

OFS Article

Designing for tomorrow with BEES[®]



Introduction

Banknote design is subject to several constraints, such as security, cost, and longevity. In recent years, sustainability has become another crucial aspect. Sustainability cannot be a consideration at the end of the design phase of a note or a series; it needs to be entirely incorporated into the design process. This is not an obvious task because it is not only determined by the note's components (inks, substrates foils, etc.) but also by the specific choice of sustainability KPIs and the country's unique preconditions and operating environment (e.g. energy mix).

This article describes one significant step forward: Orell Füssli's BEES® (Banknote Environmental Evaluation Software), an environmental footprint calculator for banknotes.

As part of Orell Füssli's sustainability journey, the company had the opportunity to participate in environmental Life Cycle Assessments (LCA) of the 8th and 9th Swiss banknote series. Part of this journey was the world's first direct comparison of two subsequent banknote series.

Over the years, these LCA studies allowed Orell Füssli to collect and analyze vast amounts of environmental data and gain expertise in LCA. These insights were applied to improve Orell Füssli's environmental footprint of its internal processes, like energy consumption and sourcing, and along the value chain, e.g. reusable transport carriers.

Navigating the complex ecosystem of banknote sustainability

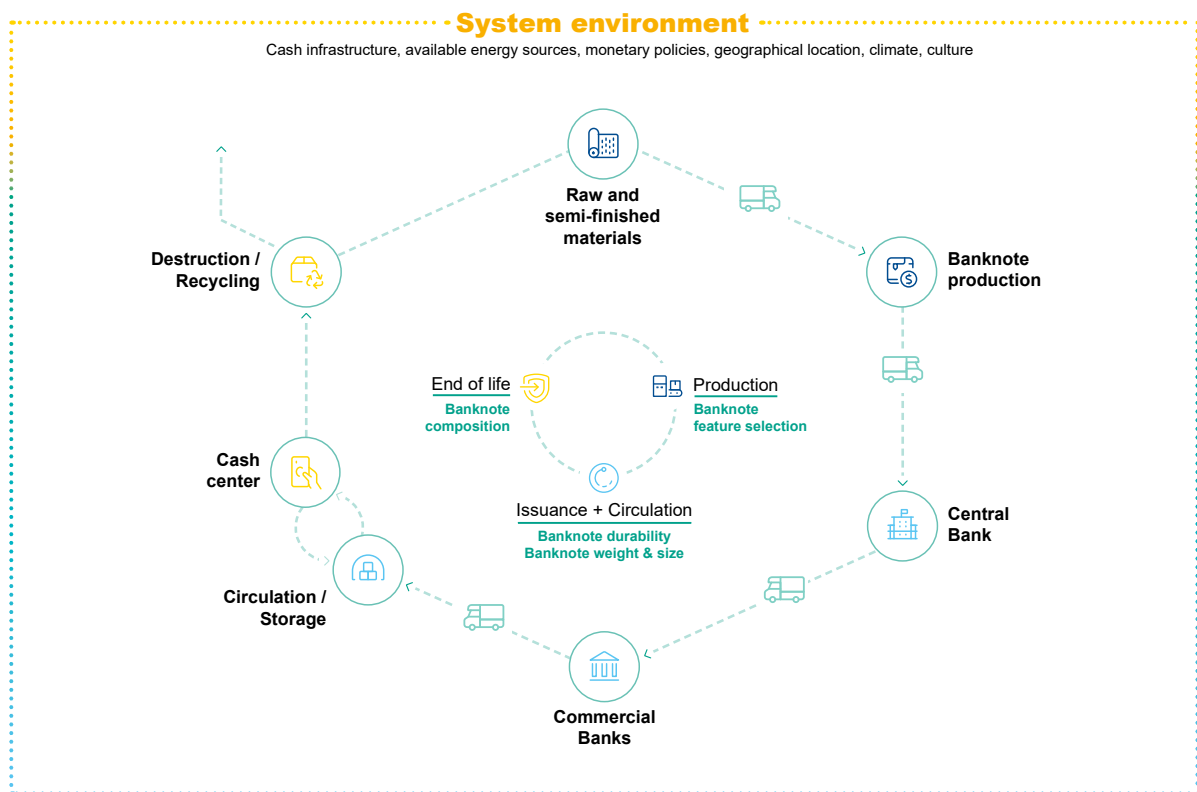
Only what is well understood can be engineered toward a defined outcome. The sustainability of banknotes is no different, even if the nature of the trade might be perceived as rather unique.

The following figure depicts the significant stages and players of a banknote's lifecycle. Roughly:

- the Central Bank, defines the product and its features and issues it.
- the Security Printer designs and manufactures the product.
- Commercial Banks and CITs handle the product in circulation.
- the Central Bank manages the destruction according to local rules and regulations.

Most life cycle stages are disconnected from each other, mainly for security reasons. Yet, all stages contribute to the overall environmental impact of the banknote. While the circulation phase mostly depends on local factors like climate or tradition of money use, the production phase can be modelled independently.

Orell Füssli's BEES® tool currently covers all processes related to the production stages of the banknotes.



Where banknote design impacts sustainability: the lifecycle of a banknote.

From an LCA point of view, static and dynamic elements can be identified throughout the banknote lifecycle:

- **Static elements:**
Some elements are relatively static, such as the local climate and culture of money use, the country's waste treatment systems, or the heating and air conditioning system of a supplier's plant. Such static elements depend on background systems and change slowly over time.
- **Dynamic elements:**
Other elements can be influenced dynamically, such as the choice of materials and the banknote's feature selection or the waste management in a company. Such dynamic elements, like banknote durability, often directly depend on decisions taken by the Central Bank or by the suppliers for banknote production.

When applying Orell Füssli's banknote assessment tool, all those elements will be considered: the more significant and static elements will influence the potential substrate alternatives as well as features such as varnishing of banknotes. Security and cost considerations will equally frame the solution space, by influencing which features are possible or even mandatory. With Orell Füssli's approach, environmental optimization can seamlessly integrate into the design phase.

Environmental footprint along the life cycle

The 2023 Product Environmental Footprint (PEF) Study from the ECB showed a rough distribution of banknotes' environmental footprint in Europe:

- ~10% due to raw materials production
- ~3% due to production
- ~87% due to use in circulation
- ~0.15% for destruction and end-of-life treatment

Although these values vary from region to region, the overwhelming impact of the circulation phase remains comparably high. This means that all decisions that directly target the footprint of this phase will yield the highest returns in terms of sustainability. To detail and develop the

underlying data sets, collaboration across the industry is a critical success factor. Henceforward, environmental considerations should start as early as in the tender phase of a banknote.

Designing sustainable banknotes

In the design phase of a banknote, the criteria are set by the Central Bank and then translated into possible banknote designs, including the features necessary to fulfil these criteria. A wide range of design and feature selection are possible for any given tenders with the given requirements. This is also true for the environmental footprint.

The main advantage of Orell Füssli's new tool BEES® is its ability to accompany the design process and easily deliver an environmental assessment of the developing banknote design. Most questions regarding the environmental effects of features and their extension into a specific operating environment can be answered, often even on the spot. How does a change of lifetime translate into an environmental footprint? What is the environmental effect of varnishing the banknote, adding polymers or, strengthening fibres, or using alternative substrates? Such decisions are major influencing factors for the overall footprint.

The method and tool Orell Füssli created allows to anticipate the environmental impact of design decisions, allowing the Central Bank to optimize its environmental footprint.

Putting the BEES® to work

With the "BEES®", it is possible to assess the environmental impact of each feature in the design process. The software is based on real-life data collected and compiled over the last 18 months.

The result is a modular LCA estimation, based on the functional design of a banknote. A Central Bank can compare different designs or variants of the same design within minutes. Designs can be altered by adding or removing features and directly seeing the environmental impact on the final product. The size and nature of each feature used in the banknote design are taken into account. BEES® uses various environmental impact categories for the assessment, such as

Global Warming, Acidification, Human Toxicity, Ecotox, and Energy use. On top of that, the tool also calculates two overall environmental scores: the Swiss 'Ecopoints' used for Swiss environmental policy and the still provisional 'European Footprint'. These environmental performance indicators can be used in the decision-making process, next to security, aesthetics and price.

BEES® is based on substantial amounts of environmental data, security features, printing processes, as well as standard processes like transport or waste treatment processes. As with every LCA, BEES® contains the entire value chain of each element, for example from cotton fields to the finished banknote substrate. This data's sources are public data, mainly via the Swiss UVEK*-ministry's environmental data inventory (UVEK: 2021) and data from companies within the banknote industry. At its launch in 2024, BEES® comprises some 25 banknote features. Over time, as new features arise or differentiate further, BEES® will be expanded. The same is true for additional environmental impact indicators.

BEES® has been designed in such a way that the footprint is calculated straight from the chosen design and relevant criteria, without any additional inputs. The analysis and its results have been tested in a robust model against earlier banknote LCA results.

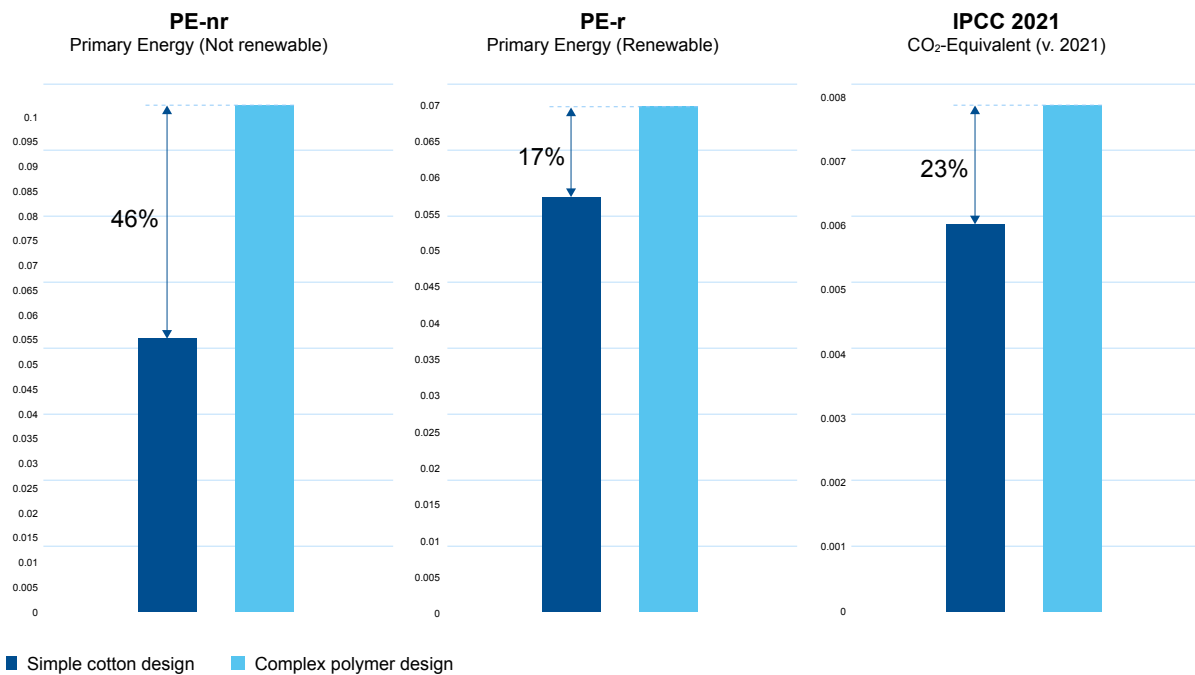
Substrate choice and banknote size are key aspects of environmental performance. However, security features may also significantly contribute to the environmental footprint. The LCA design tool can analyze these and other aspects.

The game-changing nature of this software is the fact that it works without special knowledge of how to set up and evaluate an LCA or the need to collect inventory data from actual production sites.

By providing this insight early in the conceptual phase of a banknote, Orell Füssli believes that it can positively influence banknote sustainability beyond its direct impact as a security printer. To Orell Füssli's knowledge, this may be the first design oriented LCA-tool, not only for banknotes but for any specific sector.



Substrate choice and banknote size are key aspects of environmental performance.



The graphic compares two fictional designs: a simple design on cotton and a complex design on polymer, expressed in three environmental impact indicators: non-renewable energy, renewable energy and CO₂-equivalents.

The environmental impact of the simple cotton design in production is 17% to 46% lower than that of the complex polymer design in production, depending on the chosen indicator. However, depending on the circulation conditions and the clean note policy, this relation may be equalized or even reversed by time in circulation.

Driving sustainability – by design!

The added value for Central Banks is to be in direct control in optimizing the ecological footprint of a new series. The streamlined approach offers an easy, low-cost, rapid alternative to conducting costly and lengthy LCAs. It empowers decision-makers to make informed choices during critical stages, particularly in the design phase, where decisions have the most substantial impact. Furthermore, it establishes a foundational framework for subsequent analysis and improvement endeavours. This way, Central Banks can seamlessly integrate comparable sustainability evaluations into tender processes, facilitating fair and transparent assessments, thereby enhancing overall sustainability practices within the security printing sector.

Comparing BEES® to driving a car is the difference between seeing the radar trap through the windshield or in the rear mirror. If we want to put the brake on the environmental footprint of banknotes, we need to turn the gaze where we are driving.

Orell Füssli Ltd. security printing

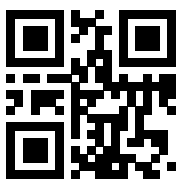
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Fact Sheet

- Sustainability is evolving to be a significant aspect of banknote design.
- Life Cycle Assessments (LCA), used to determine environmental impact, are lengthy and costly processes performed in hindsight.
- Banknote design choices impact the overall environmental footprint beyond the production stage.
- Orell Füssli has developed the assessment tool "BEES®", allowing easy evaluation of the environmental impact of different design choices without the need for an LCA. A Central Bank can compare various designs or variants of the same design within minutes.
- BEES® covers a wide range of environmental impact factors and can easily be extended. Its results have been successfully tested against actual data from existing LCAs.
- By providing this insight already in the conceptual phase of a banknote, Orell Füssli strives to positively influence banknote sustainability beyond the direct impact it has as a security printer.





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