# LCA Comparison of Flexible Packaging Printing Using Three Different Methods for Short-Run Jobs

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## Overview

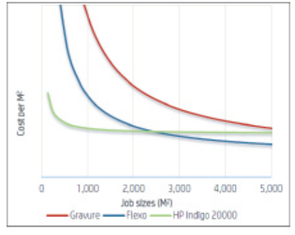
This study explored the life cycle impacts of printing on flexible packaging substrate using conventional Flexographic (Flexo) and Gravure print systems compared to digital printing using the HP Indigo 20000 printer across a range of economically relevant print job sizes and geographic regions.

Flexible packaging is a fast-growing market estimated to soon reach $100 billion annually; we used a coffee pouch as a representative example.


Results of the study indicate that the printing step contributes up to 30% of the cradle-to-gate life cycle impacts of flexible packaging (with energy consumption a major driver) and that digital printing using the Indigo 20000 results in lower potential environmental impacts for all impact categories reported at the estimated economic break even points for average Flexo and Gravure technologies.

## Introduction

- We framed our LCA around print-job sizes that reflect the economic realities of the marketplace, seeking new insights into how environmental impacts relate to economic break-even points.
- While we conducted geographic-specific analyses for Europe, the US and China, the findings for the US and China were inconclusive, largely because of energy-related issues, so they are not incorporated into this summary.
- Digital printing offers flexibility and customization, but is not economical above a certain run length. At this economic cross-over point (see below), there is user interest in whether a system is environmentally preferable. Points of interest are the break even points between digital and Gravure at 5,000 $m^2$ and between digital and Flexo at 3,000 $m^2$. Also important: understanding the change of impacts at up to 10,000 $m^2$.




## LCA Approach and Methods

*This study complied with ISO 14044 guidelines for comparative LCAs intended to be disclosed to the public and was reviewed by a third-party panel of expert stakeholders.*

### System Boundaries

- The system boundary for the LCA of flexible packaging using the Gravure, Flexo and Indigo print processes is shown in Figure 1. Print setup, consumables, production printing, and pouch processing were included, and pouch filling, distribution and use were excluded.

### Life Cycle Inventory

- Data used to model the foreground printing processes included primary data from HP for the Indigo 20000, and secondary data from print industry experts and literature for Flexo and Gravure printing. Data for background processes, including the production of consumables, coffee pouch substrate, and energy inputs were obtained from the US-EI database (North America) and Ecoinvent 2.2 database (Asia and Europe).

### Life Cycle Impact Assessment

- We used selected indicators from the Global Packaging Project (GPP) LCIA method (v 2.00) that were of interest to the printing industry and for which results were determined to be most reliable, including Global Warming Potential (kg $CO_2$ eq.), Photochemical Ozone Creation (kg NMVOC), Cumulative Energy Demand (MJ), and Water Use ($m^3$).

### Interpretation

- Sensitivity analysis was conducted to determine the influence of key assumptions and data points on the study results. Data quality scores for foreground processes were derived from a Pedigree Matrix and used to conduct Monte Carlo analysis to determine the influence of data quality on the reliability of the study results.


Figure 1

## Results

### Comparative Results – Flexo vs. Indigo

At a 3,000 $m^2$ print job size in Europe, the Indigo 20000 has lower impacts than the Flexo print system across all impact categories reported, generally by a margin of 30-60%.

### Comparative Results – Gravure vs. Indigo

For a 5,000 $m^2$ print job in Europe, the Indigo 20000 has lower impacts than printing with Gravure across all categories reported. The difference in relative impacts shows the Indigo 20000 being lower than Gravure by approximately 60–80% across all categories.

### Impact Changes at Varying Job Sizes

Maintenance and plate production required for Flexo and higher energy use in set-up and printing for Gravure result in higher climate change impacts at all print job sizes. Printing at higher speeds can reduce these differences.

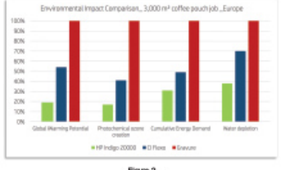



Figure 2
Characterized LCA results for a ~3,000 m² print job using CI Flexo, Rotogravure and HP Indigo 20000 print technologies on a flexible coffee pouch substrate.

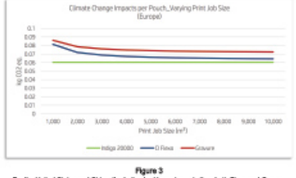



Figure 3
For the United States and China, the Indigo had lower impacts than both Flexo and Gravure up to about 5,000 $m^2$ job size, and then beyond 5,000 $m^2$ job size, the Climate Change impacts for Indigo were essentially equivalent to Flexo and still lower than Gravure.

## Conclusions and Recommendations

- The Indigo process was shown to have lower potential environmental impacts for all impact categories reported at the estimated economic breakeven points for average Flexo and Gravure technologies.
- In Europe, Indigo has lower potential impacts than Flexo in all categories reported at typical print speeds. When print speeds increase, impacts of Flexo and Gravure are generally reduced and come closer to the impacts associated with Indigo. This suggests that ultimately, for the impact categories reported, Indigo's environmental performance is comparable to both Gravure and Flexo technologies.
- Both Flexo and Indigo offer reduced environmental impacts over Gravure at all print job sizes studied. Although Gravure is well-suited for long-run print jobs, Indigo may be attractive for short-run jobs with less impact. For the impact categories reported, Indigo resulted in lower impacts than Flexo at the estimated economic breakeven point of 3,000 square meters; at print job sizes up to 10,000 square meters, Indigo still resulted in lower or equivalent environmental impacts.
- Because printing is an environmental hot-spot in the flexible packaging life cycle for all three print systems, the study recommends that printer manufacturers seek ways to reduce energy consumption and waste during print set-up and printing, and increase use of renewable energy sources.

## For More Information

- Download White Paper for This LCA, "Low Environmental Impact Printing with HP Indigo Digital Presses For Production of Flexible Packaging" at: **www.EarthShiftGlobal.com/HPindigo**