PURE FACTS

Polyurethane as an
insulating material

Promoting a dialog on resource and energy efficiency

Covestro is keen to talk to politicians and concerned individuals throughout the world. After all, polyurethane not only contributes to resource and energy efficiency but also creates jobs and wealth.

According to ISOPA figures, the European polyurethane industry employs more than 817,000 people and generates a market value of over €125 billion.

Source: image-for-you, Kaufbeuren

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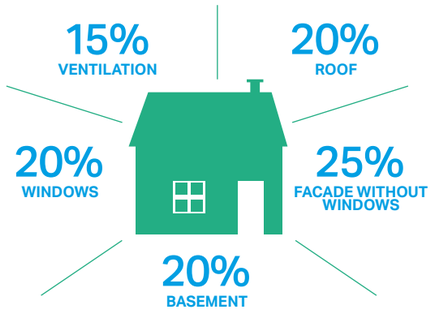
Flat roofs and walls: polyurethane insulation materials make thin fire-safe constructions possible.
(Source: Puren GmbH)

The importance of insulation

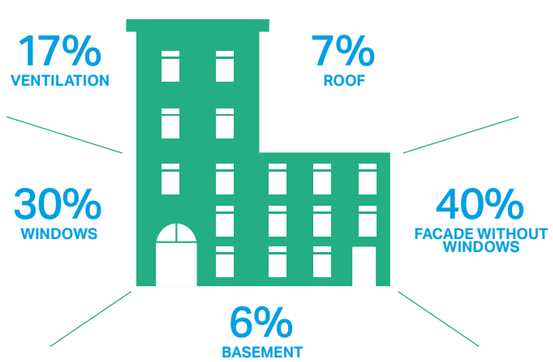
Buildings are responsible for most CO_2 emissions – at least 40 percent of global energy consumption and over a third of greenhouse gas emissions. In other words, reducing emissions from buildings is crucial in combating human-induced climate change.

In Germany, for example, around 84 percent of the energy consumed by domestic households is used to generate heat: 69 percent for room heating and the other 15 percent for hot water.
In existing buildings, energy efficiency renovation can reduce energy consumption by up to 80%. Half of this reduction comes from insulation.
(Source: Puren KFW)

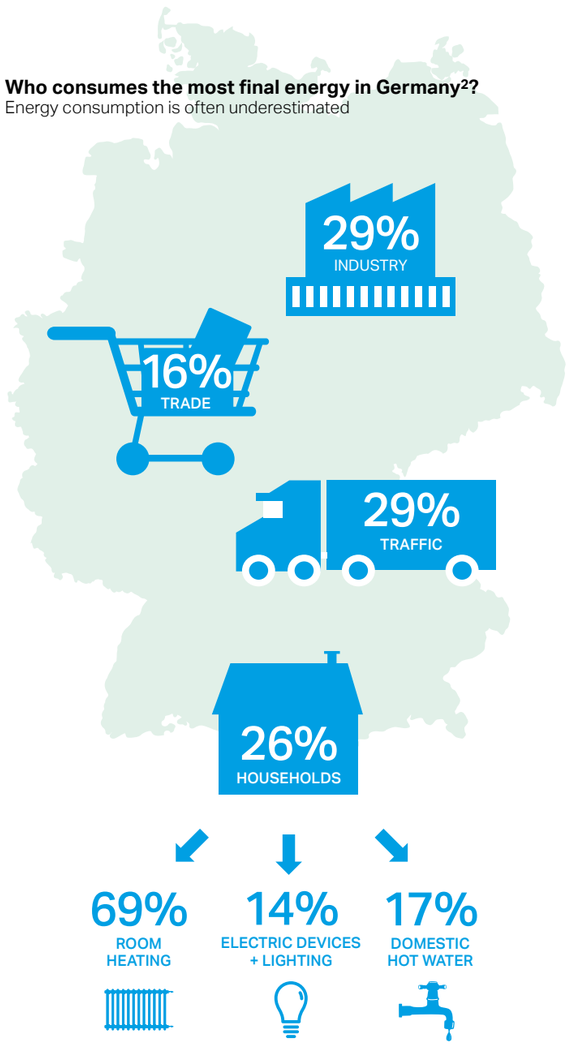
Single family home[1]
Important levers in saving heating energy



Apartment building[1]
Important levers in saving heating energy



Who consumes the most final energy in Germany[2]?
Energy consumption is often underestimated



1 Approximate figure, source: Forschungsinstitut für Wärmeschutz e.V. München

2 Source: Federal Ministry fo Economic Affairs and Energy

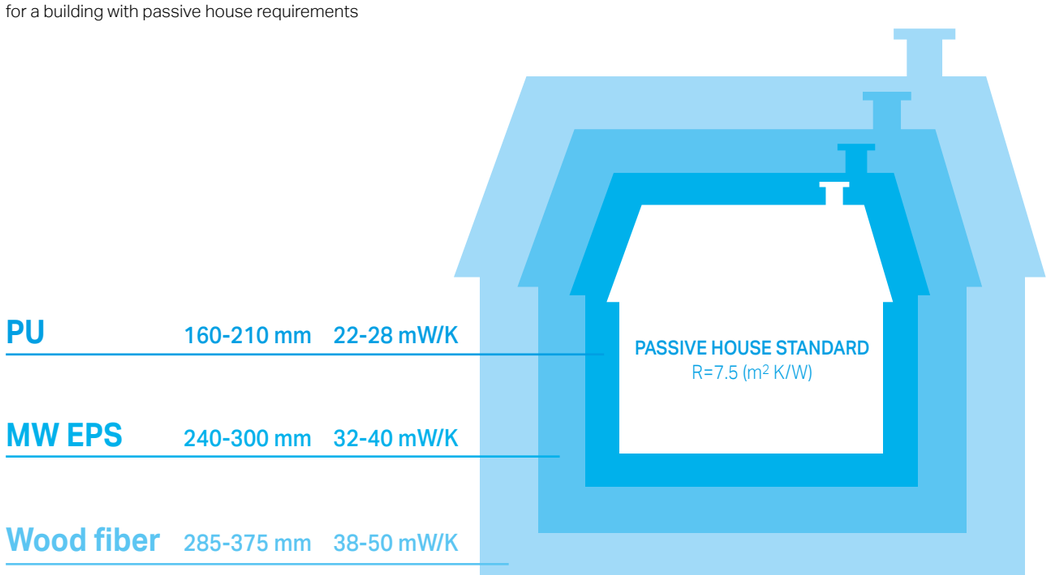
Less is more

Insulation requires space. Just how much depends on the insulating performance of the material used. Rigid polyurethane (PU) foams insulate better than most other conventional insulating materials. That makes thinner solutions possible and creates more living space.

Why PU insulates so well
PU's good insulating performance is due to its low thermal conductivity. The gas enclosed in the foam pores is also a major contributing factor. This gas is added during PU production to enhance the performance of the foam. For many applications today the gas is pentane, which has half the thermal conductivity of air.

- High insulating performance: Of all today's conventional insulating materials PU offers the highest insulating performance as it has a much lower thermal conductivity value than insulating materials such as polystyrene, mineral wool, glass wool or hemp. PU with a thermal conductivity rating of 023, for example, insulates two-thirds better than some other material with a rating of 040.
- More living space: PU enables a thinner insulating layer than other insulation materials and thus a thinner wall. This results in more interior space for new buildings and minimal space requirements for retrofit insulation of older buildings.
- High aging durability: Besides being mechanically durable, moisture- and temperature-resistant and chemically stable, PU displays high aging resistance, typically extending beyond a building's usual lifecycle.
- Great versatility: Rigid PU panels can be cut to any size using simple tools. Even more design flexibility can be achieved by foaming the insulation material. PU can also be combined with other building materials and incorporated into composite or sandwich panels. PU metal-faced sandwich panels are particularly suitable for efficient commercial and industrial constructions.
- Outstanding energy balance: From a lifecycle perspective PU has an excellent energy balance. PU used in building insulation, for example, saves approximately 70 times more energy over its entire lifecycle than is needed to manufacture it.

Insulation thickness of different insulation materials
for a building with passive house requirements



Source: Linzmeier Bauelemente GmbH

Frequent misconceptions

There are a number of common misconceptions about polyurethane (PU) as an insulating material. The facts tell a different story, as the table shows.

Misconception	Fact
Problematic fire behavior: The flammability of PU insulating materials poses an unpredictable risk.	Modern rigid PU foams with high intrinsic fire safety properties are classed by the EU as having low or normal flammability. This means they can be used in various thermal insulation applications in the construction and cold chain industry. Innovative flame retardance concepts can be expected in the future.
Hazardous to health: Production of PU involves isocyanates, which pose problems for users and processors.	PU products are made from polyols and diisocyanates, which have been produced and processed for over 75 years. Over the decades, the industry has developed and implemented comprehensive safety guidelines. If all the safety regulations are followed properly, the PU raw materials can be handled and used safely.
Not recyclable: The energy consumed to recycle PU is so high that it is impractical from an energy perspective.	As of today, Incineration with thermal recovery still seems to be among the most efficient end-of-life waste treatment methods for PU foam. As a mainly petroleum-based product, PU binds a considerable amount of energy and incineration can also eliminate the halogenated blowing agents and gases contained in building waste. The PU industry is re-assessing alternative concepts, including chemical and feedstock recycling, in order to make the best possible use of the carbon employed.
Poor sound insulation: Rigid PU foams offer inadequate sound insulation, particularly in terms of impact noise.	PU's greatest strength is indeed thermal insulation, but a significant improvement in sound insulation can be achieved by combining it with other materials, e.g. mineral wool.
High cost: The cost of PU insulating materials is so high that it is not worth using them.	In terms of price per unit of volume rigid PU foam insulation has a higher initial cost than other materials. However, it is always more sensible to evaluate an entire building system in order to obtain a comprehensive cost-performance overview, and not just consider insulation systems on the basis of the insulating materials only. From this perspective PU solutions can be more cost-efficient and sustainable than other insulation material solutions.
Not sustainable: PU has a high carbon footprint.	A lifecycle analysis shows that the carbon footprint of PU is comparable to or less than that of competing materials.

Convincing economic arguments

If the sum of all properties is taken into account, the economic arguments speak for polyurethane (PU). Rigid PU foam – in the form of insulation boards, sandwich elements or other construction material – offers tailored, economical insulating solutions for almost every possible application. Four typical applications are detailed below.

Pitched roofs
PU enables pitched roofs to be insulated over or below the rafters. The robust PU insulating boards used over the rafters also serve as a weatherproof layer during construction work. As PU is a particularly thin insulating material, it makes economical building designs possible, and the lightweight but highly stable PU insulating boards are easy to handle.
Source: Linzmeier Bauelemente GmbH

Flat roofs
The increasingly strict thermal insulation requirements for new and existing buildings can lead to ever-thicker insulating layers. But for flat roofs this can be problematic, e.g. in the case of skylights. High-performance PU provides effective insulation in a thinner insulating layer.
Source: Paul Bauder GmbH & Co. KG

Façades
Façades can be insulated very economically and efficiently using composite PU thermal insulation systems. The advantage here is once again that PU makes a much thinner insulating layer possible. A faced brickwork façade featuring PU as core insulation is not only a visually attractive solution but also a practical one, as the PU layer is much thinner than alternative insulating materials. A façade insulated with PU can actually achieve passive-house standard. And if the outer wall of a listed building cannot be insulated, PU is a practical and economical solution for interior insulation.
Source: Puren GmbH

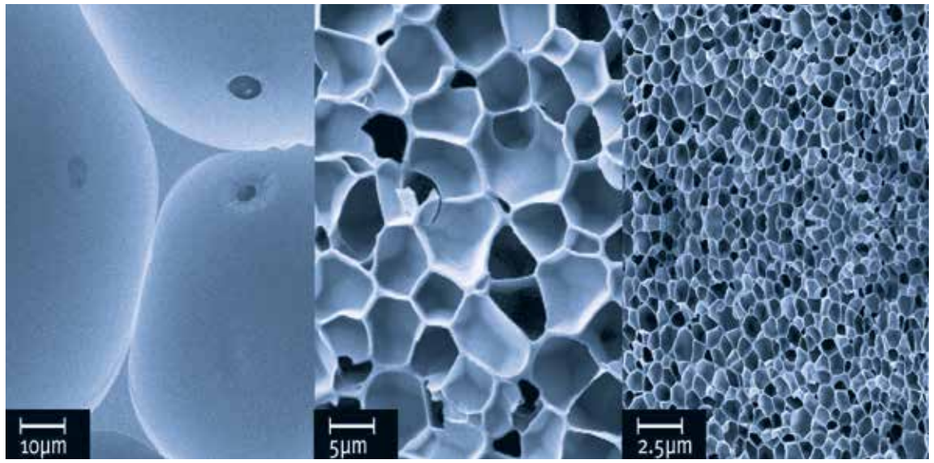
Metal panels
PU metal-faced sandwich panels are extremely light but robust prefabricated parts for roof or wall systems, offering the great benefit of a three-in-one support, sealing and insulating solution. These panels offer architects a high degree of flexibility and builders speedy construction. With state-of-the-art coatings the panels also offer good anti-corrosion and UV protection. And from a lifecycle perspective they are extremely economical thanks to their minimal maintenance and attractive energy-saving performance.
Source: Fischer Profil GmbH

Fit for the future

Polyurethane (PU) is making a key contribution to sustainable development. In the EU alone around 50 million kWh of energy are saved annually through the use of PU insulation materials. What's more, innovative developments are giving PU even better insulating qualities.

PU nano-foams
The smaller the foam pores, the better PU insulates. Today's PU typically has pore sizes of 150 µm. Covestro is researching into foams with pore diameters of 150 nm, a mere 1,000th of the current size. This would reduce PU's thermal conductivity by half. The challenge, however, is that these nano-foams have to be produced using an entirely different technology than today's rigid foams. Covestro is collaborating with scientists from Cologne University to fine-tune the chemical reaction between the PU raw materials and simultaneous expansion of the tiny foam bubbles in the micro-emulsions. Once this challenge is mastered, a specific degree of thermal insulation could be achieved through PU insulating material that is only half as thick as today's.

CO_2 as PU raw material
cardyon™ technology enables carbon capture and utilization, thus turning CO_2, a waste greenhouse gas, into a useful raw material that serves as a building block for plastics. Based on this technology, Covestro now offers a range of cardyon-branded polyols for use in all kinds of polyurethane applications. The use of CO_2 in plastics production benefits the environment by reducing the overall carbon footprint and establishing an alternative carbon source beyond fossil hydrocarbons and bio-based raw materials.



PU under the microscope: generally speaking, insulating performance increases as pore size decreases.


The Covestro House of the Future in Bottrop city center can serve as a global model for the many commercial properties in Germany and elsewhere that have not yet been energetically refurbished.

Regulations drive fire safety
Although the EU already classifies PU as having "low" to "normal" flammability, work is continuing to enhance its flame retardance properties. The strongest driver is that further tightening of the relevant regulations is expected at any time. Covestro's polyisocyanurate (PIR) system for metal-faced sandwich panels has much better fire resistance properties than conventional systems and generates much less fumes. Composite systems of this kind are used primarily to construct industrial buildings, such as warehouses, production halls and cold stores. One outcome of this innovative development is that PIR systems can be used as a viable alternative to inorganic materials if the requirements of Smoke Class s1 have to be met (in line with SBI, EN 13823). In the future, special attention will be devoted to questions of how PU foam reacts to flame in specific end applications, and the degree to which improvements can be achieved in flame retardance by combining PU with other materials. Covestro experts say the possibilities for improvement are endless. That way, PU is sure to remain one of the best insulation materials for buildings.