Energy Efficiency in Buildings

BASF and its partners:
building a sustainable future together

BASF
The Chemical Company

Building a sustainable future together

■ Dr. John Feldmann,
Member of the Board of Executive Directors
of BASF SE

BASF The Chemical Company bases its activities on the principles of sustainable development. With our management systems and tools for sustainability, we minimise the impact of our products on humankind and the environment during their entire life cycles, and create value for BASF and our partners in business and society. In partnership with our customers, we offer innovative, competent and reliable solutions for comfortable, energy efficient buildings, which are effective both in hot and cold climates and can be adapted to various architectural traditions. With this brochure we would like to show institutions, planners, construction companies, investors, craftsmen, distributors and private people that simple, cost efficient devices can lead to more comfort, less consumption and considerable savings in energy costs as well as in emissions of carbon dioxide (CO_2), the main greenhouse gas.

BASF has calculated in its climate balance that BASF products can save three times more greenhouse gas emissions than are produced during the manufacture and disposal of all BASF products. This effect is particularly significant in the construction sector where the 400,000 tonnes of insulating materials marketed by BASF worldwide in 2006 represent a total reduction potential of over 110 million tonnes of CO_2.

Our show houses all around the world prove it: for BASF, energy efficiency is competence implemented. Building a sustainable future: a challenge we can face together.

www.basf.de/sustainability
www.energyefficiency.basf.com

Energy efficiency in buildings: key topics

Towards energy efficiency: the new regulations

New regulations have been developed all over the world to improve the energy performance of buildings. It is now up to local communities, architects, planners and construction companies to transform theory into reality.
Page 3

Use your creative energy

In the energy efficiency challenge, you are not alone: BASF and its partners offer easy to apply solutions to boost the energy efficiency of any building anywhere.
Pages 4-5

Competence implemented: consulting services and show houses

Whether in hot or cold, European, Asian or American countries, BASF show houses demonstrate that our solutions work. Do you want to achieve this, too? Since 2006, we support your projects with a broad range of services and help make your ideas reality.
Pages 6-14

Energy efficiency: one challenge, different climatic zones

Achieving energy efficiency in buildings means not only implementing regulations, but also developing solutions for different climatic conditions. Scientific results show that BASF and its partners' products can achieve this everywhere.
Pages 15-25

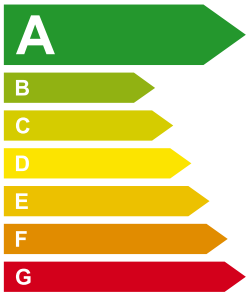
Notes

Pages 26-28

For further information on BASF competence for construction:
construction.europe@basf.com

www.europa.eu.int
www.energy.gov
www.oee.nrcan.gc.ca

EU energy pass



Towards energy efficiency

New regulations on the energy performance of buildings and the global challenge

From local, state, national and international communities alike, a united call for action on energy-conserving building practices is growing stronger by the day.

In **Europe**, private households account for two thirds of energy used in buildings. Their consumption is growing every year as rising living standards are reflected in greater use of heating and cooling systems, particularly in hot countries. The **EU Directive 2002/91/EC** has the goal of minimising energy consumption in European building standards. Measures to be taken by each EU member state include a common methodology for calculating the energy performance of a building, minimum standards for new buildings and major refurnishments, regular inspection of heating and air conditioning systems and a system of building certification which makes energy consumption levels apparent to owners and tenants.

The **United States** and **Canada** are committed through their Councils for Energy Efficiency to reducing energy consumption and greenhouse gas emissions. A huge variety of programs promoting sustainable development are also being implemented in the **Asia-Pacific region**.

By participating in the retrofitting and construction of low energy houses in Germany, the UK, Poland, Hungary, Italy, France, the USA, China and Korea, BASF and its partners are inspiring homeowners, builders and architects to seek options for a more sustainable future. The sensitivity towards energy efficiency is increasing everywhere: BASF proves that this is both feasible and affordable.

BASF and its partners' solutions

BASF and its partners offer easy to apply solutions to boost the energy efficiency of almost any building you can imagine

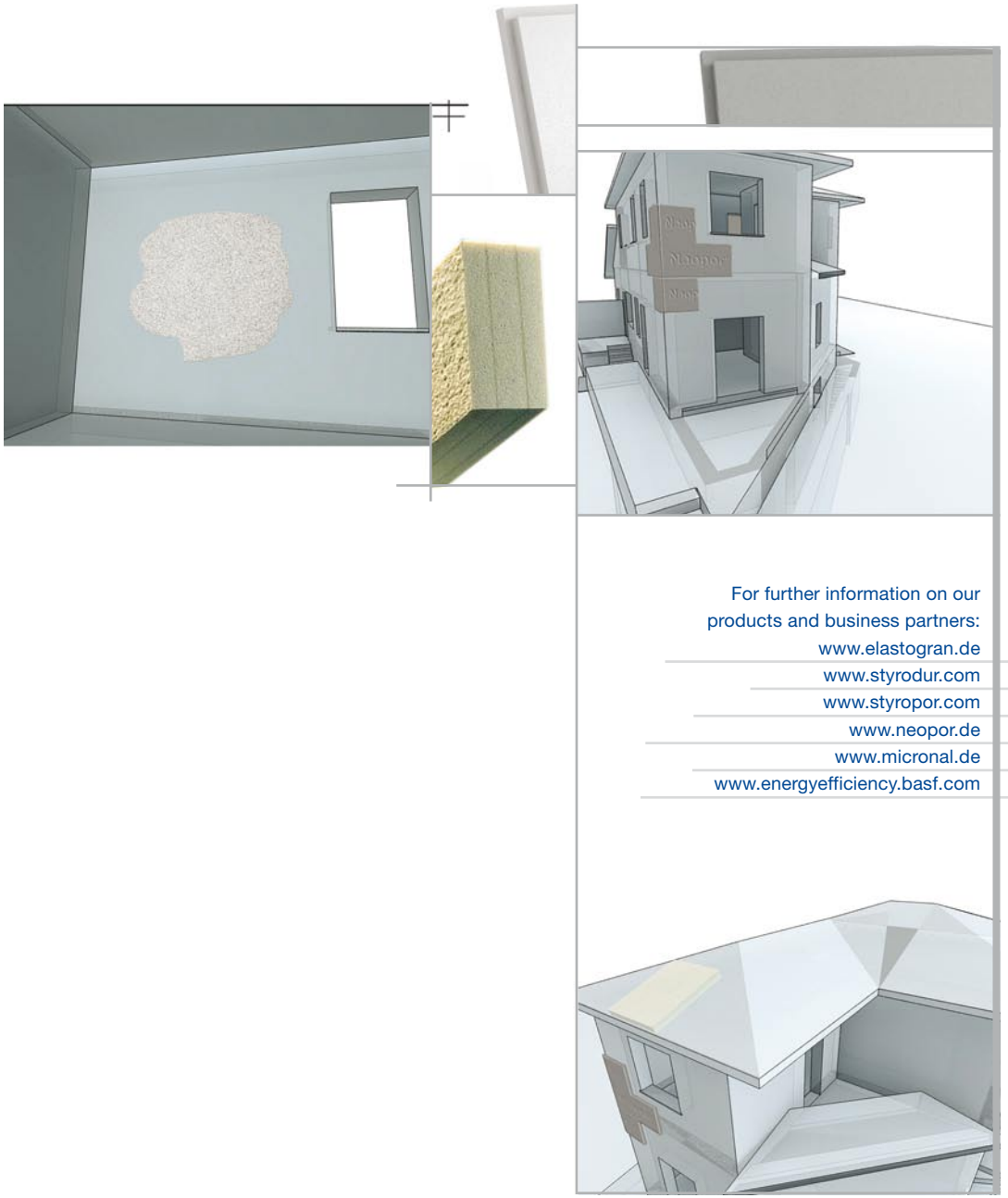
An appropriately improved insulation level, combined with phase change materials, is a simple, cost effective means of increasing comfort and drastically reducing the heating demand in cold countries and the cooling demand in hot ones. BASF and its partners offer you solutions you can adapt to most architectural traditions and to the most different buildings.

- **With Elastopor® H and Elastopir® by Elastogran you will find the perfect insulation solution** with best thermal conductivity values for all application fields in the construction sector: Polyurethane insulation boards, PU Sandwich panels, pipes and spray foam insulation for industrial and residential buildings.

- **Styrodur® C is Europe's green insulation:** The green-coloured, extruded rigid polystyrene foam (XPS) consist of cells filled with air. Styrodur® is recognised for good thermal insulation, low water absorption and high compressive strength.

- **Styropor®, the expandable polystyrene (EPS) invented by BASF over 50 years ago,** features very good heat insulation, high compressive strength, outstanding shock absorbance, low weight, resistance to moisture and a good price performance ratio.

- **Neopor® is the innovation in insulation:** innovative black polystyrene granules from BASF are processed by manufacturers to silver-grey foam blocks or molded parts that give up to 20% higher insulating performance, which means a saving of up to 50% of the raw materials required.

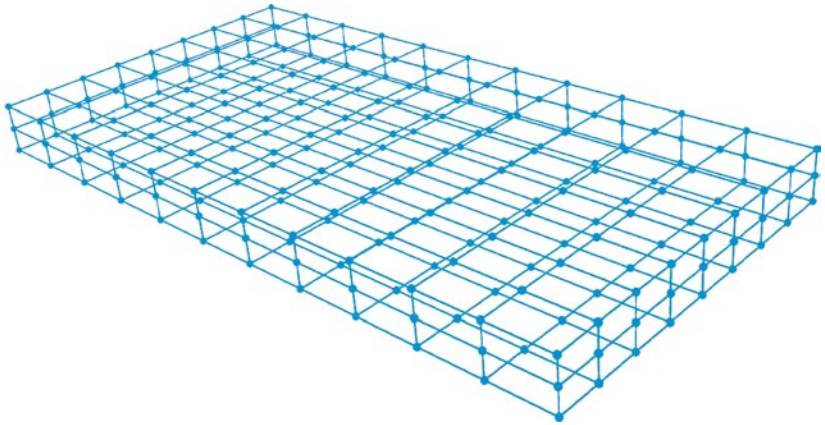


For further information on our products and business partners:
www.elastogran.de
www.styrodur.com
www.styropor.com
www.neopor.de
www.micronal.de
www.energyefficiency.basf.com

For further information on BASF competence for construction:
construction.europe@basf.com

To enhance the energy efficiency of buildings, tried and tested methods exist for insulating the outer shell as well as a range of additional products and additives. These include innovative materials such as functional pigments and phase change materials plus long-term tested products that improve air and wind infiltration resistance and prevent undesirable heat loss.

■ Just use your creative energy!



■ **Overheated rooms in summer are a thing of the past. Micronal® PCM** are microscopically small polymer beads that contain a wax storage medium on the inside. Integrated into construction materials, the wax melts or solidifies in the microcapsule as the temperature varies, regulating or stabilizing the ambient temperature by capping the temperature peaks. In summer they offer an ideal level of comfort and opportunities to save energy.

■ **Innovative black pigments from BASF** mean that surfaces can heat up in the sun to a much lower level despite the dark color – **Paliogen® Black, Lumogen® Black and Sicopal® Black.** Unlike carbon blacks, the standard black pigments, they reflect a large part of the invisible near infrared radiation (NIR) which makes up over 50% of the total irradiated solar energy. In this way, Paliogen® Black and Lumogen® Black reflect up to 45% and Sicopal® Black up to 30% of the total incident radiant energy from the sun.

■ **Rheocell ICF Mix:** This new, pumpable ICF concrete mix enables a lower carbon footprint concrete to be supplied because it reduces the demand for natural fine aggregate, such as sand by more than 12% over traditional concrete. This Rheocell ICF mix also improves the thermal and acoustic qualities of suitably designed concrete.

■ **Oppanol® keeps windows sealed:** Windows are rays of light – they link the inside of a building to the outside world and bring light, air and life into it. Heat and cold have to stay out, however. Good insulation windows are therefore double-glazed nowadays, and filled with inert gas. They have to stay tight and to insulate even after decades of weathering. This is taken care of primarily by a gas- and water vapor-tight edge composite on the insulating glass. The first stage in sealing is based on Oppanol®, the polyisobutene (PIB) from BASF. It meets these rigorous demands perfectly, because Oppanol is not just flexible, water-tight and UV-resistant, it is also extremely durable.

Competence implemented

Energy efficiency for BASF is competence implemented: consulting services and show houses

We not only produce good products, we also demonstrate that they work!

Together with our customers, we have contributed products to the construction and retrofitting to low energy standards of buildings in a number of **European**, **American** and **Asian countries**. Notwithstanding huge differences in local taste, climate and construction traditions, BASF and its customers' products have shown that they can be adapted to satisfy all conditions. Energy efficiency with BASF is competence implemented!

We support your projects with a broad range of services in Europe: **Luwoge consult GmbH**, a Europe-wide consulting firm headquartered in Ludwigshafen, Germany, offers technical and construction-related expertise in the field of energy-efficient construction and housing. Along with Luwoge, BASF's housing company, Luwoge consult has developed and completed a building that thanks to a multi-stage compound system eliminates heating costs: the zero-heating cost house.

The Italian building industry has also sought to lessen its considerable environmental footprint by making use of the five renewable energy sources: solar, wind, hydroelectric, biomass and geothermal energy. Not always are these solutions feasible, however, especially in the urban context. For this reason, BASF Italia has developed a sixth renewable energy source: **energy saving**. **E6**, as it is called, is a training and consultancy initiative to improve the energy efficiency of buildings.

■ The Wilhelm-Hack Museum is a showpiece for energy-efficient modernization in the museum world throughout Germany. This will be achieved by putting into practice the economic concept for the energy-efficient modernization of the house that Luwoge consult has developed and implemented at the request of Ludwigshafen City Council. Up to 60% of the previous energy costs can be saved in future. The German Energy Agency has included the Ludwigshafen project in its promotion program.

■ The zero-heating cost house is lined with thermal insulation panels made of Neopor®. Solar cells on the roof generate electricity, which is fed into the municipal grid. Solar panels on the south side of the façade ensure the building's hot water needs. The inside panes of the triple glazed windows can be used for heating where necessary. A controlled incoming and outgoing ventilation system ensures excellent air quality and makes optimal use of the heat in the outgoing air with a heat recovery rate of around 80%.

For more information:
www.luwoge-consult.de
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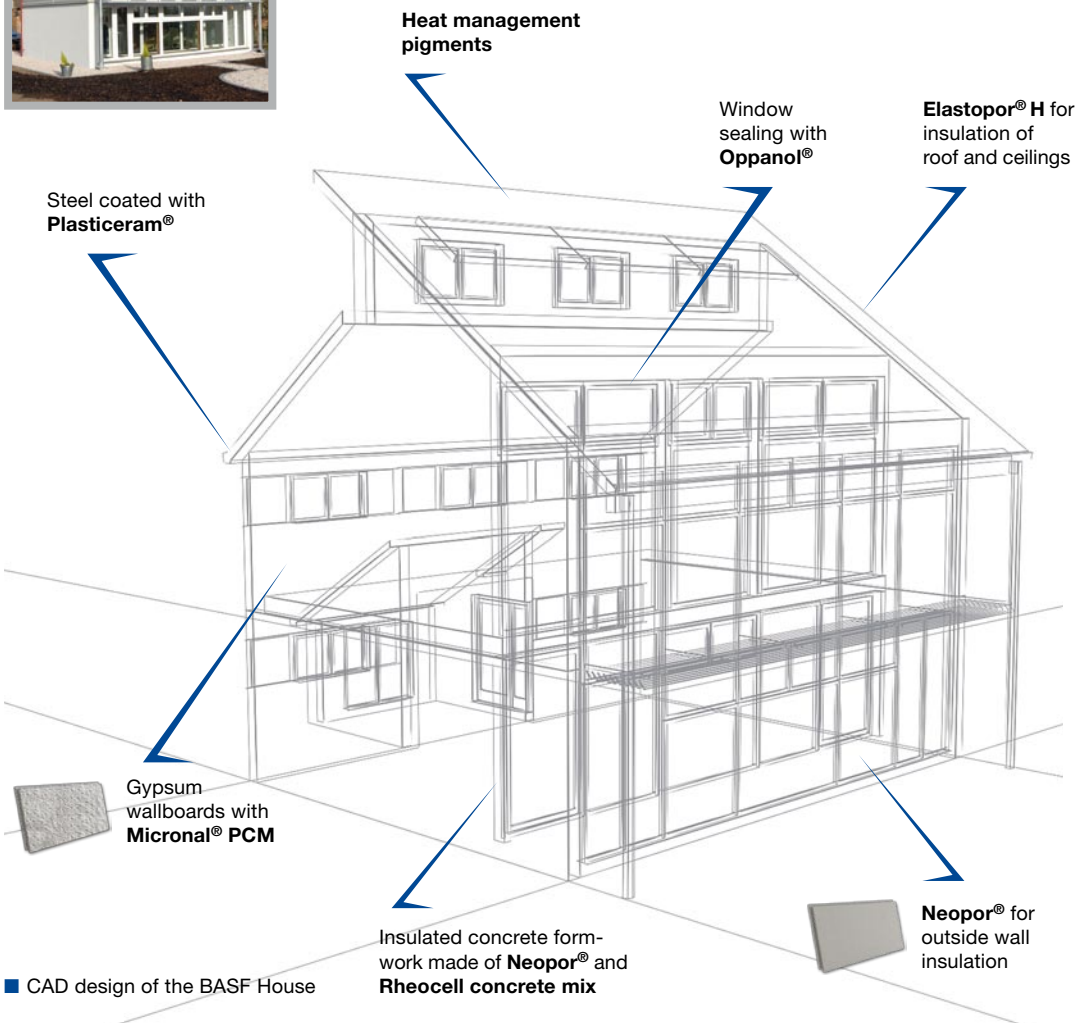
For further information on BASF competence for construction:
construction.europe@basf.com

■ In energy efficiency ratings, the BASF House has achieved outstanding ratings for energy performance and low CO_2 emissions.



■ CAD design of the BASF House

Energy efficiency and affordability*

The BASF House in Nottingham – UK

In the UK, as part of the Creative Energy Homes Project at the University of Nottingham's School of the Built Environment, BASF, helped by its customers and partners, has built a house to demonstrate how BASF raw materials can be used to create an energy efficient and affordable home. A low carbon emission target was set for the house, energy efficient products were used to create a thermally efficient home and renewable fuel is used for heating.

The house has a compact floor area and relies as much as possible on passive solar design. The environmental design strategy combines natural ventilation with a high thermal capacitance interior. For the ground floor walls we used insulated concrete formwork (ICF) made of Neopor®. Above ground floor level, a prefabricated timber insulated sandwich panel containing Polyurethane rigid foam insulation was used, so-called SIPs (structural insulated panels). The roof is constructed of the same material.

The use of these materials creates a highly insulated and energy efficient quick to erect building envelope. However, the envelope requires waterproofing. The first floor and roof require a durable waterproof cladding and we chose steel coated with Plasticeram® Top, Plastisol coil coating developed by BASF Coatings, as the most appropriate and cost effective material. The roof demonstrates BASF's heat management pigments that reduce heat gain in the metal roof preventing overheating of the roof space, helping improve the longevity of the coating and substrate, and reduction of the urban heat island effect.

www.house.basf.co.uk

* The application shown is just one example of the broad range of possibilities our products offer.

Nottingham

Cold
Moderate
Warm

Germany

Innovation in the refurbishment of old buildings*

The 3 Liter House in Ludwigshafen, Germany

The Three Liter House in Ludwigshafen is the result of retrofitting a building built during the 1950s, coordinated by Luwoge, BASF's housing company. It was possible to reduce heat requirements by around 80% to 30 kWh per square meter per year by insulating the roof, external façade and basement ceiling with insulating materials made of Neopor®, a gypsum plaster containing Micronal® PCM, a controlled ventilation and venting system, and triple-glazed windows. 30 kWh equals three liters of fuel oil or three cubic meters of natural gas.

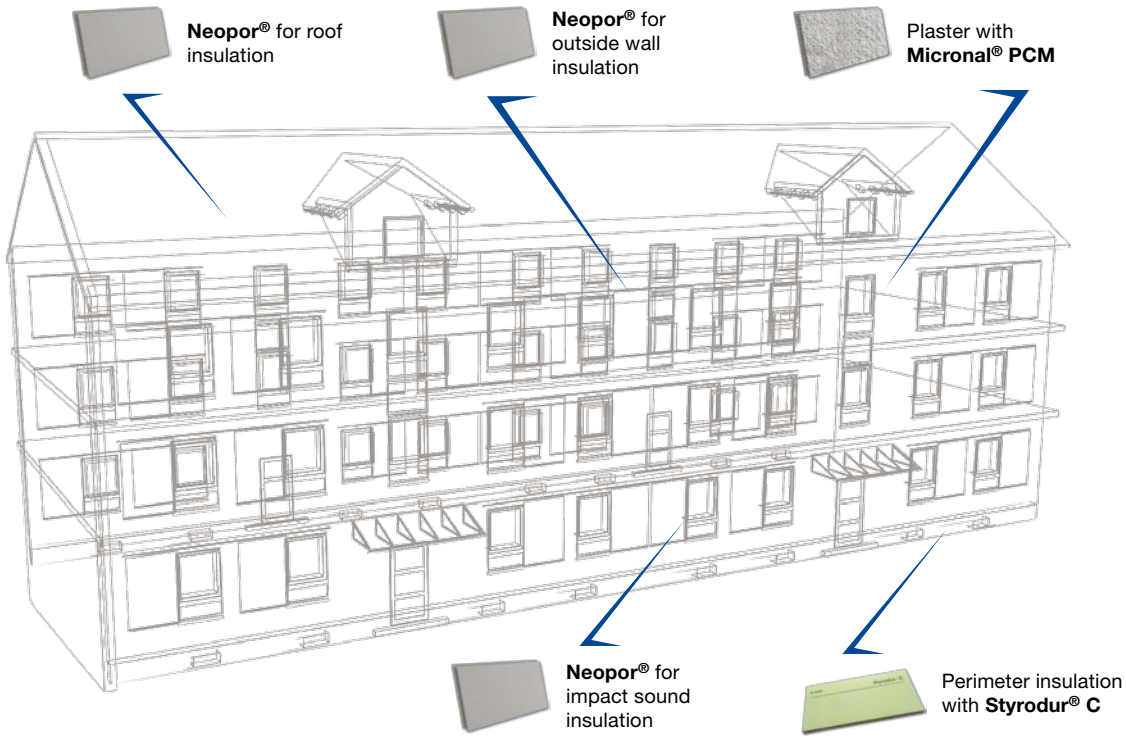
Restoration of a warehouse in the port of Hamburg, Germany

The world's largest contiguous warehouse complex is to become a commercial and cultural centre by 2015. It is a gigantic challenge for developers and construction firms, because the original character of the port buildings is to be preserved: lightweight thermal insulation was needed, featuring both high energy efficiency and a maximum thickness of only 10 centimeters. This proved to be possible – thanks to Elastopor® H by Elastogran! A conventional system with the same energy performance would be around 26 centimeters thick.

www.luwoge-consult.de
www.elastogran.de

* The application shown is just one example of the broad range of possibilities our products offer.

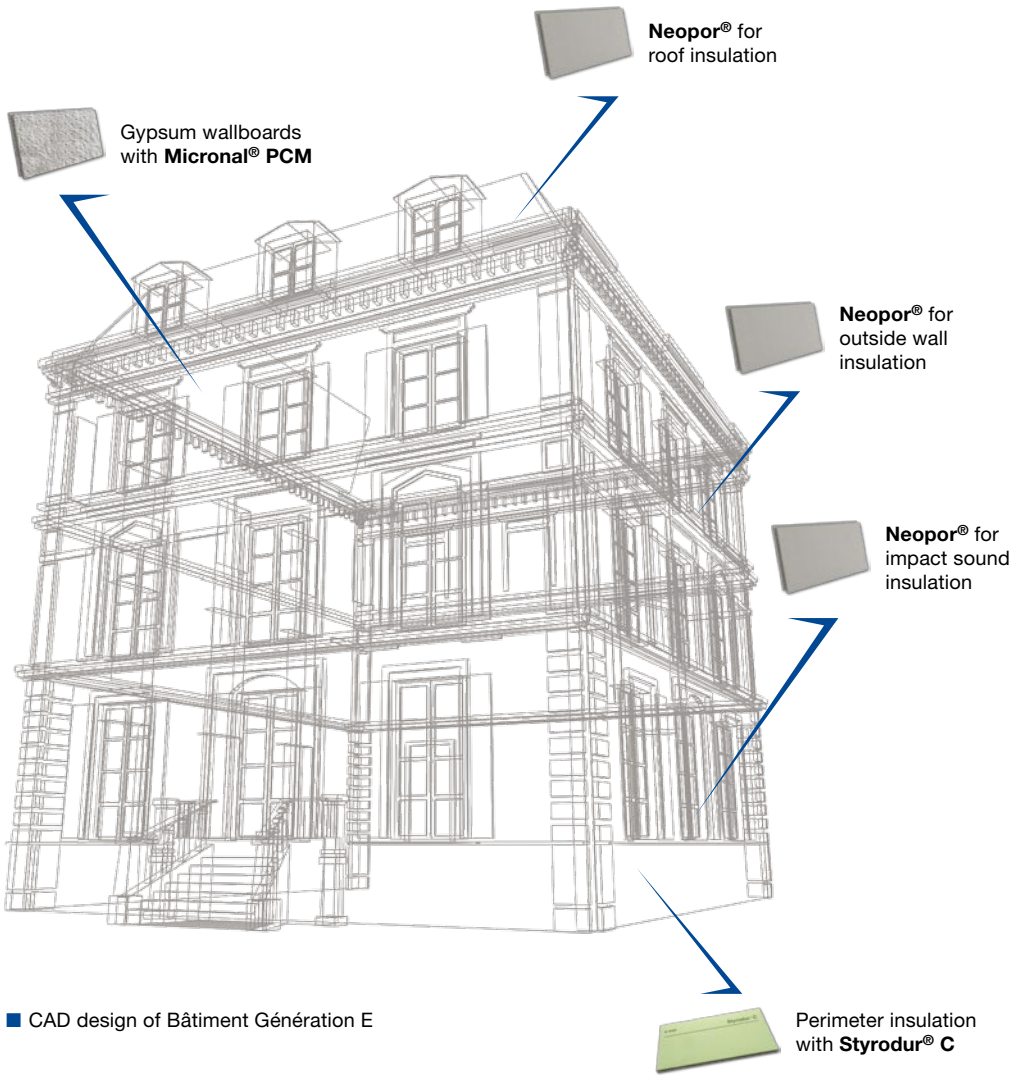
■ Picture of the warehouse in Hamburg with Elastopor® H for the roof insulation



■ CAD design of the 3 Liter House in Ludwigshafen

Ludwigshafen

Hamburg



■ CAD design of Bâtiment Génération E

Giving life to a new generation of buildings*

"Bâtiment Génération E" in Fontenay-sous-Bois, Paris – France

In French, "E" stands for environment, economy, energy and equilibrium, which are the elements on which a sustainable project should be based. This is what BASF is implementing in France together with its partners by refurbishing and modernising an old villa near Paris called "Bâtiment Génération E", which consumes 50 kWh of primary energy per square meter for heating and ventilation each year, instead of 400 before. The main contribution is provided by insulation made of Neopor® for the walls, the roof, the floors and the ceilings, by Styrodur® C for the insulation of the perimeter, and by gypsum wallboards containing Micronal® PCM from BASF. "Bâtiment Génération E": a generation of innovative, energy efficiency and sustainable buildings has come of age, thanks to BASF and its partners.

"La Clairière" – low energy standard social housing

An innovative and energy-efficient method of construction is not a privilege, as the "La Clairière" project shows. As a partner in the "Le Foyer Remois" social housing company, BASF is part of a new construction project for a house with 13 low energy standard residential units at Béthény near Reims. A thermal insulation composite system and roof insulation made of Neopor® together with triple-glazed windows retains heat in the house. In technical terms, this is complemented by a heat exchanger which uses geothermal energy for the ventilation system, and solar cells which generate energy for the hot water supply. The house should only use 15 kWh per square meter a year for heating.

www.basf.fr
point.infos@basf-france.org

* The application shown is just one example of the broad range of possibilities our products offer.

Paris

Italy

The sixth energy source*

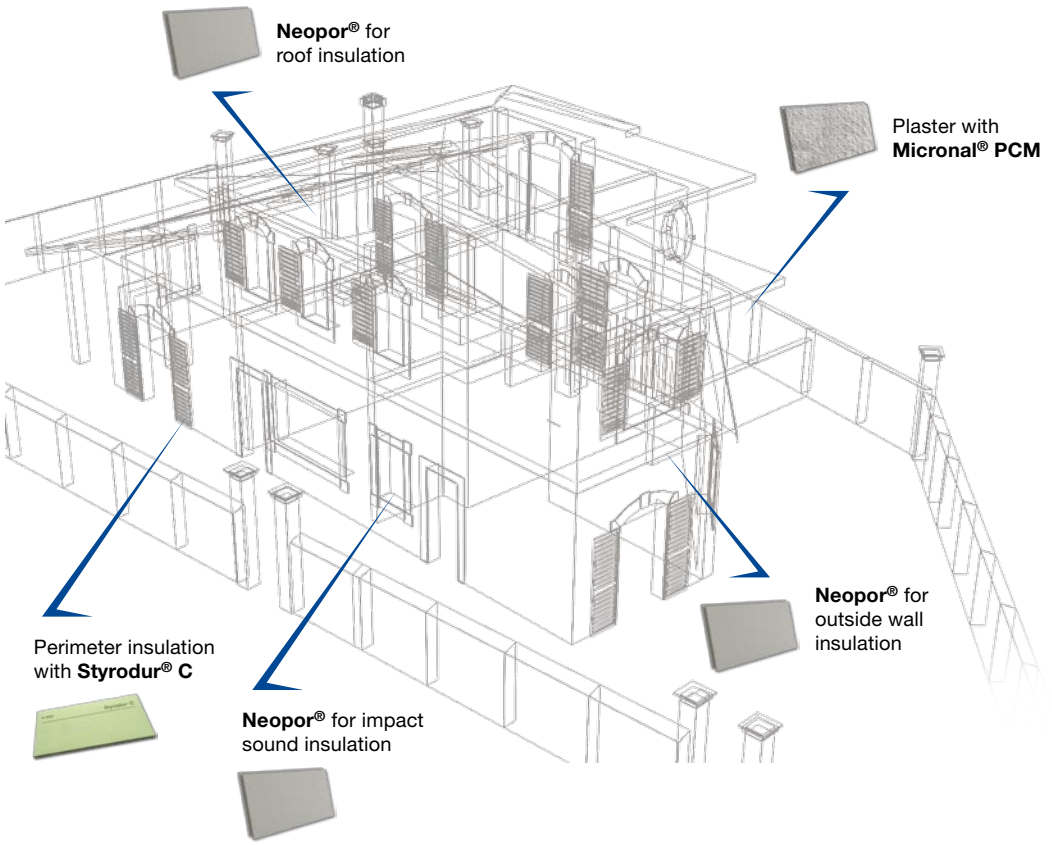
The Three Liter House in Saline di Ostia Antica, Rome – Italy

To illustrate E6 concepts, the company took part in the project of a three liter home in Ostia Antica, near Rome, to demonstrate how thermal indoor comfort can be obtained consuming only three cubic meters of natural gas per square meter and year (the equivalent of three liters of fuel), compared to the standard 9 l/sq m for new build, and 27 l/sq m of 80% of today's housing stock. To reduce heat loss towards the ground, the house's foundations were insulated with Styrodur® C. The perforated brick walls were externally insulated with panels made of Neopor® which was also used for the roof. The interior sealing is made with a plaster containing Micronal® beads that offsets temperature fluctuations.

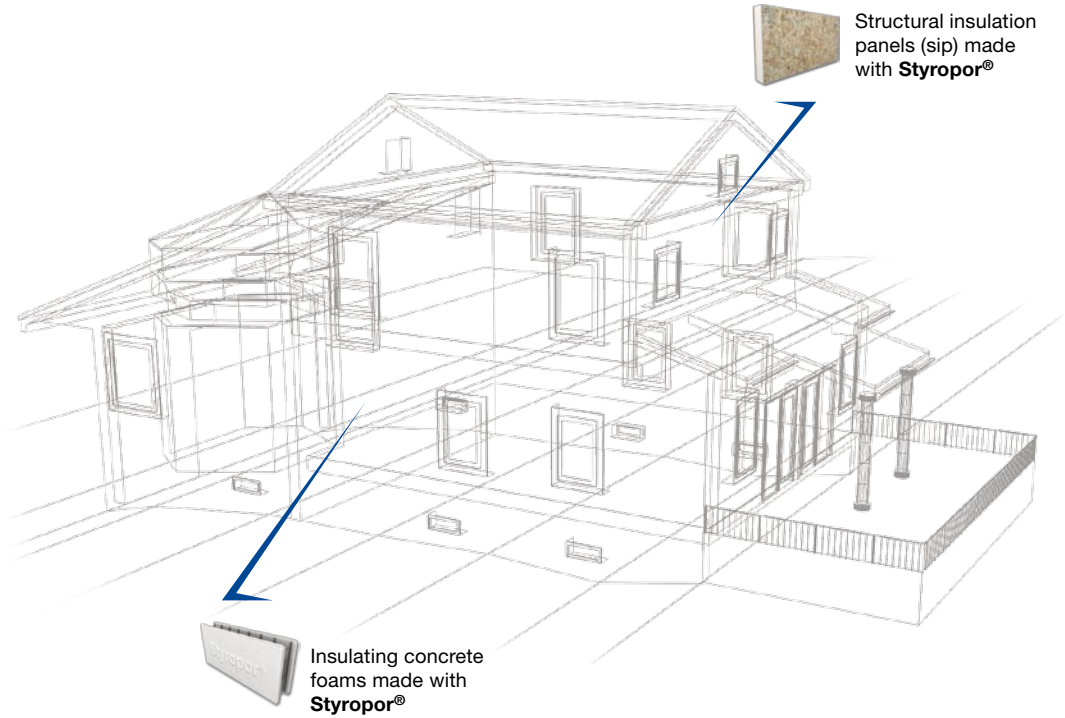
www.basf.it
www.sestaenergia.it
construction.italy@basf.com

* The application shown is just one example of the broad range of possibilities our products offer.

■ CAD design of the Three Liter House in Rome



Rome



■ CAD design of the Paterson House

Better home, better planet*

The Paterson House, Paterson – New Jersey – USA

The Paterson Show House Project is part of the BASF Corporation initiative "Better home, better planet": it brings together the best building practices, materials and technologies available today and shows how BASF products can be used to create a healthy, more efficient, more eco-friendly and more affordable home. An objective reached mainly through the use of insulating concrete foams consisting of two panels of expanded polystyrene (EPS) rigid insulation foam connected by steel ties, EPS insulation panels and structural insulation panels (SIP), made of a core of moulded EPS insulation with engineered oriented strand board (OSB) laminated to the top and bottom faces. All these solutions were developed with Styropor® by BASF. In addition to being energy efficient and recyclable, the foam building systems reduce construction time, are durable and create quieter, less draughty homes.

The Mainstream GreenHome™

The Mainstream GreenHome™ showcases a combination of environmentally responsible building technologies and materials. It's the brainchild of Cherokee Investment Partners, an international private equity firm specializing in the sustainable revitalization of contaminated real estate or "brownfields". To achieve optimal air quality, the home needed to have a tight building envelope. Therefore, the builders opted to use Comfort Foam closed-cell, spray-applied polyurethane foam insulation from BASF Polyurethane Foam Enterprises LLC. The home has been designed to consume 50% less fossil fuel and water than a conventional home.

www.betterhomebetterplanet.com
www.styroporEPS.com

* The application shown is just one example of the broad range of possibilities our products offer.

Paterson

Poland

Heat in the home – within everyone's means*

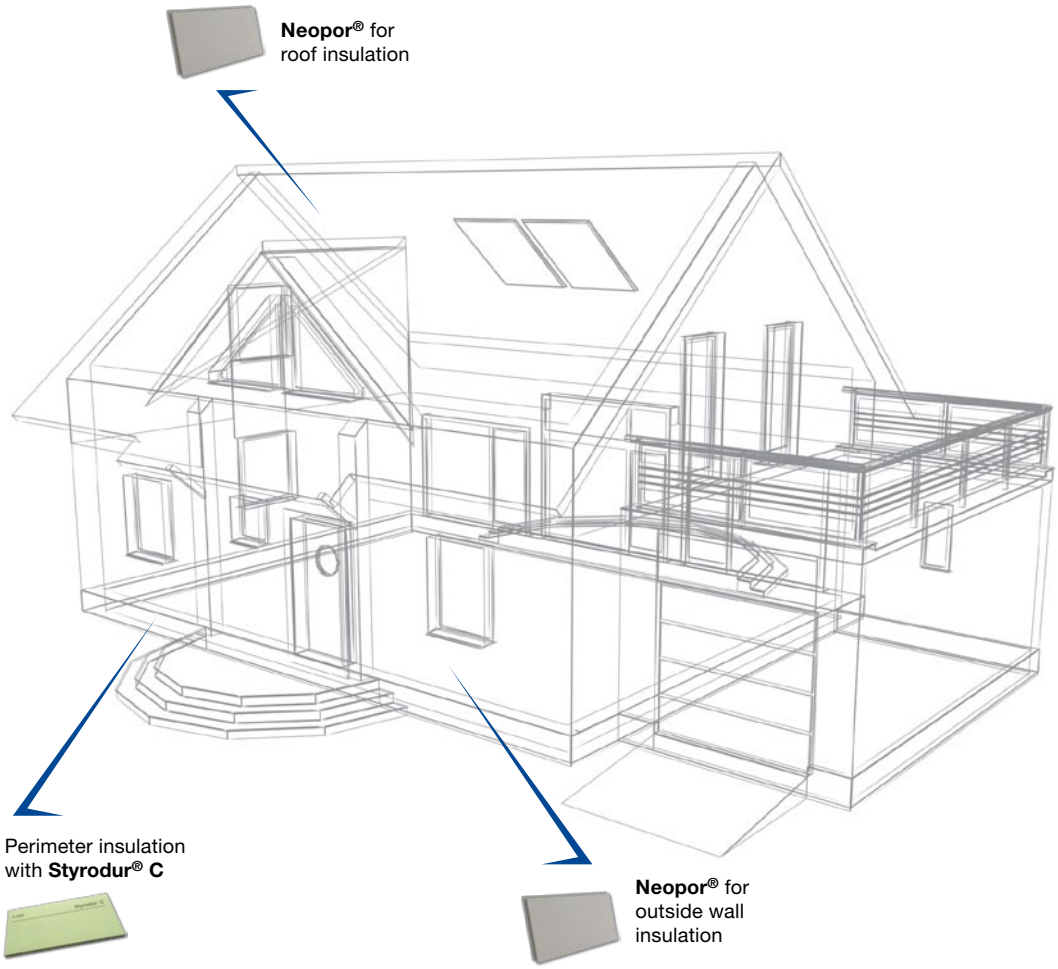
Energy-efficient and individually designed private homes all over Poland

In Poland, the demand for energy-efficient solutions in private house building is increasing because of rising energy prices. Together with the Lipinscy Domy architectural practice and the prefabricated housing supplier Termo Organika, BASF has started the “Cieply Dom dla Ciebie” project (A warm house for you). Lipinscy Domy has developed a concept for an energy-efficient private residential dwelling where the wall construction is based on “Platinum Plus” elements, produced by Termo Organika from BASF's Neopor®. The energy requirement for houses using this concept is 70% below the average. Depending on the type of energy supply, the costs for improved insulation are amortized over a period of six to 13 years. To complete the program, the fourth partner, Fortis Bank, offers an attractive financing package to the private builder. The program has been a great success. With over 200 individually designed private houses to date.

www.cieplydomdlaciebie.pl
www.neopor.pl

* The application shown is just one example of the broad range of possibilities our products offer.

■ CAD design of the passive house in Wrocław



Wrocław

Offices with a passive house certificate*

The Bauland House in Fotliget – Hungary

At Fotliget, a few kilometers east of the Hungarian capital Budapest, passive house standard office and business premises have been built in collaboration with the investor Bauland. It comprises an area of around 1100 square meters on three floors for offices, shops and restaurants. Insulation using Neopor® and additional technologies such as a heat pump and solar energy should ensure that there are no heating costs. The energy concept was developed by Luwoge consult. This project also shows for business premises that the investor can profit in the long term from a low energy standard. The Passivhaus-Institut in Darmstadt, Germany, has certified the house to 1.5-liter standard.

www.neopor.hu
www.luwoge-consult.de

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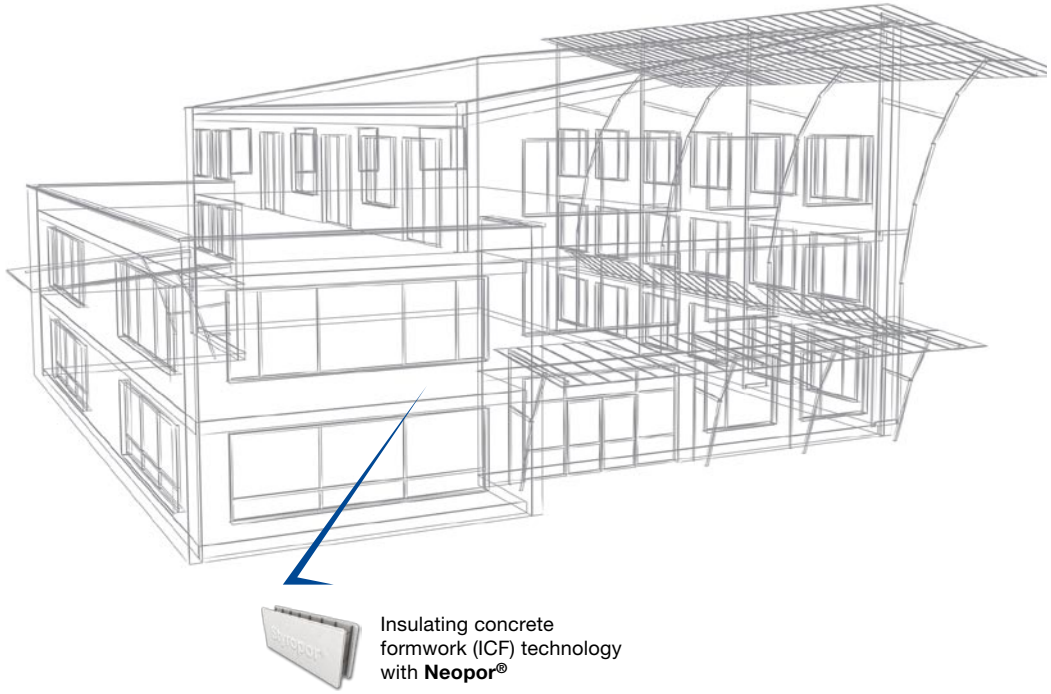


Insulating concrete formwork (ICF) technology with **Neopor®**

■ CAD design of the Bauland office and business building

Budapest

Korea

Winning the energy award*

The Three Liter House in Kyonggi – Korea

At Kyonggi in the Youngin region, approximately 40 km from Seoul, BASF, together with the construction company Daelim and the fuel cell manufacturer FuelCellPower, has developed a 3-liter house which is adapted to the Korean architectural style. The use of energy-efficient construction technology, high-quality insulating materials and a fuel cell system mean that it uses only three liters of fuel oil equivalent per square meter of living area a year. This reduces the energy consumption from one sixth to one seventh of the consumption of homes in the housing stock and CO_2 emission by around 80%.

The Korean three liter house is a true community project. BASF provided high-quality materials – the raw material Neopor® for manufacturing the insulation and Micronal® as a phase change material in the gypsum plaster – and the know-how from other three liter houses. The fuel cell system was supplied by FuelCellPower, and Daelim Industrial provided a highly efficient and energy-saving shell for the building and the construction management.

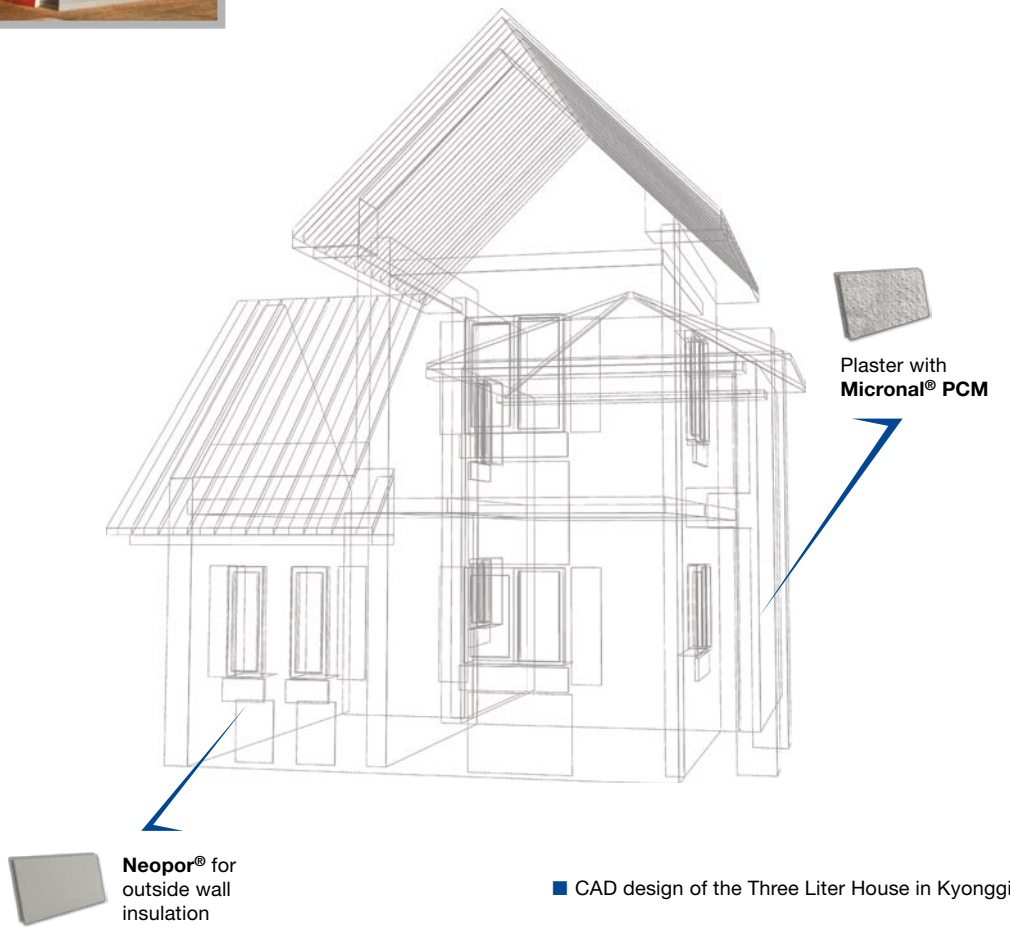
By the way: Our raw material Neopor®, used for producing insulation panels and blocks, has received an energy award in Korea, thanks to its innovative characteristics: excellent insulation performance with less raw materials.

The Korean Three Liter House is not all we are doing: BASF is also participating in other low energy projects in China, Malaysia and India.

www.basf-korea.co.kr

* The application shown is just one example of the broad range of possibilities our products offer.

■ The Korean Three Liter House with insualtion panels made of Neopor® and gypsum plaster containing Micronal®



■ CAD design of the Three Liter House in Kyonggi

Kyonggi

Cold
Moderate
Warm

Study on the effectiveness of thermal insulation with BASF and partners' solutions in different climates

In all countries there is massive potential for saving energy in buildings, both for heating and for cooling, thereby reducing energy expenditure for owners and tenants, CO_2 emissions, pollution, and securing energy supply for the coming years. A study of the Passive House Institute in Darmstadt, Germany, based on insulation products by BASF or produced with BASF raw materials (Elastopor® H, Styrodur® C and Neopor®), analyses the effect of thermal insulation on the same building in different cities.

The results of the study show that taking measures for increasing energy efficiency potentially save rather than cost money: excellent results can be effectively reached in all climates, in cold as well as in moderate and hot countries, and for almost every building you can imagine. In Warsaw, as well as in Frankfurt, Paris, London, Rome and Seville, you can reduce energy consumption by approximately 70% using a few centimeters of insulation.

DEFINITIONS

SPACE HEAT DEMAND: the annual amount of heat to be supplied to the building in order to ensure an operating temperature of 20 °C.

HEATING ENERGY DEMAND: the amount of energy, e.g. in form of fuel oil or natural gas, to be supplied to the heating system in order to ensure an operating temperature of 20 °C.

SPACE COOLING DEMAND: the annual amount of heat to be extracted from the building by cooling, in order to keep the air temperature below 25 °C.

ELECTRICITY FOR COOLING: the annual electricity demand for space cooling based on annual data of a typical split unit performance.

HOURS OVER 25 °C: percentage of hours over 25 °C without cooling.

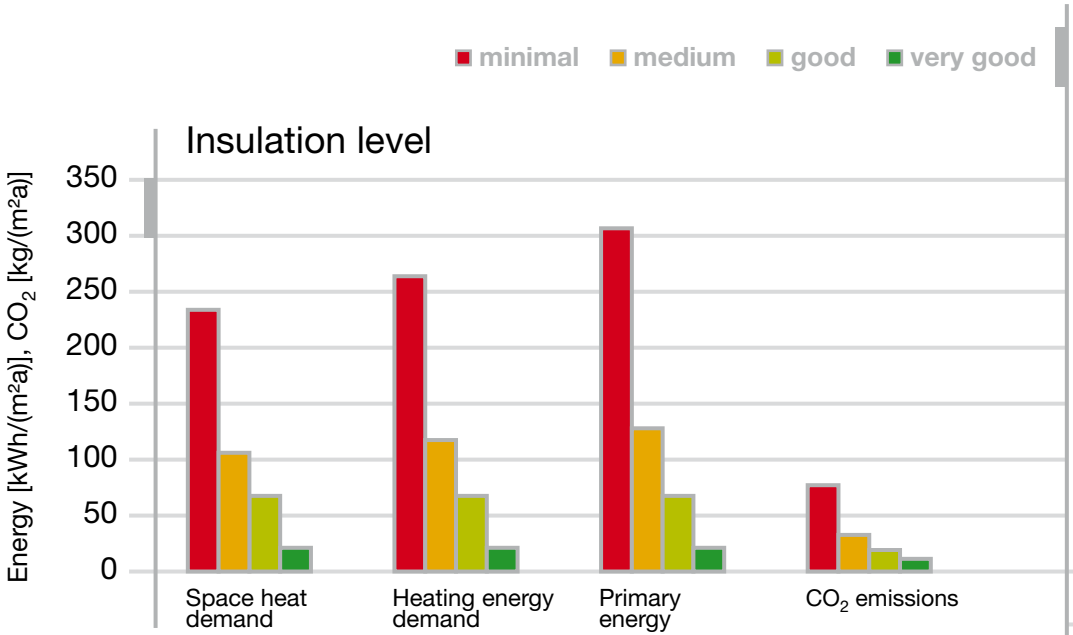
PEAK TEMPERATURE: the maximum hourly mean value of the temperature of any of the rooms during the whole year without cooling. In general, the maximum temperatures occur in the south-facing rooms located immediately under the roof.

PRIMARY ENERGY FOR HEATING AND COOLING: it is assumed that cooling is applied. The auxiliary electricity demand of the heating system was taken into account. The auxiliary electricity for cooling is included in the annual performance coefficient.

CO_2 EMISSIONS: emissions due to the use of heating and cooling systems.

Cost effective insulation in cold countries

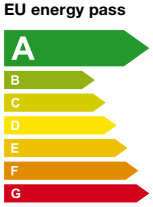
Warsaw – Poland



With only 15 cm roof insulation with Elastopor® H, 15 cm wall insulation made of Neopor® and 8 cm perimeter and slab floor insulation with Styrodur® C **you can reduce energy consumption and CO_2 emissions by almost 75%.***

Cost effectiveness of thermal insulation*

Investment [€]	5.500
Savings [€/year] at constant energy price	1.160
Pay back time [years]	4,7
Savings after the pay back time (during life cycle). Energy price development 1 [€]	21.700
Savings after the pay back time (during life cycle). Energy price development 2 [€]	51.600



*The products' applications analysed are just examples for the wide range of possibilities. Savings were calculated by comparing the building defined as "minimal" and the one defined as "good". For details see pages 22 and 24.

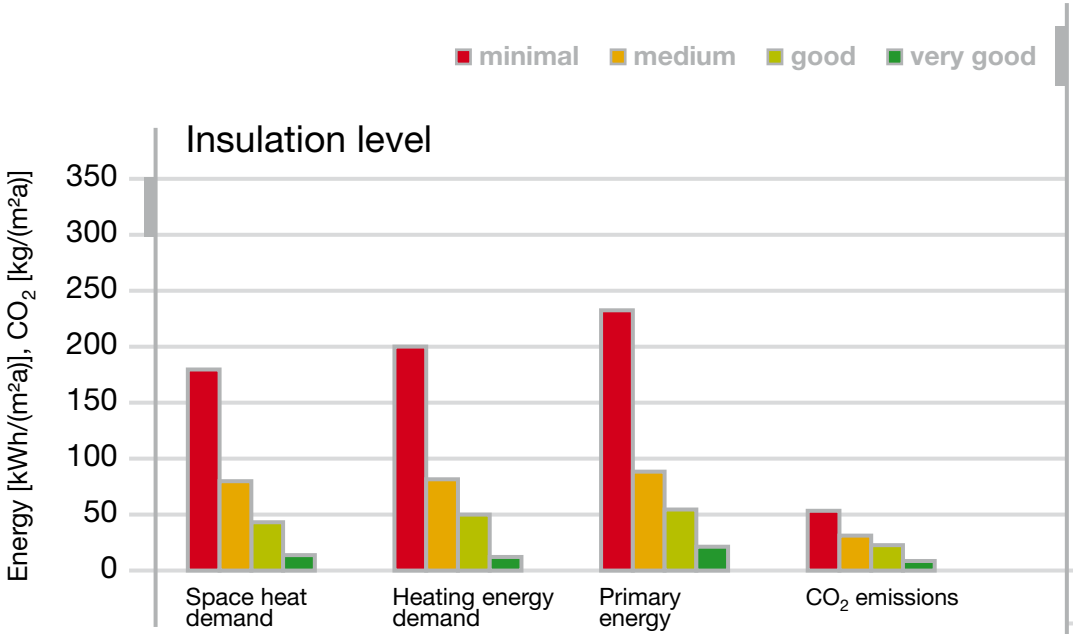
Warsaw – Poland

Reykjavik (IS) · Helsinki (FIN) · Oslo (N) · Tallinn (EST) · Stockholm (S) · Riga (LV) · Vilnius (LT) · Prague (CZ)

Cold
Moderate
Warm

Cost effective insulation in moderate countries

London – UK



With only 15 cm roof insulation with Elastopor® H, 15 cm wall insulation made of Neopor® and 8 cm perimeter and slab floor insulation with Styrodur® C **you can reduce energy consumption and CO_2 emissions by 75%.***

Cost effectiveness of thermal insulation*

Investment [€]	5.500
Savings [€/year] at constant energy price	930
Pay back time [years]	5,9
Savings after the pay back time (during life cycle). Energy price development 1 [€]	16.400
Savings after the pay back time (during life cycle). Energy price development 2 [€]	40.500

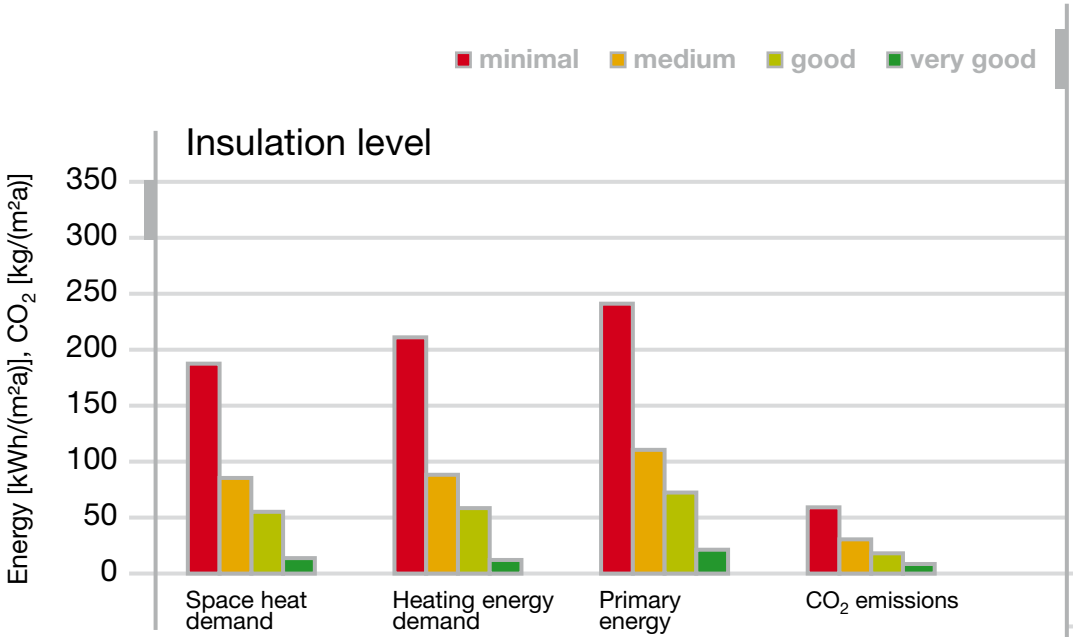
*The products' applications analysed are just examples for the wide range of possibilities. Savings were calculated by comparing the building defined as "minimal" and the one defined as "good". For details see pages 22 and 24.

London – UK

Copenhagen (DK) Dublin (IRL) Amsterdam (NL)

Cost effective insulation in moderate countries

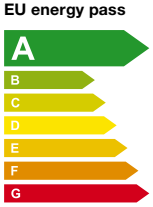
Frankfurt am Main – Germany



With only 15 cm roof insulation with Elastopor® H, 15 cm wall insulation made of Neopor® and 8 cm perimeter and slab floor insulation with Styrodur® C **you can reduce energy consumption and CO_2 emissions by 70%.***

Cost effectiveness of thermal insulation*

Investment [€]	5.500
Savings [€/year] at constant energy price	940
Pay back time [years]	5,8
Savings after the pay back time (during life cycle). Energy price development 1 [€]	16.600
Savings after the pay back time (during life cycle). Energy price development 2 [€]	40.900



*The products' applications analysed are just examples for the wide range of possibilities. Savings were calculated by comparing the building defined as "minimal" and the one defined as "good". For details see pages 22 and 24.

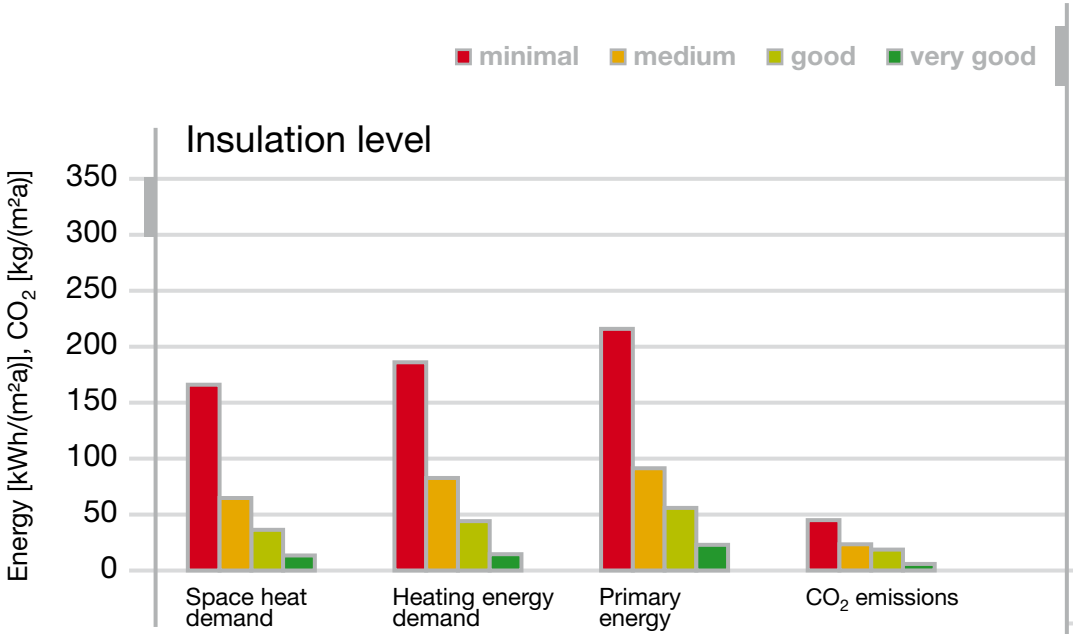
Frankfurt am Main – Germany

Vienna (A) Brussels (B) Hamburg (D) Luxembourg (L)

Cold
Moderate
Warm

Cost effective insulation in moderate countries

Paris – France



With only 15 cm roof insulation with Elastopor® H, 15 cm wall insulation made of Neopor® and 8 cm perimeter and slab floor insulation with Styrodur® C **you can reduce energy consumption and CO_2 emissions by more than 70%.***

*The products' applications analysed are just examples for the wide range of possibilities. Savings were calculated by comparing the building defined as "minimal" and the one defined as "good". For details see pages 22 and 24.

Cost effectiveness of thermal insulation*

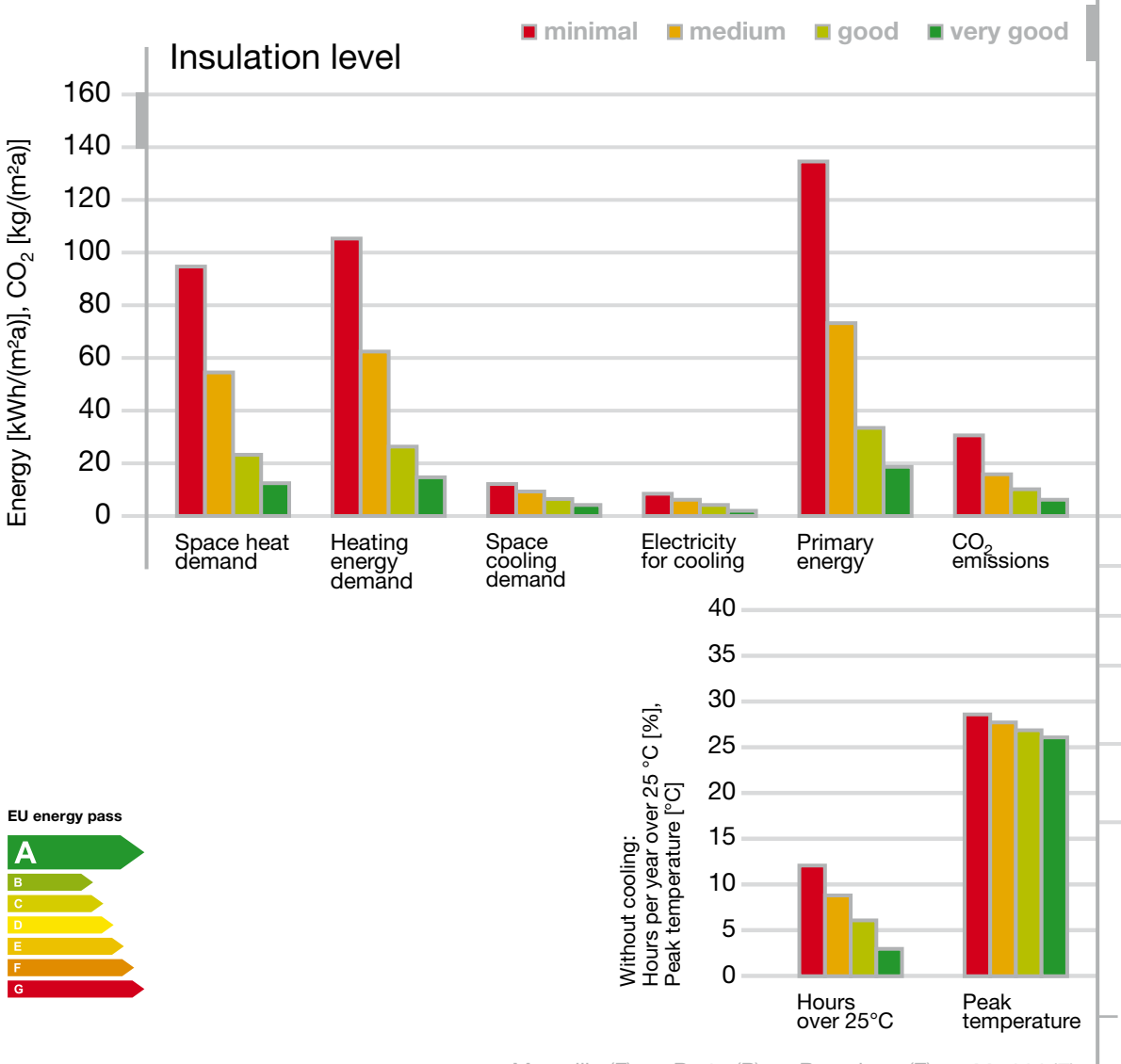
Investment [€]	5.500
Savings [€/year] at constant energy price	870
Pay back time [years]	6,3
Savings after the pay back time (during life cycle). Energy price development 1 [€]	15.000
Savings after the pay back time (during life cycle). Energy price development 2 [€]	37.600

Paris – France

Bratislava (SK) Budapest (H) Ljubljana (SLO) Milan (I)

Cost effective insulation in hot countries

Rome – Italy



With only 8 cm roof insulation with Elastopor® H, 10 cm wall insulation made of Neopor® and 4 cm perimeter insulation with Styrodur® C **you can reduce energy consumption and CO_2 emissions by about 75%.***

Cost effectiveness of thermal insulation*

Investment [€]	2.800
Savings [€/year] at constant energy price	470
Pay back time [years]	5,9
Savings after the pay back time (during life cycle). Energy price development 1 [€]	8.300
Savings after the pay back time (during life cycle). Energy price development 2 [€]	20.000

*The products' applications analysed are just examples for the wide range of possibilities. Savings were calculated by comparing the building defined as "minimal" and the one defined as "good". For details see pages 23 and 24.

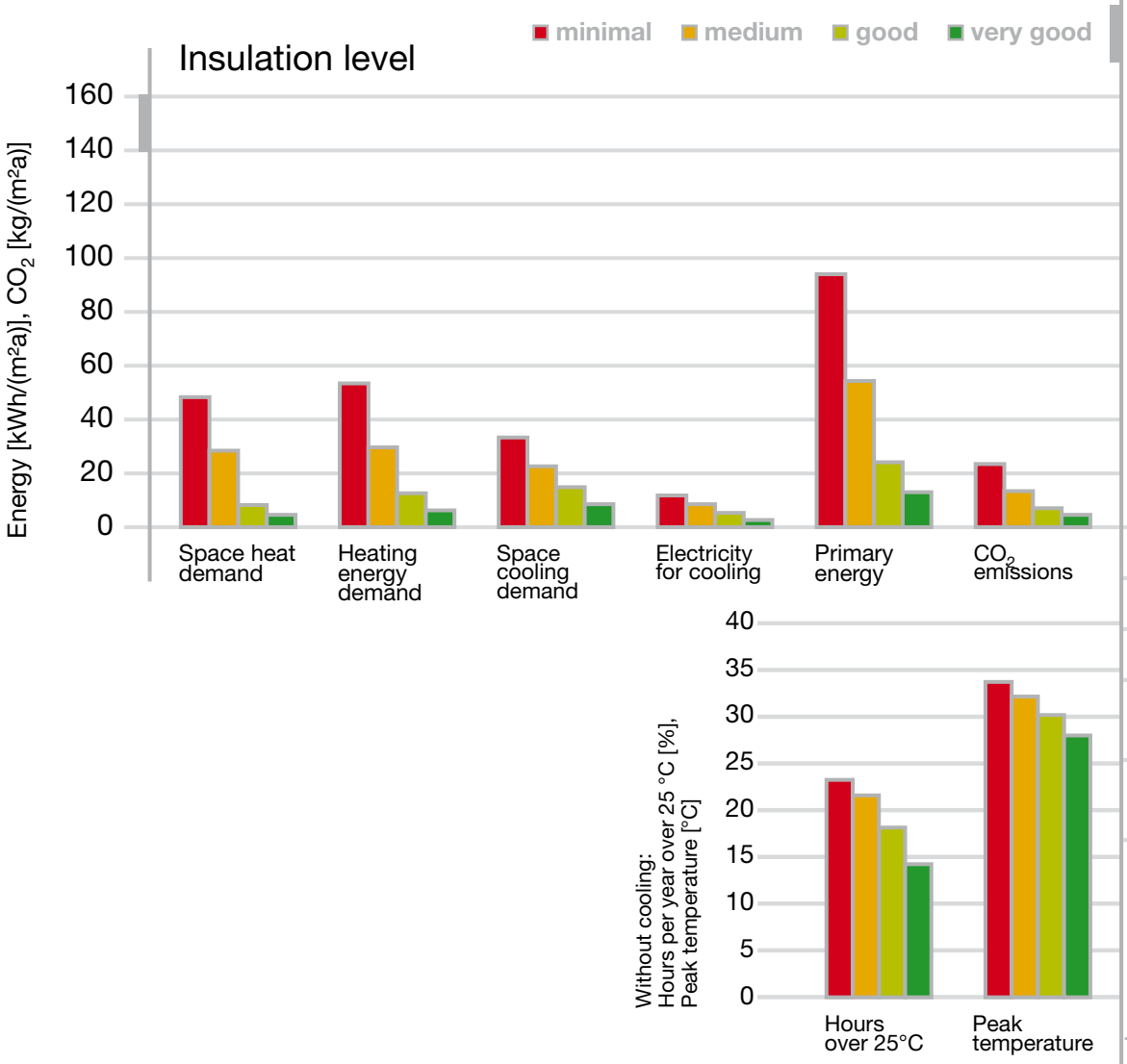
Rome – Italy

Marseille (F) — Porto (P) — Barcelona (E) — Madrid (E)

Cold
Moderate
Warm

Cost effective insulation in hot countries

Seville – Spain



With only 8 cm roof insulation with Elastopor® H, 10 cm wall insulation made of Neopor® and 4 cm perimeter insulation with Styrodur® C **you can reduce energy consumption and CO_2 emissions by 75%.***

Cost effectiveness of thermal insulation*

Investment [€]	2.800
Savings [€/year] at constant energy price	360
Pay back time [years]	7,8
Savings after the pay back time (during life cycle). Energy price development 1 [€]	5.600
Savings after the pay back time (during life cycle). Energy price development 2 [€]	13.200

*The products' applications analysed are just examples for the wide range of possibilities. Savings were calculated by comparing the building defined as "minimal" and the one defined as "good". For details see pages 23 and 24.

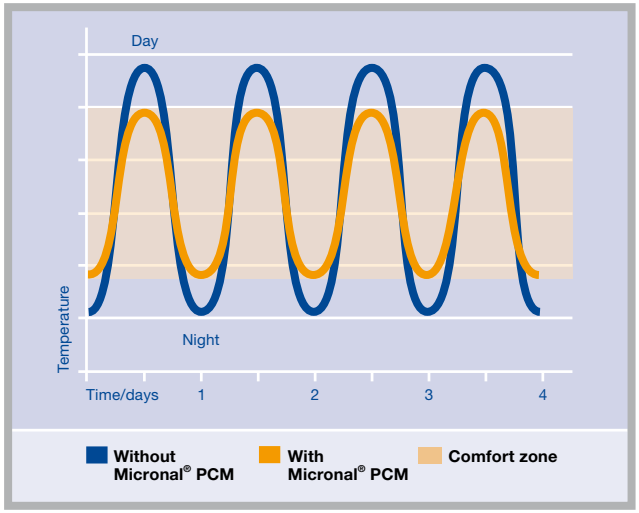
Seville – Spain

Lisbon (P) Palermo (I) Athen (GR)

Effect of Micronal® PCM (phase change material)

Micronal® PCM are microscopically small polymer spheres containing a wax storage medium in their cores which, incorporated in plasters or gypsum wallboards, melt and solidify and regulate environmental temperatures offering energy savings for cooling and great comfort in summer.

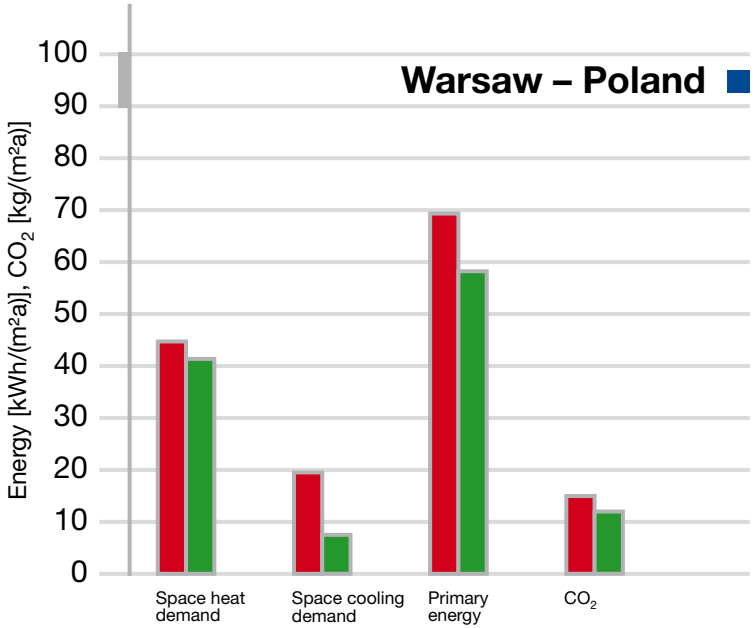
A study conducted by the Passive House Institute Darmstadt, Germany, shows the effect of 1,5 cm thick gypsum wallboards (Knauf PCM Smart-Board® by BASF with 26% Micronal® phase change material) on energy demand, both in winter and summer, and on the CO_2 emissions of the same office building under different climatic conditions.

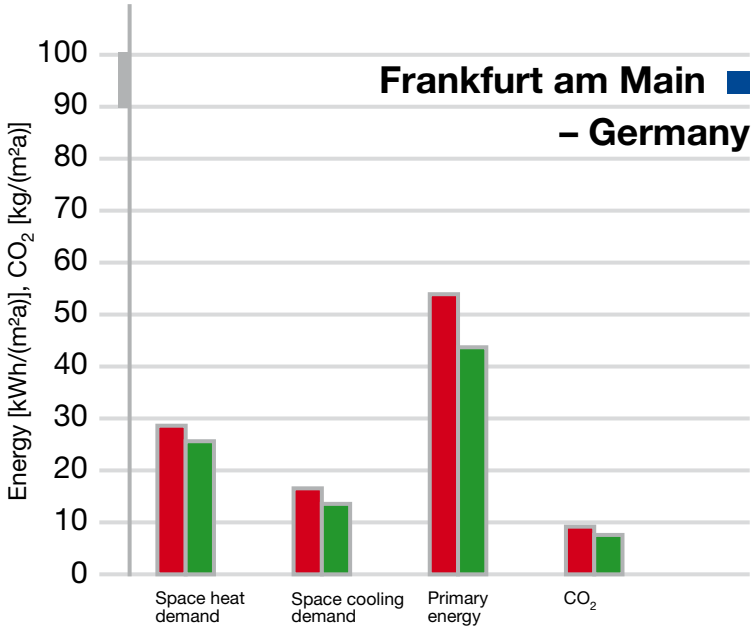


As part of a passive cooling concept, construction elements containing Micronal® PCM can in part or completely substitute energy consuming cooling systems. This leads not only to energy savings, but also to a reduction or elemination of in the maintenance and repair costs of the cooling systems, which normally have an average life cycle of 15 years.

For further information on BASF competence for construction:
construction.europe@basf.com

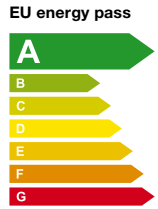
Energy consumption and CO_2 emissions





In Warsaw and Frankfurt, with SmartBoard® gypsum panels containing Micronal® PCM by Knauf, you can reduce energy consumption and CO_2 emissions by more than 15 % and 20 % respectively and significantly increase the building's comfort.

For details see page 24



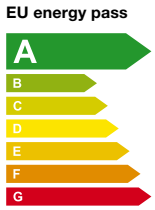
without PCM

with PCM

Effect of Micronal® PCM (phase change material)

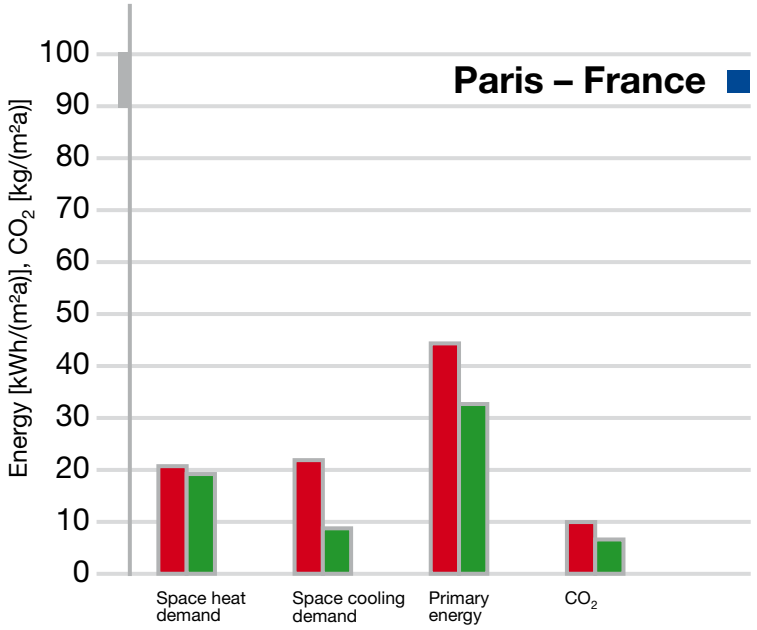
In Paris and London, with SmartBoard® gypsum panels containing Micronal® PCM by Knauf, you can reduce both energy consumption and CO_2 emissions by about 30 % and significantly improve the building's comfort.

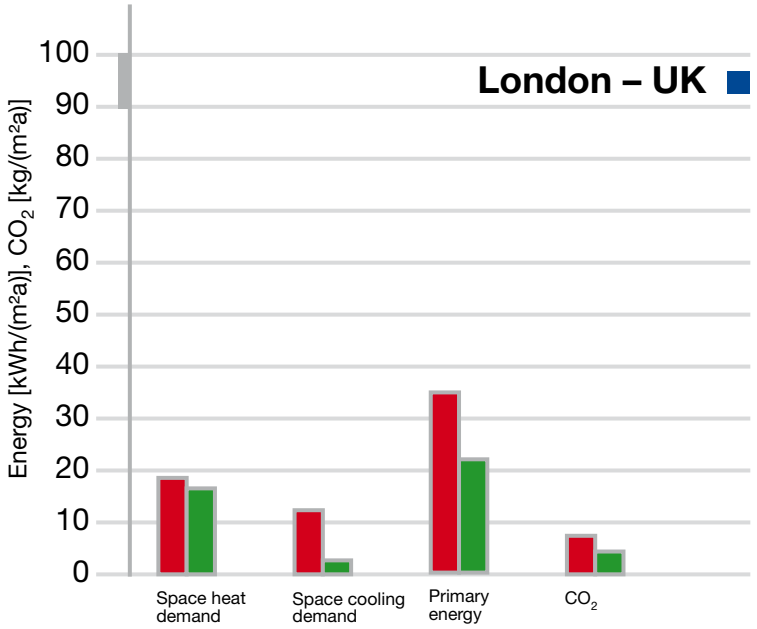
For details see page 24



without PCM

with PCM





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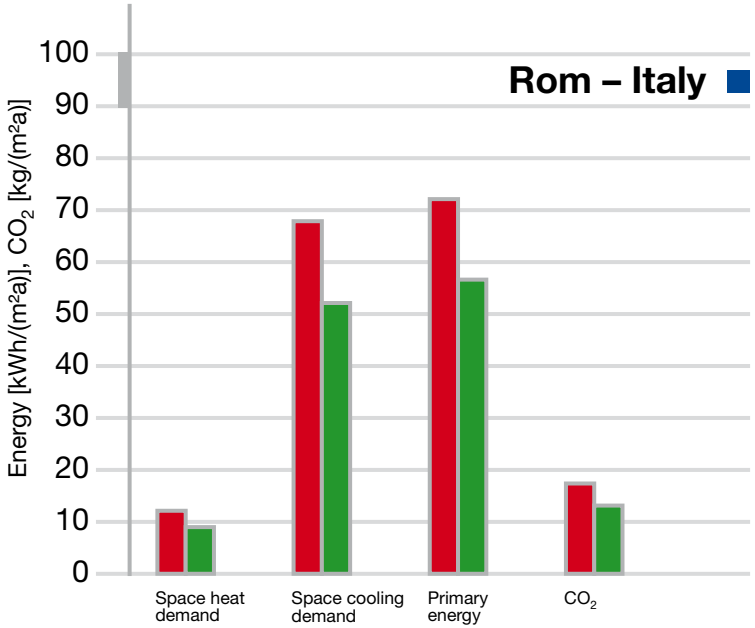
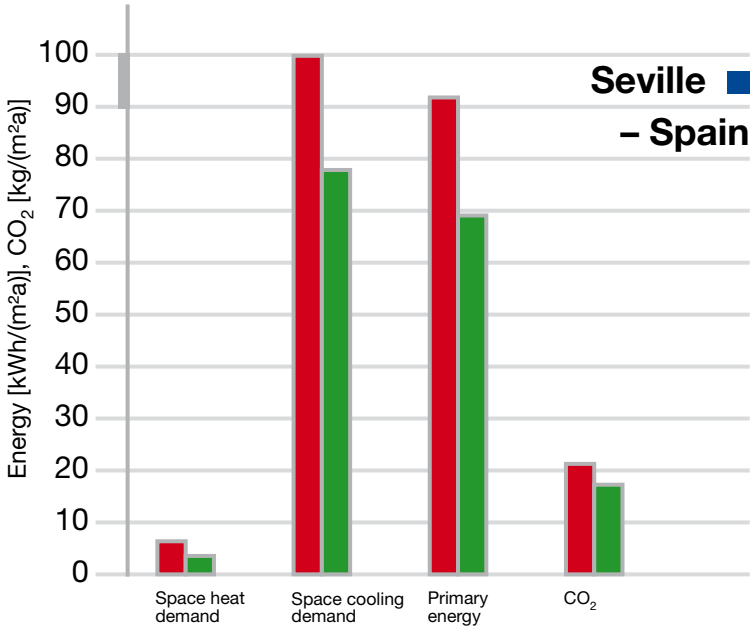
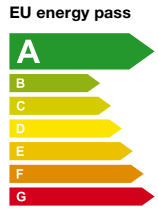
Energy consumption and CO_2 emissions





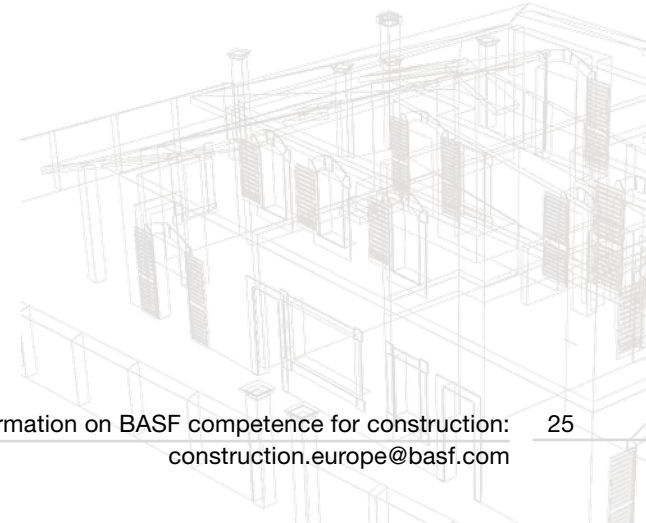
In Rome and Seville, with SmartBoard® gypsum panels containing Micronal® PCM by Knauf, you can reduce both energy consumption and CO_2 emissions by more than 20% and significantly increase the building's comfort, both in winter and in summer.

For details see page 24



without PCM

with PCM



Notes on the thermal insulation study

The calculations were performed with the dynamic simulation program DYNBIL from the Passive House Institute. Comparisons between DYNBIL simulations and analysis of existing buildings show very good agreement.

The following thermal insulation solutions were analysed:

- Insulation materials produced with Neopor® (expandable EPS containing infrared-absorbers) by BASF for the walls.
- Styrodur® C (XPS) by BASF for perimeter and floor slab insulation.
- Spray foam system or sandwich elements with Elastopor® H (polyurethane) by Elastogran for the roof insulation.

The simulation case is based on an end-of-terrace house with massive construction having two floors and a living area of 120 m^2. For the simulations south of the Alps the roof is massive and the windows have shutters. North of the Alps the roof is considered to be a lightweight construction.

U values of the building components

U Value	Roof W/(m^2k)	Wall W/(m^2k)	Floor slab W/(m^2k)	Perimeter W/(m^2k)
minimal	0,839	1,158	4,0	4,0
medium	0,181	0,297	0,694	0,699
good	0,13	0,18	0,4	0,4
very good	0,07	0,098	0,19	0,19

Building characteristics in Warsaw, Frankfurt, London and Paris

minimal

Insulation: no insulation
Double glazing, U≈2,8 W/(m^2K), g≈0,76*
68 mm wood window profiles
Air tightness: n^{50} = 6 h^{-1}
Natural ventilation (windows)

medium

Insulation: roof 10 cm, wall 8 cm, perimeter and floor slab 4 cm
Double low-e glazing with gas filling, U≈1,2 W/(m^2K), g≈0,53*
68 mm wood window profiles
Air tightness: n^{50} = 4 h^{-1}
Exhaust air plant

good

Insulation: roof 15 cm, wall 15 cm, perimeter and floor slab 8 cm
Double low-e glazing with gas filling, U≈1,2 W/(m^2K), g≈0,53*
68 mm wood window profiles
Air tightness: n^{50} = 1,5 h^{-1}
Exhaust air plant

very good

Insulation: roof 30 cm, wall 30 cm, perimeter and floor slab 20 cm
Triple low-e glazing with gas filling, U≈0,51 W/(m^2K), g≈0,52*
Passive house window profiles
Air tightness: n^{50} = 0,5 h^{-1}
Ventilation system with 85% heat recovery

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Notes on the thermal insulation study

U values of the building components

U Value	Roof W/(m²k)	Wall W/(m²k)	Floor slab W/(m²k)	Perimeter W/(m²k)
minimal	1,019	1,158	4,0	4,0
medium	0,368	0,473	4,0	1,139
good	0,224	0,18	4,0	0,699
very good	0,133	0,098	4,0	0,496

Building characteristics in Rome and Seville

minimal

Insulation: no insulation
Double glazing, U≈5,7 W/(m²K), g≈0,85*
45 mm wood window profiles
Air tightness: n^{50} = 6 h^{-1}
Natural ventilation (windows)

medium

Insulation: roof 4 cm, wall 4 cm, perimeter 2 cm, floor slab 0 cm
Normal glazing, U≈5,7 W/(m²K), g≈0,85*
45 mm wood window profiles
Air tightness: n^{50} = 4 h^{-1}
Exhaust air system

good

Insulation: roof 8 cm, wall 10 cm, perimeter 4 cm, floor slab 0 cm
Double glazing,U≈2,8 W/(m²K), g≈0,76*
68 mm wood window profiles
Air tightness: n^{50} = 1,5 h^{-1}
Exhaust air system

very good

Insulation: roof 15 cm, wall 15 cm, perimeter 6 cm, floor slab 0 cm
Double low-e glazing with gas filling, U≈1,2 W/(m²K), g≈0,53*
68 mm wood window profiles
Air tightness: n^{50} = 0,5 h^{-1}
Ventilation system with 85% heat recovery (if cooling foreseen)

* Nominal value of the glazing. The simulation program considers the dependence of the glazing characteristics from other parameters

Notes on savings calculations and the Micronal® PCM study

Notes on savings and payback time calculations

Savings beyond the payback time are referenced to a standard life cycle of the insulation measure (50 years).
Two scenarios were considered in respect of energy price developments:

- Scenario 1: moderate real price increase.

Average during life cycle: heat energy 0,061 €/kWh, electricity: 0,17 €/kWh

- Scenario 2: price increase 3.5% per year.

Averages: heat energy 0,17 €/kWh, electricity: 0,268 €/kWh

The calculation shows only the economic effectiveness of the insulation measure. Additional costs in case of renovation (e.g., scaffolding or façade painting) were not considered since they occur both in a new building and in a renovation measure alike.

Notes on the Micronal® PCM study

- The simulation case, calculated with the simulation program DYNBIL of the Passive House Institute, is based on part of an office building (light-weight construction) comprising two offices: 1,80 m wide, 4 m long and 2,80 m high and a 1,20 m wide corridor. The windows are 1,80 m high and 1,60 m wide. The external wall is insulated with 8 cm Neopor® in Italy and Spain and with 15 cm Neopor® in Poland, Germany, France and UK. The building is north-south facing.

- The office has high energy loads: one person works there from 8 a.m. to 6 p.m. (with a 1 hour break). During that time electronic appliances consume 220 W (PC, monitor, printer...) and there is a continuous miscellaneous consumption of 15 W. An cooling system is necessary, windows are opened during night time when appropriate.

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About BASF

BASF is the world's leading chemical company: The Chemical Company. Its portfolio ranges from oil and gas to chemicals, plastics, performance products, agricultural products and fine chemicals. As a reliable partner BASF helps its customers in virtually all industries to be more successful. With its high-value products and intelligent solutions, BASF plays an important role in finding answers to global challenges such as climate protection, energy efficiency, nutrition and mobility. BASF has more than 95,000 employees and posted sales of almost €58 billion in 2007. BASF shares are traded on the stock exchanges in Frankfurt (BAS), London (BFA) and Zurich (AN). Further information on BASF is available on the Internet at www.basf.com.

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