

Life Cycle Assessment of zero- emission façade construction

Authors: Barecka, M.¹; Zbiciński, I.¹; Heim, D.¹¹ Lodz University of Technology, Lodz, Poland, magda.barecka@p.lodz.pl

MOTIVATION

In the research of zero-emission building design, façade solutions like ventilated panels, photovoltaic panels and phase change materials (PCM) are used in order to reduce the energy demand and the environmental impact of the façade during operational phase. However, considering all phases of the life cycle of a façade, some solutions being energy- efficient in the operational phase,

may have a significant environmental impact on the production or disposal phase. Therefore, the Life Cycle Assessment (LCA) is needed in order to measure the sustainability of selected configuration of the façade.

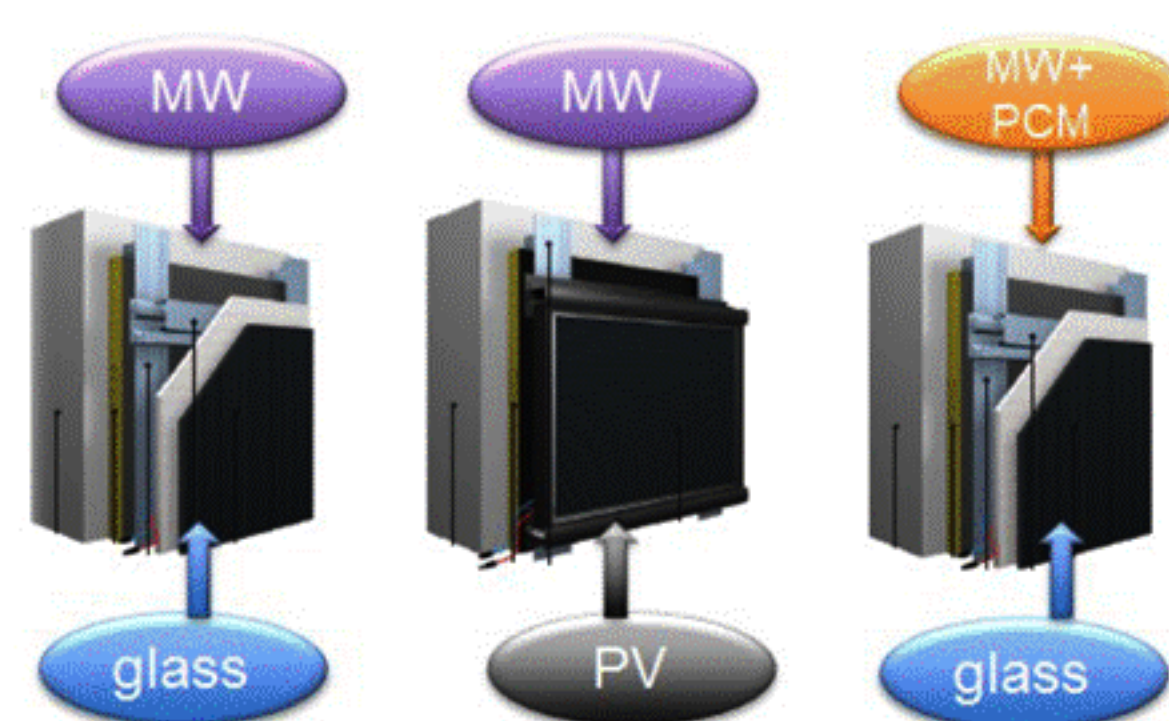
SCOPE OF THE RESEARCH

Analyzed systems

Three different opaque insulating façade panels were considered:

- panel with opaque glass finish
- panel with CIS photovoltaic finish
- panel with glass finish and PCM based on caprylic acid in the insulation

All panels are based on the same insulation layer (20 cm of mineral wool, $\lambda=0.033$ W/mK), equipped with the same alumina-stainless steel support system and façade ventilation system.



Major assumptions

The goal of the LCA analysis was to express and compare the environmental impact expressed for a functional unit- panel of dimensions of 120 cm per 60 cm. The façade lifetime is estimated to be 25 years. The energy demand that is needed to recompense the heat losses via façade, as well as the electricity production from CIS photovoltaic modules was obtained with ESP-r simulation engine for building energy performance. The electric energy demand was integrated in LCA analysis, considering the European Union electricity mix for the co-ordination of production and transmission of Electricity (UCPTE), Medium Voltage.

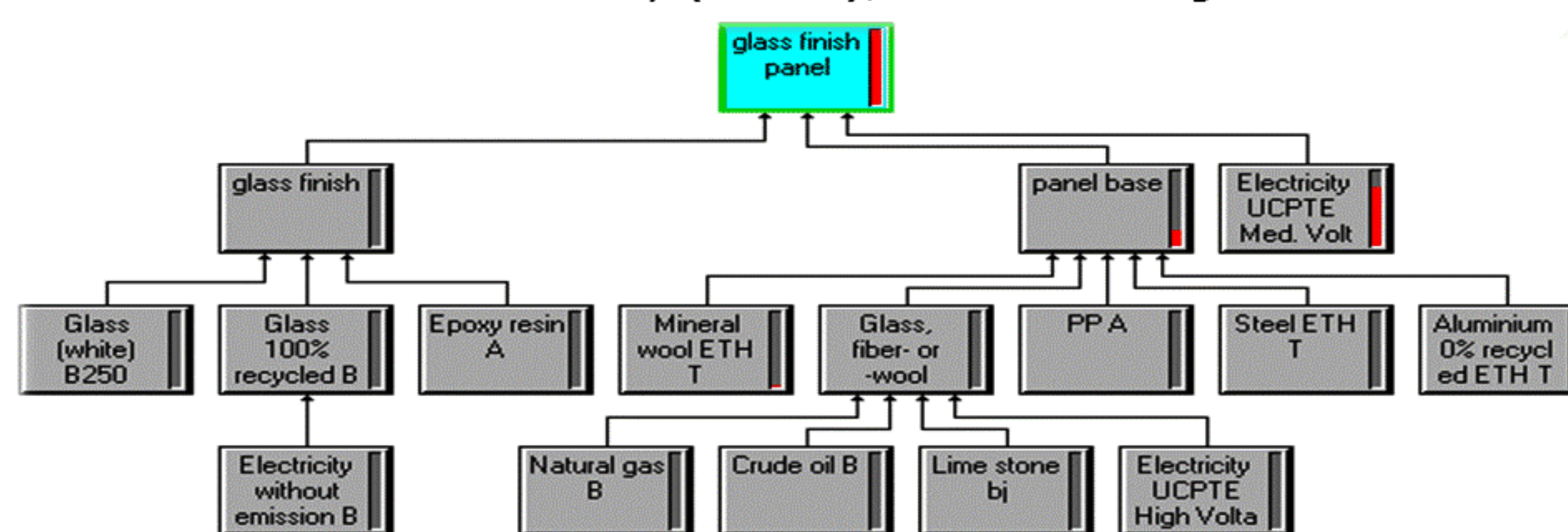


Fig. 1. 3-D schemes of analyzed panels solutions. MW stands for mineral wool insulation, PCM- phase change material, PV- photovoltaic finish.

Fig. 2. Simplified process tree for glass finish façade panel.

RESULTS

The values of LCA scores obtained with Ecopoints 99 and MIPS tool are presented in the figure 3, separately for production phase, operational phase and whole life cycle. Since the values for each method are expressed in different units (kilograms of natural resources/ points of environmental damage), they were further presented in a relative way (each value divided by the highest score obtained with the method), to make them easily comparable (figure 3 c).

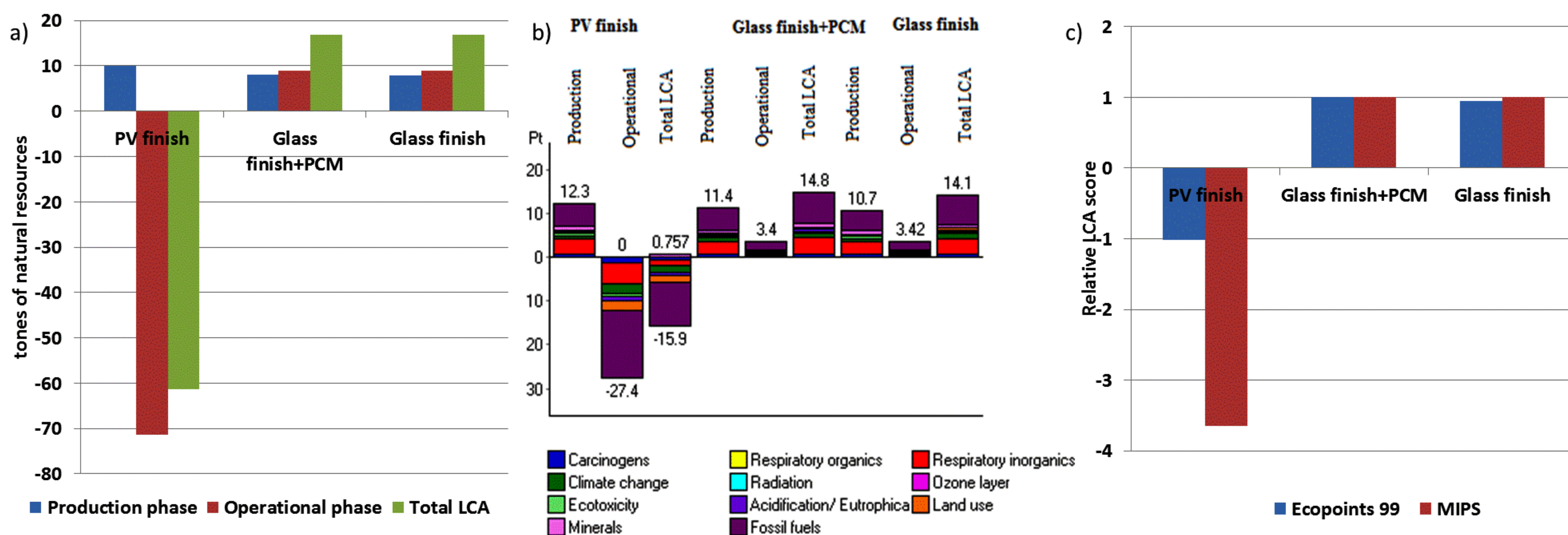


Fig. 3. LCA scores for three façade solutions: a) MIPS values, b) Ecopoints 99 values. c) relative values.

CONCLUSIONS

- Due to energy gains in the lifetime of façade, the panel with photovoltaic finish proves to be the most suitable opaque solution from the environmental point of view, as far as the façade is well exposed to the sunlight radiation.
- Application of this façade solution allows not only to reach the goal of zero- emission building in the terms of energy

consumption, but also in terms of general, long- term environmental impacts.

- Due to the long life cycle of a building, the decisive factor is energy demand for heating (even for very efficient insulating systems), related to the maintenance phase

ACKGT.

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