



Nordic Council
of Ministers

Circular plastics in electrical and electronic equipment

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This publication is also available online in a web-accessible version at <https://pub.norden.org/temanord2021-553>.

LIST OF ABBREVIATION AND ACRONYMS

BFR	Brominated Flame Retardants
CLP	Classification, Labelling and Packaging Regulation
CMR	Carcinogenic, mutagenic or toxic for reproduction
ECHA	European Chemical Agency
EEB	European Environmental Bureau
EEE	Electronic and Electrical Equipment
EPA	Environmental Protection Agency
EPEAT	Electronic Product Environmental Assessment Tool
EPR	Extended Producer Responsibility
ICT	Information and Communication Technology
GPP	Green Public Procurement
PEF	Product Environmental Footprint
POP	Persistent Organic Pollutants
PBT	Persistent, Bio-accumulative and Toxic
REACH	Registration, Evaluation, Authorization and restriction of Chemical substances
RoHS	Directive on Restriction of Hazardous Substances in Electrical and Electronic Equipment
SCIP	Substances of Concern In articles as such or in complex objects (Products) database
SCSC	Swedish Centre for Chemical Substitution
SIN list	Substitute It Now List
SME	Small and Medium Enterprise
SVHC	Substances of Very High Concern
vPvB	Very persistent and very bio-accumulative
WEEE	Waste Electrical and Electronic Equipment
WFD	Waste Framework Directive

1. SUMMARY

Electronic and electrical equipment (EEE) are becoming increasingly advanced. Smaller and smarter design is enabled, in part, by the sophisticated plastic components made possible by complex chemical additives. These additives adapt the chemical and physical properties of the plastic to achieve a desired function – for example to make the plastic more pliable, stiffer or more resistant to fire. The high pace of development also leads to short product lifetimes, rapid replacement and increased quantities of waste electrical and electronic product (WEEE). The plastic in this waste stream is typically incinerated (with energy recovery or as a means to access more valuable metal components) or landfilled. It is seldom recycled, as the additives are often hazardous, particularly if used in other contexts and product categories.

This report explores what the Nordic countries can do to promote the use of recyclable plastic components in electrical and electronic products, with particular focus on minimising their hazardous chemical component. The report provides an overview of the hazardous additives currently found in the plastic components of EEE, although this overview is limited by the information available from legislation and supporting studies, research and academia, NGOs and market actors. The number and variety of potentially hazardous chemicals used in plastics, the long supply chains with distant manufacturing, and limited control over imported products means that a comprehensive mapping has not been possible. The results presented here build upon input collected through a literature study, a policy analysis of EU and Nordic legislation and initiatives, interviews with experts across the value chain and a workshop bringing together a broader range of policy experts and key value chain actors. Together these inputs were used to assess and qualify possible future actions in the Nordic countries to minimise hazardous chemicals in plastic components of EEE.

EU legislation provides an overarching framework for the management, classification and control of chemicals, as well as limiting the use of hazardous chemicals in electrical and electronic products, including in their plastic components. The legislation is, however, limited to known harmful substances, and as new chemicals are constantly being brought to the market, it is quite possible that new and unknown hazardous chemicals that are not yet subject to legislative control are to be found in modern EEE plastics. This is particularly relevant for lower priced or budget products, products sold through internet portal, and other domains and products where control and enforcement is likely to be low. The EU's Chemicals Strategy for Sustainability Towards a Toxic-free Environment also includes the objective to make chemical legislation more agile and strengthen control and enforcement along the EU's borders.

Despite the limitations of EU chemicals legislation, it has had a definite influence on the global market. The Restriction of Hazardous Substances Directive (RoHS) has prompted similar regulation in many other jurisdictions, partly to ensure a common global market standard for EEE products. The majority of EEE is produced outside of the EU and comprises many components produced and assembled in long and complex supply chains. Yet the EU is a critical market for EEE products. As such, EU

legislation has a pronounced influence on global chemical regulation. The candidate list of substances of very high concern effectively dictates which substances producers and brands actively work to phase out of their products and production processes, and is often used as a key guide by professional procurers. The Nordic countries are very active in pushing the EU legislative process forward and have enforcement systems in place. The Nordic countries should continue this active engagement to help minimise hazardous chemicals in plastic in EEE products, and help support recycling of EEE plastics.

As part of the EU's sustainable product policy, the ecodesign requirements under the Ecodesign Directive, which previously have focused almost exclusively on energy and energy consumption, are being updated and expanded to include specifications for materials and recycling. The new requirements for electronic displays for example, prohibit the use of halogenated flame retardants, although this is subject to an ongoing legal challenge. Further EU initiatives, such as the digital product passport (DPP) and the product environmental footprint (PEF), are also under development and will likely influence design and chemical use in the EEE sector. These initiatives are anticipated to help increase transparency and enforcement within supply chains. Cooperation between the Nordic countries can help drive and define the content of these processes.

The project has produced a raft of recommendations that fall within three overarching themes: *increasing information availability; supporting green procurement; and supporting the Nordic EEE sector.*

Increasing information availability

Recommendation 1

Increase consumer awareness of circular electronics and electrical equipment including recyclability and how the use of hazardous substances hinders closed loop recycling. This needs a holistic approach to ensure that the issue does not languish in a niche environmentalist consumer segment but receives broader recognition. Such awareness raising can make use of social media channels and podcasts. This can draw on existing global ecolabels and their ability to enable a more circular purchasing choice of EEE.

Recommendation 2

Provide more information about circularity of EEE at the point of sale through collaborating with retailers and suppliers. Product information (through e.g. PEF's or ecolabels) given at the point of sale is crucial in informing consumers about how to make a more circular purchasing choice of EEE. Retailers guide and inform consumers about salient product attributes – it would be highly beneficial to ensure that one of the attributes communicated was the product's circularity (and by association hazardous content). To support this, in-store displays could be equipped with digital identifiers providing information at the point of sale (e.g. QR code connected with an application or a database such as a digital product passport).

Recommendation 3

Nordic collaboration of product passport increasing transparency on chemical content. The Nordic countries share circularity priorities and can advantageously collaborate to limit hazardous substances in EEE as part of the Sustainable Product Policy Initiative and related product passport. This will be a difficult process, but it is essential that strong voices push for a comprehensive implementation of the Product Passport.

Supporting Green Procurement

Recommendation 4

Facilitate a Nordic working group on GPP criteria for electronics and electrical equipment. The EEE procured by public and private organisations across the Nordics is largely the same. Likewise, the processes involved in procurement across the Nordic countries also have many commonalities, including the preparation of GPP criteria. As such, there is a great opportunity in strengthening exchange of knowledge and the alignment of GPP criteria in a joint effort. This will help create and support a stable and significant pan-Nordic market for circular EEE.

Recommendation 5

Join the ICT-pact harmonizing GPP criteria to push the market towards more circular (and sustainable) provision of ICT. In addition to Recommendation 3, alignment with international efforts to build a market for circular EEE is a useful strategy. Not only to ensure an even broader market for circular EEE, but also to ensure that the Nordic countries influence the shape and form of that market

Recommendation 6

Increase the capacity and competency of public officers in procurement departments to develop, process and follow-up product requirements on chemicals. Alternatively, complement procurement departments with experts from other public departments (e.g. environment agencies or departments). This will allow the effective application of chemical requirements in public tenders – also by implementing GPP criteria recommended by a Nordic working group or the ICT-pact. This is considered essential for the practical application of GPP at small and medium public authorities.

Supporting the Nordic EEE sector

Recommendation 7

Consider the application of novel policy approaches in the context of Extended Producer Responsibility (EPR). Similarly, in the context of economic incentives (such as the Swedish chemical tax), EPR fees can be adjusted to reflect the chemicals content in EEE products which negatively affect the recyclability of the WEEE collected under the scheme. Chemical content that renders WEEE plastic non-recyclable would result in higher fees (eco-modulation). This could be linked, if necessary, to recyclability criteria.

Recommendation 8

Coordinated support for importers, manufacturers and brands to help source products and components that are free of hazardous substances. This demands both knowledge of the problem area and transparency through supply chains to enable Nordic-based businesses to make the most sustainable and circular choices. Encouraging and supporting businesses to conduct due diligence on the product that they import and sell could significantly reduce the import of questionable equipment.

Individual initiatives are already underway to support better design and boost transparency within the EU and in individual countries. Positive experiences and knowledge should be shared with and between Nordic countries.

2. RESUME (PÅ DANSK)

Elektronik og elektriske udstyr (EEE) bliver stadig mere avanceret. Mindre og smartere design muliggøres blandt andet af kemiske stoffer, der tilsættes plastdele i elektronik for f.eks. at gøre ledninger mobile (såkaldte "ftalater" eller blødgørere); reducere brandrisiko (flamme hæmmere) og samtidig opnå ønskede funktioner (f.eks. tungmetaller). Produktudviklingen fører samtidig til hyppig udskiftning og genererer en stadigt stigende mængde af elektrisk og elektronisk affald (WEEE). Plasten i denne affaldsstrøm forbrændes med energiuudnyttelse eller deponeres, fordi indholdet af kemiske stoffer udgør en barriere for genanvendelse, dog sorteres værdifulde metaller fra til genbrug.

Denne rapport stiller skarpt på, hvad de nordiske lande kan gøre for at fremme genanvendelige plastdele i elektriske og elektroniske produkter med særligt fokus på at begrænse skadelige kemikalier. Rapporten præsenterer hvilke kemiske stoffer, der er til stede i plastkomponenter, og som forhindrer genanvendelse. Kortlægningen er begrænset af den tilgængelige viden – fra lovgivning, forskning, NGO'er og markedsaktører – om skadelige kemiske stoffer i elektriske og elektroniske produkter. Rapportens resultater er tilvejebragt gennem et omfattende litteraturstudie; en policyanalyse af EU- og Nordisk lovgivning og øvrige tiltag, der begrænser skadelig kemi i EEE; 16 interviews med eksperter og interessenter på tværs af værdikæden; samt en afsluttende workshop, der drøftede og kvalificerede de nordiske landes handlerum for at fremme genanvendelse af plastkomponenter.

EU's kemikalielovgivning sætter rammerne for håndtering og klassificering af kemikalier, samt begrænser og forbyder skadelige kemiske stoffer i blandt andet plastkomponenter i elektriske og elektroniske produkter. Lovgivningen er dog begrænset til at regulere *kendte* skadelige kemiske stoffer, og da nye kemiske stoffer konstant introduceres på markedet, samtidig med at lovgivningsprocessen er træg, forekommer der sandsynligvis skadelige kemiske stoffer i plastkomponenter i EEE. Ikke mindst i de lavprisprodukter, der sælges via internethandel, og hvor håndhævelsen er lav. EU's kemikaliestrategi 'for et mere bæredygtigt og giftfrit miljø' indeholder da også en målsætning om at smidiggøre kemikalielovgivningen samt at styrke håndhævelsen af kemikalielovgivningen langs EU's ydre grænser.

På trods af kemikalielovgivningens begrænsning, har denne bevist at have indvirkning på de globale markeder. Direktivet for begrænsninger af elektriske og elektroniske produkter (RoHS)-lignende lovgivning er således blevet vedtaget i store dele af verden. I og med at majoriteten af elektrisk og elektronisk udstyr produceres uden for EU, består af mange komponenter, og dermed tilvejebringes gennem komplekse og lange værdikæder, har EU-lovgivning haft stor betydning. Kandidatlisten over skadelige stoffer er ligeledes dagsordenssættende for, hvilke stoffer producenter arbejder på at undgå i deres produkter, ligesom kandidatlisten anvendes af professionelle indkøbere i kravspecifikationen. De nordiske lande bidrager til EU-lovgivningsarbejdet og har håndhævelsesprocedure i system, og de Nordiske lande bør fortsætte dette spor for at sikre at plastdele i EEE i fremtiden kan genanvendes.

Som et led i EU's bæredygtige produktpolitik udvides EU's Miljødesigndirektiv til også

at indeholde miljøkrav, der blandt andet skal fremme genanvendelse. Miljødesignkravene for skærme indeholdte et forbud mod en specifik flammehæmmer, der nu har bragt Kommissionen i retten. Dommen om, hvorvidt Miljødesignkriterier må indeholde forbud mod specifikke kemiske stoffer er endnu ikke afgjort. Øvrige EU-initiativer som digitale produktpas og metoder til at estimere en produktkategoris miljøaftryk er under udvikling, og forventes også at medtage kemikalier. Disse initiativer forventes at kunne bidrage til øget gennemsigtighed og kontrol med værdikæden, og de nordiske lande kan med fordel samarbejde for at skabe fremdrift i denne dagsorden.

Mere tilgængelig viden

Anbefaling 1

Øg forbrugernes bevidsthed om og kendskab til cirkulær elektronik og elektrisk udstyr, herunder genanvendelighed, og hvordan brugen affarlige stoffer forhindrer genanvendelse. Dette kræver en holistisk tilgang for at sikre, at oplysningen ikke målrettes et nichesegment af miljøaktivistiske forbrugere, men snarere henvender sig til majoriteten af forbrugere. En oplysningskampagne kan med fordel gøre brug af sociale medier og podcasts, og kan desuden trække på eksisterende globale miljømærker, der netop har en holistisk tilgang og begrænser brugen af skadelig kemi.

Anbefaling 2

Giv mere information om, hvor cirkulær EEE er, på salgsstedet ved at samarbejde med forhandlere og leverandører. Produktinformation (f.eks. PEF'er eller miljømærker) givet på salgsstedet er afgørende for at informere forbrugerne om, hvordan de træffer et mere cirkulært valg. Forhandlere vejleder og informerer forbrugere om fremtrædende produktegenskaber som cirkularitet (og herunder begrænsning af skadelig kemi). For at understøtte et cirkulært valg kan skærme i butikken udstyres med skannere, der ved hjælp af QR-koder eller lignende digitale systemer, som er forbundet til en database som f.eks. et produktpas, nemt videregive information til forbrugeren.

Anbefaling 3

Nordisk samarbejde om produktpas øger gennemsigtigheden i indhold af kemikalier. De nordiske lande deler prioriteter om at fremme cirkulær økonomi og kan med fordel samarbejde om at begrænse farlige stoffer i EEE som en del af EU's Bæredygtige Produkt Initiativ og tilhørende produktpas. Dette vil være en vanskelig proces, men det er vigtigt, at stærke stemmer presser på for en omfattende implementering af et produktpas.

Understøtte til grønne indkøb

Anbefaling 4

Etabler en nordisk arbejdsgruppe om grønne indkøbskriterier for elektronik og elektrisk udstyr. Professionelt indkøb af EEE er stort set ens på tværs af de nordiske lande. De professionelle indkøbsprocesser er ligeledes meget ensartede. Der er dermed en stor gevinst at hente i at samarbejde om udarbejdelsen af grønne indkøbskriterier. Et sådant samarbejde kan desuden bidrage til et fælles nordisk marked for cirkulær EEE.

Anbefaling 5

Deltag i IKT-pagten, der harmoniserer GPP-kriterier for at skubbe markedet mod et mere cirkulært (og bæredygtig) indkøb af IKT. I tillæg til anbefaling 4 bidrager fælles internationale initiativer til at opbygge et marked for cirkulær EEE, som de nordiske lande kan bidrage til og påvirke.

Anbefaling 6

Styrk de offentlige indkøbsafdelingers kompetencer og ressourcer til at udvikle, behandle og følge op på produktkrav til kemikalier. Indkøberne bør trække på eksisterende indkøbskriterier udviklet af EU, IKT-pagten og en evt. nordisk arbejdsgruppe. Ved udarbejdelse af yderligere miljøkriterier kan indkøbsafdelingerne med fordel spare med miljøeksperter.

Understøtter den nordiske EEE -sektor

Anbefaling 7

Overvej anvendelsen af nye politiske tilgange i forbindelse med Udvidet Producentansvar. For ikke alene at lægge ansvaret hos forbrugerne, kan Udvidet Produktansvar med en stærkere økonomisk incitamentsstruktur med fordel implementeres. Udvidet produktansvar kan – med den rette indretning – skabe økonomiske incitamenter til at genanvende EEE-affald. Det vil samtidig give producenterne et klart incitament til at reducere indholdet af skadelig kemi og i højere grad designe til genanvendelse. De nordiske lande kan med fordel samarbejde om at inkludere økonomiske incitamenter i det udvidede producentansvar for EEE-affald i EU.

Anbefaling 8

Bistå importører, producenter og brandejere med koordineret støtte til at købe produkter og komponenter, der er fri for skadelige kemi. Det kræver både viden om skadelige kemikalier og gennemsigtighed gennem forsyningskæder at sætte nordisk-baserede virksomheder i stand til at træffe de mest bæredygtige og cirkulære valg. At tilskynde og støtte virksomheder til at foretage due diligence på det produkt, de importerer og sælger, kan reducere importen af EEE, der indeholder skadelig kemi.

Individuelle initiativer er allerede i gang for at støtte et bedre design og øge gennemsigtigheden i EU og i de enkelte lande. Positive erfaringer og viden bør deles med og mellem de nordiske lande.

3. INTRODUCTION

Waste Electronic and Electrical Equipment (WEEE) is known to be a source of contamination of recycled plastics. As an example, WEEE plastics have been identified as the source of brominated flame retardants found in toys and everyday items^{1,2}. The hazardous substances used in EEE present a wide variety of human health and environmental risks. While some hazardous substances have been phased out through legislation, too little is known about the substances being used to replace them. Regulatory developments lag far behind technical progress. While the chemical industry is fast-moving, with large lobbying resources, regulating chemicals is a slow and complex process.

Over 140 million chemicals are listed in the CAS registry³, with an estimated 12 000 new chemicals added every day. In addition, while it is estimated that around 350 000 chemicals are in use today only about one percent have been studied for their impact on humans and the environment⁴. Throughout the life cycle, EEE products may release dioxins, halogens and other toxicants, which can persist in the natural environment and the human body. Considerable attention has been devoted to removing and/or eliminating hazardous substances during the recycling process. This project explores what can be done to ensure that hazardous substances are avoided in EEE plastics in the first place.

The point of departure for this is the legislative framework that controls and manages chemicals on European and Nordic markets. This is followed by an exploration of the hazardous substances found in EEE plastics and their potential alternatives, as well as the tools that manufacturers can use to identify and replace hazardous substances. Following this, the report investigates initiatives that seek to create a market pull, including procurement, labelling, and initiatives that more broadly seek to influence consumers. The report concludes with recommendations drawn primarily from expert interviews and an expert workshop.

It is important to note that this report draws exclusively on existing knowledge from literature, expert knowledge, legislation, and legislative processes. The hazardous substances in EEE plastics highlighted by these sources are additives that function as flame retardants, additives that function as plasticisers and heavy metals with varying functions. Other hazardous substances may be in use or in development, but if so, are not yet significantly addressed by industry, legislation, or academic research. As a result, where this report addresses specific hazardous substances, plasticisers and flame retardant are in focus. However, the broader support mechanisms for the circular EEE market, and the legislative framework controlling the use of chemicals in the EU and Nordic countries are applicable for all hazardous substances in EEE plastics (and in EEE more broadly).

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1. Andersson, M. et al. (2019). Mapping and Evaluation of some Restricted Chemical Substances in Recycled Plastics Originating from ELV and WEEE Collected in Europe. Retrieved from <http://urn.kb.se/resolve?urn=urn:nbn:se:ri:diva-38176>
 2. Straková, J. et al. (2018). Toxic Loophole – Recycling Hazardous Waste into New Products. Retrieved from <https://english.arnika.org/publications/toxic-loophole-recycling-hazardous-waste-into-new-products>
 3. CAS. (2020). CAS Registry. Retrieved from: <https://www.cas.org/cas-data/cas-registry>
 4. <https://tcocertified.com/hazardous-substances/>

Drawing on the findings of the report on expert experience, this report also presents a concise Design Guide for minimising hazardous substances in EEE, as well as a guide to support procurement of such products.

4. APPROACH

This project draws on literature and knowledge from the EEE value chain and from plastics and chemicals experts to support the assessment. This looks at EEE plastics in relation to hazardous substances that inhibit recycling and the policy perspectives that help to both directly (through addressing production) and indirectly (through addressing demand) seek to minimise the hazardous substances in EEE plastics sold on Nordic markets.

The project draws on literature, expert interviews and an expert workshop to ensure that all facets of the problem area are addressed.

4.1 Desk research and literature review

The desk research and literature review focused on four key areas:

1. Hazardous chemicals in EEE plastics
2. Policies addressing production practices
3. Policies addressing demand patterns
4. Initiatives supporting green procurement practices

These were drawn from scientific, regulatory, administrative and NGO sources. In particular, the project draws on policy documents from the EU & European Commission, supporting documentation and assessment from the European Chemical Agency (ECHA), national legislation, strategy and initiatives, ecolabelling and public procurement criteria and scientific examinations of hazardous substances related to plastics in EEE plastics. A full literature list can be found at the end of this report.

4.2 Interviews

The project team interviewed 17 experts/stakeholders in the course of the project. These include:

- Chemicals/plastics experts (4)
- National authorities (5)
- Public procurement experts (3)
- Labelling experts (2)
- Brands/manufacturers (3)

In addition, the project team have been in written communication with additional experts to check and support findings, and to gain input when the contacted expert was unavailable for a direct interview.

4.3 Expert workshop

To explore the key barriers and future opportunities for supporting the market for Circular EEE, the project conducted an online interactive workshop, with participation of 14 experts from the Nordic region. The workshop addressed the consumption of circular EEE, and as such the experts were drawn from labelling organisations, public procurement experts, brands/manufacturers, consumer experts, and consumer organisations.

The two-hour workshop was conducted making use of the facilitation tool Miro. This enabled the participants to record their own experience of the main barriers to supporting a broader market for circular EEE. Following this, in break-out rooms, participants discussed and recorded possible solutions to these barriers and other approaches that could support a stronger market for circular EEE. The input gained from the workshop has been integrated into this report.

5. MANAGING HAZARDOUS SUBSTANCES IN EEE

To improve the circularity of EEE products and particularly their plastic components, it is important to reduce or eliminate the hazardous substances in these plastics, enabling easier and better recycling and handling at end of life.

This section of the report outlines the regulatory framework for the management of hazardous substances, with particular focus on hazardous substances in EEE plastics in the EU and in the Nordic countries. In addition, it reflects, based on the input from experts and literature, on the possibilities to improve this framework and the ability of the Nordic countries to influence the manufacture and production of EEE products that appear on Nordic markets.

5.1 EU's legislative framework

The legislative framework for managing hazardous substances in EEE in the Nordic countries primarily stems from the EU, with some global and national additions. Table 1 presents key EU legislation, and global conventions implemented in EU, influencing the hazardous substances on the European market and within EEE. This section further provides a brief assessment of core EU legislation including CLP, REACH, RoHS, the Ecodesign Directive, and the WEEE Directive.

Table 1 - Overview of EU legislative framework for addressing hazardous chemicals. **Note:**⁵

	Aim of legislation	How the legislation limits hazardous substances in EEE
REACH - Registration, Evaluation, Authorization and restriction of Chemical Substances	The REACH Regulation aims to protect human health and the environment by ensuring early identification of the properties of chemical substances. It obligates manufacturers and importers in EU to gather information on the properties of their chemical substances, to allow their safe handling, and to register the information in ECHA's database.	Hazardous substances are restricted by REACH Restricted Substances List (annex 17), some of which are relevant for EEE. There are some overlaps between REACH Restricted Substances List and RoHS, and some of these overlapping substances are in some cases exempted from REACH. The Candidate list of Substances of Very High Concern (SVHC) obligates manufacturers to provide information on the use of SVHC. The list is often integrated in EEE supplier's lists of restricted materials and guides Green Public Procurement (GPP)- and ecolabel criteria. The Authorisation List (annex 14) consist of SVHC, which cannot be put on the market unless an authorisation is given.
RoHS – The Directive on Restriction of Hazardous Substances in Electrical and Electronic Equipment	The Directive aims to protect human health and the environment related to the management of electronic and electrical waste by restricting the use of certain hazardous substances in EEE. Exemptions from restrictions can be made if no safe alternatives exist.	RoHS limits the appliance of selected hazardous substances specifically in EEE. Variations of RoHS (restricting the same – or some of the same – substances) have been implemented in 50 jurisdictions outside EU, thus affecting the global supply of EEE.
WFD – The Waste Framework Directive	The WFD make up the legal framework for waste treatment in EU and aims to support a circular economy, where waste is prevented and reduced, while the harmful impact of waste is reduced, in a resource efficient manner.	Manufacturers and importers are to report their use of SVHC, when it amounts to more than 0.1% (w/w) of an article in the Substances of Concern In articles as such or in complex objects (SCIP) database (January 2021). SCIP is to ease waste sorting and promote recycling and safe substitution.
WEEE - The Directive on Waste Electrical and Electronic Equipment	The Directive aims to limit the generation of WEEE, increase re-use, recycling and recovery and improve the environmental performance of EEE. Member States are obliged to take measures to reach these objectives.	The WEEE Directive obligates MS to: a) implement Extended Producer Responsibility, which places the financial costs of collection treatment, recovery and environmentally sound disposal on producers; b) take measures to improve product design of EEE and; c) to facilitate information exchange about product composition from suppliers to waste managers/recycling operators.
The Stockholm Convention on Persistent Organic Pollutants (implemented in the EU by Regulation No. 2019/1021) ⁵	The convention is a global treaty that limits, restricts and eliminate Persistent Organic Pollutants (POPs), which are characterized by their high toxicity, persistence in the environment, ability to bio-accumulate and survive long-range transport.	Restrict the use of POPs in EEE.
CLP - Classification, Labelling and Packaging Regulation	The Regulation is an implementation of UN's globally harmonised system ensuring that chemicals are classified and labelled in a harmonised way. The regulation obliges manufacturers, importers and suppliers of substances or mixtures to classify, label and package their hazardous chemicals aligned with the harmonised system before placing them on the market.	EEE manufacturers, importers and suppliers of EEE are obliged to comply with CLP.
Ecodesign Directive	The Directive aims at improving the environmental performance of all energy related products by providing the legal basis of technical standards, voluntary standards, and market surveillance.	Sets-out mandatory eco-design requirements for EEE. Eco-design requirements of electronic displays include, inter alia, a ban of the use of halogenated flame retardants and that safe dismantling information shall be available online.
Toy Safety Directive	The Directive regulates safety criteria on toys marketed in the EU to reduce risks posed on children.	The Directive restricts certain chemical substances in electrical and electronic toys.

5. Regulation (EU) 2017/2021 on persistent organic pollutants.

REACH is the core of the chemical legislation, prescribing how substances are to be registered and evaluated, as well as banning hazardous substances across product groups. RoHS restricts hazardous substances in EEE and thus contributes to designing out hazardous substances to promote improvements in the treatment of WEEE. The Ecodesign Directive has recently been broadened to promote circularity. For example, the eco-design requirements for electronic displays, from March 2021, includes a ban of all halogenated flame retardants from plastic casings. The roadmap of the Sustainable Product Policy Initiative⁶ indicates a strengthening of the Ecodesign directive and EU policy to promote sustainability of products along value chains including digital product passports to foster transparency. These digital product passports are expected to include the content of chemicals. Overall, the Sustainable Product Policy initiative aims to promote sustainable product design that may contribute to closing the loop by promoting design for recyclability. The WEEE Directive also aims at stimulating circular design and responsible end-of-life treatment and thus contributes to limiting hazardous substances in EEE.

The EU Chemicals Strategy for Sustainability Towards a Toxic-free Environment develops a roadmap towards a toxic-free environment, where chemical control supports a green and digital transition. The strategy aims to ban the most hazardous chemicals in consumer products; account for cocktail effects when assessing risk; phasing out PFAS in non-essential application; increasing R&D in chemicals that are safe by design; and promoting simpler one-substance-one assessment of chemicals. The strategy announces specific attention on limiting the exposure to endocrine-disrupting chemicals by, among others, banning endocrine disruptors in consumer products⁷. This area of focus is closely linked to the Sustainable Product Initiative (to be launched in 2021. Q4), which, likewise, aims at ensuring that any product put on the European market is sustainable by, amongst other things, revising the Ecodesign Directive.

5.1.1 The REACH Regulation

REACH is an acronym of Registration, Evaluation, Authorization and restriction of Chemical Substances. As the acronym indicates, REACH obliges all manufacturers and importers (of more than one tonne chemical substances) within the EU to collect, register and document chemical safety information, and to carry out risk assessments. REACH is the backbone of the chemical legislation that sets out procedures across sectors and material flows including EEE.

The REACH restricted substances list (annex XVII) contains a list of restrictions of certain hazardous substances (on its own, in a mixture or in an article), being manufactured, placed on the market or otherwise used.

In addition to the restricted substance list, REACH provides the candidate list of Substances of Very High Concern (SVHC), which includes substances that are classified as:

- a. Carcinogenic, mutagenic or toxic for reproduction (CMR),
- b. Persistent, bio accumulative and toxic (PBT) or very persistent and very bio accumulative (vPvB) or

6. EC. (2020b). Sustainable Product Initiative: Ref. Ares(2020)4754440 - 11/09/2020.

7. EC. (2020a). Chemicals Strategy for Sustainability: Towards a Toxic-Free Environment. Retrieved From https://eur-lex.europa.eu/resource.html?uri=cellar:f815479a-0f01-11eb-bc07-01aa75ed71a1.0003.02/DOC_1&format=PDF

- c. Other hazardous substances that cause an equivalent level of concern as CMR or PBT/vPvB substances.

Whenever a SVHC make up more than 0.1% w/w, suppliers must within 45 days provide the consumer with information that allows safe use of the article (as a minimum the name of the substance) (According to Article 33)⁸. The candidate list of SVHC is updated twice a year. The candidate list provides manufacturers and procurers with valuable information about which chemical substances to avoid. The candidate list is often integrated in EEE supplier's lists of restricted substances and procurers ask suppliers to document the presence of SVHC in their products. The candidate list is a driver of innovation and substitution to less hazardous EEE, due to the market and investor demand to avoid SVHC: Investors often use the avoidance of SVHC as a part of ranking companies' sustainability performance⁹.

SVHC can be included on the "Authorisation List" (as per Annex 14 in the REACH directive). Whenever a substance is present on the Authorisation list, substances cannot be put on the market without an authorisation.

REACH has brought about an increased knowledge of the safe use and properties of chemical substances as well as harmonised chemical legislation, as REACH replaced around 40 different regulations, when it was first enforced in 2007. The strength of REACH is that it helps foster transparency and harmonisation. The process for adding a substance to either the Candidate list or the Restricted list is, however, long. REACH is also complicated to understand for non-experts (for example in SMEs – where knowledge of chemicals is not a core competence).

The evaluation of REACH in 2018 concluded that REACH effectively – and with proportional means - contributes to a responsible use of chemicals lowering the risk of health and environmental impacts. There is, however, further room for improvement, simplification and burden reduction¹⁰. REACH will be revised in 2022.

5.1.2 The RoHS Directive

The Restriction of Hazardous Substances in EEE (RoHS) Directive limits selected hazardous substances in EEE to improve the potential for environmentally sound waste treatment of EEE (WEEE). The most recent update (EU Directive 2015/863), added four phthalates to the list of restricted substances and took effect on July 22, 2019. These restrictions apply to all EEE with the few exemptions of more technical and industrial EEE such as military equipment and large stationary industrial tools¹¹.

RoHS, Annex 2, limits the levels of ten substances (spring 2021) including four heavy metals (cadmium, lead, mercury, hexa-chromium) four phthalates (DEHP, BBP, DBP, and DIBP) and the halogenated flame retardants PBB and PBDE, with some

8. ECHA webpage. (n.d.) Authorisation – Substances of very high concern identification. Retrieved from: <https://echa.europa.eu/substances-of-very-high-concern-identification-explained>

9. Cockcroft, L. & Persich, T. (2017). ECHA Corporate Sustainability Strategies - Final Report. Norwich: Risk & Policy Analysts. Retrieved from https://echa.europa.eu/documents/10162/13637/echa_css_report_without_case_studies_en.pdf/a0a6f46f-16c8-fbec-8b41-9ff683aaf5c

10. EC. (2018). Commission General Report on the operation of REACH and review of certain elements - Conclusions and Actions. Brussels. Retrieved from <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM:2018:116:FIN>

11. The Danish Environmental Protection Agency webpage (2021, May 27). Faktaark: Elektrisk og elektronisk udstyr (RoHS-bekendtgørelsen). Retrieved from <https://mst.dk/kemi/kemikalier/regulering-og-regler/faktaark-om-kemikalierreglerne/elektrisk-og-elektronisk-udstyr/>

exemptions (appearing in Annex 3 and 4). These exemptions can be made if no alternatives are reliable; if environmental, health or consumer safety impact outweighs the benefits of substitution; due to socioeconomic or innovative concerns. Any exemption must not weaken the protection under REACH.

The RoHS directive is a CE marking directive: companies marketing products in scope of RoHS must document compliance with the RoHS regulation before applying the CE marking on their products¹². Manufacturers are to self-declare based upon EU standards (CE-marking), which eases administration costs.

RoHS-like legislation has been implemented in 50 jurisdictions outside the EEA countries. The global outreach of RoHS demonstrates how the EU can drive a reduction of hazardous substances in global electronics value chains. Manufacturers and suppliers of EEE are well-aware of the RoHS Directive, which increase compliance. According to the industry, the EU can work closely with the other jurisdictions to ensure that the interpretation and exemptions in RoHS are aligned¹³.

RoHS has been criticised for being too limited in scope and that the restriction of phthalates, for example, has led to a larger use of other chemical substances, which are not necessarily less hazardous, but just not regulated yet. Moreover, the exemptions afforded are deviations from the legislation that can increase the negative impact on the environment. The processing of exemptions is a long process, which has been illustrated by, for example, the exemption of using mercury in fluorescent lamps. This was due to expire in 2016 but was postponed to 2022. In addition, the guidance to RoHS is outdated, and Member States interpret exemptions differently, which can be confusing for suppliers. The variation in interpretation is often regarding whether new products are eligible for exemption. As new products are constantly being developed and put on the market, any guidance to RoHS needs to take these into account and the guidance should be updated continuously. EU's "New Circular Economy Action Plan - for a cleaner and more competitive Europe" announces a review of RoHS.

5.1.3 The WEEE Directive

The Directive on Waste Electrical and Electronic Equipment aims to limit the generation of WEEE, increase reuse, recycling and recovery and improve the environmental performance of EEE in line with the waste hierarchy. The WEEE directive obliges Member States to establish systems for separate collection of WEEE for consumers and retailers, as well as to reach targets for collection, preparation for reuse, recycling and recovery. Articles 12 and 13 further include an obligation to implement Extended Producer Responsibility (EPR) schemes, financed by importers and producers, in order to incentivise waste to be designed out. The concrete implementation of the EPR-scheme differs across Member States.

Product design is further targeted in Article 4, which states that MS are obliged to encourage cooperation between producers and recyclers and to promote eco-design and production of EEE that support reuse, dismantling and recovery. Article 4 thus

12. The Conformité Européenne (CE) certification is a regulatory standard that verifies that certain products are safe for use and sale in European Economic Area. 24 directives including RoHS dictate which products require CE marking.

13. Lightning Europe (2018). Joint statement: Commission Roadmap for the RoHS Review: considering the global dimension. Retrieved from: https://www.lightningeurope.org/images/publications/position-papers/Joint_industry_statement_on_RoHS_evaluation_roadmap_-_October_2018.pdf

creates a clear link to the Ecodesign Directive and RoHS, but the concrete actions are very much up to the individual MS to define. The Swedish chemical tax is a response to Article 4¹⁴. Denmark has entered into voluntary agreement with the industry (2013–2016) and has funded a project of how to design out waste from EEE^{15,16}.

Certain substances, mixtures and components – including plastics containing Brominated Flame Retardants (BFR), external electrical cables and printed circuit boards - are according to Annex 7 - to be sorted out and treated separately¹⁷.

Under Article 15 of the WEEE Directive, producers must provide information on components, materials, and location of hazardous substances and mixtures. The information is passed on to waste management companies to promote environmentally sound treatment. Member States are to facilitate this information exchange, which is often done through some type of a platform. At the EU level, the process is facilitated by the I4R (Information for Recyclers) platform managed by the WEEE Forum¹⁸.

A study in Sweden, however, indicates a broad lack of compliance with this information transfer. Producers are not entering the required information due to lack of knowledge about the commitment and on the use of chemical substance. Waste managers and recycling facilities, meanwhile, are not drawing on the information, preferring to rely on in-house competences to identify and separate hazardous components.¹⁹ The Swedish report²⁰ and industry statements indicate that initiatives to raise compliance are needed to fulfil this obligation, although whether the obligation to report this information will, even with full compliance, be used by the recycling industry and lead to better recycling results is questionable. There are indications that recycling facilities prefer to rely on in-house technical knowledge and solutions for separating plastics containing hazardous substances rather than check and act upon data for individual products²¹.

EPR demands in the WEEE directive also appear to have had little impact on design, primarily due to the relatively low producer fees and the lack of differentiation of products²².

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14. Waugh, R. et al. (2018). Study on the implementation of product design requirements set out in Article 4 of the WEEE Directive. Brussels: Oakdene Hollins of behalf of EC. Retrieved from <https://op.europa.eu/en/publication-detail/-/publication/17b7b664-15f0-11e8-9253-01aa75ed71a1>
 15. Bundgaard, A. & Remmen, A. (2018). Designing out waste. Danish Environmental Protection Agency. Retrieved from <https://www2.mst.dk/Udgiv/publications/2018/10/978-87-93710-90-0.pdf>
 16. The project was supported by the Danish Ecoinnovation program.
 17. WEEE Directive – Annex VII – Indicative list of EEE.
 18. Weeeforum webpage. (n.d). Information for recyclers about substances in e-waste. Retrieved from <https://weee-forum.org/information-4-recyclers/>
 19. Goodpoint AB on behalf of the Swedish EPA (2017). *Information transfer on hazardous substances*.
 20. Goodpoint AB on behalf of the Swedish EPA (2017). *Information transfer on hazardous substances*.
 21. Goodpoint AB on behalf of the Swedish EPA (2017). *Information transfer on hazardous substances*.
 22. Bundgaard, A. & Remmen, A. (2018). Designing out waste. Danish Environmental Protection Agency. Retrieved from <https://www2.mst.dk/Udgiv/publications/2018/10/978-87-93710-90-0.pdf>

5.1.4 The Waste Framework Directive and SCIP

The Waste Framework Directive defines the legal framework for waste treatment in EU and aims to support a circular economy, where waste is prevented and reduced, while the harmful impact of waste is reduced, in a resource efficient manner.

From January 2021, manufacturers and importers are to report their use of Substances of Very High Concern (SVHC), when it amounts to more than 0.1% (w/w) of an article, to the European Chemical Agency and the database for Substances of Concern In articles as such or in complex objects (Products) (SCIP database). The aim of the SCIP database is to provide information on the use of SVHC to ease waste sorting and promote recycling. The reporting requirements aim to provide an incentive for companies to substitute their use of SVHC.

Interviews with EEE manufacturers indicate that although the reporting obligation is quite demanding, they do what they can to be compliant. Larger manufacturers of EEE typically make the effort to comply, and in that way EU legislation – such as reporting in SCIP – is efficient in providing the information of the content of SVHC. Smaller importers are less likely to provide information of SVHC in the SCIP database due to lack of knowledge hereof. Enforcement activities are, therefore, important to ensure compliance. Consumer organisations see a potential in providing the knowledge of the content of SVHC to inform more engaged consumers, as the information from the SCIP will eventually be made available for consumers.

However, manufacturers believe that waste companies will not make significant use of the SCIP-database in their recycling operations (just as the information under Article 15 of the WEEE Directive is under-utilised) and they, therefore, experience reporting to the SCIP-database as a potential waste of resources.

5.1.5 The POPs Regulation

The Stockholm Convention on Persistent Organic Pollutants was signed in 2001 to promote the elimination and reduction of persistent organic pollutants due to their high toxicity, persistence in the environment, ability to bio-accumulate and survive long-range transport. The Stockholm Convention was implemented in the EU by the POPs Regulation ((EC) No. 850/2004), and on June 25, 2019, the EU published Regulation (EU) 2019/1021, recasting the POPs Regulation. The new regulation took effect on July 15, 2019²³ and includes:

- Prohibited substances (Annex 1)
- Substances subject to restrictions (Annex 2)
- Substances subject to release reduction provisions (Annex 3)
- Substances that should not contaminate waste (Annex 4), as set out in Article 7.

23. ECHA webpage. (n.d). Understanding POPs. Retrieved from <https://echa.europa.eu/understanding-pops>

5.1.6 The CLP Regulation

The Classification, Labelling and Packaging (CLP) Regulation is the implementation of UN's Globally Harmonised System of Classification and Labelling for Chemicals into EU legislation and is binding within the EU. CLP ensures that all substances, mixtures and articles are classified, labelled and packaged in line with the global harmonised systems, so that everyone can understand the hazardousness nature of substances in use. The classification includes physical, health, environmental and additional hazards informing how actors in the value chain are to prevent, respond to, store and dispose of substances. This is communicated through pictograms, signal words and standard statements. If hazardous substances are placed on the market, the supplier must inform ECHA.

CLP provides the language and terminology used to describe hazards and the methods of classification applied by REACH, and in doing so has contributed to the knowledge of hazardous substances. The Public Coordination Tools that coordinate CLP and REACH will be developed further to simplify legislation. EU's Chemicals Strategy for Sustainability further announces that new hazard classes and criteria for CLP will be developed in the coming years²⁴.

5.1.7 The Ecodesign Directive

EU's Ecodesign Directive aims to improve the environmental performance of products by providing the legal basis of technical standards, voluntary standards, and market surveillance. The Ecodesign Directive originally focused on energy efficiency, but the scope has since been extended to include material efficiency and requirements to promote circular product design. The EU's Circular Economy Action Plan announced a revision of the Ecodesign Directive as part of the Sustainable Product initiative that will ensure that EEEs are designed for durability, reparability, upgradability, maintenance, reuse and recycling.

The European Commission prepares eco-requirements for selected product groups, which all products put on the European market must comply with. Similar to the RoHS directive, the CE-mark (and thus access to the European market) can only be obtained if the eco-design requirements are complied with.

Eco-design requirements of electronic displays include a ban on the use of halogenated flame retardants and, further, that dismantling information shall be available online, thus promoting recycling of displays. This is the first time that eco-design requirements under the Directive have banned a group of chemical substances. The Bromine Science Environmental Forum (BSEF), working to promote the benefits of bromines, has brought a legal action against the ban, claiming that it is disproportionate, unequal, and not based upon an appropriate impact assessment²⁵. Whereas any restrictions in REACH are based upon thorough risk assessments and socioeconomic assessments²⁶, the ban in the Ecodesign Directive has not been subject to the same level of assessment.

24. ECHA webpage. (n.d). Understanding POPs. Retrieved from <https://echa.europa.eu/understanding-pops>

25. Case T-113/20: Action brought on 20 February 2020 — BSEF v Commission. Retrieved from: <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:62020TN0113&from=EN>

26. ECHA webpage. (n.d). Socio-economic analysis in REACH. Retrieved from <https://echa.europa.eu/da/support/socio-economic-analysis-in-reach>

The life-cycle approach applied in the Ecodesign Directive implies that requirements with the greatest impact on the environment are prioritised, which enable not just requirements for limiting hazardous substances, but also design for recyclability such as design for disassembly, clean materials etc. The life cycle approach is made possible as requirements are made for specific product groups that may be more relevant and applicable. On the other hand, industry argues that this makes the legislative framework more complex and adds an additional administrative burden on manufacturers. One industry representative argues that compliance requires awareness of the existence of the eco-design requirements. Now that manufacturers are aware of RoHS and REACH, any new requirements should be added here, rather than being included in other directives. On the basis of this argument, compliance with eco-design requirements is assumed to be low. Yet, in light of the BSEF court case, the future of the ban is uncertain.

Box 1: Voluntary pledges collected under EU's Plastic Strategy

As part of EU's Plastic Strategy, the EU Commission invited stakeholder to make voluntary pledges to use or produce recycled plastics. Several EEE manufacturers have done so, including among others:

- Dell: "to use 100 million pounds of recycled-content plastic and other sustainable materials in our products, using FY14 as a baseline. Dell is pledging two plastic polymers ABS & PC. We have based our EU plastics pledge on our 2020 LoG [Legacy of Good] goal and will review should our goal change after 2020."
- Lexmark, printers: "We set the goal to reach an average of 20% PCR [post-consumer recycled plastics] weight of our total plastic usage by 2020. For Lexmark cartridges, our goal is to reach 25% PCR content by 2020"
- Whirlpool: "We pledge to use up to 44,500 tons of recycled plastics by 2025 to be used in home appliance components. Pre-condition is that the recycled material would meet ROHS, REACH requirements and would have the quality needed to comply with our performance specifications. Food Grade recycled PS would be needed as well."²⁷

27. EC webpage. (n.d). Pledges. Retrieved from https://circulareconomy.europa.eu/platform/en/commitments/pledges?populate=&field_cecon_market_area_tid%5B0%5D=341&page=1

5.1.8 The European Chemical Agency (ECHA)

EU's Chemical Agency (ECHA)²⁸ is to ensure effective management of REACH. ECHA is independent, but the European Commission assesses ECHA, takes part in the board and carries out specific task in processes regulating chemicals such as decision about restrictions and selecting substances as being subject to authorisation.

ECHA provides significant help and guidance in the processes involved in interfacing with the complex web of legislation. This includes training and courses on how and where companies should submit information, apply for authorisation, as well as how companies can begin the process of substituting hazardous chemicals for safer alternatives²⁹. ECHA's safe substitution process consists of five phases including:

1. Identify substances of concern
2. Scope the issue and identify potential alternatives
3. Assess, compare and select alternatives
4. Test, implement and improve
5. Inform your supply chain³⁰.

The EU has announced several initiatives to address non-compliance in their Sustainable Chemical Strategy including a revoke of a company's' registration number as a penalty for non-compliance and a more unified European enforcement effort³¹.

5.2 Nordic initiatives

All the Nordic countries provide information, guidance and tools to help companies understand and comply with EU's chemical legislation. The Nordic countries monitor the selected and suspicious product groups of EEE to ensure that products comply with the chemical legislation. The Nordic countries, moreover, participate in EU proceedings to limit hazardous substances in EEE, including submitting proposals for inclusion of substances for restriction in REACH and RoHS.

Norway has a priority list of chemical substances that are expected to be phased out. The list sends a clear signal to companies of which chemicals to substitute. Sweden has taken further steps to reduce hazardous substances through a chemical tax system and through various initiatives to promote substitution.

These initiatives are described in more detail below.

28. ECHA website: <https://www.echa.europa.eu>

29. ECHA webpage. (n.d). Online training on analysis of alternatives. Retrieved from <https://echa.europa.eu/online-training-on-analysis-of-alternatives>

30. ECHA webpage. (n.d). How to substitute? Retrieved from <https://echa.europa.eu/know-your-substances-and-needs-substitution>

31. EC. (2020a) Chemicals Strategy for Sustainability Towards a Toxic-Free Environment. Brussels. Retrieved from https://eur-lex.europa.eu/resource.html?uri=cellar:f815479a-0f01-11eb-bc07-01aa75ed71a1.0003.02/DOC_1&format=PDF

5.2.1 Informing businesses about EU legislation

The Nordic countries actively inform about EU's chemical legislation to help manufacturers and suppliers comply with legislation. However, as there is no full list of all EEE suppliers, it is difficult for the public authorities to ensure that all relevant companies receive the information about the legislation. As most EEE is imported, Finland has taken steps to target importers through collaborating with industrial and trade organisations to inform companies (see Box 2).

Box 2: Finnish E-learning platform "I know my product"

The Finnish Chemical Agency has developed the e-learning platform "I know my product" (Tunnen Tuotteeni)³², where in particular small and medium sized manufacturers, sellers and distributors of, among others, EEE can test their knowledge of their own product and be informed about their obligations set-out in EU legislation. The objective is to increase product safety and help companies navigate in the legislative jungle. When a company has been examined in the e-learning course, they will receive marketing material stating "I know my product", which they can use to inform consumers that they are aware about their product safety responsibility. The label is an incentive for companies to carry out the e-learning course and thus for companies to increase product safety. The e-learning platform was launched in March 2021 and concrete experiences are thus limited.

5.2.2 Surveillance of EEE

The Nordic countries conduct surveillance initiatives to ensure compliance with EU's chemical legislation. This surveillance is risk-based looking mostly into cheap, low quality and imported electronic and electrical goods. A representative from the Swedish Chemical Agency estimates that approximately 30% of samples of suspicious products are non-compliant³³.

It is impossible to control all EEE put on the market. The surveillance initiatives are limited by the resources allocated, which differ between the Nordic countries: in Finland, one person/year is used for carrying out surveillance of EEE, whereas three persons/years are used in Sweden and Norway. In Denmark around 0.5 person/years are used for RoHS, and a further two person/years for REACH, although these figures vary from year to year. Nordic surveillance authorities collaborate – also with other enforcement authorities in EU - to strengthen compliance with EU legislation.

32. Tunnen Tuotteeni webpage. (n.d). Tunnen tuotteeni -tarina järjestelmän takana. Retrieved from <https://tunnentuotteeni.fi/course/view.php?id=49>

33. Kemikalieinspektionen (2021). E-handel 2020 – Kontroll av bekämpningsmedel, kemiska produkter och varor som säljs via e-handel. Retrieved from: <https://www.kemi.se/publikationer/tillsynsrapporter>

5.2.3 Lists of chemical substances to be phased out

Norway has a priority list of chemical substances that are expected to be phased out. The lists send a clear signal to companies of which chemicals to substitute. The Norwegian Environmental Agency continuously reviews and adds to the list, which currently contains 66 substances. There is significant overlap with the candidate list, but the Norwegian priority list focuses more on environmental contaminants³⁴.

Denmark previously had a similar List of Unwanted Substances (LOUS), but the list is no longer being updated. The Swedish Chemical Agency's substitution tool PRIO contains a database with examples of hazardous substances that meet certain criteria, the database is, however, not a complete list of hazardous substances to avoid.

5.2.4 The Swedish chemical tax

In 2017, a Swedish tax on EEE containing hazardous chemicals, referred to as the "Chemical tax", took effect. The chemical tax aims to protect the environment, human health and biodiversity by lowering hazardous substances in EEE (with particular focus on flame retardants) and encourage safe substitution. The chemical tax is calculated based upon the weight and the type of electronics. Tax deductions are given if plastic components do not contain selected groups of flame retardants, namely chlorinated, brominated or phosphorus-containing retardants. In 2020, the tax was updated to target Swedish and international manufacturers and retailers equally³⁵.

An evaluation from 2020 concludes that only the group of halogenated flame retardants (chlorine and bromine) should be considered homogenous regarding their hazardous properties. The phosphorus-containing group and alternative flame retardants are less homogenous and include substances with wide variations in terms of hazardous properties. The report indicates that the chemical tax has led "some companies" to substitute their flame retardants with safer alternatives. However, as the substitution process takes 18–24 months to implement, companies in the process of substitution are unlikely to be fully captured by the evaluation. Many of these companies are in the first phase of substitution. Substitution processes can also be due to other policy instruments including GPP, ecolabels, EU legislation, and as such it is difficult to draw a direct causal line³⁶.

The lack of impact can also be due to the design of the chemical tax. The tax deductions are based on groups of substances. Within these groups the specific chemicals are, however, not always equally hazardous, (for example as indicated above, phosphorous-based flame retardants are less hazardous than halogenated flame retardants)³⁷. Also, the tax distinguishes between reactive (10% tax) and additive phosphor (50% tax), but no test methods can validate whether phosphor is

34. Norwegian Environmental Agency (2021). Den norske prioritetslista. Retrieved

from <https://www.miljodirektoratet.no/ansvarsomrader/kjemikalier/prioritetslista/>

35. Kemikalieinspektionen & Skatteverket (2020). Utvärdering av skatten på kemikalier i viss elektronik. Retrieved from <https://skatteverket.se/download/18.569165a01749e7ae789e3d/1603192562327/Utvärdering%20av%20kemikalieskatten%20inkl%20engelsk%20sammanfattning.pdf>

36. Kemikalieinspektionen & Skatteverket (2020). Utvärdering av skatten på kemikalier i viss elektronik. Retrieved from <https://skatteverket.se/download/18.569165a01749e7ae789e3d/1603192562327/Utvärdering%20av%20kemikalieskatten%20inkl%20engelsk%20sammanfattning.pdf>

37. Kemikalieinspektionen & Skatteverket (2020). Utvärdering av skatten på kemikalier i viss elektronik. Retrieved from <https://skatteverket.se/download/18.569165a01749e7ae789e3d/1603192562327/Utvärdering%20av%20kemikalieskatten%20inkl%20engelsk%20sammanfattning.pdf>

reactive or additive, and validation is therefore challenged by a documentation barrier. The evaluation further concludes that the chemical tax is not cost-effective. The tax is placed on the final product, increasing the price of electronics, which would – in theory – promote consumer to choose hazardous substance-free alternatives. However, there is no direct evidence that this is the case. Likewise, the costs of administrating the tax carried out the by the Swedish Tax Agency are much higher than the administration of other policy instruments to lower hazardous substances in electronics³⁸. The evaluation reflects that the chemical tax can still be improved, and input from the industry question whether the Swedish market is large enough to impact the supply of EEE, which is fed by global value chains with products for global distribution. In a second report, which is part two of the evaluation, there are proposals to change the tax structure to increase goal achievement³⁹.

5.2.5 Eco-modulation of fees under EPR schemes

Eco-modulation of fees based on hazardous substance content is one mechanism that could provide an economic incentive for substitution of safer alternatives. Eco-modulation is a tool that is currently being explored in the context of EPR implementation for a broad variety of product groups, although there has been only limited implementation to date. As noted earlier in the report, the EPR demands in the WEEE Directive appear to have had little impact on design, primarily due to the relatively low costs of EPR and the lack of differentiation of products⁴⁰.

One meta study into EPR systems (Eunomia, 2020)⁴¹ indicates potential for including hazardous content as an eco-modulation criterion for EEE products (note, this is for EEE products, not just EEE plastics). The report recommends:

*To exclude (to 0,1% in a homogenous material >25g in weight) a short pragmatic list of hazardous substances used in EEE, based on the most stringent current restricted substance lists of the global OEMs, and in particular:*⁴²

- *chlorine and bromine content of plastic materials;*
- *beryllium and compounds;*
- *antimony trioxide;*
- *arsenic (50ppm), e.g. as in display screen glass;*
- *phthalates on the SVHC candidate list; and*
- *PVC. or, [alternatively]...;*
- *Exclude the whole SVHC Candidate List under REACH (to 0,1% in a homogenous material >25g in weight).*

38. Kemikalieinspektionen & Skatteverket (2020). Utvärdering av skatten på kemikalier i viss elektronik. Retrieved from <https://skatteverket.se/download/18.569165a01749e7ae789e3d/1603192562327/Utvärdering%20av%20kemikalieskatten%20inkl%20engelsk%20sammanfattning.pdf>

39. Kemikalieinspektionen & Skatteverket (2021). Utvärdering av skatten på kemikalier i viss elektronik, del 2. Retrieved from <https://www.skatteverket.se/download/18.3016b5d91791bf546791837/1621318436048/Utv%C3%A4rdering%20av%20skatten%20p%C3%A5%20kemikalier%20i%20viss%20elektronik%20del%202.pdf>

40. Bundgaard, A. & Remmen, A. (2018). Designing out waste. Danish Environmental Protection Agency. Retrieved from <https://www2.mst.dk/Udgiv/publications/2018/10/978-87-93710-90-0.pdf>

41. Hogg, D. et al. (2020). Study to Support Preparation of the Commission's Guidance for Extended Producer Responsibility Schemes. European Commission. Retrieved from <https://op.europa.eu/en/publication-detail/-/publication/08a892b7-9330-11ea-aac4-01aa75ed71a1/language-en>

42. Hogg, D. et al. (2020). Study to Support Preparation of the Commission's Guidance for Extended Producer Responsibility Schemes. European Commission. Retrieved from <https://op.europa.eu/en/publication-detail/-/publication/08a892b7-9330-11ea-aac4-01aa75ed71a1/language-en>

5.2.6 Initiatives to promote substitution

Sweden's Strategy for a Non-toxic Environment (2020)⁴³ includes a clear aim of strengthening substitution, which has been on the Swedish agenda for many years. A substitution tool was launched in 2004, and relaunched in 2020 under the name "PRIO". In 2017, the Swedish Centre for Chemical Substitution (SCSC) was initiated.

The SCSC is placed at the publicly-owned research institution of Sweden (RISE). SCSC provides guidance to businesses – and in particular SME's - in conducting substitution. It provides online substitution guidance, runs a help-desk, conducts training courses and carries out technical studies. SCSC has not been targeting EEE in particular (only one webinar so far), but it is on the radar for future activities. SCSC provides guidance in supply chain management including a subcontractor certificate for plastics, where the subcontractor has to provide information about the plastic component⁴⁴, as well as guidance for risk assessments of products based upon materials available and the risk of use of hazardous chemical substances. The guidance in supply chain management increases the knowledge on the content of EEE including the use of hazardous substances, which enable suppliers to set out clear demands to sub-contractors.

Box 3: SCSC Tool for supply chain management

The SCSC tool includes a number of factors and components that provide better control and transparency along the supply chain:

- Subcontractor certification (proving the avoidance of specific materials, chemical substances, SVHC)
- Safety sheets
- Presence of sustainability policy
- ISO-certifications (Environmental management system ISO 14001; quality management system ISO 9001; Occupational health and safety ISO 45001)
- Ecolabels
- Laboratory product tests⁴⁵

43. Government Offices of Sweden webpage. (2015, August 17). Strategy for a non-toxic environment. Retrieved from <https://www.government.se/articles/2015/08/strategy-for-a-non-toxic-environment/>

44. RISE (2021). Grundkurs i substitution. Retrieved from <https://www.ri.se/sv/substitutionscentrum/filmer-och-webbinarier/webbinarium-grundkurs-i-substitution>

45. RISE (2021). Grundkurs i substitution. Retrieved from <https://www.ri.se/sv/substitutionscentrum/filmer-och-webbinarier/webbinarium-grundkurs-i-substitution>

PRIO is a voluntary online tool that companies can use in their work on substitution. PRIO is a structured four-phased approach to identifying and prioritising hazardous chemicals for substitution. PRIO has been developed by the Swedish chemicals agency and holds a database of more than 10 000 examples of substances with hazardous properties to human health and the environment. PRIO differs from other substitution tools in that it goes further than the REACH regulation requires in referring to the Swedish environmental quality objective of "A non-toxic environment". PRIO identifies two levels of substances; phase-out substances and priority risk-reduction substances. The additional phase-out substances in PRIO include fluorinated greenhouse gases, substances that are strongly allergenic or ozone depleting, particularly hazardous metals and particularly persistent substances such as per- and polyfluoroalkyl substances. The PRIO-tool is the 7th most visited page on the Swedish chemical agency's website.

5.3 Promoting non-hazardous design of EEE

Bans on specific hazardous substances force companies to find alternatives. Legislation is a key driver for reducing hazardous substances in EEE and a driver for innovation. The key challenges for strengthening the legislative framework are related to how to reduce the incidence of hazardous substances whilst they undergo the lengthy legislative procedures towards restriction, how to support the replacement of these substances with non-hazardous alternatives rather than just non-regulated alternatives, and how to ensure transparency along the complex, global supply chains for EEE.

5.3.1 Closing the response gap

The procedure for banning and restricting chemical substances is lengthy, while the production and introduction of chemical substances to the market is rapid. The EU Commission addressed this challenge in their recent Chemical Strategy for Sustainability "Towards a Toxic Free Environment" (2020)⁴⁶ by, amongst others, better coordinating the assessment of substances ("One substance, one assessment"). The industry demands a clearer and straight-forward legislative framework, with equal interpretation across member states.

As well as consolidating and simplifying the legislative processes, policy initiatives can create incentives for companies to avoid hazardous substances, *before* they are restricted or banned. Common for these initiatives is that they go further than the respective legislation, either by improving knowledge on hazardous chemicals (e.g. through a list of hazardous chemicals and guidance in safe substitution) or by creating incentives to substitute away from specific hazardous substances (such as the Swedish chemical tax, GPP criteria etc.).

One study indicated that companies' motivation for working towards more sustainable products are legislation, stakeholders' expectations and their own sustainability strategy. Those companies working actively towards sustainable

46. EC. (2020a). Chemicals Strategy for Sustainability: Towards a Toxic-Free Environment. Retrieved from https://eur-lex.europa.eu/resource.html?uri=cellar:f815479a-0f01-11eb-bc07-01aa75ed71a1.0003.02/DOC_1&format=PDF

substance use often see legislation as an opportunity of innovation⁴⁷. One brand owner also noted that companies actively call for additional restrictions of hazardous substances.

Those suppliers that go beyond legislation identify the demand for ecolabels as one of the primary drivers. The use of ecolabels within EEE is motivated by demand from professional public- and private procurers: there currently appears to be little consumer demand for ecolabelled EEE (to be further elaborated under Section 7 on consumer-targeted initiatives). Investors sometimes include information on the use of SVHC to assess the sustainability performance of a company.

5.3.2 Increasing transparency

Manufacturers and importers putting EEE on Nordic markets are often not fully aware of what their products contain. EEE often consist of multiple components, supplied by a variety of first, second and third tier sub-contractors. The product development cycle is fast, and the value chains can be long and complex. The legislative framework makes up a minimum requirement of transparency of certain chemical substances, but the content of and the level of hazardousness of the remaining chemical substances are unknown. Transparency is an important issue to tackle to limit hazardous substances in EEE and design for recycling.

Clear, harmonized and properly enforced legislation is, according to interviewed industry experts, an important driver to achieve higher levels of transparency on chemicals used in the industry.

REACH and WFD have improved the transparency on the use of SVHC's with the SCIP database that facilitates information exchange between suppliers and waste management companies. SCIP is further planned to be made available for consumers. However, SCIP only informs about SVHC – i.e. those included on the candidate list, and not about other potentially hazardous chemical substances.

One informant, representing a consumer organisation, argues that a full content declaration of chemical substances should be required for EEE in order to create transparency. Such a requirement would place significant costs at the suppliers due to the long value chains and many components of EEE and further challenge confidentiality. Ecolabels can contribute to transparency of the products they are certifying (depending on the criteria sets). By demanding ecolabels consumers and professional procurers can push forward transparency. Ecolabels placed on products can, however, be challenged by the rapid market development, which require constant certifications of new products and updates of criteria. Therefore, environmental management systems or others certification targeting the entire company can contribute to ensure that environmental procedures are in place.

If suppliers want to increase transparency, participation in networks can be a way to exchange knowledge with other partners in the industries and work together towards transparency. In Sweden, the Chemical Group for EEE is one such

47. Cockcroft, L & Persich T. (2017). Insights on the impact of REACH & CLP implementation on industry's strategies in the context of sustainability. ECHA. Retrieved from https://echa.europa.eu/documents/10162/13637/echa_css_report_without_case_studies_en.pdf/a0a6f46f-16c8-fbea-8b41-9ff683aafe5c

example⁴⁸. Also, suppliers can require supply certification, ISO standards, conduct laboratory control tests themselves, require safety sheets and so forth. Policy initiatives can support supply chain management by providing tools, standards and methods for information exchange.

For e-commerce of cosmetics, where declarations of ingredients are required, a plug-in to see whether a product contain any hazardous substances (as per the NGO's Chemsec's Sinlist⁴⁹ containing substances that are likely to be banned or restricted in the future including the substances on the candidate list) can be downloaded through an app, and contribute not just to transparency, but also help consumers in avoiding SVHC.

Box 4: Risk classification of all products in the company Clas Ohlson

Taking account of the high number of products yearly being introduced, the company Clas Ohlson has clear processes for chemical classification. Every product is classified against a risk scale ranging from *low*, when the supplier is known, hazardous chemicals are rarely used and the exposure is low, *to high* if the supplier is new, the product categories often apply hazardous chemicals and the exposure is high. High-risk products are controlled to be compliant with legislation, CE-labels are controlled, and so are ecolabels (where possible)⁵⁰.

Box 5: Swedish traceability project "Keep Electrical and Electronic Products" (KEEP)

The KEEP project, financed by Sweden's Innovation Agency, is developing a traceability system for EEE. The project is led by Chalmers Industriteknik and has 14 partners representing different parts of the value chain including manufacturers, re-users, material recyclers, information-sharing organisations, standardisation organisation as well as representative end users. The project will develop a common standard for information sharing and a platform for storing the large amount of data. In the traceability system, each electronic product will be labelled in order to facilitate access to relevant information.

The project began in 2018 with a pre-study. The project is now in its second phase and has developed a prototype of the traceability system. In the third phase of the project a full-scale traceability system will be developed and tested. The third phase is expected to start in January 2022⁵¹.

48. Kemikaliegruppen EEE in Swedish . RISE webpage. (n.d). Kemikaliegruppen - ett nätverk för textil- och elektronikföretag. Retrieved from <https://www.ri.se/sv/vad-vi-gor/natverk/natverket-kemikaliegruppen>

49. Chemsec webpage. (n.d). SIN List. Retrieved from: <https://sinlist.chemsec.org>

50. RISE webpage. (n.d). Clas Ohlson: En utmaning att fasa ut flamskydd ur elektronik. Retrieved from <https://www.ri.se/sv/substitutionscentrum/goda-exempel/clas-ohlson-vill-minska-flamskydd-i-elektronik>

51. Keep Electrical and Electronic Products webpage. (n.d). Traceability for a circular future. Retrieved from <https://keepelectronics.com/#/>

5.3.3 Digital Product passports

The digital product passports announced under EU's Sustainable Products Initiative are also expected to increase transparency about the hazardous substances content in products. It is currently not known how these product passports will be designed nor used. The trade-off between costs and transparency makes it unlikely that product passports can move beyond international standards and EU regulation.

In the EU Chemicals Strategy one objective is to *"ensure availability of information on chemical content and safe use, by introducing information requirements in the context of the Sustainable Product Policy Initiative and tracking the presence of substances of concern through the life cycle of materials and products"*. It is stated that such efforts should build on ECHA's SCIP database, ongoing work on the review of REACH (action 3)⁵², and the development of digital product passports.

There is currently a great deal of interest in digital product passports. There is however uncertainty regarding the design, content and intended use of the passport. When it comes to chemicals in products, it seems clear that such information will be part of the passport, but we do not know for certain:

- Whether the information will be limited to mainly chemicals regulated in law, or if other chemicals will be included;
- Who will be the intended users of the information (consumers, recyclers etc.);
- Whether prohibitive costs and/or trade secrets will compromise the progressiveness of the passport information.

Ideally, product passports could support various needs and processes, by:^{53 54}

- Requiring producers and importers to ensure information on the chemical content of a product is provided on the product, or is easy to obtain;
- Banning the use of a substance or substances in a given product, if these substances inhibit product recyclability, and;
- Requiring producers and importers to publish information on how they have prioritized materials that are "safe and sustainable-by-design" (thus linking to ongoing processes related to the EU Chemicals Strategy), and have substituted chemicals of concern with safer ones whenever possible.

There is, however, a trade-off related to costs for obtaining and communicating detailed information in value chains.⁵⁵ Thus, it is unlikely that digital product passports can go much further beyond existing EU laws and international practices and standards. Further, the issue of consumer information is still present: most consumers will probably not be interested in the information, even if provided.

The Nordic countries should push for more progressive practices, and to strengthen links between the SCIP, product passports and other initiatives of relevance.

52. EC (2018). Commission General Report on the operation of REACH and review of certain elements – Conclusion and Actions. COM(2018)0116

53. Löf, M. (2021). Important that Commission's Sustainable Products Initiative include transparency on chemicals in consumer products. Baltic Eye website. Retrieved from <https://balticeye.org/en/baltic-eye-blogs/baltic-eye-comments/chemicals-in-consumer-products/>

54. Undeman, E. & Bolinus, D. (2018). We must increase the transparency around chemicals in articles. Baltic Eye website. Retrieved from <https://balticeye.org/en/pollutants/policy-brief-list-ingredients-on-consumer-articles/>

55. Svenskt Näringsliv. (2020). Svenskt Näringslivs kommentarer och inspel kring frågan om Produktpass. Retrieved from https://www.svensktnaringsliv.se/bilder_och_dokument/mu3g1q_svenskt-naringslivs-kommentarer-och-inspel-om-produktpass-200422_1005630.html/SvensktNaringslivskommentarer+och+inspel+om+produktpass+200422+slutversion.pdf

5.3.4 Ensuring safe substitution

The restrictions and bans of specific chemical substances as well as inclusion of substances on the candidate list are key drivers of substitution⁵⁶. Likewise, ecolabels and GPP criteria, which limit the use of specific hazardous substances, going further than legislation, can drive substitution. According to the industry, substitutions will be conducted when the alternative is technical feasible and not increasing costs.

Technical barriers include the inability of alternatives to provide satisfactory technical performance. The gains of any substitution need to be seen in relation to the amount of replacement substance(s) for a given hazardous substance. In some cases, substitution requires several substances or a significant higher concentration to reach the same function and performance, which risk diluting the impact of substitution – also termed 'regrettable substitution'. Any alternatives must be carefully tested and assessed. When there are no technical feasible and better alternatives to the currently used hazardous substances on the market, substitution will require significant resources to carry out research and development.

The technical barriers can also be rooted in design norms and trends. According to an industry representative, the use of flame retardants can be avoided, but due to the trend in slimmer screens and smaller products, chemicals are used as a cheap solution to achieve flame-retardance properties and thus meet safety requirements. A printed circuit board in a smartphone can, for example, be encased with metals to avoid the use of flame retardants. Such design solution would, however, make the smartphone much thicker and heavier, which is not considered popular design. Substitution can in some cases require that a product is designed completely different, and that is both unattractive and costly for the companies.

The technical barriers are thus often closely related to the costs; both the price of the alternative substances and the substitution process including the assessment and comparison of alternatives, the test and implementation of a safe alternative including any design changes. SMEs are often limited from carrying out a thorough substitution process, where larger companies have greater resources to research and test alternatives for whom it is rather the actual price of the chemical substance and implementation and design costs that make up the greatest barrier to substitution.

A tax on hazardous substances can create – in theory – an economic incentive to substitute hazardous substances with less hazardous alternatives. The Swedish chemical tax has yet to prove its impact on limiting the use of hazardous substances, but the industry indicates that the Swedish tax does send a clear signal to avoid the taxed substances. The tax incentive will, however, need to be higher than the appliance of an alternative substance, which is challenged by the size of the Swedish market. Another approach is to provide funding to support safe substitution, which e.g. is taken place in TURI (see box 6).

56. ECHA. (2020). Impact of REACH restriction and authorisation on substitution in the EU. Retrieved from https://echa.europa.eu/documents/10162/24152346/impact_rest_auth_on_substitution_en.pdf/7c95222f-5f84-57f7-4cba-65b8463c79d4

Box 6: Grants that offset the costs of reducing the use of hazardous chemicals

Toxic Use Reduction Institute (TURI) in Massachusetts offers grants to incentivise manufacturers to assess and implement safe substitutions. The applications for funds have been made as easy to apply for as possible, to lower application barriers. Furthermore, manufacturers are encouraged to communicate their experience with substitution to encourage other manufacturers to follow suit⁵⁷.

For SME's, lack of knowledge on substitution opportunities can be a significant barrier. In Sweden, the Swedish Chemical Substitution Centre (SCSC) supports SMEs in the process of substituting hazardous substances. There is a tacit acknowledgment that larger manufacturers have the technical capacity to engage in substitution inhouse. Tools that provide lists of safe alternatives can help simplify the substitution process.

SCSC indicates that "chemical checks", where the use of chemicals and hazardous substances are mapped and a substitution assessment is conducted, can be one way to conduct campaigns about safe substitution. These could target SME's in specific industries that are known to use hazardous substance. Such "chemical checks" are currently in early development; full implementation of this type of support will require additional resources.

5.3.5 Influencing global value chains of EEE

Little production of EEE takes place in the Nordic region. Much of the EEE on the Nordic market is supplied through complex and long, global value chains, and the Nordic market, although significant on a per capita basis, is still relatively inconsequential at the global scale. This leaves the Nordic countries with a little direct influence on production of EEE nor the reduction in the use of hazardous substances in EEE plastics. Even within the Nordic market, lack of demand for EEE complying with the Nordic ecolabel also indicate that the market itself cannot drive global changes.

EU legislation – RoHS and REACH in particular – has proven to be useful for controlling hazardous content of EEE. The Nordic countries can work actively to enforce compliance with EU legislation. Likewise, the Nordic countries can form a strong alliance in pushing forward the agenda on limiting hazardous substances and circular EEE in the EU (through, amongst others, the revision of RoHS, the Sustainable Products Initiative, and the Circular Electronics Initiative announced in the new Circular Economy Action Plan). The Nordic countries share a common objective of promoting a circular economy, and have a long history working with the limitation of hazardous substances, which forms a common ground for an alliance.

TCO Certified, one of the two globally influential Ecolabels for EEE, is based in Sweden, so in that way, developments in the Nordic countries can have global consequences (see section 7.1.1 for further description of TCO Certified).

57. Toxic Use Reduction Institute. (n.d). Industry Grant. Retrieved from <https://www.turi.org/content/download/13517/206378/file/Industry+Grant+Overview+-+FY22.pdf>

6. HAZARDOUS SUBSTANCES IN PLASTIC EEE COMPONENTS

6.1 Introduction

Plastics are ubiquitous components of electrical and electronic equipment (EEE). They are electrically insulating, lightweight, strong, durable and easily moulded and formed into complex shapes. Many different types of engineering plastics are used in EEE. They are found in casings/housing and other aesthetic components, cables, insulating and structural components within articles and on printed circuit boards. The majority by weight is in casing/housing and cables.

The composition of plastics appearing in WEEE flows provides an indication of the most common polymers used:

- ABS (Acrylonitrile Butadiene Styrene) (30%),
- HIPS (High Impact Polystyrene) (25%),
- PP (polypropylene) (8%),
- PC (polycarbonate) (10%),
- PC/ABS (9%), and
- other mixed materials (18%)⁵⁸.

These plastics are used in complex combinations to provide the necessary mechanical and production properties required. Manufacturers use a wide (and growing) variety of additives to create specific mechanical, thermal, electrical and aesthetic qualities required for the end product, or to aid the manufacturing process. Common additives are plasticisers (substances that effect the physical properties of the plastic), flame retardants (substances that limit the flammability of the plastic), stabilisers (substances that limit the degradation of the plastic), colourants, and anti-static compounds.

In 2019, ECHA ran a project mapping the additives used in plastics^{59, 60} initially identifying 1550 potential plastic additives⁶¹, many with more than one function (for example, both a plasticiser and a flame retardant). After consultation with industry and experts, this list was reduced to 418 substances that are in use today. Of these, 66 were used as plasticisers, of which 54% were under regulatory scrutiny, and 40 were used as flame retardants, 67% of which were under regulatory scrutiny⁶².

TCO Certified, a global IT certification body based in Sweden, undertook a similar study⁶³ to identify the plasticisers and flame retardants used in electronic products.

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58. Hahladakis, J. N. et al. (2018). An overview of chemical additives present in plastics: Migration, release, fate and environmental impact during their use, disposal and recycling. *Journal of Hazardous Materials* 344, 179–199. Retrieved from <https://www.sciencedirect.com/science/article/pii/S030438941730763X>
59. ECHA webpage. (n.d). Plastic additives initiative. Retrieved from <https://echa.europa.eu/plastic-additives-initiative>
60. ECHA. (2019). Plastic Additives Initiative Supplementary Information on Scope and Methods. Retrieved from https://echa.europa.eu/documents/10162/13630/plastic_additives_supplementary_en.pdf/79bea2d6-8e45-f38c-a318-7d7e812890a1
61. ECHA. (2019). Plastic Additives Initiative Supplementary Information on Scope and Methods. Retrieved from https://echa.europa.eu/documents/10162/13630/plastic_additives_supplementary_en.pdf/79bea2d6-8e45-f38c-a318-7d7e812890a1
62. Regulatory scrutiny in this context meant: falling under REACH (incl. Authorisation list (Annex XIV), candidate list of substance of very high concern, restrictions, substance evaluation, risk management option analysis, PBT/ED assessment, manual screening) or harmonised classification and labelling of hazardous substances (CLP Annex IV/CLH).
63. Interview with programme manager.

TCO Certified identified around 25 plasticisers and around 40 flame retardants that were commonly in use. Over half of both groups were deemed hazardous according to industry standard hazard screening methods⁶⁴.

Consultation with industry experts during this project indicates that plasticisers and flame retardants are the most important source of hazardous substances in plastics in new EEE products. This is mirrored by the legislative focus: halogenated flame retardants and phthalate plasticisers are the primary focus of legislation, together with heavy metals. As such, the following sections address these main functional groups.

It is important to note that this project does not provide a comprehensive list of the hazardous substances that could be present in EEE plastics. This project uses the current legislative framework as the primary tool for identifying the hazardous substances that are likely to be relevant for EEE plastics. The hazardous phthalates and halogenated flame retardants addressed in legislation often have alternatives that, although similar and potentially equally or more hazardous, are not subject to the regulatory framework and thus have not necessarily been subject to thorough risk assessments.

As such, it is highly likely that additional potentially hazardous substances not mentioned in this report are present in EEE plastics, particularly in imported EEE products.

6.2 Heavy metals

Heavy metals can function as catalysts in the polymerisation process, as UV and thermal stabilisers and as synergists to halogenated flame retardants.

The RoHS Directive sets the following limits for Cadmium, Lead, Mercury, Hexavalent Chromium:

Table 2 - Heavy metals restricted by RoHS

Controlled Substance	Restriction/Max. concentration values
Cadmium (Cd)	0.01% by weight
Lead (Pb)	0.1% by weight
Mercury (Hg)	0.1% by weight
Hexavalent chromium (Cr6+)	0.1% by weight

In addition, Oxides of Antimony (Sb) – and particularly Antimony Trioxide – are used as synergists for halogenated flame retardants. These oxides are not currently restricted in the EU. It is registered under the CLP as being suspected of being carcinogenic.

⁶⁴. TCO uses GreenScreen, a method of comparative Chemical Hazard Assessment (CHA) for identifying hazardous chemicals and safer alternatives. GreenScreen was developed and is maintained by Clean Production Action a US-based NGO promoting cleaner production.

6.3 Plasticizers

Plasticisers enable manufacturers to adapt the physical properties of a base polymer to suit a specific application. The revised RoHS Directive includes restrictions on the following phthalates in EEE, their cables and their spare parts:

Table 3 - plasticizers restricted by RoHS

Controlled Substance	Restriction/Max. concentration values*
Bis(2-ethylhexyl) phthalate (DEHP)	0.1% by weight
Butyl benzyl phthalate (BBP)	0.1% by weight
Dibutyl phthalate (DBP)	0.1% by weight
Di-isobutyl phthalate (DIBP)	0.1% by weight

The restriction of DEHP, BBP, DBP and DIBP also applies to medical devices, including in vitro medical devices, and monitoring and control instruments, including industrial monitoring and control instruments. However, medical devices have a two-year extension to comply with RoHS 3, and must be compliant from 22 July 2021^{65, 66}.

The first three DEHP, BBP, DBP, are also restricted under Annex XVII of the Reach Directive. In addition:

- Diisononyl phthalate (DINP),
- Diisodecyl phthalate (DIDP),
- Di-n-octyl phthalate (DNOP)

are restricted under Annex XVII of the REACH Directive, as well as the Toy Safety Directive, and could potentially be found in EEE plastics⁶⁷.

Of the, approximately, 25 plasticisers identified by TCO Certified in their 2015 screening of currently applied chemicals in electronics, only eight were deemed 'non-hazardous' (GreenScreen rating 2,3 or 4), indicating approximately 17 were hazardous (a GreenScreen rating 1 – see table 8). This is a significantly higher number of hazardous plasticizers than are included in the RoHS, indicating that RoHS does not provide sufficient coverage of hazardous plasticizer substances in EEE plastics.

65. RoHSGuide webpage. (2021, June 23). Welcome to RoHS Guide. Retrieved From <https://www.rohsguide.com/>

66. EC webpage. (n.d). Waste from Electrical and Electronic Equipment (WEEE). Retrieved From https://ec.europa.eu/environment/waste/weee/index_en.htm

67. Miljøstyrelsen (2013). Business guidance on phthalates.

6.3.1 Alternative plasticisers

The most popular non-phthalate plasticizers are DEHT and DINCH. DEHT is more widely used in the United States while DINCH is more frequently used in Europe. Both can replace phthalates, often DEHP and DINP, in almost all plasticizer applications⁶⁸.

In addition, the TCO Certified certification criteria for electronic equipment works with a positive list of non-hazardous substances, which includes 16 plasticisers. These can be found in Table 4. The chemicals on the TCO Certified's positive lists are those that have undergone GreenScreen assessment and been found to be less hazardous (they have a GreenScreen score of 2, 3 or 4 – see Table 8) than the chemicals restricted by legislation, and these chemicals are thus unlikely to be included in legislative restriction lists in the future⁶⁹.

Table 4 – List of alternative plasticisers^{70,71}

Alternative Plasticiser	GreenScreen Rating
Bis(2-ethylhexyl) Adipate (DEHA)	2
2-Ethyl-1-Hexanol	2
Dimethyl phthalate (DMP)	2
Diisooctyl adipate	2
Diisononyl Cyclohexanedicarboxylate (DINCH)	2
Di(monoepoxyoleate, Monoacetate) Glyceryl Adipate	3
Oxydipropyl Dibenzoate	2
Tris(2-ethylhexyl) Trimellitate (TEHTM) Also: Trioctyl trimellitate (TOTM)	2
Diisononyl Adipate (DINA)	2
Bis(2-propylheptyl) phthalate (DPHP)	2
Di(2-ethylhexyl) Terephthalate (DEHT)	3
Acetyl tri-butyl citrate (ATBC)	3
Epoxidized soya bean oil (ESBO)	3
White mineral oil	2
Coconut Oil Polyester /GLOBINEX®T-70	2

68. ChemSec. (2019). Replacing phthalates Why and how to substitute this hard-to-spell chemical group. Retrieved From <https://chemsec.org/app/uploads/2019/09/Replacing-Phthalates-%E2%80%93-ChemSec-190911.pdf>

69. TCO Certified (2021). TCO Certified Accepted Substance List. Retrieved from: <https://tcocertified.com/industry/accepted-substance-list/>

70. ChemSec. (2019). Replacing phthalates Why and how to substitute this hard-to-spell chemical group. Retrieved From <https://chemsec.org/app/uploads/2019/09/Replacing-Phthalates-%E2%80%93-ChemSec-190911.pdf>

71. TCO Certified (2021). TCO Certified Accepted Substance List. Retrieved from: <https://tcocertified.com/industry/accepted-substance-list/>

6.3.2 Alternative plasticisers to DEHP

The following table provides a list of less hazardous alternatives to DEHP based on work by Bywall & Cederlund⁷² and ChemSec⁷³. There are some duplicates in this table and the one above from TCO Certified. They have been kept in the respective tables for the sake of completeness.

Table 5 - Alternative to the plasticizer DEHP

Cas. no	Name	Comment
166412-78-8	Di(isonyl)cyclohexane-1,2-dicarboxylate (DINCH)	DINCH substitution for DEHP does not require costly changes in the plasticizer content or in the use of viscosity modifiers. Do not pass the requirements for cables and wires as they are not suitable for high temperatures.
103-23-1	Di(ethylhexyl) adipate (DEHA)	Adipates are produced with various alcohol groups and are diesters of aliphatic dicarboxylic acids. Their classification as low temperature plasticizers make adipates a preferred plasticizer for cold solutions storage
77-90-7	O-acetyl tributyl citrate (ATBC)	Citrates are citric acid esters and represent another group of plasticizers. ATBC is a non-volatile compound that has higher water solubility and is less lipophilic compared with other plasticizers, including phthalates.
3319-31-1	Tri-2-ethylhexyl trimellitate (TETM)	Trimellitates make up about 8% of the market for alternatives to phthalates. They pass heat requirements for wires and cables and are primarily used when heat resistance is required because they are expensive compared to DEHP
6422-86-2	Di-(2-ethylhexyl) terephthalate (DEHT)	Even if DEHT are versatile alternatives, the plasticizer might not be direct drop-in replacements in many applications since additional changes are needed. Do not pass the requirements for cables and wires as they are not suitable for high temperatures.
33703-08-1	Diisononyl adipate (DINA)	Used in polymeric systems based on vinyl, nitrocellulose and rubber. It offers flexibility to products at low temperatures. Diisononyl Adipate (DINA) adds impact resistance the compound to which it is added. It has a lower volatility than other plasticizers.
77-90-7	Acetyl tri-butyl citrate (ATBC)	Acetyl tributyl citrate (ATBC) is used as a plasticiser in cosmetic products and in PVC applications. However, the use in PVC is limited due to them having a comparably high water solubility.
131-11-3	Dimethyl phthalate (DMP)	
53306-54-0	Bis(2-propylheptyl) phthalate (DPHP)	Used for softening PVC plastics and is a general-purpose PVC plasticizer. It possesses very good plasticizing properties and may be used as a direct replacement for DEHP and DINP in many applications.
27138-31-4	Oxydipropyl dibenzoate	
15834-04-5	Pentaerythritol tetravalerate (PETV)	PETV advantages can give are low volatility good UV-stability and low smoke release while burning. This is mainly due to its aliphatic structure and the absence of an aromatic ring.

72. Bywall, L. & Cederlund, S. (2020). Analysis of market and requirements of plasticizers for flexible PVC - With a focus on Perstorp's non-phthalate plasticizer Pevalen. Lund: Lund University. Retrieved From <https://lup.lub.lu.se/luur/download?func=downloadFile&recordId=9029959&fileId=9030218>

73. ChemSec. (2019). Replacing phthalates Why and how to substitute this hard-to-spell chemical group. Retrieved From <https://chemsec.org/app/uploads/2019/09/Replacing-Phthalates-%E2%80%93-ChemSec-190911.pdf>

6.4 Flame retardants

One of the most hazardous categories of EEE plastic additives include brominated (halogenated) flame retardants (BFRs), used to retard ignition and prevent fire from spreading in electronic devices. Different halogenated flame retardants are restricted under REACH, RoHS and POP, and as of March 2021, no halogenated flame retardants can be used in display casings under the revised Eco-Design Directive.

The halogenated flame retardants restricted under RoHS are:

- Polybrominated biphenyls (PBB) (mono-, di-, tri-, tetra-, penta-, hexa-, hepta-, octa-, nona- and deca) (maximum concentrations 0.1% by weight).
- Polybrominated diphenylethers (PBDE) (mono-, di-, tri-, tetra-, penta-, hexa-, hepta-, octa-, nona- and deca) – commonly used as an additive BFR in engineering thermoplastics (maximum concentration 0.1% by weight).

The Candidate list of SVHC includes:

- Hexabromocyclododecane (HBCDD) - commonly used as flame retardant in HBS engineering thermoplastics (also on the Authorisation list).⁷⁴
- Short-chain chlorinated paraffins (SCCP) (also a plasticizer)
- Tris(2-chloroethyl) phosphate.

POPs regulation Annex B

- Hexabromocyclododecane (HBCDD) – commonly used as flame retardant in HBS engineering thermoplastics⁷⁵.

In addition to the above:

- Tetrabromobisphenol A (TBBPA) – an ABS flame retardant – is recommended for inclusion in RoHS by the evaluation of RoHS (pack 15)⁷⁶.
- Medium-chained chlorinated paraffins (MCCPs) (candidate for inclusion in RoHS⁷⁷).

Given the legislative focus on them from RoHS, PBB and PBDE are those most commonly studied halogenated flame retardants. PBB and PBDE are the main groups of BFRs with antimony (Sb) as a synergist. More specifically, antimony trioxide is used in combination with BFRs to increase fire resistance. This explains the presence of antimony in the plastic components of WEEE. The typical BFR concentrations in WEEE plastics range between 3% and 25% w/w⁷⁸.

74. Intertek webpage. (2016, June 30). EU – HBCDD Prohibited under POPs Regulation. Retrieved from <https://www.intertek.com/consumer/insight-bulletins/hbccd-prohibited-under-pops-regulation/>

75. Intertek webpage. (2016, June 30). EU – HBCDD Prohibited under POPs Regulation. Retrieved from <https://www.intertek.com/consumer/insight-bulletins/hbccd-prohibited-under-pops-regulation/>

76. Baron Y. et al. (2021). Study to support the review of the list of restricted substances and to assess a new exemption request under RoHS 2. Luxembourg: Publication Office of the European Union. EC. Retrieved from <https://op.europa.eu/en/publication-detail/-/publication/ce50dc9c-6c19-11eb-aeb5-01aa75ed71a1/language-en>

77. Baron Y. et al. (2021). Study to support the review of the list of restricted substances and to assess a new exemption request under RoHS 2. Luxembourg: Publication Office of the European Union. EC. Retrieved from <https://op.europa.eu/en/publication-detail/-/publication/ce50dc9c-6c19-11eb-aeb5-01aa75ed71a1/language-en>

78. Hennebert, P. & Filella, M. (2018). WEEE plastic sorting for bromine essential to enforce EU regulation. Waste Management. 71, 390–399

As noted above, there are strong indications from industry experts that focusing only on those chemicals under legislative focus allows other equally hazardous halogenated flame retardants to be used in products sold on the European market. Not only do these chemicals slip through the regulatory framework, their presence in EEE on the European market are also relatively under-studied.

6.4.1 Alternatives to hazardous flame retardants

There are alternatives to halogen-containing flame retardants for almost all applications. Their use almost always comes down to the associated additional costs and/or technical disadvantages the manufacturer is willing to accept.

The alternative flame-retardant substances presented in the following are based on a larger screening of flame-retardant alternatives in a report conducted by the Swedish University of Agricultural Sciences to Naturvårdsverket^{79,80}. The screening of alternative fire retardants was conducted in several databases, and the following alternatives were identified:

- The US patent database
 - Pentaerythritol,
 - Melamine, and
 - Bis-(t-butylphenyl) phenyl phosphate.
- Registered substances from the European Chemicals Agency (ECHA)
 - Pentaerythritol and,
 - Melamine were found to be the alternative fire retardants used in highest quantities, followed by
 - 1,2-bis(2,3,4,5,6-pentabromophenyl) ethane (DBDPE), and
 - Triethyl phosphate (TEP).
- The Swedish product register from the Swedish Chemicals Agency (Kemi)
 - Pentaerythritol, followed by
 - 2-ethylhexyl diphenyl phosphate (EHDPP),
 - 1,2-bis(2,4,6-tribromophenoxy) ethane (BTBPE), and
 - tetrabromobisphenol-A-bis(2,3-dibromopropyl) ether (BTBPE), and
 - tetrabromobisphenol-A-bis(2,3-dibromopropyl) ether (TBBPABDBPE).

Overall, the research for alternative fire retardants conducted in the report, showed approximately 125 alternatives, which are listed in the report. However, for most of these fire retardants, the long-term health and environmental effects are unknown.

Table 6 provides a list of alternative fire retardants drawn from a report published by the Danish Environmental Protection Agency. These are potentially applicable for EEE.

79. Replacement substances for the brominated flame retardants PBDE, HBCDD, and TBBPA -2017

80. Gustavsson, J. et al. (2017). Replacement substances for the brominated flame retardants PBDE, HBCDD, and TBBPA. Uppsala, Institutionen för vatten och miljö & Sveriges lantbruksuniversitet. Retrieved From <https://www.diva-portal.org/smash/get/diva2:1133654/FULLTEXT01.pdf>

Table 6 - Alternative fire retardants potentially applicable in EEE⁸¹

Fire retardant	Polymer	Concentration	Remark
Metal phosphinates	Glass fibre reinforced poly-amides Glass fibre polyester	Up to 20%	Often combined with Nsyner-gists
Melamine polyphosphate	Glass fibre reinforced poly-amides	App. 25%	Used as synergists with phos-phorous FR
Melamine cyanurate	Un-reinforced polyamide 66 Unfilled polyamide 6 Mineral-filled polyamide	5–10% (UL 94 V-0) 5–10% (UL 94 V-0) 13–16% (UL 94 V-0)	Used as synergists with phos-phorous FR. Difficult to reach V-0 in glass filled polyamide
Red phosphorus	Glass fibre reinforced poly-amides	5–8% (UL 94 V-0)	Limited to red and black plastic. Handling and safety issues; consequently, FR is stabilized and coated
Aryl phosphates/ phosphonates	PC/ABS blends	10–20%	
Magnesium hydrox-ide	(low) Glass fibre reinforced polyamides	60% (UL 94 V-0)	Plastic difficult to process and stiff.
Ammonium poly-phosphate	Polyolefins	20–30%	Often combined with N syner-gists

The TCO Certified certification criteria for electronic equipment works with a positive list of non-hazardous substances, including 19 flame retardants⁸². These can be found in Table 7. The chemicals on the TCO Certified's positive list are those that have undergone the GreenScreen assessment and have been found to be less hazardous (a score of 2, 3 or 4) than the chemicals restricted by legislation, and unlikely to be included in legislative restriction lists in the future⁸³.

81. Nilsson, N. et al. (2016). Fire Safety Requirements and Alternatives to Brominated Flame Retardants. Copenhagen: The Danish Environmental Protection Agency. Retrieved From <https://www2.mst.dk/Udgiv/publications/2016/01/978-87-9345-22-3.pdf>

82. TCO Certified (2021). TCO Certified Accepted Substance List. Retrieved from: <https://tcocertified.com/industry/accepted-substance-list/>

83. TCO Certified (2021). TCO Certified Accepted Substance List. Retrieved from: <https://tcocertified.com/industry/accepted-substance-list/>

Table 7 - TCO Certified positive list, Flame retardants

Alternative flame retardant	GreenScreen rating
Triphenyl Phosphate	2
Resorcinol Bis-Diphenylphosphate	2
Magnesium Hydroxide	3
Aluminum oxide	2
Tetrakis (2,6-dimethylphenyl)-m-phenylene biphosphate	3
Melamine Polyphosphate/Melapur® 200	2
Aluminum Hydroxide	2
Aluminum diethylphosphinate	3
Cross-linked Phenoxyphosphazene	3
Octaphenylcyclotetrasiloxane	3
Phosphonic acid aluminium salt	3
Resorcinol Bis-Diphenylphosphate/Fyrolflex RDP	2
Substituted Amine Phosphate mixture	2
Ammonium Polyphosphate	3
Siloxanes and silicones, di-Me, di-Ph, polymers with Ph silsesquioxanes	2
Red Phosphorus	2
Phenoxyphosphazene	3
Bisphenol A diphosphate	3

6.4.2 DBDPE – a common alternative to hazardous flame retardants

DBDPE is often used as an alternative to Deca-bromodiphenyl ether(deca-BDE), which is restricted by REACH (Annex XVII). DBDPE has become one of the most widely used alternative brominated flame retardants (BFRs) around the world and is often used in the EEE industry⁸⁴. Several studies have shown the increased exposure to DBDPE worldwide in public areas, homes, offices and in school classrooms in concentrations up to 1 ng/m³. Furthermore, DBDPE has also been found in freshwaters, marine waters, sediment and sludge, soil and plants. With regard to wildlife, DBDPE has been found in moose, mouse, shrew and Arctic harbour seal livers at concentrations up to 26 ng/g. It has also been detected in polar bear adipose in Canada and in polar bear and ringed seal plasma in the Norwegian arctic⁸⁵.

Researchers have begun investigating the human health and environmental

84. Chen, T. et al. (2019). Thyroid function and decabromodiphenyl ethane (DBDPE) exposure in Chinese adults from a DBDPE manufacturing area. *Environment International*, 133, Part A

85. Herzke, D. et al. (2013). Perfluorinated alkylated substances, brominated flame retardants and chlorinated paraffins in the Norwegian Environment - Screening 2013. Tromsø: Norwegian Climate and Pollution Agency

consequences of DBDPE. Several U.S.^{86, 87} and international organisations^{88, 89} have formally evaluated the human health and environmental risks associated with the use of DBDPE. These risk assessments have found DBDPE to be safe in current use patterns. An assessment conducted by the Government of Canada concluded that the compound is not harmful to human health; however, it is harmful to organisms in the environment at current levels of exposure. They also found that the degradation products of DBDPE in the environment may contribute to the formation of persistent, bio-accumulative, and inherently toxic substances⁹⁰. Furthermore, Chen et al. 2019⁹¹ found that exposure to DBDPE was associated with changes in thyroid activity in adults exposed to a high concentration of DBDPE. Other studies have found similar correlations⁹².

Box 7: Example – cables and chargers

A survey for the Norwegian Environment Agency⁹³ found SCCP and MCCP in 11 of 67 sample articles (extension cables, power-banks, chargers). Three of these articles included SCCPs in concentrations much higher than the 0.15% limit stipulated in Annex I of the POPs Regulation, and seven of these articles contained MCCP in concentrations above 0.1%. In 2018, the Swedish Authorities proposed to restrict the use of MCCP under RoHS⁹⁴ and in 2021 the European Commission study reviewing the list of restricted substances (pack 15)⁹⁵ reinforced the inclusion of MCCP in the RoHS restricted sub-stance list.

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- 86. National Academy of Sciences. (2000). National Research Council, Subcommittee on Flame Retardant Chemicals. National Academy Press, Washington, DC
 - 87. Babich, M.A. and Thomas, T.A. (2001). Consumer Product Safety Commission, Bethesda, MD
 - 88. World Health Organization. (1994). Environmental health criteria 162: Brominated diphenyl ethers. International Programme on Chemical Safety. Geneva, Switzerland
 - 89. European Chemicals Bureau. (2002). Institute for Health and Consumer Protection. Vol. 17
 - 90. Government of Canada webpage. (2019, June 28). Decabromodiphenyl ethane (DBDPE) - information sheet. Retrieved from <https://www.canada.ca/en/health-canada/services/chemical-substances/fact-sheets/chemicals-glance/decabromodiphenyl-ethane.html>
 - 91. Chen, T. et al. (2019). Thyroid function and decabromodiphenyl ethane (DBDPE) exposure in Chinese adults from a DBDPE manufacturing area. *Environment International*, 133 (Part A)
 - 92. Wang, F. et al. (2010). Comparative tissue distribution, biotransformation and associated biological effects by decabromodiphenyl ethane and decabrominated diphenyl ether in male rats after a 90-day oral exposure study. *Environ. Sci. Technol.* 44, 5655-5660. DOI: 10.1021/es101158e.
 - 93. Sørensen, P. & Larsen, A. K. (2019). Survey of hazardous substances in articles. Norwegian Environment Agency. Retrieved from <https://www.miljodirektoratet.no/globalassets/publikasjoner/M1259/M1259.pdf>
 - 94. Chemical Watch (2018). Sweden proposes MCCP restriction in electrical, electronic goods. Retrieved from: <https://chemicalwatch.com/67604/sweden-proposes-mccp-restriction-in-electrical-electronic-goods>
 - 95. Baron Y. et al. (2021). Study to support the review of the list of restricted substances and to assess a new exemption request under RoHS 2. Luxembourg: Publication Office of the European Union. EC. Retrieved from <https://op.europa.eu/en/publication-detail/-/publication/ce50dc9c-6c19-11eb-aeb5-01aa75ed71a1/language-en>

Box 8: Example – Plastic components in mobile phones

Singh et al. 2020⁹⁶ analysed the presence of hazardous substances in the different plastic parts of mobile phones on the market from 2001 to 2015. The heavy metals; lead (Pb), cadmium (Cd), mercury (Hg), chromium (Cr), hexavalent chromium (Cr VI), arsenic (As), antimony (Sb), beryllium (Be), bromine (Br), and the flame retardants; Tetrabromobisphenol A (TBBPA), hexabromocyclododecane (HBCDD), polybrominated biphenyls (PBB), polybrominated diphenyl ethers (PBDE) were quantified with respect to their concentrations in the plastic components of phones according to their brand.

Among all the analysed metals, chromium (Cr) shows the highest concentrations followed by antimony, lead, mercury, arsenic and beryllium. Hexavalent chromium was not detected in any of the analysed samples, which is positive since it is on the list of restricted substances in WEEE. The heavy metals cadmium, lead and mercury are on the list of restricted substances in the RoHS directive. Their concentrations in the plastics parts of the tested phones were below the RoHS threshold.

Similarly, the concentrations of HBCDD, PBB and PBDE were also found to be below limit values, although there was a wide range of concentrations of TBBPA (currently not restricted under RoHS, although a candidate to be included).

Assessed against the USEtox LCIA model, the identified chromium showed the most significant eco-toxicity hazards, followed by antimony, cadmium, mercury, arsenic, lead and beryllium. Mercury posed the most significant cancer hazards for the plastics of Nokia, ZTE, iPhone, and Lephone. Lead and arsenic posed considerable cancer hazards for the plastics of all the selected brands of mobile phones.

The levels of the identified metals were assessed to not pose a potential danger to the environment and health if they were collected and recycled properly. However, the content of mercury, chromium, lead, antimony and bromine could pose a potential danger if these plastics end in open burning.

96. Singh, N. et al. (2020). Toxicity evaluation of E-waste plastics and potential repercussions for human health. *Environment International*, 137. Retrieved from <https://www.sciencedirect.com/science/article/pii/S0160412019332556>

6.5 Tools for better design

There are a variety of tools and support mechanisms that help in the substitution of hazardous substances with less hazardous alternatives. Table 8 provides an overview of the most popular.

Table 8 - Tools and support mechanisms for substitution of hazardous substances

Tool	Description
GreenScreen for Safer Chemicals ⁹⁷	An internationally recognized method of comparative Chemical Hazard Assessment that can be used for identifying chemicals of high concern and safer alternatives. Developed by non-profit Clean Production Action. Large database of comprehensive assessments of chemicals. Chemicals are awarded one of four scores: 1 - High concern/Avoid; 2 - Moderate concern/use but search for safer alternatives; 3 - Slight concern/improvement possible; 4 - Few concerns/preferable.
PRIO ⁹⁸	A tool produced by the Swedish Chemical Agency (KEMI) to help identify and replace hazardous substances in products and articles. The four-step process involves 1) identifying currently used substances 2) assessing those substances 3) prioritising those substances and 4) identifying suitable substitutes for those substances. Has a suite of integrated tools to support this process.
Substitute It Now (SIN) list ⁹⁹	Curated by ChemSec, the International Chemical Secretariat, the SIN list is a list of hazardous chemicals that are used in a wide variety of articles, products and manufacturing processes around the globe. Inclusion on the list implies that chemical should be removed as soon as possible as they pose a threat to human health and the environment. The included chemicals have been identified by ChemSec as Substances of Very High Concern (SVHC) based on the criteria established by the European Union chemicals regulation REACH. More than 130,000 chemicals can be investigated by name, CAS number or InChi(key).
SINimilarity tool ¹⁰⁰	Managed by ChemSec, the tool shows if a substance is structurally similar to a substance on the SIN List, which in turn indicates similar problematic properties. The aim is to help avoid substituting one problematic chemical with another.
QCAT ¹⁰¹	QCAT is a lighter alternative to GreenScreen developed and operated by the Washington State University Department of Ecology.
BOMcheck ¹⁰²	A commercial product for streamlining submissions to the SCIP database and supporting brand, product and supply chain compliance with European chemical legislation and reporting obligations.
Toxnot ¹⁰³	A commercial product supporting design through avoidance of hazardous substances; product compliance with EU Chemicals legislation; streamlined compliance and reporting; and supply chain information sharing and reporting.
OECD Substitution and Alternatives Assessment Tool Selector ¹⁰⁴	A database of tools that can be used to support the identification, assessment, removal and replacement of hazardous substances from products.

Tool	Description
OncoLogic ¹⁰⁵	A commercial tool for identifying and assessing the impacts of hazardous chemicals in product supply chains. Bases the assessment on similarity of chemical structure to known hazardous chemicals and chemical groups, and predicts impacts based on these relationships.
SciVera ¹⁰⁶	A commercial tool for assessing chemicals and identifying safer alternatives. Supports reporting to certification programmes.
Material IQ ¹⁰⁷	A tool from NGO GreenBlue that allows suppliers to list the sustainability attributes of their materials for customers in one place, and gives product manufacturers access to information they need to choose better materials during the design process. Uncertain coverage of EEE sector.
The Wreccs ¹⁰⁸	Supply chain management and documentation tool from UL. Includes the possibility of tracking and monitoring chemical content through the supply chain.
SubSelect ¹⁰⁹	A tool from the German Environmental Protection Agency (UBA) for identifying and replacing hazardous chemicals. A downloadable MS access database.
I4R Platform ¹¹⁰	Platform for supplying waste and recycling companies with information about EEE products to facilitate better recycling and to help fulfil the demands of Article 15 of the Waste Framework Directive.
IEC62474 – Material Declaration for Products of and for the Electrotechnical industry ¹¹¹	A reference system and standard for data reporting on substances in materials. Has lists of regulated substances that are relevant for EEE, including REACH, POPs and RoHS, but also includes substances on these lists that are not relevant for EEE. Screening is also about reporting obligations – where concentrations in EEE applications are lower than those that demand reporting, the substance is screened out

Note 97 98 99 100 101 102 103 104 105 106 107 108 109 110 111

97. <https://www.greenscreenchemicals.org/learn/what-is-greenscreen>

98. <https://www.kemi.se/prioguiden/english/start>

99. <https://sinlist.chemsec.org/what-is-the-sin-list/>

100. <https://sinlist.chemsec.org/sinimilarity/>

101. <https://ecology.wa.gov/Regulations-Permits/Guidance-technical-assistance/Safer-alternatives/Quick-tool-for-assessing-chemicals>

102. <https://sphaera.com/on-demand-webinar/bomcheck-scip-solution/>

103. <https://toxnot.com/>

104. <http://www.oecdsaatoolbox.org/Home/Tools>

105. <https://www.epa.gov/tsca-screening-tools/oncologictm-expert-system-evaluate-carcinogenic-potential-chemicals>

106. <https://www.scivera.com/>

107. <http://www.materialiq.com/>

108. <https://www.petra.com/help/werccs/>

109. <https://www.umweltbundesamt.de/en/document/subselect-guide-for-the-selection-of-sustainable>

110. <https://i4r-platform.eu/about/>

111. <https://rohs.ca/iec62474/about-iec62474/>

7. DESIGN GUIDE

To support the recycling of plastics from EEE, hazardous substances should be designed out of products. The market for chemical substances and the understanding of their hazardousness are constantly evolving, meaning that today's relevant design criteria might be outdated in a couple of years. Therefore, any design must rely on the newest available knowledge. The following design criteria builds upon existing knowledge of hazardous substances, and draws on the design guide developed by the EU-project PolyCe¹¹². The PolyCE project is the principal work addressing the design of EEE plastics from a circular perspective, and is the most relevant and up-to-date design approach currently available.

The PolyCE design guidelines address a wider set of concerns than the current project, addressing not only design for recyclability, but also use of recycled content. In addition, it addresses both product design and component design.

The following figure provide an overview of the key design components of the PolyCE system:

PRODUCT LEVEL DESIGN PRINCIPLES	COMPONENT LEVEL DESIGN PRINCIPLES
Enabling easy access and removal of hazardous or polluting parts	Avoiding hazardous substances
Using recycleable materials that will be recycled by WEEE recyclers	Enabling easy access and removal of hazardous or polluting parts
Using material combinations and connections that allow easy liberation	Using recycleable materials that will be recycled by WEEE recyclers
Using recycled materials	Using material combinations and connections that allow easy liberation
	Using recycled materials

¹¹². Feenstra, T. et al. (2021). Guidelines for electrical and electronic equipment. PolyCE. Retrieved from <https://www.polyce-project.eu/wp-content/uploads/2021/04/PolyCE-E-book-Circular-Design-Guidelines-2.pdf>

Under each of these components there are specific recommendations that can help brands and manufacturers to design products and components that have a greater chance of being circular. At the component level, the guidelines include four specific recommendations for *Avoiding hazardous substances*:

AVOIDING HAZARDOUS SUBSTANCES

Guideline 15

Avoid the use of substances that are listed for future restriction in the 'SIN list'

Guideline 16

Do not use halogenated polymers (e.g. PVC, PTFE).

Guideline 17

Avoid the use of Substances of Very High Concern (SVHC) according to REACH and substances classified carcinogenic (Carc. 1A or 1B), mutagenic (Muta 1A or 1), reprotoxic (Repr. 1A or 1B) by CLP Regulation in housing/housing parts.

Guideline 18

Avoid use of any BFR's (Brominated Flame Retardants; PBDEs, TBBPA, PBBs, HBCDs, etc.) in the product. Make it 100% BFR-free

The following provides an outline for non-hazardous design of EEE (plastics).

Table 9 - Design guide for recyclable plastic components in EEE

Design Principles	Explanation and/or reference
<i>Circular EEE plastics</i>	
Avoid Substances of Very High Concern (SVHC)	Substances added to the Candidate list under REACH
Avoid the use of halogenated polymers (PVC, TCE)	Halogenated compounds (such as chlorine) in polymers risk to be bioaccumulate, persistent and toxic as well as to accumulate over time, and thus pollute the environment. Inorganic forms of chlorine can lead to the formation of dioxin.
Avoid the use of brominated flame retardants	Flame retardants are added to plastic parts in EEE to avoid that the article catches a fire. Bromine is also a halogen that risks bioaccumulation, persistent and toxic, and thus pollute the environment.
Substitute in accordance with procedures of safe substitution as presented by ECHA	Following procedures for safe substitution (as the one presented by ECHA) decreases the risk of 'fake' or 're-gretable' substitution
Avoid the use of substances on the SIN list	The Substitute It Now (SIN) list consists of hazardous substances (defined similar to SVHC in accordance with the criteria set out in REACH) developed by ChemSec
Use chemicals from 'positive lists' rather than avoiding chemicals on hazardous lists (e.g. From PRIO)	Positive lists provide a limited number of alternative chemicals that can be used to replace hazardous chemicals. Using these lists helps limit the possibility of replacing one hazardous chemical with another. One example is the positive list used by TCO.
<i>Controlling supply chains</i>	
Source from trusted suppliers	Build relationships and use existing networks to work with trusted suppliers
Demand documentation of component/product composition	Specify clear demands and demand documentation of fulfilment of those demands
Use suppliers that can fulfil reporting standards under EU legislation	Ensure that suppliers can provide the information demanded by EU product and chemical legislation in a standardised form.
Test final products and components to ensure compliance with design criteria.	Use independent testing of products to ensure that the manufacturer and component manufacturers comply with the specified design criteria for non-hazardous content.
<i>Recyclable EEE</i>	
Use clean (no additives nor coating), mono (no-blend) and common type of polymer (e.g. ABS, PP, PA, PC, PC/ABS, HIPS, PE)	Clean, common and mono-polymers increase the likelihood of recycling. Avoid the use of coatings, foam and magnets.
Avoid plastics with glass fibres	Glass fibres pollute plastic waste streams by causing wear. Mineral filled plastics and carbon fibres are better alternatives, although they still limit recyclability.
Avoid use of thermoplastic elastomers (TPE)	If not removed, elastomers pollute PS stream. If TPE cannot be avoided, use Styrol-Ethylene-Butylene-Styrol TPE as it can function as a modifier when recycled.
Avoid the use of thermoset rubbers	Thermoset rubbers cannot be recycled
Design for disassembly: Ensure that product parts can be separated and any hazardous parts can be removed.	Avoid permanent fixing and use detachment possibilities for in particular hazardous and non-recyclable parts

8. SUPPORTING BETTER PURCHASING CHOICES – EXISTING INSTRUMENTS

Supporting the market for EEE containing plastics free from hazardous materials can incentivise their production. Consumers – and especially professional public and private procurers – can use their purchasing power to demand electronic and electrical equipment with limited hazardous substances.

Purchasing and procurement decisions are made based on a variety of criteria: price, convenience, default practice, availability, technical suitability, as well as factors like social and environmental impacts. However, these decisions are commonly made with imperfect information and thus outcomes can be sub-optimal, even given the best intention.

84% of Europeans are worried about how chemicals impact their health, and 90% are worried about how chemicals impact the environment. However, hazardous chemicals, their presence in plastics in EEE and their environmental and health implications is technical and complex, and as such only very few experts are in a position to make rational decisions.

A variety of instruments seek to provide a means by which preference and concern can be translated into actions. Chief among these are ecolabels and green public procurement criteria.

The following section examines a selection of existing instruments – structured by ecolabels, procurement and instruments that more broadly seek to influence consumption - that are used to support consumption of recyclable EEE.

8.1 Ecolabels

Ecolabels aim to provide consumers with simple information on products' environmental performance, in order to enable them to make informed choices and promote the purchase of the more environmentally friendly products. Ecolabels typically indicate environmental, health and/or social performance beyond legal minimum environmental requirements. Ecolabels can, in theory, guide consumers to select EEE with the fewest hazardous substances.

Credibility and consumer trust are critical for ecolabel schemes to improve sustainability of products and consumption patterns. Today, there are many different ecolabel schemes along with sustainability ratings, voluntary standards and certifications. These are all characterised by the use of information to encourage and enable the creation of environmental public or common goods¹¹³. The

113. Bullock, G. & van der Ven, H. (2018). The Shadow of the Consumer: Analyzing the Importance of Consumers to the Uptake and Sophistication of Ratings, Certifications, and Ecolabels. *Organization & Environment* 2020, Vol. 33(1) 75–95.

widespread use of different IBEG programs with superficially similar claims can make it difficult for consumers to distinguish “greenwash” from more credible programs^{114, 115}. The international organization for standardization (ISO) has developed a set of international standards for ecolabels, which distinguishes between three types of ecolabels (Table 10).

Table 10 - Ecolabels Type I, II and III

Type I (ISO 14024)	Environmental labelling: Products with a type I ecolabel have been independently verified to conform with a defined multi-set of criteria by a third-party
Type II (ISO 14021)	Self-declared environmental claims: Products with a type II ecolabel are claims set out by manufacturers, importers or distributors. Any claims must however rely on and document reliable evidence of this claim.
Type III (ISO 14025)	Environmental Declaration: Based on third-party verified life cycle assessment of the product, but not against a fixed criteria or limit values. ¹¹⁶

Note: ¹¹⁶

TCO Certified, EPEAT, Nordic Swan ecolabel and EU ecolabel (presented below) are all Type I ecolabels and are generally regarded as having high credibility because they are based on a multi-criterion sets, derived from a life cycle assessment and are subject to external certification by an independent body¹¹⁷. All of the four ecolabels cover EEE to some extent and have criteria that limit the use hazardous substances.

8.1.1 TCO Certified

TCO Certified¹¹⁸ is a global third-party certification for IT products. TCO Certified covers 11 product categories of office IT and data centre products including displays, notebooks, tablets, smartphones, desktops, all-in-one PCs, projectors, headsets, network equipment, data storage products and servers.

TCO Certified criteria cover social and environmental responsibility throughout the product life cycle and are specific to each product category. The criteria relate to

114. Bullock, G. & van der Ven, H. (2018). The Shadow of the Consumer: Analyzing the Importance of Consumers to the Uptake and Sophistication of Ratings, Certifications, and Ecolabels. *Organization & Environment* 2020, Vol. 33(1) 75–95.

115. Iraldo, F. et al. (2020) The future of ecolabels. *The International Journal of Life Cycle Assessment*. Vol. 25(5): 833–839. Retrieved from https://www.researchgate.net/publication/339626506_The_Future_of_Ecolabels

116. *The International Organization for Standardization. (2019). *Environmental Labels*. Geneva Switzerland: ISO Central Secretariat. Retrieved from <https://www.iso.org/files/live/sites/isoorg/files/store/en/PUB100323.pdf>

117. Defined by the International Organization for Standardization in *Environmental labels and declarations – Type I environmental labelling – Principles and procedures* (ISO 14024:2018)

118. <https://tcocertified.com/>

reduction of hazardous substances as well as other sustainability criteria including socially and environmentally manufacturing, user health and safety, product performance, product lifetime extension, material recovery and sustainability performance indicators. The criteria are developed through a broad expert and stakeholder involvement, ensuring that suppliers can meet the criteria, while continuously raising the bar. TCO Certified releases a new generation of criteria every three years. More than 3 500 products from 27 brands are currently TCO certified, and account for approximately 70% of the respective category markets.

TCO Certified uses the Green Screen methodology¹¹⁹ to benchmark chemicals and identify safer alternatives that can replace certain restricted substances such as halogenated flame retardants and plasticisers restricted in RoHS. The TCO Certified criteria, thus, only accept flame retardants and plasticisers that are verified as safer alternatives. The safer alternatives are listed in the TCO Certified Accepted Substance List. Today, chemical substances included in products that are TCO Certified must achieve a benchmark of 2 or above in the GreenScreen methodology¹²⁰. The aim is that, as the list of accepted substances expands, it will be possible to set stricter requirements, so that substances with benchmark 2 will be excluded in the future¹²¹. Because chemical substances are required to be GreenScreened, TCO Certified gives companies an incentive to provide data and thereby help address the large knowledge gap on chemicals and their hazards used in EEE.

119. GreenScreen is a globally recognized tool designed to assess and benchmark chemicals based on hazard. It is developed by the US-based non-profit Clean Production Action. See: <https://www.cleanproduction.org/programs/greenscreen>

120. GreenScreen ranks a chemical against 5 Benchmarks. Benchmark-1 is defined as a chemical of high concern and should be avoided. Benchmark-U means the minimum data requirements aren't fulfilled in order to make an assessment.

121. TCO Certified webpage. (2021, April 12). Benchmarking chemicals with GreenScreen® in TCO Certified. Retrieved from <https://tcocertified.com/updates-and-changes/benchmarking-chemicals-with-greenscreen-in-TCO-Certified/>

Box 9: TCO Certified Requirement for hazardous substances for displays (generation 9)¹²²

Heavy Metals

- the product must not contain cadmium (0.01%), mercury (0.1%), lead (0.1%) or hexavalent chromium (0.1%). Limit values for these metals are in line with RoHS Directive Annex II.
- Exceptions also in line with RoHS Directive.

Halogens

- Product housing (>0.5g) and the power PCB laminate of the internal/external power supply unit must not contain intentionally added (additive or reactive) flame retardant or plasticisers with halogenated substances. All other parts are exempt.
- The product must not contain PBB, PBDE and HBCDD. No exemptions.
- The printed circuit board must be tested for bromine and chlorine to ensure compliance with the above.
- Fluoroorganic substances used to modify dripping behaviour of plastics in fire conditions or improve process behaviour are exempt as long as they do not exceed 0.5% by weight of homogenous materials.

Non-Halogenated substances

- Product housing (>0.5g) and the power PCB laminate of the internal/external power supply unit must only contain intentionally added (additive or reactive) non-halogenated flame retardants that have been assigned a GreenScreen benchmark score of 2, 3 or 4.
- All substances of a mixture must be accounted for. Non-accepted substances must not exceed 0.1% by weight of flame retardant.
- All other parts are exempt.

Plasticisers

- Plasticisers used in product housing and cable and wire insulations must have been assigned a GreenScreen benchmark score of 2, 3 or 4 and appear on the TCO Accepted Substance List.
- The product must not contain Bis (2-ethylhexyl) phthalate (DEHP), Butyl benzyl phthalate (BBP), Dibutyl phthalate (DBP), and Diisobutyl phthalate (DIBP). No exemptions.
- All substances of a plasticiser mixture must be accounted for. Non-accepted ingredients must not exceed 0.1% by weight of the plasticiser

122. TCO Certified. (2021). Generation 9, for displays. (2nd ed.). Retrieved from <https://tcocertified.com/industry/tco-certified-generation-9/>

TCO Certified is well recognised within the procurement industry (both public and private) but is largely unknown to consumers.

8.1.2 EPEAT

The Electronic Product Environmental Assessment Tool (EPEAT) is a global ecolabel covering products and services from the technology sector¹²³. The EPEAT ecolabel is owned and managed by the Global Electronics Council. The EPEAT covers seven product categories; computers & displays, imaging equipment, mobile phones, network equipment, photovoltaic modules & inverters, servers and televisions. More than 400 labels are certified with EPEAT.

Criteria are developed through a voluntary consensus process. The EPEAT has both required and optional criteria. Products that meet all required criteria can obtain a Bronze rating. To obtain a Silver rating, the product must additionally meet at least 50% of the optional criteria and Gold-rated products meet the voluntary criteria and at least 75% of the optional criteria. The point-based system implies that EPEAT certified products might not meet the criteria related to limiting hazardous substances or design for recyclability, but rather criteria related to other sustainability aspects. Some criteria are, however, mandatory.

EPEAT includes requirements on the content of hazardous substances, some of which are optional and some of which are mandatory, depending on the product category (see the example for computers and displays below).

Box 10: EPEAT criteria on substance management (for computers and displays)¹²⁴

- Compliance with RoHS is mandatory
- *Mandatory (with exceptions)*: Each plastic part in the product exceeding 25 g shall not contain greater than 1000 ppm chlorine or greater than 1000 ppm bromine at the homogeneous level (with the exception of a) where manufacturers have conducted a hazard assessment and the brominated or chlorinated compound received a benchmark score of 2, 3 or 4 by GreenScreen or no alternatives can be found; b) where parts exceed 25% post-consumer recycled content in which case they may contain a maximum of 5000 ppm of chlorine and 5000ppm of bromine or c) where printed circuit boards, cables, wiring, fans and electronic components are excluded.
- Further reduction of bromine and chlorine in plastic parts smaller than 25 g is optional
- Avoidance of substances on the REACH Authorisation list and Candidate list is optional
- Restriction on the use of cadmium and beryllium are optional
- Full chemical assessment and selection is optional

123. <https://www.epeat.net/>

124. <https://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9062658>

EPEAT further includes plastic design for recyclability of components of more than 25 grams that must be labelled in accordance with the ISO standard stating the type of polymers etc. (ISO 11469/1043). The plastic components are further to be able to be separated from other non-plastic parts with commonly available tools (must not be moulded or glued in, nor heat or ultrasonically inserted). Plastics parts of more than 100 gram must, additionally, not have an applied adhesive, coating, paint or other finish that hinders recycling.

As with TCO Certified, EPEAT is well known among professional procurers (it is even considered a condition of entry into public procurement contracts in North America according to one of the brands interviewed), but awareness among general consumers is largely absent.

8.1.3 The Nordic Swan ecolabel

The Nordic Swan ecolabel is the official Nordic ecolabel¹²⁵ and was founded by the Nordic Council of Ministers in 1989. In contrast to TCO Certified and EPEAT, the Nordic Swan has a very broad scope with respect to product categories and groups but a narrower scope with respect to markets since the label is focused on the Nordic region. Over 25 000 different products and services within 59 different products groups are currently certified with the Nordic Swan¹²⁶. Nordic Swan criteria have been developed for TVs and projectors¹²⁷, imaging equipment¹²⁸, rechargeable batteries and portable chargers¹²⁹.

The label is widely known and popular amongst citizens of the Nordic countries; 89% of people in the Nordic countries recognise the label as a brand, and 72% of the Nordic consumers think that the Nordic Swan makes it easier for them to make environmentally-friendly choices¹³⁰. The criteria are developed by the Nordic Ecolabelling organisations. Experts from ministries, environmental organisations, producers, etc. are consulted in the development of criteria. The criteria are continuously reviewed and revised every 3–5 years.

The Nordic Swan has experienced a low level of demand for certification of imaging equipment and for TVs and projectors from the contacted brands. Tightening of the criteria sets have, therefore, not been prioritised recently, and the latest criteria for both of these product groups are from 2013¹³¹. The criteria are not expected to be renewed in the near future.

125. <https://www.nordic-ecolabel.org/>

126. Nordic Ecolabelling webpage. (n.d). The official ecolabel of the Nordic countries. Retrieved from <https://www.nordic-ecolabel.org/the-nordic-swan-ecolabel/>

127. Nordic Ecolabeling. (2020). Criteria document: Tv and projectors. Version 5.9. Retrieved from <https://www.ecolabel.dk/-/criteriadoc/5186>

128. Nordic Ecolabeling. (2020). Criteria document: Imaging equipment. Version 6.7. Retrieved from <https://www.ecolabel.dk/-/criteriadoc/5184>

129. Nordic Ecolabeling. (2021). Criteria document: Rechargeable batteries and portable chargers. Version 5.1. Retrieved from <https://www.ecolabel.dk/-/criteriadoc/5585>

130. Nordic Ecolabelling. (2018). Sustainable consumerism in the Nordic region. Retrieved from <https://www.svanen.se/siteassets/rapporter--undersokningar/the-report/sustainable-consumerism-in-the-nordic-region---the-report-by-nordic-ecolabelling.pdf>

131. When requirements are modified or altered, a new version is issued. When requirements are tightened a new generation of the criteria is issued. See: Nordic Ecolabeling, 2016: *Regulations for the Nordic Ecolabeling of Products*: <https://www.nordic-ecolabel.org/contentassets/89f071a34537452f9e64754c1c049d4a/regulations-for-the-nordic-ecolabelling-of-products-2016.pdf>

Box 11: Nordic Swan ecolabel criteria (2013–2023) of computers, monitors, tablets and smartphones related to hazardous substances and recyclability

- The flame retardants Hexabromocyclododecane (HBCDD), tris(2-chloroethyl)phosphate (TCEP) and short chain and medium chain chlorinated chloro paraffins (SCCP and MCCP) must not be added. The flame retardant Tetrabromobisphenol-A (TBBP-A) must not be added (except for in Printed Circuit Boards)
- Other organic halogenated flame retardants and other flame retardants assigned one or more of the following risk phrases, or combinations, must not be added:
 - H350 (may cause cancer)
 - H350i (may cause cancer by inhalation)
 - H340 (may cause heritable genetic damage)
 - H360F (may damage fertility)
 - H360D (may cause harm to the unborn child).
 - H360Fd (may damage fertility, suspected of damaging the unborn child)
 - H360Df (may cause harm to the unborn child, suspected of damaging fertility)
 - EXCEPTIONS: parts smaller than 25g; printed circuit boards.
- Plastic parts >25g must not contain chlorinated polymers
- The external power cable delivered with the product must not contain following substances:
 - Diethylhexyl phthalate (DEHP),
 - Dibutyl phthalate (DBP/DnBP)
 - Benzyl butyl phthalate (BBP),
 - Dicyclohexyl phthalate (DCHP),
 - Diisobutyl phthalate (DIBP),
 - Diisononyl phthalate (DINP),
 - Diisodecyl phthalate (DIDP),
 - Di-n-octylphthalate (DNOP),
 - Dihexyl phthalate (DHP),
 - Diethyl phthalate (DEP),
 - Diisoheptyl phthalate (DIHP),
 - Bis(2-methoxyethyl) phthalate,
 - Diisopentyl phthalate and N-pentyl-isopentyl phthalate

Recyclability

- Use common polymers and avoid blends
- Avoid permanent fixing and fix valuable parts with metal screws, click fingers, press-fit, shrink foil, self-screwed/tapering, or connectors.
- Use detachment possibilities for hazardous and polluting parts/materials

8.1.4 EU Ecolabel

The EU Ecolabel is the official European ecolabel, which was established in 1992 by the European Commission¹³². Its functioning is set out through a regulation of the European Parliament and of the Council¹³³. The EU Ecolabel is managed by the European Commission together with bodies from the member states. Like the Nordic Swan, the EU ecolabel has a wide scope in product categories that can be certified.

In relation to electrical and electronic products the EU ecolabel has criteria for electronic displays¹³⁴. Relevant stakeholders such as industry and service providers, environmental protection groups and consumer organisations are involved in the development of criteria,¹³⁵.

The most recent criteria for electronic screens¹³⁶, published in 2020, includes restriction on hazardous substances (see Box 12). As per 2021, very few electronic displays have been certified with the EU ecolabel.

Box 12: EU Ecolabel criteria for electronic screens (2020) related to hazardous substances and recyclability¹³⁷

- SVHC may not exceed 0.1% (weight by weight) for printed circuits boards, electrical wiring/cables, external cables, external housing, external housing and remote control and LED backlights
- Plastic parts >25 g must not contain chlorinated polymers (excl. Plastic cable housing)
- The use of classified hazardous substances (with a focus on plasticisers and flame retardants) is restricted (with derogations for specific application).
- Supply chain fluorinated greenhouse gases (GHG) are reduced.

Requirements related to recyclability of plastics:

- Plastic parts of more than 25 grams must be single polymer or a recyclable blend
- The presence of paints and coatings shall not significantly impact upon the resilience of plastic recycle produced from these components upon recycling and when tested according to ISO 180 [1] or equivalent.
- Plastic enclosures shall not contain moulded-in or glue-on metal unless the metal inserts can be removed with commercially available tools;
- Casings, enclosures and bezels incorporating flame retardants shall be recyclable.
- Information should be made available to waste operators indicating type of polymer, components containing flame retardants and toxic/eco-toxic substances.

132. <https://ec.europa.eu/environment/ecolabel/>

133. Regulation (EC) No 66/2010 of the European Parliament and of the Council of 25 November 2009 on the EU Ecolabel

134. <https://www.ecolabel.dk/en/product-groups/show-product-group?produktgruppeid=EU22&projektgruppe=Blomsten#tab:criteria>

135. Lange, P. et al. (2014). The coexistence of two Ecolabels. Copenhagen: Nordic Council of Ministers. Retrieved from <http://norden.diva-portal.org/smash/get/diva2:715474/FULLTEXT01.pdf>

136. Commission Decision (EU) 2020/1804: Establishing the EU Ecolabel criteria for electronic displays <https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:32020D1804&from=EN>

137. <https://ec.europa.eu/environment/ecolabel/documents/Electronic%2001%2012%202020-factsheet.pdf>

8.1.5 Benefits and challenges of ecolabels

The Nordic Swan ecolabel and the EU ecolabel, both of which Nordic consumers know well, can rarely be found on EEE due to limited demand from manufacturers. The industry explains that fast innovation on the market and the constant introduction of new products makes the costs of certification disproportionate. In the global market of EEE, global ecolabels - in particular TCO Certified and EPEAT – are more popular with manufacturers. Despite, the few certifications with Nordic Swan or EU Ecolabel, the industry report that they use the criteria set as a standard to set environmental goals themselves.

The Nordic Swan ecolabel has collaborated with an Asian ecolabel, so suppliers that hold the Japanese Eco Mark (administrated by the Japan Environmental Association¹³⁸) could clearly identify and document additional requirements set out in the Nordic Swan criteria set. Yet, it did not increase the demand for Nordic Swan certification. Due to the limited demand, the Nordic Swan ecolabel is not to renew their criteria of monitors; and the EU ecolabel has only criteria for electronic displays. The globalisation of markets increases the need for harmonisation and global cooperation¹³⁹. Cooperation between ecolabels already exists on a global scale e.g., facilitated through the Global Ecolabeling Network (GEN), a non-profit association of organisations operating type 1 ecolabels.

TCO Certified and EPEAT are becoming more dominant ecolabels of EEE globally and, thus, also in the Nordics. Both the EU Ecolabel and the Nordic Swan have origin in legislation giving the Nordic authorities an active role in consulting the criteria sets. The Nordic authorities have a lesser influence on the criteria set and organisation behind EPEAT and TCO.

Consumer perspective

The type I ecolabels, described in this chapter, all provide consumers with well-documented and trust-worthy documentation of the environmental performance of different electronic and electrical products. By selecting an ecolabelled product, consumers do not need to go into detail on how a product is produced, supplied and treated end-of-life. For a very technical area such as hazardous chemicals, it is extremely difficult for consumers to access the hazards of chemicals in e.g. an electronic screen, and it might not be their first priority when choosing EEE. By requesting an ecolabelled screen, the consumer is guaranteed that the environmental impact of the product is lower than other products in its category, throughout its lifecycle. If consumers are selecting EEE products with ecolabels and thus rewarding companies by voting with their wallet, ecolabels will lower the negative environmental impact from EEE. This potential impact depends, however, on a well-functioning market.

A pre-request for demanding ecolabels is that consumers are aware of these. 93% of Nordic consumers are aware of the Nordic Swan ecolabel¹⁴⁰. The awareness of the EU ecolabel is lower (42% in DK). The knowledge of TCO Certified and EPEAT ecolabels is expected to be even lower (as these are limited to EEE).

138. Nordic Ecolabeling. (2020). Criteria document: Imaging equipment. Version 6.7. Retrieved from <https://www.ecolabel.dk/-/criteriadoc/5184>

139. Iraldo, F. et al. (2020) The future of ecolabels. The International Journal of Life Cycle Assessment. Vol. 25(5): 833–839. Retrieved from https://www.researchgate.net/publication/339626506_The_Future_of_Ecolabels

140. Ecolabelling Denmark. (2019, November 6). Nordiske forbrugere værdsætter Svanemærket. Retrieved from <https://csr.dk/nordiske-forbrugere-verdsatter-svanemarket>

Consumers are different, and even those consumers that report that they intend to buy more sustainable consumer goods do not always do so. A 30% "value-action gap" exists implying that people tend to overestimate their sustainable actions by 30%. Also, uncertainty about selecting the most ethical choice, caused by an overload of conflicting information and colliding environmental considerations, risks 'paralysing' consumers. Holistic ecolabels that take into account all sustainability issues (social and environmental) can remove the burden of the consumers to access what is more sustainable, and thus make it easier for consumers to take the more sustainable choice. The strength of holistic ecolabels is that consumers do not need to decide which sustainability agenda is more important, but trust that the ecolabel has considered these issues.

A comprehensive meta-analysis study concludes that some consumers are willing to pay a significant premium for socially-responsible products. Certifications increase consumer willingness to pay up to a 7% higher price, but consumers' willingness to pay is highly variable and depends on both consumer-specific and product-specific variables.^{141, 142} The relatively limited success of ecolabels in the EEE sectors could indicate that consumers' willingness to pay a higher premium is limited or at least conceived as limited by the companies.

For instance, in the case of Information and Communication Technology (ICT) products, it is common that consumers' preference for functionality and performance overshadows sustainability concerns. Increasingly, research on consumption policy questions the idea that consumers can be the major actors driving change, and it becomes evident that when information-based instruments are used alone, they are rarely effective.^{143, 144} Ideally, ecolabels would be more effective in conjunction with supporting policies, in a balanced policy mix for consumers.

Responsiveness to product labelling systems depends on certain demographic characteristics of the consumer,¹⁴⁵ which need to be taken into account when introducing this policy measure. Consumer income level, for example, is consistently associated with higher willingness to pay for an ecolabelled product.¹⁴⁶ Age is also highlighted as an important parameter in some studies, although the results are mixed.¹⁴⁷ The level of education and general consumer knowledge of environmental issues are seen as enablers of a higher uptake of ecolabels.¹⁴⁸

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141. Bullock, G. & van der Ven, H. (2018). The Shadow of the Consumer: Analyzing the Importance of Consumers to the Uptake and Sophistication of Ratings, Certifications, and Ecolabels. *Organization & Environment* 2020, Vol. 33(1) 75–95.
 142. Tully, S. M. & Winer R. S. (2014). The Role of the Beneficiary in Willingness to Pay for Socially Responsible Products: A Meta-analysis. *Journal of retailing*, Vol. 90 (2), 255–274.
 143. Mont, O. et al. (2013). Improving Nordic policymaking by dispelling myths on sustainable consumption. Copenhagen: Nordic Council of Ministers. Retrieved from <https://norden.diva-portal.org/smash/get/diva2:702825/FULLTEXT01.pdf>
 144. Power, K. & Mont, O. (2010). The Role of Formal and Informal Forces in Shaping Consumption and Implications for Sustainable Society: Part II. *Sustainability* 2(8), 2573–2592. Retrieved from <https://doi.org/10.3390/su2082573>
 145. Boyer, R. H. W. et al. (2021). Product Labels for the Circular Economy: Are Customers Willing to Pay for Circular? *Sustainable Production and Consumption*, vol. 27, 61–71. Retrieved from <https://doi.org/10.1016/j.spc.2020.10.010>
 146. Sønderskov, M. S. & Daugbjerg C. (2010). The State and Consumer Confidence in Ecolabeling: Organic Labeling in Denmark, Sweden, The United Kingdom and The United States. *Agriculture and Human Values*, vol. 28 (2011), 507–517.
 147. Ward, D. O. et al. (2011). Factors Influencing Willingness-to-Pay for the ENERGY STAR® Label. *Energy Policy*, vol. 39 (2011), 1450–1458.
 148. <https://op.europa.eu/s/sgli>

Manufacturer's perspective

The cost of product certification is a barrier for manufacturers. Likewise, the cost for allocating internal resource and ensuring proper competencies to manage and maintain the certification process can be a barrier. The perceived benefits for adopting an ecolabel – such as increased competitiveness – are, in some cases, insufficient or too uncertain to make the investment attractive for companies¹⁴⁹. A challenge for ecolabelling programmes is therefore the trade-off between highly stringent requirements and market penetration. Ambitious and strict requirements increase the barriers of adopting the ecolabel and can, therefore, result in a low market penetration. The aims of stringent and effective criteria requirements and high market penetration can often be mutually exclusive¹⁵⁰, where either high market penetration or stringent criteria are a more realistic goal.

The complex product design with many components and long value chains of EEE is also a barrier for the adaptation of stringent requirements as it requires high levels of transparency, which remains a great challenge to the industry. This challenge is likely to reinforce the view that the costs associated with certification are too high. Major producers will often not be able to get detailed information on what is in materials and components provided by suppliers.

Despite, the limited products certified with the Nordic Swan and the EU ecolabel, industry representatives report that they use the criteria set to identify relevant environmental requirements that they can work to achieve in the long term. Also, global suppliers face an increasing demand for EPEAT and TCO certified from public procurements. In the US market, public procurers typically demand EPEAT.

8.2 Green Public Procurement

Green Public Procurement (GPP) is *“a process whereby public authorities seek to procure goods, services and works with reduced environmental impact through their life cycle when compared to goods, services and works with the same primary function that would otherwise be procured”*¹⁵¹. GPP can be used to achieve several policy objectives including circular economy and sustainable development, as well as to promote a market of environmentally friendly goods – such as recyclable EEE with limited levels of hazardous substances.

The EU provides the legislative framework of public procurement that ensures equal competition, transparency and proportionality. GPP is a voluntary tool, which is up to the Member States and/or regional and local authorities to implement. The Circular Economy Action Plan, however, promises minimum mandatory GPP criteria and compulsory reporting to monitor GPP.

The European Commission provides guidance on GPP including common GPP criteria that can be applied in tenders, based upon a balance of environmental performance, costs, market availability as well as verification possibilities.

The EU's GPP criteria for computers, monitors, tablets and smartphone include requirements that limit hazardous substances and promote recyclability as

149. Iraldo, F. et al. (2020) The future of ecolabels. The International Journal of Life Cycle Assessment. Vol. 25(5): 833–839. Retrieved from https://www.researchgate.net/publication/339626506_The_Future_of_Ecolabels

150. Iraldo, F. et al. (2020) The future of ecolabels. The International Journal of Life Cycle Assessment. Vol. 25(5): 833–839. Retrieved from https://www.researchgate.net/publication/339626506_The_Future_of_Ecolabels

151. COM (2008) 400 Public Procurement for a better environment

illustrated by Box 13. The EU's criteria distinguish between core- and comprehensive criteria. Core criteria are minimum standards that address key environmental impacts, while comprehensive GPP criteria go somewhat further and demand more environmentally-friendly products. Implementation of the comprehensive criteria is more challenging and often requires some form of validation – such as market and/or user dialogue.

Box 13: EU's GPP criteria for computers, monitors, tablets and smartphones (2021)¹⁵²

Limiting the use of hazardous substances (with the exception of refurbished EEE)

- The tenderer must demonstrate use of a framework for Restricted Substance Controls (RSC) of a) substances restricted under RoHS, b) Substances on the REACH restricted substance list (Annex XVII) or c) Substances on the REACH candidate list along the supply chain for the products to be supplied.
- Plastic parts more than 25 g (5 g for smartphones) must not contain [only] low [concentrations of] halogenated substances: Plastic parts must contain less than 1000ppm of bromine and chlorine (0.1% w/w) (core criteria)
- Points will be awarded if the following product parts - motherboard, display, casing and bezels, external keyboard, mouse and/or trackpad, as well as External AC or DC power cords - do not contain any SVHC (0.1% w/w)
- Points will be awarded if the substitutions of plasticisers restricted under RoHS and halogenated flame retardants are based upon methods and tools for comparative hazard assessment are followed as defined by the European Chemical Agency and OECD.

Promoting design for recyclability (Comprehensive criteria)

- External plastic casings, enclosures and bezels with a weight greater than 25 g must be marked in accordance with ISO 11469¹⁵³ and ISO 1043¹⁵⁴ Section 1 and 4 (with a few exceptions)
- Additional points will be awarded if all discrete plastic parts >25 g do not contain a metal insert or fastener that is moulded-in, inserted by heat or ultrasonically, or glued-in, unless the metal component is either separable by breaking it off from the plastic part or is separable by using commonly available tools. Fan impellers are excluded from this requirement.
- Additional points will be awarded if the presence of paints and coatings in the plastic components of the devices does not have a significant impact on the resilience of plastic recycle produced from these components upon recycling and when tested according to ISO 180 or equivalent (see the explanatory note below).
- Discrete plastic parts >25 g must not have an adhesive, coating, paint or finish that is incompatible with recycling.

152. https://ec.europa.eu/environment/gpp/pdf/210309_EU%20GPP%20criteria%20computers.pdf

153. ISO 11469: 2016 sets out a harmonized marking of plastics materials that contribute to proper waste management

154. ISO 1043-1: 2011 specifies basic polymers and the use in plastics through abbreviated terms and symbols

Box 14: EU's GPP criteria for "Imaging equipment, consumables and print services" (2020)

- No REACH candidate substances may be added to the product, including if recycled material is used (core criteria)
- Halogenated polymers or compounds must not be used as flame retardants (with some exceptions)

Denmark¹⁵⁵, Finland, Sweden¹⁵⁶ and Norway¹⁵⁷ (tablet, computers and screens) have, similarly, developed GPP criteria for IT, which to a large extent are based upon EU's GPP criteria. The EU GPP criteria are, however, quite technical, difficult to document, and not directly applicable for public contractors therefore, Norway and Sweden have adapted these to make them more practicable.

In Norway, actors across the value chain participate in a stakeholder consultation and a smaller expert group is subsequently formed. This expert group systematically examines the EU GPP criteria to ensure that they are relevant and applicable for Norwegian contracting authorities. It is ensured that the criteria allow both competition and documentation. The EU GPP criterium concerning the use of ECHA's substitution process has been criticized by key market players in Norway for being mostly about writing the 'best essay' and not focusing on the actual substitution performance. Due to the high requirement of documentation, the Norwegian GPP criteria only refer to the legislative requirements of hazardous substances (RoHS, POP and REACH). Design for recyclability is included by a base criterium that external plastic components of more than 25 g must be labelled in accordance with ISO 11469 and ISO 1043, which define and mark the type of plastic used and, thus, promote recycling.

In Sweden, a similar process has taken place to validate the criteria. Sweden is to revise its criteria and the focus will be on extension of the life cycle as it is the most impactful circular strategy. Sweden includes more GPP criteria to limit hazardous content (see Box 15). In Sweden, there are examples of where public contractors have tested the content of hazardous substances at laboratories to document meeting the criteria (however, it is rarely that resources allow such monitoring).

The Danish criteria (for screens) include an expanded requirement that plastic components of more than 25g must not contain flame retardants or mixtures that are cancerous, damaging to fertility, damaging to foetuses or cause inheritable genetic defects (based on the now outdated R-categorisation of hazard).¹⁵⁸

Likewise, points are awarded if the plastic components can be separated and easy to recycle with normal tools, are marked according to ISO 11469 or similar, and consist of the same or compatible polymers.

155. Den ansvarlige indkøb webpage. (2019, March 19). It og elektronik – skærme. Retrieved from: <https://csr-indkob.dk/products/it-og-elektronik-skaerme/>

156. Upphandlingsmyndigheten webpage. (n.d). Hitta hållbarhetskriterier. Retrieved from <https://www.upphandlingsmyndigheten.se/kriterier/>

157. DFØ webpage. (n.d). Kriterievejviseren: https://kriterievejviseren.difi.no/nb/wizard?stage=group&group=73&group_depth=1

158. <https://csr-indkob.dk/products/it-og-elektronik-skaerme/>

Box 15: Sweden's GPP criteria for computers and screens¹⁵⁹

- The supplier must have routines for controlling and managing information on the presence of hazardous substances (SVHC and RoHS restricted substances) in the products.
- The supplier must offer computers and monitors from manufacturers with routines for substitution of chemicals. The routines must be documented and applied concurrently during the full contract period. The routines must include at least the 5 steps in the European Chemicals Agency's (ECHA) model for substitution of chemicals.
- The supplier is awarded points if the power cables and motherboard contain a maximum of: 900 ppm chlorine, 900 ppm bromine, and 1500 ppm halogens.
- External cables must not contain DEHP, BNP, DBP, DIBP nor chained chlorinated paraffins (MCCP, alkanes C14-17). The maximum allowed concentration is 0.1% by weight of the cable mantle's polymer material per phthalate.
- Cases and front panels weighing over 100g, and with a surface over 50cm² is to be marked according to ISO 11469:2016 and ISO 1043:2011, (part 1), or equal.
- Cases and front panels weighing over 25g for computer tablets and portable all-in-one computers, and 100g for computers and monitors, and, in both cases, with a surface over 50cm² are to be marked according to ISO 11469:2016 and ISO 1043:2011 (part 1 and 4), or equal.

There is significant cross-over and mutual compatibility between GPP criteria and ecolabelling criteria with product categories. For example, the Norwegian GPP criteria have been inspired by TCO Certified's criteria. The Norwegian GPP criteria rely on a benchmark that 30% of the market should be able to comply with a given criteria within a given product category, which ensures the required level of competition for public tenders.

The municipality of Copenhagen has a policy of requiring ecolabelled products and services, when the supply of ecolabelled products and services are of a large enough volume to ensure competition. To implement this decision, the municipality has classified product and service groups into four categories depending on the market penetration of ecolabels; from Category 1, where there are many products that have the Nordic Swan ecolabel or EU ecolabel, to Category 4, where there are no products that have either the Nordic Swan Ecolabel or the EU Ecolabel. Personal computers, laptops, tablets and white goods all fall into Category 4: there were no products with the Nordic Swan or EU Ecolabel in 2017¹⁶⁰. The candidate list of SVHC and the Sinlist likewise function as a guidance to develop GPP criteria.

159. Upphandlingsmyndigheten webpage. (n.d). Hitta hållbarhetskriterier. Retrieved from <https://www.upphandlingsmyndigheten.se/kriterier/>

160. Københavns Kommune (2017). Ny politik for miljømærkede indkøb i København. Retrieved from: <https://www.ecolabel.dk/~media/Ecolabel/Files/Indkoebere-private-og-offentlige/Cases-om-groenne-indkoeb/60944-Faktafolder-KBH-K-web.ashx>

Market dialogue is an important tool in setting suitable environmental criteria, mapping:

- What environmental performance the market can offer
- Whether it is possible to establish a circular model (e.g. take-back system)
- If enough suppliers / producers can meet a given requirement
- Which way the development is going
- If the environmental criteria influence price
- How user behaviour impacts the environmental performance.

All the Nordic countries have various initiatives to promote GPP, but common for these are their soft and informative character. However, examples where public authorities voluntarily commit themselves to GPP – either through partnerships or strategies - can be found across the Nordic countries. The following section presents a selection of initiatives that might have the effect of lowering the content of hazardous substances in EEE.

In Finland, the private development company, Motiva, is the focal point for GPP. Motiva coordinates the competence centre for sustainable and innovative public procurement, KEINO. KEINO offers networks of specific procurement categories, best-practice cases, advice on strategical procurement and education in public procurement¹⁶¹. Denmark has a similar initiative, the Forum for Sustainable Procurement, which facilitates knowledge exchange, arranges seminars, and disseminates best-practices – some of which relate to EEE e.g., a working group and a guide for sustainable IT acquisition.¹⁶² The Forum for Sustainable Procurement further provides tools for market dialogue and contract management that can promote procurement of more circular products not limited to, but including EEE. The Danish Partnership on Green Public Procurement (POGI) is a more binding partnership that, amongst others, sets out objectives for GPP of specific product groups including IT. These objectives are currently under development (2021).

In Norway, the Division for Public Procurement provides various information and guidance on green and circular public procurement, including an e-learning tool and a hotline. For IT, the Division for Public Procurement indicates the key factors to consider prior to conducting an acquisition, including whether to lease or purchase IT, the presence and relevance of ecolabels and the potential carbon footprint of the product or service¹⁶³. The Swedish procurement agency also provides general guidance on sustainable public procurement, and has developed and uses the GPP criteria of electronics as described in Box 15. Sweden is further developing a risk assessment for IT that point to hotspots that public procurers should pay special attention to when acquiring IT¹⁶⁴.

161. KEINO webpage. (n.d). Retrieved from: <https://www.hankintakeino.fi>

162. Forum for Bæredygtige Indkøb (2020). Omstil din organisation til bæredygtigt IT. Retrieved from: <http://ansvarligeindkob.dk/wp-content/uploads/2020/11/Baeredygtig-IT.pdf>

163. DFØ webpage. (2021 June 23). It-utstyr. Retrieved from <https://www.anskaffelser.no/hva-skall-du-kjope/it/it-utstyr>

164. Upphandlingsmyndigheten webpage. (n.d). Identifiera hållbarhetsrisker i leveranskedjan. Retrieved from <https://www.upphandlingsmyndigheten.se/riskanalyser/>

8.2.1 Impacts and challenges

The actual environmental impact of GPP is still largely unknown. Public spending in the Nordic countries amounts to 171 billion Euro annually¹⁶⁵, indicating a significant purchasing power. GPP is gaining ground across the Nordic countries, and the Nordic governments have clear strategies that promote GPP. GPP is increasingly used as a tool to reach environmental and climate objectives, also regionally and locally. Despite the good intentions, GPP is facing a range of barriers. The majority of these barriers are not related specifically to EEE, but are rather organizational in character.

First of all, it is often assumed that it is more expensive to purchase green, which is not always the case. Market dialogue, competitive criteria rather than minimum criteria, development criteria and green procurement clusters (where actors with similar consumption patterns make common tenders to strengthen their purchasing power) can contribute to lowering the price. This barrier should be addressed through clear strategies and priorities, and by incorporating green concerns throughout the procurement process.

Secondly, lack of competencies in developing environmental criteria. Procurers are technically proficient in procurement processes but are not necessarily comfortable navigating complex environmental problems. Specifically, regarding chemical requirements, the sheer number of hazardous chemicals that potentially may be present in different parts of EEE amplifies the knowledge and information gaps. For example, despite the fact that the Swedish Agency for Public Procurement has developed "*copy and paste*" chemical requirements, including guidance on how to apply them, a recent study¹⁶⁶ identified lack of knowledge and guidance as a significant barrier for applying chemical requirements in procurement.

To effectively apply chemical requirements, predefined or not, chemical expert knowledge is necessary. In turn, expert knowledge requires specialized personnel, which small public organizations have difficulties getting access to. As well as the concrete GPP criteria, public procurers can draw support from environmental departments in smaller municipalities. Building competencies and awareness is a key factor in ensuring the GPP goals and objectives can actually be implemented in practice. This challenge is, to a large extent, met by the tools provided by the European Commission and the respective national governments. Moreover, research is drawing attention to the possibility of a reasonable and efficient option to develop and implement organisational solutions and introduce new (*work-sharing*) cooperation models that can enable also small public administrations to access the competence and skills that are necessary to tackle the implementation of requirements on hazardous chemicals in procurement.¹⁶⁷

Lastly, GPP is voluntary, and the lack of monitoring gives no guarantee that public authorities conduct GPP. Yet, in Norway, public procurement must be conducted to limit the negative impact on the environment and support climate solutions "where relevant" according to § 5 in Norway's Procurement Act. It is up to public procurers

165. Nordic Ecolabelling webpage. (n.d). Green Public Procurement. Retrieved from <https://www.nordic-ecolabel.org/why-choose-ecolabelling/green-public-procurement/>

166. Wendt-Rasch, L. et al. (2021). Chemical requirements in Swedish municipal green public procurement: Challenges and opportunities. *Journal of Cleaner Production*, 299, 126701.

167. Wendt-Rasch, L. et al. (2021). Chemical requirements in Swedish municipal green public procurement: Challenges and opportunities. *Journal of Cleaner Production*, 299, 126701.

to identify which procured goods pose a significant impact on the environment and, thus, when it is relevant to include green criteria, including procedures to ensure compliance in accordance with the contract. By placing this interpretation of the legislation with decentral public procurers, there is a risk that the interpretation of environmental impact is driven by their own specific interests e.g. where it is cheaper to include GPP criteria.

Despite that, best practice option would be to have more consistent requirements among Nordic GPP activities. While technical specifications may be one way forward, there is often uncertainty about available sustainability requirements. If too stringent requirements are applied it may mean that nothing can be procured. Yet, reward criteria and increase the weighting for sustainability criteria can be applied to increase competition of environmental performance. One potential way to reward progressive manufacturers would be to provide a high weighting for products with safer chemicals. The manufacturers could prove that their chemicals are safe by:

- Making use of screened chemicals (e.g. the ones on the TCO Certified's list), or
- Providing documentation that shows that the chemical is safer than traditional ones.

However, evidence from Sweden reveals that the follow-up of contract compliance regarding chemical requirements and the actual documentation is severely neglected, which both procurers as well as suppliers identify as a crucial area for improvement.¹⁶⁸

Box 16: KemKollen

KemKollen is a Swedish coordination platform and tool run by the Adda group, owned by Sweden's municipalities and regions. In relation to municipalities and regions sustainable procurement, Kemkollen follow-up on chemical requirements.

Every year, a new focus area for KemKollen is chosen. Together with KemKollen's expert group, which consists of representatives from municipalities and regions, contracts, chemical requirements and products are selected for the year's follow-up, and the products are sent for chemical analysis. The results help suppliers to replace goods containing hazardous substances with better alternatives. Over time KemKollen will become a knowledge portal. The prioritised focus area in 2022 is called "at the desk" and will have special focus on IT equipment¹⁶⁹.

168. Wendt-Rasch, L. et al. (2021). Chemical requirements in Swedish municipal green public procurement: Challenges and opportunities. *Journal of Cleaner Production*, 299, 126701.

169. Adda webpage. (n.d). KemKollen. Retrieved from <https://www.adda.se/om-oss/vi-tar-ansvar-for-hallbarhet/kemkollen/>

Box 17: Circular and Fair ICT Pact

On 14th of June 2021, seven countries (Norway, Belgium, Germany, UK, Austria, Switzerland and initiated by the Netherlands) signed the "Circular and Fair ICT Pact", which commits the partner countries to join forces to demand more circular and socially-responsibly-produced laptops and smart phones. These countries find themselves too small to impact the market individually, but by joining together, they hope to push the industry to become more circular and more socially responsible. Procurement bodies being a part of the pact commit themselves to harmonise their demand and to share experiences¹⁷⁰.

8.3 Professional private procurers

Professional procurers are not subject to the same legislation as public procurement officials, but have a clear incentive to ensure competition to get the best price. Experiences from the Danish Forum of Sustainable Procurement indicate that the network is facing difficulties in reaching professional, private procurers – in particular in SME's where internal procurement receives less attention, competencies are lower and awareness of environmental concerns also potentially lower.

The Danish Network for Ecolabelled Procurement consists of larger companies that aim to conduct responsible and sustainable procurement. The network is led by Ecolabelling Denmark and the members are obliged to require ecolabelled goods and services, where possible. Members of the network exchange experiences and share tools related to sustainable procurement, and together drive a market of ecolabels. In 2019, the network purchased 121 million DKK worth of ecolabelled goods and services.¹⁷¹

8.4 Influencing consumers

Communication initiatives conducted by public authorities can be categorised into two main types:

- Communication available at the public authorities' webpages and social media targeting those consumers (or stakeholders) who actively search for knowledge
- Targeted communication where a campaign is designed to deliver a certain message to a defined target group through selected channels.

The focus of most consumer-oriented communication on hazardous substances is on the potential direct impacts to human health or the environment. This is highly evocative and enables consumers to form a direct relationship between the substance and the danger it poses to them. When communicating on the potential

170. Circular and Fair ICT Pact webpage. (n.d). Retrieved from <https://circularandfairictpact.com>

171. Netværk for Miljømærket indkøb. (n.d). Nå jeres mål for miljømæssigt bæredygtigt indkøb. Retrieved from: <https://www.ecolabel.dk/da/indkoebere/-/media/OCA4256D76924276B9639212C34CEF51.ashx>

presence of hazardous substances in EEE plastics, the problem is less related to the potential direct consequences for human health or environment, but on the impact that these substances have on the recyclability of EEE plastics and by association the hazardousness of recycled plastics. This may make it more difficult to engage consumers, as there is no (assumed) direct threat to their wellbeing from the product(s) in question.

Communication on hazardous substances tends to take a broader approach, addressing hazardous substances as an overarching issue, and only diving down into specific product categories where there is a potentially direct impact on human wellbeing for example with cosmetics, cleaning and care products.

ECHA's webpage "chemicals in our life" informs consumers about the chemicals in everyday products including those present in electronics. The information about chemicals in electronics briefly presents how certain chemicals can be released to air and dust (although electronics are rarely in direct contact with skin) as well as those groups of heavy metals to pay attention to. ECHA recommends consumers to choose ecolabels and CE markings (CE-markings are mandatory for all EEE products placed on the European market, but goods can be found that are not compliant), follow usage instructions, air out and use their right to ask about the content of SVHC (see below). The Danish EPA and Swedish Chemical Agency provide similar information.

The new Circular Economy Action Plan (CEAP) announced a revision of EU consumer law to ensure that consumers receive trustworthy and relevant information on products at the point of sale, including on their lifespan and on the availability of repair services, spare parts and repair manuals. The Commission will also consider further strengthening consumer protection against greenwashing and premature obsolescence, setting minimum requirements for sustainability labels/logos and for information tools.

Box 18: Finnish campaign "At your own risk"

E-commerce enables consumers to buy EEE from all over the world. Suppliers of cheap imported goods from developing countries are not always aware of EU legislation, there is thus a high risk of non-compliance with EU legislation. The Finnish campaign "At your own risk" advises consumers to consider how the price might impact the quality of the product. As the campaign title indicates, the campaign emphasises that the consumer is responsible for what is bought. The campaign strives to strengthen consumers' competencies on how to identify whether an online shop is reliable¹⁷².

172. Tukes webpage. (n.d). På eget ansvar. Retrieved from <https://tukes.fi/sv/pa-eget-ansvar>

8.4.1 Scan4chem

To take consumers' chemical concerns into account, REACH (article 33(2)) includes a consumer right to know the content of SVHC of any product. Consumers can ask a supplier if a product contains any SVHC, and have a right to get a response within 45 days.

The app Scan4Chem, developed in the project LIFE AskREACH, builds upon this right by facilitating the dialogue between the consumer and the supplier to increase the transparency of content of hazardous chemicals. The idea is that when a consumer has asked about the content of SVHC in a specific product, another consumer will be able to find the information in the app by scanning the barcode of the product. However, not all suppliers are responding through the app, but rather directly to the consumer, implying that few products can be found through the barcode. Consumers, therefore, need to ask the supplier every time they want to know about the presence of SVHC in a given product and wait up to 45 days for an answer. The response rate is 50%. The lack of response can be due to the fact that the product does not contain SVHC, whereby the suppliers are not obliged to respond. Looking forward, data from the SCIP database will be integrated in Scan4Chem, thus addressing the challenge of lack of information.

Another challenge of the app is the technical responses given by suppliers, such as a safety sheet, which can be difficult for a consumer to comprehend. The app is, therefore, mostly relevant for more engaged consumers with technical knowledge, if no initiatives are taken to translate the technical information given to something an average consumer can understand.

Scan4chem is funded by EU's LIFE programme with the German EPA as a project manager and with more than 20 partners across EU's member states. Scan4Chem is based upon the Danish app "Tjek Kemien" (check the chemistry) from 2013, developed by the Danish consumer organisation and the Danish EPA. The app Scan4Chem is available in several European countries including Denmark and Sweden.

8.4.2 Chemical podcast

The Swedish Chemical Agency (KEMI) launched a podcast "Kemikaliepodden" in 2016 that aims to inform consumers and stakeholders about chemicals and how to take conscious chemical purchase choices in everyday life. At the same time, the podcast enabled KEMI to test how to best express technical chemical knowledge in an understandable and interesting way. The podcast has, thus, also had an internal educational aim.

The chemical podcast includes an episode about electronics, and the concrete messages and information are similar to the information found on the KEMI webpage, but the format has been pepped up and includes questions sent to KEMI by consumers concerned about chemicals in electronics and takes a practical approach to the subject grounded in concrete cases.

The episodes have on average been downloaded 2570 times, assumingly by consumers interested in the area. Currently, KEMI has little information about the

listeners, but the podcast is to be evaluated later in 2021. KEMI assesses that the chemical podcast is successful due to the few resources used and the relatively wide reach.

Box 19: Advice from the Swedish chemical podcast "Kemikaliepodden"¹⁷³

- Clarify purpose, target group, key messages and desired impacts
- Write a rough, not too detailed script to ensure a natural conversation flow
- *"Producing a podcast does not have to take as much time and resources as you might think, it is possible to achieve a good result with few resources".* It took approximately two working days to produce one episode.

Campaigns targeting specific behavioural changes - stimulating the demand for recyclable EEE with limited content of hazardous substances - are limited. Most initiatives focus only informing consumers (which can itself lead to behaviour change).

¹⁷³. Kemikalieinspektionen webpage. (n.d). Lyssna på vår podcast Kemikaliepodden. Retrieved from <https://www.kemi.se/kemikalier-i-vardagen/vara-rad-om-kemikalier/lyssna-pa-var-podcast-kemikaliepodden>

9. SUPPORTING BETTER CONSUMPTION – FUTURE POTENTIALS

Circular consumption ideally prioritises those circular strategies with the lowest resource use and carbon footprint. Circular strategies are illustrated by the below table¹⁷⁴ in prioritised order, together with examples of how that circular strategy can be applied through procurement. Guides to circular public procurement already exist (for example the Danish Cirkulær indkøbsguide¹⁷⁵). Here we focus on how, in the future, consumers and procurers can demand recyclable EEE with limited content of hazardous substances.

Table 11 - Prioritised circular economy strategies

CE strategy	Explanation	Example of consumer/procurement practices
R0 Refuse	Making a product redundant by cancelling its function, or by substituting it with a radically different product	EEE is avoided e.g. through virtualisation or by change in use (such as less printing)
R1 Rethink	Intensifying product use (e.g., via product sharing or multifunctional products)	Employees share screens and/or other IT equipment (enabled by some employees working remotely or not daily use). An electrical tool is leased, ensuring intensified use or by designed for longer lifetimes.
R2 Reduce	More efficient use and/or manufacture of products through the use of fewer natural resources and materials	EEE with less materials or lower energy use.
R3 Reuse	Reuse of discarded yet still usable product, for the same purpose, by a different user	The EEE is reused, consist of reused components or is taken back for reuse.
R4 Repair	Repair and maintenance of defective products so it can be used with its original function	The product is designed to be repairable. Product as a service system ensure continuous maintenance and repairs.
R5 Refurbish	Restore an old product and bring it up to date	Old equipment is given/sold for refurbishment.
R6 Remanufacture	Use parts of discarded product in a new product with the same function	The supplier takes back the product to remanufacture spare parts.
R8 Recycle	Process materials to obtain the same (high grade) or lower quality (downcycling)	The product is designed to be recycled.

174. The ladder of circularity stems from PBL (2018). *What we want to know and can measure*. "R9 Recover" has tentatively been removed.

175. Such as: Forum for Bæredygtige Indkøb. (2017). Cirkulær Indkøbsguide. Retrieved from http://ansvarligeindkob.dk/wp-content/uploads/2018/09/pdf_cirkulaer_indkoebsguide.pdf and

The following section explores the potentials for influencing consumers, strengthening ecolabelling schemes and strengthening procurement tools and practices.

9.1 Influencing consumers

As knowledge of hazardous substances is very technical and sometimes ambiguous, any communication efforts must consider how to create an understandable message and promote clear actions. In CEAP, the EU aims to empower consumers by ensuring that products contain trustworthy and relevant information (which, amongst others, will be pursued through the initiative on substantiating green claims, Product Environmental Passport (PEP) methods and digital product passports). It is not stated that this information should include information on chemical substances included in the product.

Requiring manufacturers to provide information about the amount and hazardousness of chemical substances in EEE – which is partly being done with the SCIP database – would create transparency, but few consumers know what e.g. “DEHP” means, so some form of translation is needed for consumers in order to use that knowledge to acquire EEE with limited hazardous substances. Some industry representatives argue that due to the complexity of chemical substances, it does not make any sense to put that responsibility on the consumer.

The Danish App “The chemical lens” (kemi-luppen), administrated by the Danish Consumer Organisation “TÆNK”, targets chemistry in cosmetics, but experiences from the use of that app can inspire communication of hazardous substances in EEE. Similar to Scan4Chem, consumers can scan a product and find information about the content of hazardous chemicals. Yet, where Scan4Chem delivers technical information directly from the companies, the Chemical Lens translates the information for consumers to understand the level of hazardousness. The Scan4Chem targets engaged consumers with a specific interest in chemical substances, while the Chemical Lens targets concerned consumers with no technical knowledge.

Other formats such as podcasts and campaigns shared through various platforms, where consumers are present, might be a more efficient channel to reach a broader consumer group. Such communication initiatives can target specific groups that are interested in e.g. electrical and electronic gadgets. An example of a successful targeted campaign promoting reuse, repair and sorting of clothing is “Love not landfill”, which targets Londoners between 16–24, using young language and visual communication through social media platforms as well as shopping malls and cafes, where young Londoners go.

A campaign, stimulating circular consumer electronics and electrical equipment, seems more appealing to consumers rather than one solely focusing on chemicals. A broader campaign would also avoid tunnel vision, while enable a more holistic approach limiting the environmental impact of EEE. The message of design for recyclability and limitation of hazardous substances could be one theme amongst those targeting longer lifetime, repair, reuse, remanufacturing and treatment after end use.

Box 20: Shift 1.5 by SITRA

The Finnish Innovation Fund, SITRA, provides materials and methods to inspire consumers to a more sustainable lifestyle. The “1.5 shift” refers to a lifestyle that correspond with global warming below 1.5 degrees. It divides consumers into four groups to map what motivates each one of them based on their value and social positions in terms of their outreach (local/global) and whether individuals or systems are to change. These four types are presented by four real consumers, whose story is presented, and for which solutions are identified. The campaign gives concrete recommendations on how to target different consumer segments¹⁷⁶.

Box 21: Campaign “Circular future”

The PolyCE project¹⁷⁷, whose aim is to improve recycling of plastics parts in EEE, has designed a consumer campaign, which acknowledges that consumers are key actors in the circular strategies – borrow, repair, share, reuse, – that maintain the highest value of resources. The campaign informs what the consumers can do to implement each of these circular strategies¹⁷⁸.

Knowledge does not lead to behavioural change on its own. Behaviour also depends on socioeconomic conditions, lifestyles, habits, norms and ideals, media and marketing. Industry representatives expresses that the design and new functionalities of EEE – and in particular consumer electronics – are guided by demand expectations. Campaign designers must understand these underlying structures to create a campaign that leads to more circular consumption of EEE.

An expert from the European Environmental Bureau (EEB) stressed that circular and sustainable choice should be the default, thus limiting the responsibility of the consumer in ensuring EEE with limited hazardous substances. Such default solution can be supported through legislation. A sustainable supply of EEE needs to be in place for consumers to require these, it should further be accessible and easy for the consumer. Such default solutions can be promoted through the Ecodesign criteria establishing market standards limiting hazardous substances and promoting recyclability.

Price signals, where the most sustainable option is the cheapest, and the most

176. Impiö, J. et al. (2020). 1.5-degree lifestyles by 2020. Helsinki: Sitra. Retrieved from <https://www.sitra.fi/en/publications/pathways-to-1-5-degree-lifestyles-by-2030/#main-messages>

177. PolyCE (Post-Consumer High-tech Recycled polymers for a Circular Economy) is a multi-annual project funded by the European Union involving 20 partner organization drawn from industry and academia. (www.polyce-project.eu).

178. EEB webpage. (n.d.). Circular future. Retrieved from <https://eeb.org/circular-future#Recycle>

hazardous is the most expensive, is another way to create clear incentive for behavioural change. The Swedish chemical tax is an attempt to create such an incentive. However, as discussed earlier in this report, the tax must be redesigned to effectively support non-toxic electronics. Product taxes also risk hitting social unequally, which should be kept in mind when designing any economic incentives.

Retailers can also be an important gate-keeper in nudging the consumers towards selecting the more sustainable choices and to ensure a sustainable alternative. Retailers can assist consumers to make more circular choices, close the loop/ promote reuse, and take an active responsibility themselves.

9.2 Strengthening ecolabels

As discussed, highly technical and complex information on hazardous substances can most easily be communicated through ecolabels, and at the same time be balanced with other sustainability considerations. Ecolabels further offer consumers an easy sustainable purchasing choice. However, the ecolabels that Nordic consumers know best and are highly trusted – the Nordic Swan and the EU ecolabel – do not cover most types of EEE. The EU ecolabel is limited to electronic displays. This application is still rather new and would benefit from steps taken to promote the use of it. The limited size of the Nordic market for EEE and the limited demand for both the EU and the Nordic Swan ecolabel (despite efforts collaborating with Asian ecolabels) leaves the promotion of global ecolabels as the current most viable alternative.

Global ecolabels – TCO Certified and EPEAT – have a larger market share but are lesser known amongst consumers. Consumers need to be aware of the ecolabels, trust them, and be motivated to demand them. As both TCO Certified and EPEAT are type I ecolabels requiring certification from third-party organisations and globally recognised, trust in the labels is assumed to be present, though perhaps to a lesser extent than for the Nordic Swan ecolabel and the EU ecolabel.

An important question is who should be responsible for increase awareness of these global ecolabels?

Producers and suppliers can provide more detailed information about ecolabels on the product and through their channels (webpages; social media etc.). Retailers can also deliver information and guidance on more circular purchases as well as disposal after end use. Public authorities can likewise recommend consumers to choose an ecolabelled EEE, but they seem more reluctant to recommend specific labels that are not officially recognised. Public authorities can be pro-active in collaborating with private ecolabel owners and actors across the value chain to support global ecolabels stimulating circular EEE.

Lastly, consumers must somehow be motivated and capable of demanding an ecolabel (which is partly discussed in the previous section). There is however no easy fix, and no full agreement on how policies can promote consumer behaviour. A first step would thus be to create the knowledge base on how to design policies that effectively target consumer behaviour towards purchasing more circular EEE.

What can we learn from mandatory EU energy labelling?

One type of mandatory label that has been quite successful is energy labelling. The success is demonstrated through evidence that consumers actually use it in purchasing situations, and that producers benchmark their products against the label. A product database¹⁷⁹ related to labelling was really introduced, and consumers can use a QR code system¹⁸⁰ to access information about products in that database. The database can also be used by surveillance authorities. There is also a website with information for consumers.¹⁸¹

The energy label is today multidimensional, including issues such as noise levels, water consumption and duration of programs (depending on product group). Thus, it is probably not impossible to start working on a 'substance label', which would be product-specific, for chemical content. The idea might be new for many people working with chemicals policy, as it currently relies more on bans and phase-outs. However, when it comes to energy efficiency of products, products that do not comply with the Ecodesign Directive are not allowed in the EU; whereas products that comply can be rated in the energy labelling scheme. Thus, it should be possible to imagine a similar regime for toxic substances in EEE. However, it might be more challenging to rate EEE with respect to their toxicity rather than energy efficiency.

9.3 Strengthening (public and private) Procurement tools and practices

Easy applicable GPP criteria are reported as the most usable tool to promote GPP of EEE, in particular when it comes to hazardous substances, on which public procurers have little information. Public procurers prefer copy-paste GPP criteria, which can be directly pasted in tender documents. Copy-paste criteria cannot always be developed due to different local circumstances requiring some market validation. Some types of GPP criteria for electronics are in place across all the Nordic countries, but do not exist for electrical products to the same extent. As the market for EEE is global, products are to a large extent the same across the Nordic, giving significant opportunities for Nordic collaboration on the preparation of GPP criteria. The ICT-pact recognises the opportunity in joining forces to push for a more circular market of ICT – a pact which Norway already participates in and where the other Nordic countries can follow suit. The ICT pact contributes to an alignment of criteria and ease the preparation of GPP criteria of ICT.

In the Nordic countries current GPP criteria, the limitation of hazardous substances is included together with other, often more highly prioritised, GPP criteria such as prolonging of lifetimes/reuse, which arguably have a greater environmental benefit with respect to electronics. Where this guide mostly looks into the limitation of hazardous substances and design for recyclability, it is important to emphasize that these criteria must be balanced with other sustainability objectives. However, the

179. EC webpage. (n.d.). Product database. Retrieved from https://ec.europa.eu/info/energy-climate-change-environment/standards-tools-and-labels/products-labelling-rules-and-requirements/energy-label-and-ecodesign/product-database_en

180. EC webpage. (n.d.). QR-code and the new energy label. Retrieved from https://ec.europa.eu/info/energy-climate-change-environment/standards-tools-and-labels/products-labelling-rules-and-requirements/energy-label-and-ecodesign/product-database/qr-code-new-energy-label_en

181. Visit the website at <https://www.label2020.eu>

importance of addressing hazardous substances should not be understated despite its high level of complexity.

As the market of EEE and the content of chemicals are constantly changing, the GPP guidance included here is rather a process to ensure the preparation of GPP criteria. Different levels of ambition can be applied in demanding EEE with limited hazardous substances:

1. Limiting hazardous substances by requiring a limitation of SVHC from REACH, the Sinlist or similar lists of hazardous substances
2. Demand ecolabels or similar requirements
3. Encourage safe substitution e.g. demanding procedures for safe substitution
4. Require the use of substances that are identified as safe alternatives
5. Follow-up and monitoring of product claims.

For any decentral public authority, the level of ambition must be decided strategically and a political/managerial mandate should be ensured. A strategic roadmap can be advisable, depending on the maturity of the contracting authority and the market. A starting point can be to limit hazardous substances, but in the longer run the contracting authority should communicate a higher ambition to the market e.g. by encouraging safe substitution either through market dialogue or through a development clause.

Market dialogue is a key tool in ensuring ambitious requirement on hazardous substances that are subject to competition. Procurers should consider which environmental standards are present in the market (which can be included as technical requirements) and where the market can compete on environmental performance (enabling award criteria). It is further recommended to consider how any requirements can be documented. Increased cooperation with suppliers and an independent supplier dialogue allows for decisions on the appropriate level of "strictness" of chemical requirements which are ambitious while still allowing enough suppliers to bid in the tendering process.

Furthermore, at the national level, the assignment of specific environmental requirements (e.g. chemicals) for procurement contracts could be held centrally by a national public procurement agency, which has the mandate to provide competency and capacity for such complicated processes. Such an effort would provide more and updated chemical requirements, including more detailed requirements for specific products, and information on whether GPP requirements regarding chemicals result in increased costs. Moreover, a central processing of chemical requirements in GPP contracts would be enabled by a product database specifying the chemical content of products, which such an agency could develop.

In conclusion, Nordic cooperation on such initiatives would enable a more streamlined approach in chemical requirements and would create a stronger market lever than individual countries can achieve on their own.

10. PROCUREMENT GUIDE

Aside from the stepwise approach included in the guide below, there are two important overarching components that need to be considered from a strategic perspective:

1. Cooperation at the Nordic level – create a larger unified market space for sustainable EEE
2. Long-term strategy for GPP for EEE – indicating what requirements are now and how they will be assessed and potentially tightened in subsequent procurement windows/contract periods. This indicates a clear and stable *direction* that GPP will take in this product domain.

The following guide provides an overview of the guiding questions that should help steer each stage of the procurement process.

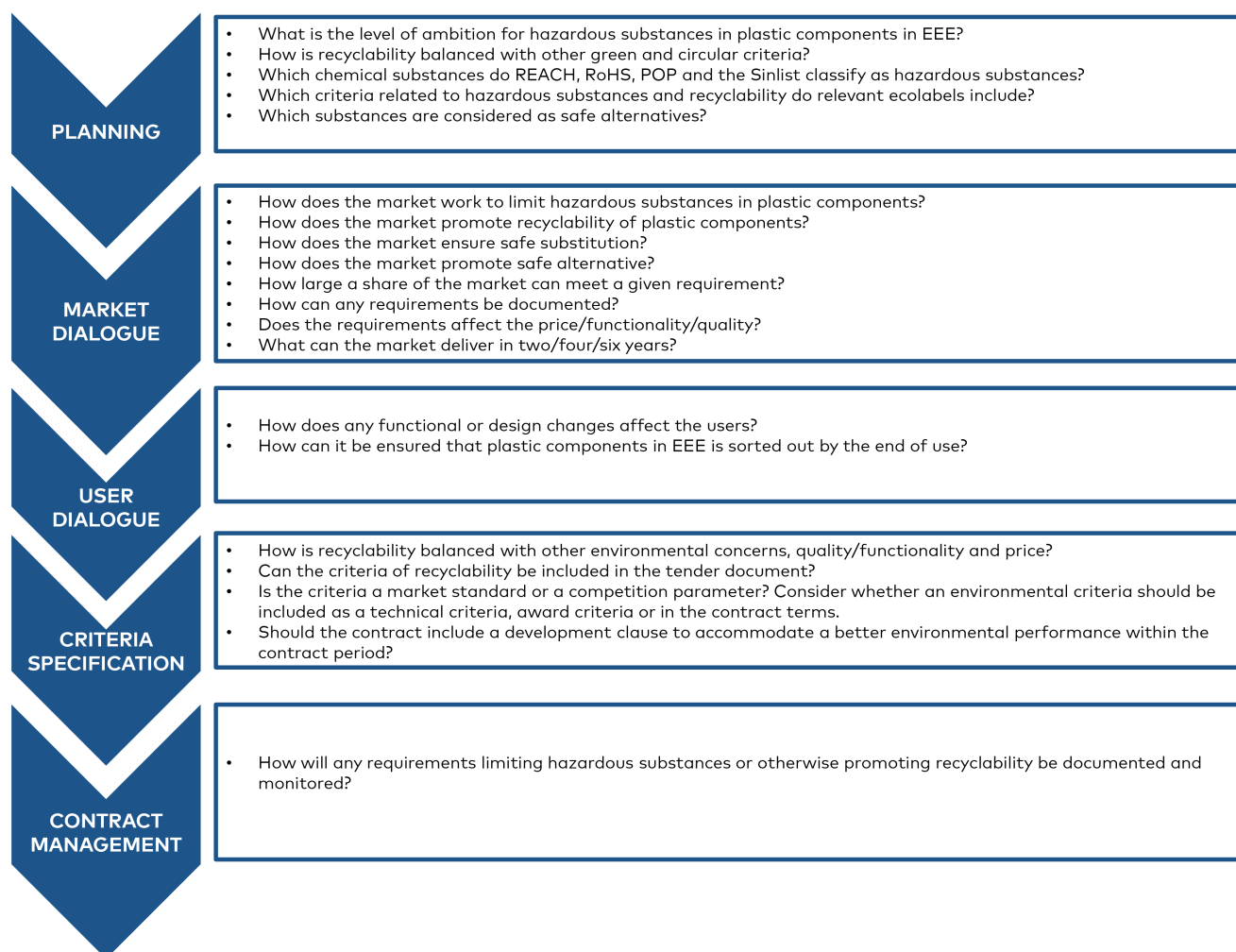


Figure 1: Procurement guide to promote recyclability of plastic components in EEE

11. RECOMMENDATIONS

The following recommendations have been grouped into three thematic areas: *increasing information availability; supporting green procurement; and supporting the Nordic EEE sector*. They are, however, largely complimentary. In addition to these specific recommendations, the Nordic countries should continue to proactively engage with European policy processes to help minimise the incidence of hazardous chemicals in EEE plastics.

11.1 Increasing information availability

Recommendation 1

Increase consumer awareness of circular electronics and electrical equipment including recyclability and how the use of hazardous substances hinders closed loop recycling. This needs a holistic approach to ensure that the issue does not languish in a niche environmentalist consumer segment but receives broader recognition. Such awareness raising can make use of social media channels and podcasts. This can draw on existing global ecolabels and their ability to enable a more circular purchasing choice of EEE.

Recommendation 2

Provide more information about circularity of EEE at the point of sale through collaborating with retailers and suppliers. Product information (through e.g. PEF's or ecolabels) given at the point of sale is crucial in informing consumers about how to make a more circular purchasing choice of EEE. Retailers guide and inform consumers about salient product attributes – it would be highly beneficial to ensure that one of the attributes communicated was the product's circularity (and by association hazardous content). To support this, in-store displays could be equipped with digital identifiers providing information at the point of sale (e.g. QR code connected with an application or a database such as a digital product passport).

Recommendation 3

Nordic collaboration of product passport increasing transparency on chemical content. The Nordic countries share circularity priorities and can advantageously collaborate to limit hazardous substances in EEE as part of the Sustainable Product Policy Initiative and related product passport. This will be a difficult process, but it is essential that strong voices push for a comprehensive implementation of the Digital Product Passport.

11.2 Supporting green procurement

Recommendation 4

Facilitate a Nordic working group on GPP criteria for electronics and electrical equipment. The EEE procured by public and private organisations across the Nordics is largely the same. Likewise, the processes involved in procurement across the Nordic countries also have many commonalities, including the preparation of GPP criteria. As such, there is a great opportunity in strengthening exchange of knowledge and the alignment of GPP criteria in a joint effort. This will help create and support a stable and significant pan-Nordic market for circular EEE.

Recommendation 5

Join the ICT-pact harmonizing GPP criteria to push the market towards more circular (and sustainable) provision of ICT. In addition to Recommendation 3, alignment with international efforts to build a market for circular EEE is a useful strategy. Not only to ensure an even broader market for circular EEE, but also to ensure that the Nordic countries influence the shape and form of that market

Recommendation 6

Increase the capacity and competency of public officers in procurement departments to develop, process and follow-up product requirements on chemicals. Alternatively, complement procurement departments with experts from other public departments (e.g. environment agencies or departments). This will allow the effective application of chemical requirements in public tenders – also by implementing GPP criteria recommended by a Nordic working group or the ICT-pact. This is considered essential for the practical application of GPP at small and medium public authorities.

11.3 Supporting the Nordic EEE sector

Recommendation 7

Consider the application of novel policy approaches in the context of Extended Producer Responsibility (EPR). Similarly, in the context of economic incentives (such as the Swedish chemical tax), EPR fees can be adjusted to reflect the chemicals content in EEE products which negatively affect the recyclability of the WEEE collected under the scheme. Chemical content that renders WEEE plastic non-recyclable would result in higher fees (eco-modulation). This could be linked, if necessary, to recyclability criteria.

Recommendation 8

Coordinated support for importers, manufacturers and brands to help source products and components that are free of hazardous substances. This demands both knowledge of the problem area and transparency through supply chains to enable Nordic-based businesses to make the most sustainable and circular choices. Encouraging and supporting businesses to conduct due diligence on the product that

they import and sell could significantly reduce the import of questionable equipment.

Individual initiatives are already underway to support better design and boost transparency within the EU and in individual countries. Positive experiences and knowledge should be shared with and between Nordic countries.

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