10 Polyurethane insulating materials and sustainability

Ecological building is currently on everyone's lips, and is generally considered to be construction using natural or near-natural materials, which thus saves resources, is environmentally sound and poses no health risks. Ecological building has also come to be seen as beneficial, or at the very least better than conventional construction, which also makes use of industrially manufactured building products

However, it has become clear from the growing scientific and political debate on ecology that the term "ecological" as used by many interest groups represents a one-sided way of thinking and is not a benchmark for sustainable building.

The concept of sustainability

In Germany, people are gradually realizing that the model of sustainable long-term development also offers important opportunities for development "beyond the ecological dimension". Because of the complex relationships between the three dimensions or aspects – ecological, economic and social – they must be treated as a whole. This is, figuratively speaking, not a conflation of three parallel elements, but the development of a three-dimensional perspective based on real experience. In the debate, there is an increasing tendency to interpret sustainability policy as a social policy that in principle and in the long term gives all these dimensions fair and equal treatment.

Source: final report of the Enquête Commission "Protection of mankind and the environment", 1998

Thus, the concept of sustainability as a model for policies in general and for building in particular provides the decisive evaluation criteria of:

- environmental compatibility,
- cost efficiency,
- social acceptability.

The demands of environmental associations, economic viability and society have repercussions on sustainable construction and for buildings. This means:

- **meeting ecological targets,** for example by conservation of resources, saving energy, reducing CO_2 and recycling
- **taking account of economic targets,** for example by reducing building costs and running costs by using building products with an appropriate level of physical and technical performance,
- **simultaneously providing high-quality buildings and architecture** with respect to the use, function and design of buildings and their suitability for healthy living.

As regards sustainability, the following four aspects of the quality of building products should be considered:

- constructional performance
- life cycle costs
- environmental compatibility
- health and safety.

With their products, the Industrieverband Polyurethan-Hartschaum e.V. (IVPU) and its member firms are taking on responsibility for this model of sustainable future-proof development.

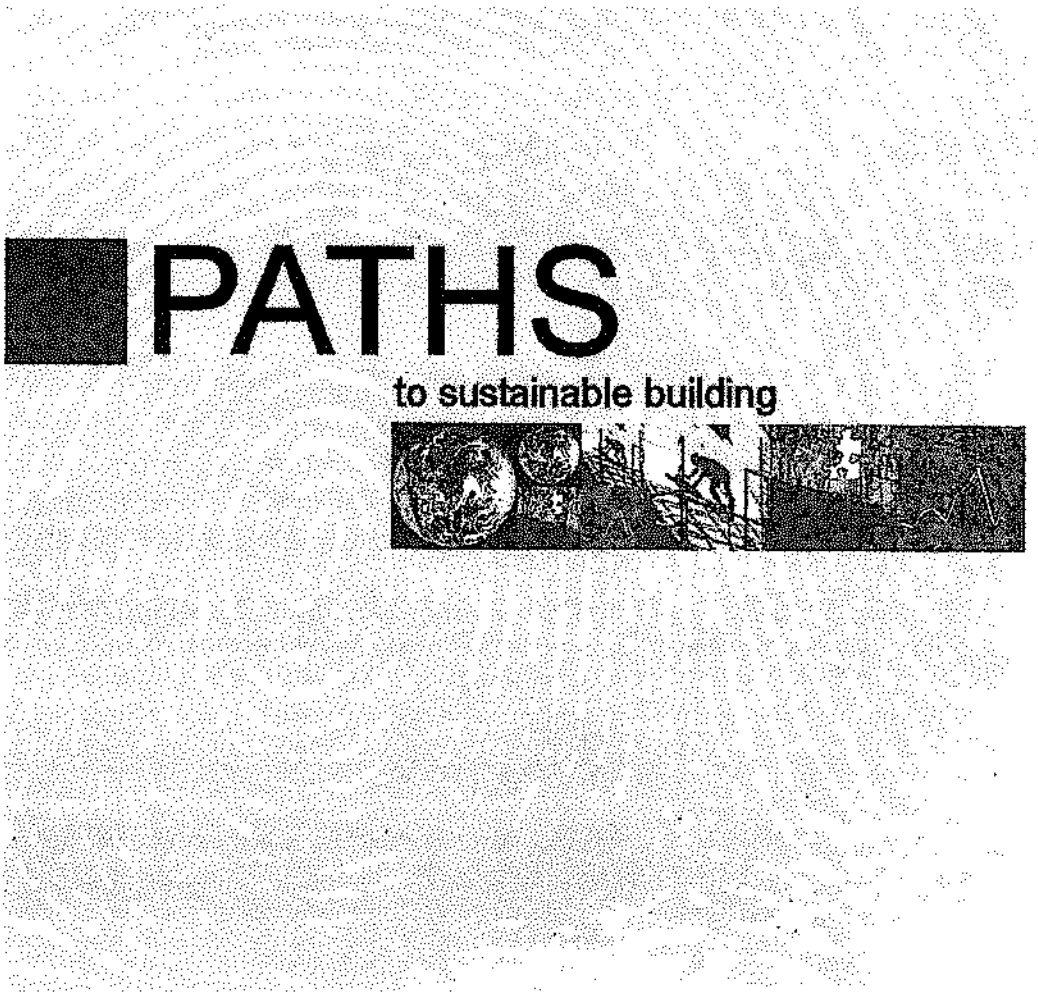

Fig. 46: Paths to sustainable building

This IVPU document contains facts and targets for sustainable building and tools for energy optimization.

10.1 Polyurethane rigid foam insulating material as an energy multiplier

Sustainability and energy

The shared model is sustainable development. In practice, implementing this principle of sustainability means giving equal consideration to economic, ecological and social aspects. With regard to the supply and use of energy, the equally ranked aims of energy policy are

cost efficiency

security of supply

environmental compatibility

Source: conclusion of the energy discussion of June 5, 2000:
German Minister of Commerce, Dr. Müller;
President of the Board of Trustees of the Forum on Future Energies, Dr. Breuer.

The basic raw materials for manufacturing polyurethane rigid foam insulating materials are crude oil or renewable raw materials such as sugar beet. The two primary components polyol and polyisocyanate are produced from these. Therefore, instead of being used for heating (70 % of crude oil production), crude oil is used to produce an insulating material which will save energy, and thus crude oil, for 30-50 years.

With only 4 % of crude oil currently being used for plastics production, it is hardly possible to imagine a more sustainable use of crude oil in view of the finite total resources (see Chapter 1, page 6).

The manufacture of polyurethane rigid foam has matured in technical terms, and for the last forty years has been carried out on a large-scale by the polyaddition process. In this production process, the total energy consumption for a 1 m^2 aluminum-laminated polyurethane rigid foam insulating board 6 cm thick is approximately 80 kWh. This value includes the extraction of the raw materials from the earth, the production of the panel and delivery to the building site.

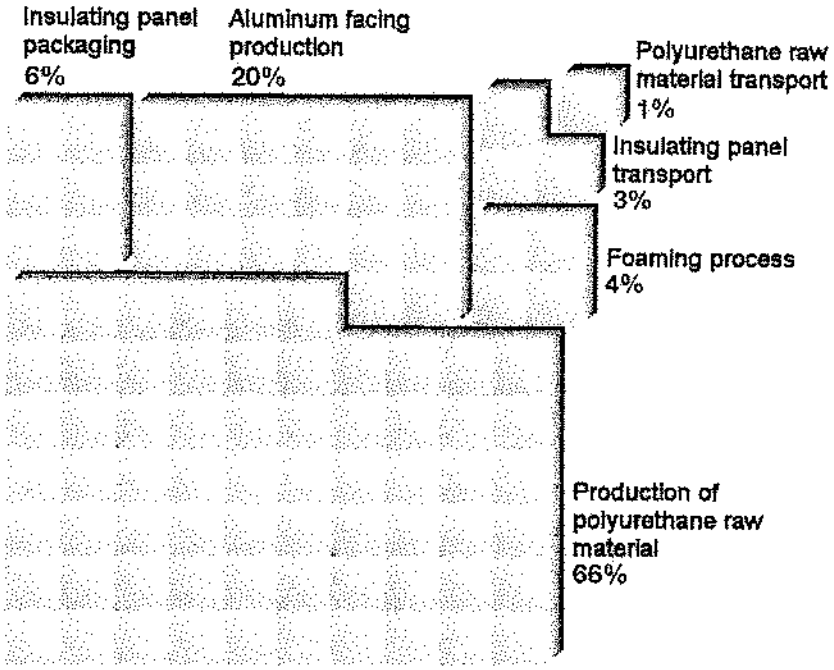

Fig. 47: Stages in production and their contribution to the total energy consumption (in %)

This low energy consumption for the manufacture of a 1 m^2 polyurethane rigid foam insulating board stands in contrast to an energy saving of over 7,000 kWh over the product's life of 50 years. The energy consumption for manufacture is thus recouped through energy savings after the very first heating period.

A specimen calculation for a single-family house with a 150 m^2 polyurethane steep-pitched roof gives a saving of approximately 1 million kWh over 50 years. Polyurethane rigid foam insulating materials are thus real energy multipliers. [12]

10.2 Polyurethane insulating materials and recycling

There are three options for recovering or recycling polyurethane rigid foam:

- Manufacturing particle board
- Reuse and energy recovery
- Raw material recovery (glycolysis)

When **manufacturing particle board,** polyurethane production waste such as scrap and milling dust undergoes a special recycling process to form high-grade, moisture-resistant

panels, which may be used for example in floor construction as a "replacement" for timber boards and wood particle board.

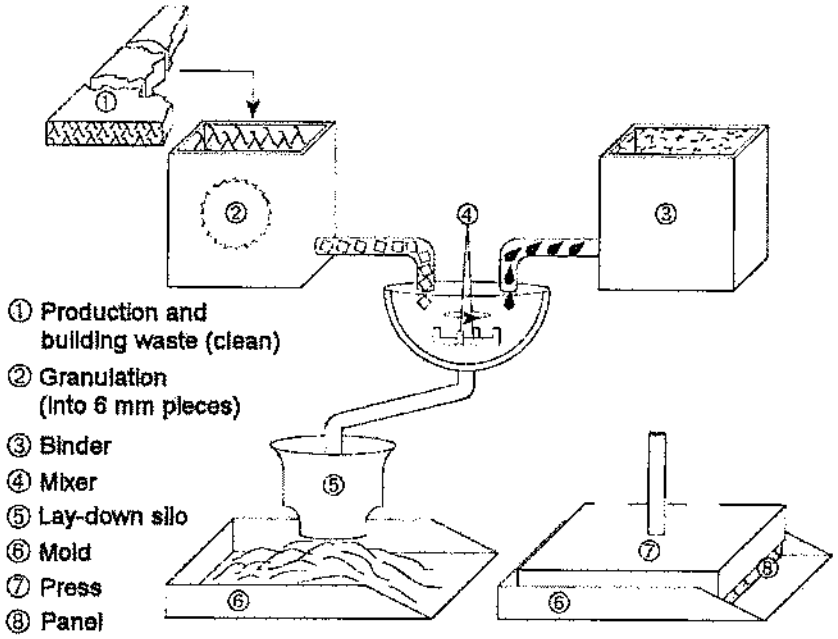

Fig. 48: Polyurethane particle board production

It is generally possible to **reuse** polyurethane insulating boards, but this depends on the condition of the panels after disassembly.

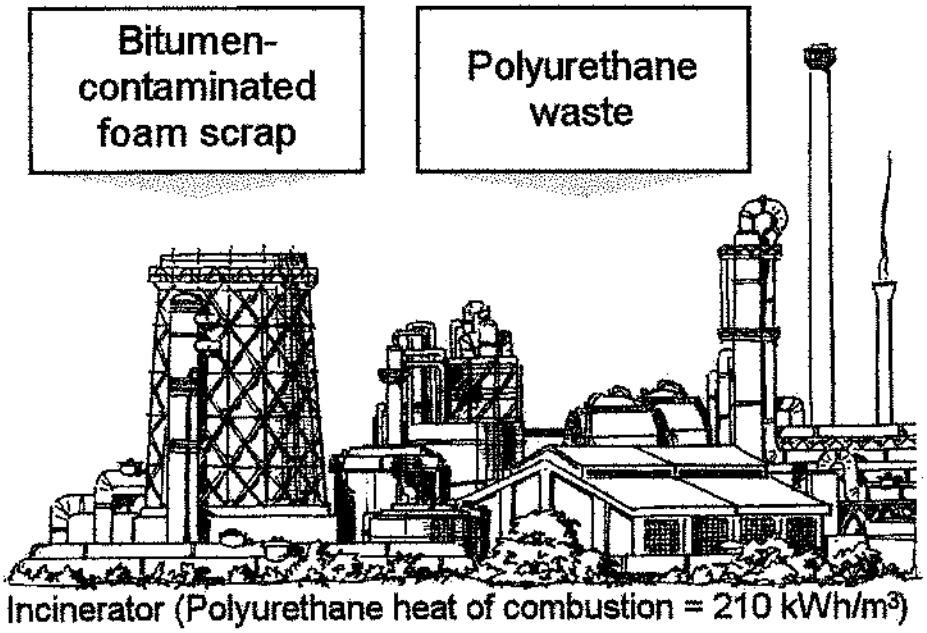

Fig. 49: Energy recovery from polyurethane rigid foam

Energy recovery is also possible under the Law on Life-Cycle Management. Building site waste and polyurethane rigid foam panels that are left after demolition and may be contaminated with bitumen for example can be used as an auxiliary fuel in modern incinerators.

Glycolysis is used for **raw material recovery** from a component. This method is only possible with waste of a known composition.

10.3 The life cycle of polyurethane insulating materials

The sustainability of polyurethane rigid foam insulating materials should also be assessed on the basis of four quality criteria. These are:

a) constructional performance

b) life-cycle costs

c) environmental compatibility

d) health and safety.

The four quality features are also applicable to the three major parts of the life cycle:

- manufacture
- application/use
- disposal: recycling, elimination

The **product life analysis** ("from the cradle to the grave") for polyurethane rigid foam insulating materials can be summarized as follows:

a) Constructional performance

Application/use

- high insulating capacity
- high compressive strength
- good long-term stability
- lack of thermal bridges
- multifunctional: i.e. steep-pitched roof insulation, ceiling insulation, flat roof insulation, façade insulation, core insulation, floor insulation, basement insulation, perimeter insulation

b) Cost advantages taking into account the overall make-up of a component

Manufacture

- low row material consumption
- low energy costs

Application/use

- optimum thermal insulation with a small insulating material thickness
- example: above-rafter insulation over the entire area without thermal bridges, i.e.
    - low material consumption (no additional construction, small insulating material thickness)
    - low labor costs (simple processing, fewer steps)

Disposal

- recycling (secondary raw material)
- elimination (can be placed in landfills)

c) Environmental compatibility

Manufacture

- crude oil used as a raw material to save energy (material consumption 4 %)
- emissions harmful to the environment are low in comparison with energy saved
- energy consumption is negligible in comparison with the energy saved over 50 years

Use

- energy saving due to insulating effect
- reduction in CO_2 emissions
- long lifetime (50 years or more)

Disposal

Recycling

- reuse
- material recovery as particle board
- energy recovery
- raw material recovery

Elimination

- can be placed in landfills
- no harmful emissions from energy recovery and heat treatment

d) health and safety

Manufacture

- Adherence to occupational exposure limits and requirements of the German Clean Air Act

Application

- insulating material does not emit physiologically relevant amounts of chemicals
- free from formaldehyde
- no static build-up
- resistant to rot and mildew
- odorless

Disposal

Recycling and elimination

- does not emit physiologically relevant amounts of chemicals