

Comparative full life cycle assessment of B2C cup of espresso made using a packaging and distribution system from Nespresso Espresso and three generic products

Executive summary

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Nespresso

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This report has been prepared by Quantis, a team of world-leading experts in the field of environmental life cycle assessment. Quantis works with companies, governments and other decision makers to identify and implement the right actions for minimizing the environmental footprint of products and services. Founded in 2006, the firm maintains its global headquarters in Lausanne, Switzerland with branches in Boston, Montréal, and Paris. Quantis provides the highest level of proficiency in delivering state-of-the-art analysis and solutions for organizations striving to be leaders in the global sustainability effort.

This report has been prepared by the Swiss office of Quantis. Please direct all questions regarding this report to Quantis Suisse.

Quantis Suisse

Parc scientifique EPFL, Bât D

CH - 1015 Lausanne

Suisse / Switzerland

Tel: +41 21 693 91 92

E-mail: info@quantis-intl.com or directly Carole Dubois, key account manager for Nestlé (carole.dubois@quantis-intl.com) or Sébastien Humbert, scientific director (sebastien.humbert@quantis-intl.com, +41-79-754-7566).

Web: www.quantis-intl.com

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Project team	- Carole Dubois, Key account manager for Nestlé and project manager (carole.dubois@quantis-intl.com) - Sébastien Humbert, Dr, Scientific director (sebastien.humbert@quantis-intl.com) - Manuele Margni, Dr, Internal quality control (manuele.margni@quantis-intl.com)
External reviewers	- Michael Hauschild, Dr, Chairman, LCA expert, Technical University of Denmark, Denmark (mic@man.dtu.dk) - Bruno De Wilde, Biomaterial expert, Lab manager at Organic Waste Systems (OWS), Belgium (bruno.dewilde@ows.be) - Stéphane Arditi, Consumers expert, Policy officer on waste and products, European Environmental Bureau (EEB), Belgium (stephane.arditi@eeb.org) - Aafko Schanssema, Plastic expert, Advisor to PlasticsEurope, Belgium (aafko.schanssema@plasticseurope.org)
Client contact	Christophe Boussemart, Sustainable Development Project Manager Nestlé Nespresso SA Av. De Rhodanie 40 CH – 1007 Lausanne + 41 21 796 95 83 christophe.boussemart@nespresso.com
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Executive summary

During the year 2010, three generic espresso capsules compatible with the Nespresso machines were launched in France and Switzerland, and therefore becoming a competitor to Nespresso's own capsule. Nestlé Nespresso, wondering about the advantages and disadvantages of these products in terms of environmental impacts, has commissioned Quantis to analyze and compare the environmental profile of these four products, using the life cycle assessment (LCA) methodology, in conformity with the requirements of the international standards ISO 14040 and 14044.

Goal and scope

The main goal is to compare the four products to be able to answer customer questions such as: *Which solution is the most environmentally friendly among the Nespresso Espresso and the alternative Espresso? What happens if I throw my capsule to the "trash"? What about if I recycle my capsule or throw it into the green wastes bin?*

The study compares packaging systems with specific designs and not materials.

Products and system boundaries

The functional unit considered for this study is ***To provide a 40 ml cup of espresso coffee prepared in a Nespresso machine in a business-to-consumer (B2C) environment (at home) for a Swiss and French market.*** The Nespresso product is made of an aluminium capsule, a portion of a sleeve and of a tertiary packaging. The generic product 1 is made of a polypropylene, aluminium and polyethylene capsule, a surpackaging, a portion of a sleeve and of a tertiary packaging. The generic product 2 is made of a polypropylene and PET capsule, a surpackaging, a portion of a sleeve and of a tertiary packaging. The generic product 3 product is made of a bioplastic capsule (mix of polylactic acid and starch), a portion of an overwrap, a portion of a sleeve and of a tertiary packaging. The analysis includes the coffee supply, the packaging, the production center, the distribution, the use and the end-of-life stages.

Table 0-1: Packaging systems studied. PP: polypropylene, PE: polyethylene, PET: polyethylene terephthalate, LDPE: low-density polyethylene, PLA: polylactic acid, SBB: solid bleached board, CB: corrugated board.

	Nespresso	Generic product 1	Generic product 2	Generic product 3
Capsule	Aluminium capsule Aluminium membrane Coating Total mass: ~1.1 g/capsule	PP capsule Aluminium –PE membrane Total mass: ~1.5 g/capsule	PP capsule PET membrane Total mass: ~1.7 g/capsule	Bioplastic capsule made of a mix of PLA and starch Paper filter and laminate membrane Total mass: ~4.4 g/capsule
Surpackaging /Overwrap		Surpackaging for one capsule in PE-aluminium – PET laminate Total mass: ~1.6 g/capsule	Surpackaging for one capsule in PE – aluminium – PET laminate Total mass: ~0.9 g/capsule	Overwrap for 10 capsules in PP and PET, paper label and cardboard insert Total mass: ~0.3 g/capsule
“Sleeve”	Sleeve for 10 capsules in SBB Total mass: ~1.6 g/capsule	Sleeve for 12 surpackagings in SBB Total mass: ~3.7 g/capsule	Sleeve for 10 surpackagings in SBB Total mass: ~2.8 g/capsule	Sleeve for one overwrap in SBB Total mass: ~2.3 g/capsule
Tertiary packaging	Box for several sleeves in CB, LDPE film and pallet Total mass: ~0.8 g/capsule	Box for several sleeves in CB, LDPE film and pallet Total mass: ~3.3 g/capsule	Box for several sleeves in CB, LDPE film and pallet Total mass: ~1.8 g/capsule	Box for several sleeves in CB, LDPE film and pallet Total mass: ~1.0 g/capsule

Various end-of-life scenarios have been studied as well as a comprehensive range of environmental indicators. The executive summary focuses on the greenhouse gases emissions, which is the most common indicator reported; results for other indicators are available in the full report.

Results

Overall results to deliver a cup of coffee

Figure 0-1 shows the overall results for Swiss and French scenarios, for one cup of espresso grouping the scenarios into two categories of “behaviors”: whether the capsule is disposed into the “trash” (*aka* household waste, left group) or into the “valorization bin” (right group). Note that the Direct Fuel Substitution (DFS, incineration with high energy recovery, e.g. in a cement plant) end-of-life route modeled for the generic product 2 is an hypothetical scenario, as this end-of-life route does not exist at the moment in Switzerland and France. Remind that the generic product 3 Espresso capsule is made of a mix of PLA and starch bioplastics with uncertainties on the ratio, therefore the net impacts lie between the results for these two types of bioplastics.

Here, only Nespresso Espresso and generic product 1 are shown for the Swiss market, as the generic product 2 and 3 are not sold in Switzerland. The generic product 1 is also not shown for the French market as it is not sold in France. In the main report, all capsules are shown for all markets to show future possibilities.

The most impacting life cycle stages regarding greenhouse gases (GHG) emissions are the use stage, the coffee production, and the packaging production and disposal. An eco-design process should consider improvement potentials on these three life cycle stages in priority but also on the other life cycle stages. The packaging improvement is only one aspect in the eco-design process.

It appears that the espresso made with a Nespresso Espresso capsule has the lowest greenhouse gases emissions impacts within both behavioral groups (within “trash” or within valorization scenarios).

When thrown into the “trash”, the Nespresso Espresso capsule shows up being the best choice, followed by the generic product 2 Espresso and finally the generic product 3 Espresso. Within a Swiss context, a generic product 1 capsule thrown into the “trash” has higher impacts than a Nespresso capsule thrown into the “trash”.

The best scenario among all is the Nespresso Espresso sent to recycling, followed by a similar impact of the Nespresso Espresso to “trash” and anaerobic digestion of the generic product 3 Espresso capsule. It has to be noticed that if a direct fuel substitution (DFS, incineration with high energy recovery) route was created for the generic product 2 Espresso capsules, it would become a solution with similar impact as that of Nespresso Espresso recycling.

Note that the generic product 3 Espresso capsule is made of a mix of PLA and starch bioplastics, therefore the net impacts lie between the results for these two types of plastics.

The worst alternative among French scenarios is the generic product 3 Espresso capsule made of starch thrown into the “trash”, due, among others, to methane emissions from the starch degradation in landfills. Among Swiss scenarios, the generic product 1 capsule thrown into the “trash” or potentially valorized in DFS has higher impacts than both the Nespresso capsule recycled and thrown into the “trash”.

Other environmental impacts have been tested: resource consumption and impacts on human health show the same conclusions as greenhouse gases emissions. The impacts on ecosystem quality show that there are no significant differences between Nespresso Espresso and the generic product 2 Espresso systems, but both having slightly lower ecosystem quality impacts than the generic product 1 and 3 systems. Because of uncertainties, no conclusions can be drawn about water use.

Focus on packaging

Figure 0-2 shows that if only the packaging production and its end-of-life are considered, the Nespresso Espresso recycling scenario has lower GHG emissions impacts than the generic product 1 or 3 Espresso (since the latter is a mix between starch and PLA) for all end-of-life routes; and lower impacts than the generic product 1 for all end-of-life routes except for DFS where it has similar impacts (note that DFS end-of-life route does not exist at the moment for the generic product 2 Espresso).

The results have been tested with extensive sensitivity and uncertainty analyses showing that the conclusions are robust and the underlying assumptions and data uncertainty do not significantly influence the conclusions. Some limitations apply to this study and should be communicated along with the results (including that the coffee production was considered identical in all products and that the conclusions apply only to the systems studied and are not general statements about materials environmental performances).

Conclusion

The Nespresso Espresso product, when capsule is sent to recycling, is the alternative among the investigated alternatives that has the lowest overall environmental impacts (significant for GHG emissions, resource consumption and human health, while ecosystem quality and water use show similar impacts between Nespresso Espresso recycling and others best scenarios)¹.

An eco-design process should consider improvement potentials on the entire life cycle (notably coffee supply and use stage) and not only on the packaging aspect.

These conclusions are about product systems with specific design and not about the various materials used to produce the capsules.

¹ Note that differences in the total impacts are not significant for the generic product 2 capsules sent to DFS and Nespresso capsules sent to recycling when distribution is excluded. The distribution contains some uncertainties, but its impact is lower for Nespresso than for the generic product 2, and when included it creates a slight advantage for Nespresso sent to recycling compared to the generic product 2 sent to DFS. However, considering uncertainties and current data, the difference in overall environmental impacts between Nespresso sent to recycling and the generic product 2 Espresso sent to DFS is considered not significant

Greenhouse gases emissions for a cup of espresso

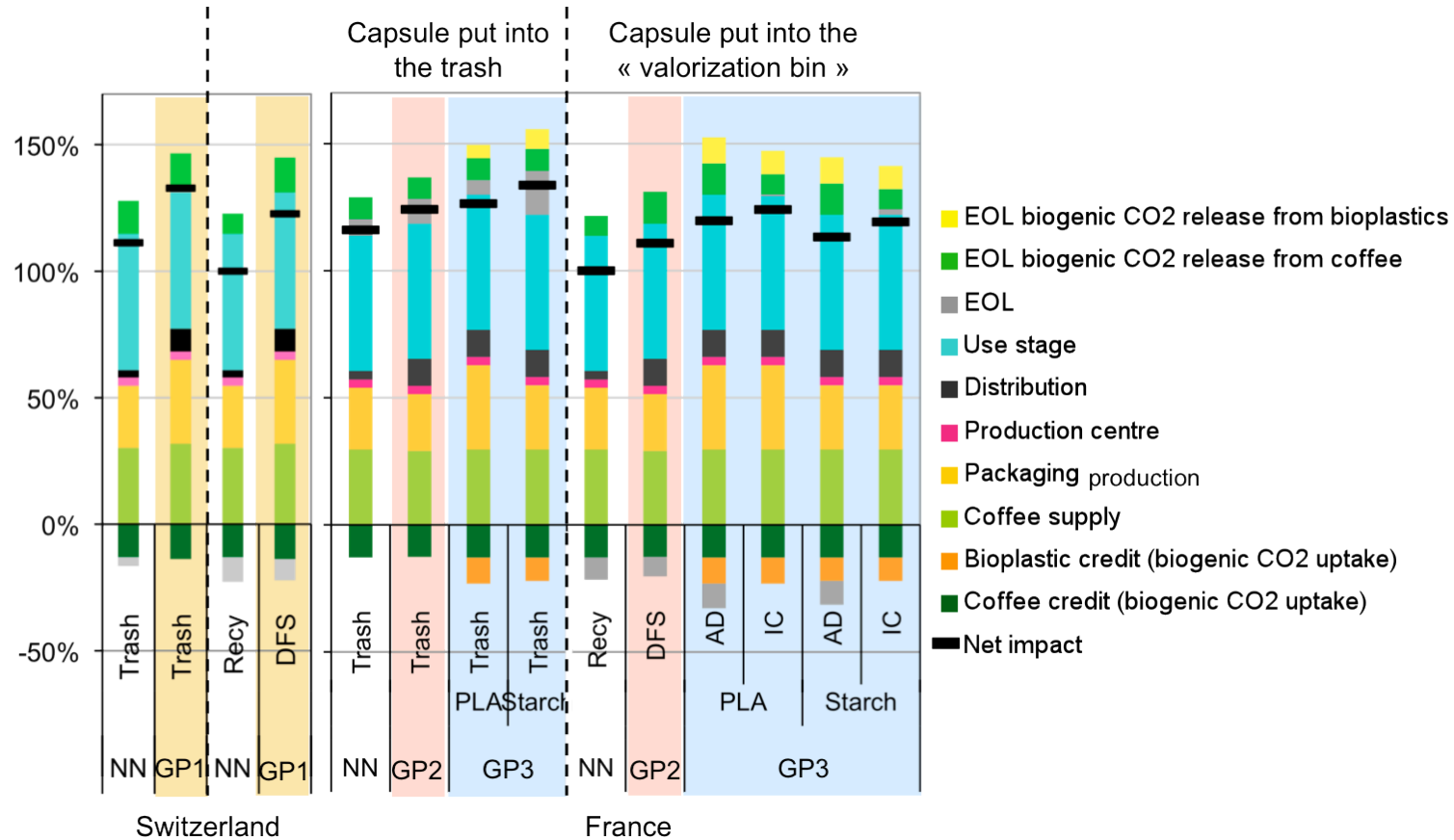


Figure 0-1: Greenhouse gases emissions for one cup of coffee for the main scenarios in g CO₂-eq/cup, in comparison to the Nespresso Espresso recycling scenario put at 100%. NN: Nespresso Espresso, GP1, 2 and 3: Generic product 1, 2 and 3 Espresso, “Trash” (aka household waste): 100% incineration with energy recovery in Switzerland, 51% incineration with energy recovery and 49% landfill in France, Recy: Recycling, DFS: Direct Fuel Substitution, AD: anaerobic digestion, IC: industrial composting. EOL: end-of-life. Recycling, DFS and anaerobic digestion result in a net end-of-life credit due to material recovery (for recycling) and energy recovery (DFS and anaerobic digestion) and agricultural benefits (for anaerobic digestion) causing more credits than impacts.

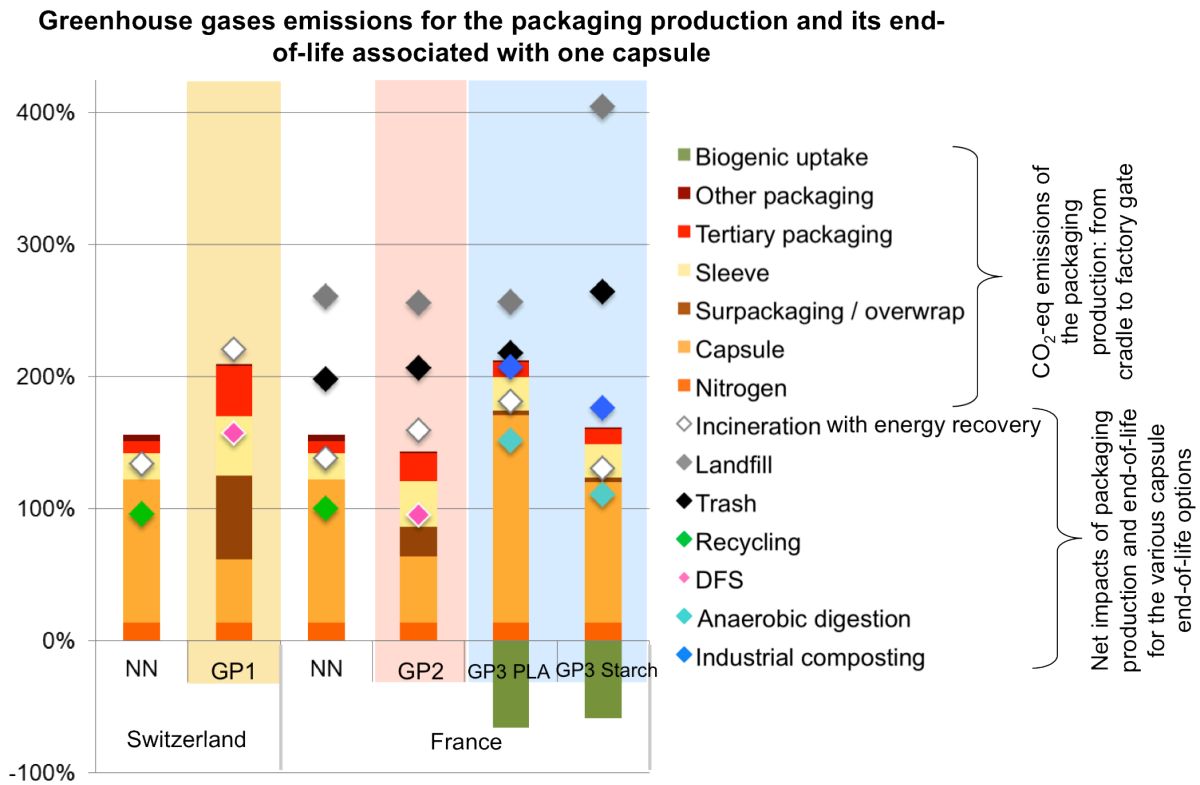


Figure 0-2: Greenhouse gases emissions for packaging production and end-of-life, in comparison to the French Nespresso Espresso recycling scenario set to 100%. The end-of-life of packaging corresponds to the net impacts of packaging and packaging end-of-life. NN: Nespresso Espresso, GP1, 2 and 3: Generic product 1, 2 and 3 Espresso, PLA: polylactic acid capsule, Starch: starch bioplastic capsule. DFS: Direct fuel substitution. The diamonds correspond to the net impacts of packaging production and its end-of-life. Note that only the end-of-life for the capsule varies among end-of-life options; end-of-life of sleeve, tertiary packaging and other packaging follow the average end-of-life route.