



Sustainability

of facade variations in natural stone and glass

Deutscher Naturwerkstein-Verbands e.V., Würzburg

Sustainable Building - Building with Natural Stone

- ▶ **What is sustainable building?**
 - ▶ **for all phases of building life cycle - from creation to decommissioning - to minimize the consumption of energy and resources.**
-
- ▶ Reducing energy demand and consumption of resources
 - ▶ Avoid transportation of building materials
 - ▶ Use of reusable / recyclable construction
 - ▶ Extending the life of construction products and building structures
 - ▶ return of safe building materials in the natural cycle



Sustainable Building - Building with Natural Stone

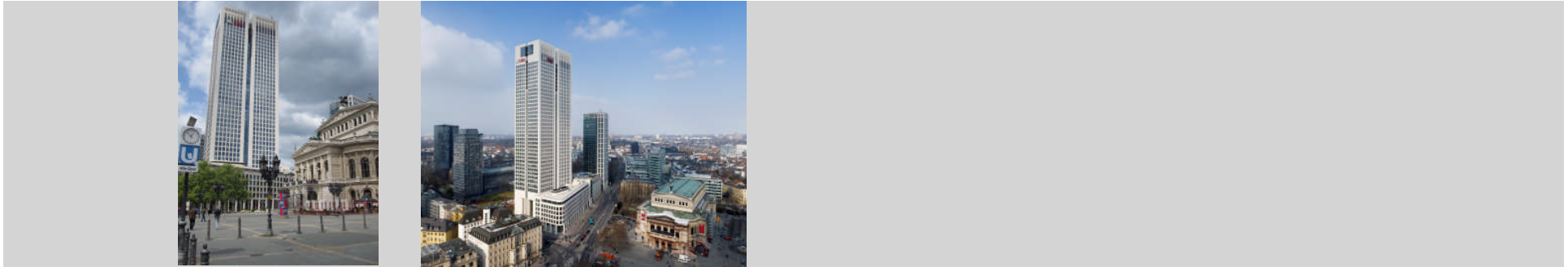
- ▶ What is sustainable building?
- ▶ construction processes and real estate management with ecological, economical and social aspects



- ▶ various certification systems: in the UK BREEAM, LEED by the U.S. Green Building Council, DGNB (German Certification for Sustainable Construction)
- ▶ All together:

The sustainability of the building is responsible for the ecological quality

Sustainable Building - Building with Natural Stone



The Opera Tower in Frankfurt is considered by experts as the most spectacular German office building since years. For energy reasons architect Christoph Mäckler prefer a natural stone facade to a pure glass facade. The Opera Tower is saving about 23% of energy compared with a glass facade - 1,800 tonnes of carbon dioxide are saved annually.

Because of the stone façade, the opera tower is one of the first office building in Europe, to become gold in LEED standards of the U.S. Green Building Council.

LCA study

- ▶ LCA – Life Cycle Assessment
- ▶ systematic analysis of environmental effects

This LCA study refers to a systematic analysis of the environmental impacts of products throughout the entire life cycle ("cradle to grave"). These include all environmental impacts during production, as the use and disposal of the product, and the related upstream and downstream processes (eg production of raw materials and supplies).

LCA study



► „Guideline for Sustainable Building of the German Federal Ministry“

Hrsg. Bundesamt für Bauwesen und Raumordnung, Januar 2001

The necessary exchange of materials within the use phase is determined by the "Guideline for Sustainable Building of the Federal Ministry. This provides for natural stone an average lifetime of 80 years.

This is a convention and does mean that lifetime in fact may be significantly higher.

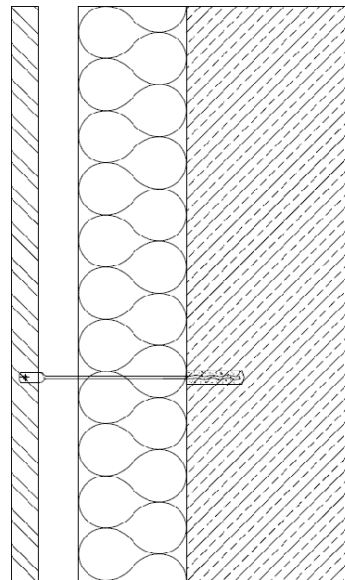
LCA study – part 1

- ▶ Part 1 „Sustainability of facade systems with natural stone and glass “
- ▶ Comparison of 1 m² natural stone facade ventilated with 1 m² glass facade

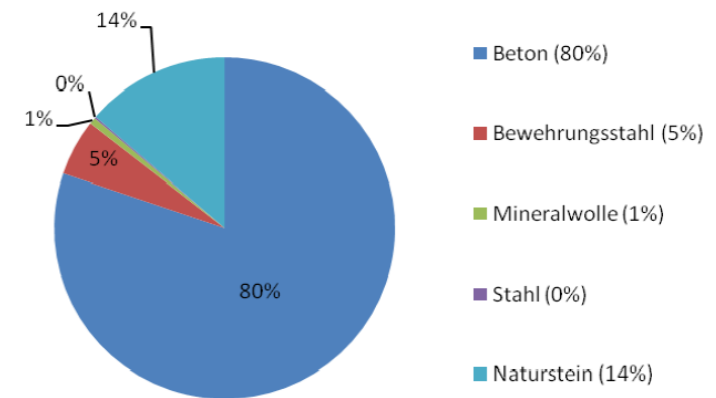
The first part of the study deals with the comparison of two typical facade construction with natural stone and glass in a period of 100 years. One square meter of a ventilated natural stone facade including insulation and reinforced concrete wall compared with one square meter of glass facade with a substructure of aluminum.

LCA study – part 1

- ▶ 1 m² of a ventilated natural stone facade including insulation and reinforced concrete wall

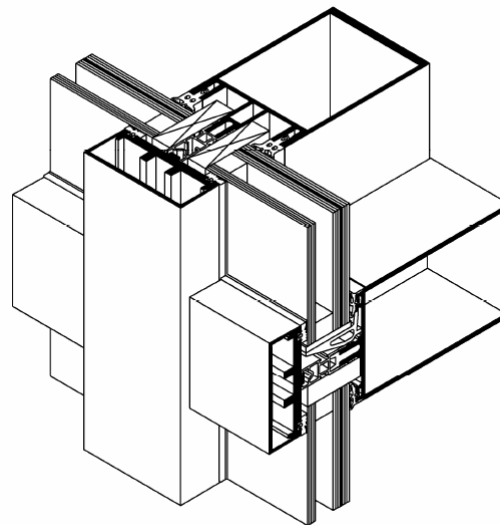


Massenanteile von 1 m²
Natursteinfassade

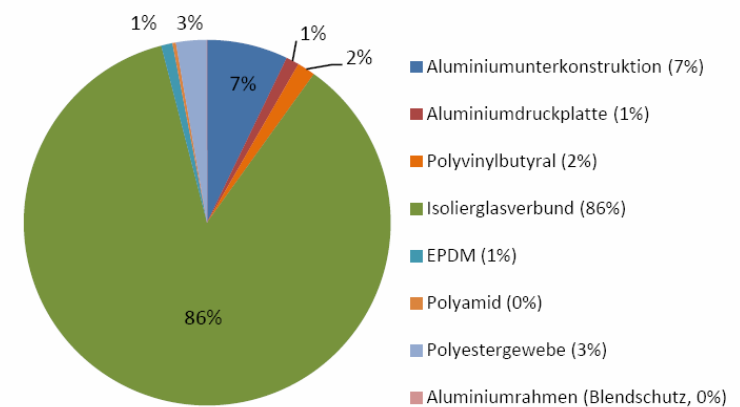


LCA study – part 1

► 1 m² glass facade with a substructure of aluminum



Massenanteile von 1 m² Glasfassade



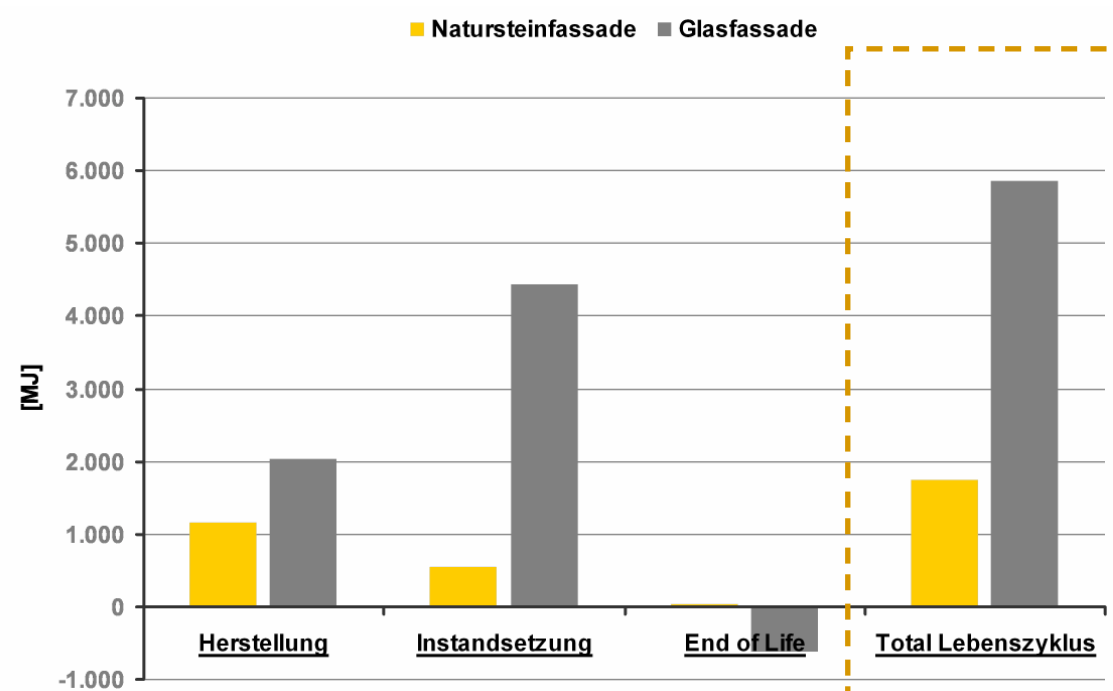
Results Part 1 - Primary energy demand in [MJ]

- ▶ the natural stone facade shows significant environmental benefits
- ▶ Glass facades need three times more primary energy

Over a period of 100 years, the stone facade shows significant environmental benefits to a glass facade. In summary, natural stone facades, both in manufacturing and in the use phase, require much less primary energy than glass elements.

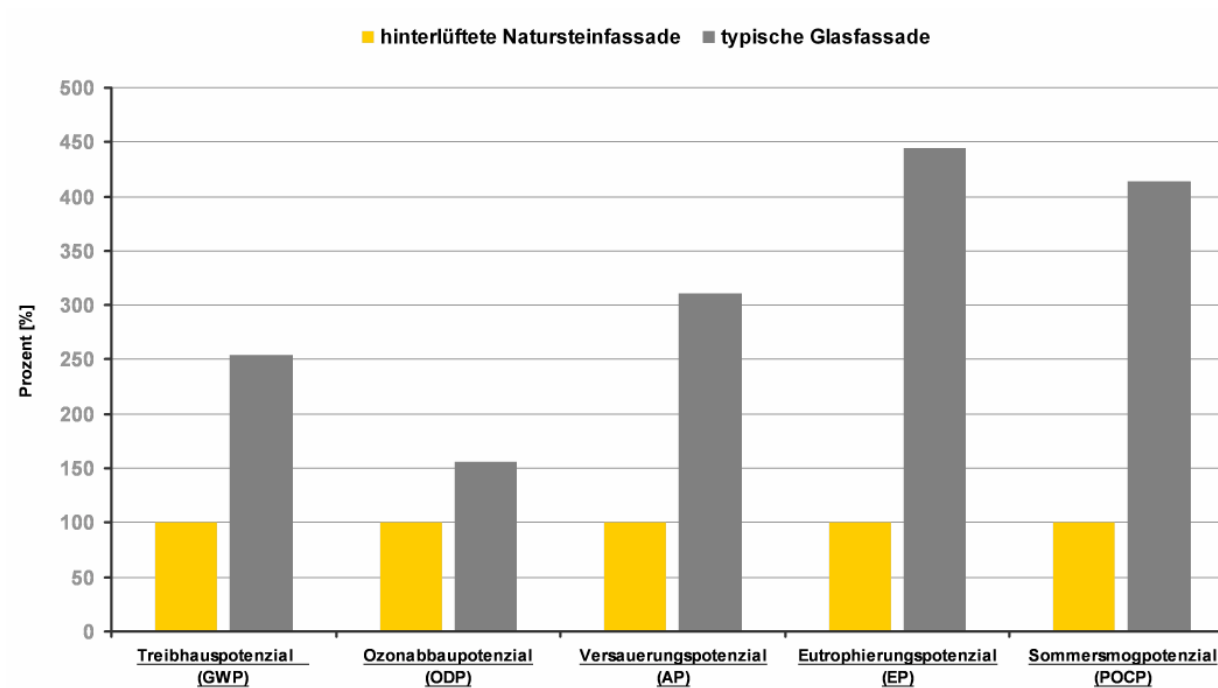
Results Part 1 - Primary energy demand in [MJ]

- ▶ the natural stone facade shows significant environmental benefits
- ▶ Glass facades need three times more primary energy

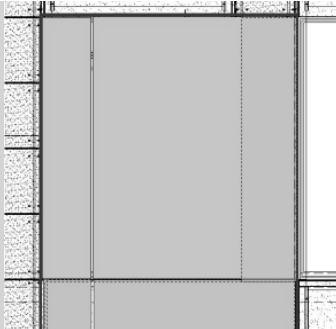


Results Part 1 - Environmental effects in [MJ]

- ▶ Natural stone facade shows significant environmental benefits
- ▶ Environmental effects of the glass facade up to 360% higher



LCA study – part 1



- ▶ "Life cycle assessment study on variations in natural stone facades and glass facade at the example of the OperaTower Frankfurt “
- ▶ Comparison of primary energy and environmental impacts over 50 years

Façade Type 1:

realized facade, consisting of a unitised, ventilated facade of natural stone (17%), ventilated stone facade according to DIN 18516-3 (33%), and glass elements (50%)

Façade Type 2:

ventilated stone facade according to DIN 18516-3 (50%) and glass elements (50%)

Façade Type 3:

adequate glass façade, consisting of glass elements (90%) and ventilated stone facade according to DIN 18516-3 (10%)



Results Part 2 - Primary energy demand in [MJ]

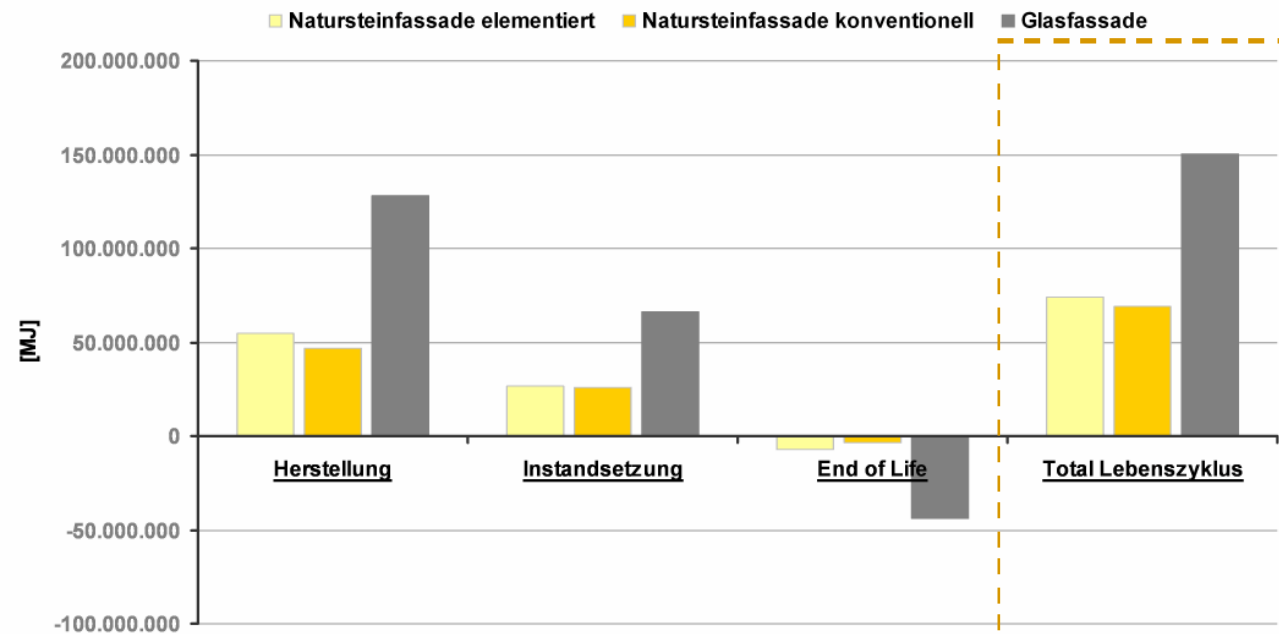
- ▶ Over lifetime of 50 years the natural stone façade shows significant environmental benefits
- ▶ Glass facades need more than double of primary energy

A comparison of the facade variants in the second part of the study shows, based on the approximately 30,000 square meters façade area of the Opera Tower, also very significant environmental benefits of both natural stone facades to the glass facade.

The primary energy consumption of a glass facade (facade type 3) is more than two times higher than comparable natural stone facade (facade type 1 and 2).

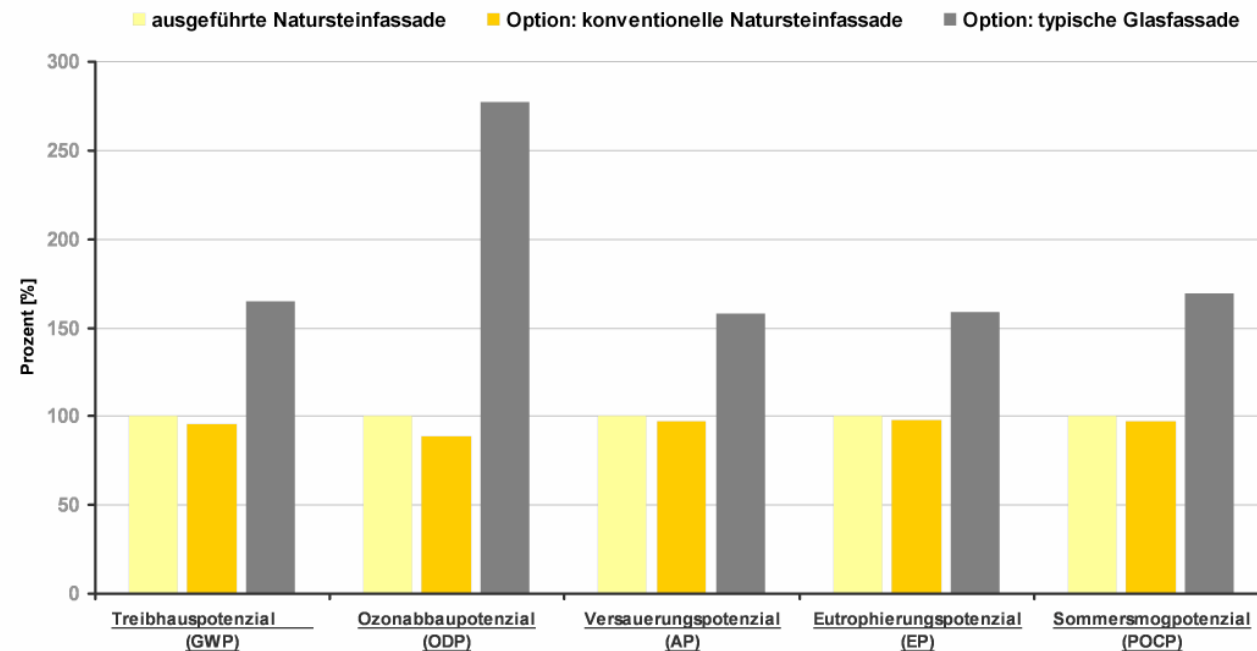
Results Part 2 - Primary energy demand in [MJ]

- ▶ Over lifetime of 50 years the natural stone façade shows significant environmental benefits
- ▶ Glass facades need more than double of primary energy



Results Part 2 - Environmental effects in [MJ]

- ▶ Over lifetime of 50 years the natural stone façade shows significant environmental benefits
- ▶ Environmental impacts of the glass facade are up to 175% higher



Economic benefits of natural stone facade

- ▶ The thermal transfer value of natural stone facades is significantly lower than of glass facades
- ▶ Glass façade: loss of heat in winter, enormous demand for cooling in summer

Natural stone facades offer not only ecologically but also economically significant advantages: For example, the significant thermal protection value of $0.32 \text{ W / m}^2 \text{ K}$ for the natural stone façade is much lower than the value of $1.25 \text{ W / m}^2 \text{ K}$ for glass facade. This means that the transmission heat losses and the energy consumption for heating in the stone facade are much lower.

Economic benefits of natural stone facade

- ▶ Manufacturing and cleaning of a natural stone facade is much cheaper than of a glass facade!

	Natursteinfassade	Glasfassade	Quelle
Production costs	640 [€/m ²]	1280 [€/m ²]	/ORH 2008/
Maintenance costs	4,50 [€/m ² a]	9,00 [€/m ² a]	/DGNB 2009/
Cleaning cost	--	1,50 [€/m ² a]	/DGNB 2009/