

# Exploring the Relationship between Environmental and Economic Payback Times, and Heritage Values in an Energy Renovation of a Multi-Residential Pre-War Building

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## Supplementary material - Additional information and data

Additional information and data on the environmental assessment of the renovation are provided.

### S.1 Data for the environmental assessment

#### S.1.1 Construction materials

Several sources were used to collect environmental data for the production (including extraction of necessary raw materials), installation and end-of-life treatment of the construction materials involved in the renovation. All data, except for basement door for which data were provided by the constructor, are openly available from environmental product declaration (EPD) databases or from the Ökobilanz [1] and Ökobaumat databases [2]. The list of datasets selected for the study is provided in Table S.1.

Table S.1. List of the environmental datasets selected to account for the for the materials used for the renovation.

Component	Material	Related environmental data
<b>Wastes</b>		
Roof	Clay	Ökobilanz (Elimination, bâtiment, brique en terre cuite, élimination)
Façade	Asbestos	Ökobilanz (Elimination mixte, plaque de plâtre armé de fibres)
Windows	Miscellaneous	Ökobaumat (Construction rubble landfill)
Others	Miscellaneous	Ökobaumat (Construction rubble landfill)
<b>Roof</b>		
Tiles	Clay	EPD (FDES tuile terre cuite)
Insulation	Phenolic foam	Ökobaumat (Phenolic resin foam)
Roofing felt	Polypropylene film	Ökobilanz (Lé d'étanchéité polyoléfine)
Frame	Pine wood	EPD (Number S-P-01325)
Walkway and snow fences	Steel	Ökobilanz (Profil en acier, nu)
<b>Façade</b>		

Insulation, 1 <sup>st</sup> floor	Expanded polystyrene	Ökobilanz (Polystyrène expansé)
Cladding material, 1 <sup>st</sup> floor	Plaster	Ökobilanz (Enduit en plâtre et en ciment)
Insulation, other floors	Glass wool	EPD (Number NEPD-1435-457-EN)
Cladding material, other floors – case of the implemented renovation with cultural recreation	Pine wood	EPD (Number S-P-01325)
Cladding material, other floors – case of a fictive renovation without cultural recreation	Fiber-cement board	Ökobilanz (Bardeau de fibrocement)
<b>Windows and doors</b>		
Windows	Wooden and aluminum framed 3-pane windows	Ökobilanz (Triple vitrage, U<0.6 W/m2K, épaisseur 40 mm, Cadre de fenêtre bois-aluminium)
Entrance door	Pine wood and 3-pane glazing	Ökobilanz (Portes extérieures bois, avec vitrage)
Basement door	Oak and aluminum	Information from constructor

The amount of materials collected and available in Table 2 also include the percentage lost during the construction process and the extra due to purchase obligations.

#### S.1.2 Transport of materials to and from the renovation site

When the transportation to the construction site was not included in retrieved environmental data, an estimation was made with the help of the Ökobilanzdaten database [1] (Table S.2) for the impact of transportation systems, and of the default transport scenario of 1 200 km by truck suggested by the PEF method [3] when information on the location of the production site was missing. For waste and the end-of-life scenario of the new materials, we also assumed that they joined the nearest waste disposal located 25 km from the construction site by truck (Table S.2).

Table S.2. Environmental data used in the study for the transport of construction materials [1].

	Primary energy consumption	Global warming potential (GWP)
Transportation by truck	0.52 kWh primary energy/(t.km)	0.11 kg CO <sub>2</sub> -eq/(t.km)

#### S.1.3 Data on energy production

Updated data on the Swedish electricity mix are easily accessible but it was not possible to find updated data on the environmental impact generated by the different types of electricity production. As mentioned in section 3.2, data for the efficiency of the energy production and the GWP impact for the production of district heating and electricity was retrieved from the report from Liljenström et al [4] (Table S.3). The values are based on the average Nordic electricity mix between 2009 and 2011, Swedish district heating statistics between 2010 and 2012, and environmental data from the ecoinvent database.

Table S.3. Environmental data for energy production used in the environmental assessment of the renovation [4].

	Primary energy consumption	Global warming potential (GWP)
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Electricity production	2.1 kWh primary energy/kWh	0.16 kg CO <sub>2</sub> -eq/kWh
Heat production	0.79 kWh primary energy/kWh	0.097 kg CO <sub>2</sub> -eq/kWh

Other values for the GWP impact associated with heat production were found in different documents, ranging from 0.059 (average over the year 2017 in Gothenburg [5]) to 0.14 CO<sub>2</sub>-eq/kWh (average for Sweden, retrieved from the Swedish national environmental database IVL500 [6]). For the initial assessment, the value from Liljenström et al [4] was chosen to be consistent with the source of data for primary energy consumption, but the effect of the range of uncertainty for the GWP from heat production is estimated in section 4.5.

## References

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