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Working Paper

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ZEW Discussion Papers, No. 04-02

Provided in cooperation with:
Zentrum für Europäische Wirtschaftsforschung (ZEW)

Suggested citation: Tuerpitz, Katharina (2003) : The Determinants and Effects of Environmental Product Innovations - An Analysis on the Basis of Case Studies, ZEW Discussion Papers, No. 04-02, http://hdl.handle.net/10419/23993

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The Determinants and Effects of Environmental Product Innovations – An Analysis on the Basis of Case Studies –

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Zentrum für Europäische Wirtschaftsforschung GmbH
Centre for European Economic Research

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The Determinants and Effects of Environmental Product Innovations – An Analysis on the Basis of Case Studies –

Katharina-Maria Türpitz

Non-technical summary

The technical and economic limits to additive 'environmental protection' are becoming increasingly apparent. There is also a growing awareness of the importance of the consumption and disposal phases relating to both production processes and the extraction of raw materials. In response, institutions such as the OECD, the UN Commission on Sustainable Development, and the European Commission, have initiated programmes aimed at developing an 'Integrated Product Policy' (IPP). Despite the recent IPP Green Paper and Communication published by the European Commission, which outline proposals for the promotion of an IPP, we still have only a rudimentary understanding of the factors and policy instruments which influence the environmental performance of products. In particular, there is a need for empirical analyses of the driving forces influencing environmental product-related innovations. In this context, the European Commission's Communication proposes the setting up of pioneer projects.

Against this background, the paper investigates the determinants and effects of innovative behaviour in companies with regard to environmentally-friendly product innovations. By considering technological, political, market-related and company-specific determinants, the paper takes account of both environmental and industrial economics as well as environmental management issues. In the process, the paper pays particular attention to the impact of the basic proposals contained in the Green Paper - i.e. product-related policies, eco-labels, environmental management systems (EMAS, ISO 14001), life-cycle analyses and producer's responsibility for products.

The paper includes several case studies of manufacturing companies operating in different industrial sectors in Germany. These case studies are based on both expert interviews and analyses of company-specific documents which provide IPP-relevant information.

Given the sample size, the results cannot be regarded as statistically representative, but they are nonetheless amenable to interpretation and do provide indicators which intimate a wider picture. General results will be drawn from an empirical analysis based on a large scale survey carried out between August and November 2003 at the Centre for European Research in Mannheim.

In summary it is apparent that, as far as the possible determinants of ecological product innovations are concerned, regulation appears to be one of the main drivers of ecological innovation. Proactive eco-innovators also appear to be significantly geared towards future policies. Furthermore, instruments which take account of manufacturers' product responsibility appear to have a major impact on ecological product design. Recyclable or green eco-design are much more likely to be created if manufacturers have a vested interest in taking back and recycling their products.

New technology is another important driver. An increasing number of firms from different industries have identified the ecological and economic potential which lies in the consumption and waste disposal phases. This may be largely due to the fact that past environmental activism has been more or less additive in nature with a focus on processes rather than products.

Nevertheless, marketing issues and weak market performance are issues which also confront eco-efficient products. Neither eco-labels nor life-cycle analyses appear to be of great significance for innovating firms as they are far too costly and time-consuming – especially in the short term.

The Determinants and Effects of Environmental Product Innovations
An Analysis on the Basis of Case Studies

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November 2003

Summary

The aim of the Integrated Product Policy (IPP) is to promote product-related eco-innovations. These, in turn, depend on both support for the development of environmentally-friendly products and stimulation of demand for such products. However, it is companies that play the crucial role in the ecological optimisation of products as it is they who – during the R&D phase - determine the basic environmental characteristics for the product utilisation and disposal phases. This paper therefore examines the main determinants and effects of environmental product innovations, including several case studies of companies in the German manufacturing sector.

With regard to the possible determinants of ecological product innovations, regulation appears to be one of the main drivers of ecological innovation. New technology is the second most important stimulus. An increasing number of firms from different industries have identified the ecological and economic potential which lies in the consumption and waste disposal phases. Nevertheless, eco-efficient products still have to grapple with the problem of weak market performance. Neither eco-labels nor life-cycle analyses appear to be of great significance for innovating firms as they are – especially in the short term- far too costly and time-consuming. On the other hand, instruments which take account of manufacturers' product responsibility appear to have a major impact on ecological product design.

Keywords: Integrated product policy (IPP), environmentally-friendly product innovations, innovation research, case studies.

1 Introduction

Over the past three decades additive environmental protection has significantly improved the quality of our environment. Today, however, the technical and economic limits of this approach are - in some branches of industry at least - becoming increasingly apparent (BERKOUT and SMITH 1999). In addition, newly developed methods of assessing the ecological dimension of entire product systems have revealed the growing importance of the consumption and disposal phases in relation to the extraction of raw materials and the production process.

Institutions such as the OECD, the UN Commission on Sustainable Development, and the European Commission have responded by initiating programmes aimed at developing an 'Integrated Product Policy' (IPP). The European Commission has also recently published a Green Paper and Communication which outline proposals for the promotion of an IPP (EU 2001, 2003).

Integrated product policy is defined as public policy which explicitly aims to modify and improve the environmental performance of product systems throughout their entire life-cycle (RUBIK 2002a). In other words, the aim of IPP is to improve the environmental performance of both products and services in order to achieve a broad reduction in all environmental impacts resulting from the production and consumption of products. Although services do play an important role with respect to IPP, they are not the primary goal. Services should not however be excluded whenever IPP proves to be essential for reducing the environmental impacts of product systems (EU 2001).

It should be stressed that the Integrated Product Policy is not a completely new kind of policy, but a concept designed to harmonise the various product-related policies which currently exist within the European Union. The purpose of IPP is to help avoid the difficulties stemming from the different national product-related policies existing in the member states.

Despite the major political, ecological and economic significance of IPP, we still only have a rudimentary understanding of the factors and policy instruments which influence the environmental performance of products. In particular, there is a need for empirical analyses of the driving forces influencing environmental product-related innovations. This paper aims to contribute to this topic.

2 Topic and objective of this paper

KNEESE and SCHULTZE pointed out as early as 1975 that "in the long run, perhaps the most important single criterion on which to judge environmental policies is the extent to which they spur new technology towards the efficient conservation of environmental quality" (KNEESE and SCHULTZE 1975: 82). With regard to IPP, a study of its effect on the development of environmentally-friendly product innovations is therefore of key importance. Special attention is paid to the effect of measures which already exist today (such as life-cycle analysis, environmental labelling, manufacturer responsibility). The future potential of measures which are currently only at the planning stage, such as setting appropriate prices, is also of special interest.

As the promotion of product-focused innovations involves both supporting the development of and stimulating demand for environmentally-friendly products, an IPP policy must tackle both supply and demand-side issues right from the start. However, companies play a crucial role in

the ecological optimisation of products as they determine - in the R&D phase - the basic environmental characteristics for the utilisation and disposal phases of the product. For this reason, this paper deals with the corporate level.

This paper draws on empirical company case studies to address the following issues:

? What are the essential stimuli for the introduction of product-integrated innovations and what role do environmental policies or environmental instruments play?

? When and for what reasons have these innovations succeeded both ecologically and in the market? (It is assumed that the ecological potential of product-focused environmental innovation is only realized if the product succeeds in the market.)

3 Methodology

A total of six case studies were performed on companies operating in the German manufacturing sector. These case studies include expert interviews with those responsible for product-focused environmental protection as well as the analysis of company-specific documents.

The expert interviews have an explorative character and are designed to rationalise research work and "to obtain – in an economic manner - an initial overview of the situation in a social field not immediately accessible to the researcher" (WALTER 1994: 271). There are various criteria for determining expert status (WALTER 1994, MEUSER and NAGEL 1994). This study follows MEUSER`S and NAGEL`S points of view according to which experts do not engage in problem-solving from the outside, but are themselves defined as part of the activity field affected by a particular problem. The interviewees selected in this paper were managers responsible for product-related environmental protection.

The advantage of analysing written documents – as in this case – is that the contents of such documents are not influenced by the research topic itself and provide an initial insight into the activities of the firm in question. However, it is important to remember that such documents were also originally produced for strategic reasons. The environmental declarations and reports analysed in this phase of the study, for example, not only have an in-house regulatory and communication function, they are also intended to project a particular image of the company to the outside world. The purpose of these documents must therefore be taken into critical account during the analysis (MAYRING 1999).

Table 1 details the companies surveyed and includes information on the nature of their business and the documents included in the analysis.

Table 1: Companies included in the case studies

Company	Industry	Documents / Information
Siemens Medical Solutions	Medical technology, healthcare equipment	Environmental Report (2002)
Toshiba Europe GmbH	Computer systems, electronic components	Environmental Report (2002)
Schott Glas AG	Glass industry, home appliance, optics etc.	Environmental Report (2000) Glas (Schott Glas (Ed.)) Occupational Safety and Environmental Care (Schott Glas (Ed.))
Continental	Car tires, automotive systems, Conti-Tech	Standards of Environment, Security& Health Eco-balance of a car tire (Continental AG (Ed.))
Ergo-Fit	Cardio, medical equipment	Environmental Report (2000)
Ensinger Mineral-Heilquellen	Beverage industry, spa	Environmental Report (2000)

The scope of the collected data is too meagre for the purposes of a representative analysis; however, the advantage of this method is that it offers an initial insight into the innovation processes in individual companies. This enables company innovation processes to be studied in detail and the influences which support or impede such innovation to be analysed on the basis of specific examples. Moreover, in contrast to extensive surveys – which provide a cross-section overview at a given point in time - case studies are able to take account of the timeframes of company processes.

Case studies allow industry and technology-specific information to be collected which would not be available for econometric analysis. In this context, JAFFE and PALMER (1996: 19) argue that " ... to develop a better understanding of the nature of the relationship between regulation and innovation would be to conduct some focused industry studies. These studies ... could include a more detailed analysis of particular classes of regulation, say by media, on innovation effort."

Finally, a further rationale for these case studies is that they lay the groundwork for a subsequent extensive company survey on the same topic. The results obtained from the case studies can be used to design an interview questionnaire which is geared towards the real circumstances prevailing in companies. The large-scale survey conducted at the ZEW between August and December 2003 will enable general results to be drawn from the empirical analysis based on the survey.

4 Theoretical approach

As the research field dealt with in this work combines approaches from the field of industrial economics, environmental economics and environmental management it could be fittingly referred to as environmental innovation research. The reason why it is important to combine these three research approaches which focus on environmental innovations – and in this case on product-related environmental innovations – is explained in the following.

4.1 Industrial economics

From an industrial economics perspective, technological progress is an economic phenomenon that can be explained at the microeconomic level of the individual market according to supply and demand side factors, such as :

? Technological opportunities, i.e. the ability to access economically usable knowledge

? Market demand

For a long time the literature on the determinants and impact of innovations focused almost exclusively on these two factors - the so-called technology push and the market pull hypotheses (SPECHT and BECKMANN 1996, ROTHWELL 1995, SCHMOOKLER 1966). While the technology push theory assumes that the main driving forces of progress are newly developed technologies, the market pull theory states that innovation activities are mainly determined by market demand. At present the consensus appears to be that technological progress is relevant in the initial stages of the life-cycle of an innovation and market factors for their further diffusion (PAVITT 1984).

Not only that, established approaches to innovation research have tended to assume that the role of the state and policymaking was solely to provide the infrastructure required for the generation, transfer and application of existing knowledge. Central importance was consequently attached to research policies and the promotion of research facilities (OECD 1999).

4.2 Environmental economics

However, as numerous studies of environmental economics have shown, environmental policy also has a powerful influence on the speed and direction of technological progress with regard to eco-innovations. Bearing these studies in mind - and taking particular account of environmental innovations - another function of the state is to establish a 'national innovation system'. According to RENNINGS (2000), there is even a need for a specific environmental and innovation policy. One of the reasons RENNINGS cites is the aspect of spill-over effects triggered by environmental innovation, i.e. on the one hand, the positive spillovers generated by innovations in general and, on the other, the positive external impact of environmental innovations in terms of 'higher environmental quality'. As these environmental improvements are unlikely to generate direct returns or market benefits, the creation and diffusion of eco-innovations are largely dependent on political influences (JÄNICKE 2000). These influences are referred to as regulatory push/pull effects and illustrate that the role played by the state in this context is much more significant than the influence it exerts by means of its technological policy.

Nonetheless, despite the regulatory push/pull of environmental innovations, environmental policy is only one of the factors influencing the environmental innovation behaviour of companies.

4.3 Environmental management

Shifting the perspective from individual markets or sectors to individual companies, the three factors - technological push, market pull and regulatory push/pull – discussed so far are complemented by a fourth crucial element: company-specific features (SCHWARZ et al. 2002, RUBIK 2002b). The specific characteristics of individual companies mean that the point of departure in terms of innovation activities differs from company to company. These different starting points also explain the different effects and intensities of the determinants and effects of product-specific environmental innovations.

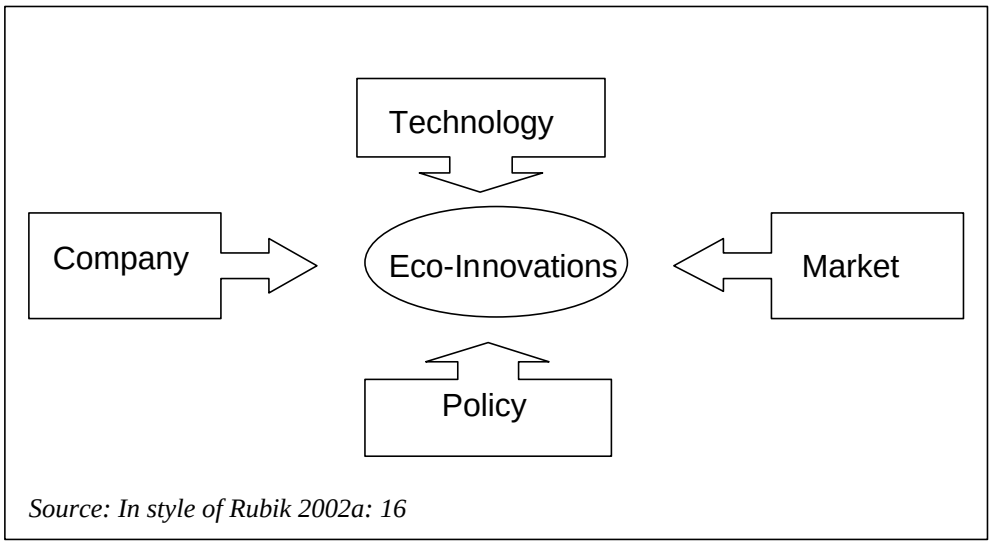
4.4 Discussion

Empirical studies focusing on the determinants and effects of eco-innovations demonstrate how closely interrelated and interdependent the four determinants - technological, market-driven, political and company-specific factors - are (CLEFF and RENNINGS 1999, HEMMELSKAMP 1999, GREEN et al. 1994).

These studies suggest that environmental innovations are influenced by complex interactions between a wide range of technological, market, policy, and company-specific determinants (SRU 2002).

This paper studies each of these four stimulus factors and thereby encompasses industrial economic, environmental economic and environmental management perspectives.

Figure 1: Main determinants of eco-innovations



Source: In style of Rubik 2002a: 16

5 Case studies

The following questions were used as a rough structure for the firm interviews:

? What relevance do ecological product innovations have for your company?

? What influence do environmental policies have on company activities in the field of product-specific environmental protection?

? What is the significance, in particular, of market and technology-specific company objectives?

? What is the role of particular product-specific environmental policy instruments - such as life-cycle analysis, environmental labelling and producer responsibility.

Product-specific environmental innovations are defined as follows:

According to HEMMELSKAMP (1999: 15), environmentally-friendly product innovations in the manufacturing sector comprise "... the launch of new or completely modified products and improvements in the technological performance of products through the use of new materials, expendables or new functional product components in a company." At the same time innovations contribute to the avoidance or reduction of environmental burdens (KEMP and ARUNDEL 1998). Environmental innovations can be generated with or without the explicit goal of limiting environmental damage. Environmental innovations may therefore also be the product of company targets such as cost-cutting efforts or continuous quality improvement, and they thereby combine ecological with business or consumer-oriented benefits.

5.1 Technical progress and environmentally-friendly product innovations

All the interviewees concurred in the view that ecological innovations in general are of the utmost importance, mainly because of the directly or indirectly related economic benefits they generate - cost-cutting, the safeguarding of market share, or the creation of a positive corporate image in the financial community and among the public at large. In the long run, ecological innovations therefore appear to have both an ecological and economic potential.

The companies surveyed regard the utilisation phase, in particular, as playing a key role in product improvement. However, extensive technological research is necessary if this potential is to be exploited. Information on the options for improving ecological product properties is collected by companies from sources along the value chain. According to VON HIPPEL (1982), information from the downstream sections of the value chain in particular impact product innovations. One reason for this may be that information from and contact with potential customers and users can help to reduce the market uncertainty surrounding product innovation. This was also noted by PESONEN (2001) who claims that the main contractors in a value chain "…become increasingly aware of the environmental impacts of the raw materials and components of their products" (PESONEN 2001: 46). However, this study also reveals that – as far as the development of environmentally-friendly products is concerned – suppliers (i.e. upstream information) have an important role to play (HEMMELSKAMP 1999). This finding also appears to be plausible given that the environmental friendliness of a product is not only directly determined by the product innovator, but also indirectly by primary products and the input raw materials.

The major improvement potential available during the utilisation phase referred to above may largely be due to the fact that environmental protection has to date – in most cases at least – focused on processes and machinery. Considerable progress has already been made in these areas

and in many cases, further improvements can therefore only be realised at substantial additional cost. In contrast, the utilisation phase - which has been neglected in the past – offers significant easily-exploitable cost-saving potential. This in turn explains why companies regard this phase as offering the most effective – economic and ecological - implementation opportunities.

A good example is provided by the eco-balance sheets drawn up in some companies for specific product groups which reveal that the environmental impact of products is greater during the utilisation phase than during the manufacturing phase. This applies, for example, to car tyres and, as demonstrated by other studies, household appliances, electrical devices and motor vehicles (refer to http://www.environdec.com for more information (July 7, 2003)).

The positive economic potential of ecological innovations can, however, be accompanied by economic and technical risks, such as high investment costs, heavy technological burden or uncertain profitability - factors which impede innovation activity in this field.

5.2 Market signals

The high potential inherent in environmentally-conscious product use means that customer's utilisation behaviour is just as important as their spending behaviour. These behaviour patterns not only influence the utilisation-related environmental impact of products, they also determine market demand and, as a result, the innovation activities of companies. In contrast to the results of a study carried out by HEMMELSKAMP (1999), demand and customer needs would appear to have a more immediate impact on the development and production of environmentally-friendly products (CLEFF and RENNINGS 1999) than environmentally-friendly process innovations. This is particularly true as far as companies' short-term innovation projects are concerned.

The intensity of market factors appears to vary according to sector and consumer group, however. In the electrical industry, in particular, original equipment manufacturers (OEM) and major customers demand that ecological criteria are met. The typical end-customer of electronics products, by contrast, is more concerned with the balance of technical features and price. Consumers of personal and health goods, such as foodstuffs, textiles or home-improvement materials, on the other hand, demand that environmental aspects are taken into account by manufacturers (see e.g. SCHWARZ 2003).

The survey results reveal that – leaving aside the eco-market - companies regard themselves as being confronted with major problems during the commercialisation of environmentally-friendly products and with overall weak market demand. Left to their own devices, companies can do little – by means of advertising, for example – to influence patterns of customer spending. In some cases advertising or the highlighting of ecological benefits even has negative effects. Customers frequently associate environmental friendliness with low-quality products, for example, or may subsequently be confused about the environmental friendliness of products by the same manufacturer which are not explicitly marketed as environmentally friendly. By and large, advertising the ecological qualities of a product appears to be successful if customers are already aware of ecological issues, have already signalled interest and expressed environmental preferences in their spending patterns.

Outside of the environmental protection market, environmental friendliness appears to be an added extra for which – on some markets – there is very little willingness to pay. Insufficient interest, inadequate or misleading information, or non-existent legislation are other obstacles to commercialisation. The commercial environment is seldom auspicious for the launch of ecological products.

5.3 Role of Environmental policy

Bearing in mind the obstacles to innovation referred to above, it is not surprising that one of the main drivers for product-based eco-innovation activities appears to be companies' efforts to comply with existing and future legal and normative requirements. Environmental policy is a key factor influencing innovation activities. At the same time, however, companies tend to anticipate that such innovative activities – if undertaken at an early enough stage – will generate lower costs in the medium and long term. Further catalysts for product-specific environmental innovations are:

- Early identification and analysis of potential improvements regarding the disposal, treatment and use of recyclable waste and early and appropriate protective measures.
- Securing long-term markets by preparing for future market and customer needs.

This suggests that, in the long term, regulatory instruments generate an innovation dynamic which impels companies to engage in innovation activities which by far surpass the legal and normative requirements. Comparative studies on the innovation incentive effects of individual environmental instruments reveal that economic instruments (taxes and permissions) are preferable to regulatory instruments as they represent a permanent inducement to companies to look for broader, cost-efficient means of easing the environmental burden (MICHAELIS 1996). On the other hand, regulatory instruments which are anticipated to come into effect in the future also have an incentive effect by initially alerting firms to the existence of specific problems. Companies which recognize these problems subsequently identify the associated long-term ecological and economic potential and endeavour to exploit this in a cost-effective way (QUELLA 2000).

5.3.1 Life-cycle analysis

Life-cycle analyses (LCA) are one of the instruments which the Commission of the European Communities regards as beneficial for companies' IPP activities (EU 2001). In fact, most companies already appear to deploy a variety of instruments and procedures designed to provide them with insights into the ecological characteristics of their products throughout the product life-cycle. ISO 14040 eco-balance sheets are one fundamental means of performing life-cycle assessments. Eco-balance sheets are drawn up with the aim of identifying both the potential environmental impact of specific products and the innovation potential for product improvements, product changes or completely new product lines.

The survey results do, however, indicate that while eco-balance sheets are extremely useful for product development and improvement purposes, companies do not believe they represent appropriate standard instruments which can be used across different sectors or product groups. The benefits which companies believe LCAs offer appear to be dependent on product-specific characteristics such as the type, complexity and lifetime of the product. These are the decisive parameters which influence the form and extent of ecological LCAs. Life-cycle analyses appear to be useful for companies that mass produce a few complex products or products with similar key characteristics. Another common argument advanced against LCAs is that their completion is costly, time consuming, and personnel intensive. This explains why some companies regard eco-balance sheets as impracticable and refuse to draw them up at all, or simply create a one-off eco-balance sheet for an 'average product' which then serves – at least for a limited period of time – as a form of benchmark for the company, providing information about an entire product group. This is the case, for instance for tyre manufacturers, where an eco-balance sheet makes sense for an average car tyre.

The expense and work involved in eco-balance sheets represent obstacles, in particular, for innovative companies operating in economic sectors with short innovation cycles, such as high-tech firms. As the high innovation pressures in these sectors demand creativity, flexibility and especially speed, eco-balance sheets are too time consuming to be appropriately applied to new ideas. LCAs appear to be more suitable for companies' medium and long-term innovation activities.

5.3.2 Environmental labelling

Environmental labelling does not represent an entirely satisfactory solution to the commercialisation problems referred to above either. Given the wide diversity of labels on the market, eco-labels often tend to confuse customers. Customers find it to difficult find out whether the information is reliable and are uncertain whether labels provide criteria for objective purchase decisions. Misleading information, such as the one-sided positive highlighting of certain aspects, may even result in the concealment of negative aspects and therefore undermine customers' trust both in particular manufacturers and in environmentally-friendly products in general.

The study also reveals that the time and money which needs to be invested in environmental labelling discourage their use. Short product lifetimes, a small number of output units, and a wide variety of products, for example, may make environmental labelling inefficient, and products which comply with label requirements may not use them at all.

5.3.3 Producer responsibility

The legal requirements for producer responsibility in Germany are anchored in the 1994 Recycling and Waste Act. The law requires manufacturers to take back products from the consumer at the end of the utilisation phase. However, this does not imply that products necessarily have to be taken back physically. It is sufficient for the take-back costs borne by waste disposal or recycling firms to be met (refer to BMU 2003 for more information).

One fundamental problem, however, is that the overall costs of waste disposal cannot be easily attributed to individual products. As a result, the selling price of products often fails to reflect their true costs. If all the costs which accumulate throughout the life-cycle of a product – manufacturing, distribution, and particularly disposal costs - were included in the selling price, environmentally-friendly products would in many cases even cost less than conventional ones.

If, on the other hand, the manufacturer continues to have a vested interest in a product after the utilisation phase, this appears to have a positive impact on environmentally-friendly product design. As an example, the study illustrated that companies which take back products or earn money from their recycling pay particular attention to recycling-suitable product designs. This may, for example, involve a manufacturer cooperating with a waste disposal firm or performing the take-back or disposal/recycling activities itself. These collaborative aspects have also been highlighted by MAYERS and FRANCE (1999).

This principle is based on the simple idea that manufacturers not only determine the basic utilisation and recycling features of their products, but can also influence recycling and waste treatment costs during the product planning and development phases. How easy or difficult it is to recover raw or residual materials from consumer goods after use and/or to reduce emissions during waste treatment, depends on the product design, for example. The integration of production and disposal/recycling activities leads to the internalisation of product design externality: a 'green' product design is now in the manufacturer's own interest (PETHIG 2002).

5.3.4 Company specific features

Finally, company size also appears to be an important factor influencing a company's product-related innovation effort. While big firms tend to engage in the mass production of environmentally-friendly products, smaller firms are more likely to attempt to penetrate small market niches by producing specialised eco-products.

A further impetus to eco-innovation is the personal involvement and commitment of individual employees – particularly those in the company's R&D department – who often ensure that project innovations are implemented despite the uncertainty and risk attached to such activities.

Other important company-specific factors are corporate culture and attitudes towards environment-related topics. The study revealed that, on the whole, all the firms surveyed emphasise the importance of the company's endeavours in the field of environmental protection. Companies are either certified to the EMAS scheme or the ISO 14001 standard. Environmental protection is now also an integral element of the guidelines used by all the companies surveyed, which suggests that environmental protection objectives – alongside and at the same level as corporate business and social objectives - are pursued throughout entire companies.

The importance of these objectives is also highlighted by:

- High production and manufacturing standards
- High innovation efforts in ecological areas
- Strong commitment to social responsibility

These companies explain their commitment to environmental protection in terms of the direct business advantages which accrue from reductions in energy costs and waste, attracting attention, conveying a positive corporate image to the media and social institutions as well as motivating employees. Last but not least, the earlier a company begins to perform environmental-related activities, such as energy-saving-programs, the more expertise it is able to acquire in this field. As a result, these companies are able to fall back on a relatively broad base of knowledge which can lead to the generation of further environmentally-friendly eco-innovations.

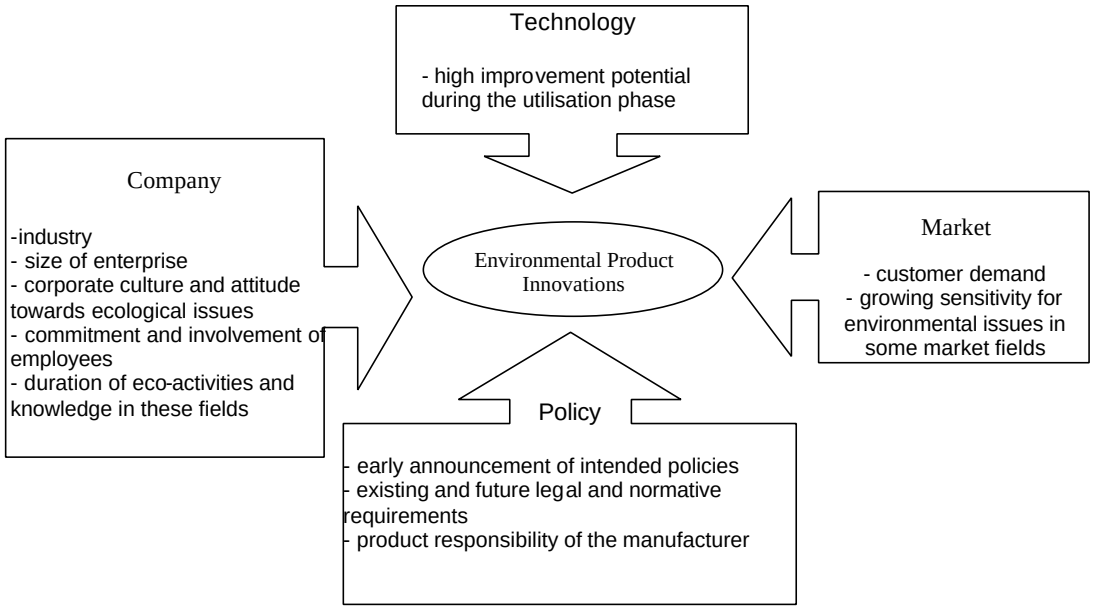
6 Conclusions

According to the companies surveyed, ecological product innovations appear to offer significant ecological and economic potential in the medium and long term. The ecological aspect is illustrated, in particular, by product-specific company targets such as energy-saving during the utilisation of a product, multiple use of products and improved recyclability. The key direct and indirect economic benefits are: cost-savings, the safeguarding of market share, and a positive corporate image both among the public at large and in the financial community. These benefits correspond with the results obtained by CLEFF and RENNINGS (1999) and show that the implementation of environmentally-friendly product innovations is related to company targets such as cost-cutting, quality improvement and the preservation of market share. SCHALTEGGER and FIGGE (2000) come to the same conclusion and, with regard to environmentally-related issues, emphasise the relevance of company strategy. However, in addition to the positive potential, the companies surveyed also recognise the implicit economic and technical risks, such as high investment costs, high technical input costs or uncertain profitability.

This discussion of the factors influencing product-specific environmental innovations suggests that innovations are triggered by four basic innovation catalysts: technology, market, environmental policy and intra-corporate factors (see figure 2).

The primary stimulus emanates from existing and future environmental laws and guidelines, followed by the technological potential that companies discover in the product utilisation phase in particular. Further influencing factors include market signals and satisfaction of existing or anticipated customer needs, as well as company-specific factors. As far as instruments such as life-cycle analysis, environmental labelling, and extended producer responsibility are concerned, only the latter has proved to promote innovation. In contrast, the use of eco-balance sheets and environmental labelling appears to provide only a minor stimulus impact on the development of environmentally-friendly products. Instead, these instruments provide indicators of environmental innovation: companies which engage in product-specific environmental protection are more likely to use life-cycle analysis and environmental labelling.

Figure 2: Main determinants of product-related eco-innovations



The next step was to perform a large-scale survey of a random sample of firms. Its objective was to discover to what extent these findings can be applied to other companies and to lay the groundwork for statistically representative results. First results will be available in Spring 2004. Above all, it will allow the following questions to be answered: how do environmentally-friendly companies differ from non-environmentally-friendly companies – particularly in terms of IPP activities - and to what extent do environmentally innovative firms differ from environmentally non-innovative ones.

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