IS-SusCon

# CASE STUDY

**Construction**

EXTERNAL WALLS

**Location**

Hungary

**System boundary**

production of building products (A1-A3)
transport to construction (A4)
internal painting in every 10 years (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**"

# EXTERNAL WALLS

**Functional unit**

1 m2

U-value 0.23-24 W/m2K

50 yr building life time

**Solutions:**

| | internal plaster | wall | external plaster | Insulation | external cover |
|---|---|---|---|---|---|
| **Brick25 EPS** | lime-cement | hollow ceramic **brick 25 cm** with cement mortar | cement | **EPS** foam | cover coat with glass fibre reinforcement |
| **Brick30 EPS** | lime-cement | hollow ceramic **brick 30 cm** with cement mortar | cement | **EPS** foam | cover coat with glass fibre reinforcement |
| **Brick30 grey EPS** | lime-cement | hollow ceramic **brick 30 cm** with cement mortar | cement | **EPS** foam with **graphite** | cover coat with glass fibre reinforcement |
| **Brick30 MW** | lime-cement | hollow ceramic **brick 30 cm** with cement mortar | cement | **mineral wool** | cover coat with glass fibre reinforcement |
| **Brick30 WW** | lime-cement | hollow ceramic **brick 30 cm** with cement mortar | cement | **wood wool** | cover coat with glass fibre reinforcement |
| **Brick38** | lime-cement | hollow ceramic **brick 38 cm** with cement mortar | **insulating plaster** | | |
| **AAC25 EPS** | lime-cement | aerated concrete **25 cm** with cement mortar | cement | **EPS** foam | cover coat with glass fibre reinforcement |
| **AAC37** | lime-cement | aerated concrete **37,5 cm** with cement mortar | cement | | - |

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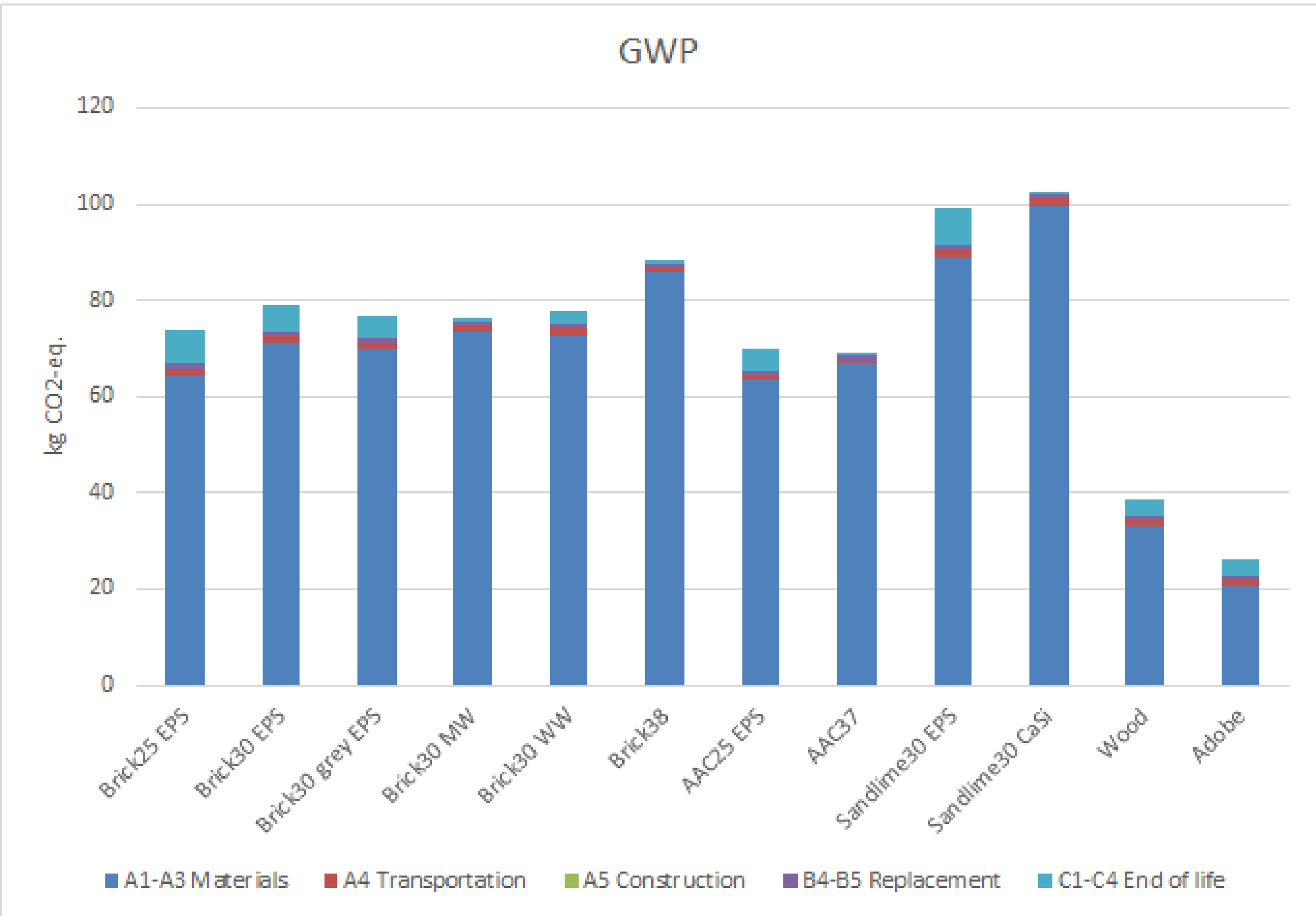
| | internal plaster | wall | external plaster | Insulation | external cover |
|---|---|---|---|---|---|
| **Sandlime 30 EPS** | lime-cement | sand lime **brick 30 cm** with cement mortar | cement | **EPS** foam | cover coat with glass fibre reinforcement |
| **Sandlime 30 CaSi** | lime-cement | sand lime **brick 30 cm** with cement mortar | cement | **calcium silicate** | cement plaster |
| **Wood** | **gypsum board** + **OSB board** | **vapour barrier membrane** **wooden** battens and stud, cement bonded **chipboard** | | **mineral wool and EPS** | cover coat with glass fibre reinforcement |
| **Adobe** | **adobe** plaster | **adobe** brick with adobe mortar, wooden stud | adobe and **silicate** plaster | **straw** | |

**Impact assessment**

**Global Warming Potential (GWP)**

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Interpretation of GWP results:

- Wood and Adobe external walls have significantly lower GWP than the other solutions: choosing the Wooden solution, GWP is around the half, while choosing Adobe it is even lower compared to the other solutions. It is clear that the absence of energy demanding manufacturing processes makes these solutions very advantageous if we focus on GWP.
- Sandlime wall solutions have the highest GWP and they are also the heaviest construction: the mass of the 30 cm sandlime wall is more than double compared to hollow brick. Please note that the heavy weight has advantages that cannot be quantified here: the high thermal mass is beneficial for both heating and cooling and also its acoustic performance is excellent. The sandlime option with CaSi has the highest value due to not only the sandlime brick itself (70%) but also the CaSi insulation panels (16%) and cement plaster (11%).
- Between ceramic brick and aerated concrete the AAC solutions have slightly lower GWP thanks to also its lighter weight.
- Within the ceramic brick wall alternatives the thickness of the brick counts mostly. Brick with 38 cm without insulation has higher GWP than the thinner (25-30 cm) and insulated brick walls.
- Type of insulation (EPS, EPS with graphite, Rockwool, Wood wool) has limited effect on the GWP of the entire wall constructions in this comparative assessment. Production of mineral wool and wood wool may have the highest GWP but the end of life treatment of EPS (incineration) roughly equalizes this impact.

Note: Carbonation in the use phase of AAC is not considered that can potentially reduce the GWP.

**Other Hotspots**

GWP is the most important indicator in the building industry.
However, other categories can identify some additional hot-spots.

- **EPS insulation**

The following figure compares the POCP (Photochemical Ozone Creation Potential) results of the ceramic brick and aerated concrete solutions. It clearly shows that wall constructions without EPS insulation have significantly lower values then the EPS insulated solutions. Thinner wall requires EPS insulation with higher thickness which leads to higher POCP value. The POCP impact of EPS is related mainly to the emission of blowing agents into air during manufacturing.

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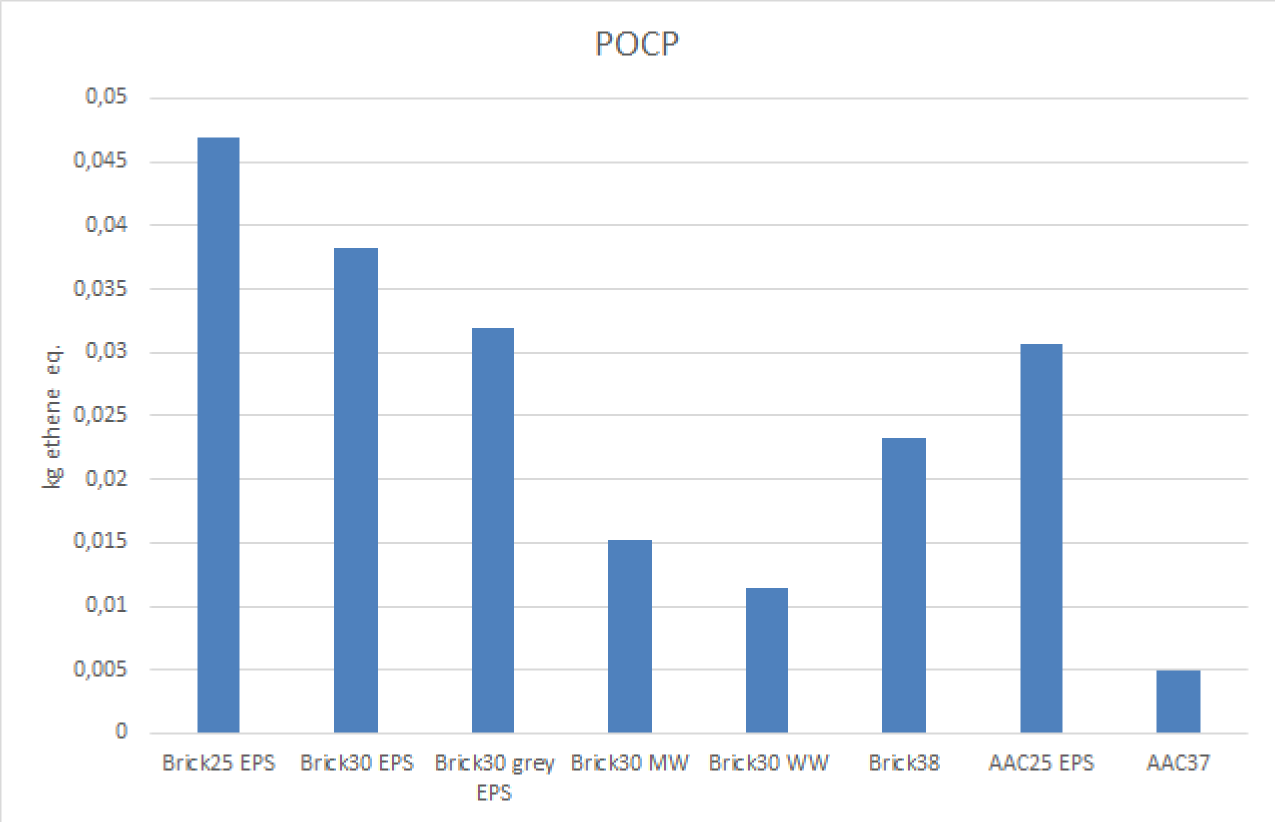


- **Insulation materials**

As we have seen, comparing GWP of ceramic brick solutions, the values are higher with increasing brick wall thickness. Instead, if we analyse Acidification Potential (AP) and Eutrophication Potential (EP) values the disadvantage of the 38 cm thick brick wall (without insulation material) disappears because the insulation materials of the alternative solutions, such as mineral wall, wood wall and EPS, have more significant contribution to these impacts than to GWP.

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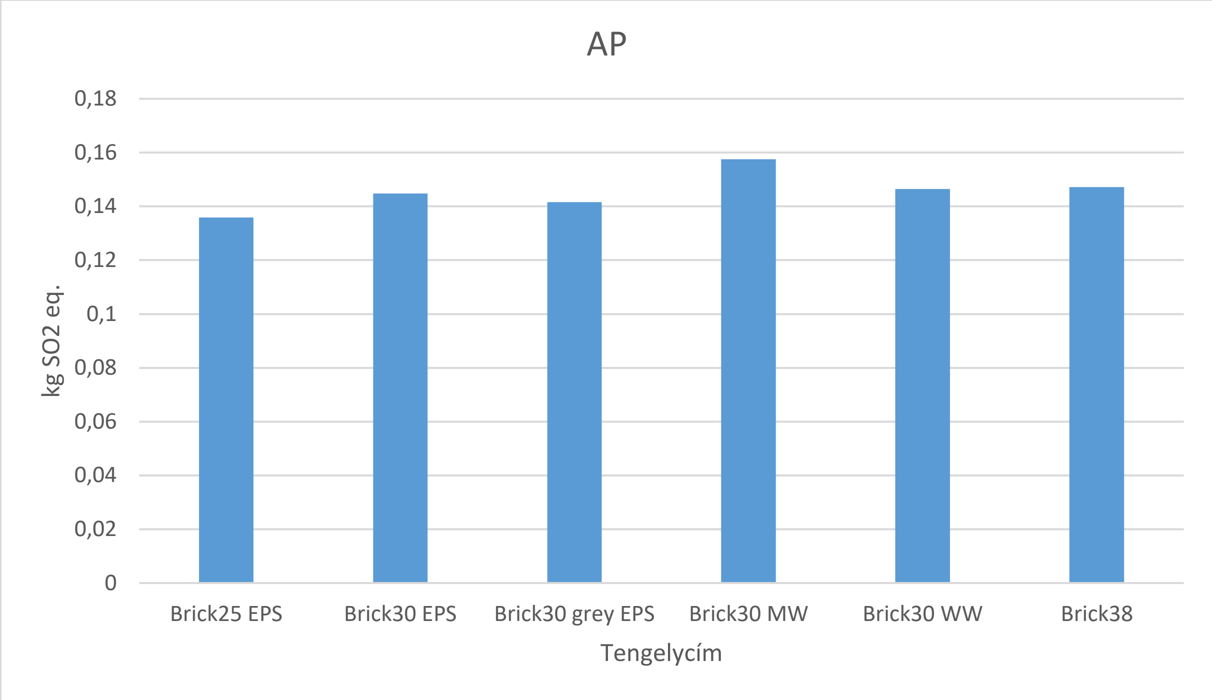


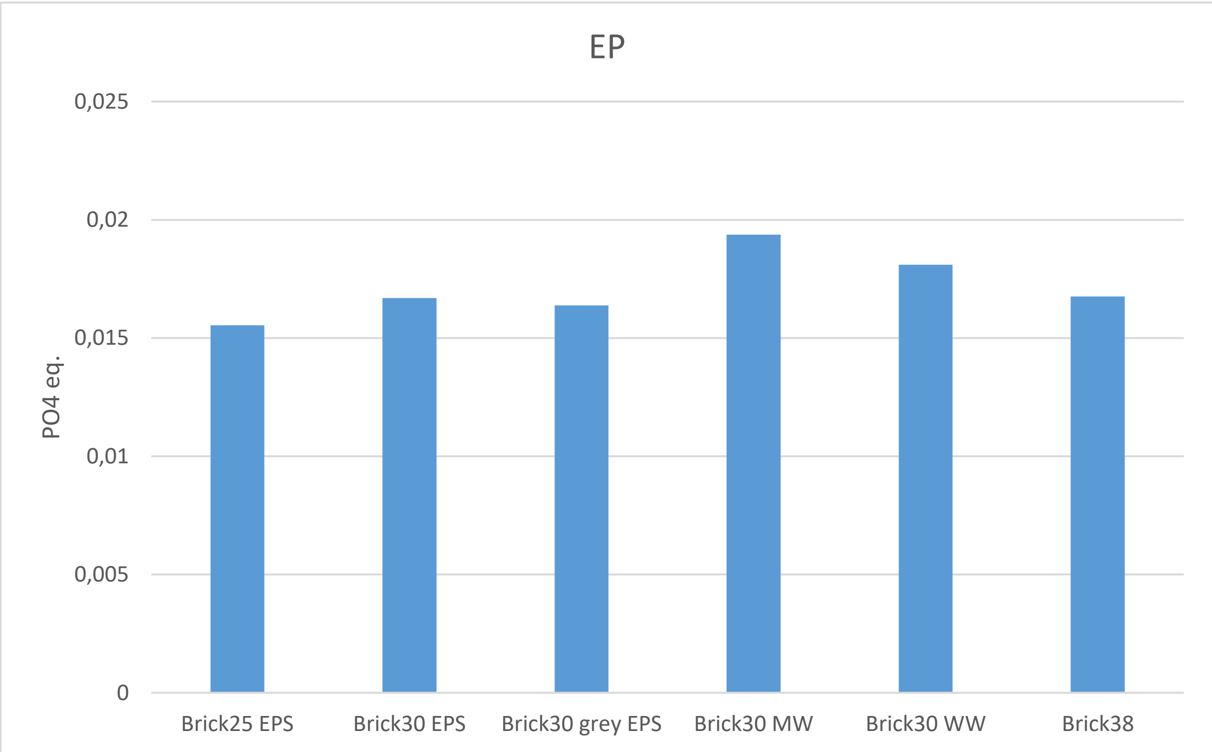


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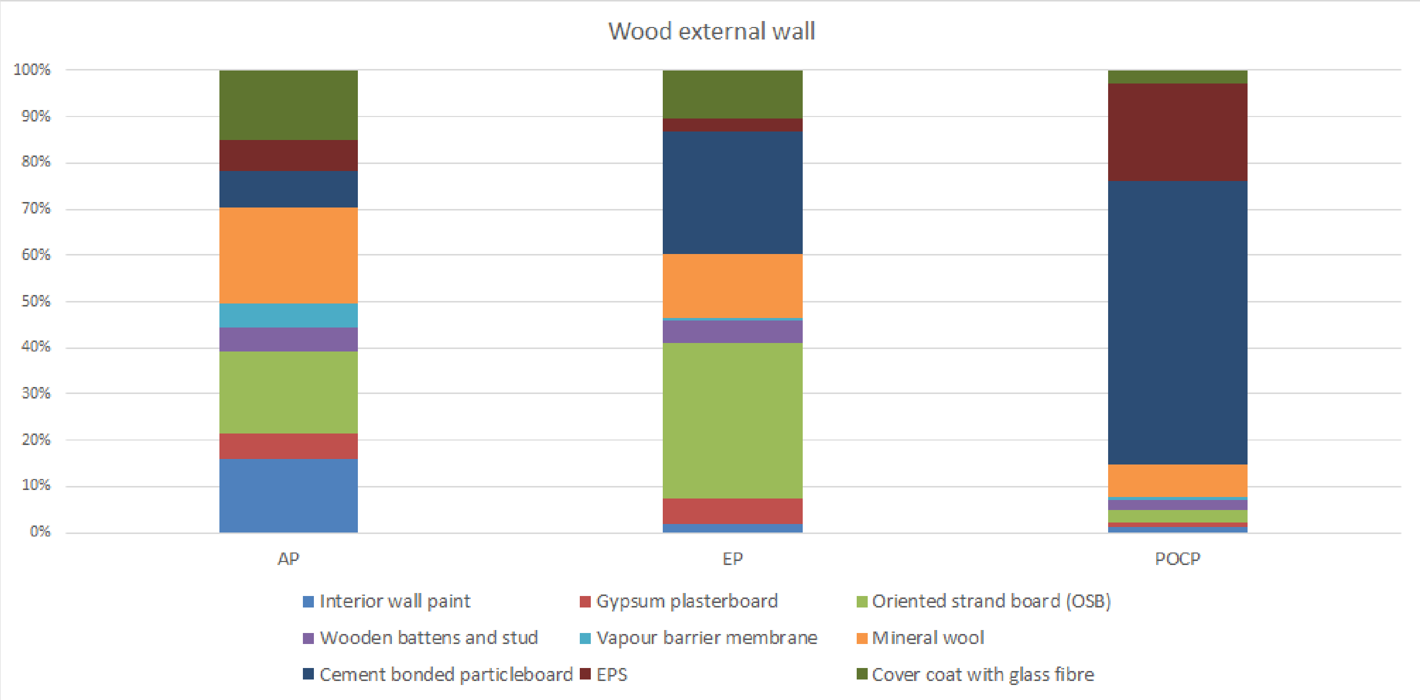
- **Wood construction**

Benefits of wood construction concerning GWP are not confirmed in AP, EP, POCP. The constructing elements, such as mineral wood, EPS, OSB and cement bounded panels potentially increase these environmental impacts. The following figure shows the contribution of the different components of the Wood solution in these impact categories.
OSB panels have also formaldehyde emission during use phase, which was not considered in this case study.

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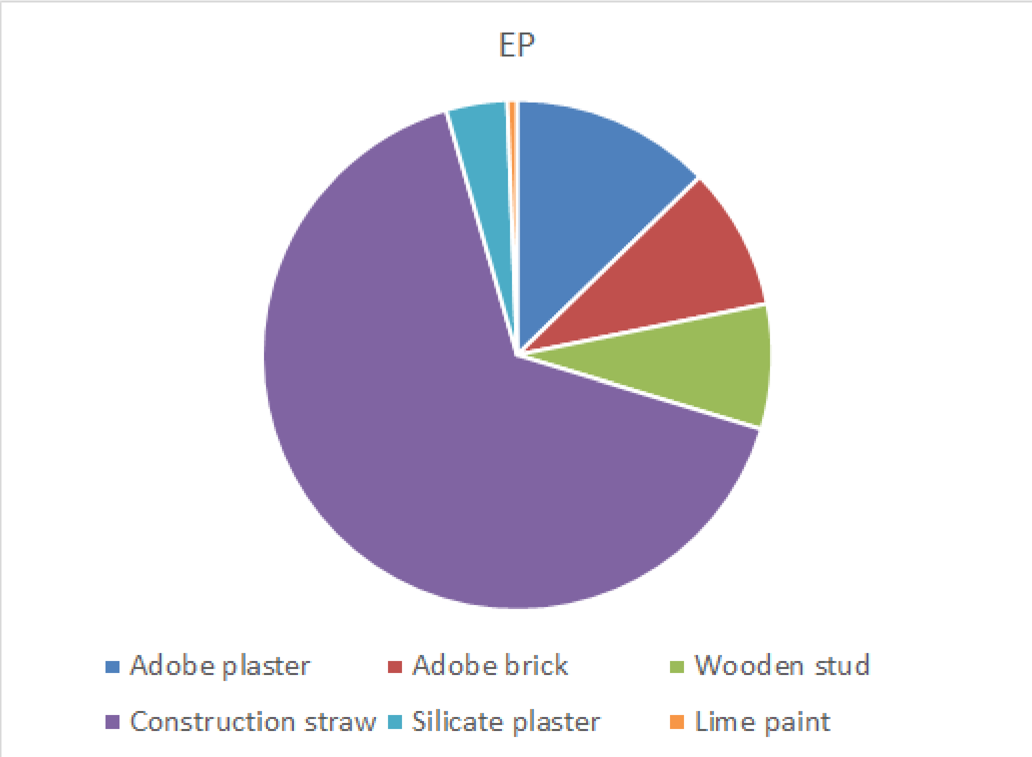
- **Construction straw**

Adobe construction has one weak-point: EP impact of straw. In this impact category Adobe solution has values in the same order of magnitude as other brick solutions. 70% is because of straw and related agricultural activity.

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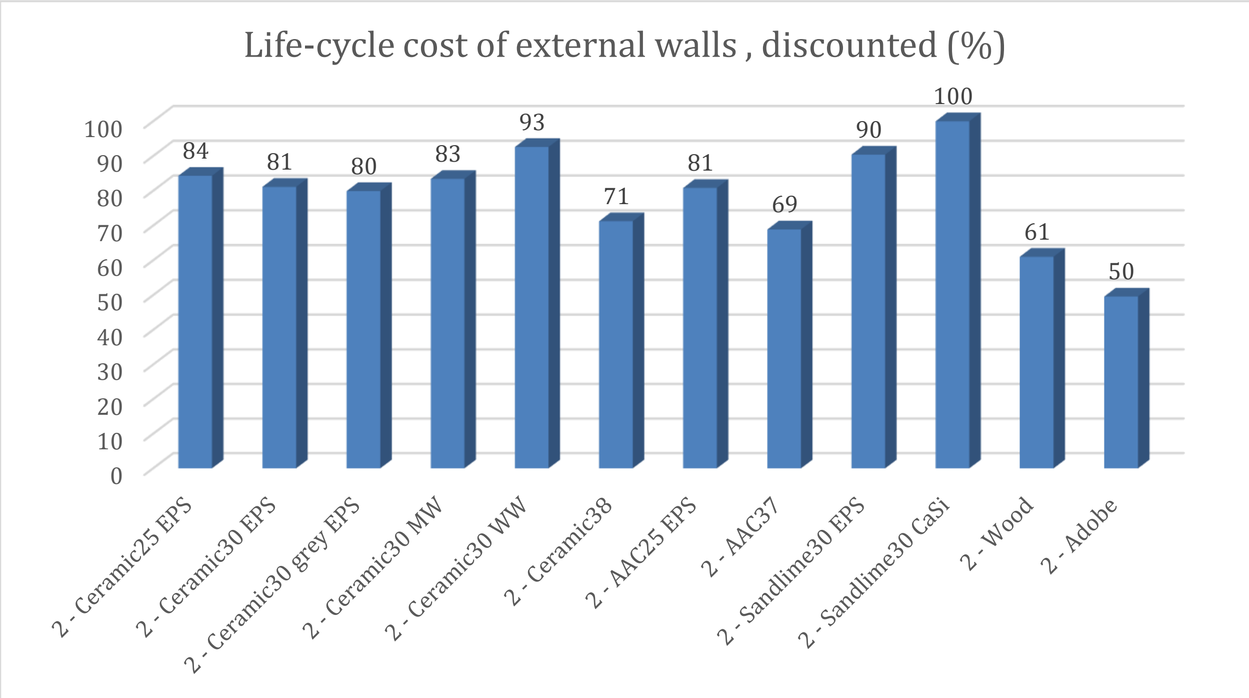
| Cost | |
|---|---|
| **Results** | |

12 designs of external walls have been analysed that meet the technical requirements of the lifetime but contain different building materials. Life cycle cost analysis is just one test method that helps to select the structure of external walls in addition to technical and environmental performance. These designs can be realized from the building blocks available on the market. Life cycle cost analysis was implemented in the IS-SusCon project with One Click LCA software. Discount rate is 3 %, Inflation rate is 0 %.



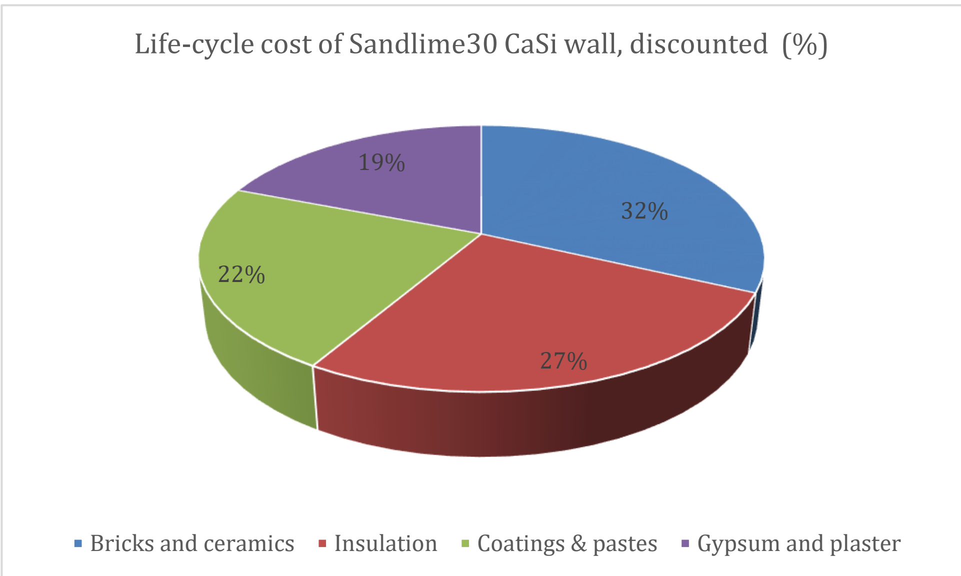

The figure shows that the most expensive external wall is the Sandlime30, CaSi construction The LCC of Ceramic30 WW and Sandlime30 EPS are 93% and 90% of the Sandlime30 CaSi. The cheapest external wall is the Adobe. It is about 50 % of the Sandlime30 CaSiexternal wall cost, The wood wall seems to be also cheap: 61 % of the most expensive wall cost. The Ceramic38 and AAC37 walls seem to be about 30 % cheaper than Sandlime 30 CaSi wall.

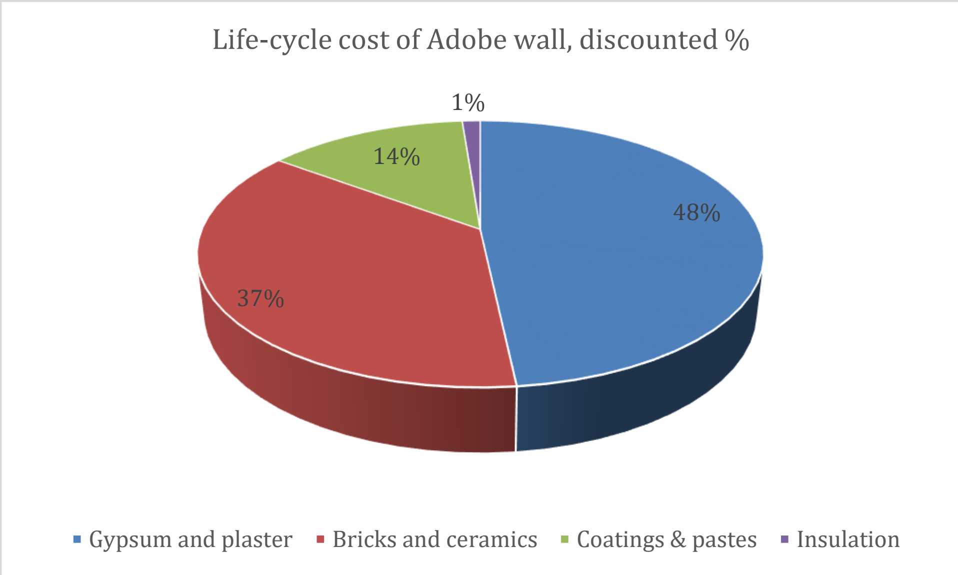
The discounted cost includes all net cost of materials and labour cost without tax.

LCC of external walls by life cycle stage (HUF)


The cost distribution within each structure depends on the structural material of the walls and the insulation material used, the paints and their service life. Renovation costs range from 10% to 30 %, while end-of-life costs range from 1 to 1,5 %. Costs of coatings and pastes cost varies from 14% to 28 %, the insulation cost is about 25 % except adobe wall, where the cost of straw insulation is only 1 %.

Examples about contribution of coatings/pastes, insulation, bricks and gypsum/plaster:






LCC by life cycle stage

The Replacement/refurbishment cost is related to the internal painting in all cases.

We can summarize that the cost of external walls depends on building materials and different elements of the designs that need to reach the requirement of U-value 0.23-0.24 W/m$^2$K. All solution equates to the criteria, but the difference in price reaches 50 % between the cheapest and the most expensive solutions. The price difference between alternatives is usually 20 or 30 % . In two cases it is only less than 10 %. The cost of the B4-B5 stage is the same in the case of all external walls except Adobe structure.

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