



Study on the implementation of product design requirements set out in Article 4 of the WEEE Directive

The case of re-usability of printer cartridges

Final report

Prepared by

OAKDENE HOLLINS
RESEARCH & CONSULTING

[Written by Rachel Waugh, Harry Symington, David Parker, Maximilian Kling, Ferdinand Zotz]
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Directorate B — Circular Economy & Green Growth
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Contact: Maria Banti

E-mail: Maria.Banti@ec.europa.eu

*European Commission
B-1049 Brussels*

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of product design
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GLOSSARY

EEE	Electrical and electronic equipment
WEEE	Waste electrical and electronic equipment
OEM	Original equipment manufacturer
ETIRA	European Toner and Inkjet Remanufacturers Association
EU	European Union
GPP	Green Public Procurement
LCCP	Lexmark Cartridge Collection Programme
POM	'placed on market'
PRO	Producer responsibility organisation
SMEs	Small and medium sized enterprises
VA	Voluntary Agreement for imaging equipment

For the further avoidance of doubt, this work uses the following terms and phrases:

"reuse" – a waste prevention operation whereby products collected deliberately after use, that are not waste, are remanufactured or otherwise rejuvenated and successfully placed back on the market to be used again for the same purpose for which they were conceived.

"preparation for reuse" – a waste recovery operation whereby products that have become waste undergo processes of checking, cleaning, refilling, repairing, remanufacturing or otherwise rejuvenation which return them to a useable and marketable condition for the same purpose for which they were conceived.

"take-back" – a system of collection put in place by producers or third parties acting on their behalf to gather used products before they are consigned as waste, with the intent to undergo **re-use** (see above).

"recovery" – operation defined in Directive 2008/98/EC relevant to the treatment of printer cartridge wastes or other WEEE.

UNITS

Conventional SI units and prefixes used throughout.

RECORD OF DATA APPROVALS AND PERMISSIONS

Approval to display and cite the following figures and data has been received:

Data Item	Company	Date permission received
Figure 1 (left hand) Figure 2 (schematic)	Lexmark	19/05/2017 (email)
Figure 3	Kyocera	24/07/2017 (email)
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Figure 4 (adapted) Figure 5 (adapted) Figure 6 (adapted) Table 4 (adapted) and related text references	Keypoint Intelligence - InfoTrends	05/06/2017 (email)

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ABSTRACT

The objective of this study is to provide DG Environment with evidence to assess the implementation of Article 4 of the Directive 2012/19/EU on waste electrical and electronic equipment (hereafter referred to as the 'WEEE Directive') through the case of re-using laser and ink-jet printer cartridges. The project has produced targeted recommendations for the consideration of the Commission to address weaknesses in the Voluntary Agreement associated with Article 4, and wider measures to improve the robustness of both the new and the reused cartridge markets.

The process of this study has been primarily through a stakeholder consultation involving imaging equipment manufacturers (OEMs), cartridge remanufacturers, trade bodies and printer service providers amongst others. It has gathered quantitative and non-quantitative information on the markets for new and reused consumables by economic and volumetric activity, and queried business practices regarding new sales, reuse and associated barriers and enablers. It has examined actions taken to promote reuse under the WEEE Directive, complementary actions by Member States and also the effect of the industry's Voluntary Agreement under the Ecodesign Directive.

The actions suggested in this study can address the headline issues raised by the range of stakeholders. A clear finding is that the cartridge market is very competitive (or, in economic terms, well-functioning), but the regulatory environment is not well suited to promoting reuse of products or – better – encouraging dematerialisation and greater material efficiency. For this, significant alterations to – as a minimum – EPR scheme structures are proposed.

EXECUTIVE SUMMARY

The objective of this study is to provide DG Environment with evidence to assess the implementation of Article 4 of the Directive 2012/19/EU on waste electrical and electronic equipment (hereafter referred to as the "WEEE Directive") through the case of re-using printer cartridges. The project has produced targeted recommendations for the consideration of the Commission to address weaknesses in the Voluntary Agreement associated with Article 4, and wider measures to improve the robustness of both the new and the reused cartridge markets.

This project was built upon three distinct tasks:

- To provide a qualitative and quantitative analysis of the current EU-28 printer cartridge market (Task 1).
- To identify and assess measures currently taken at Member State and industry level to support implementation of Article 4 of the WEEE Directive, and to evaluate their efficiency (Task 2).
- To present proposals and recommendations for further actions by Member States and stakeholders with regard to reusing printer cartridges and other types of electrical and electronic equipment (EEE) (Task 3).

A description of the findings and recommendations is provided in Section 8, but summary findings and abbreviated recommendations are presented here.

Markets

European inkjet and toner cartridge markets are worth around €9.4 billion and €10.2 billion respectively per year, equating to 370 million and 135 million units respectively.

The supply of inkjet and toner cartridges is dominated by the Original Equipment Manufacturer (OEM) suppliers. The collection rate of printer cartridges via take-back schemes of OEMs is around 18% and 25% respectively but the reusable fraction of these cartridges is quite high at 75-80%. Because of the low collection rate, it is rare for a printer cartridge to be refilled more than once. However, the high fraction of reusable product indicates that there is substantial technical potential for increased collection and reuse through improved handling of the fraction of cartridges which enter the WEEE stream, diverting them from recycling and energy recovery. Non-OEM 'clones' represent under 5% of both markets, but are the source of significant concerns in all quarters for reasons of IP infringement, build quality, hazardous content and price under-cutting.

A graphical representation of the flows of toner cartridges and ink-jet cartridges and their fates may be seen in

Figure 35 and Figure 36 respectively.

Operators

Re-use of cartridges is dominated by the activities of operators different from the OEMs represented largely by SMEs. If organisations surveyed in this work are typical, these companies take quality and environmental obligations seriously, including end-of-life responsibilities. As a result, reused cartridges typically achieve a sales price of 50% of new.

OEMs are almost exclusively large enterprises with substantial EU sales, largely in excess of €50 million per annum. They all operate a take-back scheme, either in-house or via agents. However, only 3 of the 11 survey respondents indicated that these were for reuse. Of those OEMs replying, the recycling rate of discarded

cartridges ranged from 65% to 100%, indicating that OEMs currently prioritise waste recovery strategies over reuse.

Article 4 – Member State action

All Member States have taken measures for the transposition of the revised WEEE Directive into national law. No measures in support of Article 4 have targeted printer cartridges directly. The overall performance of WEEE management in terms of collection, preparation for reuse, recovery and recycling of WEEE varies markedly between Member States, but there is no obvious correlation with the adoption of a particular measure or set of measures. Efficacy is more likely a function of the effectiveness of the implementation, policing and enforcement regimes and prevailing cultural factors in the Member State in question.

EPR schemes as implemented appear weak in motivating product reuse. This can be attributed to the relatively low level of the fees producers pay for the management of the waste coming from the products they place on the market when these products reach the end of their life; that the fees are used typically to build waste management infrastructure which is inappropriate for the sound retrieval of good quality products before they become waste; and there are no mandatory targets for reuse.

Article 4 – Industry action

The review of industry actions has found that most of the activity has focused on the early research and design phases of the supply chain, with an emphasis on facilitating the recovery of material from collected WEEE, i.e. plastics recycling. Producers are broadly concentrating on recycling their products where these have been collected under take-back actions.

No evidence of collaboration between OEMs and remanufacturers could be found, with actors appearing to act independently in their own sphere of influence, e.g. OEMs focus on design aspects.

There are, however, some significant product developments which eliminate or minimise the need for unified cartridges, although most of these are not new or directly attributable to the legislation. These include Xerox's Solid Ink system, its toner bottle replacement system; and Kyocera's long-life print-head and toner cassette. On the ink-jet side, Epson's Ecotank® system allows direct ink refilling without cartridges. All except Kyocera's have been on the market for some time, involve significantly more expense on purchase of imaging equipment, and tend to target the higher volume users in the larger office environments. Their material benefits are, however, well documented.

Eco design Directive - Voluntary Agreement action

Since 2012, producers of imaging equipment are committed under a Voluntary Agreement¹ (VA) to improving the environmental performance of this type of equipment placed on the European market and the signatories committed to the use of cartridges not preventing reuse, preparation for reuse or recycling, and to not prevent the use of a non-OEM² cartridge. In response to the requirements of the EU Ecodesign Directive, the major imaging equipment OEMs established a self-regulation

¹ <https://ec.europa.eu/energy/sites/ener/files/documents/VA%20Imaging%20Self-Regulatory%20Initiative-V-4-0.pdf>

² Non-OEM Cartridge is a toner or ink cartridge not sold by the original equipment manufacturer (OEM) that is remanufactured and/or refilled.

coordination body, EuroVAprint in early 2011. Since then, membership has comprised: Brother, Canon, Epson, HP, Konica Minolta, Kyocera, Lexmark, OKI, Panasonic, Ricoh, Samsung, Sharp, Toshiba and Xerox. This body is responsible for collecting audit information from the OEMs in respect of commitments made regarding improving printer performance impacts and collection aspects of cartridges.

The information collected as part of the annual review process of the Voluntary Agreement does not include statistical assessment of outcome measures that might demonstrate any progress in cartridge reuse rates, or indeed the recycling or recovery for un-reusable products collected under take-back actions, or any quantitative assessment of steps taken to improve design for recycling or diversions from this principle.

Further, three of the signatories to the Voluntary Agreement will drop out in 2017, somewhat undermining its authority, although the remaining members still may represent over 80% of the market.

Effect of Ecolabels

Of the three major ecolabelling schemes in Europe (EU Ecolabel, Blue Angel and Nordic Ecolabel), there are no licenses for printers under one (EU Ecolabel), but substantial numbers under the other two systems. More specifically, Blue Angel and Nordic Ecolabel have separated printer licenses from reused cartridge licenses, thus simplifying applications and permitting agents other than the OEM to legitimately and defendably (by using published test standards) support the re-use objective.

In June 2017, the Commission finalised an extensive evaluation (fitness check) of the EU Ecolabel scheme. As a result of this evaluation it has been decided to discontinue the EU Ecolabel criteria for Imaging Equipment product group. Nevertheless, a stakeholder survey conducted by the JRC in the preliminary phase of the revision of the EU Ecolabel and Green Public Procurement criteria³ (i.e. prior to the results of the fitness check) showed that there is substantial stakeholder interest in developing EU Ecolabel criteria for remanufactured cartridges along the lines of Nordic Ecolabel et al. and this is supported by the findings of this current study.

Areas for concern and potential action

This study has identified concerns and corresponding actions at many points in the supply chain and related to different stakeholders categorised as follows:

- Creating a level playing field for the new and re-use/ second-hand markets.
- Consolidating patent holder and OEM protection and second user rights.
- Improving design for reuse, recycling and recovery.
- Ensuring reused cartridge performance.
- Improving reuse performance disclosure.

To improve the market situation for both legitimate new and reused cartridge sales, a range of measures is proposed for consideration:

- Addressing the issue of 'rogue clone' imports.
- Ensuring reuse agents do not mis-represent reused units as OEM products.
- Improving access to cartridge design and consumables specifications.
- Revising the EU GPP criteria to address 'remanufactured and refilled cartridges.'

³ JRC (2017) 'EU Ecolabel for imaging equipment – Interest in the label and reasons for the lack of uptake'

- Improving user information on all cartridge packaging to reveal true performance.
- Creating a rating system for cartridge quality ('failure rate') matched to user expectations.
- Rationalising acceptable phrases to be used to describe new and reused cartridges.
- Reviewing the Voluntary Agreement so that data on rates of take-back, re-use, recycling and other recovery operations is routinely collected and published.
- Expanding scope of actions by producers of cartridges to promote and support the reuse option as an alternative to take-back.

Context for further action

The potential actions described in previous sections relate, on the whole, to moderate adjustments to the prevailing systems of business within the established legal and administrative framework.

It is the general finding of this study that the market of imaging devices and their related consumables is a mature one, and that all actors in the market are behaving perfectly rationally in their response to the competitive and legislative environment.

However, this does not mean that, from a resource efficiency perspective, the current situation is optimal. Cartridge reuse rates are well below 30% of items in circulation, but could be substantially higher from a technical perspective.⁴ The fact that some OEMs have successfully adopted reuse models for cartridges, without print quality impacts, strongly indicates that higher rates of reuse are possible. Particularly in the large office and professional sectors there is an apparent shift towards, at least, a more service-based approach.

It is apparent that technology developments in solid inks, simple toner and ink reservoir refill systems can dematerialise the consumables aspect, but these demand more robust print-heads in the imaging equipment with a corresponding increase in up-front capital expenditure. There are well-quantified benefits in terms of cost per print and materials and energy impact over the printer life.

As previously noted, this is a mature market with well-established brand names competing for share and to maintain profitability. The 'two-part' business model has become embedded, in particular in the small office and home markets, because of this competition to hold share in new sales and the potential to reclaim margins through the not-altogether transparent cost of the toners and inks over the printer life. In addition, the unified cartridge model offers very high convenience to home users especially. The threat of low but rising competition from Asian manufacturers only serves to embed the low-price printer model further.

Skewed pricing for the cartridges is a direct result of the need for margins to recover printer sales costs. It is therefore no surprise that independent agents and new entrants have been attracted to enter the market both as an opportunity to rejuvenate once-used units and to offer lower price and (perhaps) lower quality new cartridges. This is the sign of a competitive, well-functioning market. There appears to be a market for both these products, satisfying whatever level of requirements the consumers have. However, it does mean that the cartridge market size for the printer OEMs will be squeezed if no other action is taken.

⁴ Statistics assembled from source of Footnote 13 and supplemented by others

The research of this study indicates that OEMs are indeed operating used EEE return programmes, by direct communications to business and household users and also by use of brokers. Some OEMs do employ these take-back products to engage in re-use as a waste prevention activity. However, most OEMs use these collected items as feedstock for recycling and recovery operations including energy recovery from waste, along with a proportion of items that cannot be reused. It is the case, however, that statistics on the return rates, reuse rates and recovery rates of take-back cartridges are not published by the sector under the Voluntary Agreement, and this may be a potential area of improvement.

Independent refilling and remanufacturing agents also work directly with customers or employ brokers to retrieve cartridges for reuse and thus before being consigned as waste. A high proportion of these cartridges are processed for reuse (as above), but similar issues on data collection regarding reuse fractions and waste pertain.

It is clear that a substantial fraction (over 70%) of used cartridges is consigned as waste and undergoes recovery operations. Anecdotally, it is considered that very little of this undergoes preparation for reuse due to cartridges being easily damaged when a careful collection system is not in place. Given the mechanical sensitivity of cartridges, greater efforts might be employed by producers and retailers to improve the rates of collection and to apply collection conditions that allow the reuse or preparation for reuse of the collected used cartridges. This might include specific drop-off points at retail locations – including return packaging – profile raising or incentives.

The WEEE Directive encourages – as indicated in Articles 5, 6 and 8, for example – a stratified approach to waste management in line with the waste hierarchy as established in Article 4 on the Directive on Waste 2008/98/EC. However, the evidence of this study is that, as formulated, EPR and EoL schemes do not send a strong signal to encourage anything beyond recycling, and certainly do not encourage reuse or even dematerialisation. Besides, as noted above, statistics on cartridge reuse as reused EEE, being outside the waste statistics remit, are not routinely collected; the opportunities for the sector to obtain credit for reuse activities are therefore not apparent.

From a material and environmental perspective, assuming quality of remanufactured cartridges can be maintained, reuse appears to be desirable. However, this does not mean it is economically desirable. The cost structures and obligations of OEMs may not provide a clear-cut financial case for reuse with its higher labour elements, uncertainty of core supply and core quality, and absorbing of some systemic costs which independent agents do not incur. Under these circumstances, opting for a safer model in which cartridges are recycled might be preferable for the OEMs.

Potential changes to EPR schemes

Whilst a number of non-OEM stakeholders reported that there was a lack of used cartridges to feed their business, many of the complaints were directed at OEMs. Complaints were made that OEMs were taking-back cartridges and then sending the cartridges for recycling thus removing it from the potential reuse stream.

These criticisms appear mis-directed. They do not consider, for example, why reuse rates for used cartridges are well below 30%, with the remainder being directly recycled, incinerated or landfilled. Accordingly, this study has considered the operation and objectives of the 'EPR' schemes. EPR seeks to achieve a reduction in the environmental impact of products, throughout their lifespan, from production through end-of-life. Such obligations are mandatory in several waste streams, including WEEE.

The language of EPR is informative: although the ethos of EPR is life-cycle management and waste prevention, the prevailing paradigm for its implementation – in EEE – in practice is almost entirely focussed on managing waste, diverting from

landfill into recycling and not on reuse of products. Worse, most of Member States' actions under collective schemes treat end-of-life EEE as already waste, promoting the materials recovery aspects of treatment infrastructure. This embeds the paradigm of used products as waste even before being consigned as waste, but also severely hampers the possibilities of maintenance of used EEE as reusable product or the maintenance of WEEE in order to ensure its preparation for reuse. This situation is well-described in reviews conducted for the Commission examining EPR practices across the EU, the learning from them and available guidance on setting up new schemes. The main mechanisms outlined for this which could be exploited are:

- Much greater clarity over the objectives of an EPR scheme.
- Designing of a metric which fairly measures success according to agents in the supply chain.
- Ensuring true costs are accounted for (which we could interpret as going beyond collection and treatment and including notional environmental impact not fully costed elsewhere) in order to promote the higher forms of product and material efficiency.
- Ensuring that these costs and benefits are fairly distributed amongst agents in the supply chain.

In reuse, the last point offers greater complexity than typical collection and recycling-based EPR schemes, which essentially preserve the linear product economies. This indicates the challenge of EPR in the higher echelons of the Circular Economy: How to formulate and translate a higher objective into an equitable cost/benefit system.

The solution to this in the longer term may involve relaxing a fixed opinion on particular products which appear to be the headline concern and creating individual solutions. Instead the system should reward systemic technical solutions of higher material intensity, which dematerialise or eliminate take-back and waste management issues. These will demand producers to pay fees which are significantly higher than those used to fund material recycling infrastructure imposed today.

In the short term, EPR schemes could provide for different financial fees upon producers depending on the selected operation among energy-based recovery, material-based recovery, product-based recovery and reuse. Put simply, the fees paid by the producers to the collective scheme should be linked to product fate not to product placed on the market, with a differentiated scale of highest fee for energy recovery operations and no fee at all for reuse. This would motivate reuse as well as dematerialisation by any technical route. Deposit-return systems for cartridges could be beneficial for motivating greater returns in the home and small office markets.

The issue of how to include third party remanufacturers in this scheme would require further consideration. Firstly, they would incur no fees for refilling and remanufacture of cartridges which they sell still under the trademark of the OEM. For the refilled/remanufactured cartridges they sell under their own trademark, they are also considered as producers in the context of the WEEE Directive and for these they would incur the fees (or a fair proportion of their market share).

Potential modifications to the regulatory regime

The WEEE Directive incorporates the waste hierarchy as established in Article 4 of Directive 2008/98/EC on waste, it introduces a joint 'recycling and preparation for reuse target' and provides for reuse centres to have access to WEEE. However, against the above background, it is still considered that the stipulations of the WEEE Directive do not provide a strong impetus to reuse.

The obligations of the industry VA similarly provide no overt impetus to reuse; there are no metrics associated with take-back, reuse and recovery rates of un-reusable products, or targets to improve in this respect as there are in energy usage of the

imaging equipment itself. That is in itself a clear failing of the current VA. However, a simple take-back and reuse target would not motivate reuse above the current performance; there is no evidence of a market trend in this direction as things stand.

This will require a more nuanced approach than simply requiring reuse of discharged cartridges. Such a target would receive strong opposition from manufacturers as it would attract criticism that market choices were being arbitrarily and unfairly skewed; winners and losers would be being picked without a sound basis.

What is required is a metric that encourages competition, is technology-neutral, but drives improvements in the efficient use of materials. By technology-neutral, it is understood that no one particular method of efficiency is promoted or favoured ab initio. Although this study has considered cartridge reuse, there has been a persistent theme that superior life-cycle efficiencies can be achieved by dematerialisation tactics – elimination of cartridges or at least driving down their complexity and embedded impacts. Any proposed metric should be agnostic regarding such choices and encourage development of new technologies and services.

This topic requires substantially more consideration than can be provided in this study. However, a metric which uses as a proxy for materials, the energy (or CO_{2e}) equivalent of the LCA of the cartridges is a possibility. To make a genuine and comparable ranking of all potential delivery technologies, this measurement should assess not only the cartridges, but the net impact per print page (normalised in some fashion) of the entire print technology. This should be published, with the expectation of continual reductions in this impact.

One comparator is in the automotive sector where year on year reductions in net CO_{2e} emissions per km are mandated under EU directives across the whole of a manufacturer's fleet of vehicles produced, weighted according to production volume. Equivalent 'fleet' statistics are already collected by imaging equipment OEMs in support of current VA reporting obligations, so a basis exists.

There are undoubtedly many further aspects, not to say objections, to consider in such a proposal, for example, whether remanufacturers and refillers and other cartridge providers would report into this system too. If remanufacturing a particular OEM's cartridge, they could be obliged to 'credit' this to the OEM via EuroVAprint, thus underwriting and validating OEM assertions of their use and reuse assumptions. In this way, more agents who are often currently in opposition can be tied into a unifying and mutually beneficial framework.

1. INTRODUCTION

The European Commission Action Plan to support the Circular Economy emphasises, the importance of ecodesign to make products more durable or easier to repair, upgrade or remanufacture, and to, overall, help save precious resources. It highlights that electrical and electronic products are particularly significant in this context, and, inter alia, announces that:

"the Commission will emphasise circular economy aspects in future product design requirements under the Ecodesign Directive... The Commission will analyse these issues on a product by product basis in new working plans and reviews, taking into account the specificities and challenges of different products (such as innovation cycles), and in close cooperation with relevant stakeholders".⁵

However, provisions on eco-design are also already included in Directive 2012/19/EU on waste electrical and electronic equipment (hereafter mentioned as the "WEEE Directive")⁶. According to Article 4 of the WEEE Directive, Member States:

"shall encourage cooperation between producers and recyclers and measures to promote the design and production of EEE, notably in view of facilitating re-use, dismantling and recovery of WEEE, its components and materials".

In this context, the Directive obliges Member States to:

"take appropriate measures so that the ecodesign requirements facilitating re-use and treatment of WEEE are applied and producers do not prevent, through specific design features or manufacturing processes, WEEE from being re-used, unless such specific design features or manufacturing processes present overriding advantages, for example, with regard to the protection of the environment and/or safety requirements".

However, so far, little progress appears to have been made in the implementation of this requirement, inter alia because the interests of producers, users and recyclers are not aligned. It is therefore essential that Member States take appropriate measures and provide incentives to promote improved product design, preserving the single market and competition, and enabling innovation.

Moreover, the Commission in its legislative proposal on waste⁷ proposes to encourage better product design by differentiating the financial contribution paid by producers under extended producer responsibility schemes on the basis of the end-of-life costs of their products. This should also create a direct economic incentive to design products that can be more easily recycled or reused.

In order to address the implementation of the product design requirement under Article 4 of the WEEE Directive, and related deficiencies, barriers and possible further steps, the case-study of printer cartridges has been selected. Printer cartridges are a typical example of equipment that can be re-used many times before coming to the end of its life. Printer cartridges which contain electrical/ electronic parts and are dependent on electric currents or electromagnetic fields in order to function properly meet the definition of EEE and therefore fall within the scope of the WEEE Directive. Inter alia,

⁵ COM(2015) 614 final: COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS: Closing the loop - An EU action plan for the Circular Economy (<http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52015DC0614>)

⁶ OJ L 197, 24.7.2012, p. 38

⁷ <http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52015PC0595>

the requirements under Article 4 of the WEEE Directive imply that measures are to be taken by Member States that producers of such EEE do not prevent, through specific design features or manufacturing processes, used cartridges from being re-used. Moreover, there is a requirement in the Directive that by 2019 there be a separate collection of WEEE at the rate of 65% of the average weight of EEE placed on the market in the three preceding years or alternatively of 85% of WEEE generated in a given year.

The Commission Joint Research Centre (JRC)⁸ reported that 300-500 million ink cartridges and 10-20 million toner cartridges are sold annually in the EU. Only 20% of these are reused while it is estimated that in total volume, per year, 40-70% of the cartridges end up in incinerators and/or landfills. Depending on their design for durability, some cartridges may typically afford several reuse cycles. From a resource use perspective, considering the quantity of cartridges placed annually on the market (and subsequently discarded), design for reuse, recycling, reduced material usage and recovery resulting in increased durability contributes to maintaining/creating 'green jobs', notably SMEs, as well as social sector enterprises and volunteer and charitable organisations.

Compared to reuse/preparation for re-use practices, the production of new cartridges results in higher resource and energy use and associated toxic waste to be disposed. Many European SMEs are in the cartridge reuse (remanufacturing) market. However, rather than rewarding a resource-saving practice, these are frequently exposed to litigation for allegations of copyright infringement, with cartridges often designed to inhibit reuse or refilling, for example through use of glues and sealing rather than screws.

Market analyses show that different producers have chosen different business models as regards the re-usability of their cartridges and the services they provide to their customers in relation to the collection of the used printer cartridges. Different models have also applied for different types of cartridges with professional cartridges being quite often reusable while the cartridges put on the consumer market indicated to be for 'single-use'.

From a consumer perspective, ink and toner cartridges constitute 63% of their expenditure of 256 billion euro, over the life time of a printing device⁹. This ratio tends to be even higher for lower cost printers and multi-functional devices (MFDs).

Since 2012, producers of imaging equipment are committed under a Voluntary Agreement¹⁰ (VA) to improving the environmental performance of this type of equipment placed on the European market and the signatories committed to the use of cartridges not preventing reuse or recycling, and to not prevent the use of a non-OEM¹¹ cartridge.

⁸ IPTS Working Document for the development of EU Ecolabel criteria for imaging equipment (July 2013), http://ec.europa.eu/environment/ecolabel/documents/Technical%20Background%20Report_Imaging%20Equipment.pdf

⁹ Impact Assessment Accompanying the document REPORT FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT AND THE COUNCIL on the voluntary ecodesign scheme for imaging equipment (SWD(2013) 15),

<http://eurlex.europa.eu/LexUriServ/LexUriServ.do?uri=SWD:2013:0015:FIN:EN:PDF>

¹⁰ <https://ec.europa.eu/energy/sites/ener/files/documents/VA%20Imaging%20Self-Regulatory%20Initiative-V-4-0.pdf>

¹¹ Non-OEM Cartridge is a toner or ink cartridge not sold by the original equipment manufacturer (OEM) that is remanufactured and/or refilled.

Voluntary ecolabelling schemes have been put in place to increase user awareness and guide sustainable purchasing choices. The current EU Ecolabel criteria established for imaging equipment¹² include “*Design for recycling and/or reuse of toner and/or ink cartridges*” and even “*cartridge take-back*” as awarding requirements.

The objective of this study is to contribute to the implementation of the WEEE Directive and to be used in order to further promote actions to increase re-usability of EEE and the prevention of WEEE generated, in line with the waste hierarchy as established in Directive 2002/98/EC on waste.

To assess the implementation on the ground of Article 4 of the WEEE Directive, the case of the re-usability of printer cartridges and possibly of other types of EEE is used.

The study has addressed three main tasks:

- **Task 1** provides a qualitative and quantitative analysis of the current EU-28 printer cartridge market.

Specific aspects of the market have been researched, surveyed and described:

- Information on the different types of printer cartridges in the market (and past evolution) both for professional and for consumer use (Section 4.1).
- Information on the potential to re-use (re-fill) printer cartridges i.e. the percentage of printer cartridges on the market which are re-usable (re-fillable) (Section 4.2).
- Information on business practices, including by the original manufacturers, that may hinder re-usability (Section 0, Section 5.3).
- Data on the percentage of reused (re-filled) printer cartridges and information on the level of development and organisation of the re-use sector (Section 4.4).

This task has been conducted by a collation of key market reports and a bespoke survey to stakeholders in the printer industry (see following section regarding process of the study). Quantitative information has been obtained regarding sales and volumes of new and reused cartridges, company sizes and sectoral activities; and qualitative information regarding attitudes, barriers and enablers to reuse.

- **Task 2** has sought to identify and assess measures currently taken at Member State and industry level to support implementation of Article 4 of the WEEE Directive, and evaluate their efficiency.

This task has entailed:

- describing different business models that are applied by the producers as regards the re-usability of the printer cartridges they place on the market and the services they provide to their customers in relation to collection of the used printer cartridges (Sections 5.1, 5.3 and Section 3).
- reviewing measures that have been taken by Member States to implement Article 4 of the WEEE Directive and evaluate their efficiency (Section 5.4).

¹² Commission Decision 2013/806/EU establishing the ecological criteria for the award of the EU Ecolabel for imaging equipment

- presenting a description and an assessment of the actions already taken by the industry in relation to the implementation of the requirements set out in Article 4 of the WEEE Directive, including the ecodesign industry voluntary agreement on imaging equipment, its implementation and efficiency - for example with regard to the re-use of printer cartridges (Section 5.5).
- Presenting a description of the relevant ecolabel criteria and reviewing available information on their application (Section 6).
Identifying good practices and supporting instruments that may have been applied either by Member States or by producers to facilitate re-use or to eliminate obstacles to the re-usability of used printer cartridges including, where relevant, Green Public Procurement criteria. Accordingly, assessing whether it is feasible to apply these practices on a broad scale and possibly to other types of EEE as well, taking into consideration the relevant costs and benefits (Section 7).

This activity has been conducted via a review of published actions and any relevant legislation.

- **Task 3** presents proposals and recommendations for further actions by Member States and stakeholders with regard to reusing printer cartridges and other types of EEE giving effect to the requirements set out in Article 4 of the WEEE Directive. It has built on the findings with respect to beneficial Member State policies and actions (Section 8).

This work has not sought explicitly to review whether re-use is a desirable activity or whether particular approaches to re-use are preferable. However, within the survey, relevant – although conflicting – positions were declared with respect to, for example, the feasibility, quality and environmental impact of cartridge reuse. Within their submissions, cartridge OEMs did indeed acknowledge certain advantages associated with re-use as listed below:

- Enables a competitive and dynamic market.
- Tends to be respectful of patent rights when patented features are reused or repaired (provided that the reused or repaired patented feature was first sold, together with the cartridge, in the European Union).
- Services customers that prefer remanufactured alternatives.
- May support local businesses (if cartridges are not just imported from China).
- Promotes to some extent a responsible culture towards the environment.

These are good and responsible reasons for reuse. However, there are some concerns about the business models applied by most OEMs which may be unfavourable to reuse. Therefore, this report also presents those OEM perspectives, with their associated evidence, as a counter-balance to other stakeholders.

2. METHODOLOGY

This study is centred on information gathered from practitioners and stakeholders in the printing industry. For the purpose of the study, 'printing', refers specifically to laser- and inkjet-based printer systems which are serviced by toner and inkjet cartridges and toner refills, for both commercial and consumer domains. Such stakeholders include:

- OEMs – manufacturers of new consumables to support their own-brand printers.
- OEM remanufacturers and their approved agents.
- Independent refillers and remanufacturers.
- Suppliers of compatible cartridges, toners and inks (new or refilled).
- Print service providers, i.e. commercial users of printers and cartridges.
- Users of printers and cartridges.
- Others including cartridge sub-component suppliers and trade bodies representing any of the above.

The method of data gathering has been primarily via an online survey with three variants targeting the OEMs, refillers and other stakeholders, representing broad classes of sometimes competing interests. An on-line survey method was chosen because the data aggregation and analysis tools available enabled rapid processing of the incoming results; and the target audience was very well identified and accessible both from contacts already known, and via the substantial trade bodies and interest groups active within the sector.

Table 1: Aspects interrogated within surveys by target respondent

Aspect ↓	Agent →	Independent remanufacturers etc.	OEMs	Other stakeholders
About the Survey		Yes	Yes	Yes
Contact details		Yes	Yes	Yes
About the respondent's business		Yes	Yes	Yes
About business operations		Yes		
About new cartridge business			Yes	
About take-back schemes			Yes	
About the current market		Yes	Yes	Yes
About current reuse markets				Yes
About the future market		Yes	Yes	Yes
Comments and data confidentiality options		Yes	Yes	Yes

A mail-out alert to the presence of the survey was generated by aggregating contact lists from a range of sources including the Commission's own contacts, those of the contractors and general web searching for OEMs and non-OEMs. A mail and link was sent to these potential respondents with an overview of the work and an invitation to respond by a date in the spring of 2017. Some of these contacts were trade bodies, and they distributed the link within their membership. This may have resulted in

some duplication of contact though duplicate returns i.e. from the same organisation, were rationalised during the data analysis.

The on-line survey used – Data Monkey – does offer analysis of results itself. However, due to the mixed quantitative and qualitative aspects, it was easier to export the information into spreadsheet format, and undertake bespoke analysis.

Acknowledging confidentiality and data security issues, the survey permitted respondents to remain anonymous within this report, though not within the raw data. Further, respondents were asked whether they would be open to follow-up questioning; in a number of cases, such respondents were contacted for clarification or expansion.

The level of expertise and knowledge of certain respondents has warranted face-to-face interviews to ensure issues have been accurately and comprehensively understood. Since OEMs are prime targets of the WEEE and Ecodesign Directives, it was certainly appropriate that they were given the opportunity via interview or a visit to expand on the issues raised, particularly where relevant supporting information – such as life-cycle analyses – is available. A number of OEMs took advantage of this possibility.

This survey has provided, more widely, opportunity to volunteer other opinion, supporting documentation and reference to other stakeholders or sources of information such as market studies.¹³ EuroVAPrint has directed the contractors to its latest annual report of progress under its voluntary In addition, the Commission has made available related studies and working documents from related activities such as those of the Joint Research Centre on imaging products and corresponding discussions on changes to the EU Ecolabel and Green Public Procurement criteria for this group. This has been acknowledged in the text.

Quantitative aspects, such as those on market sizes, sizes of operators, percentage of business associated with reuse etc. have been largely report graphically within this report to aid understanding and interpretation. The qualitative aspects generated responses which often embrace contradictory stand-points but this is highly dependent on the type of business of the respondent. Accordingly, this report has aggregated, in key areas, response of the user types. Even so it is acknowledged that responses are not uniform even within the types. To accommodate this, the full range of comments is presented in annexes, and the main body of the report provides a commentary and – where sensible – a consensus view.

¹³ For example, the trade body ETIRA has provided a market study for new and used toner and inkjet cartridges which is referenced in this report.

3. AN OVERVIEW OF PRINTER CARTRIDGES RE-USE PRACTICES

Re-use represents the inner loop of the Circular Economy, with the opportunity to preserve the embedded energy, water and other material resources encapsulated within manufactured products, and to divert material from landfill. In addition to the potential environmental benefits of reuse, remediation activities constitute a valuable social and economic activity, creating local jobs and developing manufacturing skills.

Ink cartridges (as used in inkjet printers) and toner cartridges (as used in laser printers) are printing consumables that are commonly associated with re-use activities. Though laser printers dominate business-based and commercial printing, inkjet printing is still common in homes.

Reuse activities

There is a distinction between the different types of re-use activities associated with printer cartridges, namely; refilling, reconditioning and remanufacturing. The BS 8887-2 definition states that *remanufacturing* is the process of:

"Returning a product to at least its original performance with a warranty that is equivalent or better than that of the newly manufactured product."

However, for the purposes of this study in assessing the level of and potential for further reuse, all these activities are aggregated. It is acknowledged, however, that certain barriers to re-use may be more relevant to one or other of the activities and this is highlighted where appropriate.

Ink-jet printers

Depending on their manufacturer and design, inkjet cartridges either consist of a separate print-head and ink reservoir, or the ink reservoir and a high precision print-head are combined in what is known as a 'unified cartridge'. Unified cartridges are regularly remanufactured, whereas the low value of the separate print-head and reservoir cartridges leans towards plastics recycling. It should be noted that a variant of the cartridge system is in place whereby the ink reservoirs are a permanent feature of the machine and may be refilled externally using inks supplied in simple packaging; this latter system by-passes the obligations of the WEEE Directive insofar as printers and cartridges are concerned, but offers a positive response to the issue of minimising waste associated with the life-cycle operations of ink-jet printing systems.

Laser-toner printers

Toner cartridges are more valuable than ink cartridges, containing a large aluminium print-head and more than 100 moving parts. Due to their high value, toner cartridges are widely remanufactured. However, separate print-head and toner reservoir variants are also marketed: In the Kyocera system, a long-life ceramic print-head is a permanent (but serviceable) element, and the cartridge is a simplified toner reservoir, still subject to WEEE Directive end-of-life considerations; in the Xerox system, the print head is also permanent, but the toner is introduced by a simple plug-in bottle which being of simple material construction falls outside the WEEE Directive and into standard recycling processes. A further Xerox variant sees the toners replaced by solid inks, again by-passing the use of consumable cartridges altogether with quantified environmental benefits.

Business models

A wide variety of business models is apparent in the supply of imaging equipment, its support, repair, upgrade and replacement, including operating printing as a service. At the service end of the spectrum, ownership of printer assets remains with the OEM

or retailer, which may drive maximising printer life and optimising the use of toners and inks and their related cartridge systems with consequent cost and environmental benefits. Such systems are typically seen in the office and professional markets where scale, cost, availability and outsourcing of supporting capabilities are key factors in purchasing decisions.

Where users take responsibility for their own assets and for the purchase of consumables such as cartridges, ink or toner refills, they have the option of purchasing replenishment materials from the OEM or from a third party. With respect to this report, this entails buying new cartridges from the OEM, new from a third party, refilled from the OEM (where available) and refilled from a third party. These cartridges are subject to the WEEE Directive and thus trigger obligations on the manufacturer or retailer to manage their take-back. Such obligations do not pertain to the alternative toner and ink refill options.

The question arises – as it does in other product sectors – as to how these asset/consumable combinations are marketed by OEMs, and consequently, how other independent competitors respond. It is generally considered that the prevalent printer OEM business model is one typically known as the 'two part' or 'razors and blades' model. With the consumables as an integral part of the use of the device, a common practice is to sell the base asset (a razor or printer, say) at a substantial discount, but to generate exceptional margins through the price of the consumable element (the blade or cartridge, say). Over a period of use, the losses made on the asset sale can be recouped through the sale of consumables.

This certainly appears to be the case for ink-jet and laser printers within the consumer and small office segments, where usage may be less intensive and purchasing decisions are more heavily influenced by the up-front asset purchase cost. Here the unified cartridge offers simplicity albeit at higher unit cost because of the high technical complexity of the unified unit.

In the larger office, institutional and professional markets, where there is generally greater scrutiny on lifetime cost of ownership and asset management practices, the relative costs are more towards the asset. This is because the assets may have more advanced functions, handle higher print rates and volumes are physically more robust, but also because they tend to contain the printer heads as fixed elements with cartridges as more simple toner/ink reservoirs. For their part, the consumables (cartridges and toner refills) tend to higher capacities than consumer variants, thus offering lower price per print.

Market economics

To a large extent this study queries whether there are factors which are preventing the market from performing better than it does. Factors that could indeed prevent lowering consumables prices by frustrating competition include: poor design for remanufacture; system dependencies between asset and consumable (chips, software); lack of access to spare parts; intellectual property rights; removal of used units from the market, for example. These issues have arisen during the stakeholder consultation and are relevant to the headline question of actions taken by OEMs under Article 4 of the WEEE Directive.

In any case, the consumable elements offer an opportunity for higher revenue generation although this is clearer in the consumer markets where there is strong competition in new equipment purchase. It is therefore not surprising that this market has attracted third parties who wish to remanufacture and refill toner cartridges in particular, as well as new cartridge manufacturers from low cost economies, thus providing a substantial downward pressure on prices. Notwithstanding the widespread allegations made to the contrary, cartridges are a product generally well-designed for

deconstruction and remanufacture. It could therefore be strongly argued that third party activities are a powerful indicator of a well-functioning market.

Competition in formats appears to be robust yet the overall outcome in terms of resource efficiency is sub-optimal. Ideally, a greater proportion of cartridges would be captured after first use and, of these, a larger proportion would be refilled, refurbished or remanufactured. This is unlikely to occur within the existing regulatory framework: Incentives for reuse are weak or non-existent.

4. DESCRIPTION OF THE CURRENT MARKET SITUATION

The printer cartridge market in Europe is valued at €19.7 billion per year equating to sales of 505 million units annually.¹⁴ Note that all financial and volume data is reported on an annual basis unless otherwise stated.

4.1. Types of printer cartridges in the market

The printer cartridge market can be segmented by a number of characteristics: technology, customer type, cartridge type and cartridge features.

The most common segmentation is by **technology**, distinguishing between ink and toner cartridges.

Ink-based printer cartridges contain a liquid ink and are used in inkjet printers. Inkjet cartridges can be further subdivided into two different technologies¹⁵ and a variant: separate print-head and ink reservoir; unified print-head and reservoir; and 'supertank' systems.

Unified inkjet cartridges

- The cartridge contains both an ink reservoir and a high precision print-head. The fully integrated nature of these cartridges makes them more complex units than the separate print-head/reservoir. Accordingly, they have a higher inherent value than the separate cartridges.

Separate print-head and ink reservoir cartridges

- The print-head assembly is made of two distinct components: the print-head and an ink reservoir. The print-head is a permanent component in the printer; it contains most of the electronics involved with the printing process and the high precision nozzles that dispense ink onto paper. The ink reservoir is essentially a small plastic vessel containing ink and is the only item which needs replacing when refilling the printer with ink. Reservoirs are generally low in value, contain only small amounts of electronics and are relatively easy to produce.

'Supertank' systems

- The printer contains fixed ink reservoirs and high precision print-heads as in separate print-head systems. The ink reservoirs may be refilled externally using ink supplied in low-cost, recyclable bottles which are not classed as WEEE and which are significantly cheaper than cartridges of any format. A prime exemplar of this technology is EPSON with its Ecotank® format.

The total current market size for inkjet cartridges in Europe is around 370 million units sold annually and approximately €9.4 billion.¹⁴ ETIRA estimates that there are around 400 to 600 different inkjet cartridge models currently on the market.

In contrast, **toner-based cartridges** contain a solid toner powder and are used in laser printers. Again, there are unified, un-unified and cartridge-less variants of this system.

¹⁴ Keypoint Intelligence - InfoTrends data cited by ETIRA, 2016 in 'Position Paper on the EU Commission Circular Economy policy proposals and the upcoming review of the EU Voluntary Agreement Imaging Equipment' plus information from Lexmark et al.

¹⁵ <http://www.remanufacturing.org.uk/pdf/story/1p275.pdf>, Product Group Report: Office Equipment

Figure 1: Unified (left) and separate (right) ink-jet cartridges



Source: Lexmark (left hand) and Oakdene Hollins (right hand)

The EPSON Ecotank® system may be viewed on the EPSON website at <https://epson.com/ecotank-super-tank-printers>

Unified Toner cartridges

- Toner cartridges are considerably more valuable per item than inkjet cartridges. Their design incorporates an ink store and a large print-head (generally made of aluminium) which is the same width as the paper. A toner cartridge can contain more than 100 moving parts. This system offers simplicity of operation in homes and small offices, and lowers the imaging equipment but at the cost of a more expensive consumable.

Separated print-head and toner cartridges

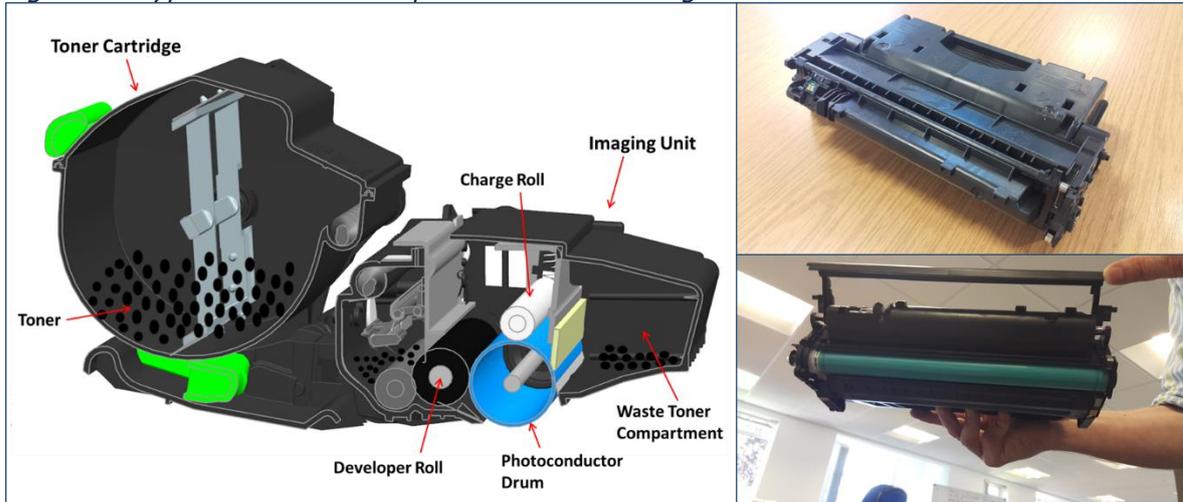
- In this system, the print head is a permanent (though serviceable) component of the imaging equipment, and the cartridge is restricted only to carrying the tone. This considerably simplifies the construction and material impact of the cartridge. For example, Kyocera has reduced this to 5 parts in 2 plastics. However, a more robust and expensive print-head is likely required meaning this system is more seen in large office environments. With no electronic functionality, such cartridges are not classified as EEE and thus fall outside the scope of the WEEE Directive, but producers may still separately collect and recover them as part of a duty of care.

Cartridge-less systems

- In these systems, the cartridge as a replaceable element has disappeared completely. Xerox has replaced the cartridge by a refillable toner reservoir replenished from simply-packaged toner refills (but there is still a waste toner cartridge to replace). In another of its products, it uses non-toxic, clean-to-handle solid inks which are dropped into chambers in the imaging equipment almost completely removing packaging. Again, a more robust print-head is required, thus leaning these products towards the large office markets. The net environmental benefits in terms of material used are clear and quantified. Note that these replenishment systems avoid being classified as EEE.

Figure 2 illustrates the major components of a laser printer toner cartridge alongside pictures of actual units from an HP printer.

Figure 2: Typical unified laser printer toner cartridge format



Source: Diagram courtesy of Lexmark; photos © Oakdene Hollins

Figure 3: Kyocera 5-part toner cassette



Source: Courtesy of Kyocera

Images of the Xerox Solid Ink system may be found at https://www.xerox.co.uk/office/solid-ink/engb.html#_overview

The total current market size for toner cartridges in Europe is around 135 million units sold annually and worth approximately €10.2 billion.¹⁴ ETIRA estimates that there are up to 200 different toner cartridge models currently on the market.

The market can also be segmented by **customer type**, distinguishing between the professional business user, and the home-printing consumer. The different needs of the professional and consumer/household printer are described in table 2.

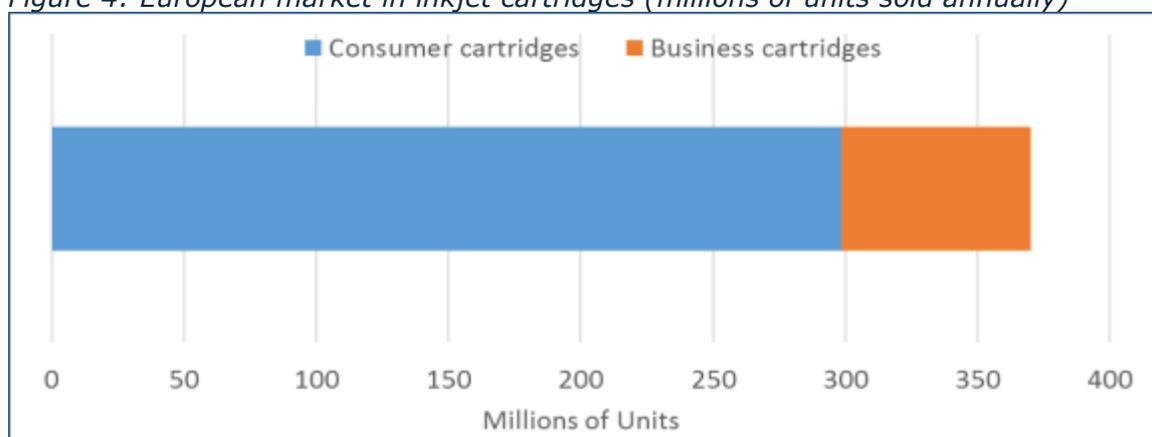
Table 2: Customer needs by customer type

Printer Characteristic	Professional printer	Consumer/ Household printer
Print speed (pages per minute, ppm)	Fast	Slow
Price per page (ppp)	Low	Less important
Print volume	High	Low
Print demand frequency	Regular	Intermittent
Printer costs	Moderate - high	Low – moderate
Network functionality	Important	Less/not important

In general, business customers opt for laser printers because they need high print speeds and volumes and lower costs per page, and are able to bear the higher costs associated with purchasing a laser printer. Business customers therefore most commonly use toner cartridges. In contrast, home-printing customers can generally tolerate lower print speeds due to lower print volumes and more intermittent printing demand. The lower print volumes and more intermittent printing demand makes lower-cost inkjet printers more attractive than laser printers for home-print consumers. In addition, while the price per page of laser printing may be comparable to or lower than that of inkjet printing, the higher up-front cost per unit for a toner cartridge may make laser printing less accessible to home-print consumers than inkjet printing.¹⁶ Home-print consumers therefore most commonly use inkjet cartridges.

That inkjet cartridges are sold mainly to home-print consumers, rather than business consumers, is demonstrated in Figure 4 below:

Figure 4: European market in inkjet cartridges (millions of units sold annually)



Source: Keypoint Intelligence - InfoTrends¹⁴ modified by data from Lexmark et al.

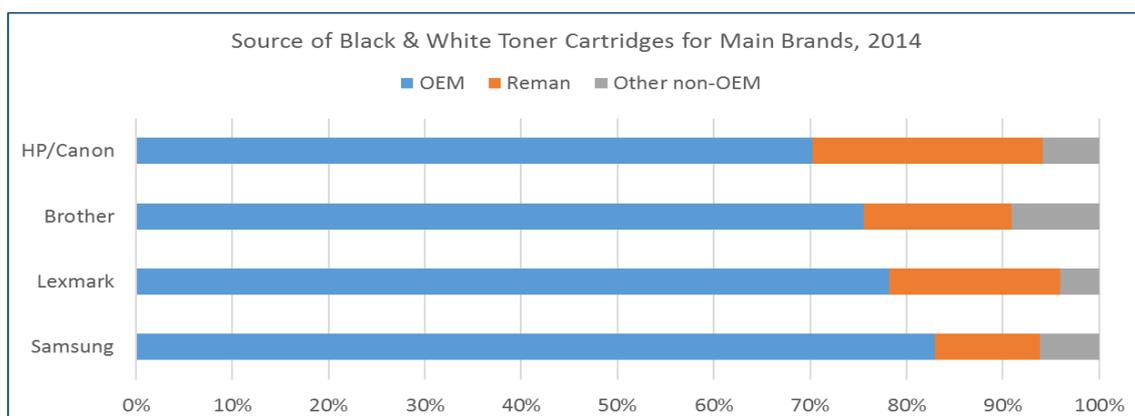
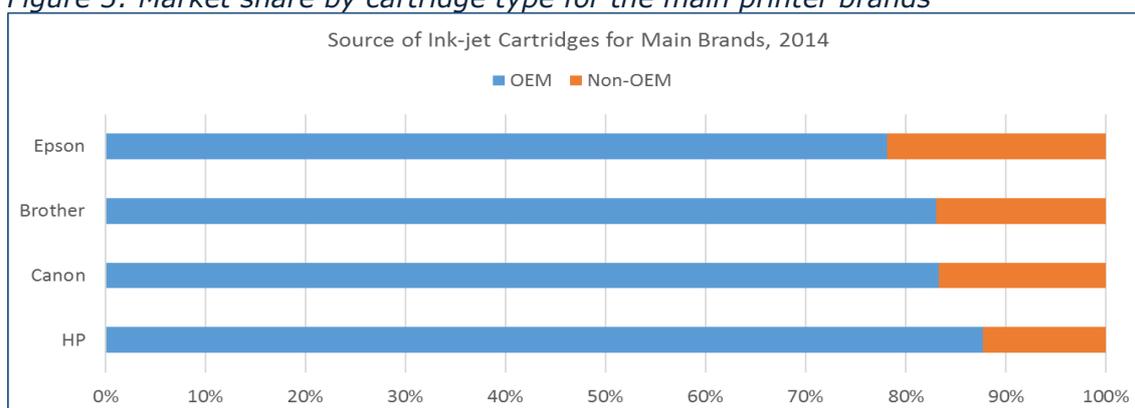
The market can be segmented by **cartridge type**, distinguishing between OEM, compatible, remanufactured, refill and counterfeit cartridges.

¹⁶ E.g. at a common UK household electronics provider (PC World), HP inkjet cartridges were available from £9.99 per cartridge (4.0p per page), while HP toner cartridges were available from £49.99 (4.2p per page).

- *Original equipment manufacturer (OEM) cartridges* are new cartridges manufactured by printer manufacturers and then sold under the OEM brand name.
- *Compatible cartridges* (or new-built non-OEM cartridges) are new cartridges manufactured by a third party (not an OEM), which are sold under a third-party brand name. Stakeholders have observed an increase in supply of low-cost compatible cartridges imported from Asia, with some of these cartridges observed to infringe OEM patents (often referred to as “clones”).¹⁴
- *Counterfeit cartridges* are new cartridges manufactured by a third party (not an OEM), but illegally branded under an OEM brand name.
- *Remanufactured cartridges* are used printer cartridges that have been collected at their end-of-use and which have then undergone a series of rejuvenation operations, typically including: sorting, disassembling, cleaning, replacing worn parts, electronics resetting/replacement, refilling and testing. The used cartridges may have been new OEM or compatible cartridges, or may have been previously remanufactured.
- *Refill cartridges* are used printer cartridges that have been collected at their end-of-use and which have then been cleaned and refilled with toner or ink. Refilling operations are generally less rigorous than remanufacturing operations, with less technical equipment and procedures.

OEM cartridges make up most of the market for both inkjet and toner cartridges, as shown in the figures below:

Figure 5: Market share by cartridge type for the main printer brands



Source: Keypoint Intelligence - InfoTrends¹⁴

ETIRA estimates that, of the €19.7 billion printer cartridge market in Europe, 10% arises from sales of remanufactured and non-OEM cartridges. This estimate appears broadly in line with the findings of the market survey conducted by the European

Remanufacturing Network, which estimated the market value of remanufactured cartridges (not including non-OEM cartridges) at €1.3 billion per year.¹⁷

Finally, the market can be segmented by **cartridge feature**. The most fundamental feature is the colour of the ink/toner, e.g. black, often referred to as a monochrome cartridge; or colour, either an individual colour (cyan, magenta, yellow), or (for ink cartridges), tri-colour, i.e. three colours contained within one cartridge unit. Additional features are generally provided via electronic functionality linked to the printer, e.g. ink indicator levels and anti-fraud technology.

Generally, monochrome printers are only available using laser printing technology; colour printers are available using either laser or inkjet technologies. The figure below shows the split of the toner cartridge market for black and colour cartridges in the European market.

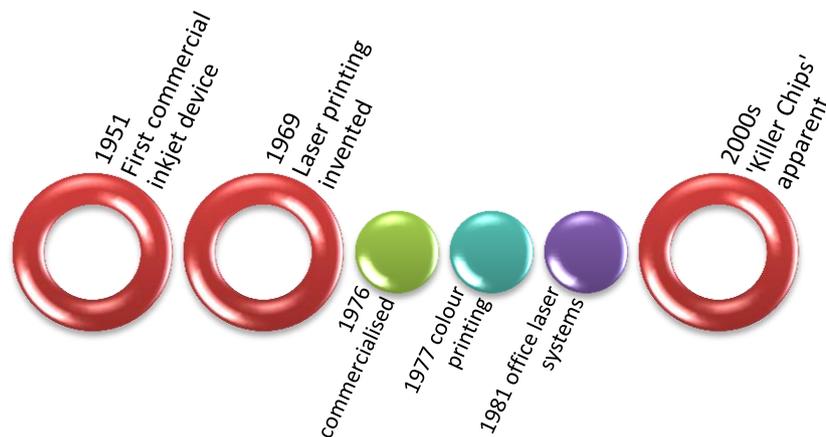
Figure 6: European market in toner cartridges (millions of units per year)



Source: *Keypoint Intelligence - InfoTrends*¹⁴ modified by data from *Lexmark et al.*

Printer technology has developed over the last 70 years, first with inkjet technology, and later with laser technology. Figure 7 illustrates some of the key milestones that mark the evolution of printing technology.

Figure 7: Printer evolution timeline¹⁸



¹⁷ European Remanufacturing Network, 2015, Remanufacturing Market Study

<https://www.remanufacturing.eu/remanufacturing/european-landscape/>

¹⁸ 'Killer chips' are electronic components which provide useful functionalities for the user, e.g. ink detector levels, or page counters, that make re-use difficult if they do not include provision for resetting the chip during reuse.

4.2. Potential to re-use printer cartridges and percentage of reuseable printer cartridges on the market

The potential to re-use printer cartridges can be defined in two broad categories: *technical potential* and *economic potential*.

Table 3: Definition of technical and economic re-use potential

Technical re-use potential	Economic re-use potential
Technical re-use potential refers to the ability of a printer cartridge to technically be processed for reuse. For example, the use of adhesives may make it impossible to disassemble a printer cartridge without damaging the components beyond repair. If a printer cartridge cannot technically be remanufactured or refilled, the only end-of-life options will be recycling, energy recovery, and landfill.	Economic re-use potential refers to the economic business case for undertaking reuse. It may be technically feasible for a cartridge to be remanufactured or refilled, but if the cost of these operations (including any reverse engineering activities required, e.g. software development) is so high that the printer cartridge cannot be sold on the market for a profit, then there is no business case for undertaking re-use activities.

According to Article 4 of the WEEE Directive, Member States

"shall encourage cooperation between producers and recyclers and measures to promote the design and production of EEE, notably in view of facilitating reuse, dismantling and recovery of WEEE, its components and materials".

In this context, the Directive obliges Member States to

"take appropriate measures so that the ecodesign requirements facilitating re-use and treatment of WEEE are applied and producers do not prevent, through specific design features or manufacturing processes, WEEE from being reused, unless such specific design features or manufacturing processes present overriding advantages, for example, with regard to the protection of the environment and/or safety requirements".

Based on the wording of Article 4 of the WEEE Directive, we would expect that there would be few instances where printer cartridges could not technically be reused, without evidence of environmental or safety advantages.

Another instance where printer cartridges on the market may be incapable of re-use for technical reasons is when a cartridge has already been reused multiple times and another re-use cycle would produce a product of insufficient quality. However, anecdotal evidence from an OEM remanufacturing facility (where there is a policy of rejecting printer cartridges for re-use where the cartridge has already been remanufactured twice), reports that they "cannot remember" the last time a cartridge was rejected for this reason. This can likely be attributed to the low proportion of reused cartridges on the market (<10%) and a low core take-back rate (<30%). Additionally, the two-re-use cycle policy of this OEM may not represent the true technical limit of reuse. It may be possible to re-use a cartridge for further cycles; however, as so few cartridges arrive having undergone multiple re-use cycles, it may not be worthwhile developing the associated procedures and protocols to process these cartridges.

The assessment of economic re-use potential is likely to be more subject to greater uncertainty based upon factors such as:

- The cost of labour: remanufacturing and refilling activities are labour intensive and high labour costs may make re-use uneconomical.
- Economies of scale: processing large volumes of cartridges may result in bulk discounts for components, increased efficiency through learning effects, and the possibility of automation, all of which could reduce costs.
- Cartridge model: some models may be easier to re-use than others, use lower cost components, require fewer components to be replaced and/or have a lower failure rate.
- Cartridge technology (ink vs. toner).
- Quality standards used: more stringent quality standards may incur greater cost.
- Warranties offered: a longer or more comprehensive warranty may necessitate greater quality control costs.
- Whether the cartridge is virgin or previously reused: this may influence the ease of remanufacture and failure rate of the remanufactured product.
- The price of equivalent compatible cartridges.
- Access to product design and software information (influences reverse engineering costs).

4.2.1. Top-down analysis of the potential to re-use printer cartridges

A study by Keypoint Intelligence on behalf of HP¹⁹ has investigated the collection and recycling practices of printer cartridge remanufacturers in Western Europe. That study identified two main reasons for remanufacturers being unable to remanufacture collected cartridges:

- 'Bad' cartridges – these are cartridges that either cannot be successfully remanufactured (due to technical reasons, e.g. damage in transit, not robust enough to withstand the remanufacturing process etc.), or have no market.
- 'Wrong vendor' cartridges – these are cartridges that are typically not remanufactured.

In translating these failure modes into the categories of technical and economic potential to re-use printer cartridges, the following is assumed:

- Half of the failure rate associated with 'bad' cartridges is assigned to technical barriers, and half to economic barriers.
- The failure rate for 'wrong vendor' cartridges is assigned to economic barriers, i.e. there is no market for these cartridge brands/models.
- The failure rate for 'wrong vendor' cartridges only applies to 'virgin' cartridges, i.e. those cartridges that have not been remanufactured previously. If a cartridge has previously been remanufactured (a 'non-virgin' cartridge), it is presumed that a market for this cartridge brand/model still exists.
- The failure rates for 'virgin' cartridges apply to both OEM and non-OEM cartridges. This may not be accurate, i.e. a greater failure rate might be expected for non-OEM cartridges due to lower material quality, etc. However, there is no additional information on the disaggregation of virgin cartridge failure rates. This assumption will also lead to a lower bound estimate on re-use potential, which is considered prudent.

¹⁹ Keypoint Intelligence - InfoTrends, Western European Cartridge Collection and Recycling Report 2016; N.B. Western Europe = Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, UK

The size and structure of the printer cartridge industry is estimated below.

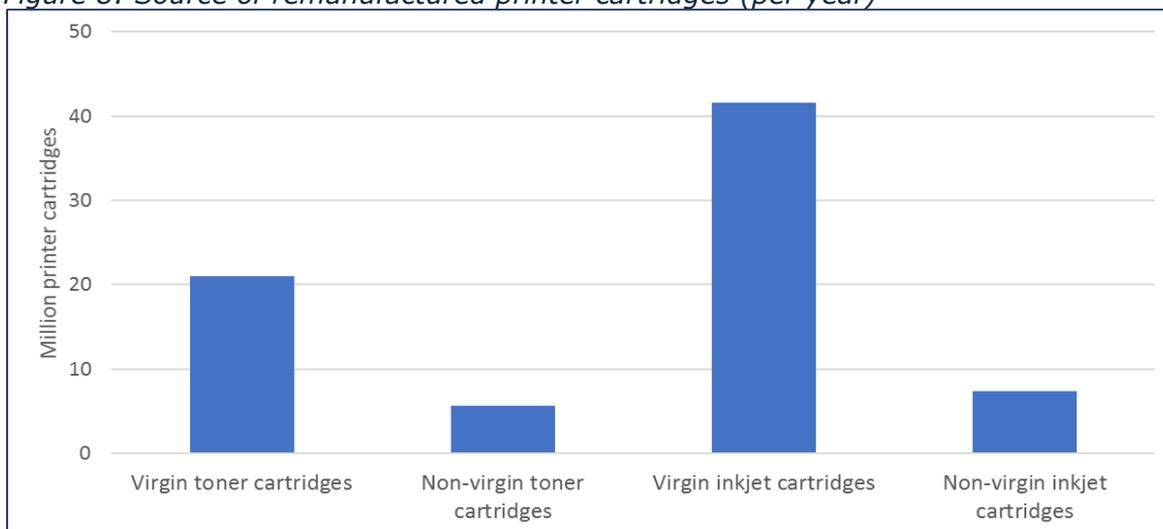
Table 4: Size and structure of European printer cartridge industry (annually)

	OEM	Non-OEM	Remanufactured
Toner cartridges	76%	4%	20%
	101 million units	5 million units	27 million units
Inkjet cartridges	85%	2%	13%
	316 million units	7 million units	49 million units

Source: See Footnote 20

The 2016 Keypoint Intelligence study reports that 21% of remanufactured toner cartridges and 15% of remanufactured inkjet cartridges are produced using previously remanufactured cartridges. This information can be used to infer the source of remanufactured toner and inkjet cartridges, as shown in Figure 8.

Figure 8: Source of remanufactured printer cartridges (per year)

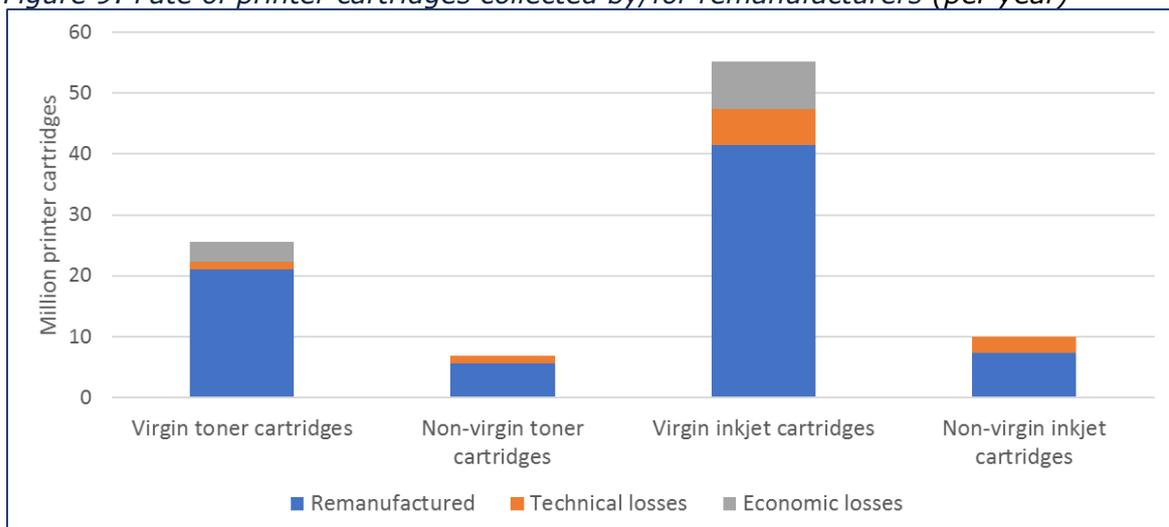


Source: Oakdene Hollins

The 2016 Keypoint Intelligence study provides information on the percentage of collected cartridges that cannot be reused. This information can be combined with the information in Figure 8 to estimate the fate of printer cartridge core collected by (or for) remanufacturers.

²⁰ Structure estimated from data in source of Footnote 19. Size breakdown estimated from ETIRA information on market size (Footnote 14) and assuming lower bound estimate of current remanufacturing activity, i.e. 15% of cartridges (by volume) are currently remanufactured plus information from Lexmark et al.

Figure 9: Fate of printer cartridges collected by/for remanufacturers (per year)



Source: Oakdene Hollins

Extrapolating this information to the whole printer cartridge market (as described in Table 4) leads to the estimates of the technical and economic potential to re-use printer cartridges in Table 5 below:

Table 5: Estimates of technical and economic potential to re-use printer cartridges

	Technical potential	Economic potential
Toner cartridges	92%	86%
Inkjet cartridges	87%	84%

Note that this is a theoretical potential based on the current market structure. If the proportion of OEM/non-OEM to remanufactured cartridges were to change significantly, then the potential would likely reduce, i.e. as the market is made up of more non-virgin cartridges (with higher associated failure rate), the technical potential rate would decrease, unless additional actions to improve the ability of OEM cartridges to be remanufactured were pursued.

4.2.2. Impact of increased reuse

To put the issue of cartridge recycling in perspective, the net impact of increasing remanufacturing rate of toner cartridges in Europe from 25% to 75% has been roughly assessed. This has taken the figures published by EuroVAprint for the remanufacture and new unit manufacture (namely 0.15 kgCO₂/unit and 0.21 kgCO₂/unit) with no other impacts of recycling or incineration offsets, across the total use of 135 million units per year. The change in total CO_{2e} impact is a reduction of around 4 kt per year (about 20% reduction).

This ignores any of the alleged effects of adverse quality on increasing paper consumption as it assumes all remanufactured units are fit for purpose.

4.3. Obstacles to re-using printer cartridges

Stakeholders interested in re-using printer cartridges may encounter a range of barriers and obstacles that make these re-use activities difficult, or even impossible. These obstacles can be categorised into five main categories (Figure 10) and are described in greater detail below.

Figure 10: Categories of barriers to printer cartridge reuse



Technical barriers

These barriers hinder re-use based on technical characteristics of the printer cartridge. Most often, these barriers are introduced at the design phase of printer cartridge production, whereby design decisions are made without the ambition to facilitate or encourage re-use of the product at end-of-life. Examples include the use of irreversible joining manufacturing practices, e.g. gluing components together. The greater use of electronics in printer cartridges has also resulted in barriers to re-use for independent remanufacturers and refillers. Dubbed by the industry as 'killer chips', some electronic components which provide useful functionality for the user, e.g. ink detector levels or page counters, may make re-use difficult if they do not include provision for resetting the chip during reuse. Independent remanufacturers without access to or knowledge of the hardware and software systems involved may either have to undertake reverse engineering activities, or replace the relevant microchips with new components.

Of the survey responses from independent printer cartridge re-use stakeholders, nearly 30% reported encountering technical barriers to reuse. Table 24 of Annexe A summarises some of the comments on technical barriers received, but the following box insert captures the prevailing view:

Majority opinion

The issue of so-called 'killer chips' and their associated printer software in blocking re-use is a prime concern. Such combinations, exacerbated by OEM updates, may prevent third party (non OEM) cartridges from operating fully or as expected by, for example, registering as empty even when full. Inability to reset the chips appears to be a hard block, as is a chip which is tied to use on a single printer and only for first use.

The increasing technical complexity of, in particular, ink-jet cartridges was reported as creating barriers to reuse. The accusation is that such developments are largely driven to frustrate re-use rather than for performance enhancement, and their effect is exacerbated by lack of transparency in technical data.

Design and related IP protection is also a common complaint. Fragile and complex construction also foils disassembly, particularly where technical information is not made available by OEMs.

Legal barriers

These barriers hinder re-use based on legal aspects. This mostly concerns legal action taken by printer cartridge manufacturers for infringement of copyright or patents. Patents on printer cartridge components, or complete devices, make it harder for independent actors to undertake re-use activities as they must ensure any activity does not infringe upon the OEM's intellectual property. This is a contentious issue as intellectual property protection is an important and valid activity, providing it protects genuine innovation and does not unnecessarily contravene the ambition of Article 4 of the WEEE Directive to promote reuse. Three main concerns over intellectual property rights creating inappropriate barriers to re-use include:

1. Inappropriate granting of patents on non-innovative aspects of printer cartridge design. This is especially problematic on components subject to degradation during use, as their replacement is patent-protected, but necessary to produce a high-quality product.
2. The patenting of cartridge remanufacturing, even when the OEM does not intend to remanufacture its own cartridges. This prevents third parties from remanufacturing these cartridges and reduces the core available to them.
3. Independent remanufacturers are often small companies and do not have the resources available to participate in lengthy legal processes against large OEMs, even if the remanufacturer is operating legally. This perceived threat may make businesses reluctant to join the re-use market.

Of the survey responses from independent printer cartridge re-use stakeholders, nearly 30% reported encountering legal barriers to reuse. Table 24 of Annexe A summarises some of the comments on legal barriers received, but the following box insert captures the prevailing view:

Majority opinion

A number of legal issues were raised, but the most fundamental from a European perspective was the distinction between second-hand products and waste and the different requirements applying to these. This is a common feature across many re-use activities whereby different Member States classify used goods intended for re-use as waste, which then requires special requirements.

The issue of 'vexatious' blocking patents was raised, including on replacement components and combinations of components and technical 'systems'; and even on remanufacturing techniques themselves, and which could be seen as in contravention of the 'exhaustion of rights' legislation.

The 'killer chip' feature in various software/hardware combinations persists.

It also appears that the format of public tendering may be hampering reuse. Here, there appears to be a reluctance to specify a single ecolabel for competitive reasons. In addition, public sector purchasers may be guilty of purchasing patent-infringing clones without checking the provenance of these imports. They are thus complicit in fraudulent activity which undermines the sector.

Marketing barriers

These barriers hinder re-use based on marketing messages that overtly or covertly create customer mistrust towards the use of reused printer cartridges. These messages may be conveyed via a range of routes, including company websites, printed material (e.g. an instruction manual for a printer), media coverage, and others.

Of the survey responses from independent printer cartridge re-use stakeholders, nearly 10% reported encountering marketing barriers to reuse. Table 26 of Annexe A summarises some of the comments on marketing barriers received, but the following box insert captures the prevailing view:

Majority opinion

Respondents reported that whilst printer manufacturers did not make absolute claims that reused cartridges would cause damage or invalidate warranties, the possibility of these ideas was firmly planted in the minds of consumers and purchasers by printer and OEM cartridge documentation, and 'nag-ware' flashed to the user when a non-OEM cartridge refill was detected, or when a replacement cartridge was needed. These act to make the user err on the side of caution. Of course, there are genuine concerns from all industry players about unregulated imports which undermine the sector.

OEM cartridge literature accentuates the impression of OEM cartridge quality compared to a refill. As above, this may be true, but should not be a blanket statement in the absence of independent test data. In addition, quality may be a question of fitness for purpose, although the user requires information which is usually lacking to make this choice.

There is the distinct impression that OEMs can disfavour certain retail partners if they engage in selling compatible cartridges. Tactics include lower marketing spends and unfavourable pricing.

The resellers themselves may engage in cynical practices whereby they do not differentiate well between genuine OEM originals or refills and compatible brands. These may be sold as equivalents or even exchanged without knowledge without any support for claims of performance equivalence.

Logistical barriers

These barriers hinder re-use based on logistical barriers to conducting re-use activities. There may be barriers to collecting and transporting the core that acts as the raw materials for the re-use process. Logistical barriers may also exist in the organisation and execution of re-use operations.

Of the survey responses from independent printer cartridge re-use stakeholders, over 10% reported encountering logistical barriers to reuse. Table 27 of Annexe A summarises some of the comments on logistical barriers received, but the following box insert captures the prevailing view:

Majority opinion

Respondents also questioned the obligation to remove branding from cartridges for resale. For example, this practice was compared to resale of Apple phones where this was not required. In some cases, the brand logo has a technical function, so defacing it results in cartridge failure or underperformance.

Independent remanufacturers or re-use operators cited OEM take-back schemes as a barrier to reuse. This is a valid complaint only to the extent that most OEM take-back goes for material recycling and energy recovery rather than to reuse. OEM efforts are otherwise welcomed.

An issue that is clear from the reuse statistics generated and anecdotal evidence is that of the more than 70% of cartridges which are consigned as WEEE, only a very small amount goes through preparation for reuse. This represents a substantial lost technical potential which might be addressed through collective actions by the industry to improve collection opportunities for users and to ensure that collection conditions allow for preparation for reuse.

Market barriers

These barriers hinder re-use based on market features that may unfairly disadvantage the re-use sector. There are two main themes of market barrier; firstly, procurement specifications that either explicitly exclude the use of reused cartridges, or fail to promote or encourage their usage; and secondly, competition with low cost imports of compatible cartridges from Asia, which may infringe OEM copyright and may also be unsuitable for subsequent reuse.

Of the survey responses from independent printer cartridge re-use stakeholders, over 20% reported encountering market barriers to reuse. Table 28 of Annexe A summarises some of the comments on market barriers received, but the following box insert captures the prevailing view:

Majority opinion

Some core concerns were expressed within this theme, most prominently the issue of cloned cartridges entering the market at a competitive price. Their credentials are often mis-represented with little effort to clamp down on the practice. Such products undercut new and genuine re-use products, and cannot themselves support re-use technically or economically.

A related concern (raised also under Legal Barriers) was that public sector purchasers do not always query supplier credentials; worse, much of the public sector did not recognise the potential of buying quality reused cartridges. Certainly, public sector targets for percentages of re-use are a rarity.

A number of respondents also believed that the high 'innovation' rate of printer models and cartridge types was simply a vexatious attempt to frustrate reuse. Small operators would find it increasingly difficult to assemble large enough volumes of take-back of particular cartridge types to make reprocessing economic.

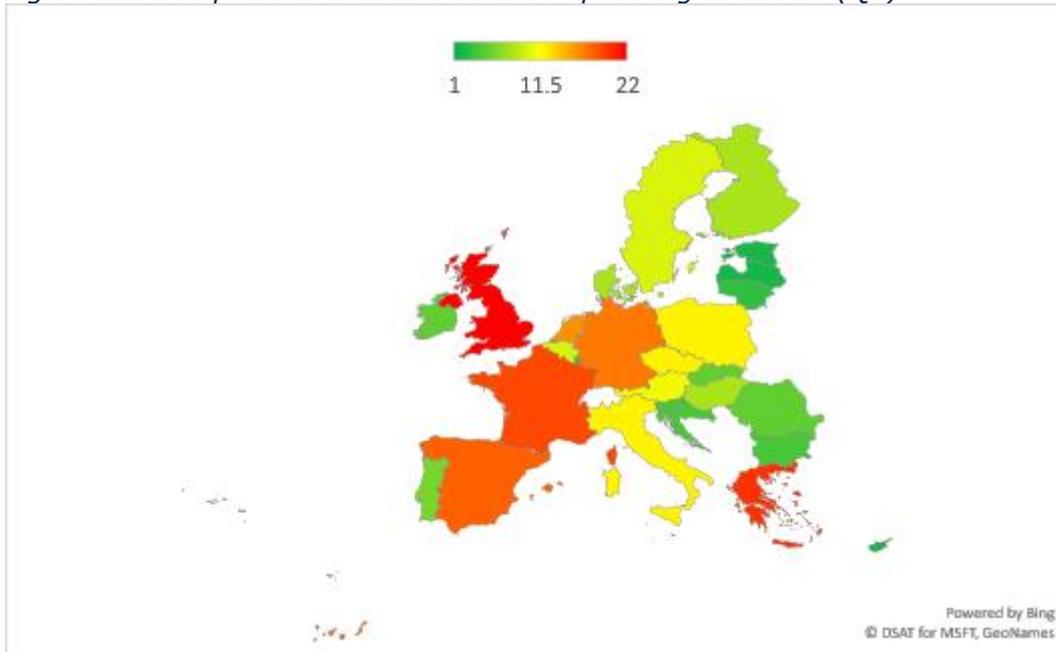
4.4. Characteristics of the re-use sector

4.4.1. Independent remanufacturer survey results

In total, the independent remanufacturer survey received 85 responses. Only 57 were chosen for analysis because the rest were insufficiently completed. The full survey can be found in Annexe C Stakeholder questionnaires.

Figure 11 shows a 'heat map' of the locations of the survey respondents representing independent remanufacturers. The highest response rate was found in Western Europe and in Greece.

Figure 11: Independent remanufacturers operating in the EU (Q7)



Data source: Oakdene Hollins, Survey Monkey - 56 respondents answered this question

All operators have activities in at least one EU country, except one which didn't declare a location. Nearly 40% of respondents reported undertaking remanufacturing activities outside of the European Union. The locations of these activities are listed in Table 6.

Table 6: Remanufacturing locations outside the EU by region and nation

Region	Nation	Region	Nation
Asia	China, South Korea	Europe	Switzerland, Norway, Turkey, Serbia, Bosnia-Herzegovina, F.Y.R.O.M, Albania
Eurasia	Russia	North America	USA, Canada
Asia (Middle East)	Saudi Arabia, UAE, Israel	Latin America	Mexico, Brazil
North Africa	Not specified	Oceania	New Zealand

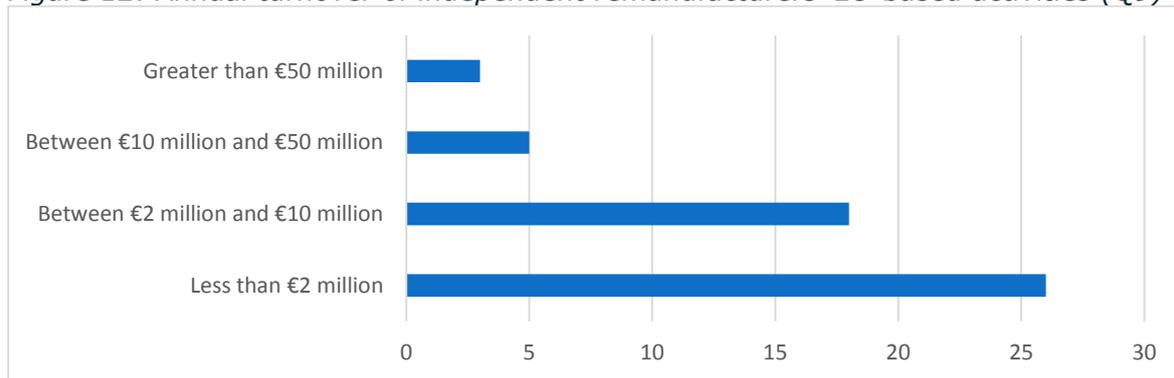
Data source: Survey Monkey - 22 survey respondents answered this question

Figure 12 shows that around half of independent remanufacturers generate an annual turnover of less than €2 million, and 85% have an annual turnover of less than €10 million. It is likely, however, that the survey is biased towards operators who have a higher profile and more resources to respond to surveys. There is undoubtedly a long tail of small and micro-operators not represented in this study.

Key learning

Most the actors in the independent remanufacturing sector for printer cartridges are small enterprises (based on turnover).

Figure 12: Annual turnover of independent remanufacturers' EU-based activities (Q9)



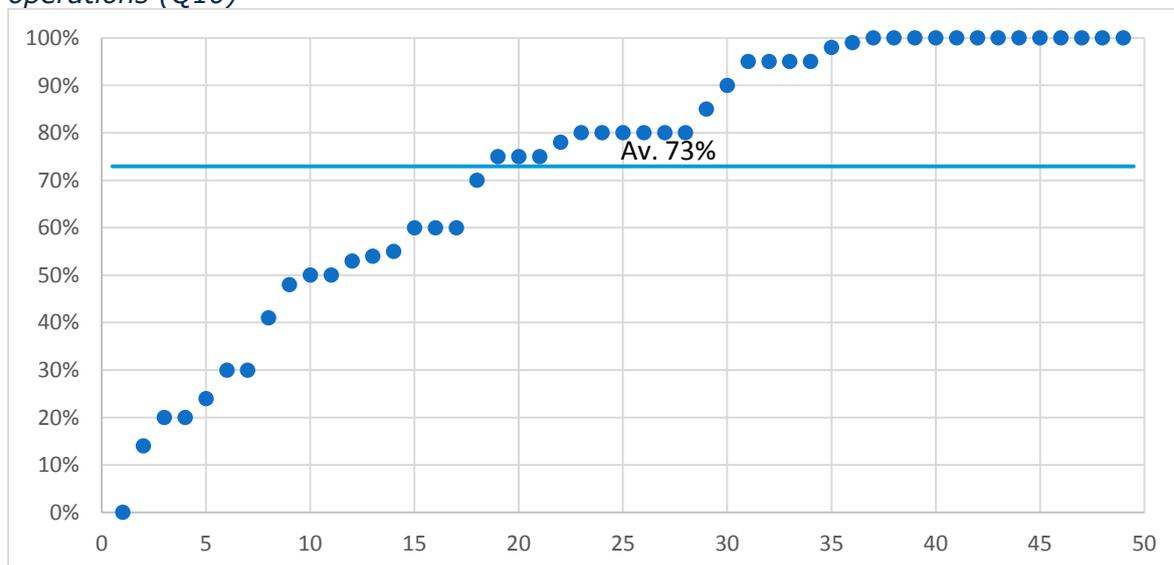
Data source: Survey Monkey – 52 survey respondents answered this question (to date)

Figure 13 shows that, for the survey respondents, an average of 73% of their European turnover is generated via printer cartridge re-use operations. For over 80% of respondents, printer cartridge re-use operations were responsible for at least half of their turnover, but only 25% of respondents generated all of their income solely from printer cartridge reuse.

Key learning

For actors in the printer cartridge re-use market, most generate most of their turnover from re-use operations; few rely solely on these activities for income.

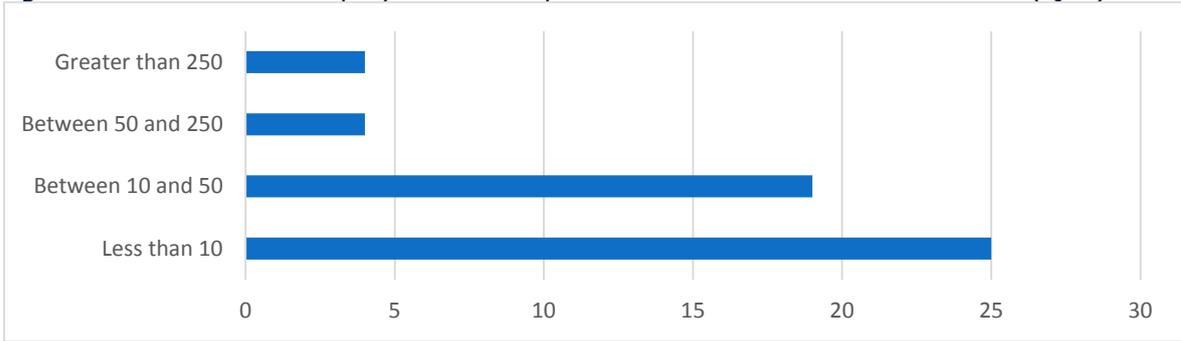
Figure 13: Percentage of European turnover relating to printer cartridge re-use operations (Q10)



Data source: Oakdene Hollins, Survey Monkey – 49 survey respondents answered this question

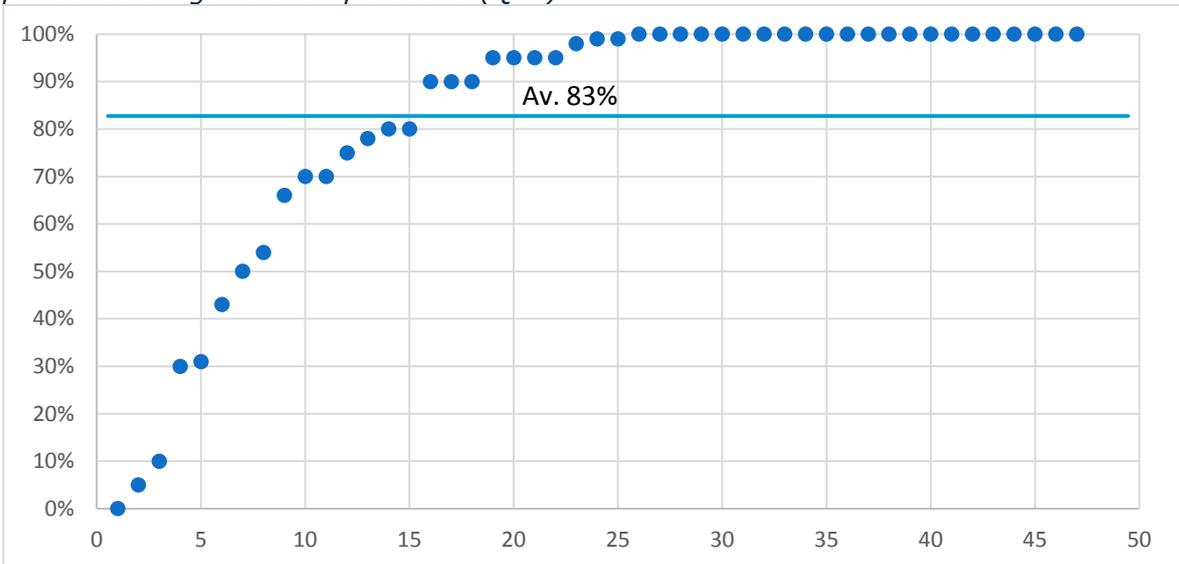
Most independent remanufacturers are SMEs, with the majority employing fewer than 10 employees (Figure 14). On average, over 80% of the employees devote their time to printer cartridge re-use operations (Figure 15).

Figure 14: Number of employees at independent remanufacturers in the EU (Q11)



Data source: Oakdene Hollins, Survey Monkey – 52 survey respondents answered this question

Figure 15: Percentage of employees at independent remanufacturers involved in printer cartridge re-use operations (Q12)

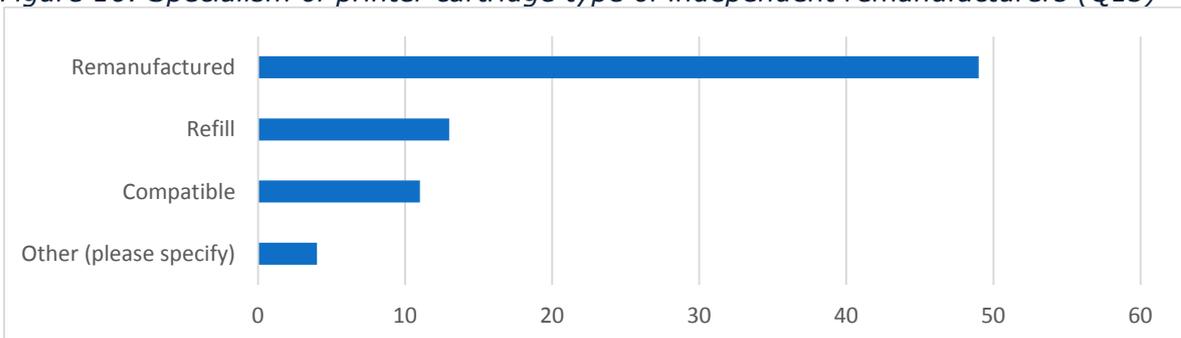


Data source: Oakdene Hollins, Survey Monkey – 47 survey respondents answered this question

Key learning:
 Most of the actors in the independent remanufacturing sector for printer cartridges are small enterprises (based on headcount).

Figure 16 shows that almost 50 survey respondents specialise in remanufactured printer cartridges, 13 specialise in refill, while 11 are involved in the manufacture of new, compatible cartridges.

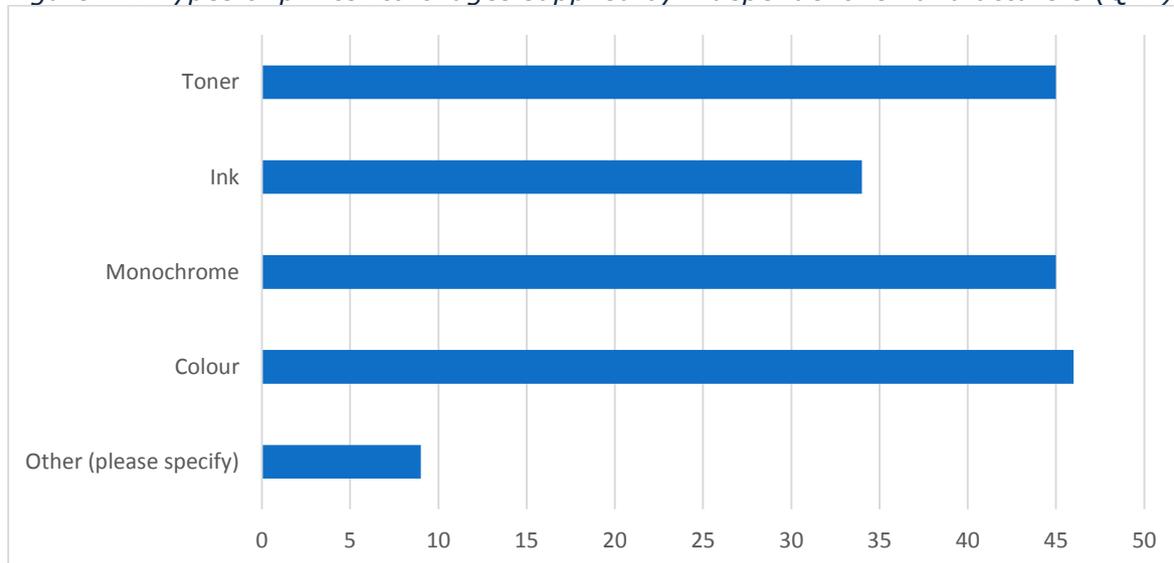
Figure 16: Specialism of printer cartridge type of independent remanufacturers (Q13)



Data source: Oakdene Hollins, Survey Monkey – 50 survey respondents answered this question

Figure 17 shows that over 40 survey respondents supply toner and over 30 supply ink cartridges. Over 40 survey respondents supply monochrome and colour (reused) printer cartridges. Other printer cartridge types and accessories highlighted by survey respondents included ink-tanks, ribbons, plotter inks, franking machines, copier bottles, large format inks, and imaging drum units.

Figure 17: Types of printer cartridges supplied by independent remanufacturers (Q14)



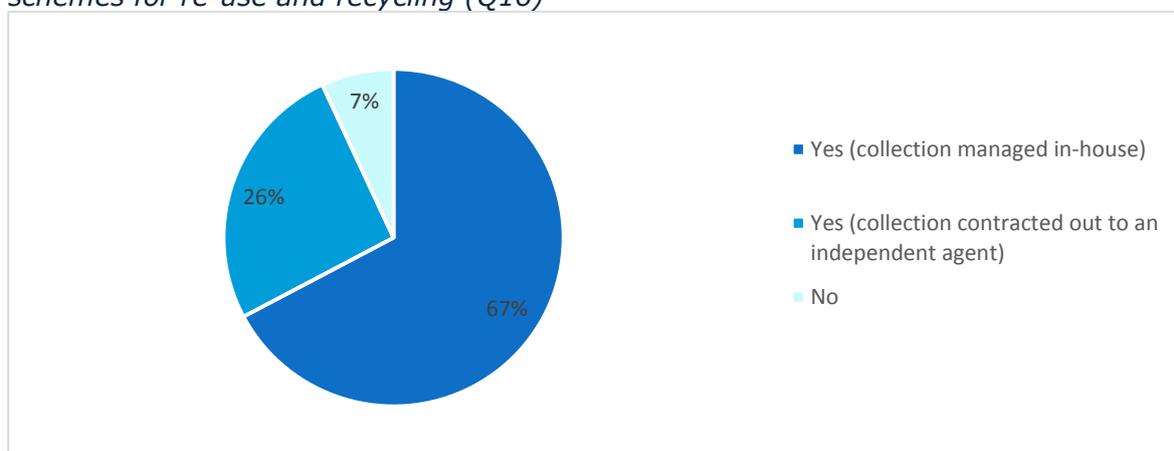
Data source: Oakdene Hollins, Survey Monkey – 48 survey respondents answered this question

Two-thirds (67%) of the survey respondents stated that they manage in-house collection schemes, and 26% outsource that operation to independent agents such as traders or brokers. Less than 10% have no collection scheme in place. The total number of cartridges collected annually, as stated by 42 survey respondents (to date), is approximately 45.8 million (Ref: Q17). The total number of cartridges that are recycled annually, as stated by 34 survey respondents (to date), is approximately 9.3 million (Ref: Q19).

Key learning

Most independent cartridge remanufacturers manage in-house collection schemes for collecting printer cartridge core. About 20% of the cartridges collected by remanufacturers end up being recycled.

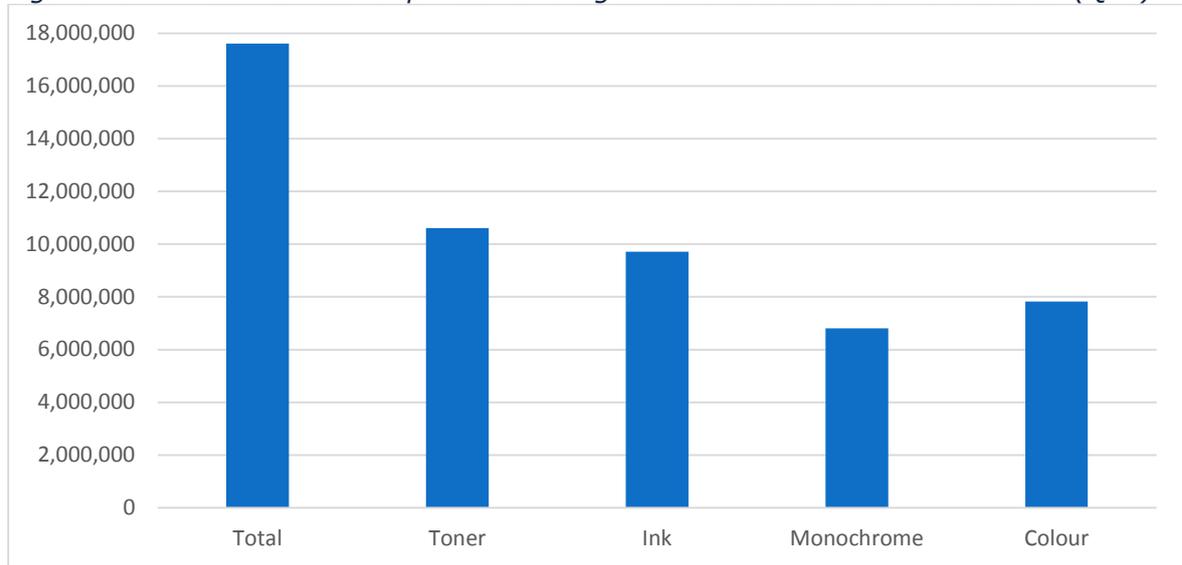
Figure 18: Independent remanufacturer’s involvement in collection or take-back schemes for re-use and recycling (Q16)



Data source: Oakdene Hollins, Survey Monkey – 47 survey respondents answered this question

Figure 19 records the number of printer cartridges remanufactured or refurbished by type and technology. In total, approximately 17.6 million printer cartridges are reused each year (in line with the aforementioned end-of-life activities). Based on the analysis of the reused printer cartridge industry in Table 4, which estimates nearly 70 million units reused per year, this suggests the respondents to the market survey cover about a quarter of the whole market.

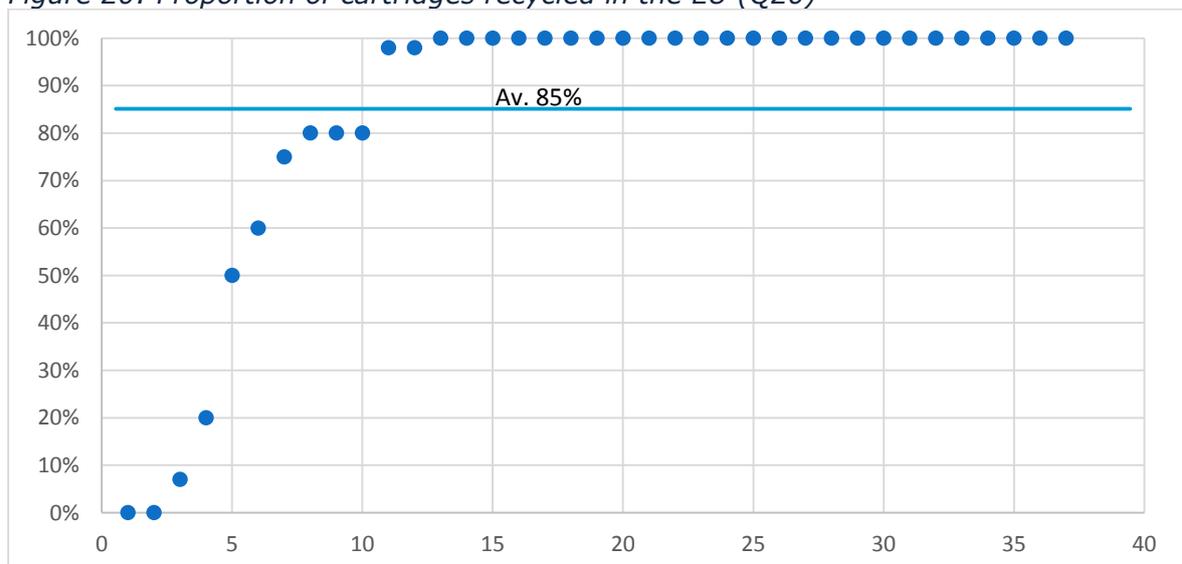
Figure 19: Annual number of printer cartridges remanufactured or refurbished (Q18)



Data source: Oakdene Hollins, Survey Monkey – 36 survey respondents answered this question

Figure 20 shows the average proportion (85%) of printer cartridges which are separately collected/taken back through collection schemes and recycled in the EU. Over 60% of survey respondents stated that all of the cartridges they recycled are processed in Europe.

Figure 20: Proportion of cartridges recycled in the EU (Q20)



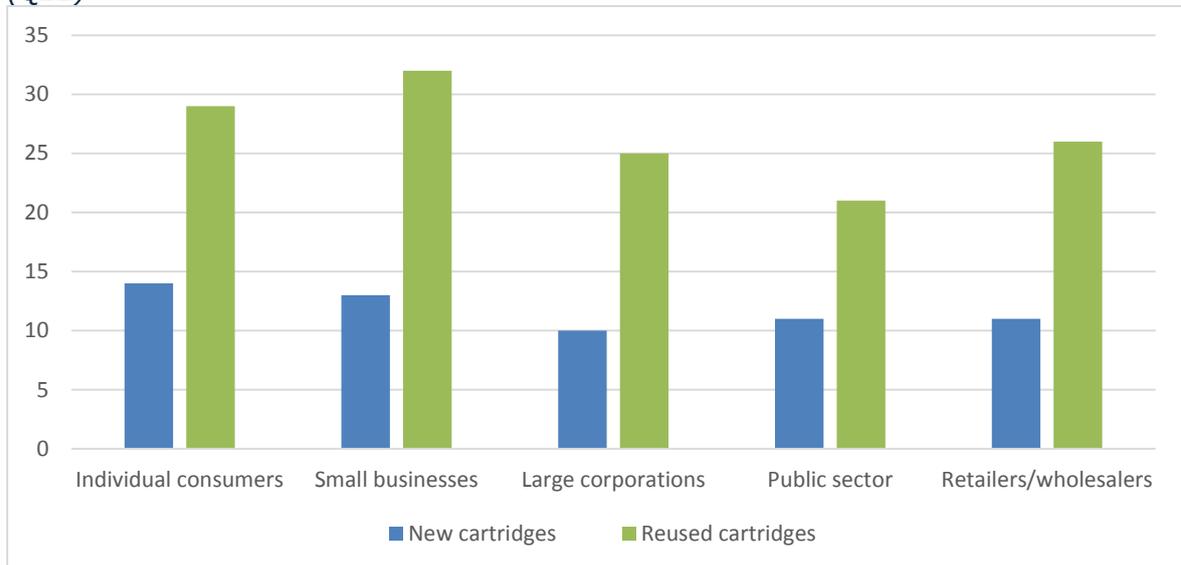
Data source: Oakdene Hollins, Survey Monkey – 37 survey respondents answered this question

Key learning

Most independent cartridge remanufacturers send all their cartridges that cannot be refilled to recycling operations within the EU, i.e. cartridges are not exported outside the EU for recycling.

Figure 21 highlights that independent remanufacturers provide a service for a wide range of customers, for both new and reused cartridges.

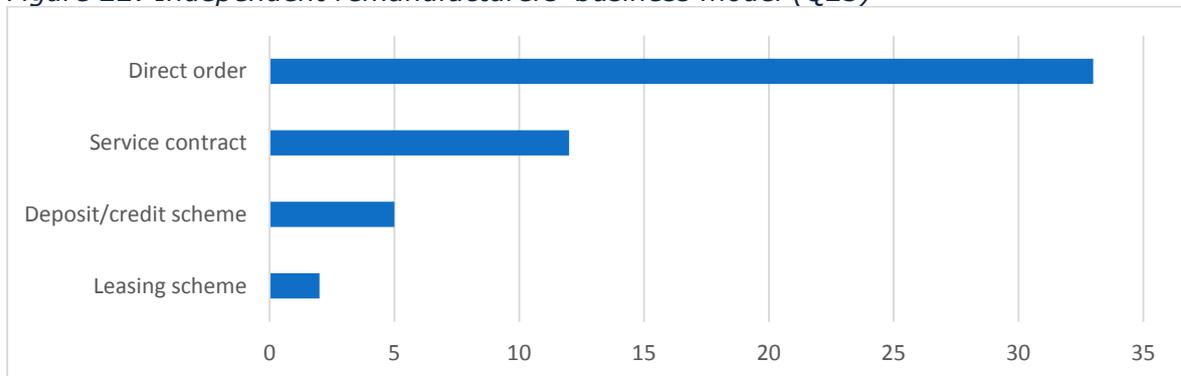
Figure 21: Type of customers purchasing printer cartridges from remanufacturers (Q22)



Data source: Oakdene Hollins, Survey Monkey – 42 survey respondents answered this question

Figure 22 identifies direct order sales as the most commonly adopted business model by independent remanufacturers, with service contract sales following behind.

Figure 22: Independent remanufacturers' business model (Q23)



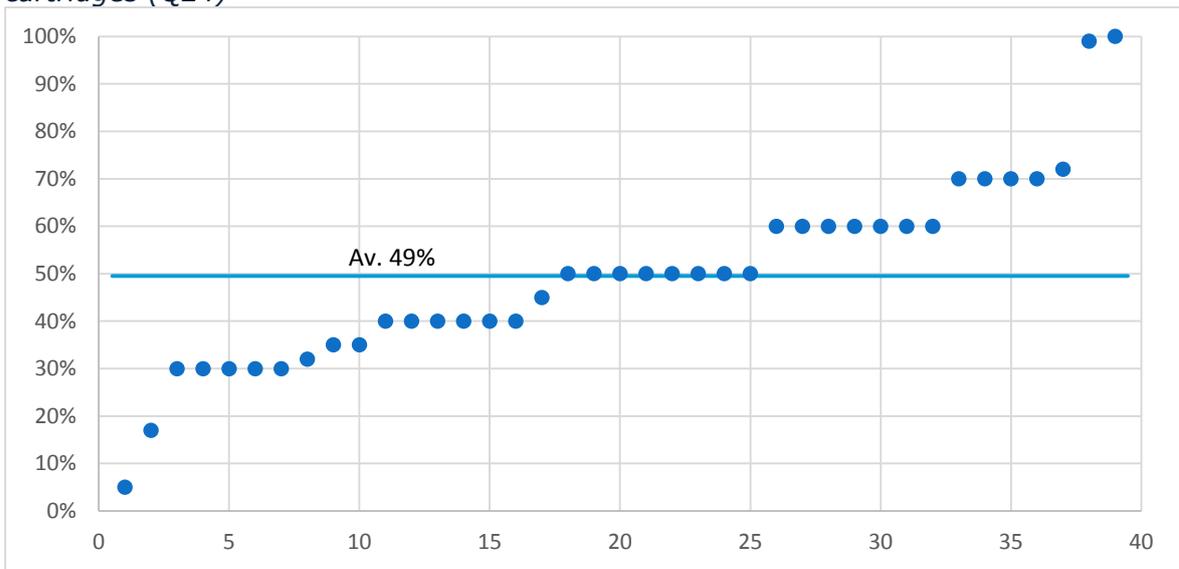
Data source: Oakdene Hollins, Survey Monkey – 33 survey respondents answered this question

Key learning

Direct sales is the most common business model for independent cartridge remanufacturers.

The price of reused printer cartridges compared with new printer cartridges appears to vary considerably. Figure 23 shows a range of 95% (5-100% of new cartridge price). This variation may be due to regional differences in pricing, and/or differences in the price of new cartridge selected as a reference value. Taking an average value suggests that reused printer cartridges are approximately half the retail value of new printer cartridges. However, the variation in responses suggests that this value should be used with caution and is unlikely to be representative.

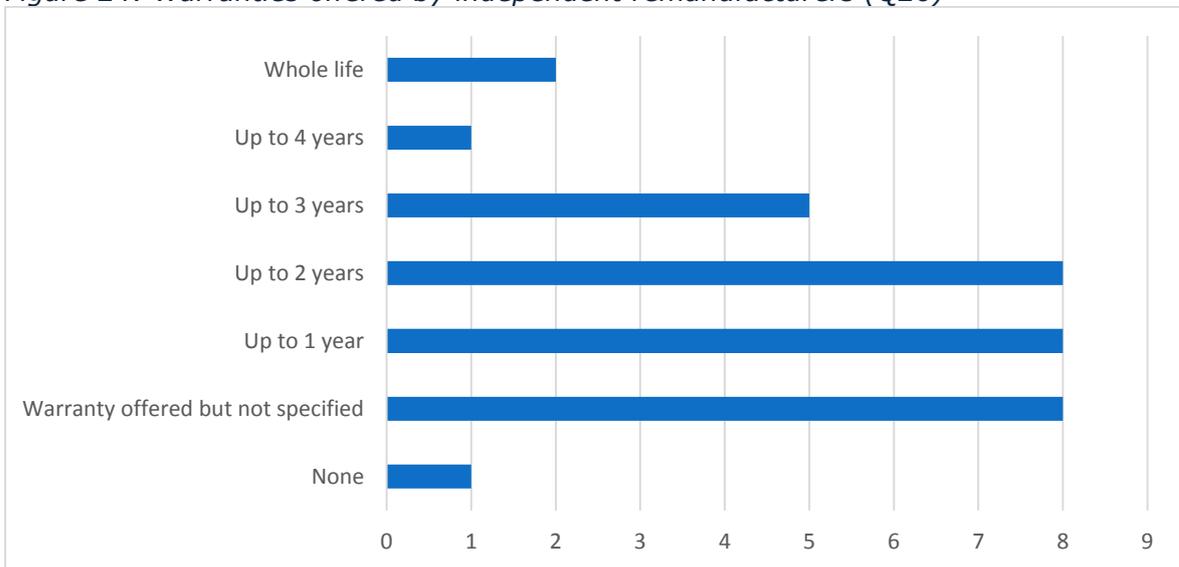
Figure 23: Price of reused printer cartridges as a proportion of the price of new cartridges (Q24)



Data source: Oakdene Hollins, Survey Monkey – 39 survey respondents answered this question

Warranties for reused printer cartridges were offered by all but one of the survey respondents. Figure 24 shows that the length of warranties offered by independent remanufacturers ranged from a year to the entirety of a cartridge’s use phase. Where a timescale of a warranty was not specified, most offered an assurance that a reused printer cartridge with defects could be exchanged or refunded.

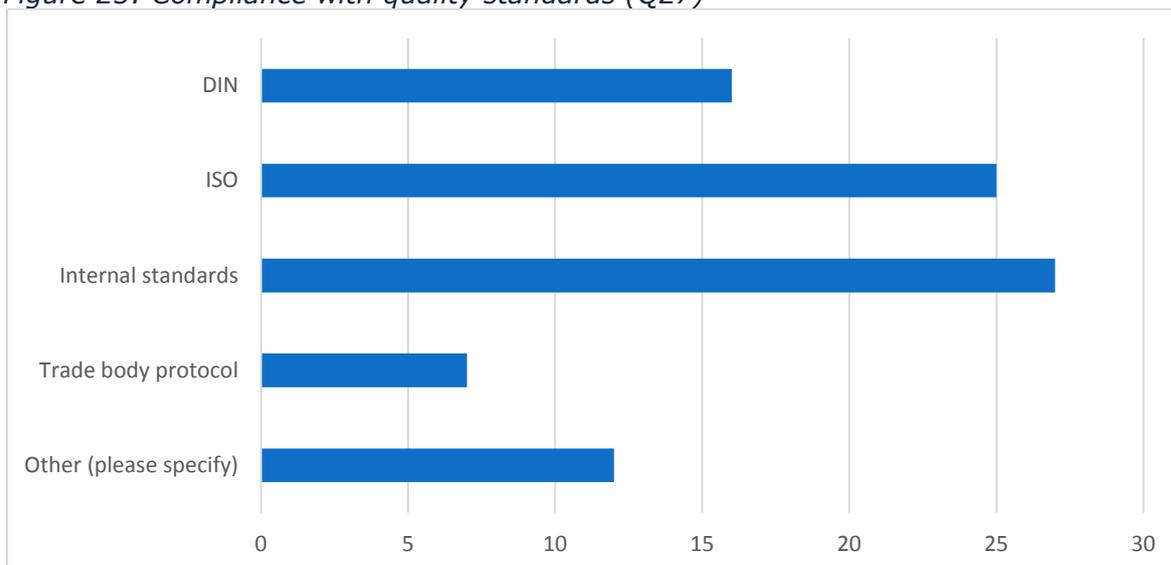
Figure 24: Warranties offered by independent remanufacturers (Q26)



Data source: Oakdene Hollins, Survey Monkey – 33 survey respondents answered this question

Figure 25 shows that independent remanufacturers comply with a variety of quality standards deriving from industry-wide protocols (such as ongoing eco-labelling initiatives) to domestic and international oriented standards. It appears that internal standards are most commonly employed in the re-use activities.

Figure 25: Compliance with quality standards (Q27)



Data source: Oakdene Hollins, Survey Monkey – 37 survey respondents answered this question

Some survey respondents stated additional quality standards that they comply with:

- Blue Angel Certification²¹ - German eco-labelling body that assesses and certifies environmentally-friendly products and services.
- OHSAS (Occupational Health and Safety Assessment Series) 18001²² – British standard that is internationally recognised. The standard outlines the minimum requirements for best practice relating to occupational health and safety management.
- Canadian quality standard for remanufactured toner cartridges- Canadian General Standards Board (CGSB)²³

The following bodies are also active in the development of relevant standards that are of interest to stakeholders, although stakeholders did not state which standards they used.

- ASTM International²⁴ - USA-based international quality standards body – relating to printers and printer cartridges.
- Institute of Turkish Standards.²⁵
- International Organization for Standardization (ISO) and the International Electrotechnical Commission (IEC) ISO IEC²⁶ - International standardization relating to the area of information technology.
- Standardised Test Methods Committee (STMC)²⁷ – A global committee that sets standards to evaluate toner printer cartridge performance.

Figure 26 categorises the main areas of competition to independent remanufacturers operating in the European printer cartridge market. The imports from Asia (mainly China) of clones and compatible cartridges in very competitive price, and competition from OEMs were the two areas most commonly referred to by the survey respondents.

²¹ <https://www.blauer-engel.de/en>

²² <https://www.bsigroup.com/en-GB/ohsas-18001-occupational-health-and-safety/>

²³ <https://www.tpsgc-pwgsc.gc.ca/ongc-cgsb/programme-program/certification/prog/toner-eng.html>

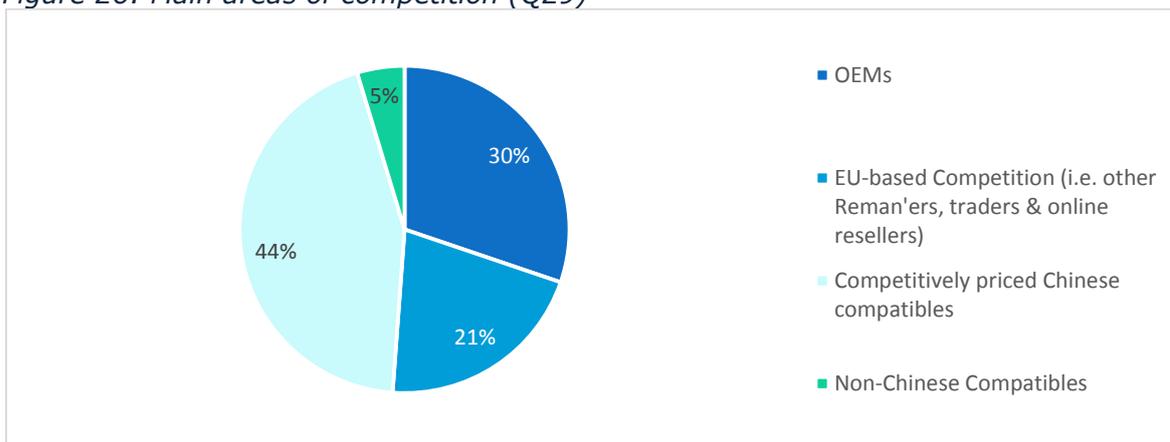
²⁴ https://www.astm.org/BOOKSTORE/BOS/TOCS_2016/15.09.html

²⁵ <https://www.tse.org.tr/en/>

²⁶ <https://www.iso.org/isoiec-jtc-1.html>

²⁷ <http://www.i-itc.org/stmc.html>

Figure 26: Main areas of competition (Q29)



Source: Oakdene Hollins, Survey Monkey – 34 respondents answered this question

Comments on the size of the EU printer cartridge market (Q30) were provided by some of the survey respondents, and are captured in Table 7.

Table 7: Size of the EU printer cartridge market from survey respondents

Size of the EU printer cartridge market: comments* extracted from the survey

"The total European market is huge, probably around 100 million units for use in printers. The remanufacturing rate compared with new is far below 10%."

"According to recent studies, the ink and toner cartridges make up almost 1.3 billion per annum... 100-150 companies with an estimated number of 10k employees."

"Industry turnover estimated at \$5 billion."

"150 million inkjets & toners sold each year. Between 500 and 1000 European companies."

"...approximately 1,500 companies active in the cartridge remanufacturing business, and employment at over 10,000 people. Total turnover estimated at €1.2 billion."

"Total market: 500 million inkjet printer cartridges and 50 million toner printer cartridges."

*Some comments have been edited for clarity

Comments on the size of printer cartridge markets in individual Member States are provided in Table 8.

27 survey respondents estimated the proportion of the EU printer market (by volume) that is made up of reused cartridges (Q32). The average of the estimates was calculated at 20%, with a range between 5% and 30%. In terms of value (Q33), 25 survey respondents estimated the proportion of the EU printer market, and an average was calculated at 15%, with a range between 3% and 37%. It seems likely that many of the respondents get their information on the European market size from ETIRA, the remanufactured printer cartridge trade association.

The range of comments received suggests there is no clear consensus on the future expansion or contraction of the printer cartridge market over the next 5 to 10 years. One respondent was optimistic that the re-use market could increase if promoted to end-users and through engagement with OEMs to address technical barriers to reuse.

Table 8: Size of Member State printer cartridge markets from survey respondents

Size of individual Member State printer cartridge markets: comments* extracted from the survey (monetary values: company sales income)

Czech Republic: 9-10 companies, 300 employees. Mainly export to Germany, Poland, Italy.

Hungary: 2-3 remanufacturers with a combined turnover of approx. €2 million & approx. 100 employees.

Greece: 200+ very small remanufacturers (1 person/owner), 20+ small remanufacturers (1-4 employees), 5+ medium remanufacturers (5-15 employees).

Slovakia €20 million; Czech Republic €50 million; Croatia €20 million; Serbia €20 million; Slovenia €6 million*; Romania €45 million; Bulgaria €15 million.

*Note: OEM cartridges not included.

Poland: 15 million by quantity, €450 million by value, 10 dominant brands, 300 small companies.

UK: Over 900 companies employ over 5,000 workers producing over 6 million cartridges /yr.

Western Europe: 200 million pieces of cartridges sold a year, 80% of which is supplied by OEMs (original products).

**Some comments have been edited for clarity*

Some respondents also commented on other factors. Three underlying themes were drawn from the comments and grouped as following:

1. Views on OEM behaviour

Majority Response

In response to increased market pressure from compatible cartridges, OEMs will continue to shift to print service business models. This may adversely affect remanufacturers, for example through their ability to collect core and access to customers who are tied to OEMs.

2. Views on imports from Asia, compatible cartridges and clones

Majority Response

There was a strong view that South-East Asian imports of compatible cartridges would put remanufacturers under severe pressure unless the imports are subject to the same stringent manufacturing and quality requirements as local production.

3. Calls for EU-level action

Majority Response

Action was requested in the area of green public procurement (GPP) to pull through remanufactured cartridges; and increased regulation on compatible cartridges that either infringe IP, are of lower quality, or do not meet health and safety obligations.

4.4.2. Non-manufacturing stakeholders survey results

In total 25 entities responded, but only five were used for the analysis as most respondents failed to provide sufficiently relevant information or to complete the survey in full. As a result, only qualitative data was extracted. Non-manufacturing stakeholders that completed the survey included trade associations and players in the

printer cartridge re-use supply chain, such as printer cartridge suppliers and traders of refilled cartridges.

Survey respondents were asked to comment on selected issues and trends in both the new and re-use markets. Primarily, most responses were from those who specialise in new builds and compatibles. The complete response set is given in Annexe B and the main responses under each one of the themes are described below:

What is the threat to domestic markets posed by the non-European players?

Majority Response

Non-European players (especially South-East Asian) pose a significant threat to the domestic market and jobs for both OEMs and the independent sector. The environmental impact is also of concern as these products do not have a regulated return/recycling route and may be of inferior quality.

Please describe in detail any barriers to re-use (e.g. technological, legal):

The responses to this question have been incorporated into Section 0 on obstacles to reusing cartridges.

How do you expect the market for reused printer cartridges to change in the next 5-10 years?

Majority Response

Respondents believe that, without intervention to enforce e.g. Article 4, the market for remanufactured printer cartridges will decline and OEMs will continue to discourage reuse.

How do you expect the market for new printer cartridges to change in the next 5-10 years?

Majority Response

Respondents believe that the market for new printer cartridges will remain largely the same, but with some consolidation in the sector. There will be a continuing technical and legal battle between OEMs and counterfeit/compatibles suppliers.

Are you aware of ecolabelling and green public procurement (GPP) schemes that are applicable to the printer cartridge sector?

Majority Response

The sole respondent felt that the EU's GPP criteria and Ecolabel for printing systems are without any practical impact as few public bodies use these GPP and no EU Ecolabelled printer models exist in the EU today.

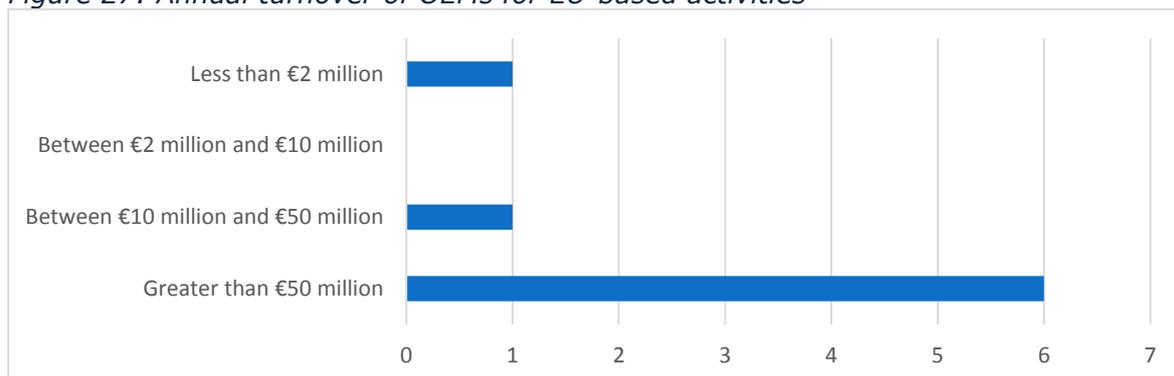
N.B. There are other ecolabelling schemes that can be used and which can demonstrate a significant uptake. For example, Blue Angel offers labels for the printer and remanufactured toner cartridge separately. The lack of responses to this question may indicate a problem with awareness of such schemes. See Section 6.

4.4.3. OEM Survey data

In total, 19 responded but only 8 responses were used for this analysis. As in the answers to the non-manufacturing stakeholder survey, little quantitative data was offered to enable a robust quantitative analysis. Figure 27, Figure 28 and Figure 29 give the perspective of the responding OEMs on the printer cartridge market, but the statistical findings will not necessarily reflect that of all OEMs.

Of the eight respondents that completed the OEM-oriented survey, six generate more than €50 million, one between €10 million and €50 million, and one less than €2 million.

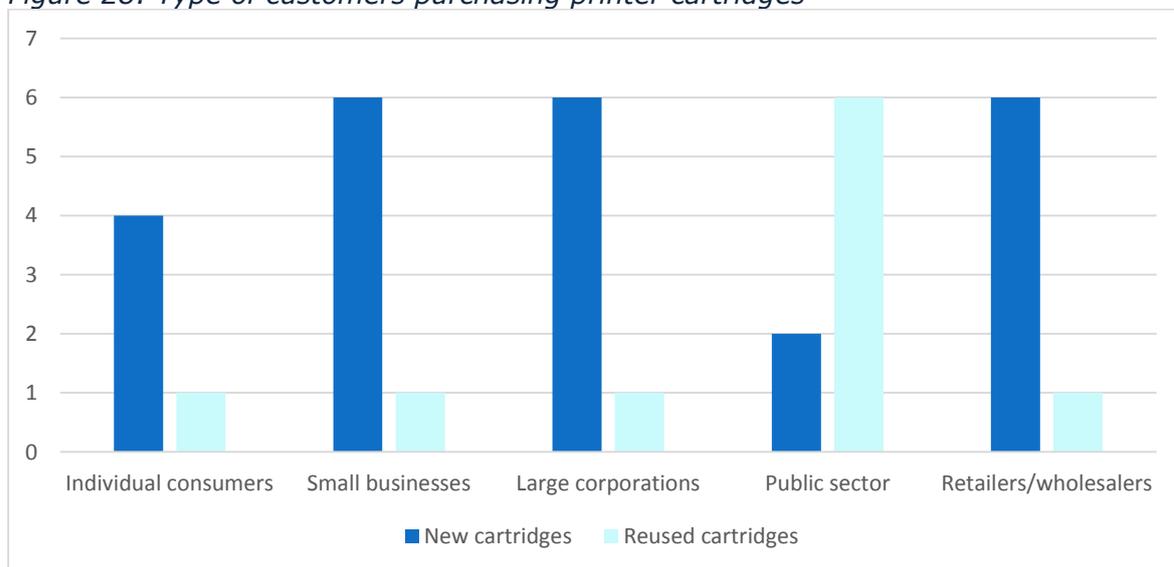
Figure 27: Annual turnover of OEMs for EU-based activities



Data source: Oakdene Hollins, Survey Monkey

In contrast with Figure 21 (type of customers purchasing printer cartridges), from the perspective of OEMs Figure 28 implies a preference for new cartridges by all customer types, except for public sector entities.

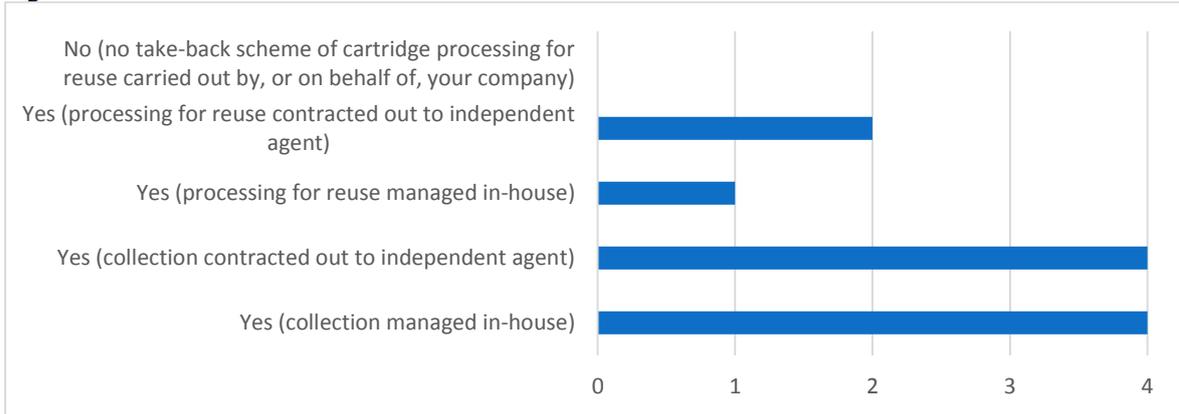
Figure 28: Type of customers purchasing printer cartridges



Data source: Oakdene Hollins, Survey Monkey

Figure 29 shows that all OEMs have some type of end-of-life collection scheme in place, whether in-house or external.

Figure 29: Prevalence of OEM collection schemes



Data source: Oakdene Hollins, Survey Monkey

Survey respondents were asked about the recycling rate of discarded cartridges, to which five responded, with answers ranging from 65% to 100%, suggesting that OEMs currently prioritise recycling and recovery strategies over reuse.

As regards the future of the printer cartridge market, the OEMs in general agree that set against a declining overall market, sales of new-build compatible cartridges are expected to increase (with consequent increase in cartridges to landfill if there is not a significant change in the current practice). This may result in the decline of EU-based remanufacturers who cannot compete on price unless promoted through policy instruments like GPP. A shift from asset ownership to print service models will continue.

5. MEASURES AND PRACTICES TAKEN BY OEMS TO PROMOTE PRINTER CARTRIDGE REUSE

5.1. OEM re-use schemes

Manufacturers of imaging equipment also manufacture printer cartridges for their devices. ETIRA reports¹⁴ that for each printer brand, it is the OEM that dominates cartridge sales for that device, with OEMs capturing 80-90% of their inkjet cartridge market and 70-82% of their toner cartridge market (see Figure 5). The key OEMs identified in the European market are (in alphabetical order): Brother, Canon, Epson, HP, Kyocera, Lexmark, Samsung and Xerox.²⁸ Given the dominance of these OEMs, this report has focussed on their practices, but augmented by those of minority manufacturers where they exemplify leading-edge product design or business practice. This section reviews the re-use practices employed by each of these companies – and selected others with advanced practices – and identifies those considered to be market leaders in the re-use of printer cartridges.

5.1.1. Brother

Brother offers recycling schemes for both toner and inkjet cartridges. These schemes are free of charge for genuine Brother cartridges. Both toner and printer cartridges are sent to its facility in the Netherlands for consolidation, before being sent to one of its two recycling facilities in Ruabon, North Wales and Slovakia.

Toner cartridges

Brother offers three routes for returning used toner cartridges, depending on quantity:

1. Up to 4 toner cartridges: free postal return. Customers can print out a free postal label and are instructed to pack the empty toner cartridge into the box in which the new toner cartridges arrived.
2. Between 4 and 12 toner cartridges: free drop off. Customers can order a recycling box with a free postage label to return their cartridges.
3. More than 12 toner cartridges: free courier collection. Customers can register their details to receive a recycling box to store empty cartridges. Once the box is full, customers can contact Brother to arrange free collection.

The Brother website states that:

"We assure you that absolutely nothing goes to landfill and any empty cartridge we cannot re-use will be recycled. This means you are contributing to a sustainable circular economy."²⁹

The Brother Recycling FAQ section provides further information on the fate of returned toner cartridges:

What happens to the used toner cartridges when I return them?

"All Brother used toner cartridges returned from Europe are recycled at our facilities in the U.K. or Slovakia. Durable components from your returned toner cartridge are recovered and utilized within a new cartridge to conserve resources and reduce the environmental impact of producing new toner cartridges."

²⁸ Note that according to a later InfoTrends report (Footnote 19), in 2015, the 4 OEM's HP, Canon, Epson and Brother jointly hold almost 100% of the market in consumer inkjet printers in Western Europe.

²⁹ <https://www.brother.co.uk/recycling/toner-recycling> [Accessed 9 March 2017]

*Components that are not re-usable are recycled responsibly at our facilities.*³⁰

Brother reports that 1.8 million toner cartridges are recycled each year, sourced from across Europe, and that 96% of toner parts are recovered.³¹

Brother also reports that 95% of the cartridges it receives back from customers will perform 'as new' after undergoing cleaning, worn part replacement, refilling and quality checking. Some of these processes, e.g. dismantling, refilling and cleaning, are automated and use robotic technology. For those cartridges that are unsuitable for reuse, the Ruabon facility has an on-site Moulding Division for granulation and recycling of toner cartridges.³¹

The manufacturing processes for producing a reused toner cartridge are reported to have an environmental impact 14% lower than the impact of a new toner cartridge.³²

Inkjet cartridges

Brother offers its customers the opportunity to return inkjet cartridges for free by ordering a free postal paid envelope. Customers can return up to five cartridges per envelope.

The Brother Recycling FAQ section provides further information on the fate of returned inkjet cartridges:

What happens to the used ink cartridges when I return them?

*"Brother sends the cartridges for recycling, so the components are reused to their full potential. Our recycling facilities have a zero waste to landfill accreditation, and Brother is fully committed to the protection of the environment."*³³

5.1.2. Canon

Canon offers recycling schemes for both toner and inkjet cartridges. These schemes are free of charge for genuine Canon cartridges. Both toner and printer cartridges are sent to local hubs for consolidation, before being sent to Canon's recycling facilities - Canon Bretagne S.A.S. in France.

Toner cartridges

Canon was the first OEM to introduce a toner cartridge recycling programme, in 1990, and from 2003 has eliminated waste to landfill. The Canon toner recycling scheme operates in 18 European countries.³⁴ The following diagrams illustrate the fate of different components from the toner cartridge. These diagrams show that most toner cartridge components undergo recycling and energy recovery operations, with only the charging roller and magnetic roller being reused in new cartridges.

³⁰ <https://www.spring-radar.com/customers/000253703/en/FAQ/FAQ.aspx> [Accessed 9 March 2017]

³¹ Brother UK, Community Engagement Report 2015-2016

³² Brother Group, 2016 Brother Group Corporate Social Responsibility Report – Environmental Activities

³³ <https://www.spring-radar.com/customers/100002606/en/FAQ/FAQ.aspx> Accessed 9 March 2017

³⁴ Canon Europe, Canon EMEA Sustainability Report 2014

Figure 30: Fate of Canon toner cartridge components

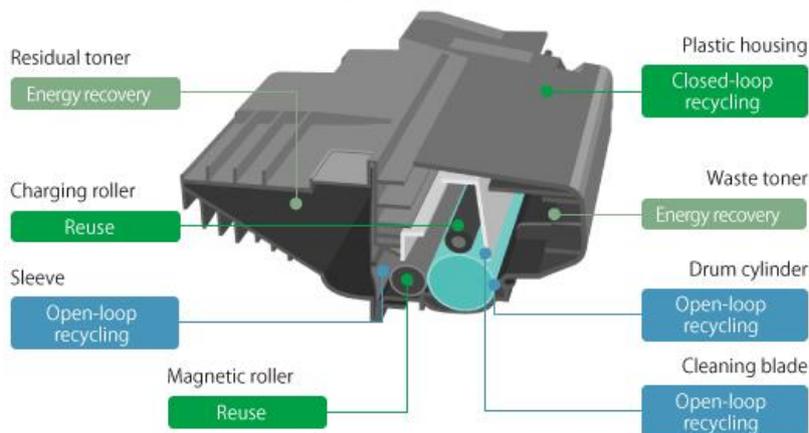
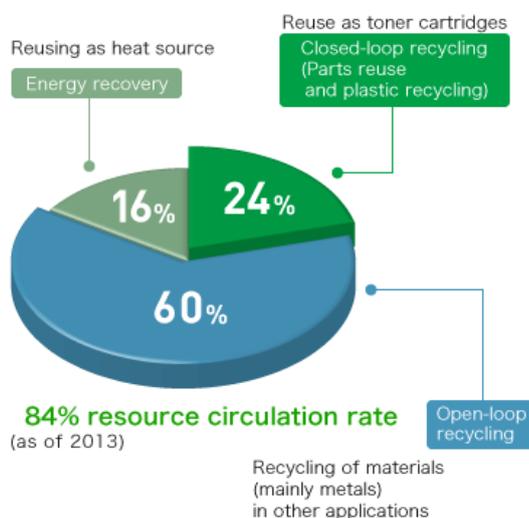


Figure 27 (cont.)



Source: Canon³⁵

Canon has focused on developing technology for plastics recycling (including closed-loop recycling), for example by selecting plastics more resilient to recycling processes, reducing the variety of plastics used in each cartridge, and reducing contaminants, such as labels, by engraving information directly onto products.

While re-use of roller components takes place, there is no evidence of re-use of whole toner cartridges.

Inkjet cartridges

Canon inkjet cartridge recycling schemes operate in 15 European countries and over 97% of the cartridge is recycled.³⁶ The scheme does not involve re-use of the cartridge, either whole or as individual components. Cartridges are crushed before sorting and then recycling. Any material not suitable for recycling is used in energy recovery.³⁷

³⁵ <http://www.canon.com/environment/cartridge-sp/recycle/index.html> Accessed 9 March 2017

³⁶ http://www.canon.co.uk/about_us/sustainability/environment/recycle/ Accessed 9 March 2017

³⁷ <http://www.canon.co.uk/recycling/inkjet/#wpir> Accessed 9 March 2017

5.1.3. Epson

Epson offers recycling schemes for both toner and inkjet cartridges through its 'Cartridge Collection & Recycling Programme'. These schemes are free of charge for genuine Epson cartridges. Users who own over 10 Epson printers are requested to register to order cartridge collection boxes, while users with fewer than 10 Epson printers are able to apply online for free return postage labels.

In Europe, Epson's 'Cartridge Collection & Recycling Programme' is running in all EU countries (excluding Malta) as well as Norway and Switzerland. The cartridges for recycling are consolidated at local third-party partner depots before being sent to Belgium for treatment.

During the recycling process, for both toner and ink cartridges, the cartridges are broken up using an energy efficient process and separated into raw materials before being used in the manufacture of a variety of new products. Epson is also investigating the possibility of creating a range of remanufactured toner cartridges that will match the quality of newly made cartridges. Since 2012, Epson has been refilling the cartridges from nearly 30,000 coupon printers in stores across Japan.³⁸ The quality of all parts of these refilled cartridges is managed just as it is for new cartridges.

Inkjet systems

It is highly relevant to the current study to note that EPSON is an established operator of the 'Supertank' system under its Ecotank® brand whereby the ink tanks and print-heads are a permanent feature of the printer, but the ink tanks are capable of replenishment externally. Inks are supplied in simple, conventional packaging bottles which are themselves not classified as EEE, but may be capable of recycling via established waste management systems especially as the inks are non-toxic. These refills are technically simple and much cheaper than refilled cartridges. Much resource (material, energy, labour) are avoided, and they do not fall within the remit of the WEEE Directive thus by-passing its end-of-life obligations. On the other hand, the printers themselves are significantly more expensive than rival equivalents – between 2 and 4 times – although the target market is the corporate and professional user.

5.1.4. HP

HP offers recycling schemes for both toner and inkjet cartridges through its 'HP Planet Partners programme'. This scheme is free of charge for genuine HP cartridges and offers different solutions for individual and bulk collections.

Toner cartridges

Users returning low volumes of toner cartridges can print postage-paid return labels to return up to four toner cartridges per parcel. Users returning more than 15 toner cartridges can arrange for cartridge collection boxes to be delivered and then collected when full.

HP reports that 76% of returned toner cartridges are processed into raw materials that can be used in the manufacture of new products (printer cartridges and other products)³⁹ and all its toner cartridges now have a recycled plastics content of

³⁸ Epson, Sustainability Report 2016 p63. Coupon printers are the machines that print coupons/vouchers at the check-outs/tills of supermarkets and other shops.

³⁹ HP, Sustainability Report 2015, p62

10-33%.⁴⁰ In 2016 HP also started recycling the toner material contained in the toner cartridges collected for recycling in North America and Australia for use as colorants in the manufacture of consumer products.

Inkjet cartridges

Users returning low volumes of inkjet cartridges can apply for postage-paid return envelopes to return up to ten inkjet cartridges per envelope. Users returning more than 100 inkjet cartridges can arrange for cartridge collection boxes to be delivered and then collected when full.

HP reports that 79% of returned inkjet cartridges are processed into raw materials that can be used in the manufacture of new products (printer cartridges and other products)³⁹ and that over 80% of its inkjet cartridges now have a recycled plastics content of between 45 and 70%.⁴⁰

End-of-life processing

Neither toner nor inkjet cartridges, nor their components, are reused at end-of-life; instead, HP has focused on developing a 'closed loop' recycling process for toner and inkjet cartridges, which is summarised in the diagram below, Figure 31.

HP states on its website that:

"No Original HP cartridges returned through HP Planet Partners are ever sent to a landfill, and HP never refills or resells cartridges."⁴¹

HP has made a strategic decision not to engage in printer cartridge or component re-use (instead focusing on materials recycling) and cites two main reasons for this decision. Firstly, HP-commissioned analysis reports higher print quality and reliability from HP original cartridges, compared to remanufactured and compatible cartridges, resulting in lower reprints and therefore lower paper, ink and energy consumption and faster printing times. Secondly, HP notes that - unlike many OEMs - cartridge remanufacturers do not operate with a zero-waste to landfill policy. These issues are further explored in Section 5.3.⁴²

⁴⁰ HP, Sustainability Report 2015, p47. Split between pre- and post- consumer recycled content also listed in <http://h20195.www2.hp.com/V2/GetDocument.aspx?docname=4AA5-4602ENUC>

⁴¹ https://h30248.www3.hp.com/recycle/ereturns/welcome-hpe.asp?_cc=gb&_la=en&segment=em
Accessed 10 March 2017

Figure 31: Summary of HP "closed loop" recycling process



Source: HP⁴²

5.1.5. Kyocera

Kyocera offers a take-back system for toner cartridges accessible across the EU via its web portal.⁴³ This free take-back service takes the form of medium and large boxes delivered to customers and capable of accepting up to 25 and 50 cartridges respectively. It is also possible for smaller users to return single cartridges by generating a return postage label and sending wrapped used units back for processing. This service caters for both unified and toner-only cartridge variants.

It is important to note that – as described elsewhere in this report – the Kyocera Ecosys printers which incorporate the long-life print-head and toner-only cassette are generally sold via a leasing arrangement to users (mostly corporate users). This is so Kyocera can maintain control of the assets and optimise their servicing and life extension. Accordingly, consumables management may also be part of this service, thus removing the need for user interaction on consumable return and maximising collection rates.

On arrival at their Authorised Treatment Facility the toner cassettes are checked and verified to ensure that they are KYOCERA only – other printer consumables cannot be treated in the same way because of their complexity. Any residual toner is removed from the toner cassette using a vacuum and processed to produce a variety of products including adhesive and thermal insulation for the construction industry. The polymers in the toner cassette are separated and then granulated and prepared for reuse as "recyclate" which can be added to virgin materials to manufacture a variety of products.

⁴² HP, 'Partner with HP for the environment' brochure

⁴³ <http://kyocera.takeback.eu/>

5.1.6. Lexmark

Lexmark operates the 'Lexmark Cartridge Collection Programme (LCCP)' and offers different solutions for small, medium and large businesses.⁴⁴ Small businesses consuming fewer than 10 toner cartridges per year can apply on-line for free postal labels (toner) or envelopes (inkjet). Medium-sized businesses consuming between 10 and 40 cartridges per year can apply on-line for a free postage-paid Ecobox, which can be filled with used cartridges and then sent back to Lexmark when full. Lexmark also offers customers an Eco Report, summarising the sustainability benefits of the cartridges they have returned.

Large organisations using more than 40 cartridges per year can register to receive a range of container sizes for storing used cartridges. When the container is full, users can scan the container's QR code using a specific Lexmark mobile app, which will notify Lexmark to arrange collection. As for medium-sized businesses, Lexmark offers Eco Reports for large organisations participating in the LCCP, to summarise the sustainability benefits of their cartridge reuse.

Cartridges, components and materials recovered through the LCCP are used to produce two lines of cartridges: Corporate Cartridges and Return Programme Cartridges. Both cartridge lines are offered at a discounted price in exchange for the customer's agreement to return used cartridges to Lexmark. Lexmark reports that, in 2015, 35% of toner cartridges shipped worldwide were returned through the LCCP.⁴⁵

Cartridges in the Return Programme Cartridge line contain plastic components made with up to 25% post-consumer recycled material (average of 18%⁴⁶) from recycled printer cartridges. Cartridges in the Corporate Cartridges line may contain up to 90% of reused components⁴⁷ (although they may contain no reused components at all⁴⁸). Both Corporate Cartridges and Return Programme Cartridges are offered with a limited lifetime guarantee.⁴⁸

Lexmark had previously only offered Corporate Cartridges to its large account holders, but they are now available to small and medium sized business customers. Corporate Cartridges are currently only available for two printer devices due to the "more durable, robust toner cartridge design" associated with these devices and the lower friction toner used in these systems, which reduces component wear. Lexmark hopes to offer Corporate Cartridges for more printer models in the future.

Lexmark operates a zero-landfill and zero-incineration policy for cartridges returned via the LCCP. (However, recovered waste toner powder is incinerated with energy recovery. In 2015, this made up 3% of the total tonnage of materials recovered through the LCCP.⁴⁵) The company's ambition is to re-use 50% (by weight) of material recovered through the LCCP by 2018, with the value in 2015 at 36%.⁴⁵

⁴⁴ http://www.lexmark.com/en_gb/products/supplies-and-accessories/lexmark-collection-and-recycling-program/cartridges-and-other-supplies.html Accessed 16 March 2017

⁴⁵ Lexmark, 2015 Corporate Social Responsibility Report

⁴⁶ Sylvie Thomas, Lexmark, Lexmark sustainable innovation and the circular economy, Presentation at the launch of the Conseil Européen de Remanufacture, Brussels 27 January 2017

⁴⁷ http://www.lexmark.com/en_gb/products/supplies-and-accessories/lexmark-collection-and-recycling-program/recyclingapp.html# Accessed 16 March 2017

⁴⁸ http://www.lexmark.com/en_gb/products/supplies-and-accessories/corporate-cartridge-faq.html Accessed 16 March 2017

5.1.7. Samsung

Samsung operates the 'Samsung Take-back and Recycling (STAR) programme' for retuning used toner cartridges, which began in 2006.⁴⁹ The STAR programme is available in 13 EU countries (Austria, Belgium, Denmark, Finland, France, Germany, Ireland, Luxembourg, Netherlands, Portugal, Spain, Sweden and the UK) and Samsung reports that all of the recovered materials are recycled, with no incineration or landfill.

Samsung requires users to register their details and the printer and cartridge type before they are issued with a postage-paid return label, which can be used to return empty Samsung cartridges at no cost. There is currently no return solution for bulk cartridge users; however, Samsung reports that this is in development.

Figure 32: Recycling process for Samsung cartridges



Source: Oakdene Hollins adaptation of Samsung⁵⁰

Limited information on the recycling process undertaken could be found, with the recycling process summarised in Figure 32, but there is no explicit mention of product or component reuse, suggesting that all returned cartridges are recycled rather than reused. Additionally, it appears that the recycled materials are used in the manufacture of non-printer cartridge products, making it an open-loop recycling process.

5.1.8. Xerox

Xerox offers a global toner cartridge take-back and recycling service under its Green World Alliance programme.⁵¹ This has operated since the mid-1990s and has kept over 65,000 tonnes of material out of landfill through recovery and recycling, largely servicing corporate users. This service is well advertised on Xerox's web-site and is easily accessed, allowing users to return cartridges without postage costs by printing their own labels. All Xerox products contain up to 5% post-consumer recycled plastic.⁵²

⁴⁹ https://support-prc.samsung.com/star_b2b/pages/design/about.aspx Accessed 16 March 2017

⁵⁰ Samsung, Working together to protect the environment leaflet, 2010

⁵¹ <https://www.xerox.com/about-xerox/recycling/enus.html> [accessed September 2017]

⁵² <https://www.xerox.com/en-us/about/ehs/reduce-waste> [accessed September 2017]

It should be acknowledged that Xerox’s target market is primarily the corporate user. Their emphasis is therefore highly geared towards providing printing as a managed service. This embraces not only provision of print assets and consumables supply on demand, but importantly education and provision of information to the user to help them understand and manage their print usage and to dematerialise their printing needs to operate in a more digital workflow environment.

Xerox’s Digital Alternatives helps organisations transition from paper-based tasks to streamlined digital workflows, increasing the efficiency of routine document processes. The Xerox Print Awareness Tool® provides end-users with graphical displays of their print usage as well as ‘eco-tips’ to enhance sustainability awareness and choices.

As regards product innovation to avoid e-waste, Xerox is a strong proponent and developer of the technology of cartridge-free ‘Solid Ink’ printing. Solid Ink sticks are non-toxic and non-smudging, avoiding the additional packaging required by toner cartridges: Fewer resources are used and less energy is invested in manufacturing and transporting Solid Ink. This translates into up to 90% less printing waste in the office and up to 13% lower greenhouse gases across the product lifecycle based on a Xerox-conducted lifecycle assessment that was peer-reviewed by the Rochester Institute of Technology. The assessment compares a Solid Ink device to a comparable colour laser multifunction device.⁵³

With respect to the ultimate objective of dematerialisation, Xerox should therefore be seen as a class leader. It is widely recognised as the pioneer in the related practice of printer asset take-back and remanufacture and is perhaps the most often quoted case study in this area.

5.2. Identification of market leaders in reuse

Several different factors can be used to identify market leaders in the field of OEM printer cartridge reuse. These factors are summarised in Table 9 below.

Table 9: Factors for identifying re-use market leaders

Factor	Description
Year re-use scheme established	Leaders in the field will likely have been involved in re-use activities for longer.
Position of activities on waste hierarchy	Leaders in the field will operate higher up the waste hierarchy. The hierarchy can be summarised as follows:

The diagram illustrates the waste hierarchy as an inverted pyramid with five horizontal levels. From top to bottom, the levels are: PREVENTION, PREPARING FOR RE-USE, RECYCLING, RECOVERY, and DISPOSAL. A red horizontal line is drawn between the 'PREVENTION' level and the 'PREPARING FOR RE-USE' level. To the left of this line, a green box labeled 'PRODUCT (NON-WASTE)' is positioned above the line, and a green box labeled 'WASTE' is positioned below the line.

⁵³ <http://www.office.xerox.com/solid-ink/solid-ink-faq/enus.html> [accessed September 2017]

Re-use scale	Re-use can occur on a product or on a component level. Recycling embodies re-use on a material level. In general, the larger the re-use scale (i.e. product > component > material), the more of the embodied energy, emissions and labour can be saved.
Closed vs open loop recycling	Closed loop recycling, where materials are recycled into the same product, (i.e. printer cartridge casing recycled into printer cartridge casing) is generally considered to be higher up the waste hierarchy than open loop recycling, where material from one product is recycled into material for other products.
Incentives for product returns	Leaders in the field may offer financial or non-financial benefits for customers returning their used printer cartridges.
Commendations/ awards	Leaders in the field may have been awarded commendations for their re-use schemes.
Prominence and detail of re-use scheme marketing	Leaders in the field may have detailed marketing materials, including on-line information, promoting their re-use schemes and providing details of their re-use operations.
Life-cycle approach	Leaders in the field may have conducted life-cycle analysis to monitor the impact of changes to product design and re-use activities.

The following tables describe how each of the six OEMs reviewed in Section 5.1 perform against the factors in Table 9.

Table 10: Establishment year of OEM re-use schemes

OEM	Year re-use scheme established
Brother	Unknown
Canon	1990
Epson	1999
HP	1987
Kyocera	Unknown
Lexmark	1991
Samsung	2006
Xerox	Pre 1997

Table 11: OEM end-of-life activities and position on waste hierarchy

OEM	Position of activities on waste hierarchy
Brother	Brother reports re-use and recycling of toner printer cartridges and components, with a zero-waste-to-landfill policy. Inkjet cartridges are recycled (not reused), again with a zero-waste-to-landfill policy. It is not clear whether any incineration or energy recovery takes place.

Canon	Canon reports energy recovery of waste and residual toner, which makes up 16% of toner cartridge material. Next up the waste hierarchy, waste plastic from the sleeve, drum cylinder and cleaning blade undergoes open-loop recycling. This makes up 60% of toner cartridge material. The plastic housing undergoes closed-loop recycling, i.e. is recycled back into plastic housing, and the charging and magnetic rollers are directly reused.
Epson	Epson avoids waste by the use of its 'EcoTank'® refillable ink-tank system. This replaces cartridges by simple bottles of ink sold in larger volumes less frequently with lower virgin material use and consequent lower take-back demand. It generates no WEEE waste and therefore falls outside of the collection system. It does however illustrate that alternative approaches can avoid the waste issue. Epson has toner and ink cartridge recycling schemes. During the recycling process for both schemes, the cartridges are broken up using an energy efficient process and separated into raw materials before being used in the manufacture of a variety of new products.
HP	HP operates a zero-waste to landfill policy. Of the returned printer cartridges, 79% of inkjet cartridges and 76% of toner cartridges are recycled in open and closed-loop processes. HP also incorporate used beverage bottles and clothes hangers in their recycling processes. Over 80% of new inkjet cartridges have a recycled plastics content of 45-70%, while all new toner cartridges have a recycled plastics content of 10-33%. ^{39,40,42} HP does not undertake re-use of components or products.
Kyocera	Kyocera operates a toner cartridge return scheme which enables single and bulk returns at no cost. ⁵⁴ Although Kyocera's web site is exemplary in its provision of Corporate Social Responsibility (CSR) and innovation for reduced impact information, it is short on detail of the fate of returned cartridges. The CSR reports detail the well-quantified comparative material, repairability through design, cost and other impacts of innovative products such as the ECOSYS range which has reduced the toner cartridge to a 5-piece, 2-material element and extended the print-head life by up to 30 times, thus avoiding the generation of WEEE.
Lexmark	Lexmark operates a zero-landfill and zero-incineration policy (waste toner is incinerated with energy recovery). The remainder of the printer cartridge material is recycled or reused, with closed-loop recycling programmes incorporating up to 25% post-consumer recycled plastics in their Return Programme Cartridge range. Lexmark currently reuses 36% (by weight) of recovered toner cartridge materials, with a target to re-use 50% by 2018. Up to 90% of a Corporate Cartridge may consist of reused components. ⁴⁵
Samsung	Samsung operates a zero-landfill and zero-incineration policy. Samsung reports that all recovered materials are recycled, with no mention of product or component reuse. Marketing material suggests that an open-loop recycling process for plastics is used. ⁴⁹
Xerox	Like Epson, Xerox has a diversified technology portfolio which includes 'ink only' replacements. For one, it has its Solid Ink technology, a clean easily rechargeable colour stick system usable in a range of office printers; and

⁵⁴ <https://www.kyoceradocumentsolutions.co.uk/index/landingpages/carbonfootprint.html>

secondly, a toner bottle refill system for office printers. Neither generates WEEE and therefore fall outside of the collection system. These too demonstrate that there are viable alternatives to the 'two part' model that **avoid** the generation of WEEE.

Xerox has also operated a conventional toner cartridge take-back programme since the mid-1990s under the brand 'Xerox Green World Alliance' programme. All Xerox products contain up to 5% post-consumer recycled plastic.

Table 12: Scale at which OEM re-use activities take place

OEM	Re-use scale
Brother	The description of re-use activities undertaken by Brother on toner cartridges (dismantling, cleaning, worn part replacement, refilling, quality checking) implies re-use at a product level. ³¹ Re-use of components and material recycling also takes place.
Canon	The description of re-use activities from Canon suggests component level re-use – the charging and magnetic rollers are reused.
Epson	The relative size of the Ecotank business (WEEE avoidance) is unknown. Epson carries out material recycling of toner and ink cartridges, approximately 97% of material recycled and remainder sent for energy recovery.
HP	Re-use for HP cartridges occurs at a material level, with material recycling.
Kyocera	Kyocera undertakes open loop recycling of its recovered toner-only cassettes and unified cartridges.
Lexmark	Lexmark undertakes re-use at a product, component and material level.
Samsung	The only re-use activity described by Samsung is material reuse, i.e. recycling.
Xerox	The relative size of the 'solid ink/toner only' business (WEEE avoidance) is unknown. Xerox has a well-established take-back system for office toner cartridges which has – over the last 20 years – kept more than 65,000 tonnes of waste out of landfills.

Table 13: Closed loop vs open loop recycling

OEM	Closed vs open loop recycling
Brother	Information not available.
Canon	Closed and open-loop recycling of plastic components.
Epson	Open loop recycling only.
HP	Closed and open-loop recycling of plastic components.
Kyocera	Open loop recycling at least.
Lexmark	Closed and open-loop recycling of plastic components.
Samsung	Open loop recycling only.
Xerox	Information not available.

Table 14: Incentives for product returns

OEM	Incentives for product returns
Brother	Free postage for product returns.
Canon	Free postage for product returns.
Epson	Free postage for product returns for small clients and box collection scheme for larger clients.
HP	Free postage for product returns. The recently launched Instant Ink programme offers fast replenishment and cartridge return benefits.
Kyocera	Free postage for product returns for small clients and box collection scheme for larger clients.
Lexmark	Free postage for product returns and discount available on Corporate and Return Programme Cartridges, in exchange for customer's agreement to return used cartridges to Lexmark.
Samsung	Free postage for product returns.
Xerox	Free postage for product returns.

Table 15: Recognition of achievements

OEM	Commendations/ awards
Brother	Not available.
Canon	Green Apple Award 2015 – Gold Award for Environment Best Practice for toner cartridge recycling programme. The Circulars 2016 - People's Choice Award.

Epson	Not available.
HP	Award for Best Environmental Management Practice in the Electrical and Electronic Equipment manufacturing sector from the EC, regarding the closed-loop-recycling process of ink cartridges, in March 2015. ⁵⁵ Green Apple 2014 - Gold Award for Environment Best Practice for HP's closed-loop ink cartridge recycling process.
Kyocera	Numerous recognitions for innovation, sustainable practices and CSR efforts. Product design for reuse and tear down praised by 'celebrity' designers in the media in the UK, for example. In 1997, KYOCERA's ECOSYS FS01700 and FS-3700 became the first printers in the world to acquire the Blue Angel ecolabel.
Lexmark	Not available.
Samsung	Not available.
Xerox	Numerous industry awards for innovation in green chemistry and environmental performance including the 2017 Ecovadis award for sustainability in manufacturing.

Table 16: OEM Prominence and detail of re-use scheme marketing

OEM	Prominence and detail of re-use scheme marketing
Brother	Website with information on re-use practices, including videos.
Canon	Detailed website including information on recycling practices, history, facts and figures and awards.
Epson	Website detailing returns procedure but limited information on recycling/re-use practices.
HP	Website with information on recycling practices, including videos and FAQs.
Kyocera	Website detailing returns procedure which includes both toner cartridges and refill bottles.
Lexmark	Detailed website with information on recycling and re-use practices with videos and FAQs.
Samsung	Website with some information on recycling practices with FAQs.
Xerox	Website with detailed information on end-of-life return options for consumable products, cartridges and print engines. In addition, Xerox offers "Digital Alternatives" and a Print Awareness Tool to encourage digital workflow as opposed to paper based.

⁵⁵ http://susproc.jrc.ec.europa.eu/activities/emas/documents/BEMP_EEE_Manufacturing.pdf

5.2.1. Conclusions

Based on the factors described above, Lexmark appears to be the clear market leader in printer cartridge reuse, presenting a comprehensive set of re-use statistics. Brother, and to a lesser extent Canon, also appear to be engaged in some re-use activities, with the other OEMs focusing primarily on recycling or energy recovery.

In inkjets, Epson have avoided having to treat cartridges as WEEE by employing the 'Supertank' external refillable reservoir system. In laser printers, Kyocera and Xerox have reduced the waste associated with unified cartridges by employing separate toner reservoirs. In the case of Xerox, a simple toner bottle plugs into the machine, whereas Kyocera use a simplified cartridge of much lower material impact.⁵⁶

Xerox also markets a solid ink printing system which is replenished by clean and simple colour sticks against a long-life permanent print-head in the machine. These solutions are not classified as EEE and so do not appear in the statistics collected here regarding cartridges meeting the definition of EEE set out in the WEEE Directive and therefore falling within the scope of this Directive.

HP appears to have conducted the most extensive life-cycle analysis to quantify impacts of reuse of cartridges versus new manufacture. The EuroVAprint position paper of 2017 does, however, admit that such comparisons are highly dependent on specific user behaviours in relation to the quality of print obtained from a refilled cartridge as opposed to a remanufactured one. In support of alternatives to cartridge systems, Epson has evaluated the impact of its Ecotank® systems, and Xerox conducted a full comparative life-cycle analysis on its Solid Ink system, both with significant resource benefits.

5.3. Arguments against reuse

A variety of arguments have been put forward – largely by OEMs – against the re-use of cartridges, inkjet or toner. In brief, they are:

- Print quality considerations.
- Unfavourable life-cycle impacts.
- Non-adherence to safety, health, environmental and related issues.
- Infringement of intellectual property or brand distortion.
- Alternative printing technologies.
- Other generic issues.

Print quality considerations

A recurring theme of OEM engagement is their concern that reused cartridges will not perform to the standards of OEM-approved new cartridges regarding the quality of printing. For example, cleaning cartridges of residual old toner is "difficult and expensive" and is a step which may be carried out with varying degrees of rigour, but can lead to poor print quality and "potential damage to other components".

HP has submitted testimony that independent tests conducted by Stiftung Warentest, the German consumer organisation, comparing its and other OEM cartridges with generic brands reveal that a significantly higher fraction of printed pages from the reused devices fail 'standardised' tests. These tests are based on user perceptions of quality adjusted for the proportion of prints that must meet specified levels for external, internal and personal use with corresponding demand for rework if

⁵⁶ Kyocera's toner cartridge consists of 5 pieces all ID coded in only 2 plastics materials.

unacceptable.⁵⁷ HP claims that, for highest quality demands, up to 150% more pages are required using an average remanufactured cartridge, though a 50% excess is typical over the range of quality uses envisaged.

If it is taken that the user is sensitive to this issue, the 'failure' would represent both a failure in performance as a deviation from their expectations of OEM cartridges (i.e. fitness for purpose) and a significant source of rework and wasted paper. See also Life-cycle impacts below.

It is noted that the Lexmark approach runs counter to this. Lexmark places the same quality guarantees on its new and remanufactured (toner) cartridges which are to all intents and purposes manufactured on the same production lines.

Life-cycle impacts

As noted above, substandard print quality might create rework, the environmental impact of which can be calculated using life-cycle analysis techniques. Such studies have been conducted by HP, most recently in 2016, and made available to this project team.⁵⁷ Whilst it is acknowledged that net environmental benefits of re-use can accrue when the toner cartridge is considered in isolation, HP contends that the use phase, and especially the extra burden of transport and rework (the manufacturer of extra paper, lower page count of the cartridge etc.), substantially overwhelms the re-use benefit. Under this analysis, which is methodologically robust, remanufactured toner cartridges show at least 35% higher impact across the major indicators. The conclusion is that re-use should not be encouraged and an alternative system of take-back and recycling should be implemented. This is the route HP has taken for cartridges of all types.

A minor criticism of the analysis is the assumed difference in end-of-life treatment of cartridges: In HP, these are recovered and recycled; for the remanufacturer, they are 'returned to reman', which appears to have a lower impact offset and is therefore not as favourable.

This analysis depends critically on the user sensitivity to the quality issue, an issue which has been explored in the HP analyses. Since the target audience for the testing was HP business users, the quality expectations of this segment may differ from other cohorts; for example, other OEM brand users or consumer users who are not sensitive to brand.

Infringement of intellectual property and brand distortion

An issue of high concern expressed by OEMs relates to the fact that reused cartridges – in general – still bear the original markings of the OEM. Any purchaser of such a reused cartridge might then assume that all liabilities, certifications and guarantees associated with the item might still apply and – even more – might be endorsed and warranted by the OEM. This can be compounded by the use of such misleading sales tagging as 'genuine OEM remanufactured' which might give the impression that the OEM had conducted or perhaps approved such a re-use operation and even offered some sort of guarantee. This in itself is an abuse of the intellectual property, not to say a misrepresentation of the ownership and liabilities.

⁵⁷ 2016 Four Elements Consulting LCA study, commissioned by HP, compared Original HP 80A and 83A monochrome toner cartridges with a sample of remanufactured alternatives across eight environmental impact categories. For more, visit www.hp.com/go/EMEA-LJLCA-2016. The LCA leverages a SpencerLab2016 study, commissioned by HP, comparing Original HP LaserJet toner cartridges with six brands of non-HP toner cartridges sold in EMEA. For details, see <http://www.spencerlab.com/reports/HPReliability-EMEA-RM2016.pdf>

Non-adherence to safety, health, environmental and related issues

A number of OEMs and third party refillers raise the issue of consumables which do not meet EU health and safety considerations being used in cloned and compatible cartridges. These issues largely originate from suppliers outside the EU. There are concerns that, for example, toners or inks contain substances not approved for use in the EU; or that the conditions under which these substances are made and placed into consumables do not conform to workplace conditions acceptable to the EU. Such short-cuts are likely associated with cost-cutting, thus presenting unfair cost advantages in addition to the health concerns.

In addition, the consumer may have chosen a printer because it had been awarded an ecolabel such as Blue Angel; but the testing for the label used the OEM consumable - replacing the OEM toner with an unknown third-party toner – could breach the testing protocol and render the label invalid. These issues are not well understood by the consumer.

Alternative printing technologies

Manufacturer Kyocera expresses a different approach, but one that is compatible with the objectives of the Ecodesign Directive and Article 4. In short, for toner cartridges, the company has developed a cartridge in which the toner reservoir is separated from the printing function. This latter element has been designed to be inherently more robust and long-lived, enduring the equivalent of numerous life-cycles of use in normal cartridges. The toner reservoir is a low-cost, simply constructed, limited material-type consumable which can be recycled. This lifetime extension is perhaps the most prominent attempt to address Article 4 by side-stepping the current debate.

It is unfortunate that the wording of the Imaging Equipment EU Ecolabel criteria (10, 11, 12) does not give credit to this approach, as highlighted by Kyocera in its submission. The criteria refer explicitly to cartridge collection but could more helpfully refer to replaceable and consumable elements which complement durable printing elements.

A similar consideration but even more so applies to the technologies of Epson and Xerox. Epson's Ecotank® system locates ink-jet ink reservoirs to be accessible to users and capable of refilling with ink supplied in simple, recyclable packaging. This completely removes the need for cartridge handling and so falls outside of WEEE. Xerox has developed solid inks for use with laser-type printers and again avoids the need for cartridges.

Other generic issues

Because of increased transportation and sourcing challenges, an increasing number of vendors of remanufactured cartridges resell cartridges collected in other parts of the world instead of focusing on collecting cartridges from the European markets. In addition to not serving the interests of collecting used waste electronics in the European Union, this may also lead to intellectual property rights infringement since the IP rights covering these cartridges may have not been exhausted by a first sale within the European Union.⁵⁸

The Blue Angel, EPEAT and Nordic Swan ecolabels for printing systems are not valid when non-OEM remanufactured cartridges are used in the printing system. Original HP toner and ink cartridges - when tested together with HP printers and HP paper -

⁵⁸ N.B. Regarding this latter point, see the judgement of a recent US court case *Impression Products vs Lexmark International*, reviewed in Section 8.2.2, which judges that IP rights are exhausted by a first sale by an authorised vendor, hence no barrier to remanufacture.

meet or exceed Indoor Air Quality criteria established by specific ecolabels like Blue Angel and EPEAT.⁵⁹

5.4. Measures taken by Member States to implement Article 4 of the WEEE Directive

The following sections describe and analyse the measures taken by EU Member States regarding the implementation of Article 4 of the WEEE Directive. It should be noted that this analysis covers all measures taken by Member States in this respect and does not solely or explicitly target printer cartridges.

5.4.1. Overview of measures taken by Member States

Article 4 of the WEEE Directive on product design stipulates, that Member States shall generally encourage measures on product design facilitating reuse and increasing recyclability.

As context, the WEEE Directive entered into force in July 2012 and has only recently been transposed into national legislation in some Member States. Considering this time delay, only a few measures based on Article 4 in its current state may have been undertaken by EU Member States. However, Article 4 of Directive 2002/96/EC (the 'old' WEEE Directive) already stipulated the duty for EU Member States to take certain measures, to encourage product design for reuse. Thus, measures related to Article 4 of the 'new' and 'old' WEEE Directives are both considered in the following section.

General information sources for the gathered measures taken by Member States are:

- Reports of the Member States on the transposition and implementation of the WEEE1/WEEE2-Directive (2004-2006, 2007-2009, 2010-2012).
- Other publications.
- Interviews conducted with stakeholders in the Member State (authorities and other stakeholders).

Table 17 contains an overview of measures relevant to Article 4 of the WEEE Directive applied in each Member State. Most EU Member States transposed the general duties stipulated in Article 4 of the WEEE Directive into national legislation. Some Member States implemented further particular measures (legal and non-legal) which are summarised below.

Table 17: Measures taken by Member State related to Article 4 of the WEEE Directive

EU MS	Category of measure	Description of measure
AT	Eco-labelling	Austrian Standard ONR 192102 introduces an internationally unparalleled standard for white and brown goods which takes the form of a sustainability label for electrical appliances designed for easy repair (Label of Excellence for Durable, Repair-Friendly Designed Electrical and Electronic Appliances) [AT NIR 2013- 2015].

⁵⁹ N.B. This view seems too strong; it is unclear why Blue Angel would offer a remanufactured cartridge standard if this invalidated its own printer award. Nordic Ecolabel, for example, stipulates environmental and health standards equivalent to new products.

EU MS	Category of measure	Description of measure
BE National	Guidance	Eco-design is the competence of federal authorities [BE-BCR NIR 2015] [BE-Wallonia NIR 2015] [BE-Flanders NIR 2015]. Measures at federal level, other than the transposition of the Eco-Design directive, include the preparation of a policy (non-binding) document on eco-design measures by the Ministry of Energy.
	Guidance	Recupel, which is the only PRO in Belgium, has an advisory role with regard to product eco-design for its members [Deloitte ADEME 2016].
BE Flanders	Regulatory (general transposition Art. 4)	The producer has the responsibility of designing environmentally-friendly products [BE-Flanders Materials Decree 2016].
BG	Regulatory (additional to Art. 4)	PROs and producers fulfilling their obligations individually have to report on the measures taken in the previous year to facilitate pre-treatments, recovery, re-use and recycling of WEEE and its components [BG NIR 2014-2015].
CZ	Information exchange	Some manufacturers of household EEE are looking for environmentally friendly solutions providing easy dismantling and material conservation (e.g. stainless-steel parts) during manufacturing, and offer a comprehensive service to consumers throughout the life-cycle of high-quality appliances [CZ NIR 2013-14].
		In general, low cost of appliances is the principal factor for consumers which may lead manufacturers to produce low quality EEE [CZ NIR 2013-14].
CY	Regulatory (general transposition Art. 4)	No measures going beyond those stated in the WEEE Directive
		As all EEE are imported, it is difficult to influence product design [CY WEEE Electrocyclusis 2016].
DE	Eco-labelling	Ecolabel Blue Angel, which is the German Government's label for environmentally friendly products and services (https://www.blauer-engel.de/en) [DE BMUB EAR 2016].
	Non-monetary incentive	'German Federal Ecodesign Award', which recognises ecological design, i.e. innovative products and concepts that embody high ecological and aesthetic aspirations (https://www.bundespreis-ecodesign.de/en/index.html) [DE BMUB EAR 2016].
DK	Voluntary agreements	Voluntary agreement with industry, including producers and collective schemes on promoting ecodesign over 2013- 2016 period.
	Guidance	Environmental Protection Agency funded the project "Designing out waste" to develop ecodesign guidelines for

EU MS	Category of measure	Description of measure
		electronic products [DK NIR 2013- 2015].
EE	Regulatory (general transposition Art. 4)	Producers are required to design, plan, manufacture and import products which are durable and reusable and recoverable to the highest possible extent when removed from use. The requirements for environmentally sound handling of waste resulting from products, especially the requirements for waste recovery, shall be already taken into account in planning for and designing new products. Producers are required to as far as possible promote integration of secondary raw materials in products [EE NIR 2013-2015]. These requirements are set in the Waste Act. No other specific measures taken [EE MoE 2016].
ES	Non-monetary incentive	Catalonia Eco-Design Awards (8th edition in 2015) [ES NIR 2013-Feb15].
	Voluntary agreements	In Andalusia, hazardous and non-hazardous waste management plans encourage conclusion of voluntary agreements with PROs and producers aiming at the promotion of eco-design [ES NIR 2013-Feb15].
FI	Regulatory (general transposition of Art. 4)	No specific measure, apart from what is requested in the Directive: EEE must be designed to facilitate removal of battery. Producers are obliged to avoid hazardous substances, use recyclable materials and minimise the generation of waste [Deloitte ADEME 2016]. The application of requirement related to products properties and markings is supervised by the Finnish Safety and Chemicals Agency (TUKES). However, most of the equipment is imported to Finland; Finland is not an important producer of EE-equipment (especially B-to-C products); impact on design is very low [FI ELY KESKUS].
FR	Monetary incentive	France has an indirect financial incentive for ecodesign of EEEs in the form of eco-modulated contributions paid to PROs for specific products (see also above). Printers are included however the printer cartridges are not mentioned separately ⁶⁰ [FR Eco-systèmes 2016].
	Regulatory (additional to Art. 4) / Guidance	PROs involvement on ecodesign: PROs must write good practice notes to the intention of producers (specifications). One PRO developed a tool to evaluate theoretic recyclability of EEE (REEECYC'LAB) [FR Eco-systèmes 2016].
	Guidance	Participation on normative works PT5 and GWD10 [FR Eco-systèmes 2016].

⁶⁰ According to the technical note OCAD3E ("Note technique – Application des critères de modulation de la contribution environnementale"), contributions to be paid by producers to WEEE compliance schemes in France can be decreased by 20% for printers, if it is ensured that the printer can be completely dismantled with standard commercially available tools and the necessary spare parts for the equipment are provided for 5 years.

EU MS	Category of measure	Description of measure
	Information exchange	A database with inventories of life-cycles of EEE has been put in place (specific to France) [FR Eco-systèmes 2016].
GR	Regulatory (general transposition Art. 4)	No measures going beyond those stated in the WEEE Directive.
HR	Regulatory (general transposition Art. 4)	Requirement to use recycled materials as much as possible in production of EEE [Deloitte ADEME 2016] Art 6. Of Ordinance: Key measures to promote the re-use / reparation of EEE.
HU		Manufacturers have changed manufacturing processes in order to use replaceable parts to prevent whole equipment becoming waste. In some cases, modified designs make possible reusing of dismantled parts during the repairing processes.
		The competent authorities have no knowledge that producers have been trying to prevent WEEE from being reused [HU NIR 2010 – 2012] and [HU NIR 2007- 2009].
	Voluntary agreement	Ecodesign rules are followed by certain manufacturers. All Hungarian members (17) of the European Committee of Domestic Equipment Manufacturers (CECED) are committed to follow eco-design related requirements [HU HWMF 2016].
	Monetary incentive	In certain procurement procedures ⁶¹ it is specifically required from the applicants to respect the product design related rules set out in Article 4 of Directive 2012/19/EU [HU HWMF 2016].
IE	Regulatory (additional to Art. 4) / Guidance	Legal requirements for each producer regarding product design are laid down in Regulation 43 (transposing Article 4 of the WEEE Directive and providing the opportunity for the Irish competent authority to issue guidance on product design) of [IE WEEE Regulations 2014] [IE NIR 2013- 2014]. Failure to comply with these provisions can lead to enforcement action being taken by the EPA. The Regulations provide for penalties of up to €500,000 or imprisonment for a period of three years or both [IE DCCAE 2016].
	Monetary incentive	Compliance Schemes may charge their members Recycling Management Costs based on weight and other practical costs of hazardous WEEE management for costlier sub-categories of WEEE/future WEEE [IE WEEE Ireland 2016b].
IT	Monetary	Ecodesign sub-decree to Legislative Decree 49/2014 published a few months ago, stating that producers can

⁶¹ For example, those run by the Moholy-Nagy University of Art and Design, which is Hungary's largest university of art and design.

EU MS	Category of measure	Description of measure
	Incentive	ask the Ministry of Economy (MoE) to 'reduce' the weight of 'Placed-on-Market' of a specific EEE, proving that the specific EEE has a lower environmental impact. The administrative burden seems to be high in comparison with the benefit [IT ECODOM 2016] [IT REMEDIA 2016].
LT	Regulatory (general transposition Art. 4)	No measures going beyond those stated in the WEEE Directive.
LV	Regulatory (general transposition Art. 4)	No measures going beyond those stated in the WEEE Directive.
LU		In practice, no household EEE is produced in Luxembourg [LU NIR 2014- 2015] therefore, there is no opportunity to influence design.
MT	Regulatory (general transposition Art. 4)	In general, no measures identified go beyond the scope of the requirements from EU law.
NL	Information exchange	Ecodesign is promoted by the State through other schemes and activities such as knowledge networks, grants and collaboration [NL NIR 2013- 2014]. For instance, the organisation 'Partners for Innovation' is investigating, on behalf of the Ministry of Infrastructure and Environment, whether an 'Expertise Centre for Circular Design' (with a focus on eco-design) should be opened soon. ⁶²
PL	Regulatory (general transposition Art. 4)	No legal measures going beyond those stated in the WEEE Directive [PL ElektroEko 2016].
	Guidance	The National waste prevention plan 2014 presents good practices to prevent WEEE, including implementation of ecodesign principles regarding: <ul style="list-style-type: none"> • Selection of materials: promotion of use of materials which results in reduced environmental impact evaluated with LCA analysis, reducing harmful substances where technically feasible. • Use stage: standardisation that allows using parts from used equipment, design for durability, design for easy disassembly and repair, prevention of planned obsolescence.
	Eco-labelling	Promotion of eco-design can be realised by increase of production of eco-labelled products and reduction of

⁶² <https://www.raivereniging.nl/artikel/nieuwsberichten/2016-q3/0916-nationaal-grondstoffenakkoord-voor-circulaire-economie-in-2050.html>

EU MS	Category of measure	Description of measure
		packaging waste [PL NWPP 2014].
PT	Regulatory (general transposition Art. 4)	No measures going beyond the WEEE Directive provisions. As 80% of the placing on the market in Portugal are imports, there is little opportunity to influence design [PT NIR 2015].
RO	Information exchange	The Ministry of Economy supports co-operation between producers and recyclers to identify measures to promote ecodesign of EEE to facilitate re-use [Deloitte ADEME 2016].
	Regulatory (general transposition Art. 4)	Producers are required to apply ecodesign requirements and not to prevent re-use [Deloitte ADEME 2016]. In practice, most EEE are imported; some companies assemble in Romania. Ecodesign requirements are applied to some extent. [RO Ecotic 2016].
	Eco-labelling	The authorities encourage producers by awarding labels for products designed in accordance with eco-design requirements [RO Ecotic 2016].
SE	Monetary incentive	A proposal is currently discussed as part of government's budget proposal and if voted through in December 2016 they will become law from 1 January 2017: Tax on harmful chemicals in white goods (lower levy if lower amount of chemicals, penalisation if no decrease).
SI	Regulatory (general transposition Art. 4)	No further practical measures beyond legal requirements set out in the WEEE Directive are defined [SI ZEOS 2016].
SK	Regulatory (general transposition Art. 4)	No other measures than those stated in the WEEE Directive. [SK NIR 2013-15] The Slovak Ministry of Environment does not monitor or assess parameters relating to eco-design and its impacts on the WEEE management [SK NIR 2013-15]. The Ministry of Economy is competent on this issue [SK MoE 2016].
UK	Information exchange	The Waste & Resources Action Programme (WRAP) coordinates the Electrical and Electronic Equipment Sustainability Action Plan (esap), a collaborative framework for sharing evidence and implementing sector-wide actions to improve business efficiency and the sustainability of electrical and electronic products. One focus of esap is on extending product durability through design and consumer information. [UK NIR 2013 - 2015].
	Guidance	WRAP has carried out electrical design reviews on several products and published guidance to assist designers and producers to develop products that last longer and have less environmental impact [UK NIR 2013 - 2015].
		Wales explored whether it would be practical to strengthen extended producer responsibility legislation in

EU MS	Category of measure	Description of measure
		Wales with a view to ecodesign e.g. in the field of WEEE, if voluntary initiatives fail to support the achievement of the -1.2% annual waste prevention target [UK WMP WA 2011].
	Guidance / Information exchange	Zero Waste Scotland funds and conducts actions on product design. [UK NIR 2013 - 2015].

5.4.2. Categories of measures taken by Member States

Considering the above identified measures following Article 4 of the WEEE Directive applied in the 28 Member States, eight different categories of measures have been identified:

Table 18: Categories of measures taken by Member States in support of Article 4 of the WEEE Directive

Category of measure	Description
Regulatory (general transposition Art. 4)	Covers all measures that generally are contained in Article 4 of the WEEE Directive without any further regulations, incentives or other measures.
Regulatory (additional to Art. 4)	Covers any legal measures additional to Article 4 of the WEEE Directive. Examples are reporting obligations and special constraints for certain branches.
Monetary incentives	Covers all measures that target on stimulating companies by imposing taxes, penalties, benefits for well performing businesses or by adopting the procurement system.
Non-monetary incentives	Covers all measures that target on rewarding companies and businesses for best practices and outstanding performances with awards and prizes.
Eco-labelling	Covers all measures that support new labels to stimulate producers to fulfil certain requirements, providing a better market position.
Information exchange	Covers all measures that target on establishing databases and knowledge networks with the aim of guaranteeing a better transfer of information and to improve the co-operation between single sectors.
Guidance	Covers all measures that are not compulsory, including guidelines or advisory services with the aim of supporting companies.
Voluntary agreements	Covers all measures that force co-operation and agreements between producers, consumers and PROs or within groups of manufacturers.

5.4.3. Share of the measures among the Member States

Among the 28 Member States quite diverse approaches and strategies can be found. Most of the Member States (11) **directly or similarly transposed Article 4** of the WEEE Directive without any additional measures (**CY, EE, FI, GR, HR, LT, LV, MT, PT, SI, SK**).

Additional regulations could be found in 3 Member States, namely **BG, FR** and **IE**. Only in one case (BG) this was the only measure implemented in this Member State.

In five Member States, **monetary incentives** were introduced (**FR, HU, IE, IT, SE**). In three of them a combination with other measures was implemented (FR, HU, IE).

Two Member States introduced **non-monetary incentives** (**DE, ES**) and in both cases one more measure is present at the same time.

Eco-labelling measures were set up or supported by four Member States, namely by **AT, DE, PL** and **RO**. Only in the case of Austria no additional incentives or regulations were present at the same time.

Measures regarding the **exchange of information** are carried out by five Member States (**CZ, FR, NL, RO, UK**), mostly in combination with others.

A similar role is played by **guidance**, being used as a measure also by five Member States, namely **BE, DK, FR, PL** and **UK**. This course of action is also adopted in combination with others rather than individually. In a couple of countries more than one guidance measure is implemented.

Voluntary agreements can be found in three of the 28 Member States (**DK, ES, HU**). This type of measure usually gets implemented in combination with others.

Generally, if they decide to take action, most of the Member States adopt **more than one measure** (**BE, DE, DK, ES, FR, HU, IE, PL, RO, UK**). Only a few Member States limit their activity in this field to **one single measure** (**AT, BG, CZ, IT, NL, SE**).

5.4.4. Efficiency analysis of measures taken by Member States

For the analysis of the measures taken by the single Member States regarding Article 4 of the WEEE Directive, the (as of May 2017) unpublished yet study 'WEEE Compliance Promotion Exercise' provided the data basis. In this project, WEEE management approaches in all 28 Member States have been assessed permitting them to be broadly clustered into three groups titled: 'Very good performance', 'Good performance with potential to improve', and 'Large potential for improvements'.

To analyse the efficiency of measures regarding Article 4 of the WEEE Directive, the correlation between the above identified measures (or categories of measures) and the clustering of Member States in the WEEE compliance promotion exercise based on their overall WEEE management is assessed. Although the assessment results of the WEEE compliance promotion exercise which focus on overall WEEE management cannot necessarily be related to the measures taken by the Member States as regards Article 4 of the WEEE Directive, some general indications can be retrieved, which are described in the following.

Apparently, the Member States that generally only transposed Article 4 of the WEEE Directive can be found to a limited extent in the cluster named '*good performance with potential to improve*' and to a larger extent in the cluster '*large potential for improvements*'. The second finding was that, in many cases, a **combination of**

different measures led to better results, since the Member States following this approach are clustered mainly in the 'Very good performance' group. Focusing on single measures, three categories showed distinct positive results: **regulatory measures in addition to Article 4 of the WEEE Directive**, and **monetary and non-monetary incentives**. The rest of the categories are likely to influence the related issues positively, but do still depend on acceptance and execution of the single projects. For the actions taken solely or predominantly in combination with others, it appears difficult to clearly assess their individual impact. Nevertheless, taking multiple measures seems to result in better outcomes.

The categories of measures applied in the Member States and the clustering according to the 'WEEE Compliance Promotion Exercise' report is displayed in Figure 33.

5.4.5. Alternative performance indicator – re-use rates

As discussed in the previous section, the assessment in the WEEE compliance promotion exercise was related to overall WEEE management and thus may not be totally representative of the efficiency of measures taken by Member States specifically related to Article 4 of the WEEE Directive. Accordingly, the re-use rate is used as a further indicator due to its relationship to product design. Member States implementing Article 4 of the WEEE Directive facilitate reuse, dismantling and recovery of WEEE, its components and materials. This should, logically, lead to higher re-use rates.

To verify this assumption, this study compared the re-use rates of the single Member States based on data reported to EUROSTAT for the latest reference year which is 2014 and the results of the WEEE compliance promotion exercise. **14 out of 28 Member States (AT, BE, BG, CY, DE, DK, FI, FR, IE, LV, PL, PT, SE, UK)** recorded their re-use rate. Two of them are in the group 'Large potential for improvements' according to the WEEE compliance promotion exercise, five of them in the group with 'Good performance with potential to improve' and the remaining seven could be found among the top ten Member States having 'Very good performance'.

Those Member States that monitor their re-use rate usually apply at least one or more supplementary measures besides the transposition of Article 4 of the WEEE Directive.

Among the Member States that monitor their re-use rates, the most popular measures are in the category **guidance**, implemented by **five Member States** (BE, DK, FR, PL, and UK) but leading to **diverse results** (two in 'Very good performance', two in 'Good performances with potential to improve' and one in 'Large potential for improvement').

Each of the measures **regulatory (in addition to Article 4)** and **monetary incentives** were implemented in three Member States (in two Member States these two measures were implemented together). These three Member States (BG, FR and IE) were in the group with 'Very good performance' according to the WEEE compliance promotion exercise. In Sweden, the monetary incentives lead to a 'Good performance with potential to improve'.

Information exchange measures were implemented twice, in both Member States (FR and UK) leading to *very good performances*.

The remaining measures were applied once or twice by the 14 Member States and led to varying results.

No relationship could be found between the actual re-use rate (calculated based on the total WEEE collected) and the implemented measures. In general, the re-use rates are relatively low (see Figure 33).

Figure 33: Analysis of Article 4 actions taken by Member States

MS	Range	1. Regulatory (general transposition Art. 4)	2. Regulatory (additional to Art. 4)	3. Monetary incentive	4. Non-monetary incentive	5. Eco-labelling	6. Information exchange	7. Guidance	8. Voluntary agreements	re-use rate [%]
AT	very good performance					x				1,7
BE	good performance							x		3,4
BG	very good performance		x							0,4
CY	large potential for improvements	x								4
CZ	large potential for improvements						x			0
DE	very good performance				x	x				2,2
DK	large potential for improvements							x	x	0,3
EE	large potential for improvements	x								0
ES	very good performance				x				x	0
FI	very good performance	x								1,1
FR	very good performance		x	x			x	x		1,7
GR	large potential for improvements	x								0
HR	large potential for improvements	x								0
HU	very good performance			x					x	0
IE	very good performance		x	x						1,3
IT	large potential for improvements			x						0
LT	very good performance	x								0
LV	good performance	x								1,4
LU	good performance									0
MT	large potential for improvements	x								0
NL	good performance						x			0
PL	good performance					x		x		0,5
PT	good performance	x								0,03
RO	large potential for improvements					x	x			0
SE	good performance			x						0,3
SI	large potential for improvements	x								0
SK	good performance	x								0
UK	very good performance						x	x		4,6

Source: BiPRO (2017)

5.4.6. Conclusions

In summary, Member States that simply adopted Article 4 of the WEEE Directive can be found in the cluster of Member States where the overall WEEE management shows potential for improvement according to the assessment under the WEEE compliance promotion exercise. Member States with a better performance according to this

exercise usually initiated more measures, going beyond the mere transposition of Article 4 of the WEEE Directive into national legislation.

The most effective measures are (either implemented individually or in combination with themselves or other measures) additional regulatory actions and monetary or non-monetary incentives. An outstanding example measure to be mentioned is the eco-modulation of fees to be paid by EEE producers in France (see section 5.4.1) which affects printers but not in particular printer cartridges.

The additional analysis using the reported re-use rates of Member States as indicative of the efficiency of measures taken by Member States supports the findings described above.

However, it is difficult to reliably evaluate the correlation of measures taken by Member States with the assessment of overall WEEE management in the WEEE compliance promotion exercise and with the re-use rates of Member States. Some measures were adopted together with one or more others, which makes it difficult to make a reliable evaluation. In other cases, the single measures have diverse influences in the single Member State, depending on other influencing factors.

On the whole, overall performance correlates more with the archetypal perception of the maturity of a Member State's regulatory, policing and enforcement regimes than with the presence of any particular measure.

5.5. Actions taken by industry related to Article 4 of the WEEE Directive

This section identifies actions taken by industry related to Article 4 of the WEEE Directive. These actions take place at different stages along the supply chain and are identified and described in the table sections below including, where possible, the rationale for the action focus, and the level of industry awareness of the action and perceived efficiency. The level of stakeholder awareness and perceived efficiency of these measures has been investigated.

5.5.1. Statement of individual company actions

Table 19: Industry actions identified related to Article 4 of the WEEE Directive

Research and development

[C1] Canon plastics recycling research

Canon has been involved in developing plastics that are more resilient to the thermal processes undergone during material recycling to promote the recovery of post-consumer plastic.

[H1] HP closed-loop plastics recycling

HP has been involved in research to develop closed-loop recycling schemes for post-consumer printer cartridges. This technology also involves the addition of other post-consumer plastics, such as clothes hangers and beverage bottles, which are 'up-cycled' into plastic to be used in new printer cartridges.





Product and service development

[B1] Brother design for recycling scheme

Brother reports on-going efforts to improve printer cartridge design for ease of recycling by running an annual secondment scheme, whereby a product designer from the global head office is sent to the Ruabon recycling facility in North Wales to investigate how changes to product design could make cartridges easier to recycle. This initiative is reported to have reduced the overall environmental impact of manufacturing toner cartridges by 43%.

Brother Group has also included activities to improve the recycling rates of ink cartridges to 50% or more in its Environmental Action Plan 2015 (2011-2015).

Priority measure: to increase reusability and recyclability (both for main units and consumables)

Targets of Mid-Term Environmental Action Plan: (1) Promoting design for reducing man-hours required in the re-use process, and cutting the number of replacement parts and costs, in the consumables re-use business; (2) Expanding the scope of parts for which materials derived from a closed recycling system can be used.

Targets for FY2015: Recycling rate of collected ink cartridges: 50% or more.

Achievements in FY2015: The recycling rate remained at 50% or more.

It is unknown if there are related targets in the Brother Group Environmental Action Plan 2018 (2016-2018).

[C2] Canon reduction of plastic variants

Canon has been involved in reducing the variety of plastics used in each printer cartridge to promote recycling and recovery of material. Reducing the number of types of plastics used in a printer cartridge should improve the efficiency of the recycling process as fewer disassembly and sorting processes will be required (reducing costs and risk of contaminants) and help facilitate closed-loop recycling processes.

[C3] Canon contaminant reduction

Canon has been involved in activities to eliminate potential sources of contamination from their printer cartridges. This has involved replacing labels previously stuck onto cartridges by instead engraving the information directly onto the printer cartridge. Eliminating labels should help increase the efficiency of materials recycling by reducing contaminants, such as paper and glue, that could lower the quality of the recyclates or necessitate additional cleaning and/or disassembly processes.

[E1] Epson Ecotank®

Epson has adopted a 'supertank' system where the ink-jet ink reservoirs are located outside of the machine and are accessible for refill by the user.⁶³ Ink refills are supplied in simple packing that may be easily recycled using conventional routes for

⁶³ Informal feedback from users is that this system can be messy and is not as convenient as the cartridge purchase, however.

packaging and are outside of the WEEE Directive. Although the printer is significantly more expensive (2 to 4 times), the ink volumes last around 20 times as long. Savings in material use are clear.

[H2] HP design for recycling practices

Elements of design for recycling practices pursued by HP include: labelling of parts greater than 25 grams in weight with internationally recognized ISO symbols for ease of material identification; a reduction in the average number of parts in monochrome HP LaserJet print cartridges by more than half; a reduction in the average number of plastic resins in monochrome HP LaserJet print cartridges by more than two-thirds.⁶⁴

[K1] Kyocera long-life ceramic print-head

Kyocera has used its ceramic technology to extend print-head life by up to 300% whilst separating the toner cartridge functionality. This has reduced the net manufacturing impact of cartridges and simplified and lowered costs of refilling for users. The toner cassette has only 5 parts in 2 plastics.

[X2] Xerox Solid Ink

Xerox has marketed a range of Solid Ink printers since 1991. There is a robust print-head and slots for non-toxic, clean ink blocks to be inserted. This eliminates cartridges with ink blocks supplied in simple recyclable packaging. This translates into up to 90% less printing waste in the office and up to 13% lower greenhouse gases across the product lifecycle based on a Xerox-conducted lifecycle assessment that was peer-reviewed by the Rochester Institute of Technology. Solid ink printers are significantly more expensive than cartridge-based ones.

[X3] Xerox toner bottle system

The toner bottle system also eliminates the need for cartridges. Toner is supplied in relatively simple bottle packaging which slots into a permanent reservoir within the printer. This solution is aimed at high volume users usually as part of a service package. Toner bottles fall outside of the WEEE Directive. It should be noted that these printers do have a waste toner cartridge that must be replaced thus offsetting some of the benefits.



Supplier management

No actions identified



Production

No actions identified



⁶⁴ <http://www8.hp.com/us/en/hp-information/environment/design-for-environment.html> Accessed 23 March 2017



Route to market

[L1] Lexmark Corporate and Return Programme Cartridges

Lexmark Corporate and Return Programme Cartridges promote cartridges with reused and recycled content, respectively. The price discount offered to customers in exchange for their agreement to return the cartridge after use again promotes the reusability of the cartridge, its components and its materials.



After sales service

[L2] Lexmark Eco Reports

Lexmark offers its medium and large customers Eco Reports, summarising and quantifying the sustainability benefits of returning their cartridges through the Lexmark Cartridge Collection Programme, for use in producing Corporate and Return Programme Cartridges.

[X1] Xerox Digital Alternatives programme

Xerox helps organisations transition from paper-based tasks to streamlined digital workflows, increasing the efficiency of routine document processes. The Xerox Print Awareness Tool® provides end-users with graphical displays of their print usage as well as “eco-tips” to enhance sustainability awareness and choices.



Consumption

[L3] Lexmark Unison low-friction toner

Lexmark promotes the use of Unison™ Toner as a low friction toner that reduces wear on long-life components, making them more suitable for re-use at end of life.

[L4] Lexmark product design for durability

Lexmark reports that cartridges developed for its A4 CS/CX and MS/MX devices incorporate a more durable and robust cartridge design (see Section 5.1.5). These cartridges are therefore more suitable for re-use and are available as part of the Corporate Cartridge range, in which cartridges may include reused components.



Disposal

[I1] Industry-wide collection schemes

OEMs across industry operate collection schemes to allow consumers to return their used printer cartridges which is an obligation of the WEEE Directive.





Remanufacture/reuse

[B2] Brother automation of remanufacturing operations

Brother's UK recycling facilities have developed automated and robotic technology for dismantling, cleaning and refilling used printer cartridges. By automating these operations, the re-use process becomes more efficient, reduces labour costs and can improve quality.

[L5] Lexmark re-use target

Lexmark has a published re-use target to re-use 50% (by weight) of material recovered through the LCCP by 2018. The current re-use level is 36%.

5.5.2. Conclusions

The review of industry actions has found that most of the activity has focused on the early research and design phases of the supply chain, with an emphasis on facilitating the recovery of material from collected used EEE, i.e. plastics recycling. Producers are broadly concentrated on recycling their products where these have been collected under take-back actions.

No evidence of collaboration between OEMs and remanufacturers could be found, with actors appearing to act independently in their own sphere of influence, e.g. OEMs focus on design aspects.

There are, however, some significant product developments which eliminate or minimise the need for unified cartridges, although most of these are not new or directly attributable to the legislation. These include Xerox's Solid Ink system, its toner bottle replacement system, and Kyocera's long-life print-head and toner cassette. On the ink-jet side, Epson's Ecotank® system allows direct ink refilling without cartridges. All except Kyocera's have been on the market for some time, involve significantly more expense on purchase of imaging equipment, and tend to target the higher volume users in the larger office environments. Their material benefits are, however, well documented.

5.6. Structured action under the Voluntary Ecodesign Scheme for Imaging Equipment

Directive 2009/125/EC of the European Parliament and of the Council of 21 October 2009 establishing a framework for the setting of ecodesign requirements for energy-related products (the Ecodesign Directive) provides a legal framework for laying down ecodesign requirements for selected priority product groups. Imaging equipment is a qualifying group under this Directive and could therefore be subject to either mandatory (legal) or voluntary measures to address compliance. Voluntary agreements (VAs) or other self-regulation measures can be considered as alternatives to implementing measures in the context of the Ecodesign Directive, provided that they can achieve the same policy objectives more quickly or at lesser expense than mandatory requirements. VAs, when proposed, must comply with the criteria laid down in Annex VIII to the Ecodesign Directive.

Companies active on the imaging equipment market proposed a voluntary scheme for the imaging equipment product group in the EU and, accordingly, concluded a voluntary agreement laying down specific ecodesign requirements for imaging equipment placed on the EU market. The voluntary scheme was agreed on 16 February 2011.

At this point, a coordinating body, EuroVAprint⁶⁵, was established by most of the significant OEMs to manage the scheme and its compliance auditing. EuroVAprint's website is set up as a transparency measure, publishing the text of the agreement and all relevant documents, including a list of the signatories, compliance reports, invitations to Steering Committee meetings and minutes from Steering Committee meetings.

Figure 34: Original membership of EuroVAprint as of 2012 (at eurovaprint.eu)



Current membership (2016-17) comprises: Brother, Canon, Epson, HP, Konica Minolta, Kyocera, Lexmark, OKI, Panasonic, Ricoh, Samsung, Sharp, Toshiba and Xerox. However, the 2016-17 report announces that Dell, Ricoh and Panasonic will have withdrawn from the agreement by 31 March 2017, but the agreement is still valid as the remainder cover more than 80% of the industry.

The Voluntary Agreement (VA)⁶⁶ includes, *inter alia*, commitments to comply with the requirements for cartridges (e.g. the design should not prevent the reuse/recycling and use of cartridges of other producers). In addition, all new products should comply with the requirements for recycling (e.g. easy disassembly and marking of plastics).

The following specific clauses are relevant here:

- *Paragraph 5.2 Design for recycling*⁶⁷
For all product models first placed on the EU market after 1 January 2012:
 - *Plastic parts >100 g shall be manually separable into recyclable plastic streams with commonly available tools.*
 - *Product shall utilize commonly used fasteners for joining components, subassemblies, chassis and enclosures.*
 - *Non-separable connections (e.g. glued, welded)*

⁶⁵ <http://eurovaprint.eu/>

⁶⁶ INDUSTRY VOLUNTARY AGREEMENT TO IMPROVE THE ENVIRONMENTAL PERFORMANCE OF IMAGING EQUIPMENT PLACED ON THE EUROPEAN MARKET, VA v.5.2 April 2015

⁶⁷ It is assumed that cartridges qualify under this paragraph.

Note: this requirement is in the context of the imaging equipment, but arguably ought to apply to equipment and cartridges separately, and similarly with clause 5.3 on polymer composition and 5.5 on recycled content.

- *Paragraph 5.4 Cartridges*

For all new product models first placed on the EU market after 1 January 2015:

- *5.4.1 Any cartridge produced by or recommended by the OEM for use in the product shall not be designed to prevent its re-use and recycling.*
- *5.4.2 The machine shall not be designed to prevent the use of a non-OEM cartridge.*

The requirements of paragraph 5.4 shall not be interpreted in such a way that would prevent or limit innovation, development or improvements in design or functionality of the products, cartridges, etc.

- *Paragraph 6.3 Cartridge disposal and treatment*

For new product models first placed on the EU market after 1 January 2012, Signatories shall provide end-users with information on suitable end-of-life management options for used cartridges.

This information may be communicated via a company website.

It was estimated that the commitments undertaken by the signatories to the voluntary agreement would generate savings in 2020 of 15 TWh, corresponding to 4.1 million tonnes of CO₂ emissions and between 2011 and 2020 of 130 TWh, corresponding to 36 million tonnes of CO₂ emissions. It should be noted that this refers to the effect of measures beyond those related to cartridges, more specifically relating to reductions in energy usage by the printers themselves. The effects of the cartridge design and performance in this respect are not quantified or reported.

5.6.1. Verification of and compliance with the Voluntary Agreement (VA)

Progress under the VA must be reported annually and published on a dedicated website, namely <http://www.eurovaprint.eu>

Compliance with the VA is reported in the annual report, the latest version of which (April 2017⁶⁸) covers the period 1 January 2016 to 31 December 2016. An independent inspector, RINA Consulting (formerly Edif ERA), is the current agent assigned to assess members' compliance with the Voluntary Agreement. The independent inspector reports publicly on the industry's progress in meeting the agreed sustainability targets in a yearly progress report.

Signatories are required to provide the independent inspector with regular sales data for products falling under the scope of the Voluntary Agreement and the level of compliance with the criteria set out in the agreement. Information published by the independent inspector is anonymous and aggregated to respect signatories' commercial confidentiality as well as EU competition rules. Information is self-declared by OEMs, but the inspector also examines and verifies in-depth data from two randomly chosen OEMs for each annual report as a check on reporting accuracy.

⁶⁸ http://www.eurovaprint.eu/fileadmin/eurovaprint_files/Member_Only/Reports/REG0342001_EuroVAprint-7th_period_rep1.pdf [viewed 2 June 2017]

The paragraphs relevant to printer cartridges described above fall under compliance audits of Part II and Part III, for which, according to this report, 100% compliance has been achieved and verified by RINA Consulting.

5.6.2. Reporting under specific clauses of the VA

Regarding VA Paragraph 5.4: design to enable reuse

This is a 0% or 100% measure in that all cartridge/printer models must comply for each manufacturer. Since the aggregate compliance measures in Part II (of which Paragraph 5.4 is one) for all manufacturers are recorded as 100%, it is assumed that all are compliant. However, it is unclear how this clause has been verified beyond the self-declaration by the signatories.

Indeed, it is perhaps one of the most contentious aspects of cartridges and printers raised repeatedly by ETIRA and its membership. The issue of both 'killer chips' in the cartridges and complementary software on the printer generates an ongoing list of complaints and disputes in the sector. Whilst the qualifying clause admits the possibility that even products in use could be enhanced for the user by, for example, software upgrades, it seems surprising that such upgrades do not seem to be checked systematically for conflicts with cartridge systems.⁶⁹

Regarding VA Paragraph 5.2: design for recycling

VA Paragraph 5.2 considers design for recycling, but the scope of this is limited to the imaging device itself. An improvement to the VA could consider that this clause should apply to both the imaging device and the cartridges, although promoting recycling over reuse. In this area, Kyocera, for example, is open in declaring that its toner-only cassettes have only 5 parts, 2 plastics and are equipped with recycling ID labels, and with an expressed commitment to disassembly. By examination of OEM websites, declaration of recycled plastics content in any other products is variable and may not specify whether this is open or closed loop.

Regarding VA Paragraph 6.3: end-of-life communications to users

This aspect is recorded as a simple 0% or 100% compliance rate for each signatory. That is, all models placed on the market in the period must comply. For all signatories, this measure was 100% and this is simply verified by visiting their web-sites and seeing information to users on return channels.

5.6.3. Effect of measures taken by the industry under the Voluntary Agreement

The efficiency of the measures taken in respect of the VA with regard to cartridge take-back and reuse cannot be determined from the data routinely collected during the audit. The agreement clauses are presented as pass/fail and thus simply measure whether the supporting conditions for e.g. take-back are in place, but not the impact of the presence of those conditions. This is in contrast to the measures in Part I which describe e.g. energy efficiency improvements which are subject to continuous

⁶⁹ Such a case has been reported in respect of an HP printer firmware upgrade <http://www.techradar.com/news/hp-exploits-firmware-update-to-make-its-printers-reject-third-party-ink> [Accessed 21 September 2017]

improvement (though it should be noted that these aspects are not majorly dependent on the cartridges themselves, but rather on the printer).

It is therefore not possible to determine whether there has been any effect on take-back or re-use of cartridges from this source.

5.6.4. Conclusions

The Voluntary Agreement appears to be well set up to drive particular improvements in imaging equipment performance, for example, energy usage which shows a downward trend. However, it is very weak on driving improvements in the consumables aspect of printing. Its focus is clearly on conventional toner and ink cartridges, which fall within the scope of the WEEE Directive.

The clause related to 'Cartridges' outlines principles to which manufacturers should adhere, and compliance is reported as being achieved, but the method of verification is not transparent and should be made more so. More importantly, with reference to what is observed in the market, there are ongoing reports of practices which frustrate reuse via firmware. Why these contraventions have not been reported is unknown, as are the penalties associated with them beyond the naming and shaming by consumer organisations.

The clause dedicated to design for recycling should be amended to embrace cartridges and other consumables primary packing too as should clauses on polymer composition and recycled content.

More fundamentally, there are no explicit measures of performance in take-back, reuse or recycling of cartridges. There is no obligation to report progress on the impact of measures that could promote take-back, assist reuse and monitor recovery rates of un-reusable fractions in the way that, for example, energy use targets are, and these might usefully be addressed in revisions to the terms of the Voluntary Agreement.

A further area of potential lies in producers individually or collectively instituting, promoting and reporting on measures which could improve collection rates and the quality collection conditions to enable preparation for reuse activities.

6. ECOLABEL CRITERIA AND PRINTER CARTRIDGE REUSE

This section considers whether and to what extent the use of ecolabels has influenced the cartridge re-use market. Ecolabels focus on elements of design, manufacture and use in the provision of goods and services. Therefore, it can be conceived that aspects such as design for re-use of cartridges, information available to the user via the printer or leaflet, systems of take-back of used cartridges, recycled content of printer and cartridges and others could be targets for assessment under a labelling system.

Three labelling systems have been reviewed, those being the predominant ecolabelling schemes in Europe. In the sections below, clauses relevant to cartridge re-use have been identified, quoted and summarised. Uptake of the label is then quantified where information is available. A final section draws conclusions about efficacy of particular labelling approaches based on uptake as a proxy for activity in the market.

6.1. EU Ecolabel

Within EU Ecolabel (and by association, GPP), printers – as envisaged within the scope of this work – fall under the classification of Imaging Equipment. Such equipment may be awarded an EU Ecolabel license if it fulfils the criteria of the product group, the first publication of which (2013/806/EU) was adopted in 2013.⁷⁰ The criteria for printers embrace aspects of paper management, energy efficiency, indoor-air and noise emissions, hazardous embodied substances, reuse, recycling and end-of-life management and – of relevance to this work – ink and toner consumables used in printers.

Criteria 10, 11 and 12 refer to stipulations on *Ink and Toner Consumables* as follows:

1. Design for recycling and/or re-use of toner and/or ink cartridges.
2. Toner and/or ink cartridge take-back requirement.
3. Substances in ink and toners.

Criterion 10: Design for recycling and/or re-use of toner and/or ink cartridges

This criterion is quite clear that printers must be capable of accepting remanufactured toner or ink cartridges. This possibility must have been acknowledged in the design and – in particular – there must be no features in the product (hardware or software) that prevent such reuse. Further, OEM-recommended cartridges must be designed to accommodate reuse, and an example of such a remanufactured/refilled cartridge must be supplied.

"The products must accept remanufactured toner and/or ink cartridges."

"The products shall be designed taking re-use of toner and/or ink cartridge into consideration."

"The design of the cartridge recommended by the manufacturer (OEM) for use in the product shall promote its durability."

"Devices and practices that would prevent its reutilisation (sometimes referred to as anti-reutilisation devices/practices) shall not be present or applied. This requirement shall not apply to imaging equipment that is not using cartridges."

⁷⁰ COMMISSION DECISION of 17 December 2013 establishing the ecological criteria for the award of the EU Ecolabel for imaging equipment (notified under document C(2013) 9097)
N.B. 2013 also saw the revision of the imaging equipment GPP criteria.

"Assessment and verification: the applicant shall declare compliance with the criterion. The applicant shall provide to the competent body a copy of the user information. The applicant shall submit instructions on how the cartridge can be remanufactured and/or refilled or provide a proof (i.e. one sample) that cartridges have been remanufactured or refilled following the provided instructions."

Criterion 11: Toner and/or ink cartridge take-back requirement

This criterion stipulates that the applicant must offer a take-back system for cartridges which have been recommended for use with the product. The fate of these returned cartridges is left open: it expresses a preference for reuse, but acknowledges that recycling is an acceptable alternative. Accordingly, there is no mandate to re-use even though Criterion 10 sets the appropriate design framework for reuse.

"The applicant shall offer to users a take-back system for the return, in person or by shipment, of toner and/or ink modules and toner and/or ink containers supplied or recommended by the applicant for use in the product, in order to channel such modules and containers to re-use and/or material recycling with preference given to reuse. This also applies to residual toner containers."

"Third parties may be subcontracted to perform this task and they shall be provided with instructions for proper handling of residual toner. Non-recyclable product parts shall be properly disposed. Modules and containers shall be taken back free of charge by the return facility named by the applicant. The product documents shall include detailed information on the return system."

"Assessment and verification: a declaration that a take back system is offered to users for toner and/or ink modules and toner and/or ink containers and that such consumables collected are channelled for re-use and/or recycling signed either by the applicant or by the subcontracted third parties shall be provided to the awarding competent body."

Criterion 12: Substances in ink and toners

As in other EU Ecolabel product groups, this criterion restricts the chemical and bio-physical hazards associated with the toner and printer inks.

(a) No substances may be added to toners and inks (including solid inks) supplied or recommended by applicant for use in the product which contain mercury, cadmium, lead, nickel or chromium-VI-compounds as constituents. High molecular weight complex nickel compounds as colorants shall be exempted. Production-related contamination by heavy metals, such as cobalt and nickel oxides shall be kept as low as technically possible and economically reasonable.

(b) Azo colorants that might release carcinogenic aromatic amines appearing on the list of aromatic amines according to Annex XVII to Regulation (EC) No 1907/2006, shall not be used in toners and inks supplied or recommended by the applicant for use in the product.

(c) Only those substances which are listed as so-called existing substances in Annex II to Commission Regulation (EC) No 2032/2003 may be added as active biocides to inks supplied or recommended by the applicant for use in the product.

The standard offers no opinion on re-use of the consumable enclosure since it is dedicated to first use supply.

Uptake of EU Ecolabel

As of March 2017, there were no licenses awarded for imaging equipment.

In June 2017, the Commission finalised an extensive evaluation (fitness check) of the EU Ecolabel scheme.⁷¹ As a result of this evaluation, it has been decided to discontinue the EU Ecolabel criteria for Imaging Equipment product group.

Prior to this action and in support of the revision of the EU Ecolabel and Green Public Procurement criteria, the JRC had independently conducted a stakeholder survey on the imaging equipment criteria.⁷² The JRC summarised their feedback as follows: Whilst there were generally good reasons for supporting labels which promote environmental improvements, several factors act against an EU Ecolabel for imaging equipment specifically, including that other labels such as Blue Angel are more widely recognised; and that cartridge consumables (not covered to high extent in the current criteria) were considered a beneficial environmental target. It also appears that the issue of the EU Ecolabel criteria being too complicated and costly to comply with – specifically in relation to Article 6(6) related to hazardous substances – is a major barrier to uptake compared to other schemes.

Nevertheless, the stakeholder survey showed that there is substantial stakeholder interest in developing EU Ecolabel criteria for remanufactured cartridges along the lines of Nordic Ecolabel et al. and this is supported by the findings of this current study.

6.2. Nordic Ecolabel (Nordic Swan)

The Nordic Ecolabelling scheme matches closely the approach of EU Ecolabel. There currently exists an equivalent standard (version 6.3) for Imaging Equipment including consumables, generally classed in the sub-class 'extra equipment'. The standard does not, however, deal explicitly with inkjet systems; only laser printers.⁷³

Nordic Ecolabel contains two relevant clauses, namely Criteria O6 and O23:

Criterion O6: Special requirements as to products with combined toner cartridges

A combined toner cartridge integrates the toner reservoir with the pick-up and roller housing and is the predominant cartridge system. Like EU Ecolabel, clauses exist to permit the use of remanufactured/refilled units, and that a return system is in place.

"Products with combined toner cartridge may be accepted if the cartridge is not designed to prevent reuse."

"Products must accept re-manufactured toner cartridges."

"In order to ensure that the toner cartridges are returned for reuse, a return system must be offered for re-cycling combined toner cartridges and information to user about the return system must be provided" [this point is reiterated in O22 Information to Consumers].

⁷¹

http://ec.europa.eu/environment/emas/pdf/other/SWD_2017_253_F1_OTHER_STAFF_WORKING_PAPER_EN_V3_P1_942100.pdf

⁷² JRC (2017) 'EU Ecolabel for imaging equipment – Interest in the label and reasons for the lack of uptake'

⁷³ These criteria are also compatible with the Blue Angel and Eco Mark accreditation schemes.

Criterion O23: Re-cycling and re-use of consumer durables and parts that wear out

This criterion details the treatment of used consumables, and is similar to EU Ecolabel Criterion 11. Again, recycling or re-use are mandated, but there is no preference for one over the other.

"...

Collected toner cartridges, drum kits, light-sensitive drums and residual toner containers collected by the license applicant or the representative of the license applicant must be reused or re-cycled."

There is also a standard for Remanufactured OEM Toner Cartridges, selected elements of which appear below:

Criterion 2.1 (R2 et al.) Toner powder

This stipulates safety, health and environmental criteria with respect to the replacement toner (these are in addition to stipulation on metals, VOCs, SVHCs and composition of replacement parts etc. common to European ecolabels):

"The toner powder must not be classified under the EU's Dangerous Substances Directive 67/548/EEC, Directive 1999/45/EC as amended and the CLP Regulation (EC) No 1272/2008 as amended..."

"Extraction shall be provided for all handling of loose toner powder..."

These ensure that remanufacturing/refilling systems match those of new (OEM) products.

Criterion R10 Reuse

"The toner cartridge or container must be used by the consumer and then collected, cleaned, checked for defects, repaired and refilled with toner powder. The remanufactured OEM toner cartridge must comprise a minimum of 75% by weight recycled parts, as an average of at least 100 units."

The applicant is also obliged to specify this percentage, and which parts are replaced as part of re-use documentation. In addition:

"The specification for the expanded cartridge type with a new toner container must contain information on the number of printouts from the remanufactured OEM toner cartridge type. Testing is to be carried out in accordance with the chosen method in R16."

Criterion R11 Take-back systems

To ensure that the products are returned for recycling, a cartridge take-back system must be in place. Agreements between the manufacturers and distributors/resellers shall include a clause stating that the distributor/reseller shall, via their website, provide a take-back system as specified below.

Criterion R12 Waste

"All waste from production and preceding preliminary sorting must be sorted at source, and the various fractions (e.g. plastic and metal) shall principally be recycled. All toner powder waste must be packed up in suitably sealed packaging to minimise spillage. If there is documented evidence that a fraction cannot be recycled, the fraction must nevertheless be dealt with in an environmentally acceptable manner."

A waste plan must be in place to ensure that all waste fractions are responsibly handled via accredited and named operators.

Criterion R15 Print quality

"All toner cartridges must be tested to and comply with one of the following standards/test methods:

- *DIN Technical Report No. 155:2007-09*
- *ASTM F:2036 for monochrome printouts*
- *DIN 33870-1 for monochrome printouts*
- *DIN 33870-2 for colour printouts..."*

Criterion R16 Print capacity

"All toner cartridges must be tested to and comply with one of the following standards/test methods:

- *DIN Technical Report No. 155:2007-09*
- *ISO/IEC 19752:2004 for monochrome cartridges*
- *ISO/IEC 19798:2007 for colour cartridges*
- *DIN 33870-1 for monochrome cartridges*
- *DIN 33870-2 for colour cartridges*
- *ASTM F:1856*

...

Requirement level for print capacity for each cartridge type in application, in a comparison of the test results between the remanufactured OEM cartridge type and the equivalent OEM cartridge type: The average value for the remanufactured OEM cartridge type must not fall below -10% in the above comparison."

Uptake of Nordic Ecolabel for remanufactured cartridges

Uptake of the Nordic Ecolabel for the remanufactured cartridges has been extraordinary with almost 7,600 product registrations as of June 2017. These include HP (>4,300), Kyocera (>780), Canon (>670), Lexmark (>510) and Brother (>341) although these are not exclusively by the OEMs themselves (dominated by Brother and Lexmark).

6.3. Blue Angel Ecolabel

The Blue Angel scheme follows the Nordic Ecolabel closely in content. However - and significantly - it separates the imaging equipment license from the cartridge license (strictly for toner cartridges). The cartridge license⁷⁴ is aimed entirely at remanufactured units and accordingly stipulates a range of criteria that encourage such units to match the new printer 'as supplied' cartridges as far as possible. As a result, there is a very high uptake of both printer and refilled toner cartridge licenses.

The toner module criteria were updated in January 2017, replacing the existing 2013 criteria. Importantly, the criteria were renamed from 'Recycled...' to 'Remanufactured...'. This seemingly small change reveals a much stricter ambition for the criteria and the treatment of cartridges, establishing re-use as a dominant strategy over recycling.

⁷⁴ Remanufactured Toner Modules for Electrophotographic Printers, Copiers and Multi-Function Devices, version 2.0, January 2017.

Criterion 3.1.1: Collection and Disposal

This criterion details the take-back requirements of used consumables, and is like EU Ecolabel Criterion 11:

"The applicant shall be able to provide proof of an efficient collection service system. Within the scope of such system empty and used toner modules (including their components) supplied by the applicant shall be recovered for the purpose of re-manufacturing. If the applicant is not certified under DIN EN ISO 14001 the operator of a collection service system shall be certified under DIN EN ISO 14001 or present an equivalent process description.

Where, for technical reasons, the toner modules cannot be remanufactured again in compliance with the process steps described in DIN 33870-12 or DIN 33870-23 the applicant shall, nevertheless, ensure the return as well as a proper utilization and disposal of the used products.

The applicant shall make sure that residual toner is packed in dust-proof containers and delivered to material or thermal utilization facilities."

Criterion 3.1.2: Remanufacturing

This criterion is explicit in outlining the expected steps, which are typical of remanufacturing processes elsewhere. These aspects cover the processes employed. Product performance is governed by reference to external test methods as described in this abstract:

"The toner modules shall be remanufactured in accordance with remanufacturing instructions detailing the remanufacturing process. The functionality of the toner modules shall be ensured by tests and documented in accordance with DIN 33870-1 or DIN 33870-2. Remanufacturing shall include and document the following process steps:...."

Criterion 3.3(.1): Testing/Emissions

This criterion covers both emissions of chemicals and vapours in use and is designed to ensure equivalence with original cartridges:

"If original modules and original toners are used the substance emissions from Blue Angel eco-labelled office equipment with electrophotographic printing function shall not exceed the maximum values specified in the Basic Criteria RAL-UZ 205. The applicable test guideline has been published as Appendix S-M to the Basic Criteria RAL-UZ 205. The evaluation of the emission tests shall be equally applicable to re-manufactured toner modules. The determination of ozone emissions shall be exempt from this requirement."

There are also clauses similar to Criterion 12 of EU Ecolabel regarding hazardous materials in the dies and toners.

Criterion 3.3.3: Fitness for use

This criterion reinforces the requirements of Criterion 3.1.2:

"...The remanufactured modules refilled with monochrome or colour toner shall meet the requirements of German standards DIN 33870-1 for monochrome printing equipment or DIN 33870-2 for 4-colour printing equipment. The test results shall be documented for each type of toner module in accordance with Annex C to the above-mentioned standards...."

It should be noted that there is cluster of such DIN standards (see next section), which specify equivalent test protocols for toner and inkjet cartridges. There are also

ISO/IEC standards which support related test protocols for e.g. print efficiency (prints per cartridge).

The Blue Angel criteria also specify that remanufacturers must keep full audit trails for the units they process including information on parts replaced.

Uptake of Blue Angel

As noted above, the separation of the cartridge from the printer asset license appears to encourage strong uptake of both licenses. For example, there are over 1,300 printers licensed under the scheme from across all major manufacturers, and nine remanufactured cartridge licenses recorded to date.

6.4. Supporting national and international standards and protocols

The following is a tabulation of major standards and protocols which specify methods for testing one or more aspects of toner and inkjet cartridge performance. It is important to note that these protocols do not specify what the performance standard should be, simply the method by which it is assessed.

Table 20: Related national and international standards and protocols

Protocol	Description
DIN 33870-1	This standard is only for remanufactured toner cartridges (B/W). Newbuilt cartridges cannot claim they comply with 33870-1. In addition to the many technical requirements, products must be properly labelled, and the company name must be on the box. Yield data must be included. Also, a protocol about the tests and information about the collection system used must be published on the internet.
DIN 33870-2	This standard is only for remanufactured toner cartridges for 4-way colour printers. Newbuilt cartridges cannot claim they comply with 33870-2.
DIN 33871-1	This standard is only for remanufactured inkjet cartridges (B/W). Newbuilt cartridges cannot claim they comply with 33871-1.
DIN 33871-2	This standard is only for new compatible inkjet cartridges for colour printers (4-colour system).
ISO/IEC 24711	Provides for evaluation of ink cartridge page yield for ink-containing cartridges (i.e. integrated ink cartridges and ink cartridges without integrated print-heads) for colour inkjet printers. It can also be applied to the printer component of any multifunctional device that has a digital input printing path, including multi-function devices that contain inkjet printer components. Both liquid and solid ink products can be tested using ISO/IEC 24711:2007
ISO/IEC 19752:2004	Provides for evaluation of toner cartridge yield for toner containing cartridges (i.e. all-in-one toner cartridges and toner cartridges without a photoconductor) for monochrome electrophotographic printers. ISO/IEC 19752:2004 can also be applied to the printer component of any multifunctional device that has a digital input-printing path (i.e. multi-function devices that contain printer components). It is only intended for the measurement of toner

	cartridge yield. No other claims can be made from this testing regarding quality, reliability, etc.
ISO/IEC 19798:2006	Provides for evaluation of toner cartridge page yield for toner-containing cartridges (i.e. all-in-one toner cartridges and toner cartridges without a photoconductor) for colour electro-photographic printers. It can also be applied to the printer component of any multifunctional device that has a digital input printing path, including multi-function devices that contain electro-photographic printer components.
ISO/IEC 29142-2:2013	Part 2 establishes the product and package labelling, and related reporting provisions for toner and ink cartridges used in printing devices that have a digital input printing path, including multi-function devices. It is intended for equipment used in office environments. It defines the information requirements for the cartridge characterization documentation on packaging and cartridges, and in reports.
ISO/IEC 29142-3:2013	Part 3 seeks to minimize product environmental impact throughout the cartridge life-cycle and at its end-of-life. To harmonize with existing environmental labels, standards, declarations, and green procurement criteria, these are referenced wherever possible.

Source: ETIRA

6.5. Survey respondents' views on labelling and procurement criteria

The survey posed a question as to whether the respondent was aware of ecolabelling and GPP schemes that are applicable to the printer cartridge sector.

Only one non-OEM respondent (a trade body) offered an opinion on the use of ecolabels. (This was couched in terms of GPP and EU Ecolabel, and it could not be applied generally across similar labels with the same objective.) The essence of the response was that since no supplier had adopted the EU Ecolabel, there was no incentive for public sector purchasers to take up GPP criteria in their purchasing decisions. This mechanism therefore appeared to have little value in driving wider change of supplier practice.

In marked contrast, Nordic Ecolabel has had a notable uptake for its Office Machinery license (including printers), but a remarkable uptake of its Remanufactured OEM Toner Cartridge license (near to 7,600). Blue Angel has also had a substantial uptake for both the printer's license (over 1,300) and the remanufactured toner cartridge license (9 awards).

This difference is attributed to the availability of a separate consumables license distinct from the printer. The printer criteria are not too onerous in terms of consumables end-of-life management. In addition, the consumables criteria provide a good specification of the performance measures which should result in a performance on a par with OEM specification.

6.6. Conclusions

There has been no uptake of the EU Ecolabel for imaging equipment, although it is recognised that the ecolabel has only limited consideration of cartridges and consumables. A number of factors act against an EU Ecolabel for imaging equipment specifically, including that other labels such as Blue Angel are more widely recognised and that the cartridge consumables were considered a more beneficial environmental target. It also appears that the issue of the EU Ecolabel criteria being too complicated and costly to comply with are a major barrier to uptake compared to other schemes.

On the other hand, there has been a very strong uptake of the Blue Angel ecolabel with respect to printers, and an encouraging uptake of the related criteria concerning remanufactured printer supplies. Nordic Ecolabel's performance in achieving nearly 7,600 licenses for Remanufactured OEM Toner Cartridges reveals that there is an appetite for accreditation of the remanufacturing operations of – mainly – large re-use organisations.

Given that Blue Angel, Nordic Ecolabel and the EU Ecolabel are equally accessible to potential applicants, it provides a strong signal that the separation of the imaging equipment and consumables criteria encourages behaviours supportive of high quality cartridge re-use without compromising adoption of criteria beneficial to 'good' printer performance.

Accordingly, with the recent decision to remove the imaging products criteria from the EU Ecolabel license portfolio, a new set of criteria aimed at remanufactured cartridges would seem beneficial. This could be in the form of future EU Ecolabel criteria for consumables, or perhaps more immediately in the form of additions to GPP criteria.

7. GOOD PRACTICE AND INSTRUMENTS THAT SUPPORT RE-USE

This section identifies good practices and supporting instruments to facilitate re-use or eliminate obstacles to re-usability.

7.1. Practices identified within OEMs

The following table provides a reference to the actions already identified in Section 5.5 regarding actions taken by OEMs. In the table, 'Mn' refers to identified action n by company M e.g. X2 is 'Xerox action 2'.

Table 21: Supporting instruments and practices to facilitate reuse

Stage of supply chain	Technical	Legal	Marketing	Logistical	Market
Research and development	[C1] [H1]				
Product and service development	[B1] [C2] [C3] [E1] [H2] [K1] [X2] [X3]				
Production					
Route to market			[L1]	[L1]	[L1]
After sales service			[L2] [X1]		
Consumption	[L3] [L4]				
Disposal				[I1]	
Remanufacture/reuse	[B2]		[L5]		

Note: B-Brother, C-Canon, E-Epson, H-HP, I-Industry, K-Kyocera, L-Lexmark, X-Xerox

As reported in that section, the review of industry actions has found that most of the activity has focused on the early research and design phases of the supply chain, with an emphasis on facilitating the recovery of material from WEEE, i.e. plastics recycling.

No evidence of collaboration between OEMs and remanufacturers could be found, with actors appearing to act independently in their own sphere of influence, e.g. OEMs focus on design aspects.

There are, however, some significant product developments which eliminate or minimise the need for unified cartridges. These include Xerox's Solid Ink system, its toner bottle replacement system and Kyocera's long-life print-head and toner cassette. On the ink-jet side, Epson's Ecotank® system allows direct ink refilling without cartridges. All except Kyocera's have been on the market for some time, involve significantly more expense on purchase of imaging equipment, and tend to target the higher volume users in the larger office environments. Their material benefits are, however, well documented.

7.2. Measures taken by Member States

The next step is to assess whether the measures implemented in the Member States align with the industry initiatives. The categories of measures applied by Member States are mapped along the supply chain and the barriers they seek to address, illustrated in Table 22.

Table 22: Mapping of Member State actions against barriers

Stage of supply chain	Technical	Legal	Marketing	Market
Research and development	Information exchange /			
Product and service development	Monetary incentives/ Non-monetary incentives / Guidance		Non-monetary incentives / Eco-labelling	Voluntary agreements
Production	Monetary incentives / Guidance	Regulatory measures additional to Art. 4 and voluntary agreements		
Route to market				Monetary incentives
After sales service	Information exchange			
Consumption				
Disposal	Monetary incentive /			
Remanufacture/reuse	Information exchange / Guidance		Non-monetary incentives/ Eco-labelling	

It can be seen from the above table that action areas covered by Member States overlap well with the impact areas covered by the manufacturers. The causal link has not been established, but it is likely that these areas are the most practically and easily implemented, and can be tied to either financial incentives, guidance or commonly agreed standards activities which affect all equally.

As reported in section 5.4, it is not possible to disaggregate Member States' performance in treatment of end-of-life cartridges from the general WEEE statistics, or indeed from reports of cartridge take-back by each OEM. The learning here is restricted to statements regarding WEEE in general, for which there is no strong correlation between specific Member States' measures.

7.3. Expanding good practices and supporting instruments for printer cartridges and other types of EEE

The ten categories of EEE covered by the WEEE Directive are set out in its Annex I and listed below:

1. Large household appliances
2. Small household appliances
3. IT and telecommunications equipment
4. Consumer equipment
5. Lighting equipment
6. Electrical and electronic tools (with the exception of large-scale stationary industrial tools)
7. Toys, leisure and sports equipment
8. Medical devices (with the exception of all implanted and infected products)
9. Monitoring and control instruments
10. Automatic dispensers

An indicative list of EEE which fall within these categories is set out in Annex II to the WEEE Directive.

Characteristics of EEE that can be used to establish the feasibility of extending industry good practice and supporting instruments from the printer cartridge are summarised in Table 23 below. This table comments on the learning from the examination of the case of printer cartridges and its implication (indicated thus: →) when considering the equivalent aspects of other EEE products and their end-of-life treatment.

Table 23: Product/system characteristics of printer cartridges

Characteristic	General description	Printer cartridge assessment
Technical complexity	This characteristic describes how complex the product is, i.e. number of parts, range of operations etc.	<p>Inkjet cartridges are simple products with few constituent parts. Toner cartridges are more complex, but still have only basic functionality compared to many other types of EEE.</p> <p>→Product design and simplicity ought to encourage competition amongst potential reuse agents.</p>
Product pricing	The price of the product.	<p>Printer cartridges are at the lower end of the price spectrum, particularly when distinguishing between home and business users. However, they are expensive in relation to the price of the imaging equipment itself.</p> <p>→Relatively high OEM pricing attracts new entrants.</p> <p>Cartridges are part of a 'two part' sales model.</p> <p>→Skewed pricing also motivates new entrants.</p>
Product lifetime	The time over which the product will be used.	<p>Printer cartridges – toner and ink-jet – generally have a lower product lifetime than many other types of EEE. 'Hoarding' at end of life is a well-known phenomenon in certain WEEE classes, such as phones, but unlikely for cartridges.</p> <p>→The danger with short life items is that they are considered as value-less. Improved consumer information and simple return processes should be used.</p>
Ease of remanufacture	The ease with which a product can be remanufactured.	<p>The remanufacturing process for printer cartridges is not technically complex.</p> <p>→Product design and simplicity ought to</p>

		encourage competition amongst potential reuse agents.
Industry structure	The types and size of stakeholders active in the industry.	<p>The printer cartridge industry is quite concentrated, predominantly made up of a small number of OEMs. The amount of non-OEM Asian import is small but increasing.</p> <p>→ Concentration into a small number of agents is known to encourage monopolistic behaviour to the disadvantage of consumers. More than 5 agents is usually considered appropriate.</p>
Technology evolution rate	The rate at which technology changes in a way which makes subsequent evolutions incompatible.	<p>The fundamental technology for printer cartridges does not change at a fast pace. However, frequent model upgrades and software updates mean that cartridge technology does change quite rapidly.</p> <p>High technology evolution rates act against reuse except where a high fashion/status marque (e.g. iPhone) has been established.</p> <p>→ Enforce compensating principles e.g. in design for disassembly, modularity ... which can offset high evolution rates by promoting scavenging for reuse.</p>
Market coverage	The coverage of population using printers/ cartridges	<p>It is widely acknowledged that the European market is mature so competition is between established brands for imaging equipment. The corresponding threat to like-for-like cartridge replacements is threatened by lower cost imports and remanufactured units.</p> <p>→ Mature markets have embedded structures of competition for new asset sales. Where linked consumables are involved, this may encourage a trend to over-pricing of the in-use phase.</p>
Incentives for reuse	The reasons for reman or recycling	<p>The incentives for remanufacture are economic and relate to the attractive margins on new cartridges. This serves to attract independent remanufacturing activity and a good network of collection agents before the cartridges become waste. This services the small office sector well.</p> <p>The incentives for recycling are both legislative in relation to the WEEE Directive, and as a means of clearing the market of potential remanufacturing core from the OEM perspective. OEMs are</p>

therefore motivated to retrieve consumables from larger institutions.

→In the absence of forcing legislation, high-priced assets have a natural incentive for collection and reuse. The relationship to the customer has a strong impact e.g. where a leasing or servicisation aspect is used, there is a shared benefit of product life extension.

→Forcing legislation, such as EPR, may be the most effective route, but only if it motivates product retrieval, intact, before it becomes waste. Deposits which reward product return as well as reuse targets on manufacturers could be effective.

These observations relate to factors which – in general – motivates action towards actions higher up the waste hierarchy. Noting that this report has undertaken no detailed study of other EEE categories or products within categories, the following section relates some general learning which could be applied to other EEE/WEEE regarding increasing circularity.

7.3.1. General learning

The example of printer cartridges has been used as a case study in respect of the role of relevant Directives in improving resource-efficient use of products. It is fortunate that relatively good statistics and market data are available, the market is competitive and actors are – on the whole – engaged in conversations about policy and practice. This has significantly aided this work. If comparable conditions do not exist in other sectors, equivalent examination may be significantly more difficult.

In being held up as a case study, it should be acknowledged the finding that around 20% (and up to 30% for some OEMs) of cartridges in circulation have been through a reuse cycle. For such a relatively inexpensive product, this is likely a high take-back ratio compared to other type of EEE, yet substantial potential exists for higher take-back. Within the existing take-back, the overwhelming majority of reuse is classed as remanufacturing under the waste prevention action of the Waste Framework Directive 2008/98/EC. This constitutes action before used EEE is consigned as waste; not only is the action occurring at the highest level of action, but the statistics recording it are not routinely collected either to track performance or to make public performance of OEMs or producers in respect of product life extension. The availability of such data in this type of EEE has no doubt contributed to a focus by some operators on reuse business models as a differentiator amongst competitors. By comparison, other type of EEE rarely achieve such transparency suggesting that equivalent focus on reuse is unlikely until there is more widely an obligation or mechanism to collect reuse data as part of waste prevention policy under the Waste Framework Directive.

As stated, the potential for further reuse of printer cartridges is still apparent. In part, this is because the levels of reuse are not linked to public disclosure or targeted action on reuse, a lesson of value in considering other type of EEE whether this refers to waste prevention or preparation for reuse.

Considering product design, printer cartridges are well-suited to reuse via the remanufacturing route, being quite modular in construction, simple to disassemble and

with a ready access to spare parts of comparable or equal quality to those in OEM products. In other types of EEE, where these features do not pertain, high-quality reuse will be difficult to encourage.

Linked to this aspect, a key feature of the printer cartridge market is the presence of third party remanufacturers. It is commonly observed that remanufacturing markets across other sectors are stimulated by the activities of such operators, only later provoking an OEM response to reclaim the competitive space. Where OEMs do become involved, business models adapt to engage circular product and material flows. Again, product take-back often then falls outside the scope of consigned waste statistics with the result that informed policy action is not possible, assessments on the true flow of products and materials in the economy is skewed and, not least, operators are not fairly exposed or credited for their resource efficiency behaviours.

With respect to the application of EPR schemes across other EEE (or indeed all products), the same general lessons from printer cartridges apply. These are discussed more fully in the next section, but centre on disclosure, collection of waste-prevention-related reuse statistics as a complement to waste statistics, and the differentiated application of fees on non-reuse waste treatment options to motivate higher material efficiency solutions. Such solutions could, of course, include innovations in "servitisation" which further dematerialise the provision of product-services.

Further research is needed to identify which type of EEE or products within the different categories of EEE might be selected for focussed action in the point of motivation i.e. which encourage remanufacture as part of waste prevention, or as part of preparation for reuse by OEMs or third parties; by selection of aspects of collection and disclosure of statistics on reuse by OEMs etc; by availability of reuse and repair information; and potential customisations of EPR schemes that might motivate high-value reuse.

8. CONCLUSIONS & RECOMMENDATIONS

8.1. General findings

8.1.1. Market dimensions

The total current market size for inkjet cartridges in Europe is around 370 million units per year and worth approximately €9.4 billion.¹⁴ Of the 370 million units, around 20% service the business market. Of the supply into the market, around 13% is reused cartridges, with 2% from non-OEM 'clones' and the balance from OEM sources. Of the reused 13%, around 2% have been previously reused. The collection rate of used cartridges is estimated at 65 million units per year (18% of market); 75% are successfully refilled, the balance being recycled or sent to energy recovery. Considering the ultimate re-use potential, it is possible that up to 80% of cartridges could be economically reused if the market structure remains similar. The flow of new and reused inkjet cartridges is illustrated in Figure 35.

The total current market size for toner cartridges in Europe is around 135 million units per year and worth approximately €10.2 billion.¹⁴ Of the supply into the market, around 20% is reused cartridges, with 4% from non-OEM 'clones' and the balance from OEM sources. Of the reused 20%, around 4% have been previously reused. ETIRA estimates that there are up to 200 different toner cartridge models currently on the market. The collection rate of used cartridges is estimated at 33 million units (25% of market), 82% are successfully refilled, the balance being recycled or sent to energy recovery. Considering the ultimate re-use potential, it is possible that up to 80% of cartridges could be economically reused if the market structure remains similar. The flow of new and reused cartridges is illustrated in Figure 36.

8.1.2. Re-use sector characteristics

Based on turnover, most independent refilling companies are SMEs; half have a turnover less than €2 million, and 85% less than €10 million, per annum. Most mix re-use with other activities but, even so, over 73% on average of these companies' activity is related to reuse, with a slightly higher proportion of staff dedicated to it (83%) reflecting the manual intensity of remanufacture. Around two thirds of these companies undertake the most rigorous form of reuse: remanufacturing.⁷⁵

Most of these companies operate a dedicated collection scheme - their own or via agents. Only a minority (7%) do not have such a scheme. This indicates that, on the whole, operators are behaving responsible with respect to end-of-life obligations (amongst the respondents, at least). Most of the reprocessing of collected cartridges takes place in the EU; all cartridges unfit for re-use are recycled within the EU.

Business customers are most alert to the potential of purchasing reused versus new cartridges. Household consumers and public sector buyers have lower propensity to purchase reused cartridges. Most sales are direct sales rather than service contracts.

In respect of pricing, the mean resale value of a reused cartridge is around 50% of new, but this varies between 30% and 70% depending on region and other factors. Almost all suppliers offer a warranty on units, half of them for two years or more. In

⁷⁵ It is likely however, that the survey is biased towards operators who have a higher profile and more resources to respond to surveys. There is undoubtedly a long tail of small and micro-operators not represented here. Taking this into account, calculating an average turnover and using the approximate market size for reuse, the survey supports ETIRA's view that there are upwards of 1,000 companies operating in refilling / remanufacturing printer cartridges.

support of this, operators adhere to on average two international or trade body test standards and norms.

Figure 35: Flows and fates of inkjet cartridges

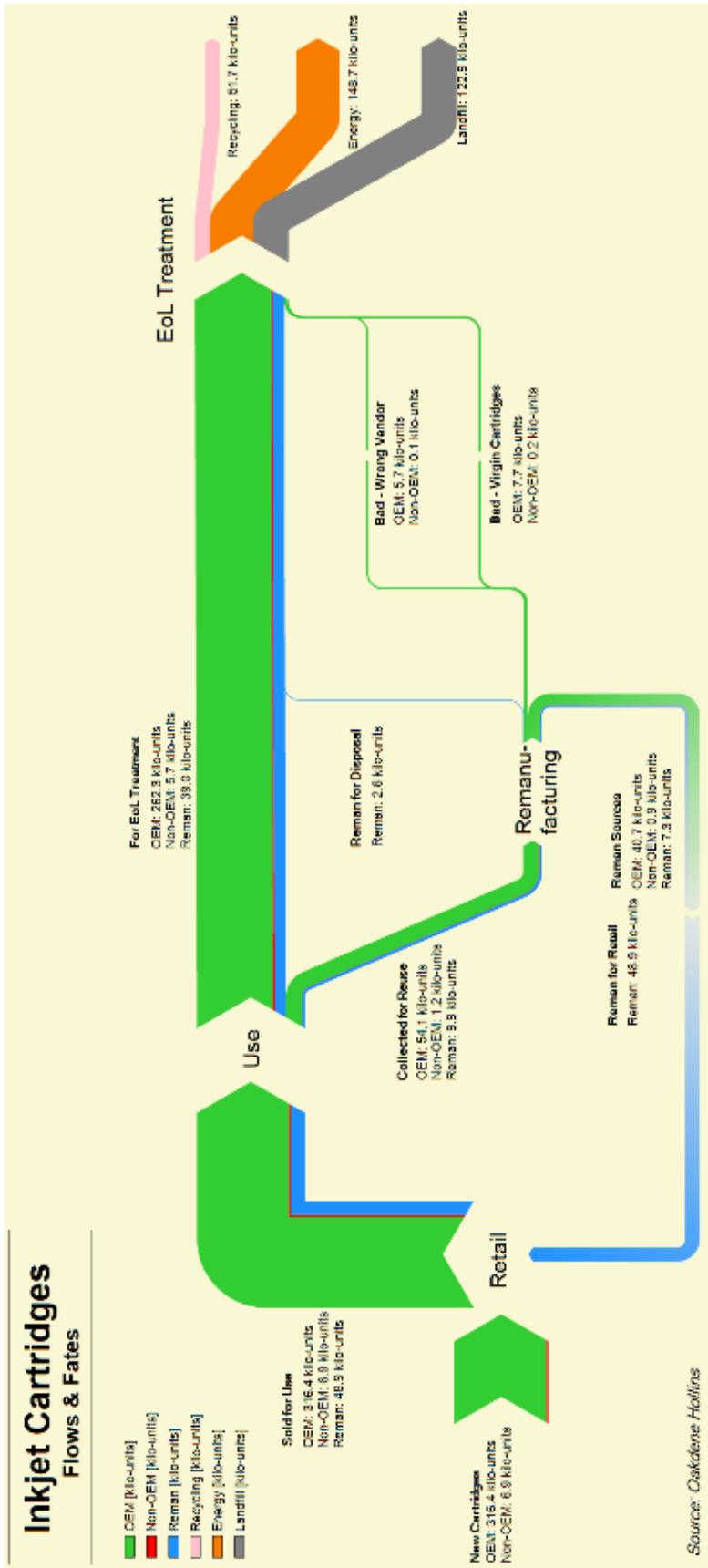
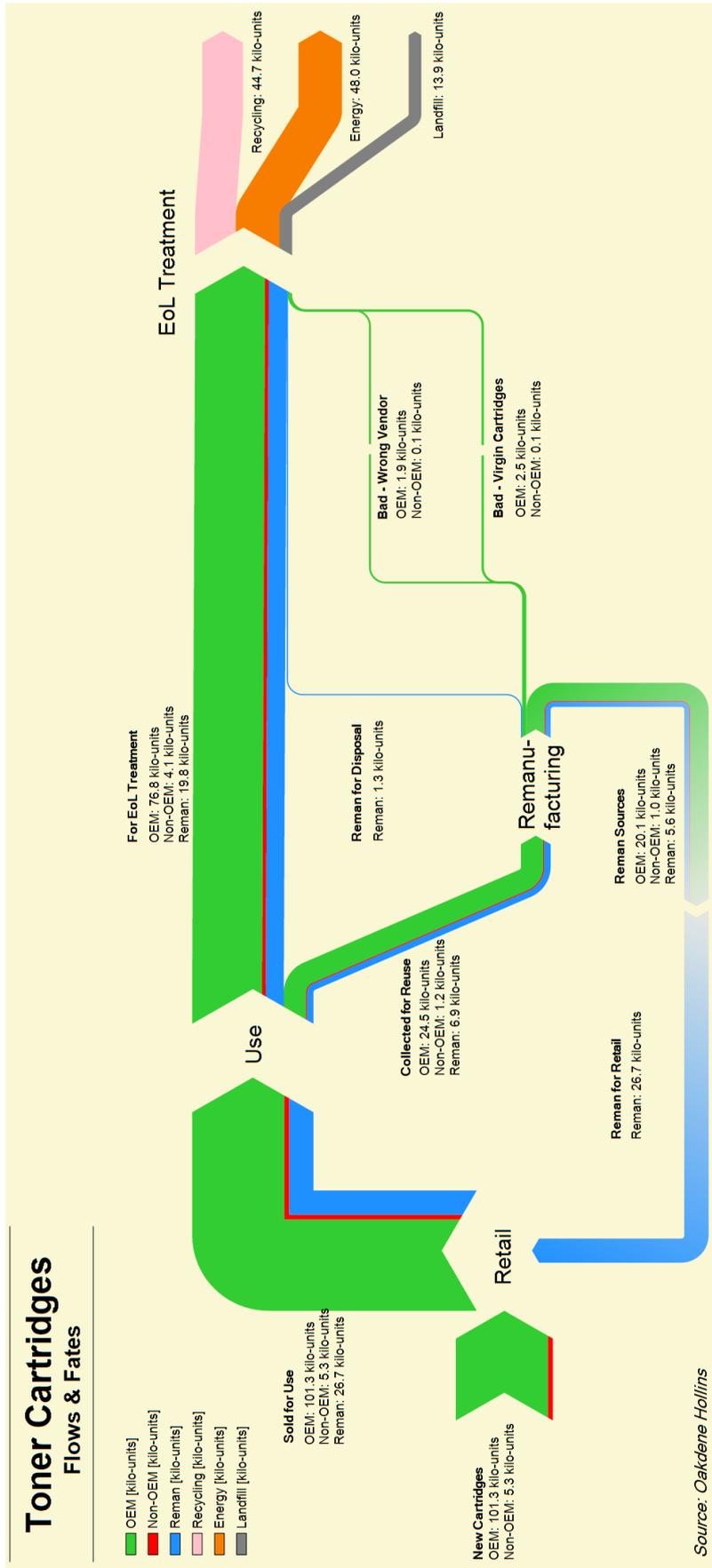


Figure 36: Flows and fates of toner cartridges



8.1.3. OEM characteristics

In contrast to remanufacturers, OEMs are almost exclusively large enterprises with substantial EU sales, largely in excess of €50 million per annum.

All OEMs operate a take-back scheme for used cartridges, either in-house or via agents. However, only 3 of the 11 respondents indicated that the collected cartridges were for reuse. Of those OEMs replying, the recycling rate of discarded cartridges ranged from 65% to 100%, indicating that OEMs currently prioritise recycling over reuse.

Amongst the customers of OEMs, the majority of sales are of new cartridges. However, the public sector shows a greater propensity to buy reused cartridges to an even greater extent than the remanufacturer sales ratios. The public sector may therefore be more trusting of OEMs.

8.1.4. Market trends

There is no clear consensus on the future expansion or contraction of the printer cartridge market. OEMs and remanufacturers alike were concerned at the growth of the import mainly from China of clones in either its compliant or its IP-breaching form as being unfair competition, undermining the market and not fulfilling quality and environmental standards in use and manufacture. Amongst OEMs, the response is a continuing shift to service models which enable closer customer relations and loop closure.

Non-manufacturing stakeholders foresee a decline in re-use unless Article 4 of the WEEE Directive or other provisions are strengthened to further dissuade OEMs from discouraging reuse. The technological battle between parties over chip/printer hardware/software will continue.

8.1.5. Measures taken by Member States in support of Article 4 of the WEEE Directive

Diverse measures have been adopted by Member States in support of Article 4 of the WEEE Directive, ranging from guidance, labelling and voluntary agreements regarding product design to monetary incentives for products designed for recycling/reuse/etc. and national regulatory measures going beyond the scope of Article 4 of the WEEE Directive. No measures have targeted printer cartridges directly. The overall performance of WEEE management in terms of collection, (preparation for) reuse, recovery and recycling of WEEE, varies markedly between Member States, but there is no obvious correlation with the adoption of a particular measure or set of measures. Efficacy is more likely a function of the effectiveness of the implementation, policing and enforcement regime and prevailing cultural factors in the Member State. In general, a combination of different measures seems to be most effective involving regulatory, monetary and non-monetary (to a certain extent) measures. There may be opportunities for cross-learning.

8.1.6. Effect of the Voluntary Agreement (VA) on imaging equipment

The Voluntary Agreement amongst (currently) 15 OEMs has been in place as an alternative measure to legislation to motivate improvements primarily in energy efficiency, but also contributing to take-back and reuse, amongst other aspects. However, the information collected as part of the annual review process does not include statistical assessment of outcome measures that might demonstrate any progress, for example, increases in rates of take-back, re-use and recycling or recovery of un-reusable fractions. This is largely because the VA contains no commitments in respect of collection of used cartridges and reuse.

8.1.7. Effect of ecolabelling schemes on supporting reuse

There are three major ecolabelling schemes in Europe: EU Ecolabel, Blue Angel and Nordic Ecolabel. Of these, there are no licenses for printers under EU Ecolabel, but substantial numbers under the other two systems, and specifically for the reused or remanufactured cartridges aspect. This appears attributable to the fact that the last two labels have separated printer licenses from reused cartridge licenses, thus simplifying applications and permitting agents other than the OEM to legitimately and defendably (by using published test standards) support the re-use objective; that the EU Ecolabel is perceived as overly complex to comply with particularly in respect of the hazardous substances content.

It should be noted that the deficiencies of the EU Ecolabel are recognised according to a recent EU Ecolabel fitness check⁷¹ and a JRC report⁷¹ on a stakeholder consultation regarding the future of the imaging equipment criteria submitted to the EU Ecolabelling Board in June 2017. The latter recognise the benefit of having a label dedicated to cartridges and specifically remanufactured cartridges.

8.2. Key areas of concern

This study has identified concerns at many points in the supply chain and related to different stakeholders. Broadly speaking, these concerns and the corresponding actions may be categorised into the following:

- Creating a level playing field for the new and re-use markets.
- Consolidating patent holder and OEM protection and second user rights.
- Improving design for reuse, recycling and recovery.
- Ensuring reused cartridge performance.
- Improving re-use performance disclosure.
- Strengthening obligations under EPR schemes.

Some of the concerns might be categorised under more than one heading, but they appear only once.

The sections below briefly summarise the key areas of concern which have been raised by the stakeholders.

8.2.1. Creating a level playing field for both new and re-use markets

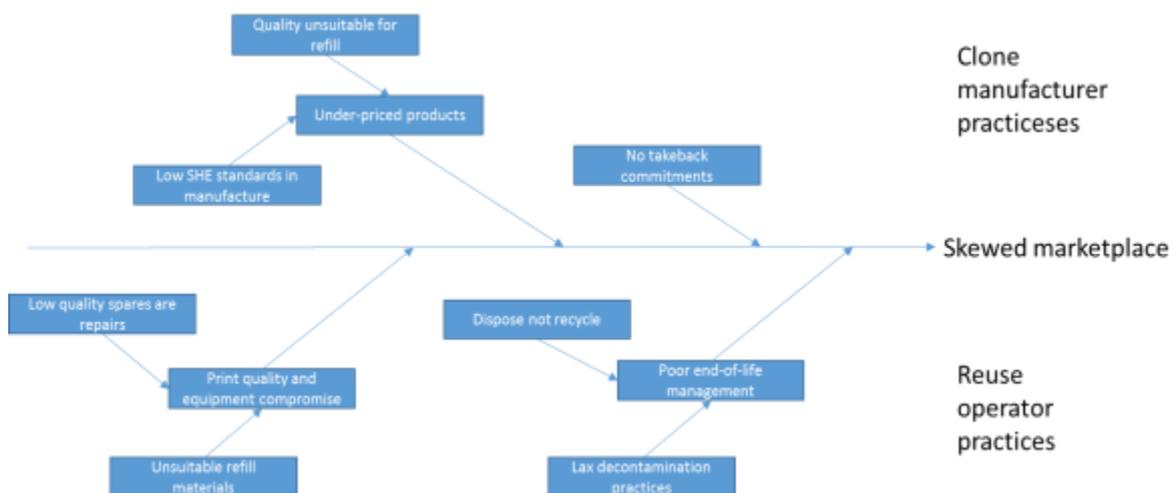
Both re-use operators and OEMs have identified aspects which impact on both new and re-use markets. In the new cartridge segment, the rise in sales of the clone is seen as a high threat. Here, (largely Chinese) imports can undercut prime producers through a combination of lower quality units and lower manufacturing standards, particularly in their health and safety aspects.⁷⁶ This has a further impact when re-use is considered as the cartridges may be unsuitable for remanufacture, contain toxic or restricted hazardous substances and may also fall short in their obligations to be taken back under the WEEE Directive.

In the re-use markets, it is not clear that all re-use operators/ remanufacturers take on burdens of product responsibility equivalent to those imposed on OEMs.

⁷⁶ Some are reported to breach IP rights of the OEM, a crime compounded by subsequent retailers and users.

According to the guidance provided in the BLUE GUIDE⁷⁷ on the implementation of EU product rules (2016), when remanufacturers of printer cartridges put on the market refilled/ remanufactured cartridges under their own trademark, and these cartridges meet the definition of electrical and electronic equipment (EEE) set out in Article 3(1)(a) of the WEEE Directive, then these remanufactures should be considered as producers of EEE. They should have the same obligations as all the other producers of EEE, including financing the take-back of waste from the EEE they place on the market when this comes to the end of its life and provide for the proper collection, preparation for reuse, treatment, recycling and other recovery. It also includes refilling cartridges with environmentally acceptable toners and inks and motivating the ultimate customers – the users – to return cartridges to the producer who placed them on the market.

Figure 37: Practices skewing new and re-use markets (by non-OEMs)



8.2.2. Consolidating patent holder and OEM protection and second user rights

'Exhaustion of first use rights' is a well-established legal principle with relevance in numerous high value markets such as automotive. Here, once a product has been sold, used and committed to disposal or reprocessing, the IP rights of the OEM no longer obtain. Subsequent operators may without hindrance repair/ remanufacture and remarket these products using their own brand name. In this case, as described in detail above, these operators are considered as producers of EEE under the WEEE Directive.

A recent court case⁷⁸ has highlighted that this issue is live within the printer community and has not been systematised in the way, for example, that the Motor Vehicle Block Exemption Regulations (BER) permit third party repair of motor vehicles (with caveats) without invalidating warranties. The judgement ruled that patents could not prevent third parties from remanufacturing cartridges retrieved under the US

⁷⁷ <http://ec.europa.eu/DocsRoom/documents/18027/>

⁷⁸ 'Ruling on IMPRESSION PRODUCTS, INC. v. LEXMARK INTERNATIONAL, INC' at https://www.supremecourt.gov/opinions/16pdf/15-1189_ebfj.pdf

domestic return programme nor imported used core.⁷⁹ The far-reaching finding is that once cartridges are sold, are the owners' to dispose of and treat them as they wish, within the law.

Clamp down on compatible imports which cannot demonstrate that: they have been made to equivalent safety and environmental standards, do not infringe IP, and have equivalent performance to new. This could be via greater diligence amongst public purchasers or more strongly through product-based legislation.

Of course, remanufacturers are not entitled to claim the rights and privileges of the OEM, but when, as described above, they are considered as producers of EEE, they should assume the onward responsibilities, warranties and end-of-life burdens.

In the case of refilled units, original branding should be removed or covered with a statement by the refiller indemnifying the OEM. There should be no statements which imply that the refilled unit is endorsed or guaranteed by the OEM if this is not the case.

8.2.3. Improving design for reuse, recycling and recovery

OEMs cannot introduce hardware or software systems that prevent the repair and re-use of the product – if it achieves the required functionality – within its use system; in this case a cartridge in a printer. This is already embedded within Article 4 of the WEEE Directive.⁸⁰ It is clear that there is a fine line between what an OEM considers to be a function or upgrade that improves 'user features' but which simultaneously for a remanufacturer creates a blockage requiring further technical workarounds. This is likely to be an ongoing source of dispute.

We recommend that as part of their commitment, EuroVAPrint publish a set of design principles for cartridges which enable or promote disassembly for the purposes of recycling or remanufacture. Such principles are well known in design and common to most products and include: use of reversible fixings with standard threads etc.; use of a limited set of common materials; non-use of embedded mouldings; minimising numbers of parts; designing key components for high durability etc.

In the same manner that they make available support information for their other EEE products, OEMs should publish disassembly and data related to the construction of their cartridges, including ink or toner specification.

⁷⁹ The judgement provided a striking example whereby, if Lexmark's claim were upheld, the analogous situation in the automotive industry would be that cars could never be serviced due to blocking by the patents of component manufacturers.

⁸⁰ Stating that "*Member States shall take appropriate measures so that [...] producers do not prevent through specific design features or manufacturing processes, WEEE from being re-used, unless such specific design features or manufacturing processes present overriding advantages, for example, with regard to the protection of the environment and/or safety requirements.*"

8.2.4. Ensuring reused cartridge performance and transparency

In the case of EU Ecolabel, the cartridge consumables criteria are bundled the imaging equipment criteria. In contrast, Nordic Ecolabel and Blue Angel have acknowledged the role of remanufactured and refilled cartridges, which are considered worthy of licenses in their own right with great success.

The recent fitness check of EU Ecolabel Regulation has led to the discontinuation of the imaging equipment product group. However, this work recommends that – if a new product group were to be created – that EU Ecolabel follows the practices of Blue Angel and Nordic Ecolabel and creates a distinct license associated with cartridge re-use and remanufacture. This will have the effect of ensuring cartridges are remanufactured by qualified and competent agents to a defined service quality akin to new. These criteria might beneficially be incorporated within GPP criteria in a short timescale.

There are concerns in all quarters regarding the provenance of both cloned new and remanufactured units. These lower priced units may compromise health and safety considerations in manufacture and use, may have lower page print performance and quality, and often avoid proper end-of-life treatment obligations.

It is recommended that all cartridges, new or refilled, should display prominently a complete range of information to inform the user of: the number of pages expected according to standardised tests e.g. DIN 33870-1/-2; conformance of toners and inks e.g. “the toner powder must not be classified under the EU’s Dangerous Substances Directive 67/548/EEC, Directive 1999/45/EC as amended and the CLP Regulation (EC) No 1272/2008 as amended...” ; and instructions for the managed collection and return of used cartridges, be that via the OEM, refiller, retailer or nominated third party.

Opinions differ between remanufacturers and OEMs, and even between OEMs, on whether there are life-cycle benefits attributable to remanufacture and re-use compared to recycling the cartridges. These arguments swing almost exclusively on the aspect of the percentage of substandard quality pages printed. Most OEMs contend that remanufactured or refilled cartridges – even if processed by them – have a higher reject rate, which disproportionately reduces headline LCA benefits (CO_{2e} in particular) associated with remanufactured versus new cartridge manufacture,⁸¹ and to the point where they may even be worse than recycling. Lexmark on the other hand claims equivalent quality to new. The ultimate choice therefore lies with the purchaser as to what is an acceptable quality. However, information to make this choice is not generated or communicated at point of sale.

⁸¹ The EuroVApriint position paper (‘The environmental impact of reuse vs. recycling of toner and inkjet cartridges - March 2017’ at http://www.eurovaprint.eu/fileadmin/eurovaprint_files/pdfs/Position_paper_LCA.pdf [accessed September 2017]) acknowledges this real difference. Its point of contention is that non-OEM remanufactured units do not meet a quality at which the performance of new and reused can be compared without considering the impact of paper wastage.

To avoid unnecessary re-work of failed prints, create a rating system for cartridges based on clear print quality criteria which establish whether a cartridge is suitable for premium quality, external or internal use e.g. by using the HP grading system used in its LCA study and by reference to DIN 33870-1/-2. The life-cycle impacts of not following this guidance can be made clear. This might usefully be appended to an EU Ecolabel criterion for remanufactured cartridges.

OEMs are particularly agitated that refillers repackage their goods with labelling such as 'genuine OEM remanufactured' which implies that the OEM itself has reprocessed or engaged an approved agent to reprocess the unit and is therefore underwritten by the OEM.

A range of acceptable descriptors should be generated by the entire sector, publicised amongst purchasers and retailers - not least by being prominently referenced on packaging, and policed for use. A 'name and shame' system could be used to alert to abuses. This is in the interests of all legitimate operators, OEM or independent.

8.2.5. Improving re-use performance disclosure

It is apparent that the Voluntary Agreement (VA) amongst printer manufacturers is not well-suited to the task of motivating transparent improvements in reuse, dismantling and recovery of printer cartridges as mandated by Article 4 of the WEEE Directive. That is not to say that such improvements have not occurred, but that the evidence collected under the VA is insufficient to support any such claims. To some extent, the efficiency of – in this case – cartridge collection, is not solely under the control of a particular manufacturer, but is also contingent within each Member State on the assisting measures in that jurisdiction. Nevertheless, by collection of appropriate statistics under the VA, it should be possible to discern, measure and publicise trends in the desired end-of-life treatments, by manufacturer and by jurisdiction.

A systematic review of the Voluntary Agreement is recommended in order that it suitably motivates collection of data relevant to the re-use market for toner and inkjet cartridges. For example, OEMs could usefully collect and publish collection (by geography) and re-use statistics (by region), even if in percentage form.

All producers and remanufacturers of cartridges should disclose their volumes of reused cartridges so that OEMs can compile and publish brand-based statistics on reuse across the sector. These metrics should include take-back rates, reuse percentage rates as well as the recovery and disposal rates for un-reusable products. Since reuse of EEE falls outside the remit of waste statistics, this would be a substantial step forward in measuring and actioning circularity and

The large fraction of cartridges going to WEEE, very little of which ends in preparation for reuse, represents a substantial lost technical opportunity. All producers of cartridges could take further steps individually or collectively - to put in place further opportunities to take-back used cartridges from users. These could be at retail outlets or at waste collection sites. Discarding used cartridges in WEEE collection sites together with other WEEE may result in damage which may not allow preparing for reuse. Therefore, measures such as making available generic packaging could assist in maintaining product integrity and allowing for its preparation for reuse. All potential reuse agents or potential preparation for reuse agents should have access to these sources of WEEE, but should conform to any quality criteria recommended in this report.

Reporting reuse, preparation for reuse, recycling and recovery via this route should be obligated in the VA for OEMs; parallel reporting by ETIRA, for the independent sector, should also be considered.

8.2.6. Strengthen obligations under Extended Producer Responsibility schemes

Whilst a number of non-OEM stakeholders reported that there was a lack of used cartridges to feed their business, many of the complaints were directed at OEMs. Complaints were made that OEMs were recovering 'core'⁸² and then sending the cartridges for recycling thus removing it from the potential reuse stream.

It is ironic that OEMs are criticised for successfully implementing a take-back scheme in line with their obligations under the WEEE Directive. The non-OEM respondents have concentrated their feedback on the outcomes of this activity rather than the mechanism which gave rise to that outcome. Their criticisms do not consider, for example, why reuse rates for used cartridges are well below 30%⁴, with the remainder being directly recycled, incinerated or landfilled. Accordingly, this study gives some consideration to the operation and objectives of these 'EPR' schemes.

According to the Commission's own text:

*'Extended producer responsibility (EPR) can be defined as "an environmental policy approach in which a producer's responsibility for a product is extended to the post-consumer stage of a product's life cycle."... EPR is typically understood to involve a shift in responsibility (administratively, financially or physically) from governments or municipalities to producers as well as an encouragement of producers to take environmental considerations into account during the design and manufacture phases of product development. EPR seeks to achieve a reduction in the environmental impact of products, throughout their lifespan, from production through end-of-life.'*⁸³

Such obligations are mandatory in a number of waste streams, including WEEE.

The language of EPR is informative: although the ethos of EPR is life-cycle management and waste prevention and relevant provisions are incorporated into the WEEE Directive, the prevailing paradigm for its implementation – in EEE – in practice

⁸² Used product, deliberately collected for remanufacture or other life extension

⁸³ http://ec.europa.eu/environment/archives/waste/eu_guidance/introduction.html

is almost entirely focussed on managing waste, diverting from landfill into recycling and not on reuse of products. Worse, the bulk of Member States' actions under collective schemes treat end-of-life EEE as already waste, promoting the materials recovery aspects of treatment infrastructure. This embeds the paradigm of used products as waste even before being consigned as waste, but also severely hampers the possibilities of maintenance of EEE as reusable product or the maintenance of WEEE in order to ensure its preparation for reuse.

This situation is well-described in reviews conducted for the Commission examining EPR practices across the EU, learning from them and providing guidance on setting up new schemes.^{84, 85} Particularly relevant findings are:

"Although sound waste management and recycling have generally increased through the implementation of EPR schemes, it is difficult to identify the impact of EPR on eco-design.

Firstly, few or no quantitative targets or indicators on eco-design and waste prevention have been developed within EPR schemes, as all of them are designed around main objectives on waste collection and recycling.

Secondly, the development of collective schemes, which mutualise responsibilities of many different individual producers, involve a risk of 'averaging' the costs among producers, thereby deter individual efforts for eco-design."

The studies outline a number of guiding principles to improve scheme performance, but on the whole their application does not acknowledge well the explicit need to move up the waste hierarchy from recycling to reuse. The main mechanisms outlined for this which could be exploited are:

- Much greater clarity over the objectives of an EPR scheme.
- Designing of a metric which fairly measures success according to agents in the supply chain.
- Ensuring true costs are accounted for (which could be interpreted as going beyond collection and treatment and including notional environmental impact not fully costed elsewhere) in order to promote the higher forms of product and material efficiency.
- Ensuring that these costs and benefits are fairly distributed amongst all actors involved in the supply chain.

With respect to products which are targeted for reuse, the last point offers greater complexity than typical collection and recycling-based EPR schemes, which essentially preserve the linear product economies. This indicates the challenge of EPR in the higher echelons of the Circular Economy: How to formulate and translate a higher objective into an equitable cost/benefit system.

The solution to this in the longer term may involve relaxing a fixed opinion on particular products which appear to be the headline concern and creating individual solutions. Instead the system should reward systemic technical solutions of higher material intensity, which dematerialise or eliminate take-back and waste management issues. These will demand producers to pay fees which are significantly higher than those used to fund material recycling infrastructure imposed today.

⁸⁴ Use of Economic Instruments and Waste Management Performance - Final Report, 10 April 2012, at http://ec.europa.eu/environment/waste/pdf/final_report_10042012.pdf [Accessed September 2017]

⁸⁵ Development of Guidance on Extended Producer Responsibility (EPR) - Final Report, for DG Environment, 2014, at http://ec.europa.eu/environment/archives/waste/eu_guidance/pdf/Guidance%20on%20EPR%20-%20Final%20Report.pdf [Accessed September 2017]

In the short term, EPR schemes could provide for different financial fees upon producers depending on the selected operation among energy-based recovery, material-based recovery, product-based recovery and reuse. Put simply, the fees paid by the producers to the collective scheme should be linked to product fate not to product placed on the market, with a differentiated scale of highest fee for energy recovery operations and no fee at all for reuse. This would motivate reuse as well as dematerialisation by any technical route. Deposit-return systems for cartridges could be beneficial for motivating greater returns in the home and small office markets.

The issue of how to include third party remanufacturers in this scheme would require some thought. Firstly, they would incur no fees for refilling and remanufacture of cartridges which they sell still under the trademark of the OEM. For the refilled/remanufactured cartridges they sell under their own trademark, they are also considered as producers in the context of the WEEE Directive and for these they would incur the fees (or a fair proportion of their market share).⁸⁶

8.3. Commentary on the context for action

The potential actions described in previous sections relate on the whole to moderate adjustments to the prevailing systems of business within the established legal and administrative framework.

It is the general finding of this study that the imaging devices and related consumables market is a mature one, and that all players, be they imaging equipment OEMs, refillers and remanufacturers, foreign 'clone' manufacturers and cartridge core collectors and brokers are all behaving perfectly rationally in their response to the competitive and legislative environment.

However, this does not mean that, from a resource efficiency perspective, the current situation is optimal. Given that cartridge take-back and reuse rates are well below 30% of items in circulation and could be substantially higher at least from a technical perspective, then there is a clear gap between what is and what could be. The fact that some OEMs have successfully adopted reuse models for cartridges without print quality impacts, strongly indicates that higher rates of reuse are possible if greater take-back could be achieved. Particularly in the large office and professional sectors there is an apparent shift towards, at least, a more service based approach. This can give rise to a number of solutions which minimise or avoid the consumables recovery issue, not least of which is much greater opportunity for cartridge reuse simply because of the good contacts with known customers.

It is apparent that technology developments in solid inks, simple toner and ink reservoir refill systems can dematerialise the consumables aspect. The flip side is that these demand more robust print-heads in the imaging equipment with a corresponding increase in up-front capital expenditure – or more likely amortised over the life of a service contract in professional use. But there are well quantified benefits in terms of cost per print and materials and energy impact over the printer life. It should be reiterated that these are not prevalent systems in the small office and consumer markets and the question is why and what further might be done in these markets.

As previously noted, this is a mature market with well-established brand names competing for share and to maintain profitability. The 'two-part' business model has

⁸⁶ They should not incur all these charges since this might have the perverse effect of OEMs 'forcing' end-of-life product down to third parties (by an unforeseen mechanism) to avoid end-of-life charges.

become embedded, in particular in the small office and home markets, because of this competition to hold share in new sales and the potential to reclaim margins through the not-altogether transparent cost of the toners and inks over the printer life. In addition, the unified cartridge model offers very high convenience to home users in particular. The threat of low but rising competition from Asian manufacturers only serves to embed the low-price printer model further.

Skewed pricing for the cartridges is a direct result of the need for margins to recover printer sales costs. It is therefore no surprise that independent agents and new entrants have been attracted to enter the market both as an opportunity to rejuvenate once-used units and to offer lower price and (perhaps) lower quality new cartridges. This is the sign of a competitive, well-functioning market. There appears to be a market for both these products, satisfying whatever level of requirements the consumers have. However, it does mean that the cartridge market size for the printer OEMs will be squeezed if no other action is taken.

The research in the context of this study indicates that OEMs are indeed operating used EEE return programmes, by direct communications to business and household users and also by use of brokers. Some OEMs do employ these take-back products to engage in re-use as a waste prevention activity. However, most OEMs use these collected items as feedstock for other recovery operations such as recycling or energy from waste, along with a proportion of items that cannot be reused. It is the case, however, that statistics on the return rates, reuse rates and recovery rates of take-back cartridges are not published by the sector under the Voluntary Agreement, and this may be a potential area of improvement.

Independent refilling and remanufacturing agents also work directly with customers or employ brokers to retrieve cartridges for reuse and thus before being consigned as waste. A high proportion of these are processed for reuse (as above), but similar issues on data collection regarding reuse fractions and waste pertain.

It is clear that a substantial fraction (over 70%) of used cartridges is consigned as waste and undergoes recovery operations. Anecdotally, it is considered that very little of this undergoes preparation for reuse due to cartridges being easily damaged when a careful collection system is not in place. Given the mechanical sensitivity of cartridges, greater efforts might be employed by producers and retailers to improve the rates of collection and to apply collection conditions that allow the reuse or preparation for reuse of the collected used cartridges. This might include specific drop-off points at retail locations – including return packaging – profile raising or incentives.

The WEEE Directive does encourage – as indicated in Articles 5,6 and 8, for example – a stratified approach to waste management in line with the waste hierarchy as established in Article 4 on the Directive 2008/98/EC on Waste. However, the evidence of this study is that, as formulated, EPR and EoL schemes do not send a strong signal to encourage anything beyond recycling, and certainly do not encourage reuse or even dematerialisation. Besides, as noted above, statistics on cartridge reuse as reused EEE, being outside the waste statistics remit, are not routinely collected; the opportunities for the sector to obtain credit for reuse activities are therefore not apparent.

From a material and environmental perspective, assuming quality of remanufactured cartridges can be maintained, reuse appears to be desirable. However, this does not mean it is economically desirable. The cost structures and obligations of OEMs may not provide a clear-cut financial case for reuse with its higher labour elements, uncertainty of core supply and core quality, and absorbing of some systemic costs which independent agents do not incur. Under these circumstances, opting for a safer model in which cartridges are recycled might be preferable by the OEMs.

8.4. Potential modifications to the regulatory regime

The WEEE Directive incorporates the waste hierarchy as established in Article 4 of Directive 2008/98/EC on waste, it introduces a joint 'recycling and preparation for reuse target' and provides for reuse centres to have access to WEEE. However, against the above background, it is still considered that the stipulations of the WEEE Directive do not provide a strong impetus to reuse.

The obligations of the industry VA similarly provide no overt impetus to reuse; there are no metrics associated with take-back, reuse and recovery actions for the fractions which cannot be reused, or targets to improve in this respect as there are in energy usage of the imaging equipment itself. That is in itself a clear failing of the current VA. However, a simple take-back or reuse target would not motivate reuse above the current performance; there is no evidence of a market trend in this direction as things stand. Something stronger is required. An opportunity exists because the voluntary agreement is open to revision. If the revised VA will not be strengthened to this respect, the option of regulation either under Ecodesign Directive or the WEEE Directive could be considered.

However, this will require a more nuanced approach than simply requiring reuse of separately collected used cartridges. Such a target would receive strong opposition from manufacturers as it would attract criticism that market choices were being arbitrarily and unfairly skewed; winners and losers would be being picked without a sound basis.

What is required is a metric that encourages competition, is technology-neutral, but drives improvements in the efficient use of materials. By technology-neutral, it is understood that no one particular method of efficiency is promoted or favoured ab initio. Although this study has considered cartridge reuse, there has been a persistent theme that superior life-cycle efficiencies can be achieved by dematerialisation tactics – elimination of cartridges or at least driving down their complexity and embedded impacts. Any proposed metric should be agnostic regarding such choices and encourage development of new technologies and services.

This topic requires substantially more consideration than can be provided in this study. However, a metric which uses as a proxy for materials, the energy (or CO_{2e}) equivalent of the LCA of the cartridges is a possibility. To make a genuine and comparable ranking of all potential delivery technologies, this measurement should assess not only the cartridges, but the net impact per print page (normalised in some fashion) of the entire print technology. This should be published, with the expectation of continual reductions in this impact.

In considering if such a metric is practical, we should seek analogies elsewhere. One comparator is in the automotive sector where year on year reductions in net CO_{2e} emissions per km are mandated under EU directives across the whole of a manufacturer's fleet of vehicles produced, weighted according to production volume. Equivalent 'fleet' statistics are already collected by imaging equipment OEMs in support of current VA reporting obligations. What is required is the energy impact component of equipment and consumables manufacture and remanufacture etc. Energy is good metric because, like money, it is fungible i.e. countable and exchangeable for equivalents elsewhere.

There are undoubtedly many further aspects not to say objections to such a proposal. For example, whether remanufacturers and refillers and other cartridge providers would report into this system too. For example, if remanufacturing a particular OEM's cartridge, they could be obliged to 'credit' this to the OEM via EuroVAprint, thus underwriting and validating OEM assertions of their use and reuse assumptions. In this

way, more agents who are often currently in opposition can be tied into a unifying and mutually beneficial framework.

Annexe A *Tabulated stakeholder responses to question on obstacles to cartridge reuse*

Table 24: *Comments by stakeholders on technical barriers to the reuse of cartridges*

Comments* on technical barriers from independent re-use stakeholders
<i>"The OEM's frequent Software/Firmware changes which cause alternative chips to fail."</i>
<i>"Firmware upgrades, sometimes pre-programmed before the printer is placed on the market, compromising third party cartridges."</i>
<i>"'Safety' measures set to ON by default at installation in [Brand A's] printers preventing compatibles from functioning or the swapping an empty cartridge for an already refilled one." 'Empty' messages and not printing without intervention to reset the device after installing a refilled or compatible cartridge.</i>
<i>"Chips on latest [Brand B's] cartridges not always able to be reset."</i>
<i>"Software update on some [Brand A] cartridges has blocked the use of remanufactured cartridges in the recent past."</i>
<i>"Mainly on integrated print-heads, we can't reset the data on the smart chip" or "Reverse-engineering a chip code is very cumbersome and expensive."</i>
<i>"Blocking chip technologies; printer behaviour changes if an aftermarket chip is detected; impossible to separate parts without damage."</i>
<i>"The main obstacles that we encounter from the original manufacturers are: constant firmware changes, encrypted chips and fragile cartridges."</i>
<i>"Firmware updates which eliminate the aftermarket."</i>
<i>"Electronic chips on cartridges and print-heads: where the chip is not resettable, then there is no notification of ink level anymore; printer firmware updates mean that remanufactured cartridges with new compatible chips do not work anymore."</i>
<i>"Inkjet cartridges with print-head: technological problems with very sensitive electronics; chip compatibility problem caused by firmware upgrades; new technology called jet intelligence - hard to remanufacture with full reliability; blocking cartridges to only operate in the first printer in which they were running."</i>
<i>"Technology barriers: on a cartridge, you can have over more than 100 patents. This impacts re-use as replacing some components to guarantee correct quality becomes very difficult. Software barriers: frequent software updates from OEMs that impact the functionality of reused products, so the user experience is negatively influenced. Just try to dismantle a laser or ink cartridge and it becomes immediately clear that they are designed to block reuse."</i>
<i>"No sharing of information on how to remanufacture OEM's do not make the information needed for easy remanufacturing available to customers or 3rd parties in any way."</i>

**Some comments have been edited for clarity and brand names removed for reasons of commercial sensitivity*

† The "first sales doctrine" refers to a (U.S.) legal concept that limits the control of patent holders after an authorised sale, i.e. after an item has been sold, the purchaser can freely use or resell the product without restriction from the original patent holder. This is analogous to the EU Principle of Exhaustion of Rights.

Table 25: Comments by stakeholders on legal barriers to the reuse of cartridges

Comments* on legal barriers from independent re-use stakeholders

<p>"Strange application of WEEE legislation in some countries. Less legislative protection against fake products as well as protection against products not fulfilling the requirements of EU legislations - no mechanism to control/prove the contents of the SDS (safety data sheets) used by some importers from Asia."</p>
<p>"No legal respect."</p>
<p>"Patents on components."</p>
<p>"Blocking patents and lawsuits with no regards for the 'first sales doctrine'"*</p>
<p>"Patents in combination with technical hurdles (patent exhaustion for OPC driving elements, etc.), no conversions legally possible (A->X), Switzerland not EU for patent exhaustion (EFTA not sufficient)."</p>
<p>"Patents, which either describe remanufacturing methods for ink and toner cartridges, or describe chip functions."</p>
<p>"Inkjet cartridges with print-head - it is not possible to exchange the electronics due to legal constraints."</p>
<p>"The law doesn't allow a tender to only one specific eco label, there must be always more eco labels or the supplier can prove that their products comply with eco label. But more eco labels allow the supply of goods on the basis of a simple affidavit, and it is not possible to check what was actually delivered. The public sector becomes the biggest buyer of cartridges that infringe patents. We know from our trading partners from other countries, that this problem isn't only in the Czech Republic. The only exception is Croatia, which solved this problem by self-certification. This certification currently satisfies only one domestic supplier."</p>
<p>"Mainly IP issues."</p>

*Some comments have been edited for clarity

Table 26: Comments by stakeholders on marketing barriers to the reuse of cartridges

Comments* on marketing barriers from independent re-use stakeholders

<p>Statements like the following from [Brand A] create customer mistrust towards the use of remanufactured cartridges:</p>
<p>"For the protection of your product, and in order to ensure that you benefit from its full functionality, this model has been designed to operate only with genuine [Brand A] toner cartridges. These can be identified by the [Brand A] trademark. Any other toner cartridge may not operate at all, even if it is described as 'compatible' or 'refilled.' If it does work, your product's performance and print quality may be degraded"</p>
<p>"OEM brands threatens that customers' machines will be out of guarantee if they use remanufactured cartridges."</p>
<p>"The use of very highly protected smart chips on cartridges means that end users get annoying pop ups that make them insecure and try to lead them back to the OEM products."</p>
<p>"Multiple warning messages when using an already used or reset remanufactured cartridge or a cartridge with new chip."</p>
<p>"The OEM's are putting up marketing and sales barriers. They make sales statements that reused products are inferior and void the guarantee of the printer. OEMs are going even further - they discriminate against partners (resellers) that are selling reused cartridges. They will get less marketing money, less good pricing etc."</p>
<p>The customer's understanding of remanufacturing: the customer usually only sees that the OEM exists and then categorises any other option as the same, an inferior refill/compatible. Resellers may also interchange remanufactured and compatibles (for their own profit) thus propagating confusion amongst purchasers.</p>

**Some comments have been edited for clarity and brand names removed for reasons of commercial sensitivity*

Table 27: Comments by stakeholders on logistical barriers to the reuse of cartridges

Comments* on logistical barriers from independent re-use stakeholders

"OEM's operating their own cartridge recycling / take back programs sucking empties out of the market [but then recycling not refilling], reducing the amount available for reuse."

"Inability to acquire used cartridges due to aggressive take back policies by manufacturers."

"Lack of (some types of) empty cartridges."

"Blocked access to empties."

"We see an increase in complexity in the sorting and testing process of empty cartridges. Nowadays we need to create several article codes for the same OEM reference. This is related to the large number of additional technical aspects of the OEM cartridges. Especially for empty inkjet cartridges it has increased to a level for which it becomes really difficult to remanufacture the cartridges in a standardized way. We are convinced that OEMs develop these technical aspects in order to block the remanufacturing industry."

"Remanufacturers of reused cartridges have to remove all the original brand names. This is quite labour intensive (increases cost) and in some cases this is impossible as the brand logo has a technical function. This is the only industry I'm aware of where this is an obligation. You buy a reconditioned iphone or ipad you still have the Apple logo; you buy a reconditioned car you still have the BMW logo, even reconditioned tyres have still the original brand name. Why should this be different for cartridges?"

**Some comments have been edited for clarity*

Table 28: Comments by stakeholders on market barriers to the reuse of cartridges

Comments* on market barriers from independent re-use stakeholders

"Governments asking implicitly for only new printer cartridges."

"The Chinese 'New Builds' kill the business due to unbelievable price dumping."

"Low cost and most often low quality compatible clones flooding the market."

Corporates and Government not embracing the re-use ideal by not stipulating that a percentage of their printer cartridge tenders must include remanufactured cartridges.

Government and Corporates not stipulating in their Managed Service and printer contracts where the toners are provided free as part of the contract that a large percentage if not all should use remanufactured cartridges or reused toner containers."

"Unfair competition from imports of Chinese toner cartridges, that infringe patent protection, are detrimental to health and they are sold at a price at which it is not possible to renovate the toner cartridge."

"The cost of developing new products. There are too many models of printer cartridges, which are not needed."

"The dumping prices and the low quality of the imported (from China) compatible cartridges are the biggest threat in our industry."

"Barriers to entry in the Public Sector (policy for original products)."

"Diversification of OEMs producing identical products except for different chip programming (useless updates that limits the quantity of empties)."

"Old versions of cartridges or protected cartridges with limited market for reuse; rebate programs as launched by Lexmark with its No.100 cartridges."

"The main barrier is that government and state authorities buy only the cheapest products (compatible cartridges), which cannot be renovated. Public contracts have price as the main

criteria and because of it compatible cartridges often win."

"New builds from Asia."

"The biggest barrier we run into is the low profitability of remanufacturing toner cartridges on a market flooded by Chinese clones. The public is very often tempted to choose lower price over quality. We are certain that there is much work educating customers to be done."

**Some comments have been edited for clarity*

Annexe B *Non-manufacturing stakeholder responses*

Survey respondents were asked to comment on selected issues and trends in both the new and re-use markets. Primarily, most responses were from those who specialise in new builds and compatibles.

What is the threat to domestic markets posed by the non-European players?

It is a huge threat to OEMs and Non-OEMs. It is an indirect threat to local EU economies and jobs, and a massive environmental threat. Millions of non-reusable compatible cartridges end up in EU markets without a strategy for effective waste collection and recovery.

A huge threat. I would like to highlight that the compatibles industry is also putting an immense amount of strain on the OEMs. The market has become flooded with compatibles (including fake OEMs) and the OEMs are feeling the pressure. If this continues then that could result in the demise of remanufacturing as well as established OEMs.

Since 2008/2009, the EU market has seen an invasion of cheap newbuilt non-OEM toner cartridges imported from SE Asia. Due to low labour costs and domestic subsidization, the products are often dumped at on the EU market for very low prices. But these Asian cartridges typically pollute the European environment as they are neither remanufactured (that would be just as illegal as manufacturing them) nor recycled. They are simply thrown away after 1st use, resulting in unnecessary extra landfill in Europe. European individuals or companies caring about sustainability should only buy remanufactured OEM cartridges. The re-use OEM market has lost the battle against these players. In East-Europe the non-OEM cartridge market is 70-90% Chinese newbuilt. In West Europe, the non-OEM cartridge market is 40%-60% re-use OEM and 60-40% Chinese newbuilts. Chinese toner newbuilts are much cheaper than re-use OEM.

Please describe in detail any barriers to re-use (e.g. technological, legal):

Technology: printer and cartridge design and digital chip encryption hamper remanufacturing.

Legal: OEM patents on design and more recently remanufacturing techniques.

OEM collection programs [but then recycling not refilling]: removing empty cartridges from market is stifling reuse.

The customer's understanding of remanufacturing: the customer usually only sees that the OEM exists and then the categorises any other option as the same, an inferior refill/compatible. A lot of resellers also don't know the difference or sell a customer a remanufactured idea but only to supply a compatible as this proves more profitable. This usually comes from pressures to compete. If the reseller can't compete with a remanufactured product, then the only option is to offer a compatible where they can compete.

Legal: Some OEM are hindering remanufacturing activities through IP limitations.

- ETIRA's response – which has been condensed to flag the key points:

- Intellectual property rights (patents) and aggressive legal actions against remanufacturers - Most OEM's have registered thousands of national and EU-wide patents on part(s) of, or on the entire cartridge, which can make (re)manufacturing that cartridge illegal.
- Embedded software preventing the re-use of the cartridge - Today, almost every cartridge is fitted with a kind of embedded software/clever chips.
- No eco-design: cartridges are not designed to allow re-use - Most cartridges today are not designed in a way to allow easy re-use as a cartridge.
- No sharing of information on how to remanufacture. OEMs do not make the information needed for easy remanufacturing available to customers or 3rd parties in any way.
- Reverse-engineering a chip code is very cumbersome and expensive, and due care must be taken not to infringe patents.
- Printer firmware updates locking out non-OEM cartridges as side-effect
- Undue pressure on business customers to not also sell remanufactured cartridges. Some OEMs oblige their customers to only sell OEM cartridges. If these distributors do not comply, OEMs will withdraw that customer's benefits and rebates.
- Denial of honouring of warranties A few OEMs still threaten end-users that the printer warranty is void only because non-original cartridges were used in the printer.
- Closed-shop customer supply programmes Many OEMs have sales programmes (MPS) whereby they sell both the printer and the full supply of cartridges during the life-cycle of that printer. But since OEMs only offer new cartridges and do not re-use the cartridges they collect after 1st use, this sales programme locks re-use cartridges out of the market.
- Closed-shop collection programmes for used cartridges. Many OEMs have company-own collection programmes for empties.

Are you aware of ecolabelling and green public procurement schemes that are applicable to the printer cartridge sector?

The EUs GPP criteria and Ecolabel for printing systems are without any practical meaning as few public bodies use these GPP and there exists not a single Ecolabelled printer model in the EU today.

How do you expect the market for reused printer cartridges to change in the next 5-10 years?

There will be a significant decrease in quantities sold as OEMs attempt to make re-use more difficult and recover more empty cartridges from the market. Increase in non-patent-infringing low-cost compatibles will impact re-use market. Further consolidation will occur.

This very much depends on government initiatives, but if no action is taken then [I] would expect the printer cartridge industry to become more and more difficult to be involved in (purely on the basis of product saturation which will have a knock-on effect from the OEM all the way through). If the OEMs fall then you will see a domino effect from remanufacturers to compatible producers. If action is taken, then the cartridge industry could easily be an extremely circular and environmentally friendly.

This may depend on whether Article 4 of the WEEE Directive is enforced. My impression is that the OEMs (with the possible exception of the Lexmark

brand) have no interest in promoting re-use themselves, and a very strong interest in preventing their cartridges being reused by third parties.

If the EU does not act now and actively support this industry it will die in 3 to 5 years, and there will only be new OEM and new non-OEM left.

To focus on niche products and keeping quality as a must.

How do you expect the market for new printer cartridges to change in the next 5-10 years?

Not too much change – some consolidation.

There will be continued penetration of the market by Chinese copyists.

OEMs appear to be taking more legal action against 'New Builds' and counterfeit products.

OEMs are developing technology that will slow down or stifle aftermarket sales.

Annexe C *Stakeholder questionnaires*

Independent remanufacturers, refillers and refurbishers survey

About this survey

Study background

The European Commission has commissioned a study to support compliance promotion relating to the implementation of Directive 2012/19/EU on waste electrical and electronic equipment (WEEE) and, in particular, its Article 4 on product design.

In order to address the implementation of the product design requirement, related barriers and possible further steps, the case-study of printer cartridges has been selected.

The collection of comprehensive real-world information is a crucial part of the project. Oakdene Hollins, which is conducting the study on behalf of the European Commission, would appreciate and value your participation in this process to ensure the highest quality and validity of the findings.

Printer cartridge reuse

Reusing printer cartridges generally takes the form of remanufacturing, refurbishing, or refilling spent ink or toner cartridges. Throughout the survey, we refer to these activities as 'reuse'.

Confidentiality

Any answers provided will be treated confidentially; all disclosed data will be aggregated to ensure anonymity before publishing. You are given the option at the end of the questionnaire of whether you would like to be acknowledged in the publicly available published report.

Contact

If you have any questions regarding this study and the treatment of the information you might provide, please contact David Parker (David.Parker@oakdenehollins.com).

(EC letter image)

About you

*1. Contact name

2. Contact position

*3. Contact email address

4. Contact telephone number

About your business

*5. Business name

6. Where are your business' headquarters / primary location? (Country)

7. In which EU countries do you operate? (Please select all that apply)

- All Austria Belgium Bulgaria Croatia Cyprus Czech Republic Denmark
 Estonia Finland France Germany Greece Hungary Ireland Italy
Latvia Lithuania Luxembourg Malta The Netherlands Poland Portugal Romania
 Slovakia Slovenia Spain Sweden United Kingdom

8. Do you operate outside of the EU? If so, please state the countries / regions.

9. What is your annual turnover related to activities in Europe?

- Greater than € 50 million Between € 10 million and € 50 million
 Between € 2 million and € 10 million Less than € 2 million

10. What percentage of your European turnover relates to printer cartridge reuse operations?

11. How many people do you employ in Europe?

- Less than 10 Between 10 and 50 Between 50 and 250
 Greater than 250

12. What percentage of your European employees are involved in printer cartridge reuse operations?

13. Which type of printer cartridge do you specialise in?

- Compatible Remanufactured Refill Other (please specify)

14. What types of printer cartridges do you provide? (Please select all that apply)

- Toner Ink Monochrome Colour
 Other (please specify)

15. If applicable, please comment on why you don't process all cartridge types for reuse. *What are the barriers (technical, economic, legal)? Is there too much competition or too little demand?*

16. Are you involved in the collection (take-back) of cartridges for reuse and recycling?

- Yes (collection managed in-house) Yes (collection contracted out to an independent agent)
 No

17. How many printer cartridges do you collect, or are collected on your behalf, annually?

18. How many printer cartridges do you remanufacturing or refurbish annually? (**Excluding recycling**)

Total
of which: Toner
of which: Ink
of which: Monochrome
of which: Colour
of which: Other

19. How many printer cartridges do you recycle annually?

20. What proportion of these (by volume) are processed in Europe?

21. Do you manufacture new cartridges? If so, please state the number of printer cartridges (by technology) that you manufacture new on an annual basis in Europe.

Total

of which: Ink

of which: Toner

22. What type of customers buy your printer cartridges? (Select all that apply)

	New cartridges	Reused cartridges
Individual consumers	<input type="checkbox"/>	<input type="checkbox"/>
Small businesses	<input type="checkbox"/>	<input type="checkbox"/>
Large corporations	<input type="checkbox"/>	<input type="checkbox"/>
Public sector	<input type="checkbox"/>	<input type="checkbox"/>
Retailers/wholesalers	<input type="checkbox"/>	<input type="checkbox"/>
Question not applicable	<input type="checkbox"/>	<input type="checkbox"/>
Other (please describe below)	<input type="checkbox"/>	<input type="checkbox"/>

Please describe your 'other' type of customers here

23. Which of the following best describes the business model in your company for reused cartridges?

- Direct order
- Service contract
- Deposit/credit scheme
- Leasing scheme
- Other (please specify)

24. What is the price of your reused cartridges, as a proportion of the price of new* cartridges? (*Your own or OEM cartridges)

About your operations

25. Please describe the reuse processes you apply to end-of-life printer cartridges.

26. What warranties do you offer on your reused printer cartridges? (If applicable)

27. Do you use any quality standards on reused printer cartridges?

- DIN ISO Internal standards Trade body protocol
- Other (please describe)

28. If possible, please provide further details of the quality standards you use.

About the printer cartridge market in Europe

29. Which companies do you see as your main competitors for printer cartridges?

30. Can you estimate the size of the EU printer cartridge market (e.g. number of companies, approximate turnover and/or employment)?

31. If possible, please comment on the size of the printer cartridge market in the individual EU countries in which you operate (e.g. number of companies, approximate turnover and/or employment).

32. Can you estimate the proportion of the EU printer cartridge market (by volume) made up of reused cartridges?

33. Can you estimate the proportion of the EU printer cartridge market (by value) made up of reused cartridges?

34. If possible, please comment on whether the market share of reused cartridges is higher or lower in the individual EU countries in which you operate. And if so, by how much?

35. Please describe in detail any barriers to reuse that you have experienced (e.g. technological, legal).

The future of the printer cartridge market

36. How do you expect the future printer cartridge market in Europe to change in the next 5-10 years?

Thank you for your participation

37. Would you like to be acknowledged for your contribution in the published report?

- Yes No

38. Would you be happy to be contacted with follow up questions?

- Yes No

39. Please add any further comments you may have here.

Also, if you would like to be contacted for a more in-depth discussion about this subject, please indicate so below.

OEM survey

About this survey

Study background

The European Commission has commissioned a study to support compliance promotion relating to the implementation of Directive 2012/19/EU on waste electrical and electronic equipment (WEEE) and, in particular, its Article 4 on product design.

In order to address the implementation of the product design requirement, related barriers and possible further steps, the case-study of printer cartridges has been selected.

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Printer cartridge reuse

Reusing printer cartridges generally takes the form of remanufacturing, refurbishing, or refilling spent ink or toner cartridges. Throughout the survey, we refer to these activities as 'reuse'.

Confidentiality

Any answers provided will be treated confidentially; all disclosed data will be aggregated to ensure anonymity before publishing. You are given the option at the end of the questionnaire of whether you would like to be acknowledged in the publicly available published report.

Contact

If you have any questions regarding this study and the treatment of the information you might provide, please contact David Parker (David.Parker@oakdenehollins.com).

(Image of EC letter here)

About you

*1. Contact name

2. Contact position

*3. Contact email address

4. Contact telephone number

About your business

*5. Business name

6. Where are your business' headquarters? (Country)

7. In which EU countries do you operate? (Please select all that apply.)

- All Austria Belgium Bulgaria Croatia Cyprus Czech Republic Denmark
 Estonia Finland France Germany Greece Hungary

- Ireland Italy Latvia Lithuania Luxembourg Malta The Netherlands Poland
 Portugal Romania Slovakia Slovenia Spain Sweden United Kingdom

8. What is your annual turnover related to activities in Europe?

- Greater than € 50 million Between € 10 million and € 50 million
 Between € 2 million and € 10 million Less than € 2 million

9. What percentage of your European turnover relates to printer cartridge reuse operations?

10. How many people do you employ in Europe?

- Greater than 250 Between 50 and 250 Between 10 and 50
 Less than 10

11. What percentage of your European employees are involved in printer cartridge reuse operations?

About your printer cartridge business

12. What types of printer cartridges do you provide? (Select all that apply)

- Toner Ink Monochrome Colour
 Other (please specify)

13. How many printer cartridges do you manufacture new annually?

Total
of which: Toner
of which: Ink
of which: Monochrome
of which: Colour
of which: Other

14. What proportion of these (by volume) are manufactured in Europe?

15. How many printer cartridges do you remanufacture or refurbish annually? (Excluding recycling)

16. What proportion of these (by volume) are remanufactured or refurbished in Europe?

17. How would you describe your reused printer cartridge business model(s)? (Select all that apply)

- Direct order Service contract Deposit/credit scheme
 Leasing scheme Question not applicable Other (please specify)

18. What type of customers buy your printer cartridges? (Select all that apply)

	New cartridges	Reused cartridges
Individual consumers	<input type="checkbox"/>	<input type="checkbox"/>
Small businesses	<input type="checkbox"/>	<input type="checkbox"/>
Large corporations	<input type="checkbox"/>	<input type="checkbox"/>
Public sector	<input type="checkbox"/>	<input type="checkbox"/>
Retailers/wholesalers	<input type="checkbox"/>	<input type="checkbox"/>
Question not applicable	<input type="checkbox"/>	<input type="checkbox"/>
Other (please describe below)	<input type="checkbox"/>	<input type="checkbox"/>

Please describe your 'other' type of customers here

19. What is the price of your reused cartridges, as a proportion of the price of (your) new cartridges? (If applicable)

20. Does your company manage a collection (take-back) scheme for printer cartridges and/or process cartridges for reuse?

- Yes (collection managed in-house) Yes (collection contracted out to independent agent)
- Yes (processing for reuse managed in-house)
- Yes (processing for reuse contracted out to independent agent)
- No (no take-back scheme of cartridge processing for reuse carried out by, or on behalf of, your company)

21. If you contract out the collection and/or processing for reuse of printer cartridges to an independent agent or agents, please indicate their names here.

Printer cartridge take-back schemes

If there is **no** take-back scheme of cartridge processing for reuse carried out by, or on behalf of, your company please move directly to the next page.

If your company is involved in the management of cartridge collection and processing for reuse please include all activity carried out by, or on behalf, of your company in your answers to the questions below.

22. How many printer cartridges do you collect (take-back) annually?

23. Please describe the collection schemes you run to take-back printer cartridges at their end-of-life. (If applicable)

24. Of the cartridges collected, what proportion are reused? (Excluding recycling)

25. Of the cartridges collected, what proportion are recycled?

26. Please describe the reuse processes you apply to end-of-life printer cartridges. (If applicable)

27. Please describe the recycling processes you apply to end-of-life printer cartridges. (If applicable)

28. What warranties do you offer on your reused printer cartridges? (If applicable)

29. Do you use any quality standards on reused printer cartridges?

DIN ISO Internal standard Trade body protocol

Other (please describe)

30. If possible, please provide further details of the quality standards you use.

The printer cartridge market in Europe

31. Which companies do you see as your main competitors for printer cartridges?

32. Can you estimate the size of the EU printer cartridge market (e.g. number of companies, approximate turnover and/or employment)?

33. If possible, please comment on the size of the printer cartridge market in the individual EU countries in which you operate (e.g. number of companies, approximate turnover and/or employment).

34. Can you estimate the proportion of the EU printer cartridge market (by volume) made up of reused cartridges?

35. Can you estimate the proportion of the EU printer cartridge market (by value) made up of reused cartridges?

36. If possible, please comment on whether the market share of reused cartridges is higher or lower in the individual EU countries in which you operate. And if so, by how much?

37. Please comment on the pros and cons of printer cartridge reuse in Europe from your company's perspective.

The future of the printer cartridge market

38. How do you expect the future printer cartridge market in Europe to change in the next 5-10 years?

Thank you for your participation

39. Would you like to be acknowledged for your contribution in the published report?

Yes No

40. Would you be happy to be contacted with follow up questions?

Yes No

41. Please add any further comments you may have here.

Also, if you would like to be contacted for a more in-depth discussion about this subject, please indicate so below.

Non-manufacturing stakeholder survey

About this survey

Study background

The European Commission has commissioned a study to support compliance promotion relating to the implementation of Directive 2012/19/EU on waste electrical and electronic equipment (WEEE) and, in particular, its Article 4 on product design.

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Printer cartridge reuse

Reusing printer cartridges generally takes the form of remanufacturing, refurbishing, or refilling spent ink or toner cartridges. Throughout the survey, we refer to these activities as 'reuse'.

Confidentiality

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Contact

If you have any questions regarding this study and the treatment of the information you might provide, please contact David Parker (David.Parker@oakdenehollins.com).

(EC letter here)

About you

*1. Contact name

2. Contact position

*3. Contact email address

4. Contact telephone number

*5. Business/organisation name

6. Relationship with the printer cartridge industry (e.g. trade association, procurer, etc.)

The printer cartridge market in Europe

If you have knowledge of the structure and features of the new/reused printer cartridge industry in Europe, please record it here.

All questions are optional.

7. What have been some of the key evolutionary milestones in the development of printer cartridges?

8. Please provide details on the size of the new printer cartridge sector in the EU:

Number of Companies Sales Turnover

Number of units sold Employment

9. Please provide details on the size of the reused printer cartridge sector in the EU:

Number of Companies Sales Turnover
Number of units sold Employment

10. To your knowledge, what is the percentage split between refilling, remanufacturing and refurbishing in Europe?

Refill Remanufacture Refurbish

11. To your knowledge, what is the percentage split between OEMs and non-OEMs operating in the European reused printer cartridge industry?

OEM Non-OEM

12. Please list the major European players who manufacture new printer cartridges.

13. Please list the major European players who reuse (reman, refurb, refill) printer cartridges.

14. Outside the EU, please list the major players, along with their cartridge type (new OEM, new compatible, reused) and technology (inkjet, toner, monochrome, colour), who export products into Europe.

15. In your opinion, how much of a threat do these players pose? (e.g. influx of cheap non-EU compatibles hindering sales of domestic printer cartridges)

About reused printer cartridges in Europe

16. Which types of customer are generally likely to purchase reused printer cartridges? (Select all that apply)

- Individual consumers Small businesses Large corporations Public sector
 Retailers / Wholesalers Other (please specify)

17. What is the average price of reused cartridges, as a proportion of the price of new cartridges?

18. Please describe in detail any barriers to reuse (e.g. technological, legal)

19. Are you aware of ecolabelling and green public procurement schemes that are applicable to the printer cartridge sector?

- Yes No Comment

The future of the printer cartridge market

20. How do you expect the market for reused printer cartridges to change in the next 5-10 years?

21. How do you expect the market for new printer cartridges to change in the next 5-10 years?

Thank you for your participation

22. Would you like to be acknowledged for your contribution in the published report?

Yes No

23. Would you be happy to be contacted with follow up questions?

Yes No

Annexe D *Measures taken in Member States relating to Article 4 of the WEEE Directive*

Sources:

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Report authors:



Harry Symington MSc, Research Consultant, Oakdene Hollins

Harry's MSc in Energy and Industrial Sustainability from De Montfort University included modules on renewable energy, sustainable development, resource efficient design, low impact manufacturing, green business, energy in buildings, energy analysis techniques, and research methods. Harry also has a BA in Accounting and Business Management, and is skilled in market research and analysis.



Rachel Waugh PhD, Technical Consultant, Oakdene Hollins

With a PhD in Engineering and an MA in Manufacturing Engineering from the University of Cambridge, Rachel's background is in resource and process efficiency: her PhD explored ways to reduce carbon dioxide emissions in global steel and aluminium industries, and she has researched emissions reductions in concrete, paper and plastics sectors. Project work includes profiling the remanufacturing industry in Malaysia for the US Government, and remanufacturing batteries for electric vehicles for the TSB.



David Parker MA MBA, Principal Consultant, Oakdene Hollins

With a degree in chemical engineering from University of Cambridge, David worked on projects related to waste and resources, working with the UK's Technology Strategy Board, Defra and WRAP. He was instrumental in setting up the Centre for Remanufacturing and Reuse. He has led major collaborative research projects, e.g. for Defra on Business Waste Prevention and for the EC on mineral resources



Edward Sims MSc, Business Development Manager, Oakdene Hollins

Edward has significant experience and expertise in liaising with stakeholders across Europe, gained in his previous role as a senior political advisor in the European Parliament. Edward has a solid background in the fields of economics, finance and business, having studied Economic History at the London School of Economics. He is fluent in English and French, and has intermediate German and basic Dutch skills.



Maximilian Kling specializes in the field of waste management policy with a focus on WEEE and hazardous waste. He is deeply involved in EU and international projects related to the design, implementation and adaption of policy instruments in waste management, e.g. guidance/information, planning, regulatory and economic instruments, e.g. landfill taxation, 'Pay-As-You-Throw' waste charging and EPR schemes for municipal and industrial waste streams.



Ferdinand Zotz was educated as a lawyer and is a key expert in waste and resource policy legislation at international, European and Member States level. His focus is on waste management legislation, emission control, and chemicals legislation (REACH, GHS, POP, mercury). Ferdinand repeatedly led projects for public and private clients and his expertise comprises questions of the general design of waste management systems, framework legislation, but also questions of classification of waste, waste treatment standards, management of problematic waste streams, and transboundary shipments of waste.

Oakdene Hollins provides research and consulting services to clients under three main themes:

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