Product-oriented Environmental Interventions. Bundling of Policy Instruments

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Bundling of effective policy instruments

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Lund in March 2010

Naoko Tojo & Thomas Lindhqvist

Executive Summary

This study constitutes one of the final steps of the research programme FLIPP – Furthering Life cycle considerations in Integrated Product Policy – a Swedish research programme that aims to develop knowledge and understanding of the dynamics, mechanisms and interactions in complex product chains necessary to underpin life cycle based decision support systems. The programme has been supported and funded by the Swedish Environmental Protection Agency. The knowledge generated from its multidisciplinary applied research approach aims to support policy-makers in decisions on how and when to intervene in product chains, when to facilitate processes already set in motion by market actors and when to leave be. The knowledge created will also support the actors in the product chains in their chain-related decisions, such as procurement, product design, production and marketing.

Purpose and key research questions

Through synthesis and analysis of the existing knowledge on various product-related policy interventions, the purpose of this study was to further the understanding of the way in which various product-oriented policy instruments can be integrated to enhance synergies, to avoid/overcome potential conflicts and to ultimately reduce environmental burdens from society.

In achieving the purpose, the following research questions were addressed.

- What constitute product-oriented environmental policy instruments, and what are their characteristics?
- How have the product-oriented environmental policy instruments been used together, and what is the potential of using the instruments together?
- What lessons can be extracted from the existing policy measures to facilitate the development of future policies that reduce environmental impacts from product systems?
- In light of existing policies and the policy development in Europe, what are the implications for developing a coherent piece of framework legislation on eco-design?

Results

In total 18 selected policy instruments addressing at least one of the following three environmental issues of high concern – resource efficiency, hazardous substances/chemicals, and energy use/climate change – were reviewed. The primary focus of the review was the interaction of instruments rather than the characteristics of individual instruments. Specific aspects of the respective instrument discussed include: 1) life cycle stages it addresses, 2) typology of the instrument, 3) stringency of environmental mandate/environmental effectiveness, 4) potential of instrument mix, and 5) influence on manufacturers, supply chain and market.

Policy instruments addressing resource efficiency

Many existing instruments addressing resource efficiency primarily concern environment and health impacts arising from the end-of-life phase of products. While good performance of these instruments certainly contributes to the reduction of environmental and health impacts from the end-of-life phase, the instruments often do not address directly the design strategies of manufacturers and suppliers (that is, upstream changes to reduce impacts at end-of-life). The performance of some of these instruments (e.g. collection targets and recycling targets) thus serves as a trigger for potential upstream changes.

Meanwhile, experiences of implementing these instruments suggest that manufacturers of final products, as well as their suppliers, have started to take the availability of clean fractions from the end-of-life phase of the products into their design considerations. Mandating specific changes related to resource efficiency upstream faces difficulties due to the innovative nature of the development, lack of information on the side of policy-makers, etc.

Instruments addressing resource efficiency from the production phase hardly exist. While such issues ought to be naturally addressed as rational private entities would pursue higher resource productivity, past experiences indicate that companies can be blind to some of these "apparent" measures. Likewise, instruments addressing the use phase are scarce. The usage of products is closely linked to the core of consumption and waste prevention, for which an effective policy measure is yet to be found. Meanwhile, waste prevention in terms of quantity has been taking place in the form of, among others, dematerlisation, light-weighting and miniaturisation.

Many of the instruments discussed are used in combination and reinforce each other. A notable example is source separation measures used in combination with instruments such as collection targets, reuse/recycling targets and deposit-refund systems. Many of these are also part of a larger policy package, such as waste policy (including recycling policy), an EPR programme, or serve as a criterion for other instruments, such as green public procurement, eco-labels and design guidelines. The timing of integrating one instrument into a policy package/another instrument does not seem to matter much. However, policy-makers should look into the availability of these instruments before introducing a larger policy package in order to avoid duplicated/conflicting efforts.

Studies indicating connections between the performance of the instruments discussed here – for instance achievement of higher recycling rate – and effects on the sales of the products are hardly found. The fact that these instruments on resource efficiency and hazardous substances address product design only indirectly, as well as the lack of connection between the actors involved in marketing and end-of-life issues, may be among the reasons for the inability of benefitting from such product features on the market. Meanwhile, one of the main barriers perceived by the producers in taking upstream measures to reduce environmental impacts from end-of-life/achieve higher resource efficiency is lack of demand from consumers. Better communication regarding the importance of a product's features with less impact at end-of-life and its connection with higher source separation/ reuse/recycling should be explored.

Policy instruments addressing hazardous substances/ chemicals

Compared to policy instruments addressing resource efficiency, the variety of life cycle coverage by those addressing hazardous substances and chemicals is wider. The fact that the negative effects of hazardous substances and chemicals to health and the environment are more tangible than effects of inefficient use of resources may facilitate policy actions. It is reflected in the fact that the first-generation environmental policy measures in many of the developed countries are the control and reduction of toxic substances.

Many instruments that primarily address end-of-life environmental impacts are often part of EPR or waste policy packages. Concerning the impacts arising from the use phase, compliance to emission standards can be a criterion for green public procurement, subsidy schemes and the like. Instruments that address the emission of hazardous substances and chemicals during the production phase often constitute parts of the environmental permit for manufacturing facilities. In addition to the use and flow of hazardous substances, the permits could cover other environmental impacts such as efficient use of energy and resources. Such practice started to appear in, for example, Sweden. The enforcement of the control of the use and flow of hazardous substances at site can be enhanced by information provision requirements.

In general, policy measures related to hazardous substances and chemicals have strong effects on producers. Unlike resource efficiency, measures related to hazardous substances often touch upon the properties of the products directly, or their production process. Especially when they are subject to mandatory, administrative instruments, products cannot be sold without following the mandate. The fact that failure to comply may have visible environmental and health effects (e.g. discharge of hazardous substances from manufacturing facilities/products to the surrounding environment) serves as a driver for producers to work on these issues.

When suppliers provide components or materials that are subject to restriction/control by a policy measure, the effect of such a measure has been evident. This has been seen in, among others, the EC RoHS Directive and REACH Regulation. Regarding emissions from manufacturing facilities of suppliers, one of the FLIPP studies highlighted the importance of setting tailored measures for the respective tiers of suppliers. Setting standards related to the production process may conflict with trade regime. However, it could in such cases be done as an introduction of a voluntary labelling scheme.

The effects of instruments on the diffusion of products vary. The effects of mandatory instruments addressing the properties of the products (e.g. emission standards and substance restrictions) are clear: when the law is enforced properly, only products that comply with the legislation should remain in the market. Meanwhile, similarly to many of the instruments addressing resource efficiency, whether the fact that products which would be taken care of in accordance with the treatment standards at their end-of-life would be favoured by consumers is not well known. Concerning taxes on hazardous substances in products, there are some positive experiences in reduction of the use of these products. Meanwhile, the level of reduction depends on factors such as the level of the tax, availability of alternatives and the like. Finally, positive examples have been found concerning the effects of information measures in inducing emission reductions by companies. However, conflicting results are found regarding whether the information indeed influences the decisions of owners of real estates close to manufacturing sites.

Policy instruments addressing energy use/climate change

Two of the instruments reviewed – energy efficiency standards and energy efficiency labels – both address the use phase energy efficiency of products that require relatively large amount of energy for their operation. The latter complements the former. They both have direct impacts on product design. The instruments' effects on suppliers are not very well studied. Energy efficiency of products are determined by the cumulative effects of their components, and the influence that producers may exert depends on the level of ambition of the producer, the efficiency of his communication channels, the power relation between the producers and suppliers, among others. Although lack of consumer uptake has been identified as a barrier to accelerate further efficiency improvements, as discussed earlier, a proper enforcement of the standard should help the penetration of energy-efficient products with time. Some of the energy efficiency labels, such as the Energy Star, enjoy good recognition by consumers and the sales of the products awarded by the labels have been increasing. Similarly to waste reduction and miniaturisation, an idea is to bundle energy efficiency with other characteristics favourable for consumers, such as battery hours.

The experience with carbon labels is quite limited so far. However, it opens a new venue to address foreign suppliers, including their production process, and transport distances in the distribution. Unlike mandatory administrative measures that may conflict with free trade rules, voluntary labels could address the production process even when the production does not take place within the country's border. However, carbon labels, as opposed to for instance Type I eco-labels, risk causing sub-optimisation between environmental impacts and, importantly, the practical implementation of carbon labels are likely to include use of generic figures for important life cycle stages, as well as cut-offs of such stages.

Energy and CO_2 taxes differ from other instruments in that there are various examples and potential for the scope of their application in term of a product's life cycle. Although it would most likely not have effect on the suppliers of specific components, it may have great impacts on the suppliers of specific services. An existing example is tax related to transports and its effect on producers of vehicles such as cars and trucks.

Assessment of combined instruments

Discussion on individual policy instruments indicates that there are some policy interventions that typically incorporate more than one instrument, and/or intend to address more than one environmental issue arising from more than one phase of a product's life. These include, in particular: 1) Directive 2005/32/EC establishing a framework for the setting of eco-design requirements for energy-using products (EuP Directive), 2) so-called Type I Eco-labels,

3) Extended Producer Responsibility (EPR), and 4) Green public procurement.

The assessment highlights, among others, the rather disappointing implementation of the EuP Directive to date. Despite the life cycle approach envisioned in the Directive, the existing implementing measures that appeared so far focus almost exclusively on the energy use arising from the use phase of the products. The stringency of the environmental mandates set forth in the implementing measures does not appear to match the state-of-the-art environmental performance of products available in the market.

Conclusions and suggestions

Despite the recognition of the importance and necessity of instrument mixes in environmental product policy, not much has been said on what constitutes a good environmental instrument mix addressing products, and how it can be achieved in an effective manner. These two "what" and "how" questions regarding instrument mixes in the context of environmental product policy were what this study primarily aimed to address. Insights gained from the review, as well as possible further actions are summarised here.

Production phase needs to be revisited

Concerning three types of environmental impacts arising from different stages of the life cycle of products, except for the management of hazardous substances and chemicals, it is not very apparent how the impacts from the production phase are addressed. Among the instruments reviewed, there is no instrument that addresses resource efficiency in the production phase.

One way of remedying this shortcoming could be that the enhancement of existing instruments is considered. How the permit conditions, laid down in particular in the EC IPPC Directive, has been/can actually be implemented, for instance by the Swedish national authorities, needs to be further investigated. As exemplified in the new Directive 2006/32/EC on energy end-use efficiency and energy services, traditional cleaner production measures can be revisited. In this regard, governments can continue to play the role of information facilitators.

Addressing suppliers' environmental impacts

Existing policy instruments have influenced the strategies of suppliers directly or indirectly regarding their engagement in improving the eco-design of final products. Some of these measures address the materials or components used in final products that are supplied by the supplier – for instance, the use of mercury in EEE will be restricted. Others affect the continued supply of the supplier – for example, collection targets set up for packaging materials enables a steady supply of clean PET, which competes with virgin PET. Requirements on information provision regarding materials, such as the REACH Regulation in Europe, also affect the suppliers (in this case the chemical manufacturers). All in all, when requirements are set on the property of end-products that affect suppliers, they would react for their survival. It can take the form of collaboration between suppliers and the manufacturers of final products. Challenges exist when final producers wish to improve the environmental property of their products without mandatory policy measures. A solution could be the introduction of separate "Type I" eco-labels for the respective stages that could be used by the buyers in the supply chain.

Enhancement of environmental performance of the operation of suppliers (e.g. production and transportation) poses challenges, especially when considering the global supply chain. Setting standards for the operation could be in direct conflict with free trade laws. Voluntary policy measures and actions by private actors play an important role here. Experiences from carbon labels can in the future provide some insights. Meanwhile, careful assessment of which part of the supply chain should be targetted should be made, in order not to oversee high impact actors for convenience reasons. Use of simplified mechanisms can be difficult in the area of resource efficiency and management of hazardous substances, as the unit of measurement will not be as uniform as for greenhouse gas emissions. An approach discussed in Japan in this regard is the diffusion of simplified environmental management systems. Operation of an environmental management system can also be considered as a lending condition for funding agencies.

Informative instrument: how to increase participation?

Some of the mandatory administrative instruments, such as material restrictions and emission standards, have been quite effective in improving the properties of products at the design stage. Meanwhile, introduction of these instruments usually encounter strong opposition. Similarly, political acceptability of fiscal measures, such as taxation, is usually low, especially when they are used to restrict actions (as opposed to subsidies to encourage actions). To be able to set the tax high enough, as was the case with the tax on nickel-cadmium batteries in Sweden, is an exception. In light of the reality that it is not so easy to introduce mandatory administrative and economic instruments, we need also to consider the potential role of informative instruments.

Similarly to administrative instruments that indicate the tasks to be achieved by the addressee, a typical informative instrument, such as energy efficiency labels and Type I eco-labels, has standards/requirements to be met by producers. An important difference might be that the producers have the liberty to continue to manufacture products that do not meet the criteria/requirements. In the case of labels that show the level of achievement, they could simply indicate the level. Producers will not be administratively "punished" as long as they do not carry a false label. Moreover, while many of the information provisions are mandatory, there are cases when provision of information is voluntary (e.g. Type I eco-labels and the Energy Star label). Thus the main issue is to accelerate the participation rate of the companies that strive for higher level of achievement.

One possibility found among the existing cases is the combined use of mandatory standards and labels. For instance, in the Top Runner Programme, mandatory standards are set to be achieved within a certain timeframe. Manufacturers do not have the mandate to meet the standards immediately, but they should show their level of achievement in terms of percentage. This helps producers to realise where they are standing in terms of achievement. Moreover, well-known companies may find it important to reach the standards to keep up with their reputation. A similar approach is introduced for restriction of hazardous substances in EEE in Japan.

Another approach could be to use the standards set forth in labelling schemes in fiscal measures, such as green public procurement and financial incentives given to consumers to enhance purchasing. This would give producers more certainty that investments they make to develop more environmentally friendly products pay off. Green public procurement in many of the European countries and the discussed tax exemption on eco-labelled products take this approach.

Innovation and standard-setting

Most of the instruments primarily addressing resource efficiency have only indirect influence on the design. High performance of instruments that have environmental impacts from the end-of-life phase of products as the immediate target (e.g. source separation and collection targets) provides only limited incentives for upstream changes. In this regard, having the concept of extended producer responsibility as the basis for policy-making is essential in connecting the upstream and the downstream. The involvement of producers in the end-of-life phase of their products gives them more possibilities and economic reasons to include end-of-life environmental performance in the design considerations. The importance of implementing individual responsibility should be highlighted here.

Setting more direct standards for the design phase of the product poses challenges due to the innovative nature of product development and asymmetric information between policy-makers and producers. However, in addition to producer responsibility, policy-makers can promote design that facilitates efficient use of resources by enhancing the awareness of producers.

An instrument that may work within a rather short timeframe is a design guideline. For instance, a framework of a design guideline that includes among others consideration on resource efficiency was developed by the government committee in the early 1990s in Japan. Based on the Guideline, manufacturers in Japan started to develop their eco-design tools incorporating the issues addressed in the

Guideline such as recyclability. This is said to have facilitated the grounding of the idea of the design-for-end-of-life among Japanese manufacturers targeted by the Guideline. Moreover, in the long run, the role of education is vital in enhancing innovation.

While the Japanese Top Runner Programme has played an important role in accelerating the application of technologies lying on the shelf, innovation has been mostly incremental. On the other hand, an annual award for remarkably energy-efficient products is considered to enhance more radical innovation. Perhaps a similar award can be introduced in the area of resource efficiency.

Furthermore, as a way of making it attractive for consumers to purchase environmentally less burdensome products, in addition to education and awareness-raising, bundling of other benefits can be considered. For instance, waste prevention in term of resource efficiency can be sold better when combined with miniaturisation and light-weighting. The benefit of energy efficiency can be grasped more easily when it is expressed in terms of battery time. These features that are positive in the eyes of consumers can be bundled in the communication. Caution should be made on the rebound effect, however. This all comes down to the necessity of research on learning how various factors affect consumers' purchasing choices.

Time required for standard-setting

It would inevitably take longer time to develop requirements for several different environmental issues arising from different phases of a product's life, as compared to addressing one singel issue. Instead of trying to set the requirements for various parts of the life cycle within one policy measure, it may be better to leave the standard-setting to individual policy instruments and incorporate these standards into one policy package as found in, among others, green public procurement.

In the case of the EuP Directive, which has not been able to incorporate environmental impacts other than the use phase energy efficiency so far, it may be worth having the Directive as one focusing on that aspect. As stated by van Rossem and Dalhammar (2010), the claim that the Directive is based on life cycle thinking may well be dropped. Meanwhile, it would be worthwhile looking into the process of developing standards that do incorporate life cycle thinking, such as Type I eco-labelling schemes, and see how the standards are developed.

Diffusion in the market

Once the environmentally superior products are available in the market, the important and crucial step is that they are actually used. In this regard, effective implementation of economic instruments, such as green public procurement and provision of incentives to consumers in the form of, among others, tax breaks, should be further considered.

Bundling of requirements from various instruments

Among the instruments reviewed, Type I eco-labels seem to have been most successful in incorporating elements of various instruments. Meanwhile, emergence of a number of other types of labels, as well as a transboundary movement of products, has led to the situation where a number of labels appear on one product. This could cause substantial confusion, as well as distrust towards the labels among the consumers. However, there is little evidence that consumers in Sweden, or other countries with well-developed Type I eco-labelling schemes, are having problems to identify the relevant eco-labels and ignore the rest.

Avoidance of duplication should be considered between different labels so as not to confuse the receivers of information. In this regard, the confusion the carbon label might cause has been criticised. The label only looks at one environmental aspect, though it could, at least in theory, cover the whole life cycle. In essence, the fact that the label is on specific products does not mean that they are necessarily environmentally superior.

A general framework legislation

There has been discussion on developing a piece of general framework legislation that incorporates various life cycle environmental impacts. Such legislation may help in paving the way for policy-makers to take further legislative measures regarding various environmental aspects of a product's life. Moreover, it may help raising awareness of the importance of product-oriented environmental policies.

On the other hand, it can be quite difficult to cover various life cycle environmental impacts in one approach, as the experience with the EuP Directive shows so far. It takes a long time to come to an agreement, and despite its initial ambition, the level of the standards that are reached in the end tends to become rather low. It has also been seen that the emergence of the EuP Directive has been used as an argument to dilute the mandate given to other directives (e.g. RoHS and WEEE Directives), despite the fact that the EuP Directive in reality does not seem to be able to capture all the important environmental impacts from products. Moreover, the actual implementation of the Directive remains to be seen.

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Abbreviations

BAT	Best Available Techniques
BREF	Best Available Techniques Reference Document
CAFE	Corporate Average Fuel Economy
DSD	Duales System Deutschlands
EC	European Community
EEE	Electrical and electronic equipment
EPCRA	Emergency Planning and Community Right-To-Know Act
EPR	Extended Producer Responsibility
ETAP	Environmental Technologies Action Plan
EU	European Union
EU-15	European Union 15 first member states
EU-25	European Union 25 first member states
EuP	Energy using Products
EUR	Euro
FLIPP	Furthering Life cycle considerations in Integrated Product Policy
GDP	Gross Domestic Product
GHG	Green House Gases
IPP	Integrated Product Policy
IPPC	Integrated Pollution Prevention and Control
IT	Information Technology
LCD	Liquid Crystal Display
MSW	Municipal Solid Waste
NGO	Non-Governmental Organisation
OECD	Organisation for Economic Co-operation and Development
PBB	polybrominated biphenyls
PBDE	polybrominated diphenyl ethers
PET	Polyethylene terephthalate
PRO	Producer Responsibility Organisation
PRTR	Pollutant Release and Tranfer Register
PVC	polyvinyl chloride
REACH	Registration, Evaluation, Authorisation and Restriction of Chemicals
RoHS	Restriction of the use of certain hazardous substances in electrical and electronic equipment
SCP	Sustainable Consumption and Production
SEK	Swedish kronor
TRI	Toxics Release Inventory
USD	United States dollars
WEEE	Waste Electrical and Electronic Equipment

1 Introduction

1.1 Background

Despite its significant achievements of material affluence, convenience and comfort, modern industrial society has not been free from negative side effects. Many of these negative effects are due to unsustainable patterns of production and consumption – unsustainable, in light of the quantity of products and services manufactured, purchased and used beyond those satisfying the basic needs, combined with the failure of distribution of wealth.[1] The conclusion that the carrying capacity of the earth cannot support the continuation of the current patterns of production and consumption seems all too evident.

As agreed upon at the Johannesburg Summit on Sustainable Development in 2002 (United Nations, 2002), governments started to strive to address sustainable consumption and production as a core element of sustainable development. At the EU level, the commitment to change current patterns on consumption and production has been reflected, among others, in the renewed European Strategy on Sustainable Development of 2006 (Council of the European Union, 2006). It is further translated into the Action Plan on Sustainable Consumption and Production in Europe, which has been published by the European Commission along with calls for a number of policy actions in 2008 (COM (2008) 397 final).

Lying at the heart of intervention measures for the achievement of Sustainable Consumption and Production (SCP) are environmental product policies. It is manifested, for instance, in the list of policy strategies and instruments put together by the European Commission to promote SCP (European Commission, 2004). The Environmental Technologies Action Plan (ETAP), an important building block of the SCP strategies in the EU (European Commission, 2004), also contains a number of product-oriented measures (COM (2004) 38 final). These measures include use of environmental labels, green public procurement and performance targets, to name but a few.

The necessity of taking a product-oriented approach in developing a good environmental intervention could be partly tracked down to the development of environmental policy. The first generation of environmental policies mostly dealt with production processes. However, measures on manufacturing sites, albeit their importance, fail to address the environmental impacts that take place once the products leave the factory. The impacts occurring outside of the factory are disperse and may be difficult to deal with. In addition, many of these impacts – toxic substances in the products, energy efficiency during the use phase, potential for recycling, among others – are "pre-determined" when the products leave the factory, or rather, when they are designed. It would be better to address these issues at the early stage of the product life cycle, thus *preventing the problems from occurring* instead of dealing with the problems after they occur.

Furthermore, when addressing the environmental impacts at the manufacturing facilities, it was observed that when an intervention deals with one environmental problem occurring in one media, it may push the problem to another media. For instance, reduction of toxic substances from the soil may lead to the increase of emissions to the air. Similar effects could occur between different parts of the product's life, and between different types of environmental impacts. This has led to *life cycle thinking* which approaches the environmental issues in a systematic manner, based on avoidance of moving environmental problems from one media to another and from one life cycle stage to another. The significance of life cycle thinking is more evident than ever in the present globalised economy in which manufacturing of a product often involves suppliers of raw materials and components from a number of countries.

[1] For instance, the world annual expenditure on makeup is approximately 18 billion USD, while elimination of hunger and malnutrition of the world is believed to be achievable by the addition of 19 billion USD. In 2000, more than 60% of private consumption occurred in North America and Western Europe, where less than 12% of the world's population live (Gardner, Assadourian, & Sarin, 2004, 6-10).

Table 1-1. Typology of instrument mixes for product-oriented environmental policy and examples

Manners of formation and implementation	**Environmental issues addressed (types, life cycle phases)**	
	Single issue	**Multiple issues**
Introduced as one policy package	Use-phase energy efficiency standard and labelling requirements	EPR programmes
Elements of separate policy interventions are combined under one instrument	Collection target and deposit-refund system for a specific waste stream	Tax relief based on use-phase energy efficiency standard and emission standard Criteria for green public procurement
Separate policy interventions co-exist without explicit coordination	Award scheme for energy efficient technology and standards	Various labelling schemes EPR programmes and energy efficiency standards Emission standards and CO_2 standards

Another advantage of taking a product-oriented approach is its appropriateness in identifying a good intervention point. Literature on various streams of thought – business strategies, innovation and management studies, among others – points out that different industry sectors have their unique dynamics: the number and type of actors in the industry, their relations and interactions, their institutional norms, innovation dynamics – each sector has its particularities in all these areas. Knowing these *sector-specific characteristics* is crucial in identifying an effective intervention point in inducing the change a policy-maker desires – in improving the sustainability of the production and consumption system.

There exist many product-oriented measures in practice. However, despite the development and implementation of various interventions in and outside of the product policy field, the fact still remains that the state of environment leaves much to be concerned.[2] The aspiration to achieve sustainable development from both ends – to survive in a transition to the competitive, dynamic and knowledge-based economy (European Council, 2000) while integrating the environmental considerations in this process (European Council, 2001) – poses further challenges. It is essential to further the understanding on how to design and implement interventions that reduce environmental impacts from the current product system effectively.

As mentioned, a core element of an environmental product policy is life cycle thinking – a good environmental product policy should reduce the overall environmental impacts of a product arising from various phases of its life cycle (from raw material extraction to end-of-life management). In addressing this wide range of environmental impacts, the need of policy mixes in environmental product policy has been widely acknowledged (Dalhammar, 2007, 134). A policy mix, or rather an *instrument mix,* in the context of government intervention can be broadly defined as the combined use of two or more instruments in addressing an issue.[3]

By observing existing product-oriented environmental instrument mixes we can make several categorisations. One distinction has to do with the formulation and implementation process of the combined use of instruments – whether the multiple instruments in question are introduced in one policy package, elements of instruments separately introduced are combined under another instrument, or different

[2] See, for instance, COM(2007) 162 final.

[3] Although some use the term "policy mix" to express more or less the same thing, the term "instrument mix" is used in this document, which in our view reflects what the term actually means more acculately.

instruments are used simultaneously without explicit coordination. Another distinction concerns environmental issues targeted by the instruments – if they address the same issue, or different issues (see Table 1-1).

As manifested in OECD (2007), combined use of policy instruments have attracted increased attention of policy-makers and researchers. However, as pointed out by Dalhammar (2007, 134), despite the recognition of the importance and necessity of instrument mixes in environmental product policy, not much has been said on what constitutes a good environmental instrument mix addressing products, and how it can be implemented in an effective manner.[4] These two "what" and "how" questions regarding instrument mixes in the context of environmental product policy are the primary themes of this study.

1.2 Purpose and research questions

Through synthesis and analysis of the existing knowledge on various product-oriented policy interventions, the purpose of this study was to further the understanding of the way in which various product-oriented policy instruments can be integrated to enhance the synergies, to avoid/overcome potential conflicts and to ultimately reduce environmental burdens from society. In achieving the purpose, the following research questions were addressed.

- What constitute product-oriented environmental policy instruments, and what are their characteristics?
- How have the product-oriented environmental policy instruments been used together, and what is the potential of using the instruments together?
- What lessons can be extracted from the existing policy measures in facilitating the development of future policies that reduce environmental impacts from product systems?
- In light of existing policies and the policy development in Europe, what are the implications for developing a coherent piece of framework legislation on eco-design?

The study constitutes one of the final parts of a research programme FLIPP – Furthering Life cycle considerations in Integrated Product Policy – a Swedish research programme that aims to develop knowledge and understanding of the dynamics, mechanisms and interactions in complex product chains necessary to underpin life cycle based decision support systems. The programme is supported and funded by the Swedish Environmental Protection Agency. The knowledge generated from its multidisciplinary applied research approach aims to support policy-makers in decisions on how and when to intervene in product chains, when to facilitate processes already set in motion by market actors and when to leave be. It also aims to support the actors in the product chains in their chain-related decisions, such as procurement, product design, production and marketing.

1.3 Scope and limitation

Various approaches can be taken in grasping and addressing environmental impacts arising from human activities. The approach in focus in this paper, given the overall focus of the FLIPP Programme, is product-oriented ones – government measures taken with the aim to reduce the environmental impacts arising from various parts of the life cycle of products.

There exists a number of policy instruments and tools that address various types of environmental impacts arising from various parts of a product's life, as found in Figure 1-1.

Based upon the emphasis given in the Action Plan on SCP, the authors focus on policy measures that address at least one of the following considered to be among the "greatest environmental concerns": climate change, energy & resource efficiency and phase-out of

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[4] In this regard, a series of OECD studies on instrument mixes for environmental policy, as summarised in OECD (2007), sheds many useful insights. However, the five case studies they conducted do not have products in focus. Moreover, the cases discuss the use of multiple instruments addressing primarily one environmental problem (household waste, non-point sources of water pollution in agriculture, residential energy efficiency, emission to air of mercury, regional air pollution), with limited attention to the interaction of these instruments with instruments dealing with other environmental problems.

hazardous substances and scarce materials (COM (2008) 397 final).

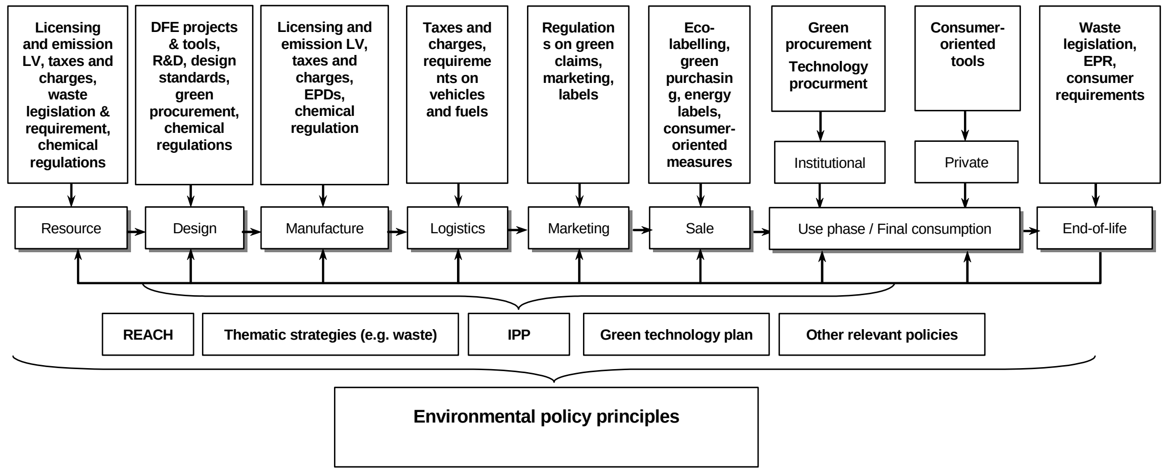

Figure 1-1. Examples of approaches for addressing sustainable consumption and production (Source: Mont & Dalhammar, 2006).

The project is primarily a desk-top research. The principal materials are of secondary nature, collected both within and outside of FLIPP projects. Outcomes of the research projects within the FLIPP programme can be roughly divided into those oriented towards governmental policy and those focusing on private sectors (e.g. supply chain management). In addition to the materials from the former, lessons relevant for policy-making from the latter are extracted and analysed.

Concerning products, we focus on products that experience interventions (e.g. cars and EEE), not least as they have been the research focus of some of the FLIPP projects. Interventions related to buildings and those that promote renewable energy, despite their importance, are not within the scope of the paper. While we seek to take into consideration policy measures addressing various stages of a product's life cycle, the main focus is from the manufacuring phase to the end-of-life phase.

The study primarily looks at the interaction of the instruments, rather than the characteristics of individual instruments. Instead of striving to delineate the effectiveness of a single instrument used in combination with other instruments, the focus is (potential) positive and negative effects of introducing the instrument in combination with other instruments. Rather than covering all the policy instruments related to environmental improvements of products, the instruments are selected based on their relevance to instrument mixes.

In discussing the instruments, we seek to illustrate the issues through concrete examples of implementation. The examples are primarily sought after in Europe. However, reference is made to approaches in other countries when we find interesting policy lessons.

A comprehensive literature review on instrument (policy) mixes was carried out by Carl Dalhammar in the framework of FLIPP and included in the reporting of his research in the FLIPP Programme. The authors refer to Dalhammar (2007) for this review.

1.4 Research approach

The study took the following three steps: 1) selection of product-oriented environmental policy instruments, 2) analysis of the specific aspects of the selected instruments, and 3) discussion of issues relevant for what constitutes a good instrument mix, and how it can be formulated and implemented in an effective and efficient way.

1.4.1 Selection of instruments

As mentioned in the scope, the authors select product-oriented environmental policy instruments addressing issues that are currently considered especially important: resource efficiency, quality of materials and energy efficiency/climate change. Among the instruments, those selected for analysis are either those that have been implemented and from which we can extract policy lessons, or currently discussed intensely in the political arena. It also reflects the issues covered by the FLIPP Programme and the knowledge base of the authors. Consequently, the instruments selected for analysis do not cover all the instruments that can address these issues. However, the authors strived to select them based on the experiences accumulated around the instruments.

1.4.2 Aspects of instruments to be considered

In addition to the introduction of the general characteristics of the instrument, the selected individual policy instruments are discussed from the following aspects: 1) life cycle stages they address, 2) typology of the instruments, 3) stringency of environmental mandate/ environmental effectiveness, 4) potential of instrument mix, and 5) influence on manufacturers, supply chain and market.

Life cycle stages addressed

As illustrated in Figure 1-1, the life of a product consists of many stages. Under this headline we briefly mention which life cycle stage(s) of a product the instrument in question intends to address.

Typology of policy instruments

Interventions can be introduced with varying level of coerciveness (mandatory to voluntary). Regarding their nature, they can be categorised into administrative, economic and informative instruments.

Administrative instruments cover various measures that concern fulfilment of certain tasks, such as achievement of a certain recycling rate, elimination of the use of certain substances and prohibition of landfilling. When mandated via legislation, it makes the target entities seek to achieve certain tasks or refrain from doing certain things, in accordance with what is demanded in the legislation (Vedung, 1998, 31-32; van der Doelen, 1998, 132). Unless exemption is granted, the target entities have no choice but to obey.[5]

Economic instruments generally provide monetary incentives – subsidies, refunds and the like – when the addressees carry out tasks that the instrument wishes to promote, or disincentives such as tax, when the addressees do not fulfil the required actions (Vedung, 1998, 32; van der Doelen, 1998, 132). The crucial difference between administrative instruments and economic instruments is that in the former, when mandated by government, the addressee has no choice but to fulfil the task, while in the latter, the addressee has the freedom of carrying out the tasks or not.

Informative instruments, or information, concern the collection and provision of information, and are used with the assumption that, people behave differently when they have better information and understanding. Also referred to as "moral suasion", they seek to influence people "through the transfer of knowledge, the communication of reasoned argument, and persuasion" (Vedung, 1998, 33).

From the perspective of level of coerciveness, policy instruments can be categorised between mandatory and voluntary. The addressee of the *mandatory* instruments is required to fulfil the tasks laid down in legislation, while the private actors can set up the goals themselves and strive to achieve them via *voluntary initiatives.* Between these two exists, for instance, *negotiated agreements*, where the government and private actors form a contract, in which the government typically agrees to refrain from enforcing legislation on condition that the private actors achieve a certain goal. Establishment of a negotiated agreement may also lead to the development of legislation.

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[5] The terms *regulations* (Vedung, 1998), *judicial control model* (van der Doelen, 1998), *regulatory instruments* or *mandatory instruments* essentially refer to these mandatory administrative instruments. However, economic instruments – for instance taxes and subsidies – and informative instruments, such as labelling requirement and provision of certain information, are often mandated by law. Thus, we chose to use the term *administrative instruments*.

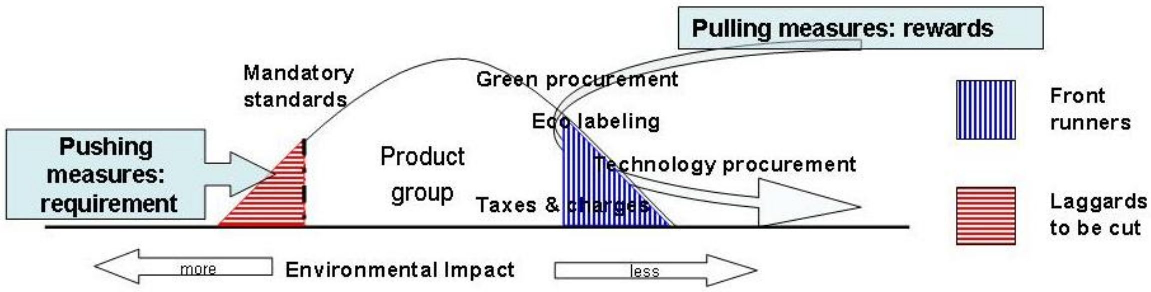

Figure 1-2. "Conventional" use of policy instruments (based on Dalhammar, 2007, 139)

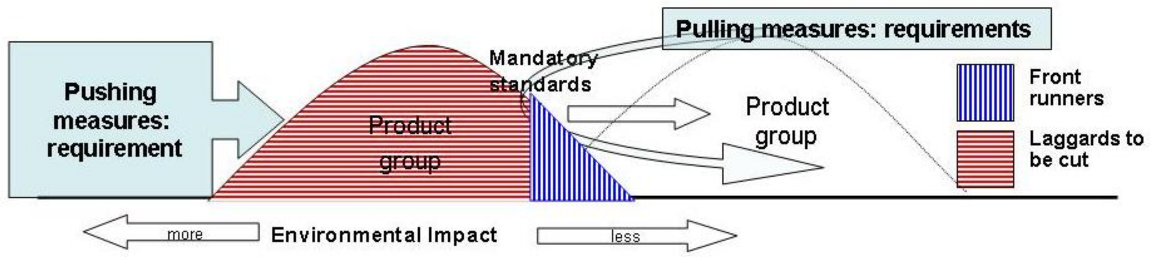

Figure 1-3. Mandatory standards cutting a large part of product groups as laggards

Stringency of environmental mandate/ environmental effectiveness

This criterion concerns the degree to which the instrument in question aims to address the environmental issue at hand. What is the expected – and achieved, when data are available – outcome of fulfilling the goal set forth in the instrument? How high is the set target?

Previous research showed the strength of mandatory administrative instruments, such as standards, in inducing/forcing upstream changes – that is, development of solutions that facilitate the prevention of environmental problems at source instead of so-called end-of-pipe solutions. However, these mandatory administrative instruments so far have been predominantly used for setting minimum standards to "cut the laggards". The environmental performance of the overall product group is "pushed" relatively slightly. The enhancement of environmental performance of already environmentally superior products – front runners – has been considered to be the role of incentive-based or suasion measures. Examples of these measures include economic instruments such as public procurement, taxes and subsidies, and informative instruments such as eco-labelling schemes (Dalhammar, 2007). This can be summarised as in Figure 1-2.

However, when mandatory standards are set at a more stringent levels, a large part of existing products become "laggards" to be cut. The level of standard can become very close to what has been set under economic and informative instruments mentioned above. This is the essence of the approach taken under the so-called Top Runner Programme in Japan, addressing energy efficiency in the use phase of selected products.[6] This can be graphically expressed as in Figure 1-3.

[6] An evaluation of its implementation is found in Tojo (2005).

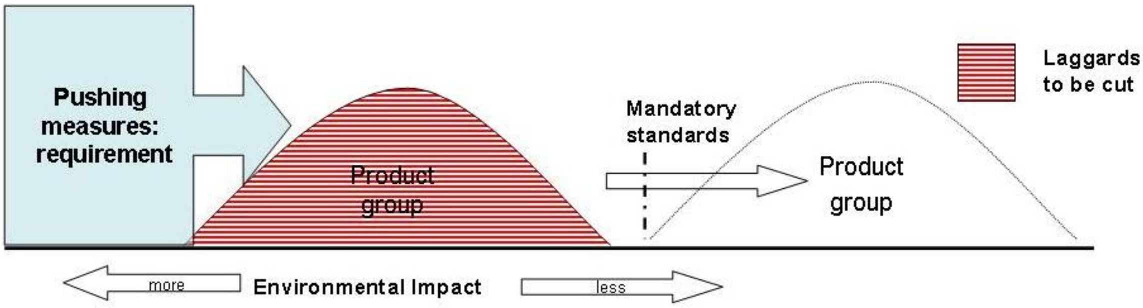

Figure 1-4. Mandatory standards set beyond what is achievable by commercialised technology

In some extreme cases, the standards are set at the level beyond what has been achieved by commercialised technologies (see Figure 1-4). This approach is found in, for instance, the standards for exhaust gas emissions introduced in Japan in the 1970s, which initially created much struggle among the Japanese car manufacturers, but eventually provided significant market advantages especially in the USA.[7]

In light of the urgency of reducing environmental impacts facing us, the standard set in an instrument, be it mandatory or voluntary, should move towards more stringent ones that indeed push the entire product group. Meanwhile, a good knowledge of existing and potential best available technologies is among the essential elements in determining the appropriate level of standard.

Typology and potential of instrument mix

As said in the introduction, the existing instrument mixes in the area of environmental product policy can be categorised based on the 1) formulation and implementation process of the combined used of instruments and level of integration, and 2) environmental issues targeted by the instruments.

Regarding the former, in some cases, an environmental product policy incorporates various types of policy instruments from the beginning. For instance, programmes based on Extended Producer Responsibility (EPR) typically includes a number of instruments such as mandates for collection and/or recycling of waste streams generated from specific products, achievement of numerical collection and/or recycling targets, recycling and treatment standards, restriction of the use of hazardous substances, provision of information to consumers and the like. The Top Runner Programme in Japan which addresses the use phase energy efficiency of selected products includes the requirements from efficiency standards and the labelling scheme.

In some cases, elements of separate policy interventions are brought into another policy intervention. For instance, criteria used in green public procurement incorporate requirements set forth in various other instruments covering different environmental issues (e.g. resource and energy use and toxicity). Similar approach has been taken as a criterion for tax relief/ subsidies.

In other cases, various interventions are introduced for the same product separately without explicit coordination. For example, in a number of OECD countries, cars and electrical and electronic equipment (EEE) are subject to EPR programmes addressing primarily the environmental impacts arising from the waste phase, as well as energy efficiency standards. Various mandatory and voluntary labelling schemes – such as Type I to III, energy efficiency labels, those on hazardous substances and recycling – exist simultaneously for EEE.

In reality, the division of the formulation process is often not clear cut. For instance, even when two instruments are introduced at different times, they may become an integral part of a new policy package later on.

7 A short note on the programme can be found in Tojo (2005).

The combination of instruments formulated and implemented in various ways as discussed above can address both *single* as well as *multiple* environmental issues.

Table 1-1 summarises the typologies described above and gives some examples of existing instrument mixes. The categorisations suggested are considered when discussing the potential for instrument mixes for different instruments with the view to improving the synergies among instruments. Although the primary focus of this study is instruments addressing multiple environmental issues, reference to the mixes addressing a single environmental issue is also made when relevant.

In addition to the typologies, consideration is also made to the rationale and criteria for using instrument mixes for environmental policy previously suggested, as summarised below (Dalhammar, 2007, 135-136; OECD, 2007, 155-221).

- Necessity of addressing multi-aspect environmental problems;
- Necessity of addressing market failures such as information failures, asymmetric information between buyers and sellers, and incomplete property rights;
- Reduction of administrative costs;
- Mutual complementarity;
- Creation of synergy/mutual support and reinforcement, which may be facilitated by the flexibility incorporated in the instruments;
- Avoidance of double work for the addressees of the instrument; and
- Provision of alternatives to another instrument.

OECD (2007) also highlights some cases where lack of some administrative and economic instruments in a policy package reduces the environmental effectiveness and/ or economic efficiency significantly. Meanwhile, it also points to cases where overlap of instruments hampers economic efficiency.

Influence on manufacturers, supply chain and market

Similarly to other environmental policies, an environmental product policy should ideally promote continuous improvement and innovation (OECD, 1997; Field & Field, 2002; Tojo, 2004). However, the discussions on innovation and environmental policy, and knowledge pertaining to innovation systems have not been well connected. As a way of bridging the gap, an analysis of selected environmental technologies was conducted, focusing three main activities crucial for the development and diffusion of innovation – *knowledge creation, pool and access, access to resources, and market formation* (Heyes et al., 2008). Due to the limited empirical information regarding the relation between the respective activities and instruments addressed in this study, it is difficult to make detailed discussions on each aspect. However, the approach is utilised when analysing the influence of the policy instruments to activities of selected actors in the product chain.

Given the focus of this study, the first crucial actor to be examined is the manufacturers of the products. While some of the instruments reviewed (e.g. material restriction and eco-labels) directly concern product design, others have more indirect roles (e.g. waste prevention targets). In analysing the instruments we try to consider how they might influence the *knowledge development and design strategies of manufacturers.*

Production of the final products available in the market involves a number of *suppliers* that manufacture raw materials, parts and components. Actors in the supply chain influence each other in various ways, and in some instances, specification given from the customers of the suppliers can be as powerful as, or even more powerful than, what is mandated by law. It would be very important for policy-makers to understand these dynamics and identify good leverage points for intervention.

Once the environmentally superior products are developed, the important and crucial step is that they are actually used. This report seeks to discuss if and how a particular instrument – or its combined use with other instruments – might help form the *market* for the products, as well as their *diffusion.*

1.4.3 Discussion on instrument mixes

Based on the analysis of individual instruments, the study seeks to extract insights regarding instrument mixes that effectively reduces the environmental impacts from a product's life cycle. This is considered mainly from two angles: the content of such a policy package and the process of formulating and implementing an instrument mix. Methods of increasing the stringency of environmental mandates addressed in a package are also considered.

In doing so, we first look at some of the existing policy packages that already incorporate various policy instruments in one way or another, followed by the extraction of some overarching insights.

Although the nature of the study does not allow the universal application of one single solution, the authors seek to extract generalisable lessons from previous studies as much as possible. The study further seeks to explore the necessity and feasibility of forming an overall policy framework that help facilitate the coherence and mutual reinforcement of these various interventions.

1.5 Structure of the report

Following this introductory chapter, Chapters 2 to 4 discuss selected policy instruments that address three key environmental impacts – resource efficiency, mitigation and management of hazardous substances and chemicals, and energy use and climate change – arising from various parts of a product's life. This is followed by the assessment of some policy interventions that typically incorporate more than one instrument, and/or intend to address more than one environmental issue arising from more than one phase of a product's life (Chapter 5). Chapter 6 subsequently highlights and analyses some of the issues relevant for use of instrument mixes. The report ends with a set of conclusions.

2 Policy instruments addressing resource efficiency

In this chapter, selected policy instruments that seek to – directly or indirectly – address the aspects of resource efficiency from various stages of a product's life cycle will be discussed. These instruments are:

- Waste prevention targets;
- Source separation;
- Collection targets;
- Reuse/recycling targets;
- Producer take-back requirements;
- Deposit-refund systems;
- Minimum recycled materials content standards;
- Tax on virgin materials; and
- Information provision.

In line with the research approach laid down in Section 1.4.2, after the introduction of the general characteristics, the following aspects of the respective instrument are discussed: 1) life cycle stages it addresses, 2) typology of the instruments, 3) stringency of environmental mandate/environmental effectiveness, 4) potential of instrument mix, and 5) influence on manufacturers, supply chain and market. The last part of the chapter summarises the discussions.

2.1 Waste prevention target

Waste prevention has been agreed upon as the highest stage of the so-called waste hierarchy, the guiding principle behind the waste management policy of the European Union since the late 1980s (Krämer, 2003). However, despite various efforts taken in the last several decades, the overall waste generation is still increasing.[8]

In order to remedy this situation, the issue of waste prevention targets have been on the political agenda at length, not least in relation to the revision of the EC Waste Framework Directive.[9] The revised Directive that was finally agreed upon (Directive 2008/98/EC) does not give any specific waste prevention targets in numerical form. However, it mandates the Commission to submit to the European Parliament and the Council reports on, among others, the decoupling objective for 2020 by the end of 2014 (Article 9 (c)). Among EU Member States, Finland in their national waste plan sets a target that waste generation is stabilised at the 2000 level by 2014 (Ministry of the Environment, Finland, 2008).

In addition to the reduction of the quantity of waste generated, which in turn addresses resource efficiency, waste prevention also refers to quality of waste. Under the revised Waste Framework Directive (2008/98/EC) this is referred to as the adverse impacts of waste on human health and the environment, as well as "content of harmful substances in materials and products" (Article 3, Para 12). This issue can be addressed in policy instruments targetting harmful substances, such as material restrictions (Section 3.2), as well as, chemical policy.

2.1.1 Life cycle stages

As the name of the instrument suggests, the instrument often comes as part of waste legislation and directly addresses environmental issues related to volume and quality of the waste (resource efficiency, landfill space, toxic substances, and human health). However, the solution to the problem lies primarily upstream (raw material extraction, design and production) as well as the use phase of the products (consumers' life style) that determines the absolute amount of waste to be generated.

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[8] Between 1995 and 2003, the generation of municipal waste in EU-25 increased by 19%, which is coupled with the growth of economy. It is predicted that MSW is increased by 42.5% by 2020 compared to 1995 levels (COM (2005) 666 final, 5).

[9] See, for instance, ENDS (2002, November 15), ENDS (2005, October 27), ENDS (2006, June 28), ENDS (2006, October 10), ENDS (2008, April 9) and ENDS (2008, June 4) for the discussion of waste prevention targets over time.

2.1.2 Type of instrument

It is an administrative instrument, and can be both mandatory (set by the governments at various levels via lawas and rules) and voluntary (industry commitment).

2.1.3 Stringency of environmental mandate

Despite the well-recognised necessity of improving resource efficiency and of decoupling the waste generation/resource consumption from economic growth, what should be achieved in this area, especially in terms of resource consumption, is not very well known (COM (2003) 572 final). The need for reduction of waste generation per se may differ from country-specific conditions. Lack of experience in this area also makes it difficult to compare the relative difficulties of achieving the target that does exist now (e.g. in Finland). The ACR+ (the Association for Cities and Regions for Recycling and Sustainable Resource Management) indicated that 15% waste reduction, corresponding to a decrease from the European average of 600 kg per capita per year to 500 kg, should be feasible (ACR+, 2008). The fact that household and municipal waste generation of roughly half of the OECD countries is less than 500 kg (OECD, 2007, 188) gives a hint that this level can be achieved in developed countries.

Translating the prevention target down to the level of specific products faces challenges especially for complex products, due to various types of materials used in products and the innovative nature of waste prevention activities. More straightforward possibilities exist for simpler products such as packaging.

2.1.4 Potential for instrument mix

The waste prevention target is typically part of a waste policy package that often addresses several environmental issues: resource efficiency, toxicity and health hazards. A waste prevention target can also be part of an EPR programme for simple products, such as packaging materials. In this case, the main issue of concern might be limited to resource efficiency. In both cases the waste prevention target would address the behaviour of actors in various parts of the life cycle and its effective achievement would require supplemental instruments, not least those related to information. Prevention targets set upon the entire waste stream may not have strong influence on the design strategy of manufacturers.

2.1.5 Influence on manufacturers, supply chain and market

When a waste prevention target is introduced for specific products, such as packaging, it would most likely influence the design strategy of material suppliers, manufacturers and users of products. However, overall waste prevention targets without targeted actors may create a situation where everyone's responsibility is no one's responsibility.

2.2 Source separation

This instrument requires separation of specific fractions of waste at source. Source separation can be done in various places, such as at consumers' residence via provision of bags, containers, boxes and the like, or at local collection points.

Three EC Directives on specific waste streams – packaging (94/62/EC as amended by 2004/12/EC), EEE (2002/96/EC) and batteries (2006/66/EC) – mandate EU Member States to establish appropriate measures to separate the fractions addressed at source. The EC Landfill Directive (1999/31/EC) requires, among other measures, the diversion of biodegradable waste, which drives many Member States to strive for source separation of that waste stream. In addition to those mandated by the EU, individual Member States may have further requirement of source separation, such as newsprint in Sweden (Naturvårdsverket, 2005, 77)[10] and Finland.[11] Source separation is practiced to a great degree in Japan as well, with municipalities deciding on various sorting categories ranging from a few fractions to above 20.

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[10] Förordning (1994:1205) om producentansvar för returpapper. Sweden

[11] No. 883. Government Decision on the Collection and Recovery of Waste Paper. 25 November 1998. Finland.

Different infrastructures – with different levels of convenience and incentives provided to the consumers – have been used for the source separation of recyclables. The main systems include: 1) deposit-refund systems (Section 2.6); 2) pay-as-you-throw approaches, 3) kerb-side collection systems and 4) collection centre ("bring") systems.

2.2.1 Life cycle stages

The instrument is focussing the end-of-life phase of a product and primarily addresses reduction of mixed waste to be disposed of. Moreover, it is a prerequisite to achieve an increase in reuse and recycling which in turn contributes to the reduction of the use of virgin materials. When the waste stream in question is hazardous, it is to prevent the waste steam from being mixed with the rest of the stream. It also facilitates the environmentally sound treatment of the collected waste.

2.2.2 Type of instrument

It is an administrative instrument often mandated by legislation, but can be implemented voluntarily as well (e.g. copying machines and waste paper).

2.2.3 Stringency of environmental mandate

The goals of source separation are reduction of the volume of waste and its environmental impacts, as well as reinforcing the linkage between upstream and downstream and thereby enhance resource efficiency/reduction of toxic substances. Except for the volume of waste, the connection between the level of the achievement of the collection targets and the achievement of these latter goals has not been studied well. This has partly to do with the fact that source separation alone cannot achieve these goals. It is often when source separation is part of a policy package that we start to see some positive signs of achieving these goals. However, we can at least conclude that source separation is a necessary step and serves as a proxy for closing the material loop thus enhancing resource efficiency, as well as, reducing the harmful effect of toxic substances.

An example of kerbside collection systems for packaging waste combined with take-back requirements is found in Germany, where, in response to the enforcement of the Ordinance on the Avoidance of Packaging Waste,[12] industry organised a nation-wide collection system, called Duales System Deutschland GmbH (DSD). Among the products covered under the Ordinance, light fractions such as plastics, tin plate, composites and aluminium are collected at kerbside, in parallel to the municipal waste management system (DSD, 2007). The collection rate achieved here has been also high, resulting in recycling rates (65-95%) well above the set target, even though those targets in 1991 were set considerably higher than in any other system. In 2007 the DSD reported recycling rates between 84 to 135% (DSD, 2008).[13] A study in the UK sought to model how an intensification of bring facilities for recyclables and kerbside source separation might contribute to people's participation in recycling activities and the level of actual source separation. The study generally suggested that kerbside source separation is more effective in enhancing source separation. The study also pointed out that the recycling rate is further enhanced when multiple materials are collected kerbside, and when the interventions are accompanied by information campaigns (Tucker & Spiers, 2002).

With regard to the bring system, the result varies. A high collection rate, sometimes above 90%, is observed for glass (for instance in Switzerland, Sweden and Germany) (ENDS; 2008, July 28; Naturvårdsverket, 2008, 16; DSD 2008).[14] All of these countries have set recycling targets (see Section 2.4) and require producers to finance collection and recycling. On the other hand, according to Ricci (2006, personal interview), approximately 2000 cases

[12] Ordinance on the Avoidance and Recovery of Packaging Waste (Verpackungsverordnung – VerpackV) of 27 August 1998 (BGBI I 1998 S. 2379).

[13] A recycling rate above 100% can be reported as the denominator in this calculation is based on the amount of packaging that has been registered with the DSD and for which fees have been paid to the system. It is an indication that producers register with competing systems that are not achieving similar levels of collection and recycling.

[14] It should be noted, however, that at least in the Swedish system, the denominator of the calculation does not include the bottles imported privately.

in Italy suggest that a bring system (to the road containers) could only achieve up to 30% of source separation of recyclables, while a kerbside (door to door) collection system can achieve 50-70% source separation. The examples from these countries indicate that the effectiveness of the bring system varies depending on the context in which the system operates.

The collection rate of WEEE in Sweden was more than 10 kg in 2001 (ENDS, 2002, October 1), and around 10 kg in 2003 in Switzerland (Buletti, 2006, personal interview), way beyond the collection targets set forth later under the WEEE Directive. These countries mandate take-back to producers, but without any collection targets in these reference years.

In addition to convenience, the characteristics of products also influence the source separation results. For instance, when a discarded product is large and heavy, people have higher tendency to bring the waste to the appropriate collection points instead of discarding it together with the rest of the waste stream. On the other hand, when a product a consumer wishes to discard is light and small, there is a higher tendency for people to put it in the residual waste bin. The effectiveness of source separation is also affected when there are similar products, and only parts of them are covered by the separate collection system. Confused consumers may stop sorting those that should be sorted, as they become uncertain about what should be sorted and what does not have to be sorted (Tojo, Lindhqvist & Davis, 2003). Examples of confusion also include source separation of plastics in Sweden, for instance in the city of Lund. Households were frequently supposed to separate only hard plastics. However, it is not always easy to know what constitutes hard plastics and what does not.

These results suggest that the effectiveness of source separation varies depending on the combination with other instruments, characteristics of products, convenience for consumers, provisions of incentives and the like. Between kerbside and bring systems, the kerbside system tends to achieve higher collection than the bring system.

2.2.4 Potential for instrument mix

Similarly to waste prevention targets, source separation requirements typically are part of a waste policy package that often addresses several environmental issues: resource efficiency, toxicity and health hazards.

The instrument is rarely introduced alone. It is often accompanied by other instruments to enhance source separation, such as collection and/or recycling targets (Sections 2.3 and 2.4), take-back requirements and EPR programmes (Sections 2.5 and 5.3), deposit-refund systems (Section 2.6), various information and awareness raising activities (Section 2.9) and the like. These accompanying instruments are often vital in ensuring the environmental effectiveness of the instrument.

2.2.5 Influence on manufacturers, supply chain and market

Source separation is a prerequisite for sourcing clean recyclable fractions from the waste stream. Availability of recyclables may have impact on manufacturers' sourcing strategies of the materials. This in turn would influence the suppliers of virgin materials who might investigate the possibility of utilising the recyclables as part of their portfolio.

Effective source separation requires participation of consumers. When source separation requires separation of products based on materials – as has been the case for packaging in some municipalities in Japan – consumers may start to ask for packaging materials that would be easy to separate. This may begin to influence the design strategy of manufacturers/ users of the packaging materials. However, the level of influence will be affected by a number of factors – such as the level of enforcement of source separation, actors responsible for collection of sorted materials and the power relation between consumers and producers.

2.3 Collection targets

As discussed in Section 2.2, numerical targets are often set to ensure and measure source separation of specific waste streams. It can be used to facilitate the closing of material loops and thus enhance resource efficiency, as well as to avoid the contamination of the rest of the waste stream by hazardous substances. It serves as a proxy for measuring the progress of activities related to the downstream of a product's life cycle, as well as, the degree of closing the material loops.

The target may be set either in absolute or relative terms. In addition to the well-known difficulties of obtaining accurate figures around waste issues, both of these approaches have challenges. The absolute figure does not reflect such differences, when introduced for a region that covers areas of varying socio-economic setting, such as the EU. This was experienced with the EC WEEE Directive (2002/96/EC) which requires Member States to achieve collection of 4 kg of WEEE per person per year from private households.

A challenge facing the target setting in relative term, especially for waste streams of durable products, is what should be the denominator. In some cases – for instance, the mandate for batteries in the Netherlands – it is based on the actual amount of waste disposed (Tojo, 2004). The denominator in this case is the sum of the amount of waste separately collected and the amount disposed of in the municipal waste stream. This method requires monitoring of what comes into the municipal waste stream, for instance, through statistical sampling. Alternatively, it can be based on the sales figure of the past several years. The latter is the approach taken for batteries in Switzerland (Tojo 2004) and the revised EC Directive for batteries (2006/66/EC). The proposal to the revision of the aforementioned WEEE Directive also includes this method (COM (2008) 810/4).

2.3.1 Life cycle stages

The instrument is used at the end-of-life phase and helps in reducing the amount of residual waste, thus reducing the waste volume, leading to better use of land that would have become landfill area. By supplementing source separation, the instrument links the end-of-life phase and the upstream phase of a product's life. When collected waste is processed to be reused/recycled, it helps reducing the use of raw materials.

2.3.2 Type of instrument

It is an administrative instrument, introduced by governments at various levels, and can be both mandatory (e.g. aforementioned legislation for batteries and WEEE) and voluntary (e.g. the collection programme for nickel-cadmium batteries in the USA).

2.3.3 Stringency of environmental mandate

The collection rate directly measures the achievement of source separation efforts. As discussed in Section 2.2, except for the reduction of mixed waste, the connection between the level of achievement of the collection targets and achievement of upstream changes has not been studied well. The collection targets still serve as one of the proxies for measuring the achievement regarding closing the material loops and thus enhancing resource efficiency, as well as reducing the harmful effect of toxic substances.

The ambition level of the target varies from one piece of legislation to another. Regarding batteries, the EC Directive for batteries (2006/66/EC) requires Member States to achieve the minimum collection rates of 25% by 26 September 2012 and 45% by 26 September 2016 (Article 10). On one hand, when looking at the achievement of the battery collection systems in the Netherlands and Switzerland, both of which exceeded 60% (Tojo, 2004), this may not look like a very ambitious target. On the other hand, generally, difficulties have been experienced to enhance high collection rates for small products such as batteries and small EEE.

As mentioned in Section 2.2, some policy packages for selected packaging waste that includes both source separation mandates and collection targets have achieved rather high collection results. Meanwhile, it also indicates that the same policy package for other packaging waste did not work very well with the possible reason being the characteristics of the type of waste. The results for the collection of WEEE in Sweden and Switzerland also suggest that the lack of collection targets does not necessarily lead to low collection rate.

All this indicates the difficulties of determining what can be achieved by collection targets independently.

2.3.4 Potential for instrument mix

Similarly to source separation, collection targets are rarely introduced alone. They almost always come together with a source separation mandate, but not necessarily the other way around. The instrument can be also included in an EPR programme (Section 5.3) accompanied by take-back requirements (Section 2.5). Depending on the type of products/waste targeted, it addresses resource efficiency and/or toxicity and health hazards.

For non-durables such as packaging materials, often the denominator for reuse/recycling targets is the amount of products put on the market during the same period as the discarded products are recycled. Thus, when there are reuse/refill or recycling targets, it is often not necessary to have collection targets.

2.3.5 Influence on manufacturers, supply chain and market

Similarly to source separation, effective collection of specific waste streams may have impact on the strategies of material suppliers. When manufacturers are responsible for achieving the collection targets, some may investigate the possibility of utilising the collected materials and/or components. The authors have not come across examples where increase in collection of discarded products has led to increased sales of products.

2.4 Reuse/recycling targets

Second highest in the waste hierarchy, reuse of products has been promoted to reduce waste and enhance resource efficiency. Following reuse is recycling, which the revised Waste Framework Directive (2008/98/EC) defines as "any recovery operation by which waste materials are reprocessed into products, materials or substances whether for the original or other purposes" (Article 3 Paragraph 13).

Reuse/refillable targets have been used extensively for beverage containers in countries such as Austria, Sweden and Germany in combination with recycling targets. In Austria, combined reuse and recycling targets were set for beverage packaging for 1994, 1997 and 2000, differentiated among the type of beverages, and ranging from 80 to 96% (Lindhqvist, 2000). The target-setting principles in Austria were changed in the revised Packaging Ordinance of 1996, which is only specifying recycling targets for the collected amounts of packaging. In Sweden, there was a target for refillable PET (90%) and glass bottles (95%) in the period 1997 – mid-2001.[15]

The so-called Type I eco-labelling schemes in some countries also include reusability as one of the awarding criteria. For instance, the German Blue Angel Programme established award criteria for: reusable transportation packaging such as reusable transportation packaging admitted to freight traffic, laundry transportation bags, heat preserving containers for food, reusable food crates, etc. (RAL-UZ27), as well as for refillable bottles (RAL-UZ 2).[16]

However, setting targets for reuse of products, especially for durable products, faces various challenges. As long as products are circulated in society as second-hand products and the continuation of the use of these products are not harmful to humans or environment, there is little reason to treat them differently from the rest of the products. Due to the nature of the market for second-hand products, it is difficult to grasp the nature and the number of second-hand products. Even when the achievement regarding reuse is well grasped, it may not be well accounted for as an achievement in waste prevention, due to the way the definition of reuse and recycling is made. For instance, as refillable bottles are not considered as "waste" in Denmark, despite their contribution to waste prevention, it has not been accounted for as part of the achievement for packaging waste management. Moreover, for some products for which use-phase environmental impacts are high (e.g. cars, white goods), it is argued that due to the advancement of technologies that enabled the reduction of environmental impacts from the use

[15] Ordinance on Producer Responsibility for Packaging, 7 May 1997, Sweden (SFS 1997:185).

[16] The detailed content of the criteria is available at the homepage of the Blue Angel Programme (www.blauer-engel.de).

phase, overall environmental impact would be lower when consumers discard an old but still functional product and use a newer model. In these cases the justification of setting a reuse targets (for the whole product) can be questioned.

"Preparing for reuse", the newly introduced concept found in the revised Waste Framework Directive (2008/98/EC), defined as follows, seems to address part of the issues.

> *..checking, cleaning or repairing recovery operations, by which products or components of products that have become waste are prepared so that they can be re-used without any further pre-processing (Article 3 Paragraph 16).*

The proposal of the revision of the WEEE Directive (COM (2008) 810/4) also includes a "preparing for reuse" target combined with recycling targets differentiated among product categories from 55 to 85%.

Recycling targets are widely used for specific waste streams. For instance, in Europe, all the EC Directives on specific waste streams (packaging, batteries, EEE and cars) specify recycling rates. Some Member States set targets higher than that of the EU, such as Germany, Sweden and Finland. Recycling targets are also set for recycling legislation on packaging and large home appliances in Japan.

In some cases, the denominator used for calculating the reuse/recycling rate is the weight of products put on the market in the same year. An example includes packaging. For others, such as cars and electronics, the denominator is the weight of cars and electronics actually collected.

2.4.1 Life cycle stages

Similarly to waste prevention targets, source separation and collection targets, reuse and recycling targets are often part of waste-related policy packages. On the waste management side they contribute to reduction of waste to be disposed of and environmental impacts associated with it. Meanwhile, it enhances resource efficiency by replacing the virgin materials with recycled materials, thus addressing the upstream of a product's life (material extraction, production and use).

2.4.2 Type of instrument

It is an administrative instrument often mandated by legislation, but can also be set up by industry as a voluntary commitment. Industry's commitment to targets are often used as a way to avoid legislation.

2.4.3 Stringency of environmental mandate

Reuse and recycling targets from environmental product policy point of view is a proxy for closing the material loop and thereby enhancing resource efficiency, especially in light of difficulties in mandating the use of recycling materials in products (Section 2.7).

In Sweden, refillable PET bottles achieved a reuse rate of 91%, and refillable glass bottles, 98% in 1999, exceeding the targets of 90% and 95% respectively.

The average recycling rate of packaging materials of the EU-15 increased from 46% to 56% between 1997 and 2004 (EEA, 2008). Meanwhile, only 8 out of 25 countries exceeded the overall recycling targets of 55% set forth in the revised EC Packaging Directive (2004/12/EC) (EEA, 2008). The recycling rate of four large appliances in Japan has been improving – e.g. from 56% to 79% between 2001 and 2006 for washing machines, and from 78% to 86% for air conditioners. These achievements exceed the target demanded by law by 20-25%. [17]

The Swedish Good Environmental Choice Programme includes recyclability as one of its awarding criteria for paper (Swedish Society for Nature Conservation, 1997). A criterion for cleaning agents concerns packaging. The packaging are to be manufactured using polyethylene (PE), polypropylene (PP) or polyethylene terephthalate (PET), and must be adapted, as far as possible, to the recommendations of the PRO for packaging materials in

[17] It should be noted that under the Specified Home Appliance Recycling Law in Japan, recycled materials that have negative monetary value – that is, materials that cannot be sold or at least given away free of charge – are not counted within the achieved recycling rate. This is considered to give incentives for producers to improve the quality of recycling and cultivate new ways of using recycled materials.

order to facilitate recycling (Swedish Society for Nature Conservation, 2002). Such requirements in eco-labelling are often what we could call additional, or even why-not, requirements, as they frequently do not address the most impacting issues in the life cycle of those products, however, they can be fulfilled without major efforts by the producers.

2.4.4 Potential for instrument mix

In most cases, reuse/recycling targets are introduced as part of a policy package related to waste.

For non-durables such as packaging materials, often the denominator for reuse/recycling targets is the amount of products put on the market during the same period as the discarded products are recycled. In this case, when there are reuse/refill or recycling targets, it is not necessary to have collection targets.

While recycling targets do contribute to the enhancement of resource efficiency via waste diversion and provision of constant supply of recyclables, the achievement of higher recycling targets does not mean the reduction of the overall resource inputs. For instance, in the case of packaging materials in Europe, while the overall recycling rate has been increasing over time, the overall packaging waste generation has also been increasing – the average per capita consumption raised from 160 kg to 179 kg between 1997 and 2004 among the EU-15 member states (EEA, 2008). In order to effectively address the consumption issue the parallel introduction of waste prevention measures is crucial.

2.4.5 Influence on manufacturers, supply chain and market

In cases it is part of an EPR programme (Section 5.3) and introduced together with take-back requirements (Section 2.5), the producers – manufacturers and importers of products – responsible for take-back are also often responsible for achieving reuse/recycling targets. This should, together with the take-back requirements, influence the design strategies of producers, which in turn also influence component and material manufacturers. As discussed in Section 2.3.5, the sheer availability of recycled components/materials in itself might influence the strategy of these upstream actors.

The availability of second-hand components has influenced the market development of non-brand second hand electronics, especially in developing countries. However, the target has not appeared to have particular influence on the development of markets for products that include recycled materials.

2.5 Producer take-back requirements

When this instrument is introduced, producers, which in most of the existing programmes mean manufacturers and importers, make appropriate arrangements so that their products that the last owners wish to discard are collected and taken care of in an environmentally sound manner. It is one of the most common and central instruments found in the existing extended producer responsibility (EPR) programmes (Section 5.3).

In the EU, three EPR-based directives for specific waste streams – cars or end-of-life vehicles (2000/53/EC), EEE (2002/96) and batteries (2006/66) – oblige producers to take back their products once those products become waste. Moreover, the majority of the EU Member States introduce producer take-back requirements when implementing the Directive on packaging materials (94/62/EC as amended by 2004/12/EC). EPR programmes with take-back obligation are found for similar product categories in the majority of OECD countries (Tojo, Lindhqvist and Davis, 2003) and a growing number of developing countries started to consider their application.[18]

The take-back responsibility given to the producers can be divided into *physical* responsibility and *financial* responsibility. The former concerns the organisation of physical management of the discarded products, and the latter is the financing of the activities (Lindhqvist, 1992). The extent to which/the manner in which these responsibilities are allocated to producers, as well as how the producers implement their responsibility in practice, differs

[18] For the discussion on its application in India, see, for example, Manomaivibool, Lindhqvist and Tojo (2007).

from one programme to another. Empirical studies show various implications of the variations.[19] While the details are not discussed here, one of the most important variables in relation to a producer's design strategies is whether producers fulfil the responsibility for the take-back requirement and proceeding recycling/ treatment activities individually or collectively.

2.5.1 Life cycle stages

Similarly to instruments introduced earlier, take-back requirements are introduced at end-of-life of products. In addition to improved waste management in terms of quality and quantity, assignment of this task to producers leads to addressing changes upstream (material extraction, design and production of products) and environmental impacts associated with them.

2.5.2 Type of instrument

It is an administrative instrument and can be both mandatory and voluntary. However, previous experiences suggest that even when industry started a take-back programme on voluntary basis, they often ask for the introduction of legislative measure to mandate their competitors to fulfil the same task in order to avoid free-rider problems and create a level playing field.

2.5.3 Stringency of environmental mandate

The environmental effectiveness of take-back requirements incorporated in an EPR programme can be discussed from two perspectives: 1) *design improvements of products and product systems* and 2) *high utilisation of product and material quality through effective collection and re-use or recycling* (Lindhqvist & van Rossem, 2005). In regard to the second point, as discussed in Sections 2.2, 2.3 and 2.4, take-back requirements used in combination with source separation mandates, collection targets and/or reuse/ recycling targets have experienced some level of achievement.

Regarding the first point, van Rossem (2008) points to a number of studies indicating the effectiveness of anticipation of EPR programmes in driving upstream changes. Regarding the continued effect during the implementation stage, the significance of so-called individual producer responsibility – when producers pay the end-of-life management of their own products – have been strongly argued by some manufacturers, the European Parliament, NGO groups and some academia (Tojo, 2004; van Rossem, 2008).

2.5.4 Potential for instrument mix

As said earlier, take-back requirement is an integral part of existing EPR programmes. By default it comes together with source separation (Section 2.2) – in a sense it is one way of implementing source separation – and often, but not always, include the mandate to achieve certain collection and recycling targets (Sections 2.3, 2.4).[20] It is also often introduced in combination with other instruments such as substance restrictions (Section 3.2), fulfilment of environmentally sound treatment/disposal standards (Section 3.3), deposit-refund systems (Section 2.6) and various design-related instruments and information to stakeholders.

When producers become responsible for covering the cost of the take-back and subsequent appropriate management of their products, they would be assumed to strive for development of an efficient system. In order to ensure the efficient management, they would also wish to have some control over the system. It has been observed that the development of such systems may, at least during the transitional phase, conflict with various existing interests of other actors in society. For instance, local governments who have been responsible for waste management may not readily give away their "work territory". However, the current implementation of the WEEE Directive in the EU

[19] Analysis of these issues can be found in Tojo (2004) and van Rossem (2008), from which readers can find other works on these issues as well.

[20] For example, the Swiss legislation for WEEE requires producers to take back their products, but does not have collection or recycling targets, and so was the case for the Swedish legislation until the WEEE Directive came into force. The Japanese EPR legislation for four large applicances, as well as, the one for old cars, and the EU Directive on the end-of-life vehicles have recycling targets, but not collection targets.

Member States suggest that continued involvement of local government may hamper the development of alternative solutions by producers (van Rossem, 2008). In some instances it touches upon social issues, for instance, the livelihood of those engaged in waste sorting and recycling activities. It may also hamper reuse of whole appliances, a direct form of waste prevention.

An example of the latter can be found in the EPR programmes for EEE in Japan. Products that are handed in by end-users must be taken to the system set up by producers for recycling. Some argue that this has killed the possibility of retailers to judge the reusability of products and if appropriate bring them to a second-hand market. It has been criticised that while the legislation facilitates collection and recycling, it jeopardises the survival of second-hand markets for EEE and has not managed to decrease the mass-production/mass-consumption and mass-disposal trend. Meanwhile, an intention behind the requirement of handing the discarded products to the system established by the producers is to avoid the mishandling of WEEE and exportation of WEEE and their components to neighbouring countries under the name of second-hand products.[21] Producers have several reasons to make sure that the discarded products come to the system they established. They would not like to see their brand ending up in the waste dump in Japan or neighbouring countries and receive bad publicity. Moreover, they established their own recycling plants, and it is in their interest to secure a sufficient flow of discarded products.

These potential negative (temporary) side-effects can be remedied by introduction of another policy instrument in some cases. For instance, in cases where producer take-back and recycling targets might hamper reuse of products, a separate target for reuse/preparation for reuse can be introduced. It can also be addressed with design guideline/requirements. A challenge facing these approaches, however, is the innovative nature of product design. Other issues (e.g. continued involvement of local government in collection activities and livelihood of informal sectors) can be addressed during the implementation phase. For instance, in cases where local governments continue to be the actors responsible for collection of specific waste streams, access to local government facilities – or their equivalent – should be given to all the producers. While the livelihood of informal sectors per se should be addressed by social policies, the skills of the existing work force can be utilised in the system established by producers, following the appropriate environmental and health standards.

2.5.5 Influence on manufacturers, supply chain and market

Take-back responsibility given to the manufacturers aims to provide incentives for prevention, both in terms of quantity and quality. The extent to which the producer take-back obligation induces changes in the producers' design strategies depends on the scope of the responsibility given to the producers, as well as how the responsibility is actually implemented. A key in this respect is the implementation of the aforementioned individual responsibility. Studies on existing EPR systems suggests that elements of individual responsibility are found in various countries, such as Japan, Switzerland, the Netherlands and some states in the USA, and practiced by some manufacturers. Individual implementation can take varying forms. In general, the more involved the producers are in the physical operation (e.g. managing their own recycling plants as found in Japan), the stronger the connection to the design change as well as manufacturers' engagement in the improvement of downstream operations. Meanwhile, as found in the case of batteries where material restriction is combined with take-back obligations (see Section 3.2), the cost could provide strong signals to producers as well. While it can take the form of an individual infrastructure managed and financed by a specific company, it may well be individual financial responsibility within the collective physical infrastructure (Tojo, 2004; van Rossem, 2008).

Regarding suppliers, in some cases, manufacturers of final products (e.g. cars) start to work with their material suppliers to seek for possibility to utilise recyclables (Tojo, 2001).

[21] The fact that end-users instead of the original purchaser of the equipment must pay for the end-of-life management of products at the time of disposal has been feared to pave ways for the development of alternative paths to handle WEEE.

The authors have not come across any examples where producer take-back requirement has influence on the sales of products. In fact, lack of consumer demand on the take-back and recycling issues has been mentioned as a factor that hinders producers to strive for design for end-of-life (Tojo, 2004). A possibility to remedy the situation can be to introduce take-back requirement as a criteria for combined instruments such as green public procurement (Section 5.4) and eco-labels (Section 5.2). Some green public procurement specifications have started to include producer take-back as a criterion.

2.6 Deposit-refund systems

In a deposit-refund system, in addition to the price of a product, a modest sum is paid at the time of purchase. When either the whole or part of the product is returned to the designated collection points, the fee is paid back to the consumer. The idea is to provide motivation to consumers to bring back the useful/hazardous parts of the products after their use, in order to increase resource efficiency, avoid littering and/or avoid the spread of hazardous substances.

Deposit-refund systems have been used for different types of products that are to be discarded from end-users in various countries. In addition to packaging materials for beverages, such as glass and PET bottles, the system was/has been used for lead-acid batteries (e.g. 11 states in the USA), cars (e.g. Norway), tyres (e.g. Rhode Island in the USA), fluorescent lights (e.g. Austria) and the like (Tasaki, Numata & Matsumoto, 2008). Tasaki et al. (2008) suggest the categorisation of these products based on their usefulness to the providers of the products, monetary value of the products and containment of toxic substances.

2.6.1 Life cycle stages

The instrument is introduced at the end-of-life phase of a product's life to facilitate source separation of waste streams generated from specific products (Section 2.2). As discussed under source separation, the system aims to reduce the volume of mixed waste, ease the handling of the remaining mixed waste, enhance resource efficiency, and secure efficient and environmentally sound treatment of the collected waste stream.

2.6.2 Type of instrument

It is an economic instrument primarily motivating the consumers to return the products they wish to discard to appropriate collection points. Introduction of a deposit-refund system would typically require legislative mandate for the products with toxic substances (e.g. batteries and fluorescent lights), uselessness for the providers and/or lack of monetary value. Meanwhile, the necessity of mandating the introduction is reduced for products that remain useful for providers even when they became useless for consumers (e.g. rechargeable cards for transportation and refillable bottles). In those cases, the benefit of additional tasks entailed in collecting the products for the providers would outweigh the cost for the providers to establish necessary logistics, as well as, for consumers to return these products. In some cases, the mandatory introduction of a deposit-refund system has been used as a "threat" to the industry to achieve higher collection targets (e.g. beverage containers in Germany, nickel-cadmium batteries in Switzerland).

2.6.3 Stringency of environmental mandate

Similarly to other measures to facilitate source separation of a specific waste stream, a deposit-refund system is one of the instruments that contribute to the enhancement of resource efficiency, as well as to the avoidance of the contamination of the rest of the waste stream by hazardous substances. Regarding downstream operations, in addition to reducing impacts from end-of-life management in terms of both quantity and quality, it aims to address littering problems.

Deposit-refund systems in different countries (e.g. Sweden, Germany, the Netherlands, Norway, some provinces in Canada, 10 states in the United States) for some packaging (e.g. glass bottles, PET bottles, aluminium cans) have achieved very high collection rates, from 70 to close to 100% (Lindhqvist, 2000). Studies of pre- and post-surveys of the so-called "bottle bills" in the United States indicate the reduction of littering by 70 to 84% (Container

Recycling Institute, 2007). Experiences of many deposit-refund systems for beverage containers suggest that the amount of refund does not have to be high, typically from 0.25 to 2 SEK (Lindhqvist, 2000).

2.6.4 Potential for instrument mix

Being one of the instruments that are used to enhance collection and source separation of specific waste streams, deposit-refund systems are sometimes incorporated in an EPR programme (Section 5.3). It can also be introduced as an independent measure, and in this case it is often accompanied by information campaigns to enhance awareness of consumers.

2.6.5 Influence on manufacturers, supply chain and market

Similarly to other source separation measures, a deposit-refund system enhances the collection of the reusable products (e.g. refillable bottles) and a clean fraction of specific materials to be recycled. As discussed earlier, the availability of the materials coming from the downstream of the product life cycle would influence the manufacturers and material suppliers.

2.7 Minimum recycled material content standards

One of the typical concerns when introducing the source separation and recycling mandates is whether there is sufficient demand for the materials recycled. A way of securing the demand is to mandate the use of a certain amount of recycled materials in new products.

The minimum recycled material content standard was used for some time in the United States for paper. However, it was cancelled as it was considered to be a way of protecting the US pulp and paper industry and making it difficult for the Canadian industry to operate.

In Japan, though not mandated, the use of recycled materials is included in the Waste Management and Recycling Guideline developed as a way to implement various policies promoting 3R (Reduce, Reuse, Recycle). The Guideline currently covers 35 product groups and has been developed by the Industrial Structure Committee under the Ministry of Economy, Trade and Industry and has been revised a number of times since its first version in 1990. Examples of recycled materials content standard which are included in the latest guideline published in 2007 are paper[22] (62%) and glass bottles (91%) to be achieved by 2011 (Industrial Structure Council, 2007).

Similarly to the Guideline mentioned above, some of the Type I Eco-labelling schemes include recycled material content as part of their criteria. For instance, the German Blue Angel Programme established award criteria for:[23]

- Recycled cardboards (except for those used for single-use packaging) and products made from recycled cardboards (e.g. the product line folders, files and registry) (RAL-UZ 56);
- Recycled graphic papers, printing and press papers and finished products made from recycled paper, such as product lines of exercise books, writing pads, drawing books, calendars, envelopes, printing and press products (e.g. telephone directories) etc.(RAL-UZ 14);
- Sanitary paper products (paper towels, toilet papers, facial tissues, etc.) made of recycled paper (RAL-UZ 5);
- Products made from recycled plastics that do not contain polyvinyl chloride (PVC), polybrominated biphenyls (PBB) and polybrominated diphenyl ethers (PBDE), halogenated organic propellants, production and processing waste, returned defective products (RAL-UZ 30a);
- Products made from waste rubber (excluding production and processing waste) (RAL-UZ 30b);
- Building materials made primarily (containing at least 80%) of waste paper (excluding unprinted mill broke) (RAL-UZ 36);

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[22] Paper in this case includes paper used for various types of products (e.g. newsprint and office paper, beverage and other packaging, and carton boxes).

[23] The detailed content of the criteria is available at the homepage of the Blue Angel Programme (www.blauer-engel.de).

- Wallpapers containing at minimum 60% of waste paper (RAL-UZ 35b); and
- Building materials made primarily of waste glass (RAL-UZ 49).

Instead of mandating the use of recycled materials, some governments take a somewhat softer approach. For example, in Finland, a public authority should use as much recycled materials as possible (Section 4 Paragraph 3 of the Waste Act). In the Netherlands, there was a government policy on construction and demolition waste for a while. The road-traffic department of the government, in their planning, specified the use of certain percentages of recycled materials (granulate). Under the public procurement policy of Denmark, municipalities are required to use recycled paper. There has been a handbook/guideline published every half a year or so to promote the use of recycled materials (Tojo, 2006).

2.7.1 Life cycle stages

The mandate addresses the design/manufacturing stage of the product, although it may be introduced as part of waste-related policy packages.

2.7.2 Type of instrument

The minimum recycled material content standard per se is an administrative instrument, although it can be part of an economic instrument such as green public procurement. It can be part of a product standard (thus mandatory), or can be part of a guideline to be followed or a manufacturer's own design parameters (voluntary). When it is one of the criteria for an economic instrument, such as green public procurement, it is in principle up to the producers to meet the standard (voluntary). The examples found today are all somewhat voluntary from the perspective of industry.

2.7.3 Stringency of environmental mandate

The mandate regarding the use of recycled material is, together with source separation, collection, reuse and recycling targets, an additional measure to enhance resource efficiency. However, as discussed earlier, the use of it in current government intervention is limited.

When examining the level of stringency found in existing intervention, the mandate found in the Waste Management and Recycling Guideline in Japan is not very ambitious compared to what is currently achieved. Namely, as of 2006, the industry-wide use of recycled paper reached 60.4%, and the recycled glass cullet in glass bottles was already 91.3% (Industrial Structure Council, 2007). On the other hand, as the achievement is already very high, especially for glass bottles, it may not be very productive to increase the targets.

In the case of the Netherlands, the use of recycled materials in road construction is no longer prescribed, but it is said that the use of recycled materials continued because those granulates became cheaper than other materials. The Waste Act in Finland faced difficulties in the actual enforcement. An attempt has been made to provide green procurement guidelines to local governments, but it was not perceived to work very well (Tojo, 2006).

2.7.4 Potential for instrument mix

Minimum recycled material content standards can be introduced as a stand-alone instrument. In practice, it has been integrated into other instruments, such as design requirement or guidelines and green public procurement (Section 5.4), or introduced within waste policy packages.

2.7.5 Influence on manufacturers, supply chain and market

When mandated by legislation as part of design requirements, the recycled material content standard would theoretically pull source separation and recycling, and would influence the manufacturers as well as preceding material suppliers.

Regarding the market, whether the use of recycled materials help the diffusion of the products is not well known. According to a truck manufacturer interviewed, the company received negative voices from their clients when they mentioned that they include recycled materials in the products.

2.8 Tax on virgin materials

In the context of environmental policy discussions, taxation on virgin materials has been considered to be a measure to enhance resource efficiency by reducing the use of virgin materials, while enhancing the demand and utiliation of recycled materials (Bruwoll, 1998; Cairncross, 1993; Grogan, 1993). While a number of OECD countries introduced taxation in the area of water, its use in the management of natural resources is limited (Söderholm, 2006). Examples related to natural resources include gravel tax in Sweden, taxation of certain materials in Denmark and taxation of aggregates (sand, gravel and crushed rocks) in the UK (Söderholm, 2006).

2.8.1 Life cycle stages

The instrument is introduced in the upstream of the product's life cycle. It addresses the downstream indirectly through the enhancement of the utilisation of recycled materials.

2.8.2 Type of instrument

It is a mandatory economic instrument.

2.8.3 Stringency of environmental mandate

Bruwoll (1998), in her simulation of the use of tax on virgin materials on plastic and paper in Norway, indicates significant potential of the instrument in reducing environmental impacts. Meanwhile, Söderholm (2006), in his analysis of the three cases of taxation of natural resources in Sweden, Denmark and the UK, indicates that from these cases it is difficult to suggest the effectiveness of the instrument in reducing the use of virgin material while enhancing the use of recycled materials. Reasons include different and unclear policy goals, existence of various factors that influence the results (Sweden), low level of tax (Denmark) short implementation period (the UK) and the like (Söderholm, 2006).

2.8.4 Potential for instrument mix

Tax on virgin materials can be introduced together with other policy instruments promoting source separation and recycling discussed in the preceding sections of this chapter. However, its introduction would most likely face the challenges of political acceptance. As experienced in taxation in general, unless the level of the tax is high enough, it may not be able to change the behaviour of the target entities (users of the virgin materials) as expected.

2.8.5 Influence on manufacturers, supply chain and market

Tax on virgin materials would influence the actors in the upstream, especially raw material suppliers. The extent to which they are affected depends on factors such as the level of the tax (if it is low enough to transfer the cost to the subsequent actors in the supply chain), power relation of the actors and the like. The diffusion of products that use less virgin materials in the market would most likely depend not so much on the fact that they use less virgin materials per se, but on its side-effects on the property of the products such as miniaturisation, less weight, quality of the materials, cost and the like.

2.9 Information provision

Effective communication of information to actors involved in various parts of the life cycle can be crucial in enabling the measures related to, among other environmental issues, resource efficiency. The information facilitates the selection of resource efficient products (e.g. products containing certain amount of recycled materials, and products with less material-intensity) and guides source separation practices. While we take a look at eco-labels covering various environmental impacts arising from various parts of the life cycle as a separate item in Section 5, in this section instruments targeting information provision on resource efficiency are discussed.

2.9.1 Life cycle stages

The addressees of the instrument are typically consumers and people engaged in waste management found in use and end-of-life phases of the product. The providers of the information include producers, retailers and public authorities in charge of waste management.

2.9.2 Type of instrument

It is an informative instrument. The provision of information is at times mandated by law, but can also be voluntary. In both cases, the concrete types of information given, as well as the means of provision, can take various forms. For instance, it appears as a symbol on products (e.g. cross-bin marks on EEE covered by WEEE Directive in Europe, and recycling symbols on plastics). In some cases, information about payment of a recycling fee should be mentioned on receipts (e.g. EEE in Switzerland). Information related to source separation at household level is often provided by local communities, waste management companies or the housing organisation that pays the waste fee on behalf of its residents. In the case of producer take-back obligation, some programmes (e.g. EPR for EEE in Sweden, for batteries in Switzerland) require producers and/or retailers to inform consumers of their duties.

2.9.3 Stringency of environmental mandate

Information is often an integral part of an instrument mix related to measures to enhance resource efficiency. However, the content of the instrument alone does not set any standard to be achieved by addressees.

2.9.4 Potential for instrument mix

The importance of information provision as a supporting instrument has been confirmed in a number of studies (see, for example, Tucker & Spiers (2002) and OECD (2007)). Virtually all the EPR programmes have some information provision requirements, and all successful source separation schemes are accompanied by information provision to consumers.

2.9.5 Influence on manufacturers, supply chain and market

Provision of information regarding the material content may provide manufacturers incentives to achieve higher resource efficiency, especially when they could have market advantage from it. In the case of dematerialisation, producers often bundle the environmental benefits associated with it as features appreciated by the wider audience, such as smaller size, less weight and the like.

2.10 Summary – instruments for resource efficiency

Table 2-1 below summarises the characteristics of instruments addressing resource efficiency discussed in this chapter.

Many of the existing instruments addressing resource efficiency primarily concern environment and health impacts arising from the end-of-life phase of a product. While good performance of these instruments certainly contributes to the reduction of environmental and health impacts from the end-of-life phase, the instruments often do not address the design strategies of manufacturers and suppliers directly (that is, upstream changes to reduce impacts at end-of-life).

Meanwhile, experiences of implementing these instruments suggest that manufacturers of final products, as well as their suppliers, have started to take the potential availability of clean fractions from the end-of-life phase of the products into their design considerations. Moreover, mandating specific upstream changes related to resource efficiency faces difficulties due to the innovative nature of the development, lack of information on the side of policy-makers, etc.

Instruments addressing resource efficiency from the production phase hardly exist. While it is in a sense naturally addressed as rational private entities would pursue higher resource productivity, past experiences with, for instance, cleaner production projects indicate that companies can be blind to some of the “apparent” measures.

One of the recent examples includes a Swedish company producing components and systems based on metallic materials tailor-made for the automotive industry. A substantial amount of production waste generated from one of their manufacturing facilities has been overlooked, as the waste metal was sold and was considered as revenue. However, when comparing the purchasing price of the metal, the facility was losing 49 million SEK, corresponding to 9% of the annual turnover, despite the income from waste sales (Jachnik, 2006).

Likewise, instruments addressing the use phase are scarce. This stage of the life cycle touches upon the core of consumption and waste prevention, for which an effective policy measure is yet to be found. Meanwhile, waste prevention in terms of quantity in the form of, among others, dematerialisation, light-weighting and miniaturisation, has been taking place. Consumer uptake of miniaturised/light-weighted products has been high.

In promoting resource efficiency measures in the use phase, those features that are positive in the eyes of consumers can be bundled in the communication. Caution should be taken to the rebound effect, however.

In terms of issues addressed by the instruments, the majority of the instruments (can) address not only resource efficiency, but also hazardous substances. Many of the instruments discussed in this chapter are used in combination and reinforce each other. A notable example is source separation measures used in combination with instruments, such as collection targets, reuse/ recycling targets and deposit-refund systems. Many of them are also part of a larger policy package, such as waste policy (including recycling policy) and EPR programmes, or serve as a criterion for other instruments, such as green public procurement, eco-labelling and design guidelines.

Table 2-1. Summary of the characteristics of selected policy instruments addressing resource efficiency

Instruments	Life cycle stage addressed	Environmental impacts addressed	Instrument mix	Effects on design change	Effects on suppliers	Effects on market diffusion
Waste prevention target	Design, use, EoL	RE, HS	Often part of waste policy	Indirect	Indirect	Miniaturisation?
Source separation	EoL, design	RE, HS	Often part of waste policy, integral part of EPR	Indirect	Indirect	n.a.
Collection target	EoL, Design	RE,HS	Supplement source separation, often part of waste policy, EPR	Indirect	Indirect	n.a.
Reuse/recycling target	EoL, design	RE,HS	Often part of waste policy, EPR	Indirect	Indirect	n.a
Producer take-back requirements	Design, EoL	RE, HS	Integral part of EPR	Individual responsibility preferred	Indirect	n.a
Deposit-refund system	EoL, design	RE, HS	Supplement source separation	Indirect	Indirect	n.a
Minimum recycled material content standards	Design	RE	Can be a criterion in a design guideline, GPP	Direct	Direct	n.a.
Tax on virgin materials	Material extraction, design, EoL	RE		Direct	Direct	n.a.
Information provision (exclude eco-labels and design guideline)	Use, EoL	RE, HS	Important supporting instrument for other instruments	Indirect	Indirect	n.a.

EoL: end-of-life, RE: resource efficiency, HS: hazardous substances, EPR: extended producer responsibility, GPP: green public procurement, n.a.: information not available

The timing of integrating one instrument into a policy package/another instrument does not seem to matter much. However, policy-makers should look into the availability of these instruments before introducing a larger policy package in order to avoid duplicated/conflicting efforts.

Studies concerning the connection between the performance of the instruments discussed in this chapter and the development of the market of products addressed by the instruments – for instance, how achievement of a higher recycling rate influences the sales of products – are hardly found. The fact that these instruments on resource efficiency and hazardous substances address product design only indirectly, as well as the lack of connection between the actors involved in marketing and end-of-life issues, may be among the reasons for the shortage. Meanwhile, one of the main barriers perceived by the producers in taking upstream measures to reduce environmental impacts from end-of-life/achieve higher resource efficiency is lack of demand from consumers (Tojo, 2004). Better communication regarding the importance of a product having less impact at end-of-life and the connection with higher source separation/reuse/recycling should be explored.

3 Policy instruments addressing hazardous substances/chemicals

Following the previous chapter, this chapter looks into instruments that aim to reduce the environmental impacts arising from hazardous substances and chemicals. These instruments include:

- Emission standards;
- Material restrictions;
- Environmentally sound treatment standards;
- Tax on hazardous substances; and
- Information provision.

As mentioned, some of the instruments discussed in the previous chapter – especially those dealing with the end-of-life environmental impacts as the immediate objective – are/have the possibility of addressing hazardous substances and chemicals as well. Consequently, discussion on these instruments is not repeated here.

The chapter follows the same structure as the previous: after the introduction of the general characteristics, the following aspects of the respective instrument are considered: 1) life cycle stages it addresses, 2) typology of the instrument, 3) stringency of environmental mandate/environmental effectiveness, 4) potential of instrument mix, and 5) influence on manufacturers, supply chain and market. The last part of the chapter summarises the discussions.

3.1 Emission standards

An emission standard, also known as an emission limit value, sets upper limits to the emission of substances harmful to human health and/or environment.

3.1.1 Life cycle stages

Emission standards can be introduced at different stages of the life cycle, and are most prominently used for production, use and end-of-life phases of products.

Emission standards concerning production and waste management facilities were traditionally set separately for different media such as air, water and soil. However, in order to avoid the situation where the targeted actor, in an effort to meet with the standards set forth for one media, shifts the emission from one media to another, governments started to use a more integrated approach for providing permits that set standards for emissions of substances to different media. The development of Directive (96/61/EC) on Integrated Pollution Prevention and Control (IPPC) in Europe, as codified in 2008/1/EC is an example of such an approach.[24] Waste management facilities are also subject to standards set forth in the Incineration Directive (2000/76/EC) and the Landfill Directive (1999/31/EC). Standards related to waste management facilities are discussed further in Section 3.3.

Emission standards are also used for the use phase of some products whose usage is accompanied by emission of harmful substances. An example is exhaust gas emissions from cars that have caused health hazards, as well as, environmental problems. The urgency of addressing the issue was highlighted since the late 1960s, and different countries set standards that have become more stringent over the years.

3.1.2 Type of instrument

An emission standard is an administrative instrument typically introduced via legislation (mandatory).

3.1.3 Stringency of environmental mandate

Regarding the stringency of the standards set for the manufacturing and waste management facilities, the IPPC Directive uses the so-called

[24] In 2007, the European Commission proposed a Directive on industrial emissions which once coming into force will join together seven existing directives related to emissions from industry facilities, including the IPPC Directive.

"best available techniques (BAT)" approach together with the subsidiarity principle. Namely, in the case of IPPC Directive (2008/1/EC), the standards applied as a condition for permit should become more stringent over time to reflect the level achieved by the technology most effective in addressing the environmental problem in question at the time of permit provision. In order to facilitate the use of standards that are indeed based on BAT, so-called BREF (BAT Reference) documents have been available for competent authorities in the Member States. The emission limit values included in the permits should be based on the best available techniques (Art. 9.4). Moreover, the Directive mandates additional measures to be included in the permit when needed for the achievement of the environmental quality standards set forth in other EC legislation (Art. 10).

Case studies on the implementation of the IPPC Directive in the pulp and paper, and dairy industry indicate that the BAT found in the BREF document may not necessarily reflect the state-of-the-art technology due to the lobbying of industry (Ganzleben, 2003; Honkasalo et al., 2005). Moreover, the Directive also leaves some room for adjusting the content of the permit to the local condition (Art. 9.4). The fact that the BAT that appears in a BREF actually may not be the "best" in town, as well as the possibility for competent authorities to adjust the content of the permit to the local conditions, may compromise the level of stringency.

The law introduced in Japan in the early 1970s incorporated the exhaust gas emission standard set forth in the U.S. Clean Air Act of 1970, which had the most stringent emission standards at that time. Despite the strong resistance of industry, the stringency of requirements and the continuous postponing and relaxation of the standards of the Clean Air Act in the USA itself, it kept most of its content in Japan. Documentation suggests that the technologies that enabled the manufacturers to meet the standard at that time was at the testing stage in a few relatively small car manufacturers in Japan. Another feature observed was the manner in which the producers involved in the decision-making process. The fact that the determination of standards for exhaust gas emissions involved interviews with individual producers by the government officials and experts, instead of consultation with the industry association, was one of the determining factors that enabled the setting of the standard at that level (Tojo, 2005).[25] A level of stringency similar to the Japanese legislation, as well as a similar development, is found in Europe. The standards set in the original Directive on the issue introduced in 1970 for light vehicles (70/220/EEC) and in 1988 for heavy vehicles (88/77/EC) have been revised several times, with the new standard coming in September 2009.

3.1.4 Potential for instrument mix

The emission standards for manufacturing and waste management facilities nowadays are typically used as part of the permit condition for operation. While a conventional permit for these facilities typically addresses environmental impacts arising within the walls of the facility, some countries started to incorporate environmental impacts arising from other life cycle phases as well, such as transportation to and from the facilities, type of materials used and the like (Dalhammar, 2007).

The emission standards for cars can be introduced as a stand-alone instrument. The standard set in a stand-alone instrument has been used as a basis for criterion for tax reduction, green public procurement and the like. For instance, the exhaust gas emission standard is used as a basis for the automobile tax reduction scheme for car owners in Japan together with the fuel efficiency standards. Regarding the exhaust gas emission, in order to be benefitted from the tax reduction scheme the reduction of the exhaust gas emission must be 50% or 75% more than what the standards prescribe.

[25] In the beginning, the discussion on the exhaust gas emission standards also involved industry associations. However, triggered by a public exposure of a memo produced by a representative of the industry association and criticism towards that, the manner of consultations towards industry changed (Hongou, 1978).

3.1.5 Influence on manufacturers, supply chain and market

Emission standards discussed above directly address the manufacturer's operations (production process and property of products). The level of influence in changing their behaviour depends on, among others, the stringency of the standards, the availability of/access to technologies that allow the manufacturers to conform to the standards, the level of priority for the government in addressing environmental performance of the industry in question and the like.

Regarding the emission standards applied for cars, it has been known as successful in driving technological advancement, both in terms of creation of new knowledge and their commercial application. For instance, the first emission standards for cars in Japan introduced in the 1970s enhanced the further development of technologies that only relatively small manufacturers possessed. The given legal requirements provide incentives for the front runners to achieve further, while they force the laggards to develop/purchase equivalent technologies. The development of technologies that achieve rather low emission standards by some Japanese car manufacturers gave them strong competitive advantage. The aforementioned tax reduction scheme that uses superior achievement in emission standards as a criterion was seen from the industry as a good way to diffuse the products.

3.2 Substance restriction

Certain substances should not be included in a product due to their harmful effects when exposed to humans and/or nature. In Europe, policies that restrict the use of these substances are applied to products such as EEE, batteries and accumulators, cars and toys. Targeted substances include heavy metals (cadmium, mercury, lead and hexavalent chromium) and chemical compounds such as brominated frame retardants and PVC (polyvinyl chloride). In addition, the so-called REACH Regulation (EC/1907/2006) governing the registration, evaluation and administration of chemicals in Europe restrict the manufacturing, placing on the market and/or use of specific substances, their mixture and their use in products. The REACH Regulation also requires authorisation of the use and the placing on the market of substances of very high concern (categorised in Article 57), and require manufacturers, importers and downstream users to indicate among others alternatives when applying for authorisation (Article 62).

3.2.1 Life cycle stages

The environmental/health impacts from the restricted substances may arise from the use or end-of-life phase of a product's life. An example of policy measures addressing the use phase is the prohibition of the use of soft PVC in toys that are intended to be placed in children's mouth, if they contain one or more of six specified phthalates (1999/815/EC, 2005/84/EC). Examples of measures addressing the end-of-life phase include the EC Directives restricting the use of heavy metals and some chemical compounds in cars (2000/53/EC), electrical and electronic equipment (2002/95/EC) and batteries and accumulators (91/157/EEC, as repealed by 2006/66/EC). Similar legislation for batteries was introduced in Switzerland. The environmental and health impacts of substances whose manufacturing, placing on the market and/or use are restricted under the EC REACH Regulation arise from both use and the end-of-life phases of the substances themselves and products containing these substances.

Meanwhile, in both cases, measures should be taken upstream, in the design/manufacturing phase.

3.2.2 Type of instrument

The restriction of the use of certain materials is an administrative instrument, typically introduced by law (mandatory).

3.2.3 Stringency of environmental mandate

The outright ban of the use of certain substances is stringent in that products that do not meet the requirement can no longer be placed in the market. Meanwhile, its effectiveness in reducing impacts from society depends on, among others, the scope of the substances and product coverage, the timing upon which the ban comes into effect and the like.

The scope of the Directive (2002/95/EC) restricting the use of hazardous substances in EEE (known as RoHS Directive) has been reduced over time despite fierce opposition of the European Parliament.[26]

Concerning the timing, on one hand, policy-makers must take into account the time it takes to phase out a substance and identify/ develop an alternative which can be used in an economically feasible way. On the other hand, the asymmetrical information and capacity between the industry and the policy-maker may lead to the timeframe becoming unreasonably long or short. The impact of the legislation also depends on the enforcement capacity of the authority.

3.2.4 Potential for instrument mix

This instrument can be introduced on its own. However, when the substance addressed cause harm at the end-of-life of a product (instead of, for example, the use phase of a product), in most of the cases, it is accompanied by other instruments that facilitate source separation (discussed in Chapter 2) and requirements on environmentally sound treatment (Section 3.3). For instance, the European Directives on end-of-life vehicles (2000/53/EC) and batteries and accumulators (2006/66/EC) both contain producer take-back obligations and treatment standards of collected products. The RoHS Directive (2002/95/EC) was introduced together with the Directive (2002/96/EC) on waste EEE (WEEE Directive) which also include take-back obligations and treatment standards. This is due partly to the time lag – there are products that contain hazardous substances already in the market, and those products need to be treated separately when they come into the waste stream. It is also very difficult to eliminate the substance entirely from products, not least when exemptions are introduced. The timing of the introduction of these different instruments depends on the main issue the policy-makers needs to address, as well as political acceptability. The instrument can also be incorporated in the criteria of green public procurement.

[26] See, for instance, ENDS (2005, April 12) and ENDS (2006, January 10), as well as Commission Decisions 2005/747/EC and 2006/310/EC.

3.2.5 Influence on manufacturers, supply chain and market

Substance restrictions have proven to be very effective in source prevention. For instance, after a decade of restricting mercury under the EC Directive, substantial amounts of separately collected batteries started to be mercury-free (COM (2003) 723 final). This, together with the producer take-back obligation, motivated the battery producers to develop technical solutions to distinguish mercury-free batteries from mercury-containing batteries (Broers, 2003, personal interview). Those who made efforts in phasing out the mercury-containing batteries wish to obtain economic reward by not having to share the cost for recycling of such batteries. The action of the producers is an evidence of the improvement of the quality of discarded products.

The proposed ban of the use of cadmium in batteries in the EU[27] has helped stimulate industry to develop rechargeable battery chemistries that eliminate cadmium. These substitutes, such as nickel-metal hydride and lithium-ion batteries, are being widely employed in electronic products. The effect was supported by the general awareness of the toxicity of cadmium.

Regarding EEE, rigorous efforts have been made to eliminate substances addressed in the RoHS Directive. The most prominent example includes development of the lead-free solders used in EEE in the anticipation of the coming into force of the RoHS Directive. The influence was not limited to the manufacturers in Europe, but also those in other countries such as Japan.

[27] Inclusion of a cadmium ban in the revised Directive on batteries (2006/66/EC) went through a long debate. A draft proposal of the Directive included the introduction of a cadmium ban for secondary batteries, but it was excluded in the final proposal presented by the Commission (COM (2003) 723, final) due to the fierce opposition of the industry (see, for instance, ENDS (2000, December 1) and ENDS (2004, April 6)). As an alternative, the introduction of a mandatory deposit-refund system for nickel-cadmium batteries was also discussed (ENDS, 2001, July 2), but in the end it was not included in the proposal. However, with a strong push from the European Parliament (see, for instance, ENDS (2004, April 20)), the cadmium ban was in the end included, with the exemptions given to portable batteries and accumulators intended for use in emergency and alarm systems, medical equipment or cordless power tools.

A study from 2001 shows that although various factors influence the upstream changes, the effects of the RoHS Directive were unanimously agreed by both Swedish and Japanese EEE manufacturers (Tojo, 2004). The Directive also had impacts on the strategies of suppliers of components.

3.3 Environmentally sound treatment standards

Despite various efforts on waste prevention, reuse and recycling, parts of the products come into the waste stream. In addition to the standards set for various waste recovery and disposal operations, which in the case of the EU are set in the Incineration Directive (2000/76/EC), the Landfill Directive (1999/31/EC) and the IPPC Directive (96/61/EC), there are standards for the intermediary and final treatment of waste that may contain toxic substances.

These standards are found in the directives governing waste streams from specific product categories. For instance, the WEEE Directive (2002/96/EC) stipulates that the treatment should use "best available treatment, recovery and recycling techniques", and that it shall "as a minimum, include the removal of all fluids and selective treatment" stipulated in Annex II of the Directive (Art. 6). Similarly, Article 6 of the Directive on end-of-life vehicles (2000/53/EC) together with Annex I set up minimum standards to be followed by the treatment facilities.

3.3.1 Life cycle stages

The standard primarily addresses environmental impacts arising from end-of-life phase of products.

3.3.2 Type of instrument

It is an administrative instrument typically mandated by government legislation. However, in some cases it can be introduced by industry. For instance, in the case of WEEE management in Switzerland, the producer responsibility organisations (PRO) – organisations that carry out the mandates given to producers in relation to the end-of-life management of their products – set forth environmentally sound treatment standards that are more stringent than the national standards. The recyclers who wish to have contracts with the PROs must comply with the standards. The operations of the facilities are subject to inspections by an independent third party (Tojo, 2004).

3.3.3 Stringency of environmental mandate

The existing standards per se, though they may vary, are in general stringent enough to safeguard environment and health. What may be often lacking is the enforcement of the standards. The government entities in charge of the permit provision and inspection may lack human capacity in effectively enforcing the standards.

In this regard, the involvement of industry associations may be of use in ensuring the appropriate operation. As mentioned above, in some cases (e.g. WEEE in Switzerland) industry associations set up standards higher than the government and enforce them by third party inspections. The car manufacturer association in Sweden checked the quality of the operation of the car dismantlers and provided with their members – that is, manufacturers and importers, who being the nominated producers are responsible for end-of-life management of their products – information as to which dismantlers comply with environmental standards (Kim, 2002). In the Netherlands, inspection of the WEEE management is also left in the hands of private actors. In this case, however, the inspection mechanism has not been perceived to be sufficient. A recycler expressed concerns that their competitors may simply put the WEEE in the cargo and ship them abroad without being checked (Tojo, 2004).

3.3.4 Potential for instrument mix

Environmentally sound treatment standards have been typically integrated into an EPR programme (Section 5.3) or waste-related policy packages.

3.3.5 Influence on manufacturers, supply chain and market

An environmentally sound treatment standard has raised reaction of producers in cases where the standard is incorporated in an EPR programme in which producers have obligation to take care of the end-of-life management of their products. While it often takes the form of removing certain duties from the producers – such as the producers of liquid crystal display (LCD) screens lobbying against the mandate to remove it prior to further treatment – it indicates the producers' concern on the difference in cost associated with end-of-life management.

The treatment standards may have some impacts on the component and material suppliers. However, in practice this may not happen to a large degree, especially when components are manufactured outside of the national border.

The authors have not come across any studies indicating the connection between compliance with environmentally sound treatment standards and the sales of products.

3.4 Tax on hazardous substances

The use of tax as a means of reducing environmental impacts of hazardous substances, though limited in its actual application, has drawn growing attention by policy-makers and analysers (Söderholm and Christiernsson, 2008). An example in the product policy area is the taxation on nickel-cadmium batteries in Sweden. It has also been used for the reduction of environmental impacts from fertilisers in some European countries (Söderholm and Christiernsson, 2008).

3.4.1 Life cycle stages

The instrument is introduced upstream (design/production phase of a product's life cycle), as well as in the use phase, although the occurrence of environmental impacts that the instrument intends to prevent occur downstream. For instance, the main environmental impacts related to cadmium in batteries occur at the disposal stage, and the impacts addressed in the taxation on fertilisers are discharges of chemical compounds into water.

3.4.2 Type of instrument

It is a mandatory, economic instrument.

3.4.3 Stringency of environmental mandate

Tax on substances aims to reduce the impacts from the substances by providing negative incentives to the users – in this case the continuation of the use of hazardous substances requires additional payment. The effectiveness of the instrument thus depends on how much incentives the instrument provides to the users. A decisive factor that influences the level of incentive is the size of the tax. Ideally, the level of the tax should be set at a level where use of alternative materials/development of alternative solutions is less costly for the polluter than the continued use of the substance.

Introduction of a material tax on nickel-cadmium batteries in Sweden, which was set at 300 SEK (ca 33 EUR) per kilogram of batteries (e.g. 15 SEK for a battery weighing 50 g) is an example where tax on hazardous substances proved useful. It led to the reduction of the sales of nickel-cadmium batteries from 328 tonnes in 1997 to 190 tonnes in 1998 (Langrova, 2002).

The taxation on fertilisers in some European countries has shown varying outcomes and experiences, as found in Söderholm and Christiernsson (2008). Some positive examples are: the reduction of phosphate fertiliser consumption in Sweden by more than half in 1991 compared to the time the tax was introduced in 1983 and the reduction of the consumption of fertiliser by 3% annually during the period the taxation was used in Austria. The level of tax was 30-35% of the sales price at its peak (1991) in Sweden. In both cases, the consumption continued to be reduced in the countries, which can be partly attributable to introduction of the cadmium tax in Sweden, while perhaps it is more due to the raised level of awareness through the introduction of the tax in Austria. In the Netherlands, the tax was targeted to the nitrogen and phosphate surpluses instead of consumption of the fertilisers per se. The measure was introduced together with a quantitative regulation that gradually reduced the allowed surplus levels while increasing the tax rate, and managed to reduce with 26% in 2001 compared to the level in 1996. However, this combined measure was abolished as its outcome failed to meet the standard set forth by the EC Nitrogen Directive, and the very high administrative cost.

In Denmark, with a number of exemptions given due to the strong power of the farmers, taxation was limited in effect only to households. Some of the measures are earmarked.

Recognising the difficulties of obtaining political acceptability for introducing a tax on hazardous substances, the aforementioned study on the taxation on fertilisers points to a number of policy lessons. Among them are the importance of setting the tax level as proportionate to damage made as possible and the effect of earmarking the tax revenue. Regarding the first, the Dutch system was a step forward, although most governments tend to focus on consumption upstream. Explanations for this could be high monitoring and administrative costs "even though the total costs to society" may be lower when the tax base is closer to damage, and the possibility to obtain "broad upstream environmental tax bases". Regarding the second, the study indicates the importance of how the collected taxes are used to gain political acceptance "…the main impact of the fertiliser taxes have not always rested on the incentives provided by the taxes, but rather on the use of the tax revenues." (Söderholm and Christiernsson, 2008).

The tax system is arguably more cost-effective than its counterpart administrative instruments (material restriction) and would provide flexibility for the addressees as how to comply. However, its implementation is accompanied by uncertainty in the level of achievement. For hazardous substances that require urgent reduction/elimination, administrative instrument may be more effective in achieving the goals (Söderholm and Christiernsson, 2008).

3.4.4 Potential for instrument mix

When environmental impacts addressed by the tax occur downstream, the instrument can be introduced within a waste policy package or an EPR programme.

Söderholm and Christiernsson (2008) argue that the existence of quantitative targets mandated by higher-level legislation (e.g. EC law) may effectively deter the introduction of a tax on the same issue. A tax system, with its given flexibility, may not be able to achieve the targets set as quickly as administrative instruments.

The effectiveness of the instrument can be greatly enhanced by accompanying informative instruments, especially when the addressee may not be aware of the introduction of the new tax.

3.4.5 Influence on manufacturers, supply chain and market

As found in the case on cadmium in batteries, mentioned in Section 3.4.3, the taxation on hazardous substances included in a product can drive manufacturers to find alternative sources. This certainly affects the amount of products with alternative products put on the market. When the tax is put on consumption (thus users must pay for it directly), its effect depends on the price elasticity of the demand, the awareness level of the addressee, availability of alternatives and the like.

3.5 Information provision

As a way of controlling the use and flow of hazardous substances, the manufacturers and users of hazardous substances are often required to provide information that indicates the location and/or quantities of these substances. The EC REACH Regulation (EC/1907/2006), given the potential adverse effects on health and the environment of chemicals in the market, goes further and mandates manufacturers and importers of all chemicals of which more than 1 tonne per year are placed on the EU market to register and provide information on their *properties*. The registration and information requirement is extended to substances in products, as discussed further below.

3.5.1 Life cycle stages

The instrument addresses potential effects of hazardous substances to humans and the environment at various phases of a product's life including production, use and end-of-life. Regarding the production phase, one of the earlier developments is the Toxics Release Inventory (TRI) introduced in the USA within the Emergency Planning and Community Right-To-Know Act (EPCRA) in 1990. Under the EPCRA, facilities manufacturing, using and storing hazardous chemicals beyond the threshold level determined in accordance with the provisions in the EPCRA must report the presence of these substances, as well as their release and transfer to various facilities and to the environment, to the designated state authorities (§11002). In addition, in accordance with the §13106 of the 1990 Pollution Prevention Act, manufacturers should also report their waste management and source reduction activities within their TRI. The information compiled by the industry is made available to the public. The idea is to empower citizens with the information and to hold companies and authorities accountable for the management of the hazardous substances (USEPA, 2008). The same concept is transferred to other parts of the world such as the rest of North America, Europe, Japan and Australia, under the name of PRTR: Pollutant Release and Transfer Register. In Europe PRTR is supplemented by the EC REACH Regulation (EC/1907/2006) based on which the suppliers of a substance must provide, free of charge, the recipients/downstream users with a safety data sheet based on their hazardousness and concentration level and other information related to use and exposure (Article 31, 37). The classification and labelling inventory required under the Regulation (Title XI) will also help the communication.

Concerning the hazardous substances within the products (thus addressing use and end-of-life phase), the EC REACH Regulation requires manufacturers and importers of products to provide information on chemicals in products when the chemical in products put on the market per year totals 1 tonne or more. Its application is limited to one of the following conditions: 1) The "substance is intended to be released under normal or reasonably foreseeable conditions of use"; or 2) the concentration level of the substance in a product is above 0.1% by weight and that producers of these products cannot "exclude exposure to humans and the environment during normal or reasonably foreseeable conditions of use including disposal" (Article 7 Paragraph 1-3). Information provision requirements can be also found for products that generate hazardous substances during their use (e.g. exhaust gas emission from cars).

Concerning the end-of-life phase, similarly to the information provision related to resource efficiency, various information measures are taken to communicate the necessity of source separation of discarded products that contain hazardous substances to consumers (see Section 2.9). For actors further down the product chain, the EC WEEE Directive (2002/96/EC) requires the manufacturers and importers to provide reuse, treatment and recycling facilities with information on, among others, the location of hazardous substances (Article 11). Similar requirements for information provision to treatment facilities are found in Article 8 of the EC Directive on end-of-life vehicles (2000/53/EC). In addition, producers of WEEE must register themselves as well as the number of products put on the market in the respective countries in Europe and label their products accordingly (Article 10). The marking requirement for presence of the specific chemical substance for electrical and electronic equipment in Japan[28] requires information provision on the containment of the same six substances covered under the EC RoHS Directive (2002/95/EC, see Section 3.2). Producers must provide information regarding whether the substances contained in the products exceed the standards set forth for the respective substances or not.

3.5.2 Type of instrument

It is an informative instrument, and is often mandated by law. However, in some cases producers provide information on a voluntary basis, especially if it is positive (e.g. mercury-free batteries, aerosol free of ozone-depleting substances). Information related to the use of hazardous substances can be also part of eco-labels (see Section 5), the application of which is voluntary.

3.5.3 Stringency of environmental mandate

Informative instruments are in general less stringent compared to administrative and economic instruments in that provision of information does not necessitate the reduction/elimination of specific substances nor

[28] The basic framework for requirement is set under the Revised Law for Promotion of Effective Utilisation of Resources, while the details are found in the standard series C0950 of Japanese Industrial Standards Committee.

influence direct costs. However, as discussed further in Section 3.5.5 provision of information may provide strong motivations for producers to reduce/eliminate hazardous substances.

Regarding coerciveness of the instrument, a study conducted on a Danish island regarding battery collection indicates that information alone is not sufficient to achieve high collection rate (Lindhqvist, 2000). While the reduction of toxics releases of the firms obliged to provide information on TRI is significant (approximately 40% according to the US EPA between 1988 and 1999, as cited by Bui and Mayer, 2003), different opinions exist regarding the contribution of TRI in inducing the reduction (e.g. Konar and Cohen (1997) and Bui and Mayer (2003)). While some studies suggest strong co-relation between the TRI pollutant releases and residential housing values (Konar and Cohen, 1997; Decker et al, 2005), others find rather an insignificant link between the two (Bui and Mayer, 2003).

3.5.4 Potential for instrument mix

Similarly to their counterpart addressing resource efficiency, instruments on information provision regarding hazardous substances have often been used together with or supplemented by other policy instruments. Information provision requirement is the basic requirements under the EC REACH Regulation (EC/1907/2006), supplemented by the evaluation and the authorisation of the use and putting on the market of substances of very high concern and the restriction of the manufacture, use, putting on the market (Section 3.2). Information requirements are essential supplementary instruments for other instruments addressing the impacts from end-of-life phase.

The content of the Toxics Release Inventory (TRI) in the United States has been gradually expanded by adding substances to be controlled under the TRI Programme, as well as supplemented by other legislation such as the Pollution Prevention Act. Information requirement regarding toxics releases can be combined with administrative instruments such as emission standards (Section 3.1), as well as companies' voluntary activities, such as introduction of environmental management systems.

3.5.5 Influence on manufacturers, supply chain and market

The impact of the EC REACH Regulation (EC/1907/2006) on one of the suppliers in the product chain – chemical producers – has been reported to be very strong. The producers of the final products have also been quite keen to see how the legislation might affect their activities.

The registration and labelling requirements given to the producers in the WEEE Directive created significant administrative burden and chaos both for producers as well as for the national authorities (van Rossem, 2008). The difficulties come from the free movement of products both before they are first sold to the consumers and after they leave the hands of the first owner as (potentially) second-hand products. The registration is linked to the distribution of end-of-life management cost of products currently disposed of (historical products): producers pay the fee into the system(s) where they register in accordance with the amount of products they put on the market. It would be ideal if there are mechanisms that the fees are somehow linked to where the products finally end their life. A solution suggested is to have a so-called European producer registration, instead of national producer registration (van Rossem, 2008).

Depending on factors such as the type of information required, the value a company puts on societal reputation and the effectiveness of communication within the company, information provision requirement can be a strong driver in changing the behaviour of the industry. For instance, when a producer must inform whether their products contain hazardous substances beyond the standard and finds it quite shameful to have to disclose this information to the public, the instrument may greatly motivate the producer to find alternative solutions. Regarding TRI, some studies indicate a strong co-relation between the disclosure of the information and the price in the stock market, and subsequent actions by the companies to reduce emission (Konar and Cohen, 1997; Ragothaman and Carr, 2008).

3.6 Summary

Table 3-1 provides a summary of the review of selected policy instruments addressing hazardous substances and chemical found in this chapter.

Compared to policy instruments addressing resource efficiency, the variety of life cycle stages covered by those addressing hazardous substances and chemicals is wider. The fact that the negative effects of hazardous substances and chemicals to health and the environment are more tangible than effects of inefficient use of resources may facilitate policy actions. It is reflected in the fact that the first-generation environmental policy measures in many of the developed countries are the control and reduction of toxic substances.

Table 3-1. Summary of the characteristics of selected policy instruments addressing hazardous substances and chemicals

Instruments	Life cycle stage addressed	Environmental impacts addressed	Instrument mix	Effects on design change	Effects on suppliers	Effects on market diffusion
Emission standards	Production, use, EoL	HS, could be extended to energy and resource efficiency	Production, EoL: part of permit, Use: criterion for GPP, subsidies	Production & use: direct and strong	Important to set standards relevant for respective tiers of suppliers	Use: enforcement of the standards should mean market diffusion, fiscal measures may promote
Substance restriction	Use, EoL	HS	EoL: EPR, criterion for labelling scheme/GPP Important to introduce with information	Direct and strong	Yes, when components contain the substances	Gradual increase in the products available in the market
Environmentally sound treatment standards	EoL	HS	Part of waste policy /EPR	Reaction from producers with take-back obligation	Indirect	n.a.
Tax on hazardous substances	Use, EoL	HS	EoL: EPR	Direct when tax must be paid initially by producers	n.a.	Use: depends on the price elasticity, awareness level, availability of alternatives EoL: Sale of products with hazardous substances reduced
Information provision	Production, use, EoL	HS	Production: emission standards, EMS; Use: authorisation; EoL: waste policy/EPR	Create administrative cost	REACH: very strong	Information disclosure under TRI effect the stock prices

EoL: end-of-life, HS: hazardous substances, EPR: extended producer responsibility, GPP: green public procurement, n.a.: information not available, TRI: Toxics Release Inventory

Many instruments that primarily address end-of-life environmental impacts are often part of EPR or waste policy packages. They are often introduced together with instruments discussed in Chapter 2 addressing end-of-life environmental impacts. Concerning the impacts arising from use phase, the compliance to the emission standards can be a criterion for green public procurement, subsidy schemes and the like. Instruments that address the emission of hazardous substances and chemicals during the production phase often constitute parts of the environmental permit for manufacturing facilities. In addition to the use and flow of hazardous substances, the permits could cover other environmental impacts such as efficient use of energy and resources. Such practice started to appear in, for example, Sweden (Dalhammar, 2007). The enforcement of the control of the use and flow of hazardous substances at site can be enhanced by information provision requirement.

In general, policy measures related to hazardous substances and chemicals have strong effects on producers. Unlike resource efficiency, measures related to hazardous substances often touch directly upon the properties of the products, or their production process. Especially when they are mandatory, administrative instruments, products cannot be sold without following the mandate. The fact that failure to comply (e.g. discharge of hazardous substances from manufacturing facilities/products to the surrounding environment) may have visible environmental and health effects may also serve as a driver for producers to work on this issue.

When suppliers provide components or materials that are subject to restriction/control by a policy measure, the effect of such a measure has been evident. This has been seen in, among others, the EC RoHS Directive and REACH Regulation. Regarding emissions from a supplier's manufacturing facility, one of the FLIPP studies highlighted the importance of setting tailored measures for respective tier of suppliers (Kogg, 2009). Setting standards related to the production process may conflict with existing trade regimes. However, it could be introduced as part of a voluntary labelling scheme.

The effects of instruments on the diffusion of products vary. The effects of mandatory instruments (e.g. emission standards, substance restriction) addressing the property of the products are clear: when the law is enforced properly, only products that comply with the legislation should remain in the market. Whether products that are taken care of in accordance with treatment standards at their end-of-life would be favoured by consumers is not well known, similarly to the knowledge of many of the instruments addressing resource efficiency. Concerning tax on hazardous substances in products, there are some positive experiences in reduction of the use of these products. Meanwhile, the level of reduction depends on factors such as the level of the tax, availability of alternatives and the like. Finally, positive examples have been found concerning the effect of information measures in inducing the emission reduction by the companies. However, conflicting results are found regarding whether the information indeed influences the decisions of owners of real estates close to manufacturing sites.

4 Policy instruments addressing energy use/climate change

In the last chapter concerning the individual policy instruments, the following four instruments addressing energy use/climate change are discussed.

- Efficiency standards;
- Energy efficiency labels;
- Carbon labels; and
- Energy taxes.

Similarly to the previous two chapters, the following aspects of the respective instrument are considered: 1) life cycle stages it addresses, 2) typology of the instrument, 3) stringency of environmental mandate/environmental effectiveness, 4) potential of instrument mix, and 5) influence on manufacturers, supply chain and market. The last part of the chapter summarises the discussions.

4.1 Energy efficiency standards

Energy efficiency standards set the level of energy efficiency performance that needs to be met with the view to decrease the use of energy arising from the use phase of "energy intensive" products. According to the Collaborative Labeling and Appliance Standards Program, as of September 2004, as many as 47 types of electrical and electronic equipment and lighting sources in total of 70 countries have either mandatory or voluntary energy efficiency standards (CLASP, 2009). In addition, energy efficiency standards have been used for products such as automobiles and gas/oil-fired water boilers.

4.1.1 Life cycle stages

To date the standards have been set to improve the energy efficiency related to the use phase of products.

4.1.2 Type of instrument

It is an administrative instrument mandated in many countries (e.g. EEE mentioned above, automobiles in Japan and the USA). In some cases, it has taken the form of voluntary agreements between the industry and the government (e.g. automobiles in the EU).

4.1.3 Stringency of environmental mandate

The stringency of environmental mandates depends on, among others, the level of the standards, the manner in which the standards are considered achieved, and the timeframe given to the addressees to meet the standards.

Regarding the level of standards, an approach taken by the so-called Top Runner Programme in Japan has been highlighted in the policy discussion in Europe. Introduced in 1999 as part of the revised Law concerning the Rational Use of Energy, it has increased its scope gradually and as of January 2009 covers 21 product groups. As indicated by the name, among the targeted products available in the market the year before the standard is discussed the use-phase energy efficiency of the product that achieves the highest performance (top runner) becomes the basis of the standards. The approach in principle moved away from the prevailing minimum standards that typically only cut the laggards that constitute a small part of product groups. Meanwhile, the standards should also take into account the potential for technological innovation and diffusion. This in practice means that the "top runner" product may not become a standard-setter when, for instance, the achievement of the same efficiency would require the application of unique technology used in the product. In addition, standards are often differentiated within the product group depending on various parameters such as the size (e.g. refrigerators and TV screens), the weight (e.g. cars), the functions (e.g. inclusion of video tape recorders in TVs) and the like. This on one hand helps secure the availability of a variety of products (e.g. refrigerators in different sizes, air conditioners tailored for rooms of different sizes, TVs with screen of different size and shape, and private cars in different size and weight). On the other hand, the necessity of having some of these products (e.g. wide-screen TV, and large and heavy vehicles) can be questioned in light of the pressing need of taking actions for energy efficiency (Tojo, 2005).

In most cases, all the products for which the standards are set must meet the standards. However, in some cases, the standards are to be met by manufacturers on a so-called fleet average/weighted average basis. Examples of the latter include the Corporate Average Fuel Economy (CAFE) Programme for passenger vehicles and light trucks in the USA (NHTSA, n.d.), as well as the aforementioned Top Runner Programme in Japan. The CAFE Programme in the USA was criticised for de facto favouring of manufacturers that produce lighter vehicles. The differentiated standards the Top Runner Programme provide remedies to this concern. Meanwhile, as discussed above, considering the urgency of the problems, the justification of the continued use of (at least a large number of) large and heavy vehicles, especially when they are not increasing the number of passengers/luggage that can be carried, can be questioned. Despite that the requirements are supposed to be met on fleet-average basis, most producers in Japan managed to have all their products meet the standard within the given timeframe.

Voluntary agreement programmes for passenger cars in Europe went even further in terms of "collective target meeting" and mandate the achievement of standards by the fleet average of industry associations representing European, Korean and Japanese car manufacturers respectively (1999/125/EC; 2000/303/EC; 2000/304/EC). Similarly to the discussion on the collective vs. individual responsibility under the EPR programmes (see Section 2.5), incentives for individual manufacturers to improve fuel efficiency would be reduced under this approach. Due to limited progress of the voluntary agreement, as well as accompanying information and fiscal measures, a new regulation that mandate the reduction was proposed in 2007 (COM(2007)856). This new regulation provides manufacturers with possibilities to achieve the target both jointly and individually. However, due to the economic crisis the deadline of the target will be delayed (ENDS, 2008, December 2).

Regarding the timeframe, differentiated time of 5-13 years was given for manufacturers to meet the standard in the case of the Top Runner Programme. While compliance with the standards on individual product basis (not fleet average basis) was achieved only at the deadline year for some product groups such as refrigerators and air conditioners, other products, such as computers and gasoline cars, met the standards some years earlier than the deadline. In these cases, new standards were discussed and determined even before the first deadline was passed. Upgrading of the rest of the products takes place as the deadline comes. Meanwhile, energy efficiency standards in Europe set forth in directives for selected products – water boilers (92/42/EEC), refrigerators and freezers (96/57/EC) and ballasts for fluorescent lighting (2000/55/EC) have not changed since their introduction. This casts doubt to the practical feasibility of upgrading the standards that will be set forth in the so-called EuP Directive (see Section 5.1).

4.1.4 Potential for instrument mix

Energy efficiency standards have been used as a criterion for various other instruments such as green public procurement, eco-labels and tax reduction schemes. Moreover, the standards often come in hand with energy labels (see Section 4.2).

4.1.5 Influence on manufacturers, supply chain and market

The level of influence on manufacturers of final products depends on the level of stringency discussed above. The Top Runner Programme in Japan accelerated the application of technologies that improve energy efficiency that would have been left on the shelf (Tojo, 2005).[29] In some cases, it is the changes of the components supplied by upstream actors (e.g. software in computers) that have substantial influence on the energy performance of the products. How much influence the standards on the final product exerted on these upstream suppliers is unknown.

[29] The overall energy efficiency improvement for the products whose target year has ranges from 21.7 % (light trucks with diesel engine) to 99.1% (computers) (ECCJ, 2008).

A concern raised by manufacturers in Japan in regard to diffusion of the products in the market is a slow uptake of consumers despite the more visible economic gains that the consumers could enjoy due to the reduced electricity cost compared to other environmental parameters (Tojo, 2005). On the other hand, the vast majority of the products manage to meet the standards by the target year – which then would mean that the products available in the market are at least as good as the standards – the Programme does contribute to the diffusion of the energy efficient products in the long run. For limited products such as cars, buyers of the products whose efficiency level reached beyond the standards by a significant percentage, combined with high achievement of emission standards, can enjoy tax reduction. The support of this fiscal measure is perceived to accelerate the diffusion of energy-efficient products in the market (Tojo, 2005).

4.2 Energy efficiency labels

First introduced in Canada in 1978 (OECD/IEA 2000), energy efficiency labels have been widely used in many countries. As of September 2004, 75 countries introduced them for over 60 types of home appliances (CLASP 2009). The idea of the energy efficiency label is to inform consumers of the level of energy efficiency of products, thereby helping them making informed choices. Some of the labels, such as the Energy Star Programme developed in the USA, indicate that a product with the label conforms to the standard set by the labelling scheme. Others, such as the EU energy labelling scheme for selected home appliances based on Council Directive 92/75/EEC indicates the efficiency level by ranking (A to G, and in the case of refrigerator, A+, A++ and A+++ have been added). The revision of the Directive to widen the scope has been proposed under COM(2008)778 final.[30] Selected EEE covered under the Top Runner Programme in Japan indicates the efficiency level in comparison to the Top Runner standards by percentage, as well as by colour of the label (green suggests compliance while orange suggests non-compliance). The latter two examples are also accompanied by information such as average energy consumption, life time, annual energy consumption and the like.

4.2.1 Life cycle stages

Energy efficiency labels concern the energy efficiency of the use phase of selected products.

4.2.2 Type of instrument

Energy efficiency labels are informative instruments. In some cases, such as those in the EU energy labelling scheme, manufacturers of the products covered by the programme must put the label in accordance with the legislation. Participation of manufacturers to other schemes, such as the Energy Star Programme developed in the USA, is voluntary. Labelling of the products under the Top Runner Programme is also voluntary, however, some regional governments in Japan mandate provision of information based on the Top Runner standards.

4.2.3 Stringency of environmental mandate

The average energy saving of using Energy Star awarded products compared to standard products is reported to be from 5-10% (e.g. boilers, air conditioners and printers) to 70-90% (e.g. lighting equipment and TVs/DVDs/VCRs) (USEPA, 2008). The labelling schemes under the Top Runner Programme in Japan, as well as the one in the EU based on Directive 92/75/EEC, are relative: it indicates the level compared to the standard/energy efficiency index. The levels of the standards under the Energy Star and the Top Runner Programme have been heightened based on the improvement of energy efficiency of the overall product group. In the EU, revision of the labels for refrigerators and freezers with the intention to reflect the energy efficiency improvement over the years has been under discussion during recent years and led to a new standard in end of 2009 (ENDS, 2009, November 17).

[30] In the case of the EU, products currently covered include refrigerators, freezers and their combinations; washing machines, dryers and their combinations; dishwashers; ovens; lamps and air-conditioners.

4.2.4 Potential for instrument mix

In cases where energy efficiency standards exist, energy efficiency labels have been used as a complementary tool to inform consumers. Moreover, the standards set in energy labelling programmes have been used as a criterion for Type I eco-labels as well as green public procurement (see Chapter 1).

4.2.5 Influence on manufacturers, supply chain and market

Interviews with manufacturers regarding the Top Runner Programme indicated the importance of voluntary as well as mandatory energy efficiency labels in working on the improvement of a product's use-phase energy efficiency (Tojo, 2005). Between 2000 and 2007, the manufacturers' participation in the US Energy Star Programme increased by more than 25%, and product models awarded by the label increased from 11 000 to more than 40 000 (USEPA, 2008).

Regarding the influence on the market, the US Energy Star Programme reports enhanced public awareness of the label and increase in the sales of labelled products. People who are aware of the label in the USA increased from 40% in 2000 to more than 70% in 2007. The sales of the labelled products increased from 600 million to more than 2.5 billion during the same period (USEPA, 2008). This is remarkable even when taking into account the simultaneous increase of the purchase of electronic products and of the availability of labelled products.

The suggested changes in the energy label in the EU brought forward the issue of the ease for consumers to understand the label. While the European Commission, industry association and some Member States suggest to include A1, A2 and A3 labels for new, more energy efficient products in addition to the existing scale of A to G, other Member States consider this change would confuse consumers. Surveys to consumers confirm the latter (ENDS, 2009, February 16; ENDS, 2009, January 30).

4.3 Carbon labels

In addition to the energy efficiency labels that address climate change by improving the use-phase energy efficiency, a so-called carbon label has started to come out to provide information on the impacts of a product to climate change. While its introduction has been discussed in a number of places, as of today it is only in the initial stages of implementation in a few countries.

4.3.1 Life cycle stages

As it is implemented in the UK today, carbon labels aim to cover the greenhouse gas emission arising from products throughout their full life cycle (Carbon Trust, 2009c). This include, among other phases, transportations during the product's life.

4.3.2 Type of instrument

It is an informative instrument, and its existing experience has been limited to voluntary participation of the industry.

4.3.3 Stringency of environmental mandate

The information provided in the carbon labels as currently implemented by the UK Carbon Trust includes at minimum 1) the figure of a footprint, 2) life-cycle greenhouse gas emissions in absolute numbers (often translated into a unit measurement easily understood by consumers, such as per serving or per wash), 3) an endorsement by the Carbon Trust and 4) a commitment by producers to reduce greenhouse gas emissions. Regarding the fourth point, unless producers manage to reduce the greenhouse gas emission within two years, they are no longer allowed to use the label. Producers can also include information on the figures comparing the product's performance to others, as well as on how a consumer can contribute in reducing greenhouse gas emission while using the product (e.g. washing in lower temperature) (Carbon Trust, 2009b).

Unlike energy efficiency labels discussed in Section 4.2, carbon labels as currently implemented do not necessarily indicate whether the product with the label contributes less to greenhouse gas emission compared to other products with equivalent functions. This makes it difficult for general consumers to judge the legitimacy of choosing the product from climate protection point of view. Meanwhile, consumers could calculate greenhouse gas emission related to their life by adding up the figures available on different products and thus create a picture of the impact of their life style.

4.3.4 Potential for instrument mix

Stakeholder consultations in relation to expanding the existing EU energy labelling scheme (see Section 4.2) indicates that the overwhelming majority of stakeholders oppose the inclusion of CO_2 emission in the labelling scheme from life cycle perspective (European Commission, 2008). Its use as a criterion for green procurement standards can be considered.

4.3.5 Influence on manufacturers, supply chain and market

The stated objective of the carbon labels is "to help businesses to measure, certify, reduce and communicate the lifecycle greenhouse gas (GHG) emissions of their products" and "to help consumers make choices that would lower their own carbon footprints, and to educate them on how the way they use the products they buy can lower their carbon footprints." (Carbon Trust, 2009a).

Walkers, a case company that became the first to be certified by the Carbon Trust, announced that they managed to reduce 7% of their greenhouse gas emissions in the last two years and continued to retain their labels (Carbon Trust and PepsiCo, 2009). Case studies of some of the companies whose products carry a carbon label now indicate enhanced communication with their suppliers and concrete measures taken to reduce greenhouse gas emission in the supply chain (Carbon Trust, 2008a; Carbon Trust, 2008b).

The awareness of consumers of the label has been increased – 36% in the beginning of 2009 compared to 26% in July 2007 shortly after the first company started to use the label (Carbon Trust and PepsiCo, 2009). While some cases indicate favourable reactions from consumers (Carbon Trust, 2008b), other cases suggest changes of the consumer purchasing behaviour as an important next step for investigation (Carbon Trust, 2008c).

4.4 Energy and CO_2 taxes

A number of countries have been using fiscal measures to reduce energy consumption, enhance energy efficiency and reduce greenhouse gas emissions. For instance, a search of the Climate Change Database, found in the website of the International Energy Agency, lists 104 policy measures introduced in 30 countries with the key word "tax" under the policy type "financial". These measures vary in terms of the scope of the addressees: some are sector-specific, such as energy production, transport, buildings, appliances, while others are overarching (e.g. multi-sectoral, industry) (International Energy Agency 2009; Speck et al., 2007; Naturvårdsverket, 2007). The design of the instruments as well as the changes over time varies as well. While energy taxes, at least in their initial phase, tend to be introduced with the main consideration on fiscal issues, the emergence of CO_2 taxes is often based on environmental ground.

4.4.1 Life cycle stages

The diverse application of the instruments mentioned above indicates the diverse range of life cycle stages upon which the instrument can be used. When the instrument is applied for the transport sector, it touches upon virtually all stages of the life cycle. Energy and CO_2 taxes on fuels address the use phase. The application on industry primarily addresses the manufacturing process.

4.4.2 Type of instrument

It is a mandatory economic instrument.

4.4.3 Stringency of environmental mandate

A review of economic instruments in environmental policy found in Nordic and Baltic countries indicates that CO_2 taxes have been environmentally effective – in the period the instruments are introduced a reduction of CO_2 emission or a decoupling of the emissions from GDP growth was observed. Meanwhile, the study also mentions that the contribution of the tax to the reduction of CO_2 may be marginal: changes could be attributed to various other factors. In addition, the study points out that the taxes could have achieved better result had they been set at the optimal level (Speck et al., 2007).

A review of evaluations of economic instruments in the environmental field in Sweden, acknowledging the existence of a fairly thorough evaluation of energy and CO_2 taxes, suggest that the CO_2 tax "in its present form and under the present technological conditions" has "a good, albeit somewhat uncertain, level of goal achievement". It argues that since the calculation in the evaluation indicates that the general CO_2 tax in Sweden "has been raised to a level" upon which point the emission won't be affected, the instrument achieves its maximum potential. It also points to the fact that the gradual shift of the weight between energy tax and CO_2 tax – the former has been decreased and the latter has been raised – proves to be positive in reducing greenhouse gas emissions (Naturvårdsverket, 2007).

4.4.4 Potential for instrument mix

The instrument has often been introduced with other policy instruments addressing energy-climate issues. The aforementioned study on the evaluations of economic instruments in the environmental field in Sweden indicates the complementary effects of the CO_2 tax and the electricity certificate scheme, which aims to increase the electricity produced from renewable sources. The study indicates the conflicting relation between the taxes and emission trading scheme when they address the same sector.

4.4.5 Influence on manufacturers, supply chain and market

When the instrument addresses manufacturing industry, it would be effective in inducing producers to reduce energy use/CO_2 emissions, though the level of effectiveness depends on the level of tax. When energy/CO_2 taxes are put on transport, it would likely influence the supplier of transport – that is, manufacturers of trucks and cars.

Some taxes, such as vehicle taxes and fuel taxes, have differentiated levels of the tax that the consumers must pay based on the environmental property of the vehicle/fuel (Naturvårdsverket, 2007; Tojo, 2005). These measures tend to be effective in steering the purchasing decision of consumers.

4.5 Summary

Table 4-1 summarises the characteristics of policy instruments addressing energy efficiency and climate change discussed in this chapter.

The first two instruments, energy efficiency standards and energy efficiency labels both address the use-phase energy efficiency of products that require relatively large amounts of energy for their operation. The latter complements the former. They both have direct impacts on product design. The effects of the instruments on suppliers are not very well studied. Energy efficiency of products are determined by the cumulative effects of their components, and the influence that producers may exert may depend on the level of ambition of the producer, the efficiency of their communication channels, the power relation between the producers and suppliers, etc. Although lack of consumer uptake has been identified as a barrier to accelerate further efficiency improvements, as discussed earlier, a proper enforcement of the standard should help the penetration of energy-efficient products with time. Some of the energy efficiency labels, such as the Energy Star, enjoy good recognition by consumers and the sales of the products awarded by the labels have been increasing. Similarly to the waste reduction and miniaturisation, an idea is to bundle energy efficiency with other characteristics favourable for consumers, such as battery hours.

The experience with carbon labels is quite limited so far. However, it seems to open a interesting venue to address transports in the distribution chain, an issue which is hardly covered by other main labelling systems. Unlike mandatory administrative measures that may conflict with free trade rules, voluntary labels could address the production process and transports even when the production does not take place within the country's border.

Table 4-1. Summary of the characteristics of selected policy instruments addressing energy use/climate change

Instruments	Life cycle stage addressed	Environmental impacts addressed	Instrument mix	Effects on design change	Effects on suppliers	Effects on market diffusion
Energy efficiency standards	Use	Energy use	Criterion for GPP, eco-labels, subsidies, often supported by energy efficiency labels	Direct	Not clear, although in some cases actions of suppliers have increased the efficiency substantially.	Perceived low uptake of consumers, but gradual increase with good enforcement?, support by fiscal measures facilitate the diffusion
Energy efficiency labels	Use	Energy use	With efficiency standards	Direct	n.a.	Increase in the sales experienced
Carbon labels	Production, use, transport, EoL	GHG emission	Potentially as a criterion for GPP	Potentially	Direct	Indication of favourable reaction by consumers
Energy and CO_2 tax	Production, use, transport, EoL	GHG emission, energy use, energy efficiency	Complement electricity certificate scheme, Conflict with emission trading scheme	Yes, depends on the area of the application	Yes, depends on the area of the application	Yes, depends on the area of the application

Energy and CO_2 taxes differ from other instruments in that there are various examples and potential for the scope of their application in term of a product's life cycle. Although it would most likely not have effect on the suppliers of specific components, it may have great impacts on the suppliers of specific services. An existing example is tax related to transport and its effect on producers of vehicles such as cars and trucks.

5 Assessment of combined instruments

The discussion on individual policy instruments in the previous chapters indicates that there are some policy interventions that typically incorporate more than one instrument, and/or intend to address more than one environmental issue arising from more than one phase of a product's life. In this chapter, we select a handful of these interventions as listed below and highlight characteristics relevant to the purpose of this document.

- Directive 2005/32/EC establishing a framework for the setting of eco-design requirements for energy-using products (EuP Directive);
- Type I Eco-labels;
- Extended Producer Responsibility (EPR); and
- Green public procurement.

In order to avoid repetition and duplication, the characteristics discussed here are limited to 1) what instruments the respective interventions (potentially) include, 2) the life cycle stages and environmental issues addressed, and 3) stringency of the environmental mandate.

5.1 EuP Directive

Originally drafted by DG Enterprise in May 2000 as a design directive for EEE, the Directive 2005/32/EC expanded its scope and became a framework directive for setting eco-design requirements for energy-using products (EuP Directive). The implementation of the Directive for specific EuP is left under the implementing measures set forth in Article 15 of the Directive. Since its coming into force in 2005, the Commission launched the preparatory study for 19 EuP to be adopted by 2009, and the study for 5 more EuP was launched in 2007.

5.1.1 Policy instruments contained

The EuP Directive, through implementation measures specified in Article 15 and further elaborated in Annexes I and II, set eco-design requirements. Annex I lays down a method for setting generic eco-design requirement without numerical limit values. It requires the Commission to identify significant environmental aspects throughout the life cycle of the EuP in question. Manufacturers should in turn develop the ecological profile of the product and evaluate alternative design solutions. Manufacturers may also be required to provide information on aspects such as manufacturing process, significant environmental characteristics and means to minimise impacts during the use and/or end-of-life phases. The requirement could also take the form of limit values for specific environmental aspects, as laid down in Annex II. In sum, while the implementing measures would be different from one EuP to the other, one can see that it is a combination of information provision and emission standards.

5.1.2 Life cycle stages and environmental issues covered

The Directive is supposed to "consider the life cycle of the EuP and all its significant environmental aspects, *inter alia*, energy efficiency" (Article 15. 4 (b)). Life cycle as defined in the Directive is limited "from raw material use to final disposal" (Article 2. 13), excluding the raw material extraction. In light of legal and practical limitation of imposing legislation outside of the national borders, this exclusion can be considered reasonable (Dalhammar, 2007). Despite this limitation, the Directive essentially should be able to address environmental impacts from the life cycle perspective. The detailed list of eco-design parameters found in Annex I endorses this.

However, a closer look at the implementing measures that appeared so far indicates that the specific eco-design requirement focuses almost exclusively on the energy use arising from the use phase of the products. It is also found that the framework developed to be used to conduct the preparatory study, based on which the implementing measures are discussed, does not allow the inclusion of some of the significant environmental impacts, such as the energy use from the production phase.[31] Limitations were also found in the scenario based upon which the environmental impacts are assessed: the scenario for instance does not take into consideration the actual collection rate of obsolete appliances when assessing the environmental impacts from the end-of-life phase (van Rossem and Dalhammar, 2010).

Some of these shortcomings may arise from the fact that the Directive should take into account "relevant Community legislation and self-regulation…" (Article 15 3 (b)). The Directive also explicitly limits the eco-design parameters to be considered to those "related to product design" (Annex I, Part 1, 1.1). Thus some of the parameters related to production, for instance, may not be considered as part of the product design. However, this does not come hand in hand with the repeatedly said life cycle approach that the Directive is based upon. It is ironic that some industry representatives argued not to include design issues related to end-of-life within the context of EC WEEE Directive 2002/96/EC, saying that the issues would be addressed in the EuP Directive.

5.1.3 Stringency of environmental mandate

Views of the stakeholders have been quite negative concerning the additional effects that the EuP Directive would have in furthering eco-design (van Rossem and Dalhammar, 2010). For instance, the requirements suggested in the Draft Commission Regulation for external chargers is that power consumption during the no-load condition should not exceed 0.5 W (Commission of the European Community, 2008), while a consumption level of 0.01 W is commercially available (Remmen et al., 2008).

5.2 Type I Eco-labels

An eco-labelling scheme is a voluntary informative instrument that aims to improve the environmental performance of products and services by providing easy-to-understand information to consumers. There are different labels that communicate environmental information to consumers. Among them, although the details vary among the schemes, a so-called Type I eco-label according to the ISO standard has the following characteristics.

The scheme rewards products that meet environmental criteria set for selected product groups. The scheme is run by an independent organisation. The criteria are set based on life cycle thinking. In order for a producer to put the label on their products, they must first design products that conform to the criteria. They subsequently apply for the eco-labelling scheme, and, when demanded, include verification from an independent body that the characteristics of the products indeed meet the criteria. The application of the symbol typically requires payment of a license fee that finances the activities of the organisation that runs the scheme.

Starting from the Blue Angel Programme in Germany in 1977, in total of 26 countries and regions are the members of the Global Ecolabelling Network as of spring 2009 (Global Ecolabelling Network, 2009). The product groups covered by the existing eco-labelling schemes range from kitchen and toilet paper, products whose function is to help reduce environmental impacts (e.g. filters applied in the kitchen sink), to computers, transport service, restaurants and the like.

5.2.1 Policy instruments contained

Type I eco-labels set requirements for various environmental parameters relevant for the product in question. The standards set in the labels can be "borrowed" from those set in other policy instruments, as long as they are sufficiently ambitious to pull the environmental performance of the whole product group. For instance, it is suggested that the revised criteria for EU eco-label for computers should include the energy efficiency requirements found under the latest Energy Star Program set in 2009 (ENDS, August 26). A criterion set for personal computers in the eco-labelling scheme in Japan is conformity with standards restricting the use of six hazardous substances (Eco Mark Office, 2008).

[31] For instance, as much as 83% of the life cycle energy consumption of a computer arises from the manufacturing phase, as compared to 13% during the use phase (Williams 2004, cited in van Rossem and Dalhammar, 2010).

In addition, the requirements may reflect the content of existing policies even when they are not explicitly mentioned. For instance, eco-label criteria for refrigerators in the EU includes requirements such as free-of-charge take-back by producers at the end-of-life, use of more than 80% recycled material for paper package and the like (Commision Decision 2004/669/EC).

5.2.2 Life cycle stages and environmental issues covered

Various environmental impacts – such as resource efficiency, toxicity, energy use, noise – arisen from different stages of the life cycle of products – raw material extraction, production, use, end-of-life, and various transports – should be taken into account.

5.2.3 Stringency of environmental mandate

A distinctive feature of a Type I eco-label is that it is set for front runners. For instance, the energy efficiency standards for refrigerators mentioned above are set for those achieving the highest standards. Mercury-free displays in laptops required in the labelling scheme in the Nordic countries were beyond all other standards available at that time (Badkas, 2008). In order to continue to "pull" the front runners, the criteria set forth in Type I eco-labels should be updated over time.

5.3 Extended Producer Responsibility

Extended Producer Responsibility (EPR), a concept that aims to improve total life cycle environmental performance of product systems, can be regarded as a founding principle to guide a shift towards a society based on sustainable production and consumption.

EPR incorporates several distinctive features considered to be important for effective environmental policy-making. It prioritises *prevention* over end-of-pipe solutions. Instead of focusing on point sources, such as production sites, it seeks to reduce the overall environmental impacts of products and the systems surrounding them throughout their *life cycle*. Without prescribing what should be done in detail, EPR aims to prevent environmental problems at source via the provision of *incentives* for changes at the design phase of a product's life. Incentives are provided via delegation of *responsibility* to manufacturers.

Since the 1990s, the concept of EPR has been incorporated into the environmental policies of a growing number of governments, especially those of OECD countries, and its application is increasingly considered in non-OECD countries.

5.3.1 Policy instruments contained

The EPR principle can be implemented through administrative instruments, economic instruments and informative instruments (Lindhqvist, 1992). As discussed in previous chapters, there are a number of EPR-based policy instruments found and/or discussed in relation to EPR programmes. These are summarised in Table 5-1. The examples provided are not exhaustive, especially considering the full potential of the application of the EPR principle in other parts of the life cycle and issues.

An EPR programme typically consists of more than one EPR-based policy instrument. For example, a manufacturer is given the task of taking back a discarded product that he/she has produced (*take-back requirement*). This requirement may be combined with an introduction of a *deposit-refund* system in order to give incentives to the consumers to bring back products to an appropriate collection point. A manufacturer may also be required to *label* material composition of components and to provide *information* to the recyclers regarding the content and structure of their products. These recyclers must meet certain *treatment standards*. Some of these policy instruments may be incorporated in the revision of existing legislation governing waste management or the establishment of supplementary legislation developed in addition to an EPR programme.

Table 5-1. Examples of EPR-based policy instruments

Administrative instruments	Collection and/or take-back of discarded products, substance and landfill restrictions,* collection, reuse (refill) and recycling targets, environmentally sound treatment standards, minimum recycled material content standards, product standard, utilisation mandates**
Economic instruments	Material/product taxes, subsidies, advance disposal fee systems, deposit-refund systems, upstream combined tax/subsidies, tradable recycling credits
Informative instruments	Reporting to authorities, marking/labelling of products and components, consultation with local governments about the collection network, information provision to consumers about producer responsibility/source separation, information provision to recyclers about the structure and substances used in products

* Some exclude substance and landfill bans from EPR-based policy instruments.
** Utilisation mandates refer to the situation where producers should achieve certain reuse and/or recycling targets, but do not have to use them within their own activities.
Source: based on Tojo (2004)

In virtually all the EPR programmes, the exact combination of these instruments varies, as evident from a number of studies. However, the widely considered EPR programmes to date include, at minimum, a take-back requirement of post-consumer products.

5.3.2 Life cycle stages and environmental issues covered

To date, EPR programmes have predominantly addressed the environmental improvement related to the end-of-life phase of the product's life – enhanced resource efficiency and reduction of/environmentally sound treatment of hazardous substances. By extending responsibility related to end-of-life management to manufacturers, an EPR programme aims not only to improve the end-of-life management per se, but also to provide incentives to manufacturers to design products that generate less environmental impacts at the end-of-life phase. Provision of responsibility is intended to link the *upstream* (design phase) of the product's life cycle with the *downstream* (end-of-life management).

5.3.3 Stringency of environmental mandate

As discussed above, existing EPR programmes address a product's environmental performance in two ways: source prevention via design improvements of products and product systems, and enhanced performance of downstream activities (efficient collection, enhanced reuse and recycling, and environmentally sound treatment). As reviewed earlier, material restriction has been an effective instrument in addressing design improvements (Section 3.2). Regarding take-back requirements and subsequent mandates of achieving reuse/recycling targets, as well as complying with environmentally sound treatment standards, the manner in which producers assume and implement their responsibility seems critical in enhancing design change. In this regard, physical involvement of individual producers in developing and managing their own recycling plants in Japan has provided various learning opportunities to improve the design. In Europe where individual producers' physical involvement has been limited, implementation of individual responsibility that enables producers to control and pay for the waste from their own products within a collective infrastructure needs further exploration.

Concerning the enhancement of downstream activities, while collection and recycling of product groups, such as packaging materials, have been enhanced over time, further efforts are needed to develop infrastructure for enhanced collection of products such as EEE. Improved collection is especially important as it is the first crucial step to bring the discarded products to the appropriate treatment facilities. The tangible involvement of producers in the downstream management in Japan has been contributing to their engagement in improving downstream infrastructure and technologies as well. The standard of treatment activities in Europe can be assured and enhanced by the involvement of industry associations as information brokers.

5.4 Green public procurement

Green public procurement means that public authorities – national, regional and local – take environmental issues into account when purchasing goods or services with tax payers' money. The sheer magnitude of purchasing power that the public bodies have – in Europe in average 16% of the national GDP – enables them to send a strong signal to the producers concerning their design strategies.

Green public procurement has been strongly pushed as an important mechanism to enhance the demand for greener products. In Europe, it is an important part of the Integrated Product Policy (IPP) (COM (2003) 302 final) and the Environmental Technologies Action Plan (ETAP) (COM (2004) 38 final), among others. A study conducted in 2005-2006 suggests that 7 countries (Austria, Denmark, Finland, Germany, the Netherlands, Sweden and UK) are among the leading countries in Europe (Bouwer et al., 2006). In Japan, the law from 2001 obliges public authorities to integrate environmental considerations when purchasing goods and services.[32] Based on the legislation, the criteria for products and services commonly purchased by public authorities have been developed.

5.4.1 Policy instruments contained

Similarly to the Type I eco-labels, standards made available during the development of various instruments can be incorporated as criteria for green public procurement. A review of procurement criteria in the European countries indicate the prevailing use of criteria from Type I eco-labelling schemes (Bouwer et al., 2006). A criterion for buses and bus services include EU emission standards (Bouwer et al., 2006). The revised criteria related to energy efficiency developed based on the Green Procurement Law for cars and household appliances in Japan utilise the upgraded standards set in the Top Runner Programme (see Section 4.1). They also utilise the verification methods developed for the Top Runner Programme.

5.4.2 Life cycle stages and environmental issues covered

Green public procurement does not per se specify which environmental aspects arising from which phases of the product life cycle that should be considered. In practice, it can incorporate various aspects and life cycle phases.

5.4.3 Stringency of environmental mandate

As mentioned above, green public procurement does not have default environmental issues that should be taken into account. Nor does it set any specific requirement as to the stringency of the requirements that should be set forward. Thus it is up to the respective public bodies to determine how "green" the standard should be, and a diversity in the uptake of green criteria is observed.

For instance, the aforementioned study of green public procurement in Europe indicates that among the tender documents for 16 product groups selected for review, the inclusion of environmental criteria is limited to 36%. The ones that include 1-3 clear environmental criteria ranges from 41% (office machinery) to 9% (computers). The ones that have more than 3 clear environmental criteria are limited to shares between 16% (chemical products, rubber, plastics) and 0% (computer) (Bouwer et al., 2006).

Meanwhile, the study of the European situation also indicates that the criteria documents that do contain environmental parameters consider the criteria documents set forth in Type I eco-label programmes (Bouwer et al., 2006). The criteria documents developed under the Green Procurement Law in Japan include some criteria that are equal to the upgraded version of the standards set in the Top Runner Programme (Ministry of the Environment, 2009). This indicates that green public procurement has good potential to enhance the green demands.

The study of the Top Runner Programme indicates that the inclusion of the Top Runner

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[32] Kunitou ni yoru Kankyoubuppintou no Choutatsu no Suishintou ni kansuru Houritsu. 2001[Law on the promotion of the purchasing of environmental products by nation and the like.]

standard in the green public procurement criteria helps accelerate the compliance, as the timing to meet the green public procurement criteria come quicker than the Top Runner standard. Moreover, as green public procurement concerns individual products instead of brands (i.e. not fleet average of the products put on the market by one brand), it urges them to meet the standards on the individual product basis (Tojo, 2005).

6 Discussion on instrument mixes

Based on the discussion in the previous chapters, this chapter seeks to extract issues that need to be considered to further reduce the environmental impacts from the life cycle of products. Reflecting upon the theme of this paper, we concentrate on issues related to instrument mixes.

6.1 Coverage of life cycle stages and environmental impacts

While environmental impacts of some phases of the product's life are addressed relatively well, reinforcement/extrapolation of policy measures in other phases seems necessary.

6.1.1 Production phase needs to be revisited

Concerning the three types of environmental impacts arising from different stages of the life cycle of products, except for the management of hazardous substances and chemicals, it is not very apparent how the impacts from the production phase are addressed. Among the instruments reviewed, there is no instrument that addresses resource efficiency in the production phase, and the carbon label has been introduced only recently.

This may partly have to do with the relative acuteness of the issues at hand, and with the gradual shift of focus from production to product, with the belief that much has been done with the site-specific environmental issues. However, it should be noted that traditional site-specific issues covered by government interventions mostly concern management of hazardous substances. As discussed in Sections 2.10 and 5.1, resource and energy use from the production phase are significant environmental impacts to be addressed for some products, with substantial potential for improvements.

One way of remedying this shortcoming could be the enhancement of existing instruments that can be considered. As discussed in Section 3.1, conditions for environmental permits could include not only emission standards for toxic substances, but also energy and resource efficiency. In fact, the IPPC Directive (1996/61/EC) in Europe does include avoidance of waste generation and efficient use of energy as part of the conditions for the facility to operate (Article 3). The proposal made by the Swedish authorities already addresses some of these issues (Dalhammar, 2007) and could be further enhanced. However, concrete measures to ensure such requirements should be looked into. Implementation of measures mentioned in Directive 2006/32/EC on energy end-use efficiency and energy services, such as energy audits (Article 12) can be one of the solutions. Traditional cleaner production measures can be used here, not only for the audit of energy use, but also for resource efficiency. In this regard, government can continue to play a role of information facilitator.

6.1.2 Addressing suppliers' environmental impacts

Measures related to suppliers can be looked upon from two view points. One has to do with the enhancement of supplier engagement in improving the eco-design of final products, and the other concerns the environmental impacts of the internal operations of suppliers themselves.

Concerning the former, existing policy instruments have influenced the strategies of suppliers directly or indirectly. Some of these measures address the materials or components used in final products that are supplied by the supplier – for instance, the use of mercury in EEE will be restricted, and components that the supplier delivers include mercury. Others affect the continued supply of the supplier – for example, collection targets set up for packaging materials enables a steady supply of clean PET, which competes with the virgin PET. Requirement on information provision regarding materials such as the REACH Regulation in Europe also affects the suppliers (in this case the chemical manufacturers). All in all, when requirements are set on the property of end-products that affect suppliers, they would react for their survival. It can take the form of collaboration between suppliers and the manufacturer of the final products.

Challenges exist when final producers wish to improve the environmental properties of their products and there are no mandatory policy measures. Findings from the case studies of supply chain management in the textile industry indicate the importance of setting relevant standards for respective stages in the chain (e.g. cotton farmers or dyers). This could take the forms of separate Type I eco-labels for the respective stages (Kogg, 2009).

Enhancement of the environmental performance of the operations of suppliers (production, transportation) poses challenges, especially when considering the global supply chain. Setting standards for the operations could be in direct conflict with free trade agreements. Voluntary policy measures and actions by private actors would play an important role here. Experiences from carbon labels, as discussed in Section 4.3, can in the future provide some insights here. Meanwhile, as highlighted in Section 5.1, careful assessment of which part of the supply chain that should be included should be made in order not to miss important environmental impacts to be addresed.

Use of simplified mechanisms can be difficult in the area of resource efficiency and management of hazardous substances, as the unit of measurement will not be as uniform as for greenhouse gas emissions. An approach discussed in Japan in this regard is the diffusion of a simplified environmental management system. Operation of an environmental management system can also be considered as a lending condition for funding agencies.

6.2 Stringency of environmental mandate and influence on design change

The stringency of the environmental mandate of policy instruments and their combination, and their influence on product design can be considered from various angles.

6.2.1 Informative instrument: how to increase participation?

Some of the mandatory administrative instruments, such as material restrictions and emission standards have been quite effective in improving the properties of products at the design stage. Meanwhile, introduction of these instruments usually encounters strong opposition. Similarly, political acceptability of fiscal measures, such as taxation, is usually low, especially when they are used to restrict actions (as opposed to subsidies to encourage actions). To be able to set the tax high enough, as was the case with the tax on nickel-cadmium batteries in Sweden, is an exceptional situation. In light of the reality that it is not so easy to introduce mandatory administrative instruments and economic instruments, we need to consider the potential role of informative instruments.

Similarly to administrative instruments that indicate the tasks to be achieved by the addressee, a typical informative instrument, such as energy efficiency labels and Type I eco-labels, has both standards/requirements to be met by producers. An important difference might be that the producers have the liberty to continue to manufacture products that do not meet the criteria/requirements. In the case of labels that show the level of achievement, they could simply indicate the level. Producers will not be administratively "punished" as long as they do not carry a false label. Moreover, while many of the information provisions are mandatory, there are cases where provision of information is voluntary (e.g. Type I eco-labels and Energy Star label). Thus the main issue is to accelerate the participation rate of the companies that strive for higher level of achievement.

One possibility found in the existing cases is the combined use of mandatory standards and labels. For instance, in the Top Runner Programme, mandatory standards are set to be achieved within a certain timeframe. Manufacturers are not mandated to meet the standards immediately, but they should show their level of achievement in terms of percentage. This helps producers realise where they are standing in terms of achievement. Moreover, well-known companies may find it important to reach the standards to keep up with their reputation. A similar approach is introduced for the restriction of hazardous substances in EEE in Japan.

Another approach could be to use the standards set forth in labelling schemes in fiscal measures such as green public procurement and financial incentives given to consumers to enhance purchasing. This would give producers more certainty that investments they make to develop more environmentally friendly products pays off. Green public procurement in many of the European countries and the discussed tax exemption on eco-labelled products take this approach.

6.2.2 Innovation and standard-setting

Most of the instruments primarily addressing resource efficiency have only indirect influence on the design change. High performance of instruments that have environmental impacts from the end-of-life phase of products as the immediate target (e.g. source separation or collection targets) provides only proxy measurements for the potential upstream changes. In this regard, having the concept of extended producer responsibility as the basis for this management is essential in connecting the upstream and the downstream. Involvement of producers in the end-of-life phase of their products gives them more possibilities and economic reasons to include end-of-life environmental performance in the design considerations. The importance of implementing individual responsibility as discussed in Sections 2.5 and 5.3 should be highlighted here.

Setting more direct standards in the design phase of the product poses challenges due to the innovative nature of product development and asymmetrical information between policy-makers and producers. However, in addition to producer responsibility, policy-makers can promote design that facilitates efficient use of resources by enhancing the awareness of producers. An instrument that may work within a rather short timeframe is a design guideline. For instance, a framework for a design Guideline that includes, among others, considerations on resource efficiency was developed by the government committee in the early 1990s in Japan. Based on the Guideline, manufacturers in Japan started to develop their eco-design tools incorporating the issues addressed in the Guideline such as recyclability. This is said to facilitate the grounding of the idea of the design-for-end-of-life among Japanese manufacturers targeted by the Guideline. Moreover, in the long run, the role of education is vital in enhancing innovation (Hayes et al., 2008).

While the Japanese Top Runner Programme has played an important role in accelerating the application of technologies lying on the shelf, innovations have mostly been incremental. On the other hand, an annual award for remarkably energy-efficient products is considered to enhance more radical innovations. Perhaps a similar award can be introduced in the area of resource efficiency.

6.2.3 Time required for standard-setting

In order to continue to move the environmental performance of the entire product group, it is essential to periodically review and upgrade the standards as well as the scope. Changes in some of the instruments, such as Type I eco-labels, emission standards, Top Runner Standards, have taken rather short time. Meanwhile, as found in the existing energy efficiency standards and the EuP Directive in Europe (Sections 4.1 and 5.1), standard-setting and revision of standards take very long time.

Swift decision-making is important especially when the changes in the characteristics of products are quite rapid and when we need to take measures urgently. The straightforwardness of the manner in which standards in the Top Runner Programme are decided is attractive in this regard. The stated necessity of taking life cycle environmental consideration in the development of requirements in the EuP Directive can be one reason for the time it has taken to develop the requirements – it took nearly 4 years since the coming into force of the Directive until the first requirement was agreed upon.

It would inevitably take longer time to develop requirements for several different environmental issues arising from different phases of the product's life, as compared to addressing one single issue. Instead of trying to set the requirements for various parts of the life cycle within one policy measure, it may be better to leave the standard-setting to individual policy instruments and incorporate these standards into one, as found in, among others, green public procurement. In the case of the EuP Directive, which has not been able to incorporate environmental impacts other than the use phase energy efficiency so far, it may be worth having the Directive as one focusing on that aspect. As stated by van Rossem and Dalhammar (2010), the claim that the Directive is based on life cycle thinking may well be dropped. Meanwhile, it would be worthwhile looking into the process of developing standards that do incorporate life cycle thinking, such as Type I eco-labelling schemes, and see how the standards are developed.

6.3 Diffusion in the market

Once the environmentally superior products are available in the market, the important and crucial step is that they are actually used. In this regard, effective implementation of economic instruments such as green public procurement and provision of incentives to consumers in the form of, among others, tax breaks, should be further considered.

Furthermore, as a way of making it attractive for consumers to purchase environmentally less burdensome products, in addition to education and awareness raising, bundling of other benefits can be considered. This is identified to be a good strategy when material/ component producers in the housing sector commercialise a new solution to their market (Emtairah et al., 2008). As discussed, waste prevention in term of resource efficiency can be sold better when combined with miniaturisation and light-weighting. Benefits of energy efficiency can be grasped more easily when it is expressed in terms of battery time.

This all comes down to the necessity of research on learning various factors affecting the purchasing choices of consumers (Leire, 2009).

6.4 Bundling of requirements from various instruments

As discussed, there are many instances when elements of various instruments are combined under another instrument. In addition to addressing a single environmental issue with a couple of instruments, as discussed above, what effective measures might be considered to incorporate life cycle environmental impacts under one instrument?

Among the instruments reviewed, Type I eco-labels seem to have been most successful in this regard. Meanwhile, emergence of a number of other types of labels, as well as a transboundary movement of products, has lead to the situation where a number of labels appear on one product. This could cause substantial confusion, as well as distrust towards the labels among the consumers. However, there is little evidence that consumers in Sweden, or other countries with well-developed Type I eco-labelling schemes, are having problems to identify the relevant eco-labels and ignore the rest.

Avoidance of duplication should be considered between different labels, so as not to confuse the receivers of information. In this regard, the confusion the carbon label might cause has been criticised. The label only looks at one environmental aspect, but could, at least in theory, cover the whole life cycle. In essence, the fact that the label is on a product does not mean that it is necessarily environmentally superior.

7 Conclusions

There are many policy instruments dealing with various types of environmental impacts (resource efficiency, toxic substances, energy/ climate change) occurring at various parts of a product's life cycle. These instruments have been, in many ways, used in combination and reinforcing each other.

There has been a discussion on developing a piece of general framework legislation that incorporates various life cycle environmental impacts. Such legislation, on one hand, may help in paving the way for policy-makers to take further legislative measures regarding various environmental aspects of a product's life cycle. Moreover, it may help raising awareness of the importance of product-oriented environmental policies.

On the other hand, it can be quite difficult to cover various life cycle environmental impacts in one law, as the experience with the EuP Directive shows. It takes a long time to come to an agreement, and despite its initial ambition, the level of the standards that they reach in the end tends to become rather low. It has also been seen that the emergence of the EuP Directive was used as an argument to dilute the mandate given to other directives (e.g. WEEE and RoHS Directives), despite the fact that the EuP Directive in reality does not seem to be able to capture all the important environmental impacts from products. However, the continued implementation of the Directive remains to be seen.

Elements of various instruments can be used 1) in another policy instrument, 2) in a policy package, and 3) in combination with each other. Examples of the first include Type I eco-labels, green public procurement, criteria for tax reliefs/subsidies, and design guidelines. Policies based on extended producer responsibility, waste policy, the EC REACH Regulation are among the examples for the second. Synergetic combination of instruments can be, among many others, cleaner production measures, an environmental management system and permits; and energy efficiency standards and labelling.

Having separate approaches may speed up the process of standard-setting, and may help in setting up higher standards. The separate issue-specific approach should be enhanced by setting up higher standards that really pull the front runners. It is crucial to talk with the individual manufacturers when setting up the higher standards. Experiences from exhaust gas emission standards in Japan show that in the end they gave market advantages to Japanese car manufacturers compared to their American counter parts, who initially managed to kill the legislation in the USA. Moreover, companies are clever enough to incorporate various environmental issues into design considerations, especially when there is a strong demand from society.

The standards or requirements that producers must fulfil should be met individually. Fulfilment of responsibility collectively leads to free rider problems and reduced incentives for companies that strive to develop products with better environmental performance.

Legislation addressing the environmental impacts of components and materials communicates rather well along the supply chain. When there is no legislation, voluntary instruments such as Type I eco-labels that address the respective tiers of suppliers can facilitate the development of environmentally superior materials/components. Environmental impacts generated from the operation of suppliers that do not have direct connection with the property of products are difficult to address, especially when the suppliers are not within national borders.

Despite various measures taken and improvements experienced in the production process under the first generation of environmental policies, other, "less acute" environmental issues – resource and energy efficiency from the production phase requires more attention. How the permit conditions laid down in the EC IPPC Directive or by the Swedish national authorities can be further implemented needs to be investigated. As exemplified in the new Directive 2006/32/EC on energy end-use efficiency and energy services, traditional cleaner production measures can be revisited.

In concluding the document, we would like to come back to the rationale behind taking a product-oriented approach when considering an effective policy intervention package. The rationale, as outlined in the introduction, could be summarised as follows:

- Prevention principle: avoidance of environmental impacts at source;
- Necessity of coordinated measures throughout the life cycle: various environmental impacts occur at various phases of a product's life, and considerations are needed to avoid transfer of problems from one media to another and from one life cycle phase to another;
- Sector specific dynamics: each industry sector has its unique dynamics with their own chain of actors interacting in varying ways; and
- Globalised economy: The above three points require even more consideration in the globalised economy where manufacturing of products often involve actors in a number of countries.

In reflecting on these points, the authors seek to put forward some suggestions for policy-makers when considering the development of new interventions.

1. Consider the relative importance of the issue the intervention intends to address: several parts of the study highlight that existing policies, albeit their importance, may not be addressing the environmental issues most relevant to the industry. It would be important to at least consider impacts arising from each phase of the life cycle of a product and check what measures are in place. It would be also important to see the complementarity of the new measure and existing measures.

2. Study the sector which is subject to the intervention:

    - Understand the innovation dynamics of the sector: e.g. who are the actors? What are their relation and interaction? Who decides what at which stage concerning the properties of the final products?
    - Check what policy interventions are in place, explore their effectiveness in addressing the relevant concerns, and the relevance to the overall goals of a new intervention.
    - Identify suitable intervention points based on the observation of the first two points: what is the relation of the actors in the sector? Who is influential? Has there been any development to address the problems that the new intervention intends to address, and if yes, who hold the knowledge? What communication channels exist to transfer the knowledge? Is there any need to facilitate the knowledge flow?
    - Check the closeness of the change the intervention intends to induce to the core business of the sector.

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Product-oriented Environmental Interventions

Bundling of effective policy instruments

IIIEE Report 2010:1

The Swedish Environmental Protection Agency decided in June 2003 to support the research programme FLIPP (Furthering Life cycle considerations in Integrated Product Policy) based on a proposal from the International Institute for Industrial Environmental Economics at Lund University (IIIEE) and Environmental Systems Analysis at Chalmers University of Technology (ESA). The FLIPP programme aimed at developing knowledge and understanding of the dynamics, mechanisms and interactions in complex product chains necessary to underpin life cycle based decision support systems.

The programme has been organised in twelve research projects and a programme management group. The programme has involved a number of researchers from IIIEE and ESA, as well as researchers from other Swedish institutions including the Royal Institute of Technology, Linköping University, Lund University, and Luleå University of Technology. A couple of projects also included researchers based in Hungary and Japan.

This report is one of the final steps of FLIPP and aims to bring together some of the important experiences of implementing environmental product policies and, in particular, explore and discuss the present understanding on how policy mixes, or instrument mixes as they are referred to in the report, can help address the life cycle impacts of a product in a coherent way. In a globalised world, with supply chains stretching over numerous borders and activities of high environmental and social concern taking place in a set of separate jurisdictions, the need for well-designed policy interventions is evidentt, while the complexity of designing effective interventions is growing for governments as well as businesses. FLIPP publications, and this report among them, will hopefully help to inspire and educate decision-makers throughout society on these issues.

Read more about FLIPP at www.iiiee.lu.se/flipp