

**An Investigation into a Triple Bottom Line Analysis of Remanufactured Toner Cartridges vs.  
OEM Cartridges**

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## **ABSTRACT**

The purpose of this report is to use a Triple Bottom Line investigation of Remanufactured and OEM toner cartridges. Remanufactured cartridges will be compared against OEM cartridges on three main evaluation criteria: Economics Benefits, Social Benefits, and Environmental Benefits. Currently, The University of British Columbia (UBC) does not have a structured program in place to regulate the purchasing and recycling of toner cartridges on campus. Our team set out to look into why remanufactured toner cartridges should be considered and encouraged in UBC's purchasing strategy. First, an estimate of the financial budget on toner cartridges purchased was compared against the costs (as seen by the customer) of remanufactured cartridges. Secondly, the carbon emissions and energy consumption was compared between the two material flows and look at the end impact in landfills. Finally, the different social impacts on both producers and consumers were considered for both options provided to the purchaser. It was found that remanufactured toner cartridges provide significant financial benefits. The consumer will likely not see any negative impacts in terms of printing performance with remanufactured cartridges with a reputable remanufacturer. The benefits then would lead to the conclusion that it is recommended that UBC adopt a plan to encourage the purchasing of remanufactured toner cartridges wherever possible.

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## **Glossary**

Toner cartridge: is a consumable component contains toner powder, which makes the image appear on the paper.

Triple bottom line: expands the traditional reporting framework to take into account social and environmental performance in addition to financial performance.

## **List of Abbreviations**

OEM: Original Equipment Manufacturer

GHG: Green House Gasses

HIPS: High Impact PolyStyrene

ABS: Acrylonitrile Butadiene Styrene

PVC: Polyvinyl Chloride

LDPE: Low-Density PolyEthylene

## **1.0 INTRODUCTION**

Remanufactured toner cartridges have some advantages over OEM toner cartridges in terms of financial aspect, environmental impact and social impact. Normally, remanufactured toner cartridges are 30 to 60 percent cheaper than OEM ones. In addition, a well resembled remanufactured toner cartridge could give better yield and longer lifespan. The recycling program that usually comes with the remanufactured toner cartridges are more convenient to customers.

The study of the environmental impact comparison between OEM and remanufactured cartridges are approached from the material production and replacement perspective. With OEM cartridges, the materials are discarded into landfills or recycled, whereas remanufactured cartridges make use of old materials, reducing the need for raw material and new parts. The impact from raw material production alone results in about 1.5 kg of CO<sub>2</sub> emission. The impact of different cartridges on the usage phase is also considered in this report, as 90% of the energy cost related to printing occurs during the usage phase.

Finally, the study of the different social impacts on the consumer, producer and society as a whole is considered. The different processes by which a consumer can get a toner cartridge (Remanufactured and OEM were considered) have a different impact on the parties that are involved. These impacts were investigated and reported.



## **2.0 FINANCIAL IMPACT**

Toner cartridges can be expensive, sometimes exceeding the cost of cheaper laser printers. Advocates of these products assert that remanufactured toner cartridges are less expensive than OEM cartridges. Switching to remanufactured cartridges can result in a cost savings of between 30 and 60 percent per unit (UoWM purchasing services, 2013). This is because merchants that deal mainly with remanufactured products are able to set their own prices as opposed to having to adhere to the prices established by companies such as HP, Epson and Dell. Remanufactured cartridges also are filled to capacity while the cartridges that come from the manufacturer oftentimes are not.

Below is the price comparison table of most frequently purchased new OEM toner versus remanufactured toner in the faculty of engineering at University of British of Columbia.  
(Digitech online catalogue, 2013)

<b>Toner Cartridge</b>	<b>OEM Price</b>	<b>Reman Price</b>	<b>Savings</b>
HP CE278A TONER	\$64.21	\$12.50	\$51.71
HP Q6000A BLACK TONER	\$68.87	\$23.00	\$45.87
HP CF280A LASERJET TONER CART BLK	\$94.90	\$49.83	\$45.07
BROTHER TN450 HY BLACK TONER	\$44.12	\$29.99	\$14.13
SAMSUNG D1630 LASERJET TONER	\$79.99	\$49.99	\$30.00
XEROX CT201499 TONER	\$74.50	\$43.49	\$31.00

Table 1. Price Comparison between OEM and Remanufactured toner cartridges

These are the models of laser toner cartridges that are commonly used in the Engineering faculty at UBC. UBC Engineering faculty uses about 8-10 toner cartridges every month, not including the toners in the labs and research labs. The total amount could be double, remanufactured toners could save Engineering faculty at approximately \$8000 a year. This is just a number from one faculty in UBC, in fact, UBC has about 10,186 small and large faculties; therefore, remanufacture toner cartridges could save the whole university millions of dollars annually instead of using OEM toner cartridges. In order to clearly see the financial benefit in a larger scale, according to the report which is to respond to the Administration Committee's request to review and evaluate the City of Toronto's experience using remanufactured toner cartridges after one year's time. From April 1st 2004 to March 31st 2005, City of Toronto

consumed approximately 4632 toner cartridges on an average price of \$197.67 per cartridge. The total usage value was \$915,610.22, and there is only a small portion of remanufactured toner cartridges were included. However, during the period of Apr 1st 2005 to Mar 31st 2006, which is exactly the same time period in the following year. City of Toronto increase the volume of remanufacture toner cartridges to a certain level, with total volume of 3658 cartridges were used. It cost them \$293,872.86 with average price of \$80.34 per cartridge. The rising volume of remanufactured toner cartridges gives City of Toronto an extra budget of \$621,737.36, which is a significant amount of money for them (City of Toronto administration committee, 2006).

The process to produce remanufactured toner cartridge is which the OEM or other compatible cartridge is dismantled after the first use. disassembled and meticulously recorded. Individual parts are cleaned, inspected and replaced if necessary. Any residual toner is removed and replenished with new toner. The remanufacturing process differs from one factory to another, as well as the quality of toner that the cartridge is filled with. These are important factors to take into account when purchasing remanufactured toner cartridges because they can ultimately lead to leaking, printer malfunction, or even damaging the printer altogether. Despite the poor quality of some of the remanufactured toner cartridge, many other companies offers very good services on replacement and recycling. Digitech is a company that supplies many of the remanufactured toner cartridges to UBC departments, Cartridges are then reassembled and quality tested four times before being delivered. They have been working with UBC to develop a campus wide toner recycling program. They offer Free next-day delivery and pickup of old cartridges. In addition, they also offer 1 year same-day replacement guarantee, which ensure that the quality of their products are as good as the OEMs (Digitech Remanufactured toner cartridge, 2013). There

are many other suppliers that offer similar programs to their customers, and these programs not only help to preserve our environment, but also bring a lot of convenience and financial benefits to their customers. Besides, normally remanufactured toner cartridges could be refilled or redone for three to four times, which yields a lifespan of three to four times longer than OEMs.

Based on the price comparison, it indicates that remanufactured cartridges are 30 to 60 percent cheaper than the OEM cartridges. In addition, remanufactured toner cartridges have way more financial benefits on the cost of maintenance, parts, recycling programs and lifespans. Economically, remanufactured toner cartridges dominants compare to the OEM toner cartridges.

### **3.0 ENVIRONMENTAL IMPACT**

A usual toner cartridge consist a casing, a toner drum, and various plastic or metal moving parts (cogwheel, rails etc). Plastics that are most commonly used for toners are High Impact PolyStyrene (HIPS) and/or Acrylonitrile Butadiene Styrene (ABS) (Berglind and Eriksson, 2002). The normal operation of a cartridge would incur little wear or damage on the plastic casing, which mean the casing is highly reusable. While the drum and and other moving parts do suffer wear and contamination for repeated usage, depending on the material, these parts can often last several usage cycle and are readily replaceable. Xerox remanufactured 60%, by volume, of cartridges returned to them. Remanufactured cartridge from Xerox contains about 90% of reuse/recycled parts (Xerox Green World Alliance, 2010). Cartridge World, another cartridge remanufacturer, produced 1,955 units of remanufactured black toner cartridge with 91 kg of material, whereas producing the same number of new cartridges would require 1457 kg of material (Best Foot Forward).

While the impact of individual cartridge may seemed small, there are estimated to be 350 million toners cartridges that are sent to landfills.(Toner Giant). Based on the aforementioned statistics, promoting usage of remanufacturing toner cartridge from used components can save a significant amount of materials from being produced and dumped into landfills, therefore reducing the amount of energy used on redundant production and as well by helping the environment through the reduction of greenhouse gas emissions.

The following section will investigate the potential environmental impact from the material production perspective, specifically, the environmental impact of producing materials used in a HP C4127X toner cartridge.

Material	Weight (g)
Aluminium	76,68
Copper	0,55
Steel	387,76
Polystyrene	449,69
Nylon	27,73
PVC	6,28
Polyurethane	19,94
Corrugated board	482,93
Paper	24,47
LDPE	26,44

Table 2. Material Composition of HP C4127X (Berglind and Eriksson, 2002)

Table 2 is the material composition of the HP C4127X, excluding the toner powder, but the cartridge packaging is included in this table. The major weight components are made of steel, polystyrene and corrugated board. The shipping weight is listed as 4.4lbs, which is about 2 kg. The total weight of the cartridge is roughly 1.5 kg, discounting the packaging, the toner itself only accounts for about  $\frac{1}{3}$  the weight of the product. The corrugated board is used for packaging and mostly made from recycled materials. The steel components, which often are the moving parts, are also durable for use for several cycles. The polystyrene, which would be the casing, is mostly reusable in subsequent remanufactured cartridges, which will be a major focus on this paper.

When a cartridge is discarded, all of its composition is discarded and new materials have to be produced to replace them, so it is worthwhile to study the impact of producing these materials first. Recycle scenario are not discussed, but both plastic and metal recycling consume significant amount of energy.(Cambridge University,2008)

For High Impact Polystyrene, producing 450g of resins alone will need 313.65g of crude oil and 186.75g of natural gas as raw material, and uses 18.86MJ of energy and produces 140.85g of CO<sub>2</sub> emission (FRANKLIN ASSOCIATES, 2011). The CO<sub>2</sub> emission figures of the plastic are from the process of creation only. About 14% of the energy required come from the electrical grid. A black coal power plant on average produces about 900 kg Co<sub>2</sub>/ MWh, which translates into about 658g for our cartridge, but this is the worst case scenario. To produce 388g of steel, 6.3 MJ of energy is used and 720g of CO<sub>2</sub> is emitted, using recycled steel cuts this figure by ¼. While the aluminum accounts for only 76.68g, it is worth noting the energy cost of primary aluminum product is 175 MJ /kg (Cambridge University,2008) .

On top of the material production costs outline here, there also additional material cost and energy related to manufacturing and transportation. On average, producing a new cartridge produces about 4.4 kg of CO<sub>2</sub> emissions, compared to 1.8 kg of CO<sub>2</sub> emission of remanufacturing the cartridge, a potential 2.5 kg of CO<sub>2</sub> emission is reduced (Best Foot Forward). If we take into account the number of cartridge going into the landfills, this becomes an alarming amount. If half of the cartridges went into landfills were remanufactured instead, we are reducing 437.5 million kg of CO<sub>2</sub> emission, which is equivalent to the emission of about 3.9 billion kilometer of driving on a 25 mpg vehicle or almost 70% of Greenland's total carbon

emission for 2010.(BC Sustainable Energy)(United Nations, 2013) If a average cartridge weight about 0.5-1 kg, huge amounts of reusable materials are being sent to landfills. In which the plastic takes hundreds of years to deteriorate due to its low biodegradability while releasing greenhouse gases and chemicals into the environment at the same time.(Styrosolution, 2012)

While there are significant environmental impact for producing toner cartridges, the usage phase of the printing process is where the majority of energy costs occurs. Roughly 90% of the environmental impact relating to printing occurs during the usage phase, accounting for both the energy cost of operation and the material costs of paper (Four Elements Consulting, 2008). Based on this, HP claims that using remanufactured cartridge actually costs more environmentally to use. HP's supporting argument stems from roughly 40% unacceptable product from remanufacture cartridges. Looking into HP's supporting studies, a diverging quality about remanufactured toner cartridges is observed (QualityLogic, 2010). In using low quality cartridges that were simply refilled without inspection does produce high failure rate as suggested, which, as HP suggested, incurs more environmental impact in the form of waste paper and energy usage. Since toner cartridge remanufacturing is a relatively new industry and largely unregulated, it is important to choose reliable products to have a positive environmental impact with using remanufactured cartridges. Details about reliability are discussed in the social section.



## 4.0 SOCIAL IMPACT

The concept of remanufactured toner cartridges may not always have been presented as a viable alternative to the OEM option. Some of this is due to misconception about poorly presented and well-advertised marketing of large OEMs, or simply through a lack of knowledge of the subject at hand.

One of the main impacts on consumers are the social barriers that hinder the purchase of Remanufactured toner cartridges. A strong media presence highlighting some negative features may be enough to persuade a potential customer. Unfortunately, most of the information has been misinformed and misinterpreted by the public.

One such common misconception is the idea that Remanufactured toner cartridges produce a lower print quality. HP released an information booklet that explained why a remanufactured cartridge will provide poorer print quality (Debunking Remanufactured Cartridges, 2010). Another similar claim is made that Remanufactured cartridges are not as reliable and may cause leaking toner (Debunking Remanufactured Cartridges, 2010). It should be noted though as we analyze the credibility of the claims put forth by HP that all the citations cited in the article are all internal documents to HP and refer to studies that were conducted inside the company. The information presented may still be valid, but without an unbiased third party involved in the investigation, we must be careful with the conclusions we gather from this information. Nevertheless, other studies show that the symptoms described above are indeed possible but are usually the result of a poor quality control process within the remanufacture company (Yamin-Garone, 2013). For example, a remanufactured cartridge may in fact produce

a lower print quality, but this is usually due to a poor quality toner being refilled. If the remanufacturer used a high quality toner then the print quality should be at least comparable to the product produced by the OEM. Also, when a cartridge starts leaving ‘vertical lines’ on the printed result it is a sign that there is a scratch on the drum. A scratched drum should be identified by the remanufacturer and replaced (Digitech Superior Performance Plan, 2013). A leaking cartridge is usually attributed to a cartridge being overfilled (Debunking Remanufactured Cartridges, 2010; Digitech FAQ, 2013). It is an indicator of their internal quality.

Another misconception about remanufactured cartridges is that it will void the warranty of the printer if a remanufactured cartridge is used. According to HP’s website, a different cartridge cannot in any way void the warranty of the printer (HP Use of Non-HP Print Cartridges, 2013). Again, we see that the quality process of the remanufacturer has the largest impact on the performance of the cartridge and not the remanufacturing process itself. That is why it is important that the remanufacturer is able to present some assurance of their quality control such as ISO certification (Yamin-Garone, 2013). If the remanufacturer properly services the cartridge according to its specifications, there is no reason to suggest that it will perform significantly different than its OEM alternative.

It should also be important that the remanufacturing process is beneficial to society and that these process channels will not cause inconvenience to the customer. The remanufacturer will usually operate locally so as to be closer to their customer base. Some companies will even provide free delivery and pickup of the cartridges to their customers with no minimum order or pick up (Digitech FAQ, 2013; Digitech Next Day Delivery, 2013). In this case, the customer can

be assured that they will not have to make another inconvenient trip to pick up a cartridge or provide shipping for the empty cartridge to be assured that the most environmentally sustainable action is being taken.

The customer can also be assured that since the remanufacturer operates locally, that in supporting them will provide local economic stimulation and involved in the local charities that are also important to the customer. When a local company is able to operate locally in such a consumer driven market where price is the main indicator in making a purchase, every citizen should take pride and make a reasonable effort to support them in building the local communities. In supporting such a company, the customer can know that a better society is being developed.

We believe then that the main reason for the unawareness within the public to accept the remanufactured cartridge as a sustainable alternative is a general lack of knowledge. Also, marketing of large OEM firms may have negatively affected the public's opinion.

## 5.0 CONCLUSION AND RECOMMENDATIONS

By comparing the price of remanufactured toner cartridges and OEM toner cartridges, it clearly shows that most likely remanufactured toner cartridges are thirty to sixty percent cheaper than OEM ones. The financial benefits of remanufactured toner cartridges are quite obvious in terms of the cost of maintenance, parts, recycling programs and lifespans. Increasing the purchase volume on remanufactured toner cartridges could save UBC faculties quite a bit money every year.

It is often difficult to qualify why the consumer base is hesitant to purchasing remanufactured toner cartridges. We believed that the main reason for this is that in general, the public are unaware of the sustainable positive attributes of remanufacturing, or have been misinformed through marketing strategies of large OEMs.

The environmental impact of producing the plastic and steel required for a HP C4127X cartridge is found to be about 1.5 kg of CO<sub>2</sub> emission, 25.16 MJ of energy and about 500g of fossil fuel as raw material input for the plastic. With this figure, we assumed on average 2.5 kg of CO<sub>2</sub> emission is saved when a remanufactured cartridge is used instead of OEM. We also concluded that reliability of the cartridge is also important to lessen the overall environmental impact of printing in general.

## 6.0 REFERENCES

1. FRANKLIN ASSOCIATES, A DIVISION OF EASTERN RESEARCH GROUP, INC.(2011),  
*CRADLE-TO-GATE LIFE CYCLE INVENTORY OF NINE PLASTIC RESINS AND FOUR  
POLYURETHANE PRECURSORS*[electronic version]

From:<http://plastics.americanchemistry.com/LifeCycle-Inventory-of-9-Plastics-Resins-and-4-Polyurethane-Precursors-Rpt-and-App>

2. Jonas Berglind & Henric Eriksson (2002),*Life Cycle Assessment of Toner Cartridge HP  
C4127X*[electronic version], From:<http://www.etira.org/wp-content/uploads/2013/07/LCA-Kalmar-Univ.pdf>

3. Best Foot Forward,*The carbon footprint of remanufactured versus new mono-toner printer  
cartridge*,From[http://www.remanufacturing.org.uk/pdf/the\\_carbon\\_footprint\\_of\\_remanufacturing\\_printer\\_cartridges.pdf](http://www.remanufacturing.org.uk/pdf/the_carbon_footprint_of_remanufacturing_printer_cartridges.pdf)

4.Lenzen, M. (2008) *Life cycle energy and greenhouse gas emissions of nuclear energy: A  
review*. Energy Conversion and Management 49, 2178-2199.[electronic version],

From:[http://www.isa.org.usyd.edu.au/publications/documents/ISA\\_Nuclear\\_Report.pdf](http://www.isa.org.usyd.edu.au/publications/documents/ISA_Nuclear_Report.pdf)

5. BC Sustainable Energy,*Calculate Your Carbon Footprint*, Accessed November, 2013 on:  
<http://www.bcsea.org/solutions/citizens-and-homeowners/calculate-your-carbon-footprint>

6. Cambridge University (2008), Steel and aluminium facts,

From: <http://www.lcmp.eng.cam.ac.uk/wp-content/uploads/W1-Steel-and-aluminium-facts.pdf>

7. Four Elements Consulting, LLC (2008), LaserJet Cartridge Life Cycle Environmental Impact Comparison Refresh Study: HP LaserJet 10A Print Cartridge vs. Remanufactured Brands in Europe,

From: [http://www.hp.com/hpinfo/globalcitizenship/environment/productdesign/suppliesLCA\\_EMEA.pdf](http://www.hp.com/hpinfo/globalcitizenship/environment/productdesign/suppliesLCA_EMEA.pdf)

8. Xerox Corporation (2010), Xerox Green World Alliance: Managing supplies responsibly,

Accessed on November 2013 on: <http://www.xerox.ca/digital-printing/latest/GWAFL-01UA.pdf>

9. Digitech Laser. *Online catalogue*. From:

<http://www.digitechlaser.com/online-catalogue>

10. University of Wisconsin Madison (2012), *Graph of Price Comparison of Most Frequently Purchased New Toner vs. Remanufactured Toner*. Purchasing services. University of Wisconsin-Madison. Retrieved from:

<http://www.bussvc.wisc.edu/purch/HowToBuy/toner.html>

11. City of Toronto administration committee review and evaluation on using remanufactured toner cartridges after one year's time (2006, May 15th), From:

[http://www.sistekdata.com/59\\_Savings.pdf](http://www.sistekdata.com/59_Savings.pdf)

12. Hewitt-Packard. (2010). *Debunking Remanufactured Toner Cartridge Myths*. Retrieved from <http://www.hpdealerinfo.com/images/custom/RemanMyths.pdf>
  
13. Digitech. (2013). *Superior Performance Plan*. Retrieved from <http://www.digitechlaser.com/services/superior-performance-plan>
  
14. Digitech. (2013). *Frequently Asked Questions*. Retrieved from <http://www.digitechlaser.com/about-us/faqs>
  
15. Hewitt-Packard. (2013). *HP LaserJet and Color LaserJet Printer Families – Use of Non-HP Print Cartridges*. Retrieved from [http://h20566.www2.hp.com/portal/site/hpsc/template.PAGE/public/kb/docDisplay/?javax.portlet.prp\\_ba847bafb2a2d782fcb0710b053ce01=wsrp-navigationalState%3DdocId%253Demr\\_nbpl03766-&javax.portlet.tpst=ba847bafb2a2d782fcb0710b053ce01&ac.admitted=1385581686297.876444892.199480143](http://h20566.www2.hp.com/portal/site/hpsc/template.PAGE/public/kb/docDisplay/?javax.portlet.prp_ba847bafb2a2d782fcb0710b053ce01=wsrp-navigationalState%3DdocId%253Demr_nbpl03766-&javax.portlet.tpst=ba847bafb2a2d782fcb0710b053ce01&ac.admitted=1385581686297.876444892.199480143)
  
16. Yamin-Garone, Mary. (2013). *The Truth about Remanufactured Ink Cartridges*. Retrieved from <http://discount-ink-cartridges-stores-review.toptenreviews.com/the-truth-about-remanufactured-ink-cartridges.html>

17. Digitech. (2013). *Next Day Delivery*. Retrieved from

<http://www.digitechlaser.com/services/next-day-delivery>

18. Toner Giant, *Cartridge Recycling Facts*

<http://visual.ly/shocking-statistics-about-printer-cartridge-recycling>

19. Styrosolution (2012). *Material Safety Data Sheet For High Impact PolyStyrene* [electronic version]

From:[http://www.styrosolution.net/wa/steu~it\\_IT/function/conversions:/publish/content/products/styrenics/downloads/EU\\_Final\\_SDS\\_HIPS\\_060412.pdf](http://www.styrosolution.net/wa/steu~it_IT/function/conversions:/publish/content/products/styrenics/downloads/EU_Final_SDS_HIPS_060412.pdf)

20. United Nations(2013), *Millenium Development Goal Indicators*, accessed

November, 2013 on: <http://mdgs.un.org/unsd/mdg/SeriesDetail.aspx?srid=749&crd=>

21. QualityLogic (2010), *Reliability Comparison Study HP LaserJet Print Cartridges vs Non HP Toner Cartridges*, accessed on November 2013

on:<http://www.qualitylogic.com/EMEAmonotonertest.pdf>