CASE STUDY

Construction

ROOFS

Location

Hungary

System boundary

production of building products (A1-A3)
transport to construction (A4)
maintenance and replacement, if necessary (B4-B5)
end of life (C1-C4)

Origin of data

Constructions: IS-SusCon project
Background data: OneClickLCA database, selection of the most representative datapoints for Hungary,
see methodological details in the document **"Hungarian building constructions"**

PITCHED ROOFS (HEATED ATTIC)

Functional unit
1 m^2
U-value 0.17 W/m2K
50 years building lifetime
painting in every 10 years
lacquer of wooden boards every 15 years
bitumen shingle in every 25 years*

*The bitumen coating needs to be renewed and replaced every 15-20 years. In practice, the existing old coating will receive a new, waterproof but thinner coating within this period. In calculating the results for the lifetime of the whole house, these two factors (lifetime, thickness) have been calculated with an average lifetime of 25 years and the same thickness.

Solutions:

short name	full name	Roof covering	Insulation	Structure and membranes	Internal covering
MW_cer	Heated pitched roof with wooden rafters, mineral wool insulation and ceramic roof tiles	Ceramic tiles	insulation between rafters (rock wool); insulation between battens (rock wool)	Roof battens wooden counter batten underlay foil, vapour open wooden rafter wooden battens vapour barrier membrane	gypsum board (2 layers) wall paint
MW_con	Heated pitched roof with wooden rafters, mineral	Concrete roof tiles	insulation between rafters (rock wool) insulation between	Roof battens wooden counter batten	gypsum board (2 layers) wall paint

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	wool insulation and concrete roof tiles		battens (rock wool)	underlay foil, vapour open wooden rafter wooden battens vapour barrier membrane	
MW_bit	Heated pitched roof with wooden rafters, mineral wool insulation and asphalt shingle roofing	Asphalt shingle	insulation between rafters (rock wool) insulation between battens (rock wool)	Wooden boards wooden counter batten underlay foil, vapour open wooden rafter wooden battens vapour barrier membrane	gypsum board (2 layers) wall paint
MW_TiZn	Heated pitched roof with wooden rafters, mineral wool insulation and titanium zinc roofing	Titanium zinc	insulation between rafters (rock wool) insulation between battens (rock wool)	Underlay OSB board wooden counter batten underlay foil, vapour open wooden rafter wooden battens vapour barrier membrane	gypsum board (2 layers) wall paint
MWab_cer	Heated pitched roof with wooden rafters, mineral wool insulation above rafters and ceramic roof tiles	Ceramic tiles	rock wool insulation above rafters	Roof battens wooden counter batten underlay foil, vapour open vapour barrier membrane	wooden board lacquer wooden rafter
GEPS_cer	Heated pitched roof with wooden rafters, grey EPS insulation above rafters and ceramic roof tiles	Ceramic tiles	polystyrene insulation with graphite above rafters	Roof battens wooden counter batten underlay foil, vapour barrier membrane	wooden board lacquer wooden rafter
PUR_cer	Heated pitched roof with wooden rafters, PUR insulation above rafters and ceramic roof tiles	Ceramic tiles	PUR rigid board insulation above rafters	Roof battens wooden counter batten underlay foil, vapour open vapour barrier membrane	wooden board lacquer wooden rafter

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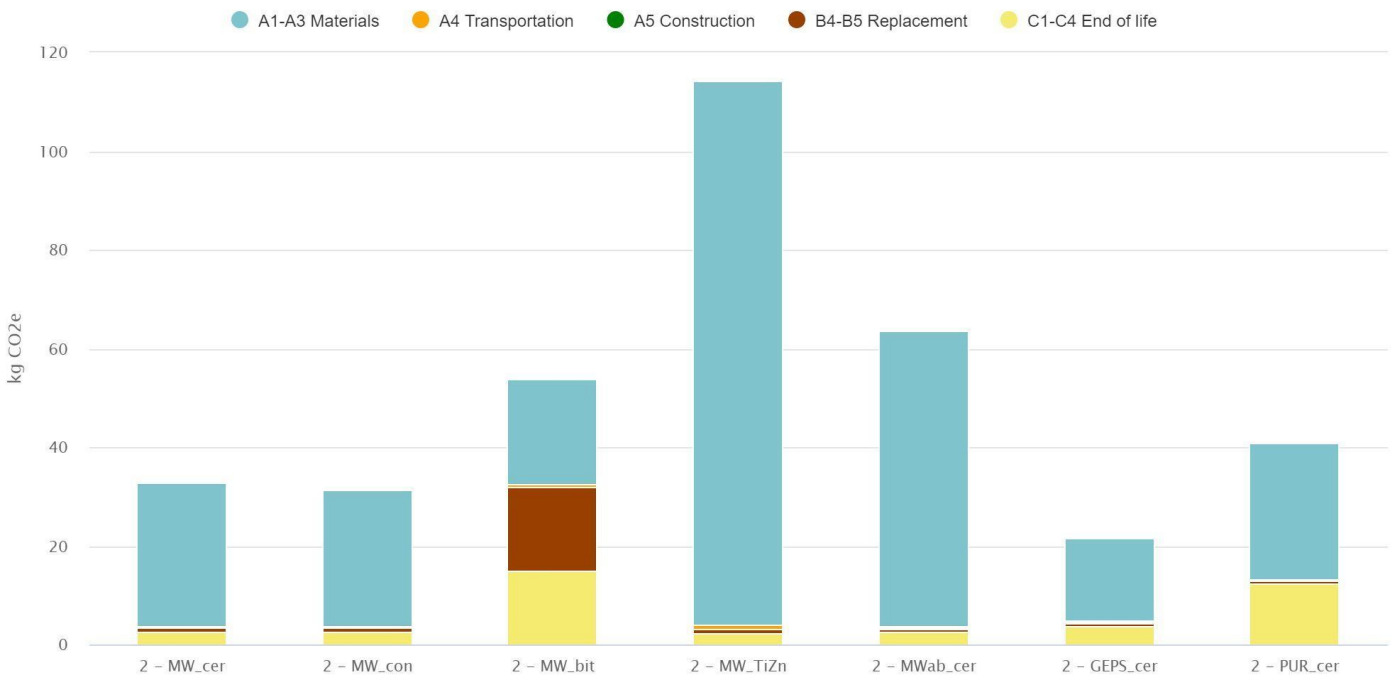
Impact assessment	
Global Warming Potential (GWP)	

Comparison of the different solutions of the roof concerning the global warming potential category.



Interpretation of GWP results:

Grouping the comparison based on the similarity of the constructions:

- 1 to 4 solutions, where the **difference is the roof covering** type:

○ Almost in all impact categories the MW_TiZn solution has the highest impact on the environment due to production (A1-A3) of the zinc-titanium alloy sheets. On the other hand, we have to remember that after usage, these metal sheets can be potentially recovered and recycled leading to GWP credits of this solution (Module D), but this result doesn't contain this information.

○ The replacement stage (B4-B5) appears to be significant for the MW_bit due to the bitumen coating replacement (braun in the figure). In this case the coating lifetime is 25 years and it needs to be replaced one more time during the house lifetime. In the database, incineration of bitumen is assumed at the end-of-life. However, bitumen is typically landfilled in Hungary, which would lead to lower impacts.

○ the difference between the impacts are small in case of the ceramic and concrete tiles

- 5 to 7 solutions, where the **difference is the insulation** type:

○ The second highest production stage (A1-A3) is related to the MWab_cer due to the rock wool insulation production as a high density rockwool product is selected here for the above rafter application.

○ The lowest impact has the sixth solution with polystyrene insulation with graphite above rafters.

○ At the last solution - which contains PUR insulation, - the impact of PUR disposal is significant.

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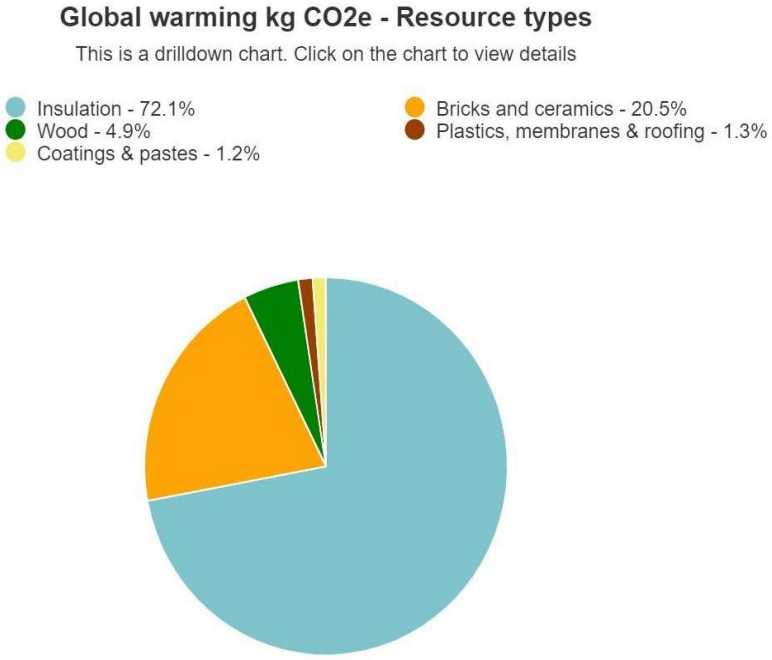


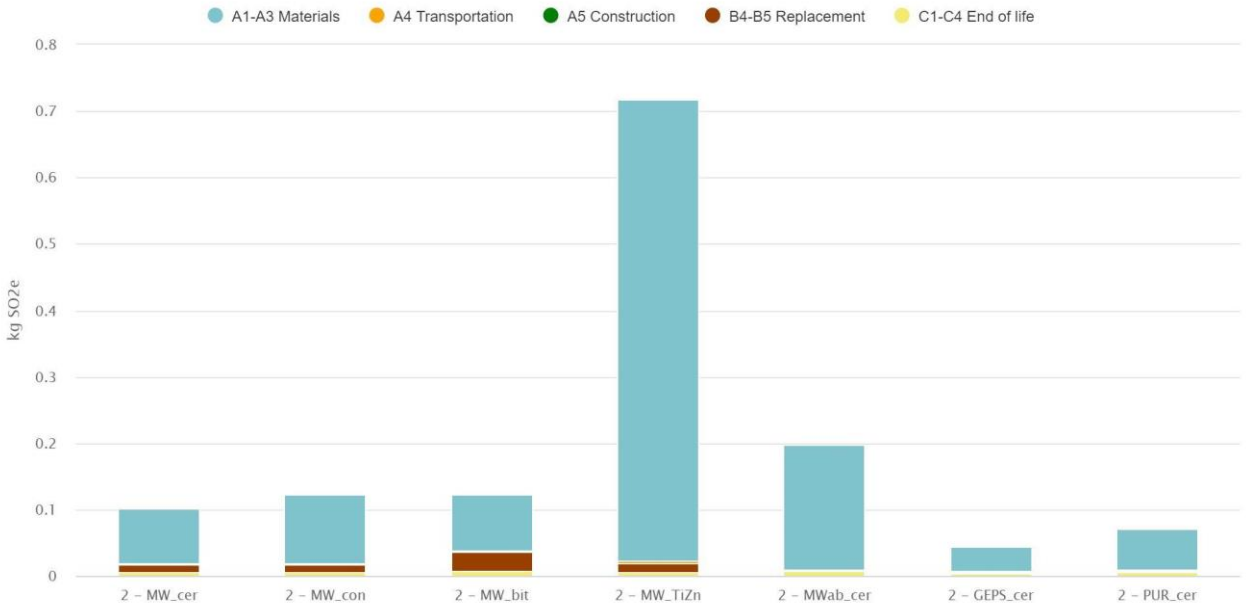
○ Regarding the materials - the insulation production has the biggest impacts and the bricks and ceramics production has the second biggest impacts on the environment in the climate change impact category, although these give also the biggest part of the constructions.

Other Hotspots

The MW_TiZn solution – Heated pitched roof with wooden rafters, mineral wool insulation and titanium zinc roofing construction has the highest impact on the environment in almost every impact category (not considering potential credits of Module D).

AP

In this impact category, the trend is almost the same as in the global warming potential category.



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- The difference of the MW_TiZn is much higher compared to the other solutions, due to the production stage (A1-A3).
- The contribution of the replacement (B4-B5) also appears in other solutions (the first four).

POCP

- This impact category is an example that the trend can change: here the GEPS_cer solution has the highest impacts due to the EPS production (A1-A3). It clearly shows that wall constructions without EPS insulation have significantly lower values than the EPS insulated solutions. The POCP impact of EPS is related mainly to the emission of blowing agents into air during manufacturing.
- In this category, the role of the end-of-life (C1-C4) stage is not significant.

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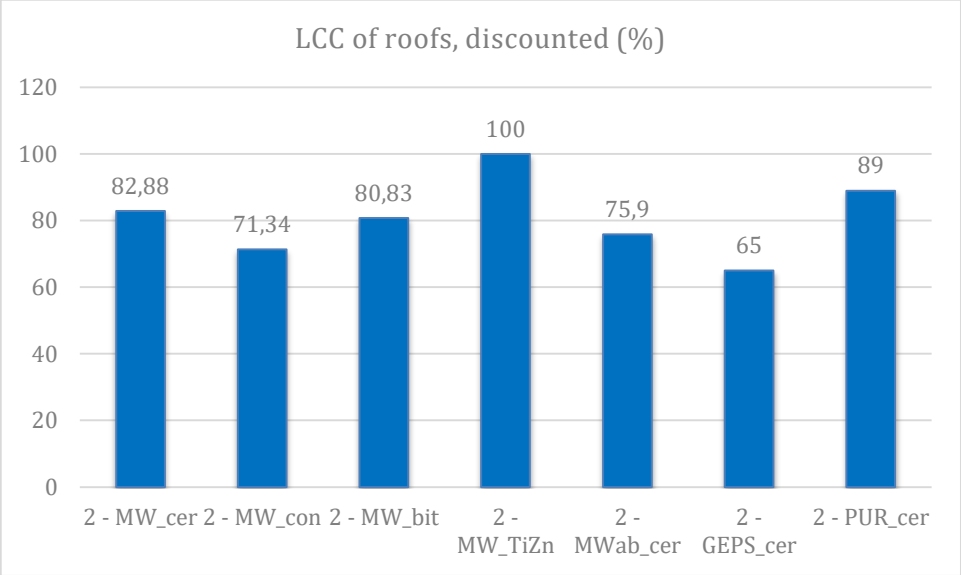
Cost

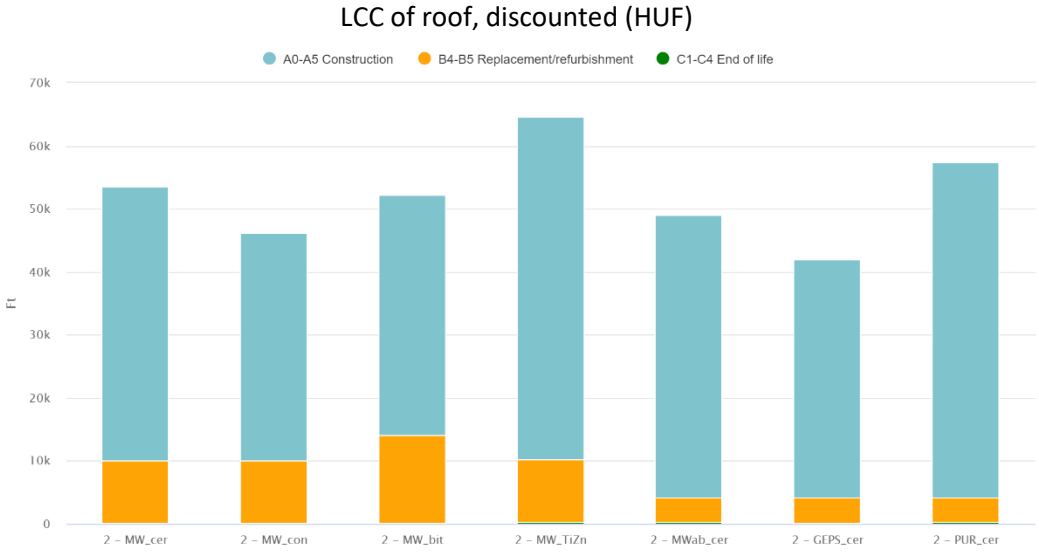
The life cycle costs of the 7 different roof structures show a max difference of 35 %. The average cost of one m^2 heated roof is HUF49000. In other words, it varies between HUF 42,000 and HUF 64500 (material cost + labour fee). The difference is due to the different roofing elements and the different insulation.



The most expensive roof is the MW-bit and MW-TiZn. Roofing with concrete tiles (MW_con) is the most cost effective solution.

The difference in cost depends not only on the roofing materials but also on the insulation material.

Roofs, except for bituminous shingles, do not need to be refurbished. Here, due to refurbishment every 20 years, this cost is close to 20% of the total LCC at a discounted price. However, painting is required on all roofs.



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