

The environmental impact of reuse vs. recycling of toner and inkjet cartridges

Quality and reliability determine whether reuse or recycling is environmentally preferable for print cartridges

Executive summary

Conventional wisdom holds that remanufacturing is always the most environmentally-sustainable end-of-life treatment for toner and inkjet cartridges. However, life cycle assessments of non-Original Equipment Manufacturer (OEM) remanufactured print cartridges show that issues with print quality, reliability, and end-of-life management practices offset the benefits accrued through reuse. Therefore, superior print quality and reliability combined with material recycling can yield the best environmental outcome for print cartridges.

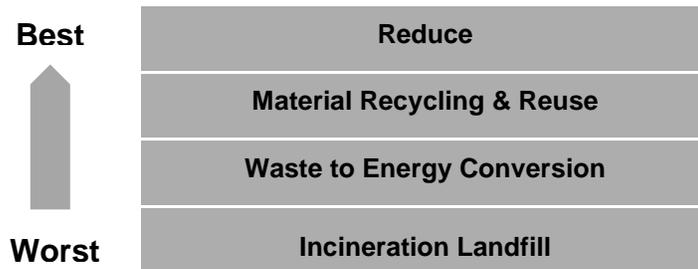
This position paper lays out the environmental costs and benefits of reuse versus recycling of toner and inkjet cartridges across the full product lifecycle using data from life cycle assessments. The main conclusions are:

- **The quality and reliability of print cartridges are the most important factors that determine the overall life cycle environmental impact** because low print quality will increase paper consumption.
- **Good environmental public policy for printers and cartridges considers all life cycle phases** in addressing the interconnected challenges posed by landfill waste, carbon emissions and natural resource depletion.
- **Life cycle assessments show that non-OEM remanufactured and refilled print cartridges are not environmentally preferable to original OEM cartridges across the entire life cycle.** Public policy that simply favours print cartridge remanufacturing and refilling will not benefit the environment.
- **Remanufacturers should be responsible for the take back and environmentally-sound treatment of their cartridges at the end of their life.** Given the inclusion of print cartridges within the scope of the new Waste Electronic and Electrical Equipment (WEEE) Directive, remanufacturers must now comply with the requirements of the Directive, including take-back, proper treatment and achievement of the recovery rates.

1. Life cycle assessment (LCA) addresses questions too complex for the “Reduce/Reuse/Recycle” hierarchy

1.1 “Reduce/Reuse/Recycle” is a useful starting point

In order to put the end-of-life impacts of toner and inkjet cartridges into proper perspective, it is necessary to first examine the hierarchy of possible end-of-life processing outcomes. At the bottom of the hierarchy is landfill disposal, the least desirable option. At the top are recycling and reuse, which offer the greatest sustainability benefit.



Landfill deposit or incineration, as occurs in a typical municipal solid waste management scenario, is the least desirable outcome, increasing a product’s environmental footprint through the release of additional carbon emissions. These processes also increase the industry’s dependence on new raw materials due to loss of potentially usable post-consumer feedstock. Most OEMs apply a “zero landfill” practice for all cartridges.

Waste to Energy Conversion, is a form of recovery in which the energy generated from the incineration is captured and used as energy.

The most optimal outcomes for a cartridge at end-of-life are material recycling or reuse.

Material recycling is desirable from a sustainability perspective because it cuts landfill waste by recycling used products into new raw materials or recycled feedstock and thus helps alleviate depletion of virgin raw materials. The recycled materials are then used in production of the same product (“closed-loop”), in production applications that preserve the value of the original materials, or lower the value (“down-cycling”).

Contrary to some common arguments, the environmental benefit of recycling the plastics, metals and other materials from cartridges back into the industrial materials stream can outweigh the additional transportation and energy emissions involved in the recycling process. For example, recycling high-density polyethylene plastic versus landfill can reduce the overall carbon emissions of that material by 30% or more.⁽¹⁾ In recognition of this sustainability benefit, most major OEMs offer cartridge take-back



and recycling programmes, diverting millions of cartridges from landfills and responsibly recycling tens of millions of kilograms of ink and toner cartridge materials annually.⁽²⁾

Reuse and remanufacturing can, under certain conditions, offer the greatest potential to avoid environmental impact. However, in contrast to material recycling, the reuse of a toner cartridge does not end the product's life cycle. Quality and reliability during use of a non-OEM remanufactured cartridge and its ultimate end-of-life management are crucial factors that shape the full life cycle footprint of the cartridge. Issues with cartridge print quality, reliability or inadequate end-of-life handling can quickly offset the benefits of materials reuse. The following section illustrates the importance of these factors using carbon footprint measurements of original OEM cartridges and remanufactured cartridges.

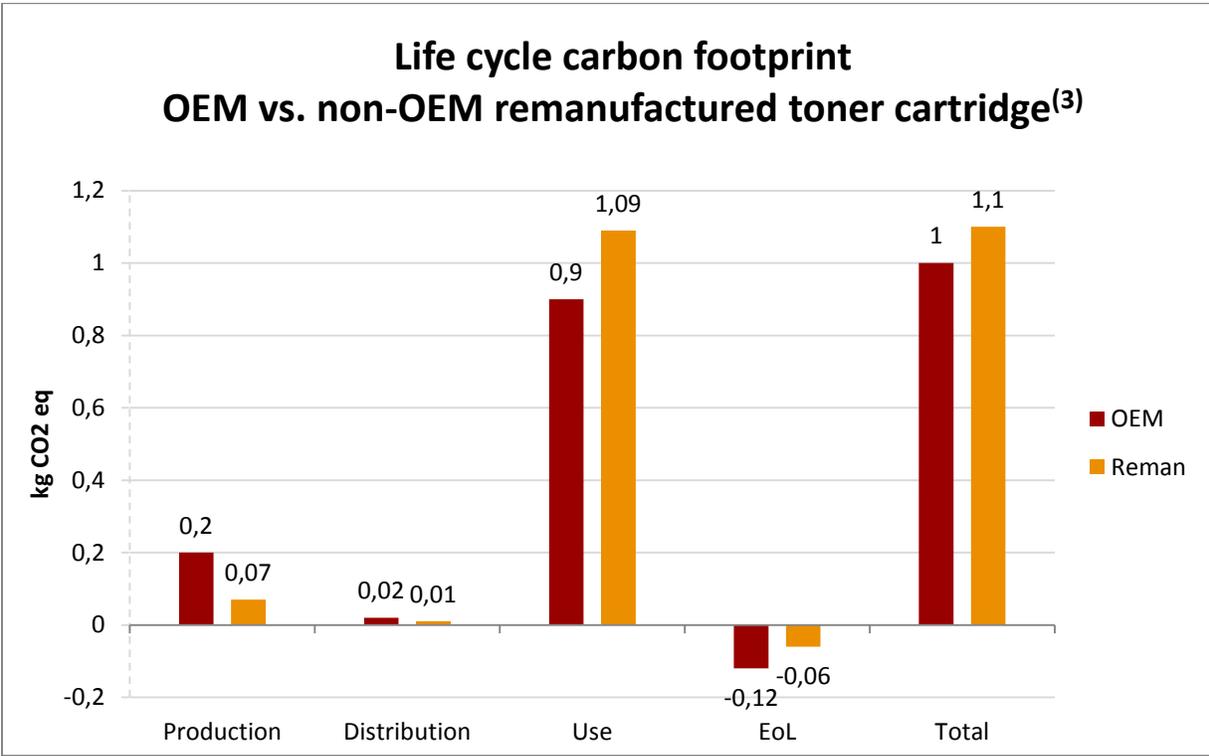
1.2 LCA must be used to assess the environmental performance of recycled and remanufactured cartridges

OEMs strive to understand the environmental impact of their cartridges so that they can identify opportunities to improve them and measure progress. To this end, they employ life cycle assessment (LCA) – a holistic technique for examining the environmental impact of a product or service throughout its lifespan- production, distribution, use and end-of-life. These studies adhere to the ISO 14040 series standards to ensure that they are accurate and reputable.

The carbon footprint of making and distributing a typical HP toner cartridge is approximately 0.2 kg CO₂e.⁽³⁾ To put that into perspective, consider a plain hamburger from the environmentally-minded Swedish fast food chain “Max Burger”. Max Burger states that the carbon footprint of one of their plain hamburgers is 0.8 kg CO₂e⁽⁴⁾, almost four times that of the toner cartridge. If one includes the paper and electricity associated with the use of that cartridge, as well as the recycling of the cartridge, the cartridge's life cycle footprint is 1.0 kg CO₂e⁽³⁾, just 25% more than a Max Burger.

Several OEMs have used LCA to compare original OEM print cartridges with remanufactured and refilled alternatives. The results reveal that the originals have a lower carbon footprint and less overall environmental impact.

For example, an LCA study of an HP toner cartridge commissioned by HP and conducted by Four Elements Consulting demonstrates that the non-OEM remanufactured cartridges have an 11% larger carbon footprint than the original OEM cartridge.⁽⁵⁾



The study highlights the importance of the cartridge use phase because it contributes significantly to the overall environmental impact. This result may surprise some, but the use phase must be considered when comparing OEM to recycled cartridges because the non-OEM remanufactured cartridges did not have consistent print quality. Low-quality prints from remanufactured cartridges lead to paper wastage. In contrast, the consistent reliability and superior print quality of OEM toner cartridges mean fewer reprints and less waste.⁽³⁾

This is why the OEMs heavily invest in research and development to ensure each and every cartridge delivers the highest level of print quality and reliability possible. Third party remanufactured cartridges often cannot attain these levels.⁽⁶⁾ Finally, the OEMs offer free and easy return options for their products in many of the countries where they are sold, while most non-OEM remanufacturers surveyed in a study failed to collect their own products.⁽⁷⁾

2. Print cartridge impact must be considered across the entire life cycle

Print OEMs design their cartridges to improve their environmental performance across the entire product life cycle. They do this by maximising material recovery during design and end-of-life and minimising waste due to issues with print quality and reliability during use. Although remanufacturing a cartridge does avoid most of the environmental impacts of building a new one, this saving can be more than offset by lower print quality and reliability and inadequate end-of-life practices on the part of many remanufacturers.



2.1 Foresighted engineering in the design phase reduces overall impact

The companies represented by EuroVAprint are working towards circular business models as described by the Ellen MacArthur Foundation in an August 2013 paper called “Towards the Circular Economy”.⁽⁸⁾ The circular economy refers to an industrial economy that eliminates waste through careful design. One way some OEMs eliminate waste is through the use of recycled plastic. For instance, HP’s ink cartridges contain up to 70% recycled content and toner cartridges up to 20%.^{(9) (10)} Lexmark’s toner cartridges offer another example. Lexmark’s toner cartridge product line contains an average of 10% post-consumer recycled (PCR) plastic content with some models utilising more than 25%.⁽¹¹⁾

Using plastic recycled from old ink and toner cartridges draws the circular economy loop even tighter than the use of multi-source plastic. This plastic is called ‘closed-loop’ and is a significant engineering innovation given the stringent technical requirements of the cartridge application, and results in an efficient, circular use of materials that reduces environmental impact. A 2014 life cycle assessment demonstrates that the closed-loop recycled PET plastic used by one OEM has a carbon footprint up to 33% smaller than that of virgin plastic, reducing fossil fuel consumption by 54%, and water consumption by 75%.⁽¹²⁾

OEM supplies are designed with the circular economy in mind. Parts greater than 25 grams in weight are marked with internationally-recognised ISO symbols to facilitate the identification of specific materials. Furthermore, OEMs have reduced the average number of parts in cartridges by more than half, which simplifies the recycling processes.⁽¹³⁾

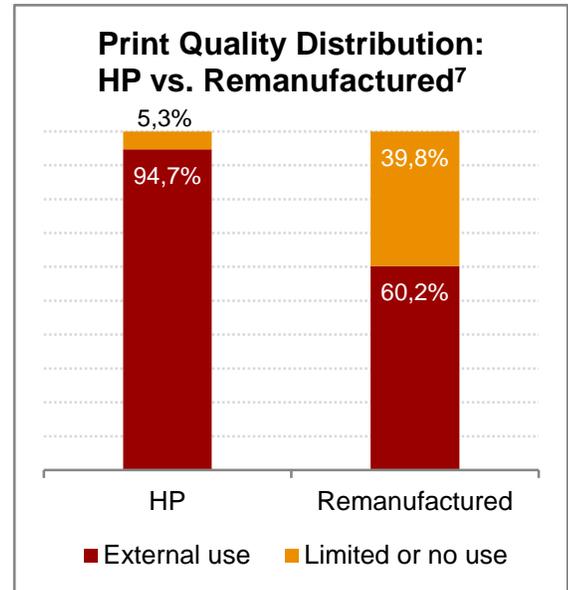
OEMs also incorporate design criteria from recognised environmental labels into their cartridge designs. For example, most original OEM toner cartridges are compliant with the criteria of the Blue Angel eco label at the time of their market introduction. The Blue Angel eco label requires print cartridges to be designed to facilitate recycling.⁽¹⁴⁾ In addition, when a new OEM printing system (printer and cartridges) is launched, the printing system with the original OEM toner cartridges meets or exceeds indoor air quality standards established by eco-labels like Blue Angel⁽¹⁴⁾ and EPEAT⁽¹⁵⁾.

Finally, a circular economy also calls for a ‘functional service’ model in which the manufacturer retains the ownership of its products and acts as a service-provider – selling the use of products, not their one-way consumption. Print OEMs are active in this area as well by providing managed print services to their customers. With managed print services, the provider owns the equipment and cartridges and charges the user per page printed. This arrangement ensures that the customer has the right amount of energy efficient printers and that the printers and cartridges are properly managed at the end of their use.

2.2 Print quality and reliability determines the environmental impact of a print cartridge

2.2.2 Consistent print quality saves paper

The reliability and quality of toner and inkjet cartridges both have significant consequences for the environment. Over 100 OEM lifecycle assessment studies show that paper has the largest environmental impact across the life cycle of a printing system. For example, Lexmark conducted an LCA on its MX711DE monochrome multifunctional laser device and found that the impact of paper accounts for almost 87% of the global warming potential across the product's life cycle. Looking at it another way, far more energy is consumed producing and distributing a single sheet of paper than is used to print on it. The production of a single sheet of paper consumes about 17 watt-hours, which is approximately 50 times the amount of energy needed to print a single page.⁽¹⁶⁾



Superior and consistent print quality, dependable page yield, and overall reliability are key criteria in a toner cartridge's carbon footprint because consistent prints mean less wasted paper and the need for fewer cartridges.

OEM supplies deliver the results users expect from their printing. According to a 2013 HP toner cartridge reliability study by SpencerLab, 95% of the pages printed with original HP cartridges achieved the study's highest print quality level as compared to an average of 60% for the non-OEM cartridges, due to streaking, "ghosting", or fading.⁽⁶⁾ Pages with print quality issues, which cannot be used for the intended purpose, must be reprinted, which wastes toner or ink and paper. Compared to an original HP toner cartridge, remanufactured toner cartridges can lead to the use of up to twelve times the amount of paper for reprinting due to inconsistent print quality.⁽³⁾

Stiftung Warentest – a leading German consumer organisation – provides independent confirmation that original OEM print cartridges deliver superior print quality. In the October 2012 issue of its magazine, Stiftung Warentest gave all OEM ink cartridges tested (from Brother, Canon, Epson and HP), and all OEM toner cartridges tested (from Samsung and HP) the highest overall rating after testing them against their respective competition from third-party brands. The original OEM cartridges outperformed their competition in page quality, which includes print quality and print permanence.⁽¹⁷⁾
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2.2.3 Good cartridge reliability avoids premature replacement

Finally, two studies show that original OEM cartridges from HP have significantly better reliability than non-OEM supplies.^{(6) (19)} The HP cartridges showed 100% reliability; in contrast, two in five non-OEM toner cartridges and more than 40% of non-OEM ink cartridges exhibited reliability problems like “dead on arrival” or failing prematurely during use. These reliability problems waste the energy and materials put into remanufacturing and distributing the cartridges.^{(7) (19)}

This situation is confirmed by those in close contact with the printers; a recent survey of EMEA⁽²⁰⁾ printer technicians finds that using non-OEM toner supplies in OEM printers from HP can damage the printer. One in three of the technicians surveyed said they replace the maintenance kits and other parts of the HP printers studied at least twice as often when non-OEM toner cartridges are used. Over three in four stated that using non-OEM cartridges in the OEM printers considered shortens the life of the printer due to problems such as toner leaks, printer mechanism breakdowns, toner sticking to the fuser, and dirt and dust in the printer.⁽²¹⁾ The repair and replacement of printers damaged by faulty cartridges will negatively impact the environment as additional energy and materials will be used to build the replacement parts and printers.

2.3 OEMs provide free and convenient recycling of empty cartridges

According to a 2014 Infotrends study, few remanufacturers surveyed collect their own products,⁽⁷⁾ whereas OEMs provide free collection of cartridges and recycling in many of the countries where their supplies are sold.

OEMs ensure that returned cartridges are recycled in compliance with ISO 14001 and 9001 certified processes, as well as the WEEE Directive. This means that the cartridges OEMs collect are not disposed of in landfills and that the plastic recovered in the process is used to manufacture original OEM cartridges with the same quality and reliability, as well as other products.

In contrast, the 2014 Infotrends study states that 27% of ink and 18% of toner cartridges collected by third party remanufacturers were unusable for remanufacturing. Of those, 15% of ink and 20% of toner cartridges go to landfill because many remanufacturers do not have a recycling process.⁽⁷⁾

Remanufacturers should be responsible for the take-back and environmentally-sound treatment of their cartridges at the end of their life. Given the inclusion of print cartridges within the scope of the new WEEE Directive,⁽²²⁾ remanufacturers must now comply with the requirements under the WEEE Directive, including take-back, proper treatment and achievement of the set recovery rates.



3. Good environmental policy for printers and cartridges considers all life cycle phases

Using data from product Life Cycle Assessments, this paper has demonstrated that in order to effectively address today's sustainability challenges, product environmental policy for toner and inkjet cartridges must consider a wide range of product attributes and life cycle impacts beyond just the potential benefits of materials reuse. The main conclusions from this paper are:

- **The quality and reliability of print cartridges as well as how they are handled at final end-of-life are the most important factors that determine the overall life cycle environmental impact** because issues with print quality will increase paper consumption.
- **Life cycle assessments show that third party remanufactured and refilled print cartridges are not environmentally preferable to original OEM cartridges.**

Given these conclusions, the OEMs recommend considering the following when it comes to potential future regulations or standards:

- **Public policy should not only emphasise print cartridge remanufacturing and refilling, but should also factor in quality, reliability, and final product end-of-life.**
- **Good environmental public policy for printers and cartridges considers all life cycle phases** in addressing the interconnected challenges posed by landfill waste, carbon emissions and natural resource depletion.
- **Remanufacturers should be responsible for the take-back and environmentally sound treatment of their cartridges at the end of their life.**

Following these recommendations will help to improve the environmental impact of the print cartridges while ensuring fair competition in the printing supplies market.



ABOUT EuroVAprint

EuroVAprint ASBL is a non-profit association consisting of the major manufacturers of imaging equipment that operate in Europe. The association supervises the implementation and monitoring of a set of binding commitments made by its members in 2011 and endorsed by the European Commission. These commitments are enshrined in a voluntary agreement which represents the industry's contribution to the EU's 2020 agenda and more particularly the Energy Efficiency Action Plan and the Resource Efficiency Roadmap. The agreement, which was negotiated under the auspices of the European Commission, also constitutes an implementing measure under the EU's Energy related products Directive.

These commitments are aimed at curbing the environmental footprint of the manufacturing and use of imaging equipment for home and office use – copiers, printers, fax machines and multifunction devices using laser, inkjet and solid ink technologies. Our website provides further information on our recent news and activities: <http://www.eurovaprint.eu/home/>

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References:

- (1) Calculated using EPA WARM calculator under http://www.epa.gov/climatechange/wycd/waste/calculators/Warm_home.html#click. Percentage difference between CO₂ eq emissions from tons landfilled versus tons recycled.
- (2) See: HP FY 2013 Living Progress Report, Lexmark 2008 Corporate Sustainability Report, Xerox 2008 Corporate Citizenship Report.
- (3) 2014 Four Elements Consulting LCA study, commissioned by HP, compared Original HP 05A and 85A monochrome toner cartridges with a sample of remanufactured alternatives across eight environmental impact categories. For details, see www.hp.com/go/EMEA-LJLCA. The LCA leverages a *SpencerLab* 2013 Reliability study, commissioned by HP, where Original HP toner cartridges were compared with 5 remanufactured brands available in Europe, Middle East and Africa. For details, see www.spencerlab.com/reports/HP-Reliability-EMEA-RM-2013.pdf. Results assume HP cartridges are recycled via HP Planet Partners Program. For details on country coverage and available service options please visit www.hp.com/recycle.
- (4) Max Burgers provides detailed carbon footprint information on their website (<http://www.max.se/sv/Ansvar/Klimatdeklaration/>).
- (5) The study was conducted by Four Elements Consulting. Four Elements Consulting, LLC is a consulting firm specializing in environmental LCA, economic life cycle analyses, and climate change/greenhouse gas issues. The Principal/Owner, Anne Landfield Greig, is an LCA Certified Professional and a globally recognized leader in LCA.
- (6) A *SpencerLab* 2013 study, commissioned by HP, compared Original HP LaserJet toner cartridges with five remanufactured brands available in EMEA for the HP LaserJet P2035 and P1102 printers, HP 05A and 85A cartridges. For details, see www.spencerlab.com/reports/HP-Reliability-EMEA-RM-2013.pdf.
- (7) InfoTrends, 2014 Western Europe Supplies Recycling study, commissioned by HP. Findings are based on average results of interviews with 12 remanufacturers and brokers. For details, see www.hp.com/go/EMEA-2014InfoTrends.
- (8) Ellen MacArthur Foundation, Towards the Circular Economy Vol.2: opportunities for the consumer goods sector, 2013.
- (9) List of all HP ink cartridges that contain recycled content at www.hp.com/go/recycledcontent.
- (10) Percentage of recycled and recovered material is based on empty cartridge weight and may vary by model and over time.
- (11) For more information, see <http://csr.lexmark.com/supplies.html>.
- (12) For PET cartridges produced in 2013 and beyond. Based on a 2014 life cycle assessment (LCA) performed by Four Elements Consulting and commissioned by HP. The study compared the environmental impact of using polyethylene terephthalate (PET) plastic with the environmental impact of using recycled PET to manufacture new Original HP ink cartridges. For details see <http://h20195.www2.hp.com/V2/GetPDF.aspx/4AA5-2308ENW.pdf>.
- (13) See <http://www8.hp.com/us/en/hp-information/environment/print-supplies-design.html#t1>.



⁽¹⁴⁾ Criteria of the German Blue Angel eco label, RAL-UZ 171, para. 3.1 and 3.2.

⁽¹⁵⁾ Electronic Product Environmental Assessment Tool (EPEAT), managed by the Green Electronics Council of the International Sustainability Development Foundation (ISDF). For printing systems the IEEE Standard for Environmental Assessment of Imaging Equipment (IEEE Std 1680.2-2012) is applied.

⁽¹⁶⁾ For more details, see http://csr.lexmark.com/product_lifecycle.html.

⁽¹⁷⁾ Stiftung Warentest, study published in issue 3/2014, pp.52-56.

⁽¹⁸⁾ For more information on the test by Stiftung Warentest, visit: Ink cartridges: <https://www.test.de/Druckertinte-Ordentlich-sparen-mit-Fremdpatronen-4446611-0/> Toner cartridges: <https://www.test.de/Toner-fuer-Laserdrucker-Sparen-mit-Fremdtoner-4446576-0/> Ink cartridges: 18 ink sets tested on Canon, Brother, Epson and HP printers and MFPs. Toner cartridges: 8 sets of toner cartridges tested on HP and Samsung laser MFPs. The following HP cartridges were tested: HP 364XL black, yellow, cyan and magenta; HP 128A black, yellow, cyan and magenta.

⁽¹⁹⁾ A Buyers Laboratory Inc. 2013 study commissioned by HP compared Original HP ink cartridges (21, 21XL, 22, 22XL, 56, 57, 140XL, 141XL, 300XL, 350, 350XL, 351, 351XL) with on-average performance of refilled and remanufactured cartridges sold in EMEA. Details: www.buyerslab.com/products/samples/HP-Inkjet-Cartridges-vs-EMEA-Refilled-Cartridges.pdf.

⁽²⁰⁾ EMEA stands for the regions of Europe, Middle East and Africa.

⁽²¹⁾ A 2014 Market Strategies International study commissioned by HP. Results based on 206 surveys from HP ServiceOne Partners who have at least 6 months of experience servicing HP monochrome and Color LaserJet printers with HP and non-HP toner cartridges installed, and have done so within the previous 12 months of the study. Study was conducted in 26 countries: UK, IE, FR, DE, IT, LU, AT, CH, BE, PT, ES, SE, RU, UA, PL, HU, CZ, HR, RO, ZA, SA, AE, EG, MA, QA, and TR. For details, see www.marketstrategies.com/hp/emeaSOPstudy.pdf.

⁽²²⁾ Under the new WEEE Directive (2012/19/EU) the European Commission has decided that printer cartridges with electronic components can be considered Electronic and Electrical Equipment (EEE) and should therefore be in scope of the new Directive. The guidance provided by the European Commission concerning printer cartridges is non-legally binding. Therefore, adoption of such guidance and timing of such adoption may vary from Member State to Member State.