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ENVIRONMENTAL PROTECTION

Experiences on the implementation of environmental product policy in the Finnish electrical and electronics industry

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Anna Kärnä

MINISTRY OF THE ENVIRONMENT

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PREFACE

This publication is the final report of the YPSE project (The Impact of Environmental Policy Instruments on Activities, Products and Environmental Capabilities in the Electrical and Electronics Industry) financed by the Finnish Ministry of the Environment and Technology Industries of Finland. The research project was carried out during 2004-2005. Its objective was to study from the perspectives of companies how environmental product policy is translated into practice and especially how companies in the electronics industry have anticipated and interpreted the requirements of the new EU environmental directives (RoHS, EuP and WEEE directives) in their practical operations.

The report examines certain key issues that Finnish companies have encountered in anticipating and interpreting the requirements and in searching for practical solutions in this context. The report provides companies with useful information for comparison of experiences gained in other companies, and public authorities with grounds for further development and targeting of environmental product policy. This report is an overview of the results of the YPSE project. The data gained during the project is discussed more extensively in separate articles and publications of which details can be found on the project website.

Petrus Kautto, Lic.Sc. (Admin.) from the Research Programme for Environmental Policy at the Finnish Environment Institute (SYKE) and Anna Kärnä, Lic.Sc. (Econ.) from the Helsinki School of Economics (HSE), Organization and Management have been responsible for the implementation of the project. The steering group for the project included Taina Nikula from the Finnish Ministry of the Environment (project coordinator), Eva Heiskanen from the National Consumer Research Center, Raimo Lovio from the Helsinki School of Economics, Peter Malmström from Finnish Technology Industries and Per Mickwitz from the Finnish Environment Institute. We thank the members of the steering group for constructive feedback and a good discussion ground. Our warmest thanks go to the companies that have cooperated with the project, Nokia Oyj and Vaisala Oyj, as well as to Aspocomp Oy, Incap Oyj, Reimax Electronics Oy and Scanfil Oyj for their active contribution and interest in the successful accomplishment of the project.

Project website http://www.environment.fi/syke/ypse

15 May 2006, in Helsinki

Petrus Kautto and Anna Kärnä

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1 Environmental product policy and the electrical and electronics industry

Products of the electrical and electronics industry have in recent years been a target of special attention in EU environmental legislation. Three new directives have been approved in 2003-2005 as part of the implementation of EU Integrated Product Policy (IPP) aiming to reduce the negative environmental impacts of electrical and electronic equipment and energy-using products. The requirements of the directives apply to the design, manufacture and waste management of these products. They carry implications not only to the manufacturers of final products or trademark owners but also to importers, suppliers of materials, components and subassemblies and contract manufacturers, in other words the whole product supply chain.

It is a new situation from the perspective of companies, but also from that of environmental policy, as the directives include many new policy tools. Such concepts as supply chain management, using environmental management systems for demonstrating compliance, increased use of standards (i.e. New Approach) and the principle of producer responsibility are all typically applied IPP policy tools. Many of them require increased interaction between companies, public authorities and other stakeholders (e.g. consumers and organizations).

The years 2004 and 2005 have thus been especially interesting both in terms of environmental management and policy in the electrical and electronics industry and of research in the field. The requirements of the WEEE directive[1] entered into force in August 2005 and the EuP directive[2] was approved in July 2005. The requirements of the RoHS directive [3] became effective in July 2006. In many respects it is too early to assess the effects of these directives, but certain practices have already started to evolve on the basis of which we can predict and assess some future impacts (c.f. Kautto & Hildén 2004).

Similar legislation is being developed outside the European Union, for example, in China. The Commission has also stated in its recent Communication[4] on the implementation of the Lisbon strategy (simplification of the regulation) that the RoHS and WEEE Directives will be assessed and possibly revised in the near future. Apart from the directives, the Commission has also put forward other initiatives to promote environmental product policy, by, for example, launching two pilot projects on Integrated Product Policy. One of the projects centers on mobile phones and is headed by Nokia Oyj.

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1 Directive 2002/96/EC of the European Parliament and of the Council of 27 January 2003 on Waste Electric and Electronic Equipment, OJ EC L 3, 13 February 2003, p. 24-38.

2 Directive 2005/32/EC of 6 July 2005 Establishing a Framework for the Setting of Ecodesign Requirements for Energy-Using Products and Amending Council Directive 92/42/EEC and Directives 96/57/EC and 2000/55/EC of the European Parliament and of the Council. OJ EC L 191, 22 July 2005, p. 29-58.

3 Directive 2002/95/EC of the European Parliament and of the Council of 27 January 2003 on the Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment, OJ EC, L37, 13 February 2003, p. 19-23.

4 Commission of the European Communities 2005a, 51.

Meeting the requirements of the new regulations will not take place in companies overnight. The related work may start years before the regulations become effective and extend from influencing the contents of the regulations to modifying company internal operational practices. Many of the requirements of the new directives are relatively clear as such but also a number of open questions have been encountered in their practical implementation. The contents and level of the requirements to be met are negotiated within companies and between different companies in the supply chains and with public authorities as well. The aim of the YPSE project has been to assess companies' response to these requirements by examining what the translation of these requirements into practice entails, what kind of changes have to be made in products and operational practices and what the new requirements in the end actually mean.

The case companies in the project have been Nokia Oyj and Vaisala Oyj and certain subcontractors and contract manufacturers of Vaisala.[5] Nokia and Vaisala are both leading companies in their business fields worldwide, although they differ greatly in size: Nokia's turnover in 2004 was over 29 000 million Euro and the company employed over 55 000 people; Vaisala's turnover in 2004 was 180 million Euro and the company employed around 1 000 people. The companies differ also in terms of their resources for environmental work. This difference is reflected in the fact that Nokia has been actively involved in the discussions related to the environmental policy requirements since the drafting stages of the Directives, while Vaisala has mostly monitored developments in this respect. What both these companies do however have in common are global markets and a proactive approach: it is better to prepare for the new regulations than to apply last-moment solutions.

The YPSE project has observed in the case of Vaisala how the company has started to implement the requirements of the RoHS directive: what effects have the RoHS requirements had on Vaisala's product development and production and how are these requirements considered in cooperation with subcontractors and contract manufacturers. The focus with Nokia has been on the work of the company's environmental experts and especially on Nokia's work in the context of the IPP pilot project, which assesses the environmental impacts of mobile phones. The IPP pilot exercise has engaged representatives of the many stakeholder groups connected with the life cycle of mobile phones in discussions on the efforts to reduce the environmental impacts of these products.

The data was collected during 2004 and 2005 by interviewing 19 people employed in the environmental and product development work at Nokia and Vaisala, representatives of four of Vaisala's contract manufacturers and two other persons who have taken part in Nokia's environmental activities and in the IPP project. As regards the process of preparing the EuP directive, twelve people were interviewed in Helsinki and Brussels and several briefer discussions were led with other people who have participated in the preparatory work. In addition to the interviews, the work of environmental experts in Nokia, the meetings of the company's IPP pilot

5 These companies are also subcontractors and contract manufacturers to Nokia and many other Finnish companies operating for example, in the electrical, electronics and telecommunication industries.

project group, Vaisala's RoHS workshop and a few other events were observed in 2005. More details can be found in the list of references for this report.

This report is structured so that Chapter 2 raises some key questions that the new environmental requirements bring about. Chapter 2.1 discusses questions concerning compliance with the RoHS requirements and Chapter 2.2 the implementation of the WEEE directive. Chapter 2.3 examines the contents of the EuP directive and Chapter 3 assesses the IPP pilot project as an operational model, centering especially on Nokia's activities in this context. Chapter 4 presents conclusions on the results of the study both from the perspective of future needs to develop companies' environmental competence and of the further development of environmental product policy.

2 What kind of new practices do the regulations bring about?

Although the preparation of the RoHS directive started already in the early 1990s, many companies whose products fall within the scope of the directive are finding themselves hard pressed to prepare for the new requirements which entered into force in July 2006. The requirements of the new RoHS, WEEE and EuP directives are in principle rather clear, but several gray areas and definitional problems have been encountered in their translation into practice, which have related, for example, to uncertainty of what products finally fall within the scope of the requirements.

The European Commission, national authorities in the Member States, research and testing institutes, consultants and industry associations are all presently working to clarify these gray areas. This work has produced, for example, different guidelines and guides (e.g. the Commission of the European Communities 2005b; Orgalime 2005; Kärnä 2005), standards (e.g. the producer and equipment marking standard EN-50419 required by the WEEE directive; the IEC draft standard on the procedures for the determination of levels of regulated substances in electromechanical products) and a number of websites providing information on the directives[6].

The aim of the YPSE project has been to observe how this work has been carried out in companies and to examine experiences in deploying the new requirements through the following questions:

- What kind of measures and practices have been adopted in companies and throughout the supply chains now than the requirements of the new directives are entering into force (2005, 2006,2007)?
- How are the new requirements interpreted in the companies: what aspects of them have been commonly discussed, what forms are the practices assuming and how are they negotiated in practice?

6 For example, website of the British Department of Trade and Industry (DTI): http://www.dti.gov.uk/innovation/sustainability/index.html

2.1

RoHS compliance: interpretation of "the gray area"

- The Directive on the Restriction of the Use of Certain Hazardous Substances in Electric and Electronic Equipment (RoHS) restricts the use of lead, mercury, cadmium, hexavalent chromium, polybrominated biphenyls (PBB) and ploybrominated diphenyls (PBDE) in certain products.

- In scope, the directive refers to Appendix IA of the WEEE directive, and thus applies to the same products as the WEEE directive, with the addition of fluorescent lamps and household lighting equipment.

- The RoHS directive is a harmonization directive, which in practice means that Member States cannot adopt national measures that diverge from its basic requirement level.

- The requirements of the directive do not apply to spare parts or reusables if the products are placed on the market prior to 1 July 2006, when the requirements of the directive will enter into force. The national authority controlling the implementation of the directive in Finland is TUKES, Center for the Development of Safety Technology.

- The RoHS directive is available at http://europa.eu.int/eur-lex/pri/eni/oj/dat/2003/l_037/l_03720030213en00190023.pdf

- The Commission Decision amending the Directive for the purpose of establishing the maximum concentration values for certain hazardous substances in electrical and electronic equipment is available at http://europa.eu.int/eur-lex/lex/LexUriServ/LexUriServ.do?uri=CELEX:32005D0618:FI:HTML.

- The Commissions Decisions amending the original Directive's exemptions are available at http://europa.eu.int/eur-lex/lex/LexUriServ/site/en/oj/2005/l_271/l_27120051015en00480050.pdf and http://europa.eu.int/eur-lex/lex/LexUriServ/site/en/oj/2005/l_280/l_28020051025en00180019.pdf.

- For the Finnish Government Bill for the implementation of the RoHS Directive (in Finnish), see http://www.finlex.fi/fi/laki alkup/2004/20040853.

- For the Decision amending the annex to the Bill (in Finnish), see: http://www.edilex.fi/virallistieto/saadoskokoelma/20060003.pdf

The objectives of the RoHS directive are twofold: on the one hand it is an internal market directive which aims to prevent barriers to trade and distortion of competition that may be caused by differences in national measures and regulations. On the other hand, its environmental and health objective is to "contribute to the protection of human health and the environmentally sound recovery and disposal of waste electrical and electronic equipment". The directive thus aims to create conditions for the implementation of the WEEE directive by "enhancing the possibilities and

economic profitability of recycling of waste electric and electronic equipment" and "decreasing the negative health impact on workers in recycling plants". The need for regulation has also been justified with the statement that "significant parts of WEEE will continue to be found in the current disposal routes".

The RoHS directive is based on a basically simple ban on the use of certain hazardous substances. But in practice the situation is more complicated, as the Annex to the directive[7] exempts certain purposes of use of lead, mercury, cadmium and hexavalent chromium. The list of exemptions will be reviewed at regular intervals. It is also possible that more materials and products will be included within the scope of the directive. The requirements of the RoHS directive apply to final products, and through that, also to their components and subassemblies, except for the exemptions listed in the Annex. Through this, the RoHS requirements extend all the way to the suppliers of raw materials. It should also be noted that if a product is regulated by the WEEE directive it is also within the scope of the RoHS directive (more details in, e.g. Orgalime 2006).

What have made the implementation of the RoHS requirements especially difficult for companies are uncertainties concerning their interpretation – which still exist at this stage when the Directive's requirements have entered into force. The definition of "homogenous material"[8] has proved especially problematic as has the question of the level at which homogenous materials and concentration values are assessed (single component, subassembly, final product). No widely used standardized method has yet been established for companies to demonstrate compliance with the RoHS requirements. An IEC standard is being prepared on the testing methods for RoHS maximum concentration values[9].

Due to these ambiguities, many companies have delayed their RoHS implementation, which is understandable as such. "Let's wait for the standards or other clear instructions on how to act". Problems are however bound to arise as there will be very limited time to carry out the changes, which influence both the products and the production processes. In other words, adopting RoHS measures "is not a piece of cake", and meeting with the requirements will require a great deal of time and resources.

Nokia has prepared for the RoHS requirements ever since the 1990s by first being involved in the discussions on the contents of the directive, but especially by modifying its own operations through various projects. During the years 2000-2005, the products of all business groups have been checked on the basis of the RoHS requirements. The project has been especially extensive for the Mobile Phones group due to the great volume of the related products.[10] Nokia had, however, started proactive work in anticipation of the RoHS requirements even before this, by for example, studying alternatives for leadfree soldering.

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7 The Annex has been amended by a Commission's Decision on establishing the maximum concentration values for certain hazardous substances in electrical and electronic equipment (2005/618/EC); and the exemptions in the Annex on products and allowed purposes of use with Decisions 2005/717/EC and 2005/747/EC.

8 Maximum concentration values have been set for RoHS substances in "homogenous materials". A homogenous material is defined as "material that can not be mechanically disjointed into different materials" (Commission of the European Communities 2005b).

9 Standard draft IEC 62321: Procedures for the determination of the levels of regulated substances in electromechanical products.

10 Nokia Oyj is the world's leading company in wireless communications offering such products and solutions as mobile phones, imaging and game and media applications to consumers, telecom operators and businesses. Nokia's four business groups are Mobile Phones, Multimedia, Networks and Enterprise Solutions. The company also has two horizontal units: Customer and Marketing Operations and Technology Platforms.

In Nokia the RoHS requirements have focused increasing attention to the management of material data. Nokia has its own "Nokia Substance List" on the substances the use of which is forbidden or restricted in the company's products. The list is not limited to legislation requirements (e.g. RoHS directive) but also contains requirements set by the company itself, which in some cases may even be stricter than those posed by current legislation. The list is used both internally in product development projects and in operating with subcontractors and contract manufacturers.

Determination of the material contents of the final products (such as mobile phones and base stations) and ensuring the RoHS compliance of subassemblies and components have been a very labor intensive operation for Nokia. This process has entailed establishing RoHS compliance as part of all supplier contracts. These contracts differ depending on the type of client-supplier relation and on how the responsibility for the products has been defined between the companies (for example, in OEM and ODM relations[11]). All in all, this has been an extremely labor intensive process for Nokia, which has already also had direct impacts on the Finnish electronics industry through product supply chain management.

The YPSE project has observed during 2004 and 2005 how Vaisala Oyj together with its main domestic subcontractors and contract manufacturers (Aspocomp Oy, Dicro Oy, Incap Oyj, Reimax Electronics Oy and Scanfil Oyj) have anticipated the RoHS requirements. Vaisala is interesting company in terms of RoHS implementation because the directive does not directly, at least in the first phase, set requirements for Vaisala's products falling within the directive's category 9 (measuring and control equipment). Vaisala's management group has however made a principle decision already in 2002 to comply with the directive's requirements by the given deadline.

There were several grounds for this decision. The availability of lead-containing components can cause problems in the medium-long term and some of Vaisala's products may also fall directly within the scope of the directive as part of a larger product system (e.g. industrial process measurement equipment). In these cases, the Vaisala products that are sold, for example, to U.S. or Japanese clients have to be RoHS compatible if they are to be sold again within the European Union as part of the clients' own products. Moreover, there are already indications that legislation in China, Japan and certain U.S. states (e.g. California) is developing in a parallel direction and that the EU requirements might become stricter.

In Vaisala, the actual RoHS compliance work began in 2004. During 2005 the RoHS projects in Vaisala's three business groups (Vaisala Measurement Systems, Vaisala Instruments and Vaisala Solutions) had proceeded at slightly different paces. Vaisala Instruments had proceeded the most because the group has the greatest amount of products that need to be assessed in light of RoHS compliance. The unit's RoHS work has partly served as a model for the other two business groups. As the products of the business groups[12] differ significantly, also the level of the required RoHS work has varied between the units. The work has also revealed that it is not feasible or possible to carry out all the design changes at once, but in some cases changes in the products will be realized along with new client projects. The pace of RoHS implementation also depends to some extent on how fast Vaisala's clients[13] will start to demand RoHS compliance. So far the clients have mainly presented questions concerning RoHS compliance rather than actual demands.

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11 OEM = origin equipment manufacturer, ODM = original design manufacturer.

12 Vaisala's business groups, Measurement Systems, Solutions and Instruments, develop, manufacture and market products and services for environmental and industrial measurements. Vaisala's markets are global.

13 Vaisala's major customer groups are meteorological and hydrological institutes, aviation organizations, defense forces, road and rail organizations, weather related private sector, system integrators and industry worldwide.

Vaisala's internal goal has been to reach RoHS compliance by the end of 2005. The deadline has stretched to some degree and the company's management group revised its decision in 2005 to the effect that RoHS compliant production will begin in stages, starting from high-volume products (e.g. radiosonds of which 400 000 pieces are sold annually). The management group has also exempted certain products from the schedule. In the following section a closer look will be taken at experiences in the practical implementation of the RoHS requirements, especially focusing on the work carried out by Vaisala Instruments.

The effects of RoHS requirements

The RoHS requirements call forth measures in the following areas:

- **Products and product design**
  - changes in current products, new products
- **Production processes**
  - leadfree solders, adjustment of production equipment and soldering processes
- **Management of components and materials**
  - changing for RoHS compatible components
  - stock monitoring and management (RoHS non-compliance/compliance)
  - collection of material data at component level
- **Demonstrating conformity**
  - declarations of conformity, agreements

Products and product design

For Vaisala's product development the RoHS directive has meant a project of altering current products to comply with the directive's requirements and integrating the requirements into the design of new products. In new product development projects, the implementation of the RoHS requirements is the responsibility of the project managers. The implementation has already been extended to the different stages and milestones of the product development process, starting from the product specifications.

With current products that are in production, the change project has been significant. In Vaisala Instruments (VIN), a project manager was appointed from within the product development group in 2004 who has coordinated the RoHS work on a fulltime basis since 2005. The work in the VIN Unit started by preparing an action plan (see also Table 1) that has laid out the grounds for:

- Reflection on what products will be sold after 1 July 2006
- Surveying of what products contain hazardous materials
- Charting of options to replace these materials
- Planning of the schedule for implementing changes by products and by components (including testing and prototypes)
- Estimation of the amount of work required
- Contacting component and material suppliers and informing them on the schedule for carrying out the changes
- Discussions on how problem cases are solved

The impacts of the RoHS directive have been compared in Vaisala to those earlier brought about by the EMC directive.[14] The RoHS directive will in some cases speed up the birth of new product generations and require strategic decisions on what products will stay in production (and be upgraded through redesign) and what products will be discontinued. Product line managers have been deciding about the "life and death" of products.

All product specifications have had to be reviewed and necessary changes made in the materials, components and printed circuit boards. In Vaisala Instruments this has meant a review of some 170 component boards. Although most of the attention in the RoHS discussion has focused on lead, it is not the only substance in question. Other problem areas that have been identified in electronic products include some chromate surface finishes in mechanics, flame retardants in plastics and cadmium as a coloring agent in cables. The selection of a viable substitution for lead solders has had to take into account Vaisala's different stress tolerance requirements for its products. The service life of a radiosond is only few hours, while with some Vaisala products the service life can stretch up to 20 years, in which case the stress tolerance requirements are of great significance.

The schedules for required changes have been discussed together with the component and material suppliers. In practice product design in the VIN Unit has proceeded by preparing ECOs[15] on changing to leadfree components (by product or by component), determining when only leadfree products will be bought and by making the necessary changes in the specifications of printed circuit boards. The key question for product design has concerned the testing of certain critical designs and how long it will realistically take for the suppliers to adopt leadfree production processes. The preparation and testing of prototypes has been slightly slowed down by problems with the availability of leadfree components.

One potential problem is that the supply of certain lead-containing components may run out in the future. This means that companies will have to start redesigning their products well in advance in relation to these components. The availability of spare parts is difficult to forecast with Vaisala's products, some of which have a very long lifespan, even up to 20-30 years.

14 Council Directive 89/336/EEC of 3 May 1989 on the Approximation of the Laws of the Member States Relating to Electromagnetic Compatibility, OJ EC L 139, 23 May 1989, p. 19-26.
15 Engineering Change Orders.

Table 1. RoHS action plan of Vaisala Instruments unit. (Source: Vaisala Oyj 2005)

Vaisala Instruments' RoHS process:	**Vaisala Instrument's RoHS requirements for subcontractors and contract manufacturers:**
• All printed circuit boards will be made RoHS compatible • Only RoHS compatible components will be bought (starting as soon as possible, so that suppliers realize the demand, and problem cases can be identified at the earliest possible stage) • Leadfree soldering processes and solders will be adopted • Necessary information will be provided to product development and production	• How have they organized: - substitution of components? - management of component data? - how is RoHS compliance reflected in component listings? - which of components comply with the RoHS requirements? • Processes: - when will leadfree soldering processes and solders be available (reflow, wave-soldering, manual soldering)? - inspections, quality control? • Who is/are responsible for the shift into RoHS production (logistics, components, processes)?

Production

Adjustment to the RoHS requirements in production processes has in Vaisala required a search for suitable leadfree solders and auxiliary materials. The adoption of new solders requires a re-optimization of soldering machinery and processes in both reflow, manual and wave soldering. After test runs, Vaisala was starting its first leadfree production runs in autumn 2005. Vaisala's subcontractors and contract manufacturers had adopted or had started the process of adopting leadfree production in stages so that with reflow and manual solders they would have been at service by the end of 2005 (see also Figure 1). The changes in wave-soldering processes have required a greater amount of work. Some of the companies already had the facilities for leadfree wave-soldering in autumn 2005 while others where still in the process of acquiring the necessary equipment or adjusting their existing machinery. Some of the subcontractors and contract manufacturers have production plants close to the client markets in, for example, China, and RoHS compatible production processes has to be ensured in every individual plant.

Before starting the testing of leadfree production processes there were general doubts in the electronics industry about how the products tolerate the higher soldering temperatures, but this has not proven an unsurpassable problem, after all. It has also turned out that many leadfree components are quite suitable for lead-based soldering. The fact that leadfree components can be used in lead-based processes also gives more time to prepare for a shift to leadfree production. New challenges may however surface concerning the stress endurance of leadfree solders. There is evidence that the solders may perform well in individual endurance tests, but once different testing methods are combined, problems are more likely to appear.

For Vaisala's subcontractors and contract manufacturers[15] it is an interesting situation: the RoHS requirements apply only to some of their clients. The subcontractors and contract manufacturers thus have to for some time maintain lead-based and leadfree production processes simultaneously. The RoHS directive does not apply to all products and branches of industry (e.g. military or medical equipment), and the clients concerned with these products want to ensure continued contract manufacturing suitable for lead-containing products even after the Directive's requirements have entered into force.

It is already evident that the clients of the subcontractors and contract manufacturers will not shift to leadfree production all at once with the same schedule. Some of the clients of the interviewed companies have long been well-informed on the RoHS requirements, while some seem to expect that their suppliers will ensure RoHS compliance for them. The RoHS work with the clients in the interviewed companies had mainly started from one product project basis. In 2005, the subcontractors and contract manufacturers have been increasingly prepared to list and check through the RoHS compliances of all the products for their clients and negotiate the schedule for shifting to RoHS compatible production.

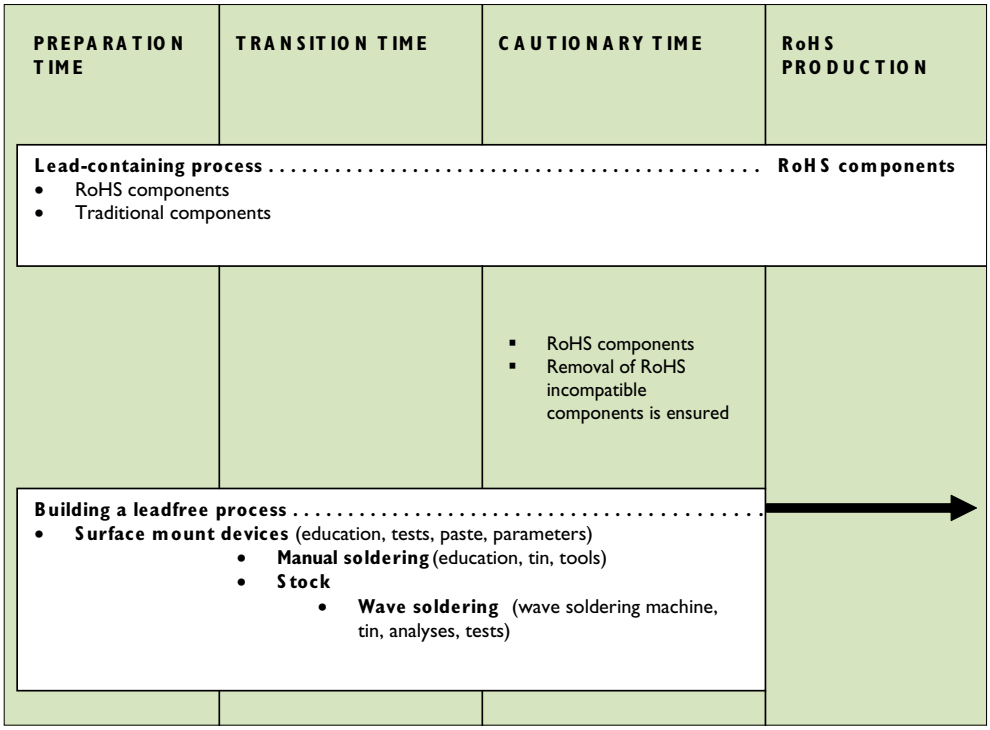

Figure 1. Stages of shifting to RoHS compatible production. (Source: Dicro Oy 2005)

15 Aspocomp Oy provides electronics components and services, such as the design and manufacture of printed circuit boards and modules. Aspocomp's products are used in the electronics industry in, for example, portable devices, telecommunication networks, automobiles and other industrial applications. Dicro Oy is a contract manufacturer of cable, electronic and electromechanical assemblies, and provides design and engineering services related to these products. Incap Oyj offers box-built services to product suppliers in the electric and electronics industry relating to electronics and mechanics, such as design services, machining and plating, component-mounting of printed circuit boards, sheet-metal mechanics, manufacture of flexible printed circuit boards, final assembly and product integration. Reimax Electronics Oy is a contract manufacturer and subcontractor in the electronics industry providing assemblies and testing for mechanical and electronic products as well as custom-made conductor and cable series. Scanfil Oyj is a contract manufacturer and systems supplier for the telecommunications and electronics industry. It offers services and products as a systems supplier to the telecommunications industry and industrial electronics customers.

Management of component and material data

Availability of RoHS compliant components was still a problem in 2005, although the situation was improving. The turn of 2005-2006 was the deadline many of the component suppliers had aimed for in this respect. But with Vaisala, for example, the availability of certain components was not guaranteed by the suppliers until the RoHS directive has entered into force. Companies have first inquired about the availability of RoHS compatible components, and then gradually started to put pressure on the component suppliers that only RoHS compatible components and materials will be bought within given timeframes.

The updating of component stocks has been surprisingly labour intensive for many of the interviewed companies. For example, the mechanics and electronics contract manufacturer, Scanfil Oyj, has 30 000 active component items and a total of 40 000-50 000 items in its stock inventory. In November 2005, less than 20% of the stock items were guaranteed by Scanfil's suppliers to be RoHS compatible. In Incap Oyj approximately two thirds of the stock value in 2005 was RoHS compatible and in Aspocomp Oy 20 % of the stock components were RoHS compatible at that same time.

A common practice seems to be that new stock items are not assigned for RoHS compliant components, but lead-containing and leadfree components are monitored concurrently for as long as there still are lead-containing items in stock. The RoHS compliant products are affixed with labels. There are, however, several types of labels for marking the components and they vary from company to company, since no official standard has yet been established for the RoHS compliance marking.

Due to the RoHS requirements the attention has strongly shifted to the better management of the product material content data. With Scanfil Oyj, for example, the mere number of component items says something about the work that is required to compile and maintain the needed data. Some of the clients of the interviewed subcontractors and contract manufacturers expect more precise or extensive data than the terms of the RoHS directive provide for and have their own lists of banned or monitored substances. These data are required even at the level of components and subassemblies. The capacities of the subcontractors and contract manufacturers to respond to these demands vary, but the most common practice is to provide a RoHS compliance declaration for the component, not for its subentities.

Material data management requires from many companies an increased amount of resources, that is, employers whose main work is, at least for a certain period of time, to collect and update data on the components' material contents. It takes time before material listings can be produced. A common problem in the collection of material data has been that obtaining the information can take much longer than anticipated, "sometimes up to 3-4 months, even when requested directly from the factory". Component batches are also bought from distributors and not from the original manufacturers, in which case obtaining the information can be even more difficult. The materials in the different batches may come from different sources, depending on which factory they have been manufactured in. There are also components on the market the origins - and through that material contents (and RoHS compliance) - of which are difficult to trace.

Demonstrating conformity

"It will be a long stretch before we can say with full certainty that a product is RoHS compliant or leadfree."

The manufacturers or actors who place products on the EU markets are ultimately responsible for the RoHS compliance of the products. However, the responsibility of demonstrating compliance is in practice increasingly cascaded to the contract manufacturers, suppliers of subassemblies, components and materials, and the distributors. In the supply chains, it is currently discussed how the responsibility should be divided, who is in charge of what part of a product's RoHS compliance: the company that has ordered and designed the final product, the contract manufacturer that acquires the components for the product from selected vendors or distributors, the vendor who sells the components, the manufacturer of the components or, at the beginning of the chain, the material manufacturers.

The following example demonstrates how the issue has been discussed between companies:

> *According to a representative of a contract manufacturer, "Vaisala defines the components for its products in its product specifications, so Vaisala has to also know the specific details of components used in its products. According to a representative of Vaisala's product development, "You manufacture the products on the basis of Vaisala's specifications. You thus have the final information on what components you have in stock. We rely on our partners' and subcontractors' knowledge in this respect. We do not purchase the components or perform the component mounting."*

How can it be ensured that a product complies with the RoHS requirements? As yet, there is no official standard or consistent method for demonstrating compliance. Different practices for demonstrating and ensuring conformity have, however, started to evolve (Mustonen 2005):

- Assurance from the component manufacturers or suppliers that the products do not contain forbidden substances beyond the established maximum concentration values. The assurance can be given in the form of a declaration of conformity or a materials safety data sheet (MSD).
- Product markings to prove conformity (labels, e.g. RoHS compliant or leadfree). The markings vary between companies since no official standards have yet been established.
- A certification of RoHS conformity by a third party that proves that the production can produce RoHS compatible materials and components.
- Testing of new components and random analysis of components in production.

Currently, companies rely greatly on the evidence of conformity given by the component and material suppliers. The costs of material content analyses on the products limit their use. There are also problems involved in the testing methods of RoHS compliance. In Nokia's experience, measuring the RoHS compliance of even a single component can prove a challenging task because every material found in the component has to be treated as a homogenous, in other words, the component cannot be treated as a single entity. Since some exemptions are allowed in the use of lead, one and same component can contain lead in both allowed and restricted use purposes. Electronic components are often extremely small, which makes the analysis complicated. A hundred components can fit in the area of a five-cent coin. It has also

turned out that different measurement methods can produce highly different results. In such cases the question to consider is who has the knowledge to interpret and compare the results and for what purposes the testing methods are best suited.

RoHS compliance is also entering contracts and supplier assessments. The contracts (procurement, product development, production and other partnership contracts) define in practice the responsibility for RoHS compliance. RoHS declarations of conformity are becoming a common practice.

Experiences from the RoHS implementation

The RoHS project in companies has not ended in July 2006. The work is by nature continuous ensuring that the components and materials used in the products meet with the RoHS requirements. This is of special importance in situations where new suppliers and components are chosen. At question here is not lead alone, since the RoHS directive also regulates the use of several other substances.

Interviews with the contract manufacturers clearly showed that RoHS implementation is not just a question of client-driven processes and cascading demands from large client companies to their subcontractors and contract manufacturers. Supply chain management works both ways. Some of the component suppliers and contract manufacturers have influenced their clients' RoHS deadlines by speeding them up. For example, Vaisala's Malaysian electronics supplier urged Vaisala's product development to address these issues even before Vaisala had the capacities to implement RoHS changes in its designs.

Is RoHS implementation expensive to companies? Even though it has been estimated that the prices of components will rise 10-20 percent, the costs increase has not in fact been so significant according to the interviewed companies. The main costs have arisen from investments in soldering equipment, test runs in production and the increased costs of solders. But even more expensive than investments in equipment has proven the manpower used in companies for carrying out their RoHS projects. Estimates by three subcontractors and contract manufacturers on the company time invested in the RoHS project varied from one to ten manpower years.[16] All in all, estimating the RoHS costs or benefits is still difficult as the work employs several people part of the time and it is distributed over several years. In addition, the most intensive phase of implementation is currently going on in the companies.

Another key question is how compliance with the RoHS requirements is controlled. Since the requirements have long been and still are unclear, the control is bound to prove problematic. Due to the great number of components and suppliers it will in the initial stages, at least, be impossible for the companies to test the reliability of the evidence of conformity. It is more of a question of trust. This, on the one hand, enables free-riding, and on the other, can lead to problem situations also in the companies that have taken the RoHS requirements seriously. The question of how public authorities are preparing for controlling compliance was not examined in this study. It is however obvious that free-riding is a serious threat to the objective of Product Policy to "reward those companies that are innovative, forward-thinking and committed to sustainable development" (CEC 2003a, 5). This means that control has to go beyond regulation "on paper".

16 In the Finnish companies Idman Oy, Tellabs Oy, Ahltronix Oy, Yleiselektroniikka Oyj, Aspocomp Oyj and Evox Rifa Oyj, interviewed in 2004, the amount of RoHS work was estimated somewhere between a few to 30 manpower months (Mustonen 2005, 62-63.).

2.2

Requirements of the WEEE directive: Stickers and collective schemes

- In the directive of the European Parliament and of the Council on Waste Electrical and Electronic Equipment (WEEE directive) the responsibility for the waste management of discarded products as listed in Annex 1A of the Directive has been placed on the producers (manufacturers and importers).

- Because it is a minimum requirement directive, Member States can, if they wish to, set stricter requirements than the ones provided for in the directive. National regulations were to become effective by 15 August 2005. This happened in Finland, but some other Member States have been late in adopting national measures.

- In Finland most of the producers have decided to look after their responsibilities through collective producer schemes, of which several have been founded (Flip, ICT Producer Organization, Selt, SERTY and Nordic Electronics Recycling Organization NERA). Their overseeing authority in Finland is the Pirkanmaa Regional Environment Centre, which maintains a registry in which all producers have to sign up independently or through a producer organization.

- The WEEE directive is available in English at http://europa.eu.int/eur-lex/lex/LexUriServ/site/en/oj/2005/l_191/l_19120050722en00290058.pdf. and the Finnish Government Bill for its implementation (in Finnish) at http://www.finlex.fi/laki/alkup/2004/20041852.

The main objectives of the WEEE directive are to prevent the generation of electric and electronic waste and a maximum recovery of the waste. Another aim is to improve the environmental performance of different stakeholders throughout the whole product life cycle of electrical and electronic products. The directive is thus based on the principle of extended producer responsibility (Lindhqvist 2000). This means that efforts are made to decrease the overall environmental impacts of products by "making producers responsible for the whole life cycle and especially for the take back, recycling and final treatment of their products". The aim is to encourage producers to take environmental issues into account already in the product design phase.

The fact that the directive has been especially targeted at electric and electronic equipment has been grounded in, for example, the fast increase of waste from these products, problems related to hazardous substances in electronic components at the waste treatment stage and insufficient recycling of the waste. The need to take action at Community level is based on the notion that differences in national measures and producer responsibility schemes could cause considerable disparities in the financial burden placed on the producers of electrical and electronic equipment and reduce the effectiveness of the recycling systems.

The directive allows companies to look after their producer responsibilities either individually (per company or product brand) or by joining a more extensive producer scheme, i.e. a producer organization. A majority of the producers have opted for the latter alternative, because the costs are usually lower within such schemes than in models based on individual producer responsibility. One potential problem, however, in the collective model is how the costs are individually divided between the members

of the producer organizations. This is essential in terms of the impact the principle of producer responsibility should have on product design (Tojo 2004). Financial responsibility at an individual level presupposes that the products are sorted out at least at a product brand level and that producers have control over their products after they have been discarded (Tojo 2004).

Nokia Oyj has for several years anticipated the requirements placed by the directive and improved the recycling and disassembly capacities of its products. The company has, among other things, developed together with telecommunication operators take-back systems for mobile phones (for further details, see Nokia 2005c; Kautto & Heiskanen & Melanen 2001, 42-23; Kautto 2006). Nokia manufactures both consumer products (mobile phones) and products for companies and operators (base stations and other products for network business), which means different practices and channels for discarding products. The main challenge in consumer products has to do with logistics: how is the collection and treatment of discarded products organized in different countries, since Nokia operates at a global level. Another challenge is presented by the growing numbers of discarded mobile phones. In 2004, it was estimated that 630 million mobile phones were sold worldwide (Nokia 2005a).[17]

The situation in Vaisala Oyj differs from Nokia's especially in that Vaisala manufactures business-to-business products and therefore it is not responsible for "historical waste" (waste from products sold before the requirements of the directive entered into force), as opposed to manufacturers of consumer products. Vaisala's only volume product is the radiosond, with a yearly sales volume of 400 000 pieces. In this respect, the practical implications of the directive have been quite different for Vaisala compared to Nokia. In Vaisala's product development, the WEEE directive has in practice meant designing a marking label in accordance with the directive (picture of waste container with crosses) and affixing it to the products that are released from production.[18]

A key question for the WEEE directive is how the collection and treatment of discarded products is provided for in the different Member States? In Finland Vaisala took part in the founding of the SELT producers' entity[19] in autumn 2004. SELT handles the collection and treatment of Vaisala's products in Finland, and also the reporting to the relevant authorities. The collection and treatment of discarded products in other Member States is handled through separate agreements between Vaisala and its clients. Traditionally business-to-business waste has not been channeled through the general municipal collection systems but has been delivered by the clients and at their cost directly to local collection operators. If the agreement is that Vaisala pays for the costs of the waste treatment, it appoints a local recycling operator to whom the discarded products are delivered. Vaisala also handles the reporting required by the national authorities or authorized representatives, and can, if necessary, join appropriate producer schemes. Decisions concerning this issue were still in the making in autumn 2005.

Because there are differences in the implementation of the WEEE Directive between the Member States and the implementation has just recently started, the situation within the producer organizations is as yet unestablished. Companies may have difficulties understanding what they are committing to as they enter agreements with producer organizations in various countries. Although the requirements for the different Member States are basically consistent, the take-back and recycling systems vary from country to country. The objective of the directive to prevent disparities

17 The figure represents the total sales of mobile phones by all the manufacturers.

18 WEEE marking standard EN-50419.

19 SELT Association is an open service organization for producers of lighting, heaters, electric tools, health care equipment and supplies of surveillance and control equipment (business-to-business/professional electronics). Elker Oy is the service organization of the recycling system (www.selt.fi; www.elker.fi).

caused by differences in the financial burden placed on producers of electrical and electronic equipment due to differences in the national producer responsibility systems, is not, in this light, being fulfilled.

Many non-EU countries (e.g. Japan, China, and some states in the US) have adopted or are in the process of preparing legislation on waste electrical and electronic products. Attention has thus to be paid on what practices are establishing themselves on these markets. Vaisala has proceeded from the principle that operating models for product take-back and recycling are first organized in EU countries. At the same time, efforts are also made to prepare for take-back requirements to be placed on other countries by 2010.

It is too early to assess the overall impact of the WEEE directive, that is, to what extent its goals have been achieved, and this would require different type of data. This is especially true for the assessment of how effective the Directive has been in preventing the generation of waste from electrical and electronic products. The directive seems, however, to have effected product design so that the recyclability of products is taken better into account in material choices and structural solutions (cf. Tojo 2004; Kautto 2006). According to preliminary data, the entering into force of the directive has enhanced the recycling of waste electrical and electronic products (cf. Tojo 2004), but the great variety of these products (compared, for example, to packaging materials) also significantly complicates the equitable sharing of costs in the producer organization models. Links to product development also remain weak if the bulk of the costs does not fall upon the producers whose products ultimately account for the greatest costs.

2.3

EuP directive: EuP – what is it?

- The directive of the European Parliament and of the Council Establishing a Framework for the Setting of Ecodesign Requirements for Energy-Using Products (EuP directive) was approved in July 2005. Its national implementation must be completed before August 11, 2007.

- The EuP directive is, like the RoHS directive, a harmonization directive, which in practice means that there should be no disparities between Member Sates concerning its level of requirements.

- The Commission will, on the basis of directive, establish more detailed, product group specific implementation measures for the product design of energy-using equipment. The Commission must adopt a working plan before July 6, 2007 on the possible product groups for which the measures have been planned at the initial stages of the process. According to the preliminary working plan included in the directive, the implementation measures will probably be at the first stages directed to the following products groups:

  - Heating and water heating equipment
  - Electric motor systems
  - Lighting in both the domestic and tertiary sectors
  - Domestic appliances
  - Office equipment in both the domestic and tertiary sectors
  - Consumer electronics
  - Heating, ventilating, air conditioning systems (HVAC)

- These product groups have been identified in the reports of the European Climate Change Programme (ECCP) as ones in which there is a special potential to improve energy efficiency (by e.g. reducing their energy-use in stand-by or off-mode) and to thus reduce the generation of greenhouse gasses. The Commission is also expected to establish a separate horizontal implementation measure to reduce the energy use of products in stand-by or off-mode, which would apply to a wider range of product groups.

- The national authority responsible for preparing the national implementation of the EuP directive in Finland is the Finnish Ministry of Trade and Industry. The EuP directive is available at: http://europa.eu.int/eur-lex/lex/LexUriServ/site/en/oj/2005/l_191/l_19120050722en00290058.pdf.

The European Commission has in the context of its preparation characterized the EuP directive as "a breakthrough in product policy", "a major contribution to sustainable development" and an "enormous cultural change" in environmental regulation (CEC 2003c; ENDS Environment Daily 2001). It has also been described by researchers of environmental policy as highly innovative legislation (Dalhammar 2005, 10). The EuP directive is the first time the New and Global Approaches generally used in product safety directives are applied to environmental regulation. This means that harmonized standards will be used in issuing technical regulations and that the assessment of compliance with the directive's requirements makes use of environmental management systems and environmental labels. The directive also embraces the idea of companies' as "regulatory surrogates", i.e. it makes them responsible for their contract manufacturers and subcontractors (cf. Gunningham & Sinclair 2002; Vedung 1997, 153).

The preparation of the EuP directive was based on an aim to define more consistent guidelines for what environmental requirements are set for the design of energy-using products. The main objectives of this process concerned improving energy efficiency within the EU region, the obligations to reduce emissions of greenhouse gasses related to the Kyoto Protocol and the goals of the European Climate Change Programme. It has been estimated that energy-using equipment consume approximately 30 percent of primary energy within the European Union, and its share of carbon dioxide emissions that end up in the atmosphere is about 40 percent (Commission of the European Communities 2003b, 5). As product design can have a preventive influence on negative environmental impacts, it has been regarded necessary to set more specific ecodesign goals. Some of the manufacturers of energy-using products have already integrated environmental aspects into their product design but many high-energy-using products are still being placed on the market that require improvement in terms of their environmental performance.

The EuP directive applies to a wide range of energy-using products, including their components and subassemblies. Only equipment for the transport of goods and people is excluded from the directive's scope of application. Even products used for the production, transfer and measurement of energy fall within the scope. The directive does however state as a criterion for adopting implementation measures that a minimum of 200 000 pieces of a regulated product are sold on the internal market per year. The product should also have significant environmental impacts that have a high potential of being reduced without unreasonable costs. In practice, the EuP directive does not impose obligations on the manufacturers and importers of products until an implementation measure has been established for the given products and its requirements have entered into force.

Nokia Oyj has, since the first drafting stages, taken part in the discussions on the formulation of the EuP directive's requirements (see Kautto submitted; Kautto 2005). Its main channel of influence has been EICTA (European Information, Communications and Consumer Electronics Technology Industry Associations), but together with other major corporations in the electrical and electronics industry (e.g. Electrolux, Hewlett-Packard, IBM, Intel, Philips, Sony and Sun Microsystems) Nokia has also had direct contacts with the EU Commission and European Parliament. Nokia's products may become subject to the implementation measures in the Commission's working plan for consumer electronics and energy use in stand-by or off-mode. It seems unlikely that the measures will apply to Vaisala's products, at least at the initial stage of implementation. Vaisala Oyj has however monitored the development of the directive's contents at the preparatory stage and organized training for product designers on the EuP requirements.

A question that is widely discussed during 2006 in the Commission and in the industry is how (with what methods) and for what products should the implementation measures be prepared. A study was completed upon the Commission's request in 2005 on the methodology and information system which could be used for the comparison of products' environmental impacts in whether they meet the criteria for implementation regulation[20]. The Commission has also launched preparatory studies on 14 product groups in early 2006. The purpose of these studies is to determine whether and what kind of design requirements should be set for products from these groups and what means there are to improve their environmental performance. The 14 product groups are:

- Boilers (gas, oil, electrical)
- Water heating equipment
- PCs and computer monitors
- Copymachines, facsimiles, printers, scanners, multipurpose equipment
- Consumer electronics: televisions
- Stand-by and off-mode consumption losses (for products other than those on which preparatory studies are made)
- Batteries and external power sources (with the exception of PCs and computer monitors)
- Office lighting
- Street lighting
- Indoor air conditioning equipment in residential buildings
- Electric motor systems
- Refrigerators and freezers in professional use
- Refrigerators and freezers in domestic use
- Dishwashers and washing machines in domestic use

What impacts does the EuP directive have? Along with the directive, ecodesign will gradually become a standard requirement for a growing number of companies. According to the basic principles of the directive, environmental goals must be integrated into product design already starting from the product specification. The requirements placed by the WEEE and RoHS directives and certain other directives are part of these ecodesign requirements. What is new about the EuP directive is that the manufacturers are obliged to prove that the most significant environmental impacts of their products during their life cycle have been assessed and that they are presented in the form of ecological profiles. The EuP directive obliges also the parts and component

20 For more information on the project Methodology Study for Ecodesign of Energy-using Products (MEEUP), see http://europa.eu.int/comm/enterprise/eco_design/

suppliers to provide material and energy data on the manufacturing of these parts so that the manufacturer of the final product can perform these assessments and ecological profiles on their products. Product manufacturers will also have to more carefully maintain documentation on the integration of ecodesign requirements into their design processes (e.g. design goals and management of product design process). [21]

The compliance of products with the EuP directive is performed by the CE-marking, harmonized standards[22], environmental labels and the manufacturers' own declarations of conformity. Management of the product design process can be proved through, for example, environmental management systems if they include elements of product design. In both Nokia and Vaisala environmental requirements, such as the RoHS substance restrictions, have been integrated into the companies' product development guidelines in different business units. Both companies have also adopted an ISO14001 standard based environmental management system.

Ultimately the level of the EuP product design requirements will not be transparent until the first implementation measures have been established. Most frequently discussed questions during the preparation stage of the directive have concerned such issues as the level of detail of the life cycle assessments required for the products and what resources do small and medium-sized enterprises have to perform these assessments. Nokia has conducted several life cycle assessments on its products and studied different methods of assessment. The results of these assessments have however been somewhat conflicted (see, e.g. Nokia 2005a; also Chapter 3 of this report). Consequently, Nokia has decided to gather material data on its products from its suppliers as extensively as possible. Systematic collection of these data started in 2001, and material data were also included already then in the coding requirements for the different component groups. Vaisala has performed a detailed life cycle assessment on one of its products, but several methods have been applied in this analysis. Vaisala has been considering options between labor-intensive LCAs and other ways of monitoring the environmental performance of products that have more practical potential in the product design work.

Even though the manufacturer of the final product is ultimately responsible for the EuP compliance of the product, product design activities are increasingly being outsourced to contract manufacturers and other subcontractors. For this reason, these companies have to also assure their compliance with the directive's requirements and be aware of their obligations.

21 For more details on the EuP requirements, see, e.g., Kärnä (2005, in Finnish).

22 The work to establish harmonized standards relating to the EuP directive has already begun. In Finland the SESKO Committee SK111for environmental standardization for electric and electronic products and systems is the national monitoring group for all IEC and CENELEC bodies involved in the standardization of the electrotechnical industry.

3 Making product policy: Nokia's mobile phones as an IPP pilot project

- In its Communication on Integrated Product Policy (2003a, 15-17), the Commission stated that it "will carry out a number of pilot projects to demonstrate the potential benefits of IPP in practice".

- In summer 2004, the Commission announced that it would launch two pilot projects, one of which centered on mobile phones and which would be headed by Nokia (Commission of the European Communities 2004; Nokia 2004). The project started officially at the turn of 2004-2005, and it has been carried out in the following stages:

1. Analysis of the environmental impacts of the product throughout its life cycle (~10/2004-2/2005)
2. Identification of options to improve the environmental impact of the product (~3-6/2005)
3. Analysis of the potential social and economic effects of the improvement options identified at stage 2 (~7-12/2005)
4. Selection of the viable options for improvement and establishment of implementation plan (~12/2005-4/2006)
5. Implementation (~4/06-04/07) and its analysis (~05/07).

In addition to Nokia and the Commission, the other participants in the project are:

- Mobile phone manufacturers: Motorola, Panasonic
- Component manufacturers: AMD, Epson, Intel
- Governmental organisations: Department for Environment, Food & Rural Affairs DEFRA (UK)
- Research Institute: Finnish Environment Institute (SYKE)
- Telecom operators (retailers): France Telecom/Orange, Telia Sonera, Vodafone
- Recycler: Umicore
- Environmental NGO: WWF
- Consumer organization: BEUC

The reports of the first two stages (Nokia 2005a; 2005b) and further information on the pilot project can be found at:
http://www.ec.europa.eu./environment/ipp/mobile.htm

The Commission's Communication on Integrated Product Policy has set as its primary objective "to reduce the environmental impacts from products throughout their life-cycle, harnessing, where possible, a market driven approach, within which competitiveness concerns are integrated". The five key principles stated in this context are life cycle thinking, working with the market, stakeholder involvement, continuous improvement and the use of a variety of policy instruments.

The YPSE research project has observed the pilot project on mobile phones especially through Nokia's involvement since January 2005[23]. The pilot project was still underway at the beginning of 2006. The third stage, which might be the most important one in terms of environmental policy formation, was being carried out during that period. However, some conclusions can already be drawn on the implications of the pilot project to Nokia. The significance of the project to the wider development of Integrated Product Policy is in turn more difficult to assess. If the third and fourth stages succeed to produce agreements on common targets of development and on their implementation, this work could have a major impact on Integrated Product Policy.

It is however already evident that this operating model has not only articulated the key principles of product policy but also brought forth certain essential issues and problems related to the implementation of product policy, especially when it comes to technically complex products like mobile phones. Among these aspects are:

- There are problems with obtaining the information required for life cycle assessments (LCAs) and with the reliability of the available information. Nokia has already for years worked with life cycle assessments concerning its products. Despite this work, there are still a number of uncertainties and limitation problems connected with the assessments. The availability of data on components and raw materials used in them varies. The available information is often so inexact that it does not, for example, reveal differences in material choices, which tend to be drowned under general informational uncertainties. The effective use of LCAs in product development work is also limited by the slowness of the analysis and the complexity of the results for product designers who may not be experts in environmental issues.

- The situation being such in a large company like Nokia that has vested a substantial effort into environmental issues, life cycle thinking could be a better premise for environmental improvements in smaller companies, especially. Alongside it, rather than life cycle assessments, the product development work could be better supported by Key Environmental Performance Indicators (KEPIs, see Singhal et al, 2004). KEPIs are also based on LCAs, but the idea is that after the initial assessment, only the most relevant aspects are selected and monitored to support product development. In the case of mobile phones, these aspects include, .e.g., products' energy consumption during their manufacture and use and reductions in the use of the most hazardous materials. The practical product development work focuses on monitoring the KEPIs, which are updated regularly.

- The Commission's Communication on Integrated Product Policy (2003a, 5) states that IPP incentives should "reward those companies that are innovative, forward-looking and committed to sustainable development".

23 In practice this has meant observation in Nokia's IPP pilot project group and a number of interviews. The reports produced within the pilot and some of their drafts have also been analyzed during the project. The research has also included some more active participation in the pilot project. See the reference list of this report for more details on the data.

Formulation of this type of policy can be problematic when carried out together with industrial organizations that are mainly interested in searching for the smallest common denominator (Martin 2000, 14; Peters 2001, 81). For example, in the formulation of the WEEE directive the Commission and the stakeholder organizations were long in favor of a model for producer responsibility based on collective financing. Studies in the field have however shown that placing financial responsibility on producers individually is the most important precondition for the effective achievement of the objectives of producer responsibility (e.g. Tojo 2004). The Electronics Coalition formed by certain major corporations (including Nokia) managed however to include in the directive the option of individual producer responsibility. The IPP pilot project has emphasized as an alternative product policy-making means the establishment of "best practices and front-runners" as a starting point for the formulation of the requirements for environmental product policies. Experiences from Japan on this "top runner approach" have been for the most part positive (Tojo 2005).

- It seems that the Commission had some difficulties to make firm commitments related to the policy tools due to the complexity of the political decision making system in the EU. That was also reflected in its difficulties in keeping up with the schedule.

- Since the ultimate objective is to bring about changes in entire organizations and not just in their units responsible for environmental issues, the commitment of the organizations' top management is an important prerequisite for the success of these types of projects.

- Activating and committing participants to a project of this kind requires a great amount of work, even in a case involving major operators and a pilot project that probably has higher visibility than other potential, similar projects are likely to have in the future. The possibilities of SMS's and NGO's to take part in these projects largely depend on the support and resources received from public authorities. The upshot is that even though a process like this can reveal many essential factors and increase the knowledge of the parties involved, participation in it is in practice only possible for major actors with the needed resources at their use. On the other hand, the same applies to any other efforts to exercise influence at EU level.

- Due to the scale of the IPP pilot project, among other things, even those who have followed it closely have trouble determining on what bases certain solutions have been chosen. The position of the organization heading the project (in this case Nokia) has been strong because only the organization itself has a clear overall view of the material produced in the project. As the writer of the reports, the company is, at least to some extent, able to choose which issues are emphasized in them.

For Nokia, participation in the project has provided especially an opportunity to present the environmental work it has carried out for years already, and which has been regarded within the company as significant. This has probably further strengthened the image of Nokia as a company with a high commitment to environmental issues.[24] Another advantage of the project has been that Nokia has had the chance to voice problems and development ideas that have to do with environmental regulation in the electronics sector. Since Nokia has, at the same time, shown careful consideration for environmental issues in its own operations, the critique the company has presented has been listened to. The most significant stage of the IPP pilot project in this respect was underway in early 2006. Nokia has, however, had several opportunities to express its views on the areas in which the WEEE and RoHS directives ought to be revised. This action has apparently born results, since the Commission has in its recent Communication (Commission of European Communities 2005a, 51) on the implementation of the Lisbon Strategy (simplifying regulation) mentioned these directives as ones that need to be reviewed.

Participation in the IPP pilot project has continued the proactive approach Nokia has assumed, according to which it is better for the company to take part in influencing the contents of the requirements than to simply adjust to regulations others have laid out and that might be less than suitable to practical business operations and environmental work. In the background of Nokia's proactive role has been, not only a shared view that influencing policy requirements should be carried out at the earliest possible stage but also dissatisfaction with the industry's contribution and cooperation in the formulation of the RoHS and WEEE directives. One thing that has enabled Nokia's increasingly active role has been the growth of Nokia's environmental organization at the end of the 1990s, which made it possible for certain persons to concentrate on discussions in the field of environmental policymaking.

Nokia's activities have largely been based on cooperation with the industry within the framework of the EICTA (European Information, Communications and Consumer Electronics Technology Industry Associations), although in some cases Nokia's views have differed from those of many other companies. In such events, Nokia has formed ad hoc coalitions (see Coen 2005) with other major corporations and organizations operating in the field. Nokia has so far been one of the few companies in the electrical and electronics industry that have lobbied for collection of material data also beyond the scope of existing legislation (RoHS requirements).

Nokia has its own office in Brussels for following EU legislative work. Since Nokia is a highly important client for many Finnish companies in the electronics industry, its active role in following the formulation of European legislation has wider significance from the perspective of the Finnish industry. This significance is further enhanced by the fact that participation in the discussions on the formulation of legislation at a European level requires a great amount of resources, which only a few companies have at their disposal (see, e.g. Mazey & Richardson 2001, 225-227).

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24 Nokia's environmental work has recently been acknowledged in several contexts, such as listings in the Dow Jones Group Sustainability Index (DJSI) since 2000 and in the FTSE4Good index on corporate responsibility. Nokia also received the Appeal of Conscience Award for corporate responsibility and commitment to environmental issues in September 2005.

4 Conclusions

This report has aimed to describe the work and experiences of Finnish companies in the implementation of environmental product policy. The situations in the companies under study, Nokia Oyj and Vaisala Oyj, differ in relation to how environmental policies are applied. Nokia has taken part in discussions related to the contents of environmental regulations for products of the electrical and electronics industry. Vaisala in turn has more monitored the development of the regulations and prepared for changes, even though all the requirements do not apply to its products directly. What both companies do however have in common is a proactive approach to this work: "we have leaned forward in the implementation and seen where there are pain spots in the implementation".

In the following section some conclusions on the results of the study are presented, first from the perspective of companies in the electrical and electronics industry and then in terms of further development of environmental policy.

4.1 On the future challenges of environmental work in companies

Implementation of the RoHS, WEEE and EuP directives has effected the operations of the manufacturers and the whole manufacturing chain of the regulated products in different ways. These effects will be discussed in the following section and are also summarized in Figure 2.

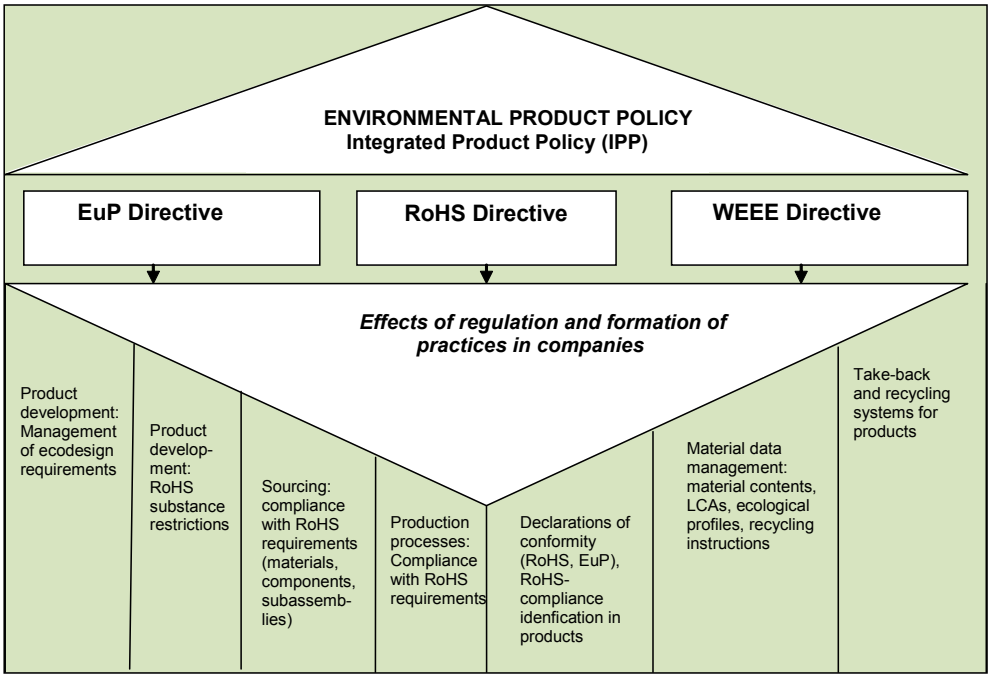

Figure 2. Effects of environmental product policies on companies' operations.

The new directives have speeded up the environmental work in the companies to which the regulations apply. Although the companies have reacted to individual questions and requirements also before (for example, restrictions on the use of CFCs, requirements of the packaging waste directive), more systematic environmental development work has not started in most companies until the late 1990s. The first stage in this work has often been to establish an environmental management system, which most of the larger companies have by now adopted. [25] After that, more and more attention has been paid to a more systematic integration of environmental aspects into product design (ecodesign). The third stage is better supply chain management which will be speeded up especially by the requirements of the RoHS directive but also by the EuP directive.

Life cycle thinking and ecodesign have also established themselves in the vocabulary of companies and gradually in their actions as well. The larger companies have already for some years been engaged in work relating to environmental issues. Even smaller companies will have to awake to the new perspectives now by the latest due to the new directives. Implementation of the RoHS requirements is, however, the first more extensive project in response to environmental legislation for companies in the electronics industry. RoHS requirements effect both product design and the way in which products are manufactured. Through this, they have an impact on business operations: RoHS compliance will become a precondition of the companies' competitiveness and the RoHS requirements will also steer the direction and speed of product development.

25 A survey carried out in autumn 2003 among the members of the Federation of Finnish Electric and Electronics Industry showed that almost all of the about 50 companies (which present around 50 % of the members) that had participated in the survey had adopted an environmental management system. The effects of the system had however been relatively small on product development (more on the results in Kärnä et al 2004, see also Kautto 2006). Environmental aspects had been taken into account in product development, but not as a result of the environmental management system. The most significant benefits of the system to the companies had been increased awareness of the environmental impacts of the companies' own operations and a higher commitment to monitoring the development of relevant legislation.

While the RoHS directive is targeted at the material and substance contents of products, as a result of the EuP directive, integration of environmental aspects into product design (ecodesign, design for the environment, DFE) will become common practice and be required of the companies. In the companies this work often begins as exercises in single projects from where it gradually becomes an established design practice, according to which all projects go through certain environmental requirements at the different stages of the product development process. DFE could be described as continuous improvement of the capacity of product development to anticipate changes in the operating environment, which includes proactive responses to legislative requirements. The RoHS directive has helped the developers of environmental work in companies. It has been a change project of such scale that is has also increased the credibility of the work carried out by these people – environmental issues are no longer something "nice to consider" but actual technical requirements for product design and production.

The RoHS directive has also launched extensive studies of the material contents of products within the industry. Collection and maintenance of product specific material data is a demanding and continuous process for companies and it requires closer cooperation in information exchange between the different organizations involved in the supply chain. The collection and interpretation of material data is further complicated by the fact that final products can be examined at many different levels: at the level of products, subassemblies, components or materials. This makes the contribution of the material, component and subassembly manufacturers and of the component distributors important in the collection of these data.

This report has largely focused on how companies are achieving compliance with the requirements of the new directives. Compliance is the first goal, but the companies that have reacted proactively to the requirements are also seeking other benefits from this work. For Vaisala, for example, as a company serving the field of environmental measurements, it has been an important question of image. It has been a question of image to Nokia, as well, as a company known for its commitment to environmental issues, but the work in Nokia has also been motivated by the need to minimize business risks. Alongside compliance with the requirements, the company has also given serious thought to how new technical solutions or applications could be developed from an environmental perspective in the long run, to be part of the product technology of the future while showing good business value.

4.2

On the future development of environmental policies

One objective set for Integrated Product Policy has been "to reduce the environmental impacts from products throughout their life-cycle, harnessing, where possible, a market driven approach, within which competitiveness concerns are integrated" (Commission of European Communities 2003a, 5-6). The five key principles stated in this context are life cycle thinking, working with the market, stakeholder involvement, continuous improvement and a variety of policy instruments. In the field of electronics and electrical industry, this policy has been manifested in practice in three EU Directives: RoHS, WEEE and EuP. They are each based on relatively different methods of regulation: RoHS on the ban and restriction of the use of hazardous substances and management of the product supply chain, WEEE on the principle of producer responsibility and EuP on management of the product supply chain and demonstrating compliance with the requirements of separately defined implementation measures (in a way chosen by companies from among certain alternatives).

It is interesting that the RoHS directive, which is based on the most traditional instruments of regulation, restrictions and bans, seems to have so far caused the most problems with the translation of the contents into practice. Since compliance with the directive's requirements was expected within just a few months' time and it is still unclear what the requirements in the end will be and how compliance with them will be controlled, it is difficult to talk about proactive responses to the regulation. A proactive approach has however been pointed out in many studies as one of the major factors that support innovations (Kivimaa & Mickwitz 2004, 369). For public authorities, uncertainties about the meaning of the requirements in practice will mean complications in controlling conformity with the RoHS requirements. These will be further increased by problems concerning the compliance testing of products. This could lead, on the one hand, to free-riding, and on the other, to problems in also those companies that take the RoHS requirements seriously.

The costs from the implementation of the RoHS directive have turned out different from what the companies initially expected: costs due to changes in materials and processes have been lower than expected and the highest costs have been connected with the labor involved in the RoHS implementation and especially in the data collection. The assessment presented in the Commission's draft proposal for the directive (Commission of the European Communities 2000, 24) was that abandoning the use of lead in soldering would be the only change resulting in "more substantial costs" and that it would be more a question of "fine-tuning alternative technologies than a cost question". According to our study, this assessment seems correct in general terms, but it excludes the largest cost item caused by the changes, that is, the output of work in the companies. It is of course mostly a question of costs connected with the transitional period, but in smaller companies, especially, the RoHS work may have delayed other development projects.

It is too early to assess the impacts of the WEEE directive at this stage and such an assessment would have to be based on different type of data. The directive seems, however, to have effected product design in the studied companies so that the recyclability of the products has been taken better into account. According to preliminary data, the directive has increased the recycling of waste electrical and electronic products. Implementation of the directive's waste management requirements appears to be mostly organized through models of collective producer organizations. In the collective producer organization models the diverse range of electrical and electronic products (compared, for example, to packaging materials) significantly complicates a division of costs in a way that is generally accepted as fair. This can also weaken the link to product development if the greatest costs are not directed to those producers whose products ultimately account for the greatest costs in the waste management systems. Consequently, the controlling authorities (and the producer organizations themselves) should pay special attention to where the costs are directed and to the flow of information within the producer organization schemes so that they would encourage continuous improvements in product development.

The industry has also been concerned about the fact that the national implementation of the WEEE directive varies greatly between the Member States. But at the same time, calls have been made for more flexible regulation through which local conditions could be taken into account in the selection of implementation measures. A similar conflict has also often appeared between predictability and flexibility. The establishment of parallel national systems has also been criticized as a waste of resources. On the other hand, they can, however, also be seen as welcome competition.

Similarly to the RoHS directive, a key aspect of the EuP directive will be supply chain management. Already now the experiences gained in the implementation of the RoHS directive offer an important point of comparison here. The RoHS experiences of the companies in our study have shown, among other things, that supply chain management is not only based on a cascade effect. It is not just a process driven by the manufacturers of final products; some of the component suppliers and contract manufacturers also tend to influence their clients' RoHS schedules by speeding them up. Supply chain management also clearly extends beyond borders and past the (EU) geographical area that is directly regulated. In this respect supply chain management, i.e. using companies as intermediaries of regulation and to control each other seems to be having an expected effect. It opens up possibilities for environmental (product) policies also in situations where production is increasingly shifting outside the EU region. But there are also problems still involved in the management of supply chains: the availability of information varies and the task of compiling information and assessing its reliability requires a great amount of resources. Supply chain management also raises the importance of questions relating to how legal responsibility is defined between product chain actors.

Another key question concerning the EuP directive is how the implementation measures are defined so that they genuinely encourage companies to continuous improvements and "reward those companies that are innovative, forward-thinking and committed to sustainable development" (CEC 2003a, 5). One interesting point of departure here could be the so-called "top runner approach" (see, e.g. Tojo 2005).

The EuP directive accepts environmental management systems as one method for assessing conformity. The practical link between these systems and product development seems however weak. Although the practices of implementing the directive will not truly form until implementation measures have been issued, controlling authorities and auditors of these systems should start to pay attention to what the ultimate objectives of the systems are for product design and what information they provide on compliance with the directive's requirements.

Apart from legislative measures, the electrical and electronics industry has been a target of Integrated Product Policy also in an IPP pilot project launched by the Commission on mobile phones in 2004. The project was still underway at the beginning of 2006, but the model may prove quite significant in terms of future development of Integrated Product Policy. However, it is already apparent that the model has pointed out some essential issues and problems that arise when the policy is targeted at products that are as technically complicated as mobile phones. These experiences need to be assessed and taken advantage of when environmental product policy is extended and developed in the future.

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Vaisala Oyj, other data

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The observation of the meeting organized by Vaisala Instruments together with its subcontractors and contract manufactures 13th January 2005 in Vaisala Oyj. In the meeting there were representatives from the following companies: Vaisala Oyj, Aspocomp Oy, Dicro Oy, Incap Oy, Reimax Electronics Oy, Scanfil Oyj and Sorv-Elektro Oy.

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Incap Oyj, Vuokatti: Heikkinen Raimo and Huotari Jukka, 9.11.2005
Scanfil Oyj, Vantaa: Jaakkola Ville, 18.11.2005
Reimax Electronics Oy, Klaukkala: Mahkonen Jarkko, 17.1.2006

* The interviewees were responsible for RoHS implementation in their organization, e.g., in production or in their customer projects. Duration of the interviews 45 min -1,5 hours.

Nokia Oyj, interviews *

Ahonen Salla, Nokia Corporation, 30.3.2005, 12.5.2005
Mäkirintala Olli-Pekka, Nokia Corporation, 24.1.2005
Singhal Pranshu, Nokia Corporation, several discussions during 2005-2006
Takalo Tapio, Nokia Corporation, 8.11.2005
Terho Markus, Nokia Corporation, 30.3.2005, 12.5.2005

Jalas Mikko, Helsinki School of Economics, Organization and Management, 13.5.2005
Seppälä Jyri, Finnish Environment Institute, several discussions.

* The interviewees were people who have been involved in Nokia's environmental work for a longer period of time, or in Nokia's IPP pilot project group and implementation work, or persons involved in the IPP pilot work as representatives of other stakeholders (SYKE). Duration of the interviews 1-2,5 hours.

Nokia Oyj, other data

Interviews of five Nokia's environmental specialists and observation of their work during 2005 (23 project meetings, 4 training days).
Observation of Nokia's IPP pilot project group meetings 19.4, 3.5., 11.5., 30.6., 18.8., 15.9., 4.10. and14.10.2005.
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Abstract	New environmental product policy measures (RoHS, WEEE and EuP directives), targeted to the products of electrical and electronics industry, are entering into force during 2005-2007. This report raises key questions that companies have confronted in anticipating and interpreting these new requirements in their operations, focusing especially on changes needed in product development and supply chain management. The report reveals that the work needed in companies to comply with the new requirements may begin years before the requirements enter into force, and it may take different forms. Depending on the resources companies possess, this work can vary from influencing the actual contents of the new regulation being developed to adjusting to new requirements and incorporating them into different company operations (product development, manufacturing, sourcing etc.). Two Finnish company cases are reported. The first describes how Vaisala Oyj is implementing RoHS requirements together with its key suppliers. The second case assesses the Commission's Integrated Product Policy pilot exercise on mobile phones, which was lead by Nokia Oyj during 2005. The report provides companies with useful information about practical experiences of proactive companies in environmental policy implementation, and policy makers with information for the assessment and future steering of environmental product policy in the European Union. This report is the final report of the YPSE research project, which was carried out during 2004-2005. It was financed by the Finnish Environment Cluster Program by the Ministry of the Environment and Technology Industries of Finland. The aim of the project was to assess how companies in the electrical and electronics industry "interpret" and negotiate with each other (and with environmental authorities) the contents of these new requirements, which are still to some extent unclear. It has been of interest what kinds of changes the new requirements create in products and what kinds of operational practices evolve in the industry, for example in the area of material data management.			
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Tiivistelmä	Sähkö- ja elektroniikkateollisuuteen ja sen tuotteisiin kohdistuvat RoHS-, WEEE- ja EuP-direktiivien vaatimukset tulevat voimaan vuosina 2005-2007. Tämä tutkimusraportti nostaa esiin avainkysymyksiä, joihin yritykset ovat törmänneet ennakoidessaan ja tulkitessaan näitä uusia vaatimuksia toiminnassaan, erityisesti tuotekehityksessä ja tuotteiden valmistusketjuissa. Tutkimus osoittaa, että työ, jota yrityksissä tehdään uusien vaatimusten mukaisen toiminnan varmistamiseksi, voi alkaa jo vuosia ennen vaatimusten voimaantuloa. Tämä työ on myös monimuotoista. Riippuen yrityksen resursseista, työ voi sisältää jopa suoraa vaikuttamista kehitteillä olevien ohjauskeinojen sisältöön. Usein työ on kuitenkin enemmän uusiin vaatimuksiin sopeutumista sekä niiden integrointia yrityksen eri toimintoihin, kuten tuotekehitykseen, tuotantoon ja ostotoimintaan. Tutkimuksen kohteena on kaksi yrityscasea. Ensimmäinen kuvaa Vaisala Oyj:n työtä tuotteidensa RoHS-vaatimustenmukaisuuden toteuttamiseksi yhdessä sen kotimaisten alihankkijoiden ja sopimusvalmistajien kanssa. Toisessa tarkastellaan EU:n komission vuonna 2005 käynnistämää yhdennetyn tuotepolitiikan pilottihankketta, jonka kohteena oli matkapuhelin, ja jossa Nokia Oyj oli mukana. Julkaisu tarjoaa yrityksille hyödyllistä vertailutietoa edelläkävijäyritysten kokemuksista ympäristöpolitiikan käytännön toteutuksesta, ja viranomaisille perusteita tuotelähtöisen ympäristöpolitiikan edelleen kehittämiseen ja suuntaamiseen. Julkaisu on YPSE-tutkimusprojektin loppuraportti. Tutkimusprojekti toteutettiin vuosina 2004-2005, ja sitä ovat rahoittaneet ympäristöministeriön Ympäristöklusterin tutkimusohjelma sekä Teknologiateollisuus ry. Tutkimusprojektin tavoitteena oli arvioida kuinka sähkö- ja elektroniikkateollisuuden yritykset tulkitsevat ja neuvottelevat keskenään (ja ympäristöviranomaisten kanssa) siitä, mitä uusien direktiivien vaatimukset käytännössä tarkoittavat - varsinkin tilanteessa, jossa nämä vaatimukset ovat edelleen jossain määrin epäselviä. Kiinnostuksen kohteena on ollut erityisesti se, millaisia muutoksia uudet direktiivit aiheuttavat tuotteisiin, ja millaisia toimintakäytäntöjä syntyy teollisuudessa, esimerkiksi tuotteiden materiaalisisältötiedon paremman hallinnan osalta.			
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Publikationens tema	Miljövård			
Publikationens delar/ andra publikationer inom samma projekt				
Sammandrag	Kraven i EUs direktiv RoHS, WEEE och EuP, som riktar sig till el-och elektronikindustrin och dess produkter, träder i kraft åren 2005-2007. Denna forskningsrapport tar fram frågor som företagen stött på då de räknat med och tolkat dessa nya krav i sin verksamhet, i synnerhet i produktutvecklingen och produkternas tillverkningsprocess. Undersökningen visar, att det arbete som görs i företagen för att garantera att de följer de nya kraven, kan börja många år före kraven träder i kraft. Detta arbete är mycket mångskiftande. Beroende på företagets resurser, kan arbetet innehålla till och med direkt påverkan på innehållet i de styrmedel som håller på att utvecklas. Ofta är det dock mera frågan om att anpassa sig till de nya kraven och att integrera dem i företagets olika verksamheter, till exempel i produktutveckling, produktion och inköp. Undersökningsobjekt är två företagsfall. I det första beskrivs Vaisala Oyj:s arbete att förverkliga kraven enligt RoHS-direktivet i sina produkter tillsammans med sina inhemska underleverantörer och kontraktsproducenter. I det andra fallet behandlas det av EU-kommissionen år 2005 startade pilotprojektet om integrerad produktpolitik, vars objekt är mobiltelefonen, där Nokia Oyj är med. Publikationen ger företag nyttig jämförelseinformation om två pilotföretags erfarenheter av hur miljöpolitik omsätts i praktiken. Den ger också myndigheter grunder för att vidareutveckla och styra en produktbaserad miljöpolitik. Publikationen är forskningsprojektet YPSE:s slutrapport. Projektet genomfördes under åren 2004-2005 och det har finansierats av miljöministeriets forskningsprogram Miljökluster och Teknologiindustrin rf. Forskningsprojektets mål var att bedöma hur el- och elektronikindustrins företag tolkar betydelsen hos kraven i de nya direktiven och hur de förhandlar med varandra (och med miljömyndigheterna) om dem – i synnerhet i situationer då dessa krav ännu i någon mån är oklara. Det har varit speciellt intressant att se hurudana förändringar de nya direktiven orsakar i produkterna och hurudan verksamhetspraxis de leder till, till exempel som bättre materialdatabehandling.			
Nyckelord	*miljöpolitik, effektivitet, elindustri, elektronikindustri, produkter, EU, direktiv, RoHS, WEEE, EuP, IPP pilotprojekt om mobiltelefoner*			
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New environmental product policy measures (RoHS, WEEE and EuP directives), targeted to the products of electrical and electronics industry, are entering into force during 2005-2007. This report raises key questions that companies have confronted in anticipating and interpreting these new requirements in their operations, focusing especially on changes needed in product development and supply chain management.

Two Finnish company cases are reported. The first describes how Vaisala Oyj is implementing RoHS requirements together with its key suppliers. The second analyses the Commission's Integrated Product Policy pilot exercise on mobile phones, which was lead by Nokia Oyj. The report provides companies with useful information about practical experiences of proactive companies in environmental policy implementation, and policy makers with information for the assessment and future steering of environmental product policy in the European Union.

The report is the final report of the YPSE research project, which was carried out during 2004-2005.

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