Bern University
of Applied Sciences

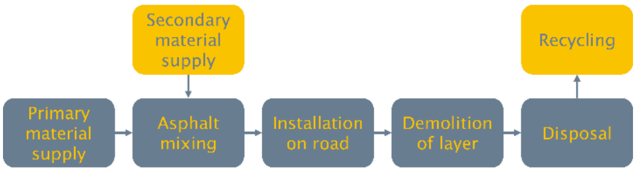
# Reference methodology for Swiss asphalt pavements

Life Cycle Assessment (LCA)

## System Description

As part of the platform KIES (www.kiesfuergenerationen.ch), a basic LCA-methodology for Swiss asphalt pavements was developed based on a literature review, a close collaboration and a review process with Umtec Technologie AG. The defined LCA methodology was applied to calculate greenhouse gas emissions, ecological scarcity and primary energy for three asphalt layers: surface, binder, and base layer. These three asphalt layers differ mainly in service life, thickness and mixture of gravel, sand, filler, bitumen and reclaimed asphalt pavement (RAP). Figure 1 shows the generalized life cycle stages of an asphalt layer, highlighting the circularity measures in yellow boxes.

Figure 1: Considered life cycle stages of an asphalt layer including the circularity measures in yellow boxes.




## Goal

The goal of this LCA study was to create a reference methodology to assess the environmental impacts of asphalt layers, especially those with a high secondary material content. The defined methodology was validated through a peer review process and applied to a realistic design of surface, binder and base layer for Swiss cantonal roads.

## Scope

The following life cycle stages were considered: raw material supply (A1), transport processes (A2, A4, C2), asphalt production (A3), installation (A5), replacement (B4), demolition (C1), recycling (C3) and landfill (C4).
Additionally, Module D was included to account for benefits and burdens beyond the system boundary (results are not shown and discussed in this document).
The functional unit is defined as 1 m$^2$ of each layer for a Swiss cantonal road with a reference service life of 60 years.
The LCA was done in accordance with the standard EN ISO 14040/44 and EN 15804+A2 using the life cycle assessment software openLCA (2.1) and the UVEK database (UVEK LCI Data DQRv2:2018).

Figure 2: Installation of asphalt layers on a Swiss cantonal road.

## Results

Considering all life cycle stages and a reference service life of 60 years, 1 m$^2$ of surface layer causes 73.8 kg $CO_2$-eq., 1 m$^2$ of binder layer 36.2 kg $CO_2$-eq. and 1 m$^2$ of base layer 13.7 kg $CO_2$-eq. greenhouse gas emissions (Figure 3). The significant differences between the layers are mainly due to the different assumed service life and the corresponding replacement cycles. The replacement (B4) accounts for around 84 % of the total greenhouse gas emissions for the surface layer (replaced 5 times over 60 years) and around 67 % for the binder layer (replaced 2 times in the same period). Since the base layer is not replaced during the 60 years, there is no replacement accounted.

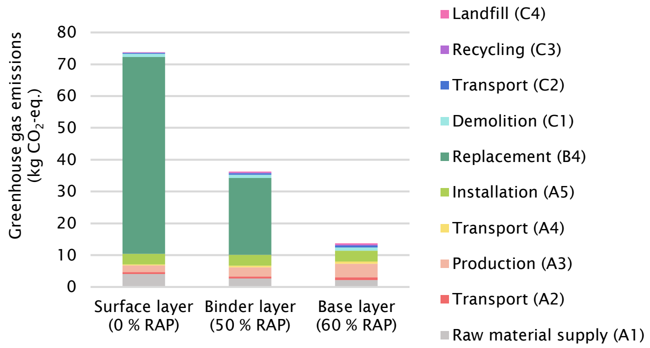



Figure 3: Greenhouse gas emissions for the evaluated asphalt layers (surface, binder and base layer) and the considered life cycle stages.

High greenhouse gas emissions were also caused by the raw material supply (A1) of bitumen, the asphalt production (A3) and the installation process (A5). The results show a reduction of environmental impacts for asphalt layers with a high RAP content. Similar patterns were observed for ecological scarcity and primary energy with comparable contributions from the different life cycle stages.

## Conclusions & Outlook

In this study a methodology for life cycle assessment of asphalt pavements was developed, validated, applied and externally validated. The results show potential reductions of environmental impacts for the different asphalt layer designs. Especially a high secondary material supply and a low bitumen content have relevant positive effects from an ecological point of view.

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