Greener Technologies Through Greener Policies? Environmental policy integration into Finnish technology policies

By

Paula Kivimaa* and Per Mickwitz

Finnish Environment Institute
P.O.Box 140
FIN-00251 Helsinki
Finland

*Corresponding author
Tel. +358 9 40 30 09 94
Fax +358 9 40 30 03 82
Email paula.kivimaa@ymparisto.fi

The integration of environmental principles into other policies is perceived important so that environmental problems can be combated as effectively and efficiently as possible. Policy integration can be an effective way to achieve political goals, but it can also be a way to diffuse attention and to obliquely resist the political goals one is declaring support for. Some methods for assessing environmental policy integration (EPI) have been developed but only a few empirical assessments demonstrating the current state have been carried out.

This paper examines the integration of environmental policy principles in the field of technology policy. We begin by discussing environmental policy integration and how to evaluate it. Subsequently, the integration of environmental conditions into technology policies in Finland is assessed empirically. The integration is examined at all levels including overall policy strategies and individual policy instruments, such as public technology programmes. The funding procedures as well as programme outputs are looked at to provide concrete evaluation of the extent of environmental policy integration. Moreover, the trends in policy development and the challenges for evaluating EPI are discussed.

The findings show that overall the actors of the Finnish technology policy have grasped the idea of environmental protection, and that environmental issues have been identified especially in the strategy level and in some technology programmes with a focus on environmental technologies. However, the integration is thus far not overarching and no assessment of the environmental impacts are required in funding applications.

Keywords: environmental policy integration, technology policy, evaluation

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1. Introduction

In 2000, OECD organised a workshop on innovation and environment pursuing two central concerns: how environmental policy can stimulate technological innovation, and how innovation policy can enhance environmentally sustainable economic development (Heaton 2000). One of the conclusions was that while some encouraging examples of policy coherence exist, they are the exception rather than the rule. Policy integration, i.e. the integration of environmental objectives into technology policies and of innovation aims into environmental policies, can be one way to promote policy coherence.

The need to integrate environmental policies into other policy fields has been acknowledged in the European Union. Starting with the EC's Third Environmental Action Programme, 1983, and strengthened in the Fourth and Fifth Action Programmes, 1987 and 1993, the need to integrate environmental considerations into the formulation and implementation of all sectoral policies has become a guiding policy principle in the EU (Liberatore 1997, 108). In 1987, the Single European Act provided in Article 130r(2) the principle that *"environmental protection requirements shall be a component of the community's other policies."*. The role of environmental policy integration (EPI) in EC legislation was further strengthened in 1997, when the Treaty of Amsterdam amended Article 130(r)(2): *"Environmental protection principles must be integrated into the definition and implementation of other community policies..."*. Despite this recognition for EPI, the decisions have been mainly disappointing (Jacob and Volkery 2003). For example in the EU transport policy, little substantial change had taken place after 8 years of discussions (Hey 1997).

Nevertheless, due to the increasing need for new types of policies to address complex environmental problems, environmental issues are gradually being recognised in other policy areas. According to Meadowcroft (1999, 229) *"*[t]*he notion that environmental management could almost exclusively be the responsibility of a single ministry has given way to attempts to integrate environmental considerations in the work of diverse government departments"*. Finland's technology policy administration among others have in recent years grasped on this idea.

Empirical evaluations of policy integration are needed to find out what kind of policy coordination problems are present in the current administration systems and to carefully examine the existing examples of policy coherence in order to learn from them and develop the practices of policy integration. Another important reason for carrying out evaluations is to examine the genuineness of the efforts to integrate policies. While policy integration can be an effective way to overcome the common policy coordination problem, it is also an old way to diffuse attention and to obliquely resist the political goals one is declaring support for through integration. Some methods for assessing environmental policy integration have been developed but only a few empirical assessments demonstrating the current state have been carried out (see Hertin and Berkhout 2003, Jacob and Volkery 2003, Lafferty and Hovden 2003).

This paper looks at the integration of environmental considerations into technology policies and whether greener, i.e. environmentally sounder technologies, could result through environmental policy integration. Although the integration of innovation concerns into environmental policies can be seen as equally important and is something we have examined in some detail previously (see Mickwitz and Kivimaa 2004), we focus here on the evaluation of environmental policy integration into technology policy strategies and instruments and into the outputs and outcomes of these policy measures in Finland. We argue that environmental policy integration needs to be evaluated in the different stages of the policy cycle to assess the sincerity and effectiveness of policy integration.

Environmental policy integration and technology policies are first discussed in Section 2. Section 3 describes the framework and methods we have used for evaluating environmental policy

integration. An empirical assessment of EPI in Finnish technology policy is carried out through out Sections 4 to 7, each section focusing on a different stage in the policy cycle. Finally, a discussion of results and conclusions are presented in Sections 8 and 9.

2. Environmental policy integration and technology policies

Previously we have found that environmental policies and technology policies frequently interact affecting the development and emergence of environmentally sounder technological innovations (Kivimaa and Mickwitz 2003). This interaction can provide synergies in the form of the aforementioned innovations but the two policy fields – as well as any other policy fields – can also create cases of goal conflict, potentially resulting in wasted R&D resources or unused technological potential. Unmanaged policy interaction can result in two types of problems: aspects of an issue not covered by any sector and aspects covered by several sectors but potentially in conflicting ways or inefficiently. It has been argued that these types of problems are present in the Finnish central administration (Bouckaert *et al.* 2000).

Policy integration can provide a way to confront the problems of goal-conflict and inefficiency e.g. by motivating coordination. According to Peters (1998), if organisations share common policy values, coordination is likely to occur with less disruption of organisational routines. However, policy coordination is not a prerequisite for policy integration. For example, a sectoral ministry responsible of trade and innovation may integrate environmental principles into its policies without the consideration of the activities of, or without being in co-operation with, the environment ministry. However, coordination can potentially improve the effectiveness in the use of public resources and promote two-way integration where the innovation objectives are integrated into the policies of the environment ministry. Underdal (1980, 162) defines a perfectly integrated policy as:

"one where all significant consequences of policy decisions are recognised as decision premises, where policy options are evaluated on the basis of their effects on some aggregate measure of utility, and where the different policy elements are consistent with each other. In other words, a policy is integrated to the extent that it recognises its consequences as decision premises, aggregates them into an overall evaluation, and penetrates all policy levels and all government agencies involved in its execution".

A more specific definition and analysis of environmental policy integration (EPI) has been provided by Lafferty and Howden (2003). They define environmental policy integration as:

- the incorporation of environmental objectives into all stages of policy making in non-environmental policy sectors, with a specific recognition of this goal as a guiding principle for the planning and execution of policy;
- accompanied by an attempt to aggregate presumed environmental consequences into an overall evaluation of policy, and a commitment to minimise contradictions between environmental and sectoral policies by giving principled priority to the former over the latter.

Environmental policy inherently aims at reducing the anthropogenic environmental impacts and at conserving natural resources. The fundamental aim of national technology policy, in turn, is to seek competitive advantages for the country in question and to increase productivity growth (Edquist 1995, Lemola 2002). This creates one of the problematic areas between environmental and technology policies, because environmental policy often aids the diffusion of environmentally beneficial innovations regardless of where they have been developed and may not necessary benefit the commercialisation of domestic technologies. Also technologies developed and supported by

public funding may have negative environmental impacts, especially if productivity growth alone is at the heart of the policies. Conflicts between the policy areas may also arise when allocating limited resources and a choice has to be made for example between supporting technology providing increased employment opportunities or more eco-efficient technology (Hyvättinen 2004).

The use of science and technology policies to achieve environmental goals constitutes a new focus for technology policy (Freeman and Soete 1997, 414). Another recently popular topic, moving from traditional technology policy towards innovation policy may create more grounds for EPI from the outset because of its wider perspective on the interaction of technology, competitiveness and the society.

3. Framework and methods for evaluating environmental policy integration

In policy analysis and evaluation, the "policy cycle" is often used as a tool to conceptualise key aspects of policy formation and implementation (e.g. Pollitt and Bouckhaert 2000). Previously we have developed a conceptual model of the policy cycle that can be used as a basis of evaluating policy integration (Mickwitz and Kivimaa 2004). The model illustrates that policy integration could, in principle, take place at many stages of the policy cycle and, assuming that there is a perception that policies should be integrated, this should be reflected at the level of policy strategies as well as at the level of the instruments by which these are implemented. Since the basic idea of policy integration is not only to change bureaucracies, but to actually change the real world it is very important, although challenging, to extend the examination to also include policy outcomes. If environmental concerns are integrated into technology policies, the aim is that the technologies developed and taken into use should become environmentally sounder and in the end this would be reflected in the state of the environment.

In this evaluation of EPI in Finnish technology policies the framework outlined in detail in Mickwitz and Kivimaa (2004) is utilised. Some key concepts of the framework that will be used here include:

- *Target groups.* The actors, i.e. decision-making entities, such as companies, other organizations and individuals whose actions the policy is intended to influence.
- *Outputs.* What the administration produces and the target groups are faced with, e.g. a seminar, a research contract or a subsidy paid. In order to distinguish outputs from the internal administrative results, it is often useful to approach outputs from the side of the target groups.
- *Inputs.* What is used by the administration to produce outputs. Such resources as personnel and finance, but also matters coming from the target groups that the agencies take into account or respond to, e.g. a R&D project application.
- *Outcomes.* The actions and the consequences of the actions taken by the target groups as a response to the outputs. Outcomes can be further divided into immediate, intermediate and ultimate outcomes. It is clear that hardly any outcome is a result of some policy outputs alone, but instead is affected by a variety of other factors. Moreover, changes in the actions of the target groups that are not at all influenced by the examined policy are clearly not outcomes.

Finnish technology policies can be categorised in several ways. In Figure 1 two broad categories, "policy strategies" and "policy instruments" are illustrated. Although policy strategies can have direct effects producing some outcomes, they are often implemented by modifying existing policy instruments or by creating new ones. In the particular case of Finnish technology policy, the policy instruments that will be evaluated are technology programmes. Thus, a new strategic review of science and technology policy or a new Tekes's technology strategy might indicate more resources

or new priorities for technology programmes. Alternatively, policy pressures coming from outside the system (general public, environmental organisations, industrial actors, other government institutions) may sometimes directly affect the formation and focus of the technology programmes. In many instances, approximately half of the total programme budget has come from industrial participants that can influence the programme content to some extent.

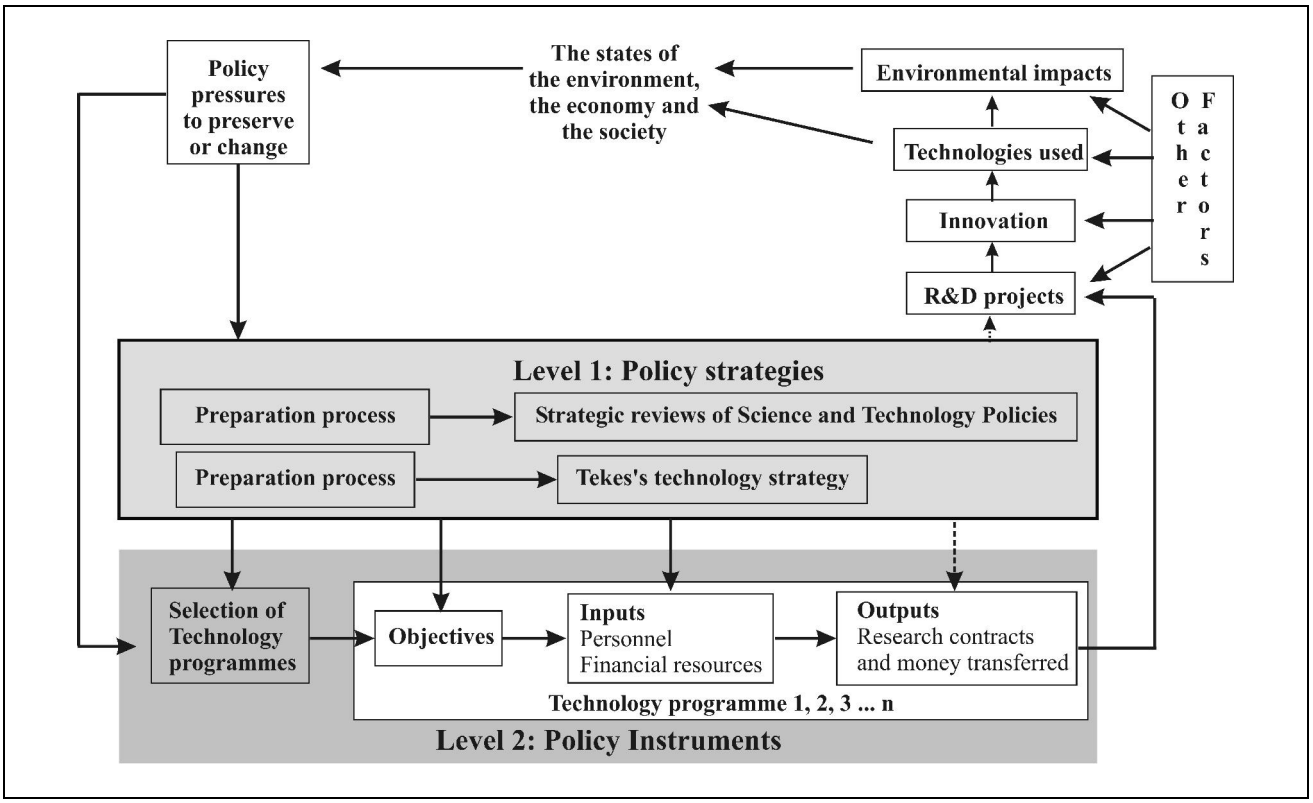

Figure 1. The stages of Finnish technology policy where environmental policy integration could take place (Application of Mickwitz and Kivimaa 2004)

The technology programmes generate several different R&D projects which may contribute to the development of new technological innovations. The subsequent use and adoption of the technologies is needed to bring about environmental benefits, but the adoption of technologies is frequently promoted by other factors than the technology programmes themselves. In the case of environmentally sounder technologies, both environmental policies and cost and competitiveness factors have played a role (Kivimaa and Mickwitz 2003, Hyvättinen and Hildén 2004).

EPI at the strategic level (level 1, Figure 1) is evaluated in Section 4 by examining both the contents of the strategy documents produced and the preparation processes. Five reviews of the Science and Technology Policy Council (1990, 1993, 1996, 2000 and 2003) and Tekes's technology strategy will be evaluated. The strategy documents are evaluated by using four different criteria: the *inclusion* of environmental aspects (at a general level or highlighting specific challenges), the *consistency* of the environmental aspect in relation to other aspects, the *weighting* of the environmental aspect with respect to other aspects, and finally *reporting*, i.e. to which degree the strategies include specifications about how their environmental aspects are to be followed up and reported. The strategy preparation process is evaluated by using a criterion: *representation* of persons with special environmental competence in the preparation process.

EPI at the policy instrument level (level 2, Figure 1) is evaluated in Sections 5 and 6. In Section 5 the focus is on the objectives of different technology programmes and on the allocation of financial

resources to different types of programmes. In Section 6 the outputs of the technology programmes, i.e. decisions on funded projects are evaluated. The objectives and the outputs will be evaluated using the same criteria as for the strategy documents: *inclusion*, *consistency*, *weighting*, and *reporting*, i.e. to which degree the assessments and evaluations of the technology programmes/projects include environmental aspects.

The empirical material used to evaluate environmental policy integration comprises six strategy level documents and 19 technology programme related documents including final reports, programme yearbooks, evaluations and other documentation. In addition, three thematic interviews were made with experts in the Finnish technology policy administration.

4. Integration of environmental aims into the Finnish strategies for technology policy

Technology policy in Finland emerged in the early 1980s and, through the establishment of the Science and Technology Policy Council in 1987, 'the innovation system' outlook was adopted. The Council, an advisory body chaired by the Prime Minister, coordinates Finnish technology policy and issues strategic reviews in every three years. Since the 1990s the reviews have emphasised environmental technologies, sectoral research by different administrative sectors and cooperation between the sectors, e.g. environment and technology policies (Science and Technology Policy Council 1990, 1993, 1996, 2000). In the latest review (Science and Technology Policy Council 2003), however, the main development challenges were focused on internationalisation with hardly any comments on environmental policies whatsoever.

The Council could perhaps be viewed as an instrument of policy integration in itself. The composition of the Council means that scientific processes and technological development are viewed from the perspectives of different economic actors, and the long-standing existence of this institution can be seen as crucial in integrating and overcoming 'territorial thinking' among ministries (Schienstock and Hämäläinen 2001, 44).[1] The Council has not always been represented by the environmental administration but the present three-year term (March 2002 – February 2005) and the three-year term preceding that have included the Minister of the Environment and the Director General of the Finnish Environment Institute. It is interesting to note that despite this, the emphasis on environmental issues has reduced in the latest review.

The National Technology Agency, Tekes, is the main public financing and expert organisation for research and development (R&D) in Finland. Presently, one of the eight thematic areas in Tekes's technology strategy is *sustainable development* covering e.g. environmental technologies and life cycle solutions (Tekes 2004a). All themes complement and overlap each other, so in a way sustainable development can be seen as incorporated in the whole strategy. In effect this means e.g. that the direct effects on social, environmental and welfare aspects are included in the criteria for selecting the funded research projects (Tekes 2004a). To which degree this criterion is actually used will be assessed in Section 6. When comparing the sustainable development theme with the other themes in financial terms, in 2003 sustainable development solutions received only 10% of the total which is below the mean and median for all themes.[2] Environmental issues, however, can potentially be included in other themes, such as welfare and biotechnology.

[1] The Science and Technology Policy Council consists of several ministers and representatives of science and technology policy, business organisations, research centres and the employers' and employees' organisations.

[2] In 2003 the funding for sustainable development solutions was 61 million EUR out of a total 591 million EUR for all themes (Tekes 2004a).

Table 1 EPI in Finnish technology policy strategies

Criteria	Result
Representation	Environmental administration is currently well represented in the preparation of the overall national technology policy strategies
Inclusion	Environmental aspects have been included in the strategies of the Science and Technology Policy Council and of Tekes, especially during the 1990s, but less in the 2003 review.
Consistency	The consistency of, or the potential conflicts between, the different objectives have not been discussed in the strategy documents.
Weighting	The importance of environmental aspects has been implicitly emphasized in the strategies. However, no ranking between the environmental and other objectives has been provided for cases where prioritization must be made. Also, the importance of environmental issues with respect to other issues, such as internationalization, appears to be declining.
Reporting	The strategies have not included specifications about how their environmental aims are to be followed up and reported.

5. Environmental objectives in the public technology programmes

The instruments used by Tekes to implements its strategy comprise technology programmes, selective project funding, commercialisation of research results, support for the creation of new companies and business operations, and the internationalisation and networking of actors (Tekes 2004a). Technology programmes, first initiated in the early 1980s, are a major technology policy instrument and a means to allocate public R&D finance. Tekes views them as a proactive instrument to make strategic choices and set priorities, direct focus on specific nationally important issues, and increase interaction between projects (Tekes 2004b, Interviews I and II). In 2003, 48% of Tekes's R&D finance was directed through technology programmes, in total around 180 million euros (Tekes 2004b).

Already in the late 1980s environmental aims were part of some technology programmes while they were not systematically part of Tekes's operation. Some of the programmes were very focused on specific environmental issues such as pollution from pulp production – due to immense public pressure to act on issues such as chlorine bleaching – while others were not. These programmes also induced some environmental improvements, such as reduced air emissions from recovery boilers. There have been clear industry and programme specific differences. For example, the first generation pulp and paper industry programmes have largely been environmentally focused, but later the focus has shifted to e.g. quality concerns (Interview III).

Eleven technology programmes, carried out during the period 1988 – 2002, were selected to examine environmental policy integration into the programme objectives and the achieved results (Table 2). All the chosen programmes included research affecting the pulp and paper industry. Some of them were completely focused on this industrial sector, e.g. RAINA, and others covered wider areas incorporating some pulp and paper sector related research, e.g. LIEKKI. This selection was made to complement our previous research on the factors affecting pulp and paper sector innovations (Hildén et al. 2002, Kivimaa and Mickwitz 2003).

SIHTI (1990 – 1992) was the first programme specifically targeted at environmental issues, i.e. the development of less polluting energy technology. The preceding programmes, such as LIEKKI (1988 – 1992), had resulted in some environmental improvements but they had focused on few selected technologies thereby excluding other types of solutions to the issues tackled, reducing the potential for achieving the most effective alternative from an environmental viewpoint and providing less opportunities for radical change. This was a general occurrence within the first technology programmes that were *"either clearly technology specific or industry specific"*

(Interview I). Nevertheless, the significance of programmes like LIEKKI should not be undervalued, because they have provided a consistent and continuous framework for generating the necessary knowledge base for innovation and created competitive know-how for Finnish companies in the world markets (Kivimaa and Mickwitz 2003).

Table 2. Public technology programmes examined

Technology programme	Duration	Topic	Total expenditure
LIEKKI[1]	1988 – 1992	Combustion technology	24 million EUR
KUITU[2]	1988 – 1992	Energy-efficient mechanical pulping	7 million EUR
RAINA[3]	1988 – 1992	Energy-efficient paper production	10 million EUR
SIHTI[4]	1990 – 1992	Energy and environmental technology	4 million EUR
LIEKKI 2[5]	1993 – 1998	Combustion and gasification technology	38 million EUR
SIHTI 2[6]	1993 – 1998	Energy and environmental technology	17 million EUR
Sustainable Paper[7]	1993 – 1998	Energy in paper and board production	20 million EUR
CACTUS[8]	1996 – 2000	Low-water-consumption paper production	26 million EUR
Pigments[9]	1998 – 2001	Pigments as raw materials of paper	4 million EUR
Wood Wisdom[10]	1998 – 2001	Integrating forestry with other parts of the production chain	33 million EUR
CODE[11]	1999 – 2002	Modelling of combustion processes	13 million EUR

Sources: [1]Hupa 1994; [2]Sundholm 1993; [3]Paulapuro and Komppa 1994; [4]Pietilä 1991; [5]Hupa and Matinlinna 1996; [6]Thun and Korhonen 1999; [7]Lähepelto 1998; [8]Komppa and Neimo 2000; [9]Tekes 2002; [10]Paavilainen 2002, Seth et al 2002; [11]Partanen 2003.

Through SIHTI the opportunities for different environmental innovations increased but its budget was small in comparison to the preceding programmes. SIHTI was followed by SIHTI 2 (1993 – 1998), with a larger budget, and other research programmes with more focus on environmental issues than before. For example, LIEKKI 2 (1993 – 1998) had *"a special focus on research serving the development of new, more efficient, environmentally friendlier technologies"* and enabled meeting the tightening NO_x emission requirements (Hupa and Matinlinna 1996). Yet, the programmes were still limited in terms of narrow scopes for environmental issues. For example, Sustainable Paper (1993 – 1998) focused on energy but excluded e.g. the use of wood for energy and environmental issues relating to energy generation (Lähepelto 1998). However, one might argue that neutral and undirected consideration of issues and technologies is not possible, or even desirable, in technology programmes. When the programmes are means for focussing on issues perceived nationally important, the role of independent funding is then to create possibilities for projects falling out of the scope of any particular programme.

Nevertheless, in the late 1990s, a more holistic perspective on environmental issues was adopted, in sectorally focused programmes at least. The CACTUS programme (1996 – 2000) principally aimed at reducing water consumption in paper manufacture but also included general environmental aims such as *"reducing environmental impacts in water, air and on land"* (Komppa and Neimo 2000). Unfortunately the programme's environmental aims did not in all cases extend to the project level. The programme was initiated by collecting at the time ongoing projects on the topic without a proper "red thread", so not all individual project objectives were in line with the programme objectives (Komppa and Neimo 2000). This was e.g. the case with the project "paper machine compact wet end" which did not include any environmental targets albeit resulting in significant water and energy savings (Kivimaa and Mickwitz 2003). Yet, CACTUS produced knowledge and practical methods for cutting down emissions through reduced water usage (Komppa and Neimo 2000). If the projects were selected based on criteria reflecting the programme objectives, a form of environmental policy integration has occurred at the output level. This has been stated to be the case (Interview III).

The more recent programmes tend to focus less on environmental technologies but may include some environmentally relevant aims. For example CODE (1999-2002) included minimising combustion emissions and increasing the efficiency of fuels used in its research focus (Partanen 2003). However, if the research focus does not include environmental aims, the environmental aspects of the programme can go completely unmentioned. For example, the final report of the Pigments programme (1998-2002) provides no information on the environmental aspects of the research area (Tekes 2002b). This may partly be explained by the horizontal application of environmental objectives in Tekes's operation, yet this should not imply that the activities have no impacts, negative or positive, on the environment.

Presently Tekes evaluates technology programme outcomes, not programme specifically, but thematically starting from the impacts and benefits and then looking at how a group of programmes have affected their emergence (Interview I). For example, recent evaluations have looked at the significance of selected technology programmes for achieving climate change targets (Hjelt et al. 2003), innovation process changes (Valtakari et al. 2004) and internationalisation (Halme et al. 2004). The achievement of societal welfare targets, however, is difficult to measure and these targets, especially the ones related to climate change, are marked by uncertainty when the impacts are realised in the long term future (Hjelt et al. 2003). Often the scopes of evaluation have included only a selection of programmes and, thus, they have excluded indirect impacts of many other programmes and technology policy measures on the studied aspects.

Table 3 EPI in the objectives of and inputs to Finnish technology programmes

Criteria	Result
Inclusion	Some environmental aspects have been well included in most of the pulp and paper sector related technology programmes; the majority of them have been energy-related aims. However, sector specific differences have been noted to exist and environmental aspects are hardly ever considered in programmes without clear environmental objectives.
Consistency	Within programme objectives no direct conflicts can be observed. However, the environmental objectives have rarely been all inclusive and have focused mostly on energy efficiency or emissions. Consistencies between the different programmes and between the objectives and all environmental impacts have not been assessed in the documents.
Weighting	In selected technology programmes some environmental issues have been emphasized and some programmes have been specifically designed for environmental technologies. Their importance, however, has reduced in recent years when the focus has shifted into quality concerns. No ranking between the environmental and other objects have usually been provided.
Reporting	Positive environmental impacts generated by the programmes have been brought up in the final reports and evaluations of only those programmes containing environmental objectives. Also some thematic evaluations of groups of programmes have been carried out by Tekes, but so far they've only covered climate change related environmental impacts.

6. Environmental aims reflected in project funding decisions

It is clear that environmental policy integration cannot be assessed simply by examining the aims and objectives of the policy strategies and instruments, because they only reveal the intentions of the policies at most and could even be reflections of symbolic policies. For example, Lenschow (2002,7) has stated that *"the integration process currently faces the challenge of ensuring that substance follows from procedure"*. Integration may have already resulted in cases where environmental aspects are implicit in policies and in new concepts. The implicitness may be an indication of bona fide integration but it complicates assessments regarding the environmental credentials of policies and policy instruments.

In selecting Tekes funded projects, environmental impacts are assessed as one criterion among many others, such as business potential, employment and regional development, and this is in practice illustrated only in those projects which have clear environmental connections (Interviews I and II). Tekes's (2004a) application forms for project finance do not itemise a section for environmental impacts despite it being one of the funding criteria according to Tekes's strategy. The company finance application for research and product development includes section 12 *"summary of other effects – indirect effects in other companies and societal impacts"* with no specific comment on environmental impacts in the application form guidelines. The public research finance application, in turn, has a section 9 *"benefits and impacts"* which refers to e.g. societal and indirect impacts. Tekes has, however, included in its internet site the grounds for finance which state that *"positive impact of the project on the realisation of generally accepted societal goals influences the finance decision favourably"* including e.g. climate change prevention and other positive environmental impacts.

In general discussions in the numerous events organised by the ProACT programme, several representatives of the agencies in charge of technology policy have expressed the view that positive environmental impacts are indeed counted as a plus in deciding on the finance application.[3] Yet, no systematic procedure seems to exist for assessing the overall environmental impacts of the proposed projects, i.e. both the positive and the negative impacts. The actual funding applications and the decisions on them are confidential, so it is not possible to access the details and conduct comprehensive evaluation of environmental policy integration at the output stage. We have attempted the acquire this information directly from the participants of two technology programmes – CACTUS (1996-2000) and Pigments (1998-2001) – with fairly low response rates (33,3% and 15,4% respectively).

The answers we received indicate that the environmental impacts of the projects were not widely analysed, not even in the environmentally focused technology programme, CACTUS. The environmental benefits of the projects could only be presumed based on their objectives and aims. However, it must be noted that in the mid-1990s when the studied programmes were initiated, the application forms did not contain the section for other effects but only a section on *"the utilisation targets in the industry"* [4] despite the fact that environmental considerations have been stated in Tekes's annual reports among the criteria for decisions on allocating finance since the early 1990s.

Table 4 EPI in the projects financed by Finnish technology programmes

Criteria	Result
Inclusion	In principle, environmental impacts are among the criteria for selecting projects. In practice, however, the funding application forms do not itemize a section for environmental impacts. Based on a limited sample of two technology programmes, a list or an analysis of potential environmental impacts is absent from funding applications and of project descriptions.
Consistency	The project objectives tend to be very specific and technically detailed. Consistency is difficult to assess without expertise in the technological field and at the absence of specific environmental objectives.
Weighting	Environmental aspects are not considered as relevant as e.g. the technological or business potential (or in some cases they may be implicit in technical project objectives).
Reporting	The ex post assessments of project outcomes are, again, very technically detailed and do not mention the environmental impacts of the projects.

[3] Participant observation by the authors.
[4] Comment by one of the respondents on the questionnaire. This is supported by the type of responses obtained from other questionnaire replies.

7. Environmental technologies as technology programme outcomes

Concrete technological innovations would be an ideal way to measure whether policy integration has resulted in positive environmental impacts. Innovations, however, result from a variety of driving forces, of which technology policy measures are only one. Even when focusing solely on public R&D efforts, an innovation may result from several consecutive technology programmes and R&D inputs, since new technologies take years or even decades to develop. Yet some assessments of programme outcomes can be found, made by the participating instances.

According to four pulp and paper companies, the feasibility studies made during the CACTUS programme increased the ability to judge problems and conditions encountered with more closed water loops, such as complications of the processes, increased use of energy, mastering of dynamics and aggravated risks of spills (Forest Industry 2001). For the technology company Metso, the deep understanding of the phenomena has created the basis to develop separate machinery and sub-processes, as well as the integration of the machines to the entire process (Pekkarinen 2001). The freshwater consumption of Metso paper machines has declined from 7,5 m^3 per tonne of paper to 2,5 m^3 during the 1990s, partly contributed by research carried out in the CACTUS programme (Haavanlammi 2001). In addition, POM technology – that has been described as one of the most significant pulp and paper innovations of the 1990s and has resulted in improved energy-efficiency and reduced water consumption – was part of the programme in its later development stages (Kivimaa and Mickwitz 2003).

Also some other environmentally beneficial technological advances have emerged from other technology programmes we have examined. Of the early 1990s programmes, SIHTI and RAINA appeared to have only modest improvements in reducing energy consumption but they provided a basis for further development of energy-efficient technologies. LIEKKI had a substantial role in developing new, more environmentally sound combustion technology and e.g. Ahlström's combustion boiler (PCFB) was tested during the programme. During SIHTI, Selective Catalytic Reduction for marine diesel NO_x emissions by Wärtsilä and NO_x scrubber for power plants by Tampella were some of the technologies tested (Pietilä 1991, MTI 1993).

The following technology programmes, during 1993-1998, had more ground to build on from the earlier programmes and several technologies emerged partly from that development. LIEKKI 2 results have given valuable information for the design of energy producing power and recovery boilers, and already in the early stages of the programme e.g. technology developer Ahlström's Pyroflow Compact multifuel boiler and Tampella's Cymic boilers were installed in Finnish power plants (Hupa and Matinlinna 1996). SIHTI 2 had a more holistic approach on the environment and it produced e.g. a life cycle databank, new emission measurement techniques and developments towards closed water cycles in the pulp and paper industry (Thun and Korhonen 1999). The considerable developments in Sustainable Paper included methods allowing a reduction of 5-15% in energy consumption of the mechanical pulping processes, a few new methods for pilot trials and making a previously developed technology, Condebelt drier, commercially available (Lähepelto 1998).

The programmes after CACTUS have had a lesser environmental focus and already the identification of technologies improving the environment was difficult. This could indicate that without environmental policy integration in the programme aims, the programmes fail to improve the environment. Alternatively, this illustrates the shortcomings of technological innovations as indicators for EPI. Some kind of ex ante and ex post environmental impact assessment procedures might be needed to systematically evaluate environmental policy integration at the instrument level, which has already been implemented in policy making

processes of many national environmental administrations e.g. in the form of Strategic Environmental Assessment (SEA) of proposed policies.

8. Discussion

8.1. The extent of environmental policy integration in technology policies

Environmental considerations have been included in the technology policy strategies of Finland and selectively in the public technology programmes, but generally they have had no principled priority over other issues. Lafferty and Hovden (2003) stated principled priority of environmental policies as one of the determinants of EPI. Liberatore (1997, 119), in turn, has argued that integration should include components of similar importance and weight – not necessarily priority – but, if one of the components is much weaker, it is likely to be diluted. Our analysis indicates that the specific emphasis on environmental issues has reduced in recent years, while it has been made more implicit in technology policy strategies. If the reducing trend continues and the specific existence of environmental considerations among the other policy objectives is not guaranteed, there is a danger that the environmental aspect is diluted and the long term effectiveness of EPI is not tested in Finnish technology policy.

The Science and Technology Policy Council of Finland involves many different actors, including representatives from the environmental administration and, therefore, the Council should have some preconditions for creating strategies that are consistent and coordinated with other policy fields. It is more difficult, however, to say how consistency is achieved in the work of Tekes but, nevertheless, no major conflicts or inconsistency have been observed between the operation of Tekes and the environmental administration. The inclusion of environmental objectives at the strategy level has been translated into criteria for project selection and for the design of technology programmes. In some cases, a problem appears in the implementation of the objectives in that, environmental aspects are in practice only considered with respect to those operations *assumed* to have clear links to the state of the environment.

Systematic assessments of the positive and negative impacts of the funded projects are not carried out, and no pre-screening is done of the overall environmental impacts of the activities promoted by the technology policies. The time periods during which new solutions are researched, developed and taken into use are long, and it takes years or even decades to observe the long term effects of the use of new technologies on the environment. Moreover, all technologies have some impacts on the environment, such as resource consumption or harmful emissions, during some stage of their life cycle, be it their production, use or disposal. Since environmental policies largely react only after problems appear, the consistency between the policies will not become apparent until after a long time. This is especially the case because of the lacking pre-screening. EPI in Finnish technology policy is not implemented to the extent that the overall environmental impacts of the policies would be systematically assessed before or after the decisions have been made.

The extent of environmental policy integration in technology programmes was found to be issue or sector specific. This means that EPI has been selectively pursued at the policy instrument level. In the environmental technology programmes principled priority for environmental issues could be observed, yet this should be self-evident. The diminished weighting of environmental issues at the strategy level is also reflected in the instrument level. For example, in the pulp and paper sector programmes the focus has in recent years shifted from environmental issues to quality concerns. Yet, this emphasis has been replaced in some other sectors, e.g. Tekes has initiated two large research programmes on climate change specific issues. Also an implementation problem at this

level can occasionally be detected: the project objectives have not always corresponded to the programme objectives.

Our results concerning the selected technology programmes indicate that, despite some new technologies providing improved environmental impacts have been created as part of the programmes, EPI at the output level appears fairly weak. Lack of environmental considerations in the project objectives and assessments is probably partly explained by the lack of requirements to consider the environmental impacts in the funding application forms. If the environmental criterion for funding is not adequately reflected in the application forms, and therefore in the funding decisions, the absence of environmental considerations at the project level is clear. Another apparent shortcoming is the lack of reporting and evaluation procedures for documenting the achievement of the environmental objectives or of EPI at all levels.

The results of this study are mostly limited to analysing the Finnish technology policy from the forest industry perspective. Especially, because sector specific differences can be observed in the execution of the technology programmes, these limitations must be acknowledged. The forest industry in Finland is highly emphasised in economic and environmental terms. Since the 1930s e.g. the forest sector agreement has meant safeguarding the growth preconditions (raw material, capital, labour, technology, infrastructure) and the competitiveness of the forest industry by many economic policy and socio-political solutions – also at the expense of other objectives (Donner-Amnell 1995, 193-4). Since the 1980s the sector has been a target of many environmental protection pressures from NGOs, customers and the regulators – more so than many other industrial sectors. These factors have clearly shaped the formation of Finnish technology policies affecting this industrial sector. One would therefore expect that environmental policies have been more rather than less integrated into programmes affecting this sector compared with other programmes. Further examination of other sectoral programmes would be needed to give more comprehensible results.

We should not overlook the fact that the Finnish technology administration has paid considerable attention to the development of environmental and cleaner technologies since the 1980s. Several technology programmes have generated new knowledge and solutions that have provided environmental benefits and competitive positions for Finnish companies in the international markets. Due to the policy focus shifting to other issues at the start of the millennium, there is a risk that the achieved benefits and the environmental know-how will be lost.

8.2. Recent trends in policy development and their implications for EPI

Public policy towards the environment has considerably changed over the last decade or so. The regulatory approaches, e.g. the permit systems, have been complemented with economic policy instruments, such as environmental taxes and permit trading, informational measures and voluntary agreements between governments and industries. Moreover, the recent policy trends in Europe include integrated product policies aiming to control the environmental impacts through product-related regulations and charges (European Commission 2003, Rubik and Scholl 2002). Product-related policies cross the boundary of what is traditionally known as environmental policy and have many links to innovation and technology policies. The emergence of these policies highlight the need for environmental policy integration at the strategic and instrument levels to enable successful implementation of and outcome for these new policies. More importantly, they may indicate a requirement for policy coordination, in the cases where the existing policy fields are overlapping.

According to Peters (1998), the changing nature of policy making in most industrialised democracies is making coordination more difficult because of the shifting nature of the issues. The EU action is increasingly dominating many previously national policy fields in its member states.

Although, e.g. energy policy is largely still a national policy (unlike environmental policy), it is being highly affected by EU level environmental policy requirements, such as regulations on combusting waste for energy. EU has taken initiatives for promoting environmental policy integration, such as the Cardiff process (European Commission 2004), but when talking about the impacts or outcomes of policies the chain (or the policy cycle) through which integration efforts are implemented becomes even longer in the EU context. This, although creating similar premises for different national policies, does not guarantee integration at output and outcome levels unless specific mechanisms for this are created either at national or EU levels. In some cases, if the national leeway in policy making is too much reduced, the EU might even diminish EPI in practice. For example the EU industry and enterprise policymakers appear much more reluctant to adopt any environmental considerations (Hertin and Berkhout 2003), than their Finnish counterparts.

Our results partly indicate that overarching national strategies, although desirable, are not prerequisites for environmental policy integration to occur at output and outcome levels. Institutions and organisations responsible for sectoral policies can execute policy integration independently *given* they have the willingness, resources and expertise required. However, strategies for environmental policy integration are especially important for cases where the sectoral organisations lack the willingness for independent actions, e.g. the organisations responsible for EU enterprise policy (Hertin and Berkhout 2003). Especially in these cases the strategies alone are not sufficient and also the implementation must be somehow guaranteed in the sectoral organisations. EPI at the national level is also of importance from the perspective of efficient allocation of resources to avoid overlapping policies and to reduce conflicts between and within policies.

8.3. Challenges in carrying out evaluations of EPI

Some initiatives have been made to create criteria for assessing environmental policy integration (e.g. OECD 2002, Hertin and Berkhout 2003, Lafferty and Hovden 2003), but they have not been consistent nor comprehensive with respect to extending the evaluation to the outputs and outcomes of policies. Policy integration is assumed and expected to occur at so many different levels (national strategies, sectoral strategies, policy instruments) and it has so many different dimensions and forms of appearance (e.g. documentation, communication, cooperation) that creating overarching and comprehensive evaluation criteria for all purposes seems impossible. Instead, case-specific criteria (e.g. for national strategy evaluation, for sectoral policy evaluation) could be further developed and tested in practice.

It is clear that it is far easier to evaluate processes and procedures than it is to evaluate outcomes due to long timeframes and complicated causal relationships. The same, however, is not automatically the case for outputs. In principle it is not harder to evaluate whether environmental issues are integrated into a contract for a research project, i.e. the output of a technology programme, than into a technology strategy. In practice, however, it is often easier to evaluate integration at the strategic level than at the lower levels of the implementation chain. This is partly due to the extent of the documentation material; while there are only a few essential strategic processes and documents, the number of processes and instruments through which they are implemented is often much larger. For example in the case of Finnish technology policies the examined six strategy documents represent, if not all, still the most of the relevant strategies. While at the level of the technology programmes the studied 11 programmes comprising hundreds of projects represent just a small sample of all the programmes and the material is several times larger. In addition to limited amount of material, the public policy strategies are often more accessible and transparent than the instruments through which they are implemented.

The challenges of evaluating EPI at the output level of the policy instruments largely depend on the nature of the policies and the policy instruments. It is clear that the situation is different in the case

of e.g. EPI in transport policies that is implemented into public plans for constructing new roads compared with EPI in technology policies that is implemented through financial support to research and development projects. The details of private and commercial R&D projects must be kept secret from the existing and potential competitors. This, however, makes independent outside evaluations of EPI very difficult as we have experienced.

Improved access to information would improve the transparency of policies and make their evaluation easier. Many of the respondents to our questionnaire, those representing research institutes rather than companies, have stated that their funding applications contain no confidential or secret elements. It appears, therefore, that the confidentiality is a general status given to all applications by Tekes regardless of the stand taken by the applicants. The evaluation of the decisions could at least be improved by allowing external access to those applications that the applicant does not require kept confidential. It could be assumed that similar information access problems occur in other sectors and other countries.

9. Conclusions

The Science and Technology Policy Council of Finland and the National Technology Agency Tekes have incorporated some environmental objectives in their policies, especially at the strategy and selectively at the instrument level, but no principled priority for environmental issues can generally be observed. Despite some problems of translating environmental objectives into action, new technologies improving the state of the environment have been created partly as a result of national technology programmes with environmental objectives. However, the environmental impacts of technologies developed in other technology programmes have not been systematically considered or evaluated.

As a result of evaluating environmental policy integration, using four main criteria (inclusion, consistency, weighting, reporting), technology policy in Finland was found to contain elements of environmental policy integration. However, the integration did not occur extensively at all policy levels, namely at the levels of policy instruments and policy outputs, and based on the reporting, consistency and weighting criteria there was an evident lack of integration. Clear specifications of how the environmental objectives were to be designed and prioritised with respect to the other objectives and how the achievement of the environmental objectives was to be assessed and reported were usually absent from the policy documentation. Policy decision procedures should be modified to include a systematic assessment of both positive and negative environmental impacts of the proposed activities – at least in some detail. In addition, the evaluation of technology policies must be further developed to see the overall impact of different policy measures at policy output and outcome levels and allow transparent evaluations.

New types of policies aiming to influence environmental impacts through product life cycles rather than production processes highlight the need for policy integration, because these policies involve issues from several traditionally different policy sectors. EU and national level strategies are not always enough to achieve effective environmental policy integration, such that is reflected in policy outputs and outcomes, if the sectoral policy organisations do not have the willingness or resources for action. When strategies are not sufficient, instruments that promote the implementation are needed as are reporting and follow-up procedures. However, where the sectoral policy organisations do have the willingness and the resources, leeway at national or even at lower policy making levels is needed to choose the best actions in those contexts and to not hinder the progress in the most advanced sectors or member states.

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Interviews

Interview I: Jari Romanainen, National Technology Agency Tekes, 31 March 2004.
Interview II: Tarmo Lemola, Advansis Ltd, 30 March 2004.
Interview III: Christine Hagström-Näsi, National Technology Agency Tekes, 22 March 2004.

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