

The carbon footprint of remanufactured versus new mono-toner printer cartridges

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Carbon footprint

This study compared the carbon footprint of a remanufactured mono toner printer cartridge with a new cartridge. There is sparse empirical evidence on the consumption of new components during the remanufacture of printer cartridges therefore we collected data on materials used over a three month period from Cartridge World, Aylesbury. The study compares the carbon footprint of a remanufactured cartridge with that of a new one, taking into account raw materials, energy, transport and disposal.

The remanufacturing process saves approximately 2.5 kg of CO₂ per cartridge compared to the production of a new cartridge. From data collected at Cartridge World, a mono toner cartridge can be remanufactured on average 3.5 times, meaning the carbon footprint from the production of the original cartridge is amortised over this extended lifetime. This needs to be added to the carbon footprint to gain an overall remanufacturing footprint. Based on these assumptions the carbon footprint of remanufactured cartridge is approximately 2.8 kg, which is 2 kg (46 %) lower than that for a new cartridge.

Table 1: A comparison of the carbon dioxide (CO₂) generated during the manufacture of a new cartridge, the remanufacture of a cartridge and the remanufacture + amortised carbon footprint.

Life Cycle Stage	Emissions per new cartridge (gCO ₂)	Emissions during remanufacture (gCO ₂)	Total remanufacturing emissions (gCO ₂)
Components (inc. End of Life)	2,136	223	650
Components Packaging	286	65	110
Cartridge Packaging	980	380	510
Components Shipping	203	19	60
UK Distribution	33	451	360
Energy Use	761	663	680
TOTAL	4,399	1,802	2,380

The large number of reused components in the remanufacturing process significantly reduces the carbon impact of production of components. This feeds through to packaging, international transport and energy use. The UK travel associated with refilling cartridges at Cartridge World Aylesbury currently produces more CO₂ than the UK distribution of new cartridges, but this effect is not great enough to offset the other refill savings.

Materials

Significant materials savings are made by remanufacturing a cartridge. When a cartridge is remanufactured at Cartridge World, worn components are replaced with new resulting in the consumption of raw materials, however, far fewer raw materials are used than the during production of a new cartridge. Indeed, Cartridge World used 91 kg of new components annually in the production of 1955 black toner cartridges, whereas approximately 1457 kg of material would be required to produce equivalent new units. The type and weight of components used are shown in Table 2.

Table 2: Components used annually at Cartridge World, and the components required to manufacture the equivalent number of new cartridges

Components Used Per Year	Cartridge World		New Cartridges	
	Number Used	Total Weight (kg)	Number Used	Total Weight (kg)
Drums	708	63.0	1,955	160.2
Wiper Blades	116	9.8	1,955	172.3
Primary Charge Rollers	196	12.9	1,955	78.6
Mag Rollers	92	2.6	1,955	52.2
DR Blades	36	2.9	1,955	104.6
Other Components	0	0.0	n/a	888.9
TOTAL	1,148.0	91.1	n/a	1,456.8

A new cartridge requires around 16 times as much material, by weight, as a cartridge refill. 45% of the material in a new cartridge is High Impact Polystyrene (HIPS); this is the plastic used for cartridge outer casings, and is not used for remanufacturing cartridges at Cartridge World. The second most largest material is steel, which is used in cartridge casings, key components such as wiper blades and rollers, and small components like screws and washers.

The major materials used by Cartridge World are aluminium, steel, polyoxymethylene and polypropylene. Toner is not included as an input material, as an equal amount is used for both manufacturing and refilling a cartridge. When considering the carbon footprint, aluminium becomes much more important due to the large amount of energy required in its manufacture. However, HIPS is still the material creating the largest difference between cartridge manufacturing and cartridge refill. Figures 1 and 2 compare the weights of materials and carbon footprint for the production of those materials for new and remanufactured cartridges.

Figure 1: Comparison of weights of materials used in printer cartridge manufacture and refill

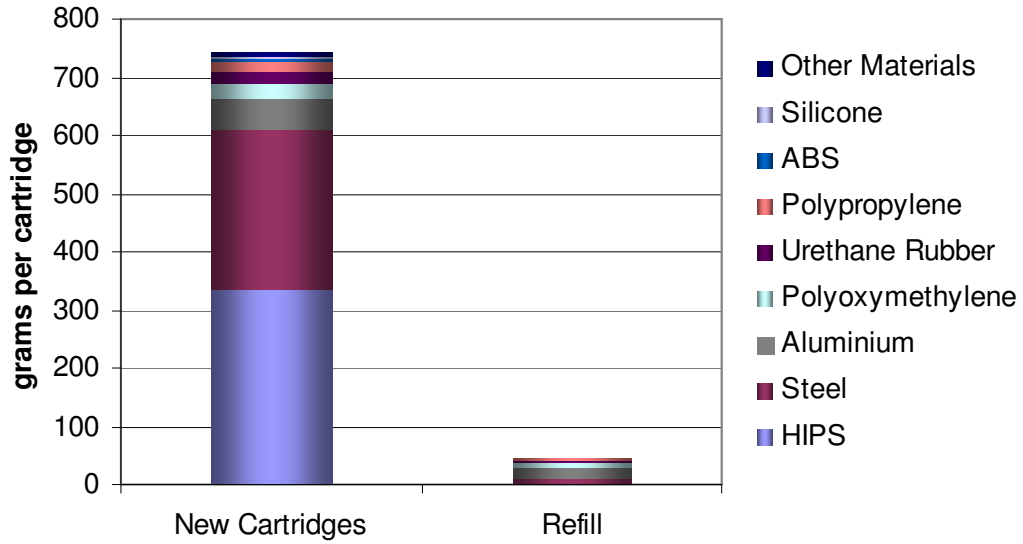
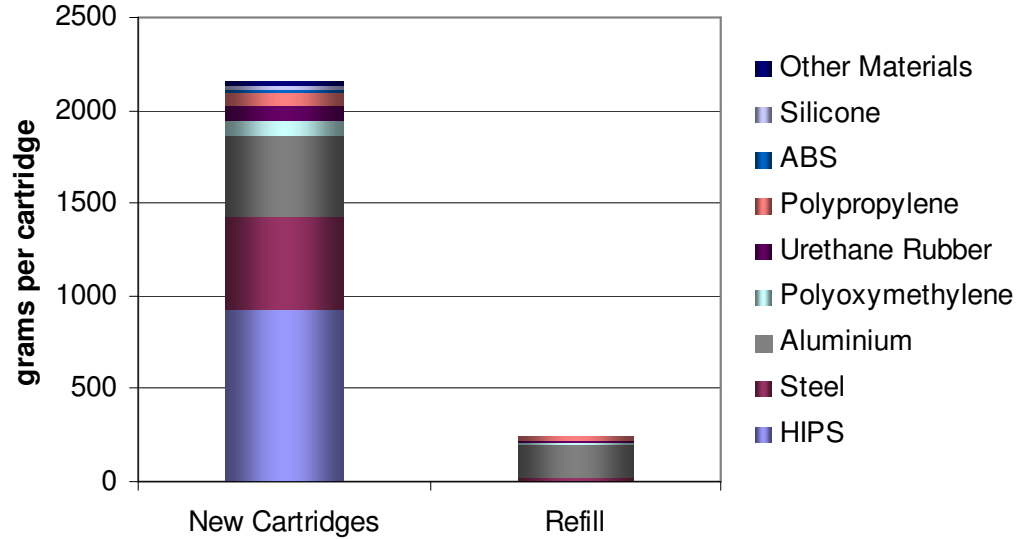


Figure 2: Comparison of the carbon footprint of materials used in printer cartridge manufacture and refill



Conclusions and further work

It is clear that remanufactured cartridges are more sustainable than new. Based on our data, a remanufactured mono toner cartridge has a 46 % lower carbon footprint than a corresponding new cartridge. In 2005, approximately 4.284 million mono toner cartridges were remanufactured in the UK, this equates to an annual reduction in CO₂ of 8,500 tonnes.

There are several areas of additional work that would contribute to this area:

- Primary data on production cartridges and components from OEMs and tier 1 suppliers would improve the accuracy of the data on production of new cartridges.
- It is claimed that the reduction in the quality of remanufactured cartridges results in more paper spoilage and therefore more pages needing reprinting. This could potentially limit the environmental benefit of remanufacturing cartridges. Actual use data, rather than synthetic tests, may resolve this issue.
- A comparison of Cartridge World's refilling process with the reuse processes used by other remanufacturers and OEMs, could provide valuable insight into the strategies and potential best practice for remanufacturing.