceptable to produce highly toxic nuclear waste and pass them on to future generations as long as the necessary technology to deal with them is not available at the moment, rather than trying to put a price on the damage from the waste produced. The same philosophical problems are present in the assessment of contingent damages (ExternE, 1998).

In an ideal case the only impacts excluded would be those of the first category. Developments in science and computational capacity, together with a wider data gathering effort could possibly improve the situation with categories 2 and 3. For the 4th category the uncertainty is generally related with attempts to project current philosophical and political beliefs in the analysis. The uncertainty will always be there with convincing arguments from all sides. It is not a weakness of ExternE not to be able to deal with these facts but an inherent difficulty of any project trying to deal with the issues. The presentation of different scenarios and a clear statement of the assumptions involved is the best way to go about it. Stimulate discussion without a dogmatic acceptance of one or the other option. None of them is totally right anyway.

The main constrain in describing the optimum impact pathways is generally lack of data. In a number of cases ExternE had to compromise on the depth and the complexity of the impact pathways under investigation due to data constrains. A second but equally important reason, is inadequate understanding of all the possible pathways from a specific burden to a number of impacts or the synergistic effects of several burdens.

The issues of synergy and complexity of the interactions between human activity and the environment are far from been fully understood, making the description of the impact pathways in many cases oversimplistic. The extremely complex nature of these problems and their slowly progressing character often make it difficult, if not impossible, to track the causes and to foresee the effects, features that could exclude them from precise quantification (Ring 1997).

There are limits to what we can expect from progress in modelling, and uncertainty will always be inherent in any calculations attempting to simulate nature's behaviour.

3.7.5. Calculating the Final Results

The third part of this discussion covers the calculations stage where extensive use of modelling takes place. The stages of the methodology examined here are:

- Quantification of burdens,
- Description of the receiving environment,
- Quantification of impacts,
- Economic valuation of impacts.

Quantification of burdens is an inventory building exercise and the method used is widely accepted. The uncertainties encountered in quantifying emissions from the up stream and downstream stages of the fuel cycles, especially in biomass, are due to the diversity of technologies used. These difficulties are bound to decrease as technologies become established and experience accumulates. In general the uncertainties in this stage are limited.

The description of the receiving environment is a crucial stage of the methodology as the impact pathway methodology is based on integrating site specific characteristics in the analysis. The main constrains are data availability and modelling capacity. Analysis over long time scale is the only area that introduces inherent uncertainty.

When the burdens are quantified and the receiving environment adequately described, the use of dose response functions leads to the quantification of impacts.

Although there is a general agreement that air pollution is associated with a variety of health problems, the mechanisms of action are not fully understood. It is difficult to identify causes by epidemiology because different air pollutants tend to be correlated with each other (Rabl and Spadaro 2000).

Some times the problems are mainly technical as in the case of PM where the data are coming from monitoring stations that measure only the mass concentration of PM without any detail on composition. Unfortunately very little is known about the effects of individual components of PM (Rabl and Spadaro).

There is great uncertainty in connecting mortality impacts with CO and ExternE did not include them leading to very small damage costs. Rabl et al (1999) wonder if this is an artefact due to the inability of epidemiology studies to correctly identify the full impact of CO.

The dose response functions for incremental doses of radiation to the public from routine operations of nuclear plants were obtained by extrapolation from the much higher doses that were received by small case study populations, introducing significant uncertainty (Rabl and Spadaro 2000).

The available estimates on the effects from a nuclear accident differ greatly depending on whether the emphasis is put upon the small probability of an accident to occur or upon the extremely high damages of such an accident. ExternE adopted a rather optimistic approach based on risk probabilities (Mirasgedis and Dialkouli 1997). Damages from the nuclear cycle represent only the French example. According to Eyre (1997), the damages due to emissions from mining and milling are unrepresentatively low in the French fuel cycle. Typical practise produces much larger collective doses of radon. Additionally, the age of the powerplant will have a significant impact on its environmental performance.

The above point highlights the different levels of uncertainty introduced in the calculations and the variety of reasons behind it (e.g. lack of scientific knowledge, technical problems, modelling capacity, data gaps). Considering that health impacts are responsible for the main bulk of damages calculated in the ExternE, one can predict significant changes in current estimations of externalities due to progress in the above sectors.

With data coming mainly from contingent valuation studies, ExternE attempted to attach an economic value on the impacts quantified in the previous stage.

Health effects are the dominant externalities and small changes in the assumptions surrounding them can have a significant impact on the results of the study. For the valuation of mortality the change from using the Value of Statistical Life to assigning a value to each year of life lost seems more realistic from a theoretical point of view (Krewitt et al 1999). However the results are extremely sensitive to the values to be selected (Madisson 1999). These values for years of life lost can only be a product of assumptions purely based on philosophical and political arguments.

Due to the highly site-specific character of renewable energy (e.g. wind mills) transferring the results of contingent valuation studies from one site to another is not a valid practice (Eyre 1997).

Relatively minor changes of discount rate can have major implications for the performance ordering of options whose environmental effects are distributed differently over time (Stirling 1997).

Emissions from activities outside the power sector might have a significant influence on what is presented as “energy related externalities”.

The figures obtained for external costs should be viewed as sub-total as there is still a number of impacts to be quantified in monetary terms. Apart from this fact the figures are already significant.

3.7.6. Climate Change Damage

Assessment of climate change damages is at a less advanced stage than the analysis in the main body of the project and major uncertainties remain.

The main problem with assessing the effects of climate change is that only a few of the uncertainties involved in the analysis concern scientific issues (e.g. sensitivity of local/global climate systems to greenhouse gas emissions). The main bulk of uncertainty concerns political and ethical issues particularly important and interrelated (e.g. choice of appropriate discount rate, assumptions on future development of world society, the rate of global emissions of greenhouse gases, population increase, economic growth) making the results produced highly dependent on the methods used and the assumptions made (Holland et al 1996). This fact is evident in the great range of results presented in studies on climate change damages available in the literature. In addition, these kind of assumptions are fundamental for the study to be able to produce any kind of results.

Given the fact that the most serious effects from climate change will be experienced many years ahead, the choice of an appropriate discount rate is of great importance for the analysis (Holland et al 1996). There is considerable debate on the issue of discounting and consensus is not expected to be reached in the near future. To deal with such a politically and ethically loaded issue, ExternE adopted the solution of scenarios exploring a range of discounting rates from 0-10% mainly focusing on a central rate of 3%.

It is beyond of the scope of this discussion to present the different approaches currently expressed in literature on the issue of discounting, or to decide in favour of a particular one. The point that has to be made here is that uncertainties around discounting will persist well ahead in the future and the produced results will be severely influenced by the selection made.

To estimate damages on human health the analysis used the VSL instead of VLYL used in the main project, due to technical difficulties. The sensitivity analysis that

performed showed that the influence of this choice on the results was not significant (ExternE 1998).

Some of the cost categories used in the study are difficult to monetise, in particular the loss of biodiversity. There is a need to consider other ways of determining the social importance placed upon such impacts. It may be that there is no socially neutral scale of measurements against which the costs and benefits can be assessed (Holland et al 1996).

The capacity of society to deal with the changes resulting from climate change will depend critically on the level of social and economic development (Holland et al 1996). Perhaps contingent valuation methods should be restricted to specific applications and should not be used to value uncertain, non-visible long-term effects, such as climate change and loss of biodiversity (Faaij et al 1998).

In the assessment of climate change damages the main uncertainties are not scientific, but based on ethical and political judgments. In these circumstances, externality analysis can play an important but restricted role (Holland 1998). Current damage estimates for climate change might be considered as a helpful indicator of potential environmental problems rather than an input to cost benefit analysis (Krewitt et al 1999). If despite the above concerns cost benefit analysis is applied to such aspects, it must be done with care, providing sensitivity analysis to inform a democratic debate (Holland et al 1996), something that the ExternE, to a great extent, attempted to do.

3.8. How to Use the Results in Policy Making

The main contribution of the ExternE results in policy formulation can be seen in the following:

- The results indicate that electricity production has significant external environmental costs and electricity is typically priced well below its full social cost.
- They provide valuable information on the scale of external costs of different fuels and technologies.

When using the results of ExternE great attention has to be paid in avoiding citing figures out of context (e.g. the damage cost of wind energy is x mECU/kWh). Factors like the site where a technology is applied and the complexity of the fuel chain that includes a variety of technologies make quotes like the above erroneous and misleading (Rabl and Spadaro 2000).

Due to site and technology specificity of the results it is difficult to draw direct comparisons. When comparisons are attempted it is suggested to take into consideration the specific assumptions used to produce the figures about to be compared so to be informed of the uncertainties involved in their calculation.

For the aggregation of results many major assumptions have been used and the figures produced are not expected to be reliable for direct use. The results should be considered as approximate figures and used as background information for establishing economic incentives or for energy planning.

Direct use of results is suggested in cases where the quantitative results are not so relevant (e.g. cost benefit analysis of policy measures, selection between different energy alternatives). This is a conclusion supported by the success of the policy case studies carried out within the project.

Attempting to use the ExternE estimations on damage costs to define a price for energy taxation, one will find that ExternE results imply quite high levels for a tax set at the marginal damage cost. The results for damages exceed the costs of most pollution abatement technologies and therefore taxes at much lower levels would still provide sufficient incentives for major environmental improvements (Eyre 1997).

Looking at carbon taxation the issue becomes far more uncertain. The value of an optimum carbon tax should be set at the marginal damage cost. However due to the great uncertainty involved in calculating global warming damages, it is not possible to identify even the approximate value of this number with any great confidence (Eyre 1997).

In general the ExternE project is attempting to highlight any known or possible source of uncertainty in the calculations of the results produced and inform the potential user for the level of reliability accompanying the results presented.

The application of ExternE estimates in policy analysis has been demonstrated in a number of case studies undertaken within the National Implementation Project. There have been mainly two different approaches in using external costs for policy analysis. In the first approach, as in the case studies undertaken by the British and the German teams, the results of external costs were used for the assessment of the social costs and benefits of energy policies. The second approach was the integration of externalities into energy planning process and was demonstrated by the Greek, Portuguese, Spanish and Dutch studies. In these studies, externalities were used as an additional criteria for the evaluation of different energy scenarios.

The French and Italian team applied the results of ExternE relatively outside the energy sector to explore the issue of municipal solid waste incineration. The Italian team compared incineration to landfilling and the French compared the damages caused by municipal solid waste incineration with those caused by cars. Both studies lead to a series of useful conclusions for policy making.

The full list of policy case studies carried out as part of the National Implementation Project is presented below.

- A Policy Case Study on Electricity Taxation (VITO)
- Benefits of an Acidification Strategy for the European Union (ETSU+IER)
- Cost-Benefit Analysis of Pollution Abatement Options for Large Combustion Plants (ETSU+IER)
- Introduction of Externalities into the Electricity Dispatching System in Spain (CIEMAT+IIT)
- Incinerators and Cars: a Comparison of Emissions and Damages (ARMINES)
- Social Costing and the Competitiveness of Renewable Energies (NTUA)
- Solid Waste Incineration vs. Landfilling (IEFE)
- Externalities of Energy Scenarios in The Netherlands (IVM)

- Cost-benefit analysis of measures to reduce air pollution & decision on building gas fired power plants in Norway (ENCO)
- Strategies for Meeting Future Electricity Demand in São Miguel Island (Azores archipelago) (CEEETA)
- Assessment of NFFO (ETSU/Metroeconomica)
- Externalities associated with the UK energy balance (ETSU)

3.9. Conclusions

In the interpretation of results one has to keep in mind the complexity of the characterisation of the uncertainty included in the figures presented. In most cases the results are produced through a combination of factors carrying different levels of uncertainty. For example certain parts of the analysis (e.g. emissions, pollutant dispersion) are known to an acceptable level of accuracy. However, other parts of the analysis (effects of different types of particulates, existence or not of thresholds, cost of specific impacts) require assumptions to be made with a varying impact on the accuracy of the results (Holland 1998).

The methodology is less flexible in dealing with social issues like equity. A more detailed assessment could investigate for example if the distribution of burdens imposed by the different options acts to alleviate or compound pre existing patterns of privilege or social disadvantage (Stirling 1997). As it seems impacts from global warming tend to fall disproportionately on the worlds poorest nations.

The issue of reversibility of the effects is another factor that could influence the assessment of damages from different fuel cycles. For example the impact of a nuclear accident and the climatic effects associated with fossil fuel consumption are effectively irreversible after the decommissioning of the plant. In contrast, the landscape impacts associated with windmills are relatively reversible after the mill is removed (Stirling 1997). This issue has not been addressed in ExternE.

The results of ExternE present an estimate of externalities of energy production based on current knowledge of the environmental effects of energy systems (11) and should be viewed like that. These estimates are about to change as more information becomes available. ExternE provides the methodological framework to incorporate this change and refine previous estimates. The reasons that future estimates may differ from those made currently include:

- Technically based uncertainties will be reduced (more data, better modelling).
- The best available technology will move to increasingly stringent standards (Holland 1998).
- Major changes in technology could lead to step changes in emissions reduction and in the efficiency of generating plants (Holland 1998).

Due to the lack of data or other constrains mentioned above, often only a part of the actual external effects can be valued, introducing considerable uncertainty in the final outcome. As a result the reliability of external cost evaluation and the way it should be used in policy making is heavily debated (Faaij et al 1998). However, the point of using such a method is to inform the decision making process despite the uncertainties involved, which at the end of the day, reflect the current environment in which decisions have to be made.

There is a need to distinguish between the “easiness” of aggregated data and their connection with reality. It is not realistic to give credit to a method just because it is easy to apply and ignore its inability to reflect “real life” situations in the results produced. Although policy makers would be delighted to have all the background information they need in an aggregated table (Krewitt et al 1999) one has to consider the consequences of decisions based on such a simplified framework.

The methodological framework developed by ExternE can expand its applications beyond the estimation of externalities from electricity generation to calculate environmental benefits from the implementation of a specific environmental policy as demonstrated in the paper by Krewitt et al (1998). The methodology was used to evaluate benefits from the implementation of the UNECE protocols on long range transboundary pollution (Krewitt et al 1998).

For the assessment of global warming damages, nuclear accidents, the long term disposal of highly radioactive waste and the misuse of fissile material, the traditional deterministic approach of external cost assessment may be inadequate and more complex social factors need to be taken into account (Eyre 1997).

As it seems, for some important impacts, reliable monetary valuations are not a realistic objective. When environmental problems are analysed through economic theories, a monetary, and therefore one dimensional, value is applied to problems of multidimensional scale. This process of compressing environmental complexity into a single metric or monetary value can result in a non-trivial loss of information (Ring 1997).

Where impacts are very long lasting and/or potentially catastrophic, the salient environmental concerns relate to the compatibility of the technology with a sustainable environment, not the net present value of expected future damage costs. Monetary valuation of impacts may be important to inform constraint setting, but other analytical methods are also needed (Eyre 1997). In particular where the overall scale of the impacts threatens critical systems, strong sustainability indicators maybe more appropriate (Remings, 1995).

It would be naive to assume that there is a single policy capable of fixing internalisation of external costs since the complexity of the real world cannot be captured fully with elementary economic theory (Eyre 1997).

An analytical criticism on the constraints of environmental valuation and externality analysis as a concept is presented in (Stirling 1997). Stirling reviewed the methodological approaches adopted in more than 30 studies on the environmental effects of electricity generation including the ExternE study as progressed in 1995. The main conclusion of the review is that the results obtained in all the studies examined are highly sensitive to the subjective assumptions and the circumstantial conditions pertaining to each individual study. The variations in results are in the scale of four orders of magnitude and one could argue that there is no single precisely expressed monetary externality value, outside of the context of the study calculated, to be used as a reliable input to policy making (Stirling 1997).

The methods used have to be open-ended and flexible recognising that environmental appraisal is an iterative and reflexive social process, rather than a single discrete analytical act (Stirling 1997). The study should be used as a “tool” in formulating policy rather than an answer to which policy should be adopted.

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4. EUROPEAN UNION ENERGY-RELATED ENVIRONMENTAL POLICY

Slade, R.

4.1. Introduction

EU energy policy is an area of policy making that is politically sensitive with little history of co-operation between Member States. Member States rely heavily on national sources of energy and are reluctant to relinquish national responsibility for energy policy measures. Although the E.C. Treaty, the Coal and Steel Treaty and the Euratom Treaty all provide for energy measures to a certain extent, energy policy operates without an express legal basis and efforts to achieve a formal competence in this area have been met with considerable opposition (Haaland-Matlary p78). Article 175(3) expressly maintains a veto right for member states in important energy matters (Kramer p269, Haaland-Matlary Chpt1) and consequentially progress towards an integrated Common Energy Policy has been slow. There has thus been a tendency for policy to be formed in a rather piecemeal manner.

The main themes of present and pending legislation for the energy sector have developed in response to two main policy drivers. Firstly, the formation of an internal energy market has led to the liberalisation of the electricity markets and the markets for other energy products; and secondly, increased awareness of the environmental impacts of the energy sector have led to political commitments to reduce acid and green house gas emissions.

Key developments in recent EU energy policy that provide the framework for current energy related environmental policies are the Energy Charter, the 1996 White Paper on energy policy and the 5th Environmental Action Programme. There are also a number of EU initiatives on energy efficiency and energy saving.

4.2. The Energy Charter

The Energy Charter Treaty and Energy Charter Protocol [Decision 98/181/EC] came into force in April 1998. The principal aims of this treaty were to improve energy infrastructure and security of supply and to develop the Internal Energy Market (IEM) beyond the EC area to include the Commonwealth Independent States. However, environmental objectives to promote energy efficiency policies to create conditions for the economic, efficient and environmentally sound use of energy, and to foster co-operation in the field of energy efficiency were also included.

The treaty incorporates the polluter pays principle i.e. that price formation should fully reflect environmental costs and benefits. It also states that contracting parties must reduce harmful environmental impacts occurring either in or outside its area from all operations within the energy cycle in an economically efficient manner.

4.3. The White Paper

The 1996 white paper on EU energy policy sets out three principle objectives for future energy policy:

- Security of supply
- Improved competition
- Protection of the environment.

In 1997 the Commission identified three points within each of these objectives on which energy measures must act:

- Reduce dependence on energy sources from outside the community
- Ensure more competitive prices for energy products
- Make energy markets more compatible with environmental objectives.

(Kramer p269)

4.4. Energy Efficiency and Energy Saving

A number of EU level programmes designed to reduce the environmental impact from the energy sector have been developed. Priorities for specific actions fall into three main categories:

- A sustained commitment to energy efficiency and energy saving.
- Developing the use of safe energy sources with low or no CO₂ emissions within the framework of member states energy policy.
- Reducing the environmental impact of the use of energy sources with high carbon content

Within these categories the priority areas for action are:

- Developing the IEM
- Promoting renewable energy sources
- Enhancing energy efficiency
- Internalising the external costs/environmental benefits.

(‘Strengthening environmental integration within community energy policy’
(CO(1998)571- in the Global Assessment COM(1999)543)

The principle energy efficiency programmes are SAVE I [Directive 93/76/EEC], which aims to improve energy efficiency in cars housing and industrial companies and SAVE II [Decision 96/273], which grants further financial assistance for energy saving measures. Both of these measures are principally aimed at domestic and commercial end users, the intention being to “reduce energy consumption without reducing the utilization of energy consuming equipment”.

Recently the Commission reviewed the need to promote energy efficiency, and in May 2000 published an ‘Action Plan to Improve Energy Efficiency in the European Community’ [COM(2000)247final]. This plan proposes three groups of mechanisms for improving energy efficiency:

- The integration of energy efficiency into non-energy policy and programme areas (e.g. regional and urban policy, taxation and tariff policy).

- Re-focusing and reinforcing existing successful Community energy-efficiency measures.
- New common and co-ordinated policies.

Community actions that could be undertaken in co-operation with member states may include the following measures:

- *Increased use of combined heat and power (CHP), including district heating and cooling, where appropriate.*
- *Increased emphasis especially on the building sector, but also on energy use by industry and households.*
- *Increased and extended use of labelling, certification and standardisation.*
- *Increased dissemination of best-practice information on the application of energy efficient technologies and techniques.*
- *Increased use of negotiated and long-term agreements on energy efficiency on a voluntary basis*
- *The revision of existing legislation and the development of new legal instruments, including the use of mandatory minimum efficiency standards, if necessary and if other measures are not appropriate.*
- *The use of instruments such as cooperative technology procurement in compliance with competition law and principles, and the taking account of energy efficiency in public sector procurement practices, as well as energy audit, if appropriate.*
- *Wider use of innovative financing instruments including third-party financing and guarantee-of-results schemes (OJC394, 17/12/98 p0001-0003).*

One of the ways in which it is anticipated that energy efficiency can be increased and GHG emissions reduced is by the increased use of CHP. A strategy for the promotion of CHP was set out in 1997 [COM(97)514 final] which sets the production of 18% of all electricity in the EU using CHP by 2010, as a target. Commitment to this strategy was re-emphasised as part of the Energy Efficiency Action Plan [COM(2000)247 final].

Specific measures under the action plan aimed to reduce technical barriers and costs associated with connection to the grid. The following additional measures have also been suggested:

- Increased use of existing Community programmes within the budgetary limits.
- Encouraging negotiated agreements with industry and in the service sector.
- Internalisation of external costs and environmental benefits.
- Financial and/or fiscal instruments, if appropriate.
- Monitoring the impact of the liberalization of the Community's energy markets.
- Measures encouraging market participants to buy energy produced from combined heat and power plants.
- Arrangements to promote district heating and cooling schemes.
- Measures to support research and technological development.

Resolution [98/C 4/01]

The revision of Large Combustion Plant (LCP) Directive [88/609] will require that new combustion plants apply CHP where feasible. The LCP Directive is discussed in greater detail below.

4.5. Renewable Energy

The 1996 White paper on renewable energy sources sets a target of doubling the share of renewable energy from 6% to 12% by 2010. The principal instrument for achieving this goal and promoting renewable sources of energy is the Altener programme [Decision 646/2000] (which follows on from the Altener I [Decision 93/500] and Altener II programmes), which provides financial incentives to encourage private and public investment.

4.6. The Carnot Programme

The Carnot Programme [Decision 99/24/EC] is intended to reduce pollution from the combustion of solid fuel by promoting clean and efficient technologies.

It applies to large electrical power generators as well as domestic, small commercial, and industrial boilers, and seeks to fulfil the following aims; firstly to promote the use of clean and efficient technologies to plants using solid fuels in order to limit emissions, including CO₂, from such use, and secondly, to encourage the development of advanced clean solid fuel technologies in order to achieve improved BAT at affordable cost.

4.7. Fifth Environmental Action Programme (5EAP)

The Fifth Environmental Action programme (5EAP) was prepared in parallel to the 1992 Rio Conference and the launch of Agenda 21, and aimed to set out a vision for sustainable development in Europe. Priority issues included climate change and acidification amongst others such as waste and biodiversity. The energy sector was targeted as a sector into which environmental concerns should be integrated.

Programmes developed under the 5EAP that have the potential to significantly affect the energy sector include:

- Air quality directives
- The IPPC directive
- Climate change initiatives
- Environmental taxation and the integration of economic and environmental initiatives
- The wider policy context / other factors affecting the level of environmental concern.

(Although not developed as part of an integrated EU energy policy, the combined effect of these programmes is likely to be greater than the impact of initiatives limited to improving energy efficiency and promoting renewable sources of energy.) These policy areas will now be considered in turn.

4.8. Air Quality Directives

The air quality directives most likely to impact on the energy sector are the Large Combustion Plant (LCP) Directive, the Air Quality Framework Directive, and the proposed National Emissions Ceilings directive. The Air Quality Framework directive also has a number of related daughter directives, which legislate for specific pollutants.

4.8.1. Large Combustion Plant (LCP) Directive

The Large Combustion Plant Directive [88/609] is a daughter directive of the 1984 “Air Framework Directive” [84/360] regulating emissions to air from industrial plants. One of the principal pieces of legislation to affect the energy sector, the LCP Directive was formed primarily in response to concerns in the early 1980’s about acidification of the environment and the death of forests. Adopted in 1988, the aim of the Directive is to reduce emissions to air of sulphur dioxide, oxides of nitrogen and particulates from combustion plants with 50MW or more thermal input. Different requirements are set for new and existing plants.

Table 4.1. Emissions Limits for Large Combustion Plants (post-1997)

Fuel	Thermal Capacity	Emission limit (mg/m ³)
Sulphur dioxides		
Solid fuels	up to 100 MW	2000
	500MW and over	400
Liquid Fuels	Up to 300MW	1700
	500 MW and over	400
Gaseous fuels in general:		35
Liquefied gas		5
Low calorific gases, coke oven gas, blast furnace gas		800
Nitrogen oxides		
Solid fuels in general		650
Solids with less than 10% volatile compounds		1300
Liquid fuels		450
Gaseous fuels		350
Dust		
Solid fuels	up to 500 MW	50
	500 MW and over	100
Liquid fuels		50
Gaseous fuels		5
- Blast furnace gas		10
- Gases produced by steel industry		50

New combustion plants (those licensed after 1 July 1997) must comply with emission limit values for sulphur dioxide, nitrogen oxides and particulates, and, where these limits are exceeded, enforcement measures may include the revocation of the plants licence to operate. The emission limits for post 1997 plants vary according to both fuel type and thermal rating of the plant. These limits are illustrated in the Table 4.1.

For existing combustion plants (licensed prior to 1 July 1997) the LCP Directive introduced country by country ceilings for total national emissions of sulphur dioxide and nitrogen oxides emitted from existing LCPs. Member states were obliged to draw up appropriate programmes for the progressive reduction of total annual emissions including timetables and implementing measures. Overall, the 12 states that were members of the EU when the Directive came into force had to lower total emissions of SO₂ in three stages, achieving a 58% reduction in SO₂ emissions by 2003, as compared to 1980. The reductions in NO_x emissions required by most member states were 40% compared to a 1980 baseline, and were to be implemented in two stages.

A proposal for amending the LCP Directive [88/609] was made by the commission in 1998 as part of a package of measures to combat acidification and low-level ozone (the other principal element of this package was a proposal for a directive on national emission ceilings). The main aim of the LCP amendment was to update the emission limit values applicable to plants licensed after the proposal comes into force, reducing emissions limit values for SO₂, NO_x and dust applying to existing plants, and also to extend the scope of the directive to include gas turbines.

Following discussions between Commission and Council a common position was formed, and subsequently adopted on 9/11/2000. Although the common position is not as ambitious as the original proposal it still fulfils some of the intended aims.

Emissions from gas turbines are to be included under the Directive. This reflects in part the growth in popularity of gas generation, and the increasing number of gas fired power stations. Offshore installations however, were excluded due to the nature of the operating conditions. Turbines on vehicles ships and aircraft were also excluded as it was felt that the directive should only apply to stationary sources.

Revised emission limits for LCPs licensed between 1 July 1987 and 1 Jan 2000 and the application of these limits to LCPs licensed prior to 1 July 1987 were not accepted, however the common position does extend the application of the requirements for new plants (as defined in D88/609) to existing plants by 1/1/2008. Furthermore these limits will have to be respected in light the pending enlargement of the community.

Plants licensed after 1Jan 2000 will not be required to meet more stringent emissions limits as it is intended that these plants should be assessed on an integrated basis under the IPPC Directive [96/61]. New plants however will also need to meet emissions targets proposed under the proposed National Emissions Ceilings Directive [99/30]. These changes reflect a more integrated approach to policy making.

Other less significant provisions made by the common position are as follows:

- Biomass - The definition was changed to ensure that exemptions not covered by legislation on incineration are covered by the LCP proposal.
- CHP - Member states are to ensure that the technical and economic feasibility of providing for CHP, for new plants licensed after the proposal comes into effect. The higher emissions limits for CHP where overall efficiency is greater than 75% will also apply to combined-cycle applications where efficiency is greater than 55%.
- Lignite burning plants – allowances for emissions in excess will no longer apply to plants licensed after the proposal has entered into force.

4.8.2. Air Quality Framework Directive

Directive 96/62 on the assessment and management of ambient air quality (Air Quality Framework Directive) came into effect in March 1998 and sought to define the basic principles of a common strategy to achieve four objectives:

- Define and establish objectives for ambient air pollution in the Community designed to avoid, prevent and reduce harmful effects on human health and the environment as a whole.
- Assess ambient air quality in Member States on the basis of common methods and criteria.
- Obtain adequate information on ambient air quality and ensure that it is made available to the public, inter alia by means of alert thresholds.
- Maintain ambient air quality where it is good and improve it in other cases.

The intention is that this directive and the subsequent daughter directives that it generates a need for, will progressively replace earlier Directives (80/779, 82/884 and 85/203), from the early 1980s and fix air quality values for SO₂, NO₂, Particulates and Lead.

The framework character of this directive means that it will only become operational when the provisions for the individual pollutants have been adopted in subsequent daughter directives. However, the directive does include a timetable by which proposals detailing limit values and alert thresholds for a list of pollutants must be submitted to Council. It also details factors such as the climatic conditions, sensitivity of flora and fauna, historic heritage exposed to pollutants, economic and technical feasibility and the degree of exposure of population sector, to be taken into account when setting alert thresholds and limit values.

Limit values are air quality values (concentrations of various pollutants in ambient air) and are defined in Directive 96/62 as “ a level fixed on the basis of scientific knowledge with the aim of avoiding, preventing or reducing harmful effects on human health and or the environment as a whole, to be attained within a given period and not to be exceeded once attained”. Limit values should not be confused with emissions limits from point sources as detailed in the LCP Directive. Furthermore, they should also not be confused with the limits set by the National Emission Ceilings Directive, which set limits for the total emissions of various pollutants.

To date there have been three proposals for daughter directives setting limit values for different pollutants. These are as follows:

SO₂, NO_x, Lead and Particulates 99/30/EC.

The first daughter directive under the Air Quality Framework Directive [96/62] was Directive 99/30/EC. This directive sets legally binding limit values and alert thresholds for SO₂, NO_x, particulates and Lead concentrations in ambient air and was adopted by Council in April 1999. Under the directive Member States shall take any action needed to prevent the limit values from being exceeded. They must also draw up programmes for the progressive reduction of annual emissions and report these to the Commission before the end of 2002, These plans will then be revised in 2006. Regularly updated emissions inventories and projections must also be prepared.

In order to provide information on the costs and benefits of meeting limit values a consultancy study “Economic evaluation of air quality targets for sulphur dioxide, Nitrogen dioxide, fine and suspended particulate matter and lead” was undertaken. This study used valuations derived from the ExternE project as well as other sources. *(The proposed council directive on sulphur in liquid fuels also used ExternE outputs)*

Although legally binding limit values are set by Directive 99/30, the means by which targets are reached is to be left for Member States to decide. Thus the effect of this Directive upon any particular sector may vary according to how it is implemented in each Member State.

CO and Benzene 2000/69/EC

The second daughter directive under the Air Quality Framework is directive 2000/69/EC. This came into force on the 16th December 2000 and specifies limit values for Benzene and CO. Member States have until December 2002 to implement the legislation into national law.

Ozone

A third daughter Directive relating to ozone is required under the Air Quality Framework directive. To meet this requirement and also as a follow up to the Commission’s communication on a strategy to combat acidification [COM(97) 88 final] the commission adopted a proposal for a Directive on national emission ceilings for certain atmospheric pollutants and a proposal for a Directive relating to ozone concentrations in ambient air [COM(99) 125]. The directives were adopted together because tropospheric ozone is a secondary pollutant and action to reduce the concentration of ozone in ambient air necessitates a reduction in the concentrations of ozone precursors (namely NO_x and VOCs).

The proposal relating to ozone sets an indicative ‘target value’ at 120ug/m³, in line with WHO guidelines, an ‘information threshold’ at 180ug/m³ and an ‘alert threshold’ at 240ug/m³. The setting of a ‘target value’ however, contrasts with the other daughter directives of the Air Quality Framework, which set mandatory ‘limit values’. The proposal reached unanimous political agreement in October 2000 moderated slightly in that Member States will be allowed to exceed the WHO guidelines on no more than 25 days each year by 2010, rather than the 20 days originally proposed. It is anticipated that the proposal will enter into force in the near future.

Despite being adopted by the Commission at the same time as the proposed Directive for ozone in ambient air, the proposed directive on National Emissions Ceilings has

progressed more slowly and met with greater resistance from member States. The progress of this directive will be considered in more detail in the next section.

Other anticipated daughter directives

It is anticipated that future proposals for daughter directives under the Air Quality Framework directive will specify limit values for heavy metals and PAHs.

4.8.3. A National Emissions Ceilings Proposal

A proposal for a directive to set national emission ceilings for certain atmospheric pollutants (National Emissions Ceilings Directive - (NEC)) was adopted by the Commission in June 1999 [COM(99) 125]. This proposal aims to tackle the interrelated problems of acidification, tropospheric ozone and soil eutrophication caused by the emission of sulphur dioxide (SO₂), nitrogen oxides (NO_x), volatile organic compounds (VOC) and ammonia (NH₃), by setting country specific emissions ceilings for each pollutant.

The concept of setting emissions ceilings is not new. The LCP Directive [88/609] sets out emissions ceilings for pre-existing plants, and the second sulphur protocol to the UNECE Convention on long-range trans-boundary air pollution already sets limits for SO₂. However, the proposed National Emissions Ceilings Directive demands stricter SO₂ targets than the UNECE Convention for several countries (including the UK), in addition to creating ceilings for the other pollutants. Relative to the LCP Directive it is intended that the ceilings set out by the NEC directive should have much greater breadth, applying across all sectors of society and to both new and pre-existing activities (Manual of Environmental Policy Release November 1999, 6.2-3).

The proposed emission ceilings for the NEC directive (and also to a certain extent the daughter directives under the Air Quality Framework Directive) are supported by analyses using the Regional Air Pollution INformation and Simulation (RAINS) model developed at the International Institute for Applied Systems Analysis (IIASA, Laxenburg, Austria). This model provides a consistent framework for the analysis of emission reduction strategies, focusing on acidification, eutrophication and tropospheric ozone. RAINS comprises modules for emission generation (with databases on current and future economic activities, energy consumption levels, fuel characteristics, etc.), for emission control options and costs, for atmospheric dispersion of pollutants and for environmental sensitivities (i.e., databases on critical loads). (*8th Interim Report – Cost effective control of acidification and ground level ozone*) Consultants for the Commission estimated the monetary benefits associated with the expected environmental benefits largely following the methodology developed by the ExternE project.

The proposed NEC Directive has met with opposition from member states and industry pressure groups. Eurelectric, the union of the electricity industry, argues that the RAINS model is 'operating beyond the range of its applicability, particularly for the very deep cuts in emissions being put forward'. Many Member States have also picked up on concerns for the power generation, industrial, transport and agriculture

sectors, and pushed for weaker targets based on the 1999 UN Gothenburg protocol. (ENDS 21 June 2000 – Ministers to water down EU air emissions law)

A common position for the NEC directive was reached in June 2000 under which Member States go slightly further than the Gothenburg protocol. The differences are illustrated in the following table:

Table 4.2. Environmental benefits compared with EU proposal

	Commission Proposal	Gothenberg Proposal	Common Position
Eutrophication	100%	27%	36%
Ozone (population)	100%	43%	51%
Ozone (vegetation)	100%	37%	47%
Acidification	100%	60%	67%

Source: European Commission in ENDS Daily – 22 June 2000)

At the time of writing, the NEC proposal was with the European Parliament for its second reading.

4.9. IPPC

The IPPC Directive [96/61] came into force in 1996 and is summarised as follows: “The purpose of the Directive is to achieve an integrated system of pollution prevention and control for a range of specified industrial activities including measures concerning waste. The aim of the integrated system is to prevent or reduce emissions to air, water and land (including waste) and to achieve a high level of protection of the environment as a whole. The Directive requires Member States to establish an integrated system of permits that contain specific conditions, including emission limit values and the application of Best Available Techniques” (Handbook on the Implementation of EC Environmental Legislation).

Installations in the energy sector are thus required to obtain a permit to operate. Permits are based on the concept of Best Available Techniques (BAT) and must take into account the whole environmental performance of the plant integrated across all media. The level of environmental protection afforded and the major costs associated with implementing the directive is thus determined by the Best Available Techniques (BAT) available. In order to clarify what BAT means, annex IV of the IPPC Directive contains considerations to be taken into account when determining BAT, and the European IPPC Bureau is producing BAT Reference Documents (BREFs) for each sector requiring IPPC permits. It is anticipated that all BREF documents will be completed by the end of 2003.

The IPPC Directive applies to all new installations from October 1999, however existing installations have an additional 8 years of grace.

4.10. Climate Change

4.10.1. The Kyoto Protocol

Following the adoption of the Kyoto Protocol in December 1997, climate change has been relatively high on the political agenda in Europe. Under the Protocol, the European Community committed itself to reducing its emissions of six greenhouse gases by 8% during the period 2008 to 2012 in comparison to 1990 levels. A number of initiatives have been proposed to enable the EU to meet these targets; however, despite a high level of awareness, many of the proposals are politically contentious and few binding measures to tackle the underlying causes of climate change have been introduced.

In May 1999, the Commission adopted a Communication on climate change that highlighted the need for a “sustained policy response” [*COM(1999)230 final - “Preparing for Implementation of the Kyoto Protocol”*]. The Communication states that observed data show carbon dioxide emissions are increasing, and that “unchecked, this trend means that the requirement of Article 3(2) of the Kyoto Protocol to show “demonstrable progress” by 2005 and the EU commitment of –8% will not be met”. Following this communication, one of the principle responses to the challenge of climate change, has been a proposal for a European Climate Change Programme (ECCP) outlined in a communication from the European Commission [*COM(2000) 88 final*]. The ECCP is intended to bring together all relevant stakeholders to cooperate in the preparatory work of common and coordinated policies and measures to reduce greenhouse gas emissions. The proposed ECCP is an instrumental part of a twin track strategy advocated by the Commission which foresees the introduction of targeted measures to reduce emissions from specific sources and the setting up of an emissions trading system within the EU for the energy sector and big industrial installations.

Policies proposed for the ECCP, which may directly or indirectly affect the energy sector include the following:

4.10.2. Energy Supply

- Further development of the internal electricity and gas market incorporating environmental considerations
- Access to the grid for decentralised electricity production, increasing the share of renewable energies
- Increase the use of combined heat and power generation
- Reduction of methane emissions in mining and extraction industries
- CO₂ capture and disposal in underground reservoirs
- Promotion of more efficient and cleaner fossil fuel conversion technologies
- Energy efficiency in the electricity and gas supply industries

4.10.3. Industrial Sector

- Improvement of energy efficiency standards for electrical equipment
- Improvement of efficiency standards for industrial processes

- Improved energy efficiency limiting CO₂ emissions (for boilers, construction products, etc.)
- Development of an EC wide policy framework for emissions trading
- Development of a framework for voluntary agreements

4.10.4. Energy Consumption in the Domestic and Tertiary Sectors

- Public procurement of energy-efficient end-use technologies
- Energy audits and heating performance certificates
- Improvement of building/lighting performances
- Building design and infrastructure planning

4.10.5. Research

- Implementation of the 5th Framework Programme, in particular the Energy, Environment and Sustainable Development Programme
- Networking of EU, national and other RTD efforts for climate change

4.10.6. International Cooperation

- Capacity building and technology transfer to developing countries through international cooperation [COM(2000) 88 final].

The Commission has also produced a green paper on emissions trading within the EU [COM(2000)87]. This makes a case for a strong community role and seeks to build upon the following elements:

- A limited emissions trading scheme by 2005 within the Community to enable ‘learning by doing’ prior to the Kyoto Protocol’s emissions trading (from 2008).
- To start with CO₂, the most easily and accurately monitored of the greenhouse gases.
- The actors most suited to start emissions trading are large fixed point sources, which account for almost half of Community CO₂ emissions.
- To ensure compatibility between any Community scheme and emissions trading under the Kyoto Protocol.

Most recently, at the time of writing, the Conference of Parties talks held in the Hague in November 2000 have not been successful in resolving outstanding problems regarding the implementation of the Kyoto protocol and the functioning of the Kyoto ‘flexible mechanisms’. The outlook for concerted international action on climate change has become increasingly uncertain.

4.11. Environmental Taxation and the Integration of Economic and Environmental Initiatives

The potential uses of environmental taxes along with other economic and fiscal measures to achieve environmental aims has been a common theme running through from the first EAP in 1973 to the present day. The 4EAP however, was the first to explicitly state that taxes charges and tradable permits were appropriate instruments for improving or preserving environmental quality. Increasing awareness of the potential uses of fiscal measures and enthusiasm for their application, contrasts with limited success in introducing these measures at a Community level. This is in part a consequence of the reluctance of Member states to allow the EC to prescribe fiscal measures.

The slow progress, and failure to date, of EU attempts to introduce a common energy tax illustrates the hurdles that other fiscal environmental measures may have to face.

4.11.1. Energy Taxation

A combined tax on energy and CO₂ was first proposed in 1992 to help combat climate change along with directives on energy efficiency and the promotion of renewable energy. However, the proposal was based upon Articles 93 and 175(1) both of which required unanimity that proved impossible to achieve. A revised proposal was presented in 1995 under which Member States remained free to introduce carbon and energy taxes, but if they did so, they would have to comply with structural requirements set out by the EU. This proposal again failed to achieve unanimous consent and was dropped in 1996.

In 1997 the Commission put forward an alternative proposal to harmonise the taxation of energy products across the community [COM(97) 30 final] (The Energy Products Directive, aka - the Monti proposal). The concept behind this proposal was that Member States should impose taxes on energy products above a minimum prescribed level set by the Community, and then to avoid an increase in the overall tax burden reduce other taxes (e.g. charges on labour) accordingly.

For electricity, it is proposed that the minimum level of taxation should be fixed at 1 ECU / MW Hour from 1/1/98, 2 ECU / MW Hour from 1/1/2000 and 3 ECU / MW Hour from 1/1/2002. This proposal proceeded slowly, but was eventually approved by parliament in April 99 subject to a number of amendments permitting exemptions and allowing Member States to refund all or part of the tax to firms able to demonstrate a competitive disadvantage.

At the time of writing, the proposal had still not been adopted. Despite the introduction of qualified majority voting (QMV) in the Amsterdam treaty for proposals using Article 175(1) as a legal basis, member states can still veto proposals that are “primarily of a fiscal nature, concern land use planning, or that would ‘significantly’ affect national energy supply choices”. Spain in particular remains strongly opposed to the idea.

Most recently, in December 2000, moves to extend qualified majority voting at the Nice summit, prior to the expansion of the EU, were rejected and this has dealt a further blow to the proposal. The UK in particular, although not opposed to the energy products directive in principle, is vehemently opposed to the extension of QMV to matters of fiscal policy (ENDS 12/12/00).

Despite slow progress at the EU level, individual Member States are more advanced in respect of environmental taxation, and have begun to use economic instruments more extensively in the implementation of environmental policy. For example, CO₂ taxes have been introduced in the Scandinavian countries, the Netherlands, Austria and Belgium. A number of the Member States also have taxes in place for Sulphur and NO_x.

4.11.2. Wider Policy Context

The political context in which environmental policy is made has a significant effect on both the type of policy initiative put forward and the likelihood that it will be implemented successfully. Some of the more influential factors upon EU environmental and energy policy include:

The drive to integrate economic and environmental initiatives

- Globalisation and Increased liberalisation of the energy market
- Expansion of the EU

4.11.3. Integration of Economic and Environmental Initiatives

Article 6 of the Amsterdam treaty established an obligation to integrate environmental requirements into all EU policies and actions. The integration of environmental and economic initiatives is also one of the central objectives of the 5EAP. The principle that major commission policy proposals should be accompanied by an appraisal of their environmental impact was again endorsed at the Cardiff European Council in 1998. The basic idea behind integration is that environmental concerns can be addressed much more efficiently and effectively if they are considered at the sectoral level rather than by separate environmental regulators.

A great deal of work has been done to develop practical policy instruments that will facilitate greater integration and these can be broadly categorized into information based strategies, directive based regulations and incentive based instruments.

Economic and fiscal instruments are expected to play a particularly important role in changing incentives and behaviour. The fundamental aim of these instruments is to internalise all external environmental costs incurred during the whole life cycle of a product, thus ensuring that the market supplies the desired level of environmental quality, i.e. that the marginal cost of environmental damage is equal to the marginal benefit of environmental protection.

A high level of interest in these tools as instruments of environmental policy follows the recognition that unlike command and control measures which are both unpopular with producers and distort the market for environmental quality, fiscal instruments may produce a double dividend generating secondary benefits from the removal of market distortions at the same time as improving the quality of the environment.

4.11.4. Globalisation and Increased Liberalisation of the Energy Market

The drive towards a more liberalized energy market is part of a general trend towards economic globalisation and the removal of barriers to trade in the pursuit of economic growth. However, the environmental consequences of a less restricted energy market are not entirely clear. In a communication from Council to the EU parliament [COM(2000)567 final] it is argued that there is no inherent contradiction between economic growth and the maintenance of an acceptable level of environmental quality, and that increased integration will facilitate environmental improvements. The Commission goes on to argue that in the case of renewable energy, increased liberalisation will help the sector develop and facilitate greater market penetration by breaking down barriers to market entry. This point of view however, is not uncontested and others argue that renewables will be undermined by their higher price unless given further support. Radical policies for energy efficiency and renewable energy have also been made politically unsustainable by low energy prices.

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COM(1999)230 final	Preparing for Implementation of the Kyoto Protocol
COM(1999)543	The Global Assessment
COM(2000) 88 final	Proposal for a European Climate Change Programme (ECCP)
COM(2000)247final	Energy Efficiency Action Plan
COM(2000)567 final	argues no inherent contradiction between economic growth and maintenance of environmental quality
COM(2000)87	Green paper on emissions trading within the EU
COM(97) 30 final	Energy Products Directive
COM(97) 88 final	Strategy to combat acidification
COM(97)514 final	Strategy for the promotion of CHP
COM(99) 125	Relating to ozone concentrations in ambient air
Decision 646/2000	Altener programme
Decision 93/500	Altener I
Decision 96/273	SAVE II
Decision 98/181/EC	The Energy Charter Treaty and Energy Charter Protocol
Decision 99/24/EC	The Carnot Program
Directive 84/360	1984 -Air Framework Directive

Directive 88/609	Large Combustion Plant Directive
Directive 93/76/EEC	SAVE I
Directive 96/61	Integrated Pollution Prevention and Control
Directive 96/62	Air Quality Framework Directive
Directive 99/30	National Emissions Ceilings
OJC394	17/12/98 - p0001-0003
Resolution 98/C 4/01	Additional measures to support Energy Efficiency Action Plan

5. EUROPEAN (MEMBER STATE) ENERGY-RELATED ENVIRONMENTAL POLICIES

Slade, R. and V. Karakoussis

5.1. Introduction

After having considered the frameworks implemented at the European level, this section reviews the individual national policies related to the internalisation of external costs of energy-related environmental pollution. It starts by looking in a little more detail on the United Kingdom, Germany and Denmark, followed by a briefer look at all the other EU countries.

5.2. United Kingdom

The UK is a leader in market liberalisation and in this regard provides a practical example to other countries still in the process of liberalising their own energy markets. The stated aim of the UK Government with respect to energy is to “ensure secure diverse sustainable supplies of energy at competitive prices”.

One of the most recent and significant legislative changes in the UK has been the enactment of the Utilities bill in July 2000 which makes substantial changes to the regulatory system for electricity and to a lesser extent gas. The bill has five principal goals:

- To create more competitive markets in the energy industry.
- Provide greater protection for consumers
- Rationalise the regulation of the gas and electricity industries.
- Promote the development of renewable sources of energy.
- Encourage energy efficiency.

5.2.2. Renewable Energy

The Government has a target of 5% of electricity to be supplied by renewables by 2003 and 10% by 2010. The Utilities bill replaces the existing Non-Fossil Fuel Obligation (NFFO) for the promotion of renewable energy sources. Instead the Secretary of State can impose a statutory obligation on suppliers to generate a specified proportion of the energy they supply from renewable sources. It is anticipated that the obligation will be gradually increased to meet these goals. Obligations will also be supported by a system of tradable green certificates.

5.2.3. Energy Efficiency

The Utilities bill also transfers the power to set future Energy Efficiency Standards of Performance (EESOPs) for energy companies from the regulator (OFGEM) to the Secretary of State. EESOPs place an obligation on the energy companies to reach an energy saving target by encouraging customers to save energy and can specify the amount of energy to be saved, it is up to the supplier however to decide how these targets can best be achieved.

5.2.4. Climate Change Programme

Under the Kyoto protocol the UK was set a legally binding target to reduce its greenhouse gas emissions to 12.5% below 1990 levels by 2008-2012. Over and above the Kyoto requirement the government has set a tougher domestic target to reduce CO2 emissions to 20% below 1990 levels by 2010. Government policies describing how the Government intends to achieve these targets was set out in “The UK Climate Change programme”. This was presented to parliament in November 2000 and describes the Governments strategy for tackling climate change.

The Climate Change Levy (CCL) was part of the Finance Act 2000 and received Royal Assent in July 2000, it is instrumental to the governments plans for tackling climate change. Essentially the CCL is a tax on energy use payable by industry, commerce and the public sector. Revenue raised will be returned to industry via a 0.3% reduction in employers National Insurance Contributions as well as further support for energy efficiency schemes and renewable sources of energy. Money raised by the CCL will also be used to set up and fund a body called the “Carbon Trust”. This will be an independent not-for-profit company charged with returning £130 million of CCL receipts to industry by helping accelerate the take up of low carbon technologies. The Carbon Trust will also use approximately £17m to support low carbon R,D&D.

Exemptions from the CCL will be granted to Renewables and good quality CHP. Energy intensive sectors, which have concluded climate change agreements that meet minimum Government standards, will be charged a reduced rate of tax equivalent to 20% of the standard rate.

The CCL is expected to raise £1bn in its first year and will apply to energy products from April 2001 at the following rates:

Taxable commodity supplied	Rate at which levy is payable if supply is not a reduced-rate supply
Electricity	0.43 pence per kwh
Gas supplied by a gas utility or any gas supplied in a gaseous state that is of a kind supplied by a gas utility	0.15 pence per kwh
Any petroleum gas, or other gaseous hydrocarbon, supplied in a liquid state	0.07 pence per kwh
Any other taxable commodity e.g. coal	0.15 pence per kwh

(BN 65/00)

In addition to the climate change levy, a series of other measures have been introduced within the climate change programme. In the March 2000 budget, enhanced capital allowances were made available on energy saving products. This was aimed to encourage firms to make energy saving investments. Other measures

include targets to double CHP capacity by 2010, and a number of product related measures such as energy labels and standards. Measures of less direct concern to the energy sector but still important in terms of achieving the governments overall targets include targets to improve fuel efficiency in the transport and domestic sectors.

5.3. Germany

Germany is the fifth largest energy consumer in the world and after the UK is the most carbon intensive country in the EU. It is also a major energy importer dependant upon imports for 63% of its energy (the bulk of domestic sources are limited to hard coal and lignite). Electricity production reflects the dependence on coal and the energy-mix comprises, approximately one-third nuclear, two-thirds coal and one percent.

German energy policy has two predominant goals:

- To forge a consensus on future energy security and energy use, particularly with regard to the roles of coal and nuclear energy, energy conservation, and the more intensive use of renewable energy sources.
 - To ensure environmentally benign energy supply and use.
- (<http://energytrends.pnl.gov/germany/ge004.htm>)

The issues of climate change, energy security, the future of nuclear power and the restructuring of the energy utilities are thus the major elements in Germany's energy debate.

Action to tackle climate change has been a high priority since the early 1990s when the first climate change strategy was introduced and a domestic target to reduce CO₂ emissions by 25% between 1990 and 2005 was set. This is a tougher target than that set by the Kyoto protocol, which commits Germany to reduce CO₂ emissions by 21% during the period 2008 – 2012.

There is considerable public opposition to nuclear power and in 1998 the SDP declared that it intended to phase out all of Germany's nuclear power plants (nuclear power currently supplies 30% of the countries electricity) and despite considerable reductions in CO₂ emissions after reunification with East Germany, it is likely to be extremely difficult to reconcile the reduction in CO₂ emissions with the proposed reduction in nuclear capacity.

The principal means of control in Germany have been financial (i.e. subsidies and levies). Germany has also been a strong proponent of EU tax harmonisation, however in the light of resistance by other Member States and the slow progress of these proposals, Germany implemented ecological tax reform in 1999 aiming to increase tax level on energy consumption and strengthen incentives to increase energy efficiency in all sectors of society. Under these proposals the tax on heating oil rose by 4 pfennigs a liter to 12 pfennigs, and gas from 0.32 pfennigs/kwh to 0.62 pfennigs/kwh. A new tax was levied on electricity at 2 pfennigs/kwh. The revenue from these tax increases will be used to reduce non-labour wage costs such as pension contributions. The response from both industry and the public to this tax reform has been negative with public protests about the price of fuel in September 2000.

a number of voluntary agreements have been made with industry committing them to reducing CO₂ emissions by up to 20% by 2002. Agreement partly achieved under the threat of increased taxation, however, dissenters suggest that industry committed itself to reductions less than would have occurred under a business as usual scenario.

Germany has actively supported renewable energy (principally wind energy) and has 45% of the installed wind capacity of the EU. Rapid growth of renewables was supported by the German Electricity Feed Law (“Stromeinspeisungsgesetz”), which came into effect in 1991. The Feed Law required utilities to accept all electricity generated from renewable sources at a price between 65% and 90% of the price to the end user, depending on the energy type. The Feed Law was revised in 1998 and utilities are not required to accept more than 5% of their total electricity from renewable sources

The main issues that Germany has to resolve concerning energy production is the future of its nuclear industry and the reform of the coal subsidies. The German government is also giving great importance to energy efficiency and electricity production from renewables. The later is supported through a number of schemes like purchase obligation at fixed prices on grid operator

Purchase obligation on grid operator is limited in so far as it does no longer apply as soon as share of RES-electricity in overall electricity delivered through the distribution grid system and the transition grid-system concerned reaches 5% in both systems (“double 5%-threshold”).

Solar and wind power is paid 90% of the average electricity price paid to end consumers in Germany in the reference year (the second but last year preceding the current year) under the Stromeinspeisungsgesetz. Small hydro, biomass, landfill and sewage gas receive 80% of the above average price, all other eligible technologies 65%. This leads to the following average prices in 1998:

- Wind, PV: . 0,0861 (DM 0,1679) per kWh
- Biomass, small hydro, landfill, sewage gas: . 0,0765 (DM 0,1492) per kWh
- Others: . 0,062 (0,1212 DM) per kw/h

Grid operator can recover possible extra costs through an increase in grid use tariffs.

Other types of support include direct subsidies; RT&D support; 100.000 PV roofs programme. Also, specific schemes for electricity from PV operated at the regional/local level. The price of renewable electricity varies between . 0,062 (0,1212 DM) and . 0,0861 (DM 0,1679) per kWh, depending on the technology.

In recent years oil product taxes have been increased substantially to favour energy efficiency. Since 1998 a VAT of 16% applies to all energy products. Contrary to coal, there are excise taxes on oil products for energy uses with a differential for automotive fuels in favour of unleaded gasoline and an even larger differential in favour of diesel oil. In the industrial sector natural gas is more heavily taxed than heavy fuel oil.

5.4. Denmark

5.4.1 Danish Environmental Leadership

Denmark has sought to take a leadership role in environmental policy and has aimed to influence other countries by acting as an example. Reflecting this stance, Danish energy policy has been characterised by strong political will to direct the energy sector towards what are considered to be socio-economically desirable goals. The pursuit of these goals has been aided by the fact that Danish Energy Agency has authority over the entire sector.

Although some features of Denmark's energy and environment policy would be more appropriately undertaken in concert with other countries, Denmark has sought to act on a national level where possible. The aim to be at front in terms of environment policy however has been limited to a certain extent by the need to be competitive and the lack of consensus at the European level on policy instruments such as standards and taxation (*IEA review 1998*)

Denmark's energy policy, "Energy 21", was published in April 1996 and outlines targets for the future structuring of the energy sector until 2005 and policy statements until 2030. The three main policy objectives are as follows:

- To expand the contribution of gas and renewable energy and replace coal-fired power with other fuels (gas, biomass and wind power).
- To improving energy efficiency and expand the proportion of CHP
- To adapt the energy sector to more open market conditions

Regarding the stabilisation and reduction of CO₂ emissions, the energy sector is responsible for more than 45% of emissions, and has been central to efforts to reduce the impact of GHG emissions on the environment. Energy taxation, the promotion of CHP and renewable capacity, and a ban on new coal fired capacity are the main ways in which the objectives of Energy21 have been implemented. Each of these will now be considered in turn:

5.4.2. Taxation

Denmark has three types of taxes on energy; an energy tax, a CO₂ tax and a sulphur tax. The environmental objectives behind these taxes were to reduce CO₂ emissions by 20% by 2005 compared to 1998 baseline and achieve an 80% reduction in SO₂ by 2000 compared to a 1980 baseline. In addition it was intended that these taxes should also raise revenue and increase the efficiency of the energy market by internalising costs.

The first CO₂ tax took effect in 1993 and was levied on energy consumption in both households and trade and industry. 50% of the tax was refunded to trade and industry and large energy intensive companies (that submitted to an energy audit) paid the tax at a lower rate of only DKK 10,000 per year. The effective level of the CO₂ tax on trade and industry was thus only 35% of the level of taxation on households.

In 1995 a bill was passed introducing a phased in multi level tax system for CO₂, energy and SO₂. The multi level nature of the tax scheme, although complex was intended to reduce any detrimental effects on the competitiveness of Danish industry in the absence of a comprehensive European policy. Special considerations were again made for energy intensive companies to allow them to compete on international markets.

The tax level varies with both the intended use of the energy (space heating, light processes and heavy processes) and the type of fuel. For each fuel type the total tax is calculated from the content of energy, sulphur and carbon. The extra revenue collected from the 1996-2000 tax package will all be recycled to trade and industry. In the transition period 1996 to 1999 subsidies were allocated for investment in energy savings, and from the year 2000, revenue will be recycled by lowering labour-related taxes.

The CO₂ tax can be characterised by the following key points:

- The effective level of taxation is the highest in the world for industry.
- The total revenue from is expected to be three billion DKK in year 2000, which is 1% of the total state revenue. The revenue is to be recycled mainly by lowering the non-wage costs of labour.
- The level of taxation depends on the purpose of the energy use. (Three types of energy use are defined - space heating, light processes and heavy processes). When companies use the same energy source for different purposes, several meters are required within the company.
- Companies with energy-intensive processes get a tax reduction if they enter an individual agreement with the Danish Energy Agency, i.e. for these companies the economic instrument is combined with an administrative one.

(<http://www.nordlicht.uni-kiel.de/sme/bl.htm#I14>)

The sulphur tax was introduced in 1996 and will reach a final level of 20DKK per KG sulphur or 10DKK per Kg SO₂ discharged in the year 2000.

In 1996, the total revenue from all 3 taxes was DKK 24.4 billion (7% of the total fiscal revenue). 84% from the energy tax (on electricity, gasoline and oil), 15% from the CO₂ tax and 1% from the sulphur tax. (Kristoffersen 1998)

In 1998 the Danish Parliament decided to increase energy taxes for the period 1998 – 2002 to the following levels:

Fuel	Tax rate
Gasoline	3.37 DKK/litre
Fuel oil	1.91 DKK/ton
Natural gas	1.47 DKK/Nm ³
Coal	1040 DKK/ton
Electricity	0.466 DKK/KWh

(Developments in energy policy in Denmark in 1998, Energistyrelsen)

5.4.3. CHP

CHP plays a major role in Danish electricity planning. Most electricity is produced by large CHP plants, which also provide heat to large Danish cities. There are also approximately 400 small-scale CHP plants in medium and small sized towns. The majority of the expansion in CHP capacity has taken place by converting existing coal, oil, and natural gas based district-heating plants to CHP systems that use natural gas, waste or biomass. This conversion has been encouraged by subsidies and other measures.

5.4.4. Renewables (Wind and Biomass)

The Danish Government promotes the use of renewable energy by a price support scheme based on fixed prices complemented by subsidies per kWh produced. Under this scheme utilities are obliged to purchase wind power from independent power producers at a price equal to 85% of the electricity net price (excluding energy taxes and fees) for a consumer with an annual consumption of more than 20,000 kWh. A state subsidy of DKK 0,10 per kWh (repayment of the CO₂ tax as it is levied on the electricity output and therefore also on electricity from RES) is granted to all wind power producers. A further subsidy of DKK 0.17 per kWh is granted to privately owned wind turbines. The average feed in price, including the subsidy, is DKK 0.59 per kWh (E 0.08), but this varies between DKK 0.52 – 0.66 per kWh.

In spring 1999 the Government entered into broad agreement to implement the EU electricity directive on the liberalisation of the power market, and this was used as an opportunity to further promote renewable energy. The present aim is to increase the production of renewable energy so that it provides 20% of the energy consumed by 2003. Under the agreement all electricity customers will be obliged to purchase increasing amounts of energy from renewable energy systems, and moreover, the Minister of Environment and Energy has laid a injunction on power suppliers to build 750MW of offshore wind turbine capacity by 2008. A new green market to be launched on January 2002 will support this increase in renewable capacity.

Electricity generated from biomass is paid on the basis of avoided costs and the price therefore depends on the specific time the electricity is produced. The same subsidy rules apply to biomass as for wind. The average price for biomass is approximately DKK 0,54 per kWh (E 0.07) but large variations (between DKK 0.41 – 1.25 per kWh) exist depending on the time of production. Other measures to support emergent technologies and R&D include grants for investment.

5.4.5. Reduction in Coal-Fired Capacity

In keeping with the objective of Energy 21 to reduce the use of coal in power plants, in 1997 the Folketing passed the “coal ban”. This has prevented permission from being given for the construction of new coal-fired power plants. This measure is not expected to have an immediate impact however as existing capacity already surpasses demand.

5.5. Austria

To promote the use of renewables, the Austrian government introduced purchase obligation at fixed minimum tariffs for wind, solar, indigenous biomass, biogas, waste gas, sewage sludge gas and geothermal energy set by regional legislation (“Bundesländer”) and, with regard to cross-border deliveries, for small hydro conventional fired CHP by Federal legislation.

The Federal Electricity Law foresees the principle of a purchase obligation on the distribution grid operator coupled with fixed feed-in tariffs, with details to be fixed by regional legislation of the “Bundesländer”. Minimum tariffs laid down in the federal legislation for small hydro-power and conventional fired CHP are:

Plants below 2 MW

- Winter: High tariff: E 0,065 (0,90 ÖS)

Low tariff: . 0,05 (0,67 ÖS)

- Summer: High tariff: E 0,034 (0,47 ÖS)

Low tariff: E 0,03 (0,42 ÖS)

Plants above 2 MW

- Winter: High tariff: E. 0,05 (0,72 ÖS)

Low tariff: E 0,04 (0,61 ÖS)

- Summer: High tariff: E 0,034 (0,47 ÖS)

Low tariff: E 0,03 (0,42 ÖS)

Tariffs fixed in regional legislation (“Bundesländer”) are in general oriented around these tariffs, however, are in some cases considerably higher, in particular with regard to wind (Kärnten, high tariff in winter: . 0,09 (1, 26 ÖS)) and PV (Kärnten: E 0,73 (10,0 ÖS)) . Possible costs stemming from the purchase obligation can be recovered by the grid-operator through the grid use tariffs. Other types of support include direct subsidies and RT&D support.

5.6. Belgium

The main price support scheme for renewables includes purchase obligation on utilities (ELECTRABEL) at a price including a bonus of E 0,05 (2 BEF) for wind and small hydro and E. 0,025 (1 BEF: “Le Franc vert”) for solar and biomass. The bonus payment was introduced on national level in 1995 and amounted initially to 1 BEF per kW/h. In July 1998 the bonus was doubled to 2 BEF for wind and small hydro.

Other types of support:

- Direct investment support
- RT&D support
- Tax incentives

Price of renewable electricity: E 0,052 (2,1 BEF) per kW/h (including E 0,025 or 1 BEF bonus).

5.7. Finland

Finland do not have any fixed price schemes to promote RES. In the fully liberalised electricity market RES-electricity must be sold in competition with conventionally produced electricity. The tax on electricity (FIM 0.025 per kWh) is, however, refunded to the producers of electricity from biomass (wood), small hydro and wind. Wind power gets an extra subsidy of FIM 0.016 per kWh.

Other types of support include tax rebates (electricity tax reimbursed to RES-electricity producers) and subsidies to investments in new energy technologies. Grants are also available for the management of young forests and for harvesting of energy wood. R&D is especially supportive of bioenergy technologies.

5.8. France

France is poor in energy resources. To limit foreign reliance, France developed an extensive nuclear programme. Today, nuclear electricity accounts for 75% of the national electricity production. Oil accounts for slightly more than 40 % of France's energy consumption while the contribution of coal to the fuel mix is steadily decreasing. The French government is supporting renewables through purchase obligation at fixed tariffs on utilities (EDF).

The feed-in tariffs are set by state regulation and are those applicable to independent power producers in general. However, since 1996 more favourable tariffs are paid for electricity from small hydro and waste. As regards wind, contracts are commissioned under the "EOLE 2005" programme following a tender procedure organised on a regular basis, tariffs depend on the outcome of the tendering procedure. As regards PV installations, utilities have to enable two-way metering and to sell and purchase electricity at the same price. Other types of support for renewables include tax incentives

Concerning climate change, the French national programme projects a stabilisation of methane emissions at their 1990 level in 2000, a 50 % cut in NOx and a 25 % reduction in SO2 and VOC emissions. The price of renewable electricity averages 0,056 (0, 337 FF).

5.9. Greece

Lignite, coal and oil dominate the energy supply in Greece by providing about 96 % of total energy supply in 1996. The main targets of Greek energy policy is security of supply and reduction of CO2 emissions through the Climate Change Action Plan. The main legislation that composes the framework for energy production comprises the Development Law, the Electricity Law and the Gas Law.

This legislation provides the background for the rapid development of Natural gas use (completion of the network) and guarantees reduced loan interest rates and tax deductions for investments in renewables.

The main price support scheme provides fixed prices for 10 years. The state power company, PPC, is obliged to purchase all electricity from private RES-electricity producers for a period of 10 years. The price paid by PPC is 70% of the low voltage tariff for autoproducers feeding in electricity to isolated grids. When fed into an interconnected system the price is set at 70% of the tariff corresponding to the level of voltage the producers is connected to. Independent producers get 90%.

Other types of support: Subsidies are given to investments in RES energy production. Households investing in renewable appliances may deduct 75% of the costs from the taxable income.

5.10. Ireland

The Alternative Energy Requirement (AER) is a competitive bidding scheme for renewables producers inspired by the UK NFFO scheme. Competition is within and not between technology bands. There have been four AER's since 1994. The successful, lowest, bidders are offered power purchase agreements for the sale of their RES-E to the Electricity Supply Board for a period of no longer than 15 years. Broadly similar entitlements apply to successful projects under EU (Thermie) schemes. The average price paid in 1997 for wind and biomass electricity was 4p/kWh. Other types of support include tax relief and capital subsidies.

5.11. Italy

The Italian energy market is characterised on the supply side by a lack of indigenous resources and a high level of dependence on imports, and, on the demand side, by a big share of oil.

Concerning the control of atmospheric emissions, a series of measures are implied to cut down CO₂ but also SO₂, NO_x and VOC emissions. ENEL the largest emitter of SO₂ and NO_x has been particularly affected by these measures, switching from high to low sulphur oils, burning more natural gas and investing heavily in low NO_x burners and fluegas desulphurisation equipment.

The main support scheme for renewables has been CIP 6/92 which obliges ENEL, for projects presented until 30.6.95, to pay a premium price. These prices are fixed for the first 8 years of operation and for the remaining lifetime a reduced price is paid for all RES covered by CIP 6/92. The following prices are paid:

- small hydro power up to 3MW: . 0.083 per kWh
- wind and geothermal plants: . 0.104 per kWh
- PV, biomass, waste: . 0.154 per kWh
- After 8 years, prices are reduced to: . 0.053 per kWh

Other types of support include capital subsidies of up to 30% for industrial users and up to 80% for isolated housing and lighting purposes.

5.12. Luxemburg

Price support schemes for renewables include a purchase obligation on utilities at fixed prices set by regulations introduced in 1994. The feed-in tariffs are set in the Grand Ducal Regulation of 30 May 1994 and are adapted annually according to the inflation rate. For electricity from wind and PV an additional prime of 0,025 (1 LUF) per kW/h is paid . This leads to the following 1998 prices :

a) Installations up to 500 kW:

- . 0,1006 (4,06 LUF, wind and PV)
- . 0,0759 (3,06 LUF, others)
- b) Installations above 500 kW:
 - wind and PV:
 - day-time tariff: . 0,085 (3,43 LUF)
 - night-time tariff . 0,056 (2,27 LUF)
 - others
 - day-time tariff: . 0,06 (2,43 LUF)
 - night-time tariff . 0,031 (1,27 LUF)

Other types of support include a subsidy scheme supporting wind and solar energy and tax incentives.

5.13. The Netherlands

The general objective of the Dutch energy policy is to provide the country with reliable, affordable and clean energy. Energy efficiency and climate change mitigation are two of the main areas of focus for energy policy.

Electricity generation is mainly based on natural gas followed by coal. Renewables are promoted in a number of ways.

Feed-in tariffs for renewables are fixed per technology by EnergieNed, the organisation of distribution companies. In 1998 they were fixed at around 8ct per kWh, based on avoided costs. The different 1998 tariffs were:

- biomass 8,0 ct Kwh)
- hydro (<15 MW) 8,3 ct Kwh
- wind 8,1 ct
- solar/PV 7,4 ct

In addition EnergieNed either gives RES-E producers the regulatory energy tax back which equals 3ct per kWh, or invests it in new renewable generating capacity. The energy distribution companies have voluntarily agreed to ensure a 1.7 billion kWh take-up of RES-E in 2001, which is 2% of total electricity generation. Not all RES-E producers participate in the scheme. Energy distribution companies purchase green labels, issued on request of producers, to fulfil their requirement. The market determines the price of the labels. The labels are not coupled to the physical electricity delivery.

Other types of support: Reimbursement of regulatory energy tax, Green labels, research and development, investment subsidies, green pricing schemes offered by some suppliers. The average price for RES electricity is 8cts/kWh.

5.14. Portugal

The price support scheme for renewables includes regulated prices for production up to 10MW, above 10 MW avoided costs are paid for 15 years. The government encourages renewable IPP's by granting them the right to supply electricity to the grid up to 10 MW at regulated prices. The tariffs are split in an energy and a power rate. The power rate varies according to production time. For systems larger than 10 MW incremental electricity production is paid for at avoided cost rates for 15 years.

In addition, capital subsidies of up to 60% of eligible costs for demonstration projects, up to 50 % for commercialisation projects and loans of up to 40% for projects increasing deployment of mature technology can be granted. Purchases of renewable energy equipment benefit from a reduced VAT rate of 5%. Other types of support include: Investment and capital subsidies, preferential loans, research and development.

5.15. Spain

Price support schemes for renewables include feed-in tariffs for companies and individuals producing their own electricity. The support of RES-E is contained in Royal decree 2818/1998 in force since 1999. The utilities have to buy electricity from individuals producing at market price plus a surplus payment set by the administration. The decree applies to plants below 50 MW. The extra costs for the utility are passed on the final consumer. Prices paid in 1999 were 11.21 Ptas/kWh for small hydro (<10 MW), 11.02 Ptas/kWh for wind and 9.46 Ptas/kWh for waste. The price paid for intermediate hydro (> 10 MW, > 50 MW) depends on the installed power. Other types of support include capital subsidies.

5.16. Sweden

Price support schemes for renewables include environmental bonus for wind producers and biomass exemptions from energy taxes.

The electricity market in Sweden is liberalised and the electricity price in general not regulated. However, small power producers (<1.5 MW) have the right to sell electricity to the local utility at regulated prices. Almost all wind power producers and many small hydro power producers are covered by this rule. Electricity from wind also receives an environmental bonus equal to the electricity tax.

Other types of support include CO₂ taxes, NO_x levies and a sulphur tax to encourage the use of RES. Until 2002 grants are available for investments in biomass, wind power, small-scale hydropower. A technology procurement programme has also been initiated.

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6. BARRIERS TO INTERNALISING EXTERNAL COSTS

Roger Fouquet

6.1. Introduction

Consumers try to satisfy their needs for heat, power and light through the use of energy with the appropriate technology. The production, distribution and consumption of fuels generate environmental costs, that individuals and firms generally fail to internalise in their decision-making process. Because of the public's willingness to pay for environmental quality and, therefore, to reduce the right to pollute, but no means of signalling to polluters these preferences, a demand for the regulation of environmental pollution has developed, which effectively seeks to internalise external costs.

The failure to internalise external costs can be the result of the breakdown of two relationships. First, the method by which the public signals its preferences about (and willingness to pay for) environmental quality is not very effective. This is one of the reasons why governments set out to gather information, such as estimating the value of environmental improvements, of which the ExternE project is a good example. Second, the government can fail to translate the public's wishes into suitable signals and incentives for the suppliers of environmental quality. There are numerous reasons why the internalisation of external costs can suffer from government failures (either because it is unwilling or unable to do so): ideological reasons, the costs of information collection and analysis, pressure groups influence politicians, bureaucratic frictions, and the costs and complexity of implementing appropriate policies.

The purpose of this paper is to present the key behavioural features in creating a process to internalise external costs. This should enable us to understand why governments may fail to internalise external costs, and start to provide ways of improving the incentive structure such that the markets for energy services, energy and environmental pollution will be socially desirable.

The next section explains how the demand for environmental regulation arises. Section three briefly considers the potential difficulties of detecting whether this demand for an internalisation process is occurring. The sections afterwards each look at one of the barriers to internalisation.

6.2. The Demand for the Internalisation of External Costs

The socially most desirable outcome in the market for energy services - such as heat, power and light - is when the highest total level of utility from consumption and highest level profits from provision are traded at the lowest total cost to society. That will occur when the unit price of an energy service is equal to the marginal social cost of its provision. Because negative externalities (resulting from land, water and air pollution) exist in the production, distribution and consumption of energy, these external costs will tend not to be reflected in the price of energy services. Thus, compared with the socially optimal level, an excessive provision and consumption of energy services will occur.

The negative externalities influence the outcome in the market for environmental quality by altering the supply, which is a function of the level of pollution emitted, nature's ability to assimilate the pollution, weather patterns and geographical factors (Pearson 1994). The demand - that is, the public's willingness to pay - for improvements in environmental quality reflects the cost to individuals of reducing environmental quality one unit (if it could be measured in units). Demand is a function of income, the price of achieving a particular level of quality, information about the impact of environmental damage and tastes (Baumol and Oates 1988). While the demand for environmental quality is likely to change through time, because of market failures, there will be few direct mechanisms signalling or creating incentives to the suppliers for them to adjust their production activities to meet the demand and, therefore, supply a desired level of environmental quality (as would happen in an efficient market).

There will generally be a need for regulation of environmental pollution to achieve the optimal level of environmental quality. In the absence of an institutional framework, polluters will tend to increase emissions until the marginal cost of abating pollution is zero - this assumes a decreasing marginal cost of abatement. Some incentives exist to encourage agents to reduce the level of pollution, such as improvements in the efficiency of equipment and implications for the company's image from causing environmental damage. Such incentives are unlikely to drive emissions to the optimal level of pollution, however. The optimal level being achieved when the marginal costs of abatement are equal to the marginal benefits of abatement (reflecting the public's willingness to pay for unit improvements in environmental quality). The public hires the government to regulate the market for the right to pollute, because it cannot directly influence environmental quality¹⁴. Ideally, this government will impose a level of permits (either rigid or tradable) or a per unit charge that will achieve the optimal level of environmental pollution (ie where demand meets supply).

6.3. Perception of the Internalisation Process

The first question to ask is "whether this demand is being met or is there genuinely a failure of government to set up the regulatory framework for internalising external costs?". It may have been introduced in other guises - other policies that are not explicitly 'for internalisation purposes' actually provide the appropriate signals. It is possible that authorities have begun to introduce an internalisation framework but, either by intent or by accident, it is a gradual process. Some have argued that policies that 'muddle through' are more effective than radical changes of strategy (Wei 1997). In this case, to some, the policies does not appear to have been adopted, although it has.

Once it appears clear that there has been a failure to introduce such legislation, the next question to ask is "how are policies introduced?" Constructing a model of political decision-making should help lead to an explanation of how legislation fails to be introduced. A neoclassical economic view of the political process is that government seeks to maximise social welfare, which can be done by undertaking

¹⁴ It may even have to regulate the market for energy to influence the market for pollution permits to, ultimately, influence environmental quality.

cost-benefit analysis and assessing which policies increase well-being. While it has the benefit of being simple and suitable for certain forms of analysis, in the case here, it ignores too many crucial elements, in particular, problems resulting from the facts that policy is endogenous to the economic system and that policy-makers do not always maximise social welfare (Drazen 2000).

There are several economic models of the political decision-making process. These focus separately on: the influence of interest groups on the supply of governmental policy; the relationship between interest groups and political party campaigns; and the social or composite utility function incorporating interest groups, as well as the general public's concerns. Dijkstra (1999) reviews these with specific consideration of environmental policy. He concludes that the most suitable model for analysing instrument choice is a rent-seeking model, which focuses on the interest groups activities; while this is no doubt the most crucial element in the choice of environmental policy, it limits the active role of the policy-maker and of voters. Politicians and civil servants do have an important role to play, whereas voters hardly do, because of the relatively low priority of environmental issues. Below, we will present what appear to be the key behavioural features of the market for environmental regulation and reasons why 'government failure' may occur.

6.4. Ideology

It is also possible that those with the power to introduce the legislation do not perceive the value of internalising externalities. This lack of perception can be either because the individual responsible for the relevant decisions, and those that prepare the legislation, do not believe any action is needed or do not believe internalisation is the appropriate method for resolving the problem.

As discussed before, the political decision-making is often seen as a process of interest groups attempting to persuade politicians of views and ideas. At a conceptual level, scientists, engineers and social scientists are trying to convince politicians about the value of their method of dealing with environmental problems. For example, economists can be seen as an interest group that will benefit from the use of their tools and methods, because it will increase the demand for environmental economic analysis and, thus, for economists. And, any individual economist, especially if a leading member, will improve his/her income, prestige, etc.. Over the last thirty years, a market for environmental policy methods and advisors has developed, in which each discipline has sought to sell its method, some times, at the expense of other subjects and approaches.

The most commonly cited debate in environmental policy methods is about 'incentives versus regulation'. In the past, many environmental economists have been prescribing in broad terms the use of market instruments rather than command and control measures (Stavins 1992). Environmental economics developed in the United States in the 1970s at a time of clash about methods between economists and policy makers, who had a "unique aversion ... to charges" (Braadbaart 1998 p.149). Because of the clash, few environmental economists in the early years of the debate were involved in policy, minimising the opportunity for empirical evidence, thus, remaining grounded in theory and limiting its appeal. In addition, and as a

consequence of economists' lack of practical experience, the discipline failed to appreciate certain of the complexities of applying the theory to practical problems.

It could also be argued that the dependence on theory was attractive to (short-termed) economists both for reasons internal to the discipline and as a means of persuasion. First, as in many scientific disciplines, theoretical, highly mathematical and complex analysis is given pride of place in the journals. The incentive structure for economists' research is, therefore, biased towards theory. Second, if presented with clarity, an argument that can be applied to all cases (ie a panacea) will lower the costs to economists of persuading politicians of the method's virtues and of using it for resolving environmental problems.

This ideological clash was particularly strong in the United States, but now has also led to the greatest acceptance amongst policy-makers of the use of market instruments. While it is not clear whether economists mould policy or policy influences economists' views, a survey of economists shows that in the United States only 21% disagree (and 56% agree) with the statement "an ecotax is more effective than a pollution limit" (Braadbaart 1998 p.147); in the Netherlands, 19% disagree, while 40% agree; in Germany and France, 33% and 41% disagree with the statement. Thus, there appears to be less agreement in Europe about accepting market-based instruments without questions. Furthermore, there is now (both in Europe and the United States) an increased acceptance that incentives and regulation are not competing ideologies, but rather complements.

6.5. Information Collection and Analysis

The costs and complexity of producing, distributing and assessing scientific or other information can hinder regulators' ability to select the appropriate level of internalisation. Environmental pollution and the attempt to minimise its consequences raise great uncertainties, which can be reduced through information collection and analysis. Since resources are limited, a trade off between expenditure on information and on action must be made. Insufficient funds allocated to information will mean an excessive level of uncertainty remains, hindering the potential for action. Excessive expenditure for information will leave implementation underfunded. Furthermore, mis-allocation of resources between these two activities (possibly for reasons discussed below) will reduce overall policy effectiveness (Brunner and Klein 1999).

The type of information that is produced through scientific analysis generally corroborates and builds upon previous research, thus, reducing the uncertainty associated with a particular issue.

Policy makers when evaluating alternatives associated with environmental issues need to base themselves on this information. At the same time, other institutions demand scientific information - especially pressure groups, such as non-governmental organisations and companies seeking to develop evidence in favour of a particular argument. Thus, the demand for reducing scientific uncertainty will come from numerous sources, and will create varying incentives for the producers of the information.

The producers of scientific knowledge, researchers in academia and in R&D laboratories of private companies, are trying to maximise their own utility functions

(Stephan 1996). The function includes the financial rewards, the development of their human capital (eg professional experience, knowledge and contacts), their reputation, their power to influence (either the funders of their research, policy makers or the public), and other perhaps more social goals (eg finding a cure for cancer, improving the environment, alleviating poverty and suffering, etc..).

The production of scientific analysis is in turn a function of the resources set aside and organisational structure. Within the confines and constraints of the research institution, funds available will be key to determining the level of cognitive ability and effort (that is, the researchers' skills in selecting a problem, understanding the sequence in which it should be investigated and solving the problem), human capital, physical capital (eg laboratory equipment) and time available for analysis. Within a particular discipline, it is probable that there is a decreasing marginal output - to reduce uncertainty further takes greater levels of funding. Also important to remember is that because of the low cost of reproducing knowledge (although not always of understanding), it generates positive externalities; thus, in a free market, there will be a tendency to produce insufficient levels of science knowledge. On the other hand, in a centralised system of allocating funds for research, there is likely to be an inefficient spread as scientists with power and influence divert excessive funds - such that the marginal social benefits of research are lower than the marginal costs.

Once research is generated, the information needs to be disseminated and made intelligible to non-scientists. Furthermore, the producers and those that disseminate, including journalists, are in competition amongst themselves to sell their 'story' - results and conclusions. This competition can lead to either inaccurate research (on the part of producers) or on invalid inferences (on the part of journalists) in an attempt to increase their 'market share'. The spread of information is particularly susceptible to cascade effects (and increasing returns to scale); thus, provided a scientific story is 'sold' enough, it is likely to be accepted by the public and government officials. Naturally, the proximity to the 'truth', clarity of the argument and its appeal (including avoidance of cognitive dissonance, dramatic content, etc..) should also increase the probability of being accepted and used. Furthermore, since many organisations, from the government (and other politicians) to non-governmental organisations to companies to the media, all want to use a story in a particular way, often with little concern for the 'truth', then the probability of a story becoming an accepted fact is even more complex. Thus, as scientific information passes from the need to reduce uncertainty about a problem, into to the market for scientific analysis with opaque methods of allocating resources and the incentives of researchers, and then into the world of media, it is unlikely that valuable, non-controversial knowledge will have been generated and used through the most efficient allocation of funds.

6.6. Pressure Groups

Pressures on politicians may sway decisions away from the ideal internalisation plan. The politicians within government are pursuing their own objectives, including re-election, personal material gains, personal power, image in history, certain ideals and personal view of common goals (Breton 1974). The government acts as a temporary monopoly supplier, enabling politicians within to use this position of power to combine public goods, such as the regulation of environmental pollution, with private goods that may, for example, assist in achieving their personal objectives. For

example, decisions may be guided by an attempt to win votes, possibly from a strategic minority (Buchanan and Vanberg 1988, Boyer and Laffont 1999) or to appease powerful lobbies with stakes in the outcome of policy choice (Fernandez and Rodrik 1991, Dijkstra 1999) or even to avoid bad press associated with policies that might harm the low-income groups more than proportionally. So, while the government decides what its outputs will be and in what quantities, it is open to influence about these decisions.

The main route for the public to influence policy is through the voting system. Consequently, politicians seek in part to satisfy their electorate. This voting and this satisfying behaviour will be crucial to the development of policy, which not always lead to a maximisation of social welfare. The electorate will tend to vote on the basis of self-interest rather than the socially-optimal solution. Such behaviour can lead to sub-optimal outcomes, as exemplified by the paradox in the prisoners' dilemma. Alternatively, knowing that their influence on policy is negligible, voters may take on a more expressive position (Buchanan and Vanberg 1988). On the politicians side, there will be an attempt to not offend voters; this may foster a conservative approach to policy making.

Individuals and firms who feel their interests are not being satisfactorily represented within the democratic process will form or join groups, of which one of the main functions is to influence policy more directly than through the voting system. This behaviour is known as rent-seeking, and involves trying (often with considerable group expenditure) to increase the likelihood that political decisions will favour the interests of the group. Rent-seeking often leads to a waste of the potential gains from a particular project due to competition amongst potential beneficiaries.

There are numerous models of rent-seeking activities and its influence on political decisions (Neary 1997). Economic agents that will suffer from the legislation, such as producers of energy with high external costs or that will lose profits as the price of energy rises and sales fall, may try to influence political decisions. In many cases, those that benefit from legislation are a large and unhomogeneous section of the population and the losers a smaller but more concentrated group. The cause in support of such reforms tend to suffer from free rider problems, whereas the smaller group of losers will have greater organisational ability to lobby against the policy. This 'non-neutrality' of pressure groups can result in the perverse outcome of socially beneficial legislation being abandoned (Rodrik and Fernandez 1993).

The position of pressure groups can vary substantially, both in their willingness to pay for internalisation and for the instrument used in the process. Company shareholders and workers tend to be against intervention, expecting declines in profits and employment levels. They may, however, be more open to the idea if some of the revenue generated from internalisation (either from taxes or auctioned tradable permits) is recycled for activities that may reduce costs to the company (Dijkstra 1999). On the other hand, company managers appear to have a preference for tradable permits which are grand-fathered; this is because the permits are free and the system creates barrier to new entrants into the market (Svendsen 1999). Trade unions may be reluctant to see internalisation in general, they appreciate that higher taxes on pollution and energy may lead to reductions in labour taxes, thus, boosting employment (Dijkstra 1999). Environmental movements are naturally in favour of

internalisation, although they have in the past been against market based instrument. This view is gradually changing and it appears that they increasingly approve of tradable permits as a way of negotiating higher abatement levels from industry (Svendsen 1999). Bureaucrats have mixed feelings about the use of market based instruments as they lose control of the internalisation process - there was some suggestion that this view was stronger at the national level than for regional agencies (Dijkstra 1999). As discussed in the section on ideology, the stances of particular pressure groups may also vary across countries, where different beliefs about the implications of internalisation and specific instruments exist.

Crucial to the likelihood of influencing political decisions is the power of the various pressure groups. This will include their individual power, the coalitions formed and their methods of influence. In the past, industrialists have generally been the most powerful group. Depending on the political persuasions of the government, trade unions would have more or less power. Smaller non-governmental organisations, such as the environmental lobbies, tended to have little pull. This is changing - events like Brent Spar are indicating that their power to influence policy, particularly on specialist subjects, is significant (Worcester 1996). Increasingly, public policy is trying to take account of groups, such a local communities, that may not set out to influence policy, but are nevertheless directly influenced by decisions (Hampton 1999). Clearly, the level of public participation in decision-making process will have an important role in determining the outcome and in minimising the level of rent-seeking (Steelman and Ascher 1997).

There is also could be some consideration about the formation of interest groups and the activities within them (Sandler and Tschirhart 1997). The problems of principal-agent theory could be extended outside government agencies (See also next section on bureaucracy). For example, there is evidence that managers of environmental groups derive benefits from expenditure beyond the objectives of the company (Hewitt and Brown 2000). This could, therefore, distort the activities of such groups, not necessarily maximising the communal welfare of the group.

Pressure groups may put financial or other (eg horse-trading) pressure on those in power to avoid introducing legislation. They might highlight some of the negative spillover effects of introducing legislation, which could increase the number of opponents, who would in turn put pressure (Lagerlöf 1997). Much of this can be done through influencing the media's coverage and focus. There is evidence that media coverage does influence environmental policy decision-making (Yates and Stroup 2000). It has been suggested that media coverage influences the distribution of opinions in the general public, which environmental agencies reacts to in policy formulation [Follow up]. On the other hand, crises, partly resulting from the intensified provision of information about a particular issue through the media, can accelerate the introduction of policies (Blacconiere and Patten 1994, Drazen 2000 Chapter 10).

The likelihood of interest groups managing to influence decisions or delaying decisions is also dependent on the institutional structural for introducing policy (Drazen 2000 Chapter 10). So, for example, it is probable that a structure such as exists within the European Union makes it easier to delay. Other governments may be easier at influencing.

6.7. Bureaucratic Friction

Bureaucracy may also limit the socially optimal decision-making of government. Although government makes the decisions, most of the funds are channelled through civil servants hands, who have their own objectives (Niskanen 1971). Each department or bureau receives funds reflecting a perception of its output - the society's benefits increase with the department's output, but at a decreasing rate. It incurs costs, which like assumptions about other organisations tend to increase more than proportionally as output increases. Ideally, the government should increase fund provision to the department until the marginal benefits equal the marginal costs. In this market for the administration and implementation of regulation, the outcome will be the result of interaction between supply (ie the department - eg the environment agency or the DETR) and demand (ie the government) (Breton and Wintrobe 1975). Because of government's inability to correctly estimate this level and one of the bureaucrat's key objectives being to maximise budget size, the government will tend to over-fund departments, reducing the efficiency of policies. Furthermore, either because internalisation is considered of secondary priority, departments may clash over objectives (Oates and Strassman 1978) or the personality of civil servants driving internalisation policies are weak (in comparison with those responsible for other policies), funds and activities are inefficiently allocated. Finally, the high costs and complexity of implementation, monitoring and enforcement may also hinder progress towards internalisation.

Civil servants have their own agendas, separate from trying to maximise social welfare. Some may clash with the internalising of externalities or an issue related to its introduction (Zimmerman and Gaynor 1999). For example, if the prestige of a particular department will be raised by its introduction, others may feel undermined and try to hinder the programme. Alternatively, a legislator may (because of affinities) seek to favour the interests of a particular group over the wider population (Gabel and Hager 2000). Another limitation could result from a clash between local, national and international legislation; acts already in place make the introduction feasible (Meadowcroft 1997). A further problem is that the bureaucratic processes may suffer from considerable inefficiencies, limiting both the number of legislation introduced and the success of any particular piece of legislation (Duncombe, Miner and Ruggiero 1997). Finally, because of the importance of other policies, the efforts to internalise external costs will be considered a low priority and delayed.

6.8. Conclusions

In an attempt to internalise the external costs of energy and, therefore, of providing heat, power and light, the public enters the market for environmental regulation and seeks provision from the government. The government decides what its outputs (eg the type of regulation) will be and in what quantities (eg the level of pollution regulation, if it chooses to regulate). There are, however, many factors that may lead to 'government failure', such that the market for pollution permits is either not regulated or sub-optimally regulated.

It is possible that despite internalisation being introduced, observers may fail to perceive the process. This is possible if policies internalise the negative externalities

although it was not their explicit intention or if policies are introduced in a gradual process (Wei 1997). So, although there is a demand for environmental regulation, it is not always simple for observers to detect whether external costs are being internalised.

There are, nevertheless, numerous reasons why governments do fail to internalise. First, other market distortions (eg a monopolistic situation) or legislation (eg local environmental standards or labour laws) introduced clash with the attempt to internalise external costs. As a consequence the policy can only achieve a second-best (Baumol and Oates 1988).

Second, regulators may fail to introduce appropriate policy due to ideological reasons - either because they are not aware of the internalisation concept or they do not consider the process beneficial (Braadbart 1998). Evidence suggests that politicians are increasingly aware of the opportunity to deal with environmental problems through the concept of internalisation. It has been argued that economists could increase their influence on environmental policy by changing their view about the objectivity of their discipline (Deblonde 2000).

Third, the costs and complexity of producing, distributing and assessing scientific or other information can hinder regulators' ability to select the appropriate level of internalisation. Environmental pollution and the attempt to minimise its consequences raise great uncertainties, which can be reduced through information collection and analysis. Since resources are limited, a trade off between expenditure on information and on action must be made. Insufficient funds allocated to information will mean an excessive level of uncertainty remains, hindering the potential for action. Excessive expenditure for information will leave implementation underfunded. Also, mis-allocation of resources between these two activities (possibly for reasons discussed below) will reduce overall policy effectiveness (Brunner and Klein 1999). Furthermore, as scientific information passes from the need to reduce uncertainty about a problem, into the market for scientific analysis with opaque methods of allocating resources and the incentives of researchers, and then into the world of media, it is unlikely that valuable, non-controversial knowledge will have been generated and used through the most efficient allocation of funds (Stephan 1996).

Fourth, pressures on politicians may sway decisions away from the ideal internalisation plan. The politicians within government are pursuing their own objectives (Breton 1974). The government acts as a temporary monopoly supplier, enabling politicians within to use this position of power to combine public goods, such as the regulation of environmental pollution, with private goods that may, for example, assist in achieving their personal objectives. For example, decisions may be guided by an attempt to win votes, possibly from a strategic minority (Buchanan and Vanberg 1988, Boyer and Laffont 1999) or to appease powerful lobbies with stakes in the outcome of policy choice (Fernandez and Rodrik 1991, Dijkstra 1999) or even to avoid bad press associated with policies that might harm the low-income groups more than proportionally. So, while the government decides what its outputs will be and in what quantities, it is open to influence about these decisions. Many different pressure groups are likely to want to influence the internalisation process, including company managers, shareholders and employees from many different industries (either as consumers or producers of energy), trade unions and environmental organisations,

etc... Their influence on the likelihood of internalisation and the type of instruments used will depend on the power of each pressure group, the coalitions formed amongst them and the methods of influencing.

Fifth, bureaucracy may also limit the socially optimal decision-making of government. Although government makes the decisions, most of the funds are channelled through civil servants hands, who have their own objectives (Niskanen 1971). Each department or bureau receives funds reflecting a perception of its output - the society's benefits increase with the department's output, but at a decreasing rate. It incurs costs, which like assumptions about other organisations tend to increase more than proportionally as output increases. Ideally, the government should increase fund provision to the department until the marginal benefits equal the marginal costs. In this market for the administration and implementation of regulation, the outcome will be the result of interaction between supply (ie the department - eg the environment agency or the DETR) and demand (ie the government) (Breton and Wintrobe 1975). Because of government's inability to correctly estimate this level and one of the bureaucrat's key objectives being to maximise budget size, the government will tend to over-fund departments, reducing the efficiency of policies. Furthermore, either because internalisation is considered of secondary priority, departments may clash over objectives (Oates and Strassman 1978) or the personality of civil servants driving internalisation policies are weak (in comparison with those responsible for other policies), funds and activities are inefficiently allocated. Finally, the high costs and complexity of implementation, monitoring and enforcement may also hinder progress towards internalisation.

Each of these factors is likely to hinder the achievement of optimal policies. As a consequence, it becomes necessary to consider the costs and benefits of government action to internalise externalities (Wolf 1979).

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7. STAKEHOLDER PERCEPTION OF BARRIERS AND WAYS FORWARD

Roger Fouquet

7.1. Introduction

This chapter presents stakeholder views on energy-related environmental policy-making. A series of stakeholders were contacted; they were either interviewed or, when they preferred, sent questionnaires. The Appendix presents the stakeholders contacted and the nature of the questions asked. The initial task was to gather evidence on the barriers to using the ExternE information for internalising external costs of energy production, distribution and use, and possible ways forward. It proved difficult to gather sufficient evidence on ExternE itself. The task's scope was broadened to consider the relationship between environmental policy-makers' objectives and the information they use.

In view of the discussions, these have been arranged in line with the analysis in Section 6, and the following parts correspond to parts 6.4 to 6.7 on ideology (7.2), information collection and analysis (7.3.), pressure groups (7.4) and bureaucratic friction (7.5). The final part summarises the overall trends, which reflect points made by interviewees.

7.2. A More 'Internalisation' Ideology

Decisions about environmental standards and the methods of achieving them depend on politicians' requirements imposed on how civil service should analyse and guide policy. Politicians' philosophical underpinnings are vital to determining those requirements. Within the United Kingdom, and elsewhere, there is a greater recognition of the need for "policy to go with the flow of the market", rather than imposing certain measures. There is also an increasing use (e.g. from Chancellor Gordon Brown) of the 'polluter pays' principle, suggesting the need to internalise external costs.

There is clearly variation between countries and government departments. For example, it was suggested that the Commission was a couple of years behind the United Kingdom in the use of economics, but was ahead of many member states. Within the Commission, some Directorate Generals are better than others in their use of economics. In the field of climate change, in particular, the Commission is making use of economics to a much greater extent than, say five years ago, and the economics is tightly bound into the policy work. This is also true of air quality, water and waste. On the other hand, the energy supply green paper was less progressive.

The United Kingdom's air quality standards are guided by the recommendations of an expert panel, EPACS. EPACS develops its recommendations based on scientific research, such as epidemiological and toxicological evidence. They do not take an economist's view of the problem and, therefore, do not consider internalisation of external costs as one of their objectives and the role of monetisation as relevant to their decision-making process. The air pollution standards, such as the National Emission Ceiling Directive, are based on more economic evaluation. In particular, the

RAINS model, developed by IIASA, compares the costs and benefits of emission abatement levels.

All current climate change policy is ultimately governed by trying to achieve the Kyoto Protocol. The protocol was a political compromise, based on scientific concerns and some concession for different countries future rates of economic growth. This suggests that there is a vague awareness of the external costs of greenhouse gases (i.e. the scientific concern) and of the costs of abatement (i.e. future growth rates). Nevertheless, the key driver is far from acknowledging the importance of internalising external costs or from being a cost-benefit analysis of climate change. In the last few years, however, governments are becoming increasingly aware of the economic reality of achieving the Kyoto Protocol and needing to take account of the costs of mitigation, probably because they hit a strong and vociferous lobby, industry. While scientists are more adamant than ever of the likelihood of climate change resulting from greenhouse gases, the benefits of abatement are too distant, distributed across the global and, therefore, too uncertain to be more than a distant influence on the debate. Thus, climate change policy is not (and probably never will be) an attempt to achieve economic efficiency, either of internalising external costs or of cost-benefit analysis.

This concern for the environment is tempered by other government objectives. In relation to energy policy, there is a need for security of supply, reducing fuel poverty and dealing with the social implications of changing energy markets (e.g. the unemployment associated with pit closures). Despite the acceptance of the need to internalise costs as a key objective of policy, the political reality of achieving economic efficiency of air and atmospheric resources is very different.

Overall, while there is a clear split between policy-advisors following a purely scientific approach and those incorporating cost-benefit analysis, there appears to be an increasing awareness of economic efficiency criteria and a growing willingness to use them for setting standards.

7.3. Environmental Information

7.3.1. Environmental Information in General

The 1980s were a period in which scientists and pressure groups were highlighting the environmental problems (from acid rain to global warming, etc.). In the late 1980s and early 1990s, governments started to recognise the need for action. More people were realising that environmental policy increasingly needs to be based as far as possible and is reasonable on good science, intelligent economics, tempered by a pragmatic approach to dealing with risk/uncertainty. This involved the demand for social and physical scientific analysis. There has been an explosion of research in this field.

There was an expectation that politicians would understand, appreciate and use effectively the information scientists had produced. In many cases, they did not. The scientific information did not necessarily fit within the politicians' 'paradigm'. For example, too few recognised that economics is really best used as a tool to clarify options and consequences, and that it is not a replacement for political decisions on

priorities. During the mid and late 1990s, some scientists began to understand how to make their information useful for politicians. Politicians (and civil servants) also made steps towards explaining what they wanted. Environmental research today is being produced, supplied and used more effectively than it was 10 or 20 years ago.

And, this process of iteration continues. Gradually, however, politicians are starting to understand what they want from scientists and how to ask scientists for this information. Meanwhile, scientists are starting to understand what politicians want and how to deliver it. Further cooperation and efforts to make the language of science and politics meet is needed.

Another important development in policy-making arena is the growth of information technology. It has led to an increased production and supply of data, and a fall in the cost of using this information. This has enabled all parties (e.g. policy-makers, pressure and analysts) to undertake more thorough studies, and non-regulators to monitor the policy-makers activities. The appreciation of the value of the information has in turn led to an increase in the demand for information from all sides. For the policy-making activities, such as the internalisation of external costs, which may have involved considerable “data-crunching”, they are more achievable than before. Thus, information technology has reduced the costs and raised the use of information, and enabled a more rigorous and technical approach to policy-making.

7.3.2. The ExternE Methods, Estimates and Uses

In discussions with civil servants, evidence suggests that, at a national level, non-economists were not sufficiently aware of the ExternE study and its estimates. Economists were familiar with the study, considering it valuable as “a first stab” at a comprehensive survey of external costs across Europe.

It was believed that the ExternE methodology had improved. Epidemiologists are starting to consider the number of years lost, rather than simply measuring numbers of deaths. In relation to morbidity, there have been attempts to take account of chronic, as well as acute, damage. On the valuation side, improvements also relate to the developments in health economics methodologies and data availability. Partly as a result, the level of uncertainty surrounding estimates is declining. By their very nature, however, the estimates will always include degrees of uncertainty, and this will be a barrier to their use. In addition, its technical nature (and, thus, the difficulties of understanding the information) and disagreements associated with methodological issues will continue to limit the ExternE’s use. Some anticipate an increased use of the results in the future.

Nevertheless, the application of the ExternE methodology has been a valuable tool in the generation of cost-benefit analysis. For example, it was used in the analysis of

- a draft directive on the incineration of non-hazardous waste,
- the UNECE Multi-Pollutant, Multi-Effect Protocol and air quality limits for SO₂, NO₂, PM₁₀ and lead.
- the National Emission Ceilings Directive

These are attempts to use estimates of external costs in the formulation of policy. They have used from the ExternE project, as well as from other studies. There is

likely to be an increasing use of external costs for estimation. Therefore, the ExternE project is useful as the development of acceptable methods for widespread evaluation of external costs.

In addition, the ExternE project has helped support and develop of a degree of external expertise that has usefully fed into subsequent contracted work - a number of people who have worked on contracted cost-benefit analysis work are closely involved in ExternE. The work on economic analysis of air quality has been much helped by this programme in this way.

7.4. Pressure Groups

7.4.1. Weakening Opposition

When a government proposes standards and how they should be met, the consultation process enables all interested parties to comment and influence policy. And, the current UK government appears to place more value on public and pressure group participation in the decision-making process. In principle, if recommendations are based on cost-benefit studies, they should have factored in the concerns of pressure groups from the outset, giving concerns of all sides the appropriate weighting and consideration. Thus, a shift towards more quantitative analysis in policy formulation does remove some of the pressure group's abuse of power of influence. Nevertheless, individual pressure groups can and do disagree with the methodologies developed, the weightings used and the inferences made. In some sense, there has been even more room for influence of decisions. Today, pressure groups are well informed about issues, and more accurate and insightful about their suggestions.

There was a feeling that both sides of the environmental debate, the pro-campaigners and industry that might suffer under new environmental legislation, are starting to accept a greater role for economic instruments in policy-making and the potential acceptability of a need to deal with issues related to air pollution, acid rain and, especially, climate change. Some felt that environmental NGOs had a strange relationship with economic instruments though - on the one hand, the NGOs support getting prices right and internalising external costs, but at the same time they are often fundamentally opposed to the techniques economists propose to try to estimate these costs or even to taking an economic approach to environmental issues at all, claiming "the environment is beyond price". In a converse vein, some industry representatives were accused of being in favour of cost-benefit analysis but this may be because they too see the possibility of 'paralysis by analysis'. There is a view that, unfortunately, the weight environmental NGOs and industry put on the economic arguments tends to vary directly with whether or not the economics supports the position they hold. Finally, it was felt that little good economic analysis of environmental problems was coming from environmental pressure groups or industry. Thus, the economics in environmental debate acted purely as rhetorical tool for pressure groups.

Progressive companies are always trying to stay one step ahead of the game. This means iterating between anticipating future issues, assessing the best outcome given the government's objectives and trying to influence policy. Progressive companies are aware of the inevitability of government demanding that the "polluter pays".

One example of progressive companies being in favour of legislation is the introduction of tradable permits. Tradable permits achieve environmental targets in a relatively cost-effective manner. If the targets are set at the appropriate level, external costs will be fully internalised. For industry, they can be a way of achieving costs at relatively low costs. If permits are allocated on a 'grandfather' basis, the company will not have to pay for their permits. They only need to pay for extra permits. In fact, if they are efficient, they can even earn money by selling the permits to other firms. Furthermore, permits can make it more difficult for new companies, which will be potential competitors, to enter the market, because these new companies need to cover the costs and time of learning about the tradable permits market and they may have difficulty negotiating permits for themselves. Thus, permits are a barrier to entry, and attractive to incumbent companies.

7.4.2. Positive Externalities

The concept of internalising external costs might be seen as a negative (or disruptive) process – imposing new costs of industry and, therefore, raising many objections. The idea of turning the internalisation into a positive (or constructive) activity is vital for using ExternE information and reducing reticence to the concept. This is why the European Directorate General on Competition's decision to use the positive external benefits associated with renewable electricity is seen as an important step forward.

Positive externalities arise from investments that create options that would not otherwise exist. They also arise when investments reduce the costs of emerging technologies, such as fuel cells, photovoltaics or renewable energy sources; by investing now, we are reducing the cost to future generations of responding to climate change. Looking at photovoltaics, for example, their external costs are quite high. While looking at lifecycle costs is an appropriate exercise, it is ignoring an estimate of the positive externalities, which can be derived from the cost curves of the technologies and assumptions about future markets and how much investments might bring costs down.

The focus of policies should – and is beginning to - be on the positive externalities of innovation. There are targets for technologies and obligations to support renewable energy. There are special levies, with the revenues being used to fund renewable energy and energy efficiency. There are R&D programmes. There are very large demonstration and procurement programs. There is discussion of offsets linked to specific technologies. There are risk-sharing arrangements between government and industry investing in the new technologies. All these are intended to drive technology forward, and are used as a complement to the taxation of pollution itself, and often as an alternative.

In sum, there is the belief that policy needs to look far more critically at the scope for innovation for reducing costs, to estimate the positive externalities of innovation, and determine what sorts of policies would internalise these benefits.

7.5. Less Bureaucratic Friction

Civil servants play a crucial role in ensuring that policy is developed. One important factor is the type of people in civil service. There might be a form of 'self-selection

bias' in the choice of civil servants. Those working in environmental departments are often strongly motivated to work on environmental issues, often have strong views on environmental issues and, it would seem, have a higher than average hostility to the use of economics. They might be similar in their views to the representatives of environmental NGOs, who are against placing a price on natural resources. Thus, within the environmental policy field generally there appears to be still some latent hostility to the use of economics, and that this impedes the effective use of economics in policy formation.

A further barrier is the particular views held by civil servants, and whether they exercise their power to influence. The culture promoting that civil servants should be neutral with respect to the objectives of policy varies from country to country. There are people who work on environmental matters who have strong views on what is 'right', and see cost-benefit analysis, or even cost effective analysis, as an obstacle to 'progress' rather than as a useful tool. The 'obstacle' appears particularly when the economics does not come up with the 'right' results. A culture of neutrality appears to be more pronounced in the United Kingdom than, for example, in the European Commission.

Despite these extremes, many civil servants are open to the importance of a knowledge-based approach to environmental policy making, with economics as one key component of this. But, environmental issues are complex. Another key factor for the successful development of a particular piece of policy is the need for civil servants to have sufficient time working on the subject (and, therefore, not to be transferred between departments). This is because for the "sherpas" to develop the human capital (i.e. skills and knowledge) necessary to understand the issues and problems, the ways of moving the process forward and advising ministers. In addition, they are crucial to adopting new ideas that politicians may not have the time or inclination to use. Thus, in the last ten years, civil servants have been increasing their 'human capital stock' associated with the complex the relationships between the economy, energy and the environment on the one hand and the politics, psychology and economics associated with these relationship.

Governments are starting to integrate environmental problems or even consider them integral parts of wider social and economic policy. This greater integration of environmental coupled with better understanding of the problems are ensuring that the bureaucratic process is now moving forward more effectively than it did at the beginning of the 1990s.

7.6. The Internalisation Process

The purpose of this section was to present stakeholder views on the role and evolution of information in energy-related environmental policy-making. While one of the objectives was to assess stakeholders' views on the barriers to using ExternE projects for policy-making, the interviews also tried to understand what factors were causing barriers to the overall internalisation process and how factors are changing or might change to reduce those barriers. To some extent the objectives of the interview process changed as it became clear throughout that few stakeholder would talk in detail about the ExternE experience. There was a lack of expertise on the subject, possibly due to a failure to disseminate the ExternE research. Consequently, the

questions became broader in scope, trying to understand the relationships between beliefs, information and incentives in energy-environmental policy-making.

Looking at this broader picture, the stakeholders who we discussed these issues with did suggest that beliefs about and information for environmental policy-making has evolved over the last ten years. The philosophical underpinnings of policy have changed, partly on the side of the politicians but also crucially on the part of the civil servants, who need to develop an understanding of these complex issues. Economic rationale for environmental policy, principally, cost-benefit analysis and internalisation of external costs, is being sought explicitly. This has led to an increasing demand for and use of environmental economic information, such as the ExternE estimates. Consequently, barriers to integrating economic rationale into environmental policy are falling. Furthermore, there is a change in the pressure groups positioning on environmental policy. Both the prospect of tradable permits and of positive externalities is non-costly to existing companies, and potentially beneficial. Thus, while there have been substantial barriers to the internalisation process, these appear to be gradually coming down.

Appendix. Stakeholders and Questions

The principle method of assessing stakeholder perception was through semi-structured interviews. These were, on the whole, very successful, and provide the bulk of the evidence. Those that preferred to be surveyed by email were initially enthusiastic but failed to respond satisfactorily. The authors would like to thank all stakeholders involved. These were of great value to our understanding of how the process of internalisation is moving forward.

Stakeholders contacted were:

Helen Dunn, Environment Protection Economics Division, DETR
Janet Dixon, Air and Environment Quality Division, DETR
Nick Hughes, Climate Change, BP
Mark Johnston, Climate Change and Transport, Friends of the Earth
Tim Jenkins, Climate Change and Transport, Friends of the Earth
Peter Roscoe, Energy Policy Directorate, DTI
Domenico Rosetti, DG Environment, European Commission
Nicola Steen, Environmental Matters, Association of Electricity Producers
Chris Tollady, Climate Change Directorate, DTI
Peter Vis, DG Environment, European Commission
Louise Whall, Air and Environment Quality Division, DETR
Rupert Willis, DG Environment, European Commission
Steve Workman, Corporate Responsibility Manager, London Electricity
Peter Zapfel, DG Environment, European Commission

The question asked were as follows:

1. (a) Do you feel that government (UK or EU) is increasingly basing its energy-environment policies on economic rationale (i.e. internalisation of external costs and cost-benefit analysis)?
(b) Have civil servants approach to using an economic rationale for environmental objectives changed?

2. (a) Are you aware of the ExternE project (a pan-European project to estimate the external costs of energy use)?
- (b) If yes, in what has been the value of the project?
- (c) Do you see any trends in the use of information (e.g scientific, economic, etc..) for environmental policy-making?
3. Has there been a change in pressure groups' (like Friends of the Earth and Greenpeace, but also oil and electricity companies) views of the use of economic rationale for energy-environmental policy.