# POLYURETHANE

# INSULATION

IN CONSTRUCTION

# COLLECTION OF EXAMPLES

Today's solution for tomorrow’s needs

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ISOLERER BEDRE

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## Today's solution for tomorrow’s needs

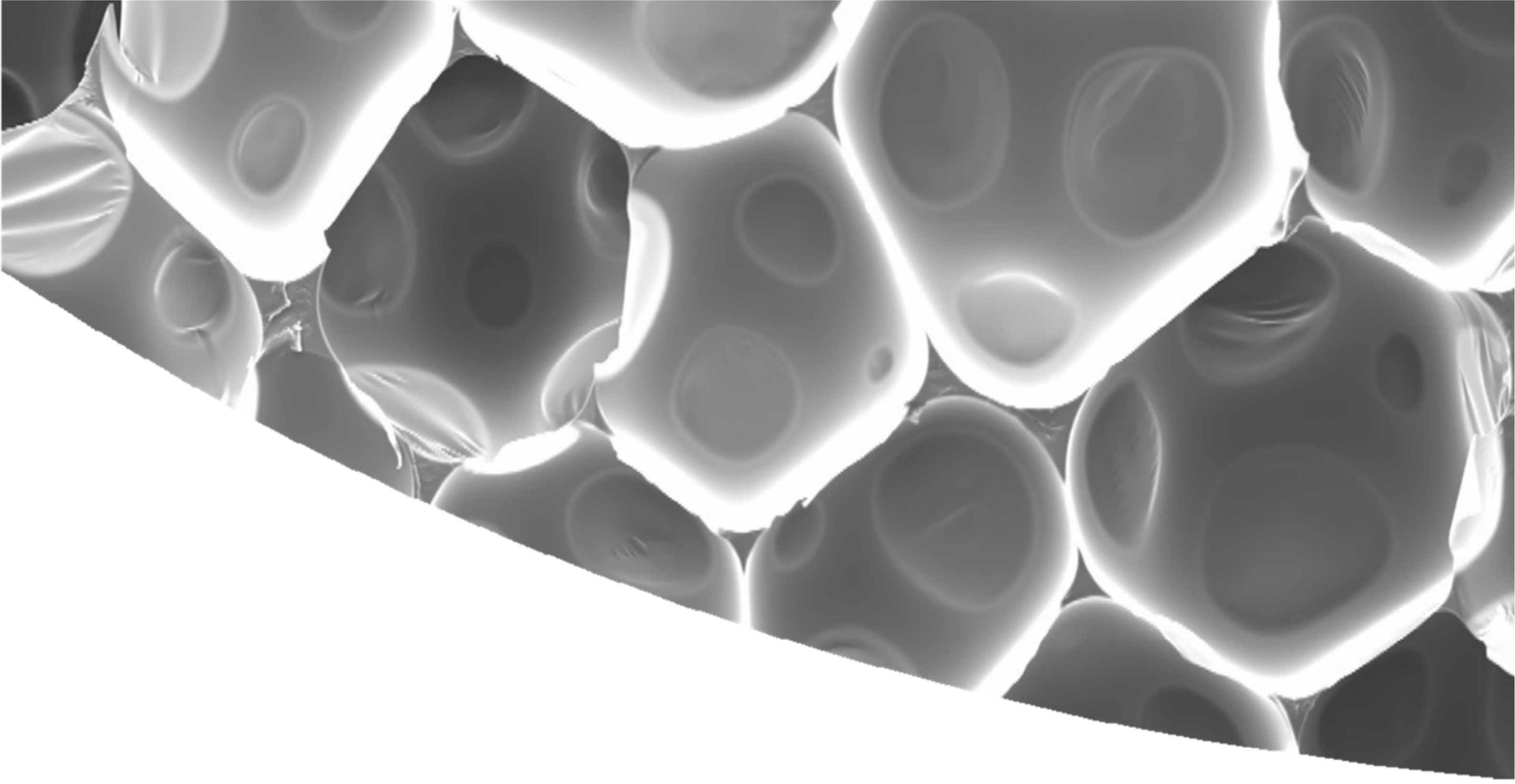
Polyurethane or PUR is one of the most efficient insulation materials currently on the market.
It is a lightweight material that is easy to handle and assemble. The material's very low heat conductivity characteristics mean that a much thinner layer of PUR is required to achieve the same degree of energy efficiency that most other insulation materials achieve by using thicker layers. The material is also extremely versatile, and it can be used almost everywhere. Because PUR does not absorb moisture or water, its high insulation properties are maintained throughout its life span.

POLYURETHAN
ISOLERER BEDRE

# POLYURETHANE INSULATION

The construction sector, which includes residential and commercial buildings, is the largest user of energy, accounting for 40% of the EU's total energy consumption. This sector is also the stakeholder that accounts for the largest proportion (36%) of the EU's $CO_2$ emissions. The construction sector has a considerable and untapped potential for cost-effective energy savings. Were these savings to be realised, it would mean that the EU would be able to use 11% less energy in 2020. Because of this, construction is the sector that has the greatest potential for cost-efficient energy savings.

All types of insulation can be used to improve energy efficiency in buildings and reduce $CO_2$ emissions, but PUR is one of the most efficient insulation materials in existence, and it can achieve very high thermal performance using minimal insulation thicknesses. With lambda values (heat conductivity characteristics) as low as 0.022 W/m·K, insulation capacity (expressed by U-values) can be achieved which is as high as the insulation capacity achieved by using other common insulation materials, even though a significantly thinner layer of PUR insulation has been used. As a material, PUR can be used in both new construction and renovations, as demonstrated by this collection of examples.



# PUR AND PIR

PUR insulation encompasses a group of insulation materials, which is based on polyurethane (PUR) or polyisocyanurate (PIR). The closed cell structure and high cross-linking density of these insulation materials mean that they have excellent insulation properties, good heat resistance and high compressive strength.

Both PUR and PIR foam are produced on the basis of polyols and di- and polyisocyanates. In the manufacture of PIR foam, a high proportion of isocyanates is polymerised into isocyanurate ring structures. PIR foam is distinguished by its resistance to high temperatures and its relative low flammability in combination with low smoke formation. PIR foam is used mainly in the manufacture of insulation panels and boards. Standards and requirements for PIR foam are the same as for PUR foam.

# PUR INSULATION PRODUCTS

Polyurethane insulation products are manufactured (inter alia) as:

- Insulation boards
- Insulation blocks
- Composite panels or sandwich panels

## INSULATION BOARDS AND INSULATION BLOCKS IN HOUSING

Insulation boards of rigid PUR are probably one of the most well-known forms of PUR insulation. The insulation boards can be used for walls, floors or roofs, behind rain screens or underneath eaves. The boards can be coated with a wide variety of materials, such as paper, cork, bitumen, glass fleece or plasterboard, but they are usually coated with a multi-layer aluminium foil.

PUR/PIR insulation boards do not absorb water. This means that the declared thermal conductivity of the boards does not increase as a result of water absorption. Insulation boards that are exposed to rain do not need to be sheathed, because water is not absorbed by the foam.

PUR and PIR foam are thermo-hardened materials that are easy to work on with cutting tools such as knife and saw. When sawing, you should avoid inhaling dust from the foam. Use of hotwires is discouraged when working with these materials.

PUR and PIR foam are fixed-dimension materials within the temperature ranges to which the foam is usually exposed during normal use. Foam material will not shrink and/or settle over time. This means that you will not experience parts of the building where the insulation has compacted.

### PUR/PIR and BREATHABLE WALLS

Moisture transport through walls in a building is negligible, independent of whether or not the wall is insulated. Water vapour diffusion figures for PUR/PIR are between 40 and 200 depending on factors such as density and manufacturing method.

You will still encounter opinions that walls in a house must be able to "breathe", even though this was already refuted in 1928 by the construction physicist E. Raisch. He discovered that airflow per hour through one keyhole in just one room is 50 times greater than through 1 $m^2$ of external wall! Living space humidity due to factors such as cooking and bathing can therefore only be evacuated using adequate ventilation.

## PUR/PIR and RESISTANCE TO CHEMICALS

Effects caused by chemical substances can have a major impact on the characteristics of an insulation material. Insulation boards made from PUR/PIR are resistant to most of the chemical substances used or found during and after construction.

## PUR/PIR and BIOLOGICAL STABILITY

PUR/PIR foam is resistant to bacteria and moulds, is odour-neutral and physiologically harmless during normal use. UV light causes a yellowing of the exposed foam, which over time will result in a coarser "sandy" surface. However, this is not a technical deficiency and can easily be removed before further use.

## INSULATION BOARDS AND INSULATION BLOCKS IN COMMERCIAL BUILDINGS

It is not only in homes that it is advantageous to apply PUR insulation.

This type of insulation can be found everywhere around us and in any type of building, ranging from hospitals and schools, offices and shops to churches and sports stadiums and it has a long-term thermal performance.

PUR insulation boards are particularly suitable for the insulation of roofs with steel cover membranes. The boards are easy to install, are dimension-stable and they are sufficiently robust that it is possible to walk on them during installation and in connection with maintenance.

## REQUIREMENTS AND CE LABELLING THERMAL INSULATION OF BUILDINGS

The DS/EN 13165:2009 standard specifies requirements for factory-manufactured rigid polyurethane foam (PUR) products, with and without rigid or flexible surface facings or coatings and with or without integral reinforcement, which are used for the thermal insulation of buildings. PUR also includes polyisocyanaurate foam (PIR). The products are manufactured in the form of boards. The standard also covers composite panels in which rigid polyurethane foam is the most important insulation material. The standard specifies product characteristics and includes procedures for testing, evaluation of conformity and labelling. Products covered by this standard must be CE labelled, see http://www.ebst.dk/byggevareinfo.dk/

## REQUIREMENTS AND CE LABELLING THERMAL INSULATION OF BUILDING EQUIPMENT AND INDUSTRIAL INSTALLATIONS

The DS/EN 14308:2009 standard specifies requirements for factory-manufactured rigid polyurethane foam (PUR) products and polyisocyanurate (PIR) products, which are used for the thermal insulation of building equipment and industrial installations. The products are manufactured, inter alia, in the form of blocks and boards. The standard specifies product characteristics and includes procedures for testing, evaluation of conformity and labelling. CE labelling of the products covered by this standard is mandatory from 1 August 2012, see http://www.ebst.dk/byggevareinfo.dk/

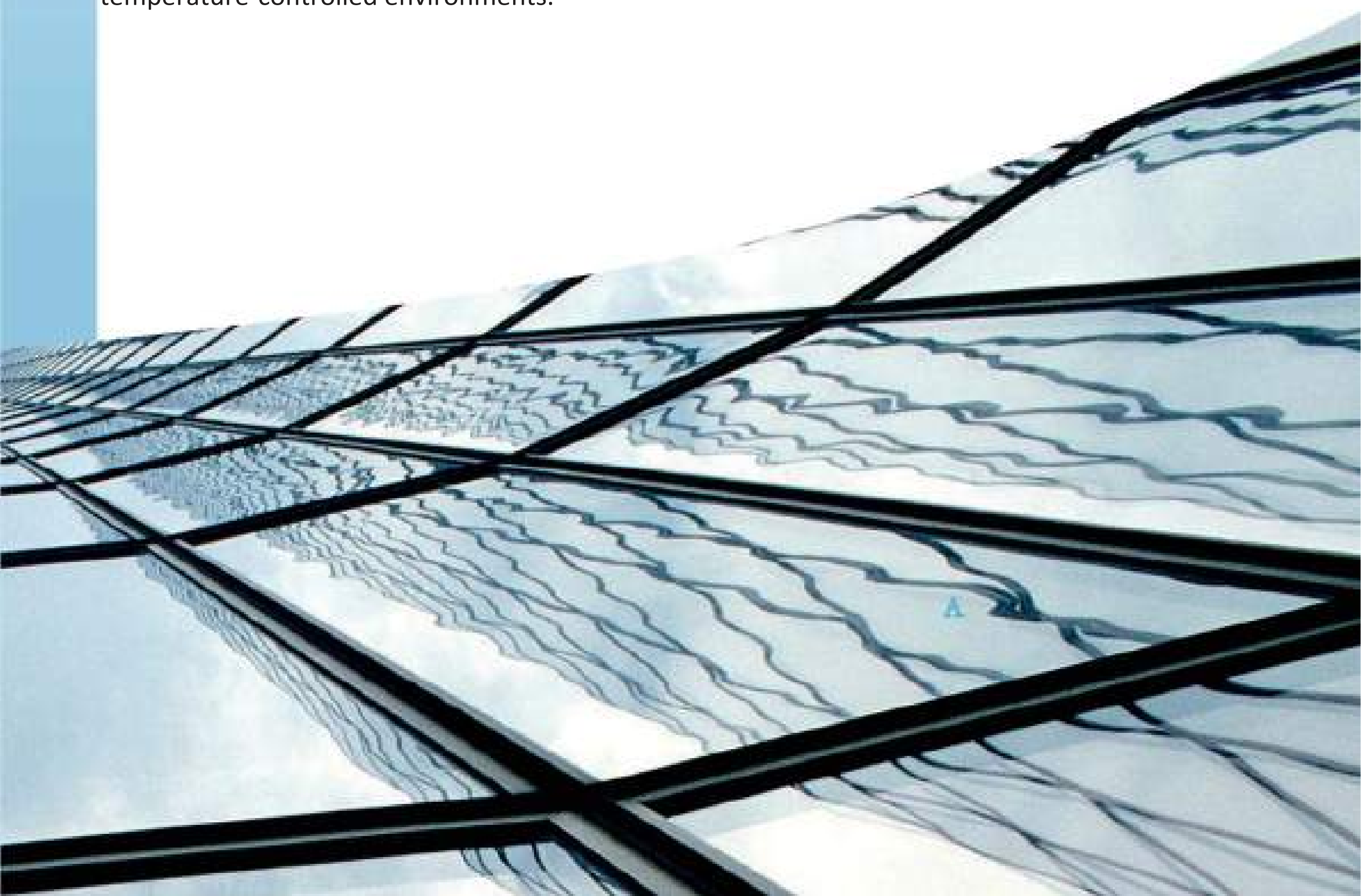
## COMPOSITE PANELS/ SANDWICH PANELS

Composite insulation panels, also known as sandwich panels, are comprised of a PUR insulation core that is coated with two rigid metal coatings, usually steel or aluminium.

The thermal performance of these panels is excellent and has guaranteed insulation durability, with factory-assembled joints which are made airtight. One of the greatest advantages of using a PUR composite system is that the composite system only needs to be fitted as a single run. This is less labour intensive and means a shorter construction time. PUR sandwich panel systems are used in department stores, offices, shops and industrial buildings, apartments, schools and hospitals. The housing sector has also discovered the benefits of using composite panels. Another very important area for PUR sandwich panels is cold storage and other chilled rooms, where the panels' excellent thermal properties make it possible to create temperature-controlled environments.

## REQUIREMENTS AND CE LABELLING DOUBLE-SIDED METAL-COATED SELF-SUPPORTING SANDWICH PANELS

The DS/EN 14509:2009 standard specifies requirements for the use of factory-manufactured double-sided metal-coated self-supporting sandwich panels in roofs and roof coverings, external walls and wall coverings as well as inner walls and ceilings. The core insulation materials covered by this standard include a range of insulation materials, including rigid PUR and PIR foam. Products covered by this standard must be CE labelled, see http://www.ebst.dk/byggevareinfo.dk/



# COLLECTION OF EXAMPLES FOR POLYURETHANE INSULATION IN CONSTRUCTION

The collection of examples includes construction examples for the following areas

- New constructions, roof constructions
- New constructions, external wall constructions
- New constructions, exploitation of constructed area
- Renovation and insulation of existing roof constructions
- Renovation and insulation of existing external wall constructions
- Renovation and insulation of existing slab and foundation
- Renovation of existing constructions, use of gross area

The collection of examples was prepared by Saabye & Partners Architectural Company and quality-controlled by RAMBØLL, Construction & Design.

The following "fact boxes" about "What it says in the Building Regulations" were prepared by RAMBØLL, Construction & Design.

## WHAT IT SAYS IN THE BUILDING REGULATIONS INSULATION MATERIALS AND FIRE

The Building Regulations themselves do not specify detailed requirements for insulation materials and fire. For building types covered by the Building Regulations, with the exception of single family houses, etc., guidelines exist in the "Collection of examples for fire safety in buildings" published by the Danish Enterprise and Construction Authority. For single family houses, appendix 5 of the Building Regulations 2010 contains rules for the use of insulation materials.

In the Danish guidelines for the use of insulation materials, no distinction is made between use as insulation boards and use in sandwich construction. Only the insulation material's fire safety properties are considered.

Some PUR and PIR types are able to satisfy the classification requirements for a class D-s2, d2 material (class B material). In the establishment of guidelines for the use of PUR and PIR insulation, a distinction is therefore made as to whether the insulation material is able to meet the requirement for class D-s2, d2 (class B material) or whether it is an inferior material in terms of fire safety.

In the "Collection of examples for fire safety in buildings", the following places/limitations are stated for the use of PUR and PIR insulation that does not meet the requirement for class D-s2, d2 (class B material):

- used on top of a storey divider, which is at least building element REI 60 A2-s1, d0 (BS-building element 60).
- used in walls if the insulation material on both sides of a vertical building element is covered by a building element of at least class REI/EI 30 A2-s1, d0 (BS-building element 30).
- used in roof constructions, providing the underlying part of the roof structure is at least class REI/EI 30 (BD-building element 30).

- used in ground slabs and crawl spaces. For buildings where floors on the upper storey are no more than 9.6 meters above ground level, the following additional guidelines apply:
- the insulation material must be covered with at least a class K10 B-s1, d0 sheathing (class 1 sheathing) along both sides of a vertical building element and along the underside of a horizontal or oblique building element, providing there are no cavities between the insulation and the sheathing. If there are cavities, the insulation must be sheathed by a building element 30 (BD-building element 30) as a minimum.

Requirements for single family homes, etc. are outlined in appendix 5 of the Building Regulations 2010 and are as described above.

Be aware that sheathing class K10 B-s1, d0 (class 1 sheathing) has material requirements and requirements for the material's insulating ability (thickness) and how the material is attached to the underlay for example the insulation.

A rain shield on the outside of the external wall and with a ventilated hole behind can constitute neither a class K10 B-s1, d0 sheathing (class 1 sheathing), a construction REI/EI 30 (BD-construction 30) nor a construction REI/EI 30 A2-s1, d0 (BS-construction 30).

For PUR and PIR insulation that satisfies the requirement for material class D-s2, d2 (class B material), only those limitations will apply for usages which in this particular context apply to all other materials with fire safety classification D-s2, d2 (class B material).

## WHAT IT SAYS IN THE BUILDING REGULATIONS REQUIREMENTS FOR U-VALUES

All new constructions in compliance with BR10 must comply with an energy framework, where U-values may vary. Minimum values must, however, be respected (section 7.6 of BR10). For walls, the minimum value is 0.3 W/m2 K. For roof and ceiling constructions as well as ground slabs, the minimum value is 0.2 W/m2 K.

For extensions and amended application (renovation), certain fixed values must be complied with as a rule of thumb. For walls, the value is 0.15 W/m2 K. For roof and ceiling constructions as well as ground slabs, it is 0.1 W/m2 K, when the area of windows and doors must not exceed 22%. For foundations, there are requirements for line loss.

When replacing or renovating individual building sections, the requirements for extensions must be complied with. If this does not make good economic sense or other practical aspects apply, concession can be made to these requirements. For significant alteration of usage, these concessions do not apply.
Examples follow of constructions where U-values have been used for extensions. Normally, these values are recommended in cases where there are no absolute requirements.

For low energy class 2015, no requirements have been established for U-values, but in order to achieve a 25% lower energy consumption, one of the things you can do is to increase the insulation thickness by 30-35%.

IMPORTANT: The following construction examples must literally only be seen as examples and are neither construction instructions nor manuals. Always seek the advice of a construction expert in relation to specific construction projects, whether they be new constructions or extensions and renovation projects.

# NEW CONSTRUCTIONS, ROOF CONSTRUCTIONS

## CONSTRUCTION EXAMPLES OF FLAT ROOFS

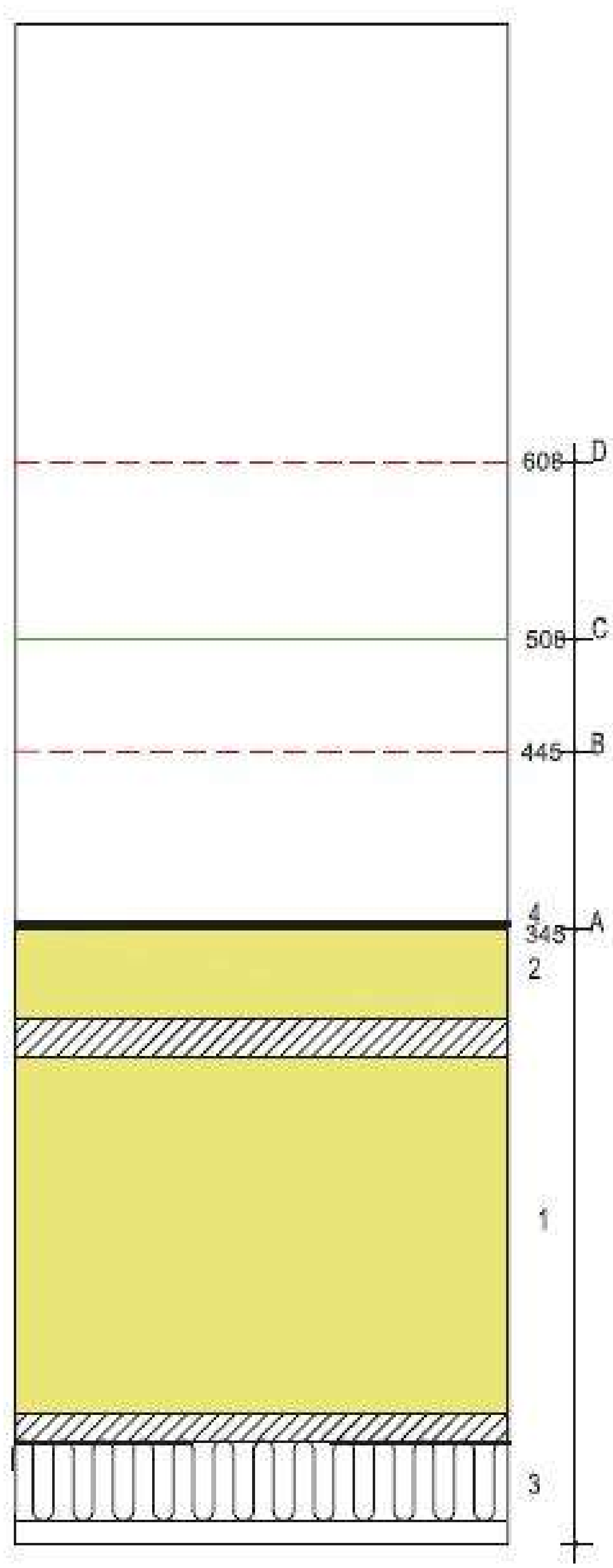



Figure 1: Construction example of new construction, roof cassette

**LEGEND: BR10**

**_ _ _ _ _ Traditional insulation**

**_______ PUR/PIR insulation**

**A** **BR10, PUR/PIR insulation**

**B** **BR10, traditional insulation**

**C** **BR10 class 1/passive house with PUR/PIR insulation**

**D** **BR10 class 1/2015, traditional insulation**

**1 .** **Roof cassette with 200 mm PUR/PIR core**
**22 mm veneer roof panel**
**15 mm veneer roof panel bottom**

**2.** **Min. 50 mm PUR/PIR lambda 23**

**3.** **45 mm new loft insulation class 37 with vapour barrier**

**4.** **2x roofing felt**

**ENERGY REQUIREMENTS:**

| | |
|---|---|
| **BR2010 Min. requirement (BR08)** | **U=0.11 W/m² K** |
| **BR2010** | **U=0.08 W/m² K** |
| **BR2010 class 1/2015** | **U=0.06 W/m² K** |
| **Passive house** | **U=0.06 W/m² K** |

**NB! The insulation thickness can vary according to the heat loss calculation and selected energy solution.**

**NB! The roof covering is for reference only!**

# CONSTRUCTION EXAMPLES OF SLOPING ROOFS

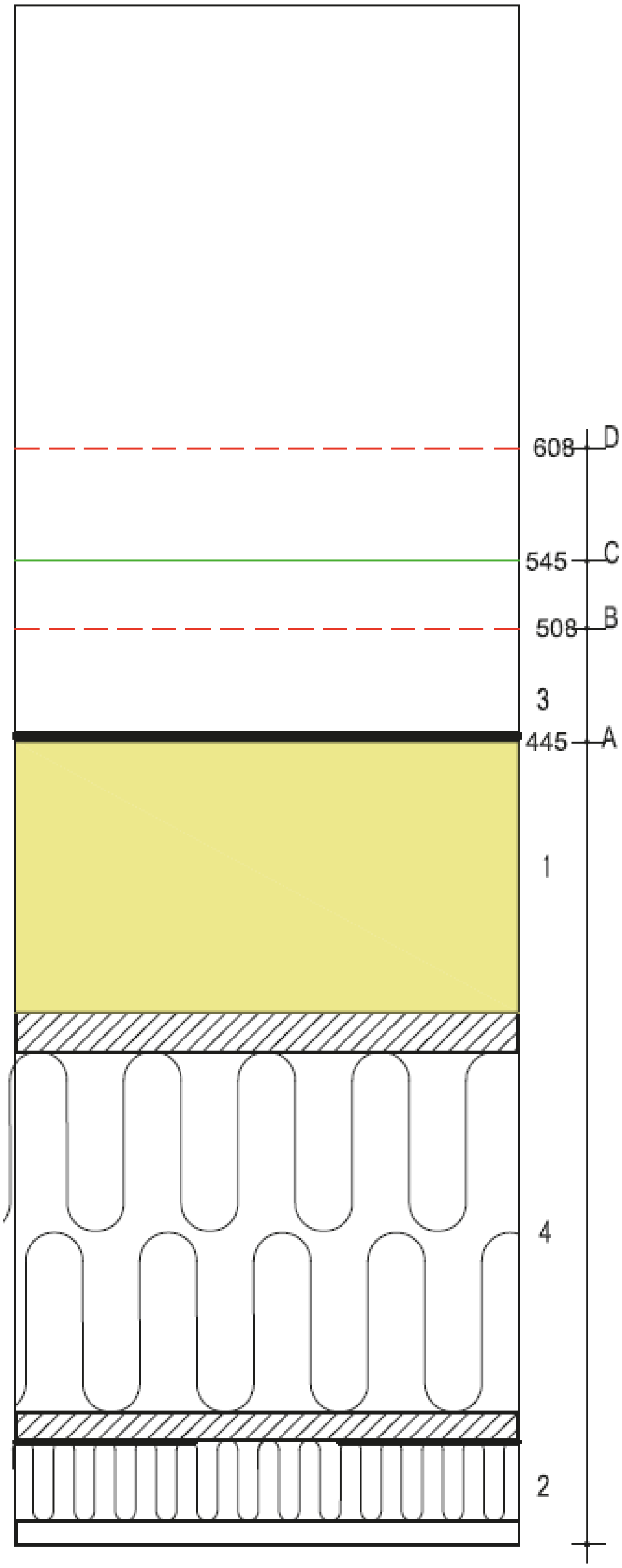



Figure 2: Construction example of new construction, sloping roof

**LEGEND: BR10**

**_ _ _ _ _ Traditional insulation**

**________ PUR/PIR insulation**

**A** **BR10, PUR/PIR insulation**

**B** **BR10, traditional insulation**

**C** **BR10 class 1/passive house with PUR/PIR insulation**

**D** **BR10 class 1/2015, traditional insulation**

1. **150 mm PUR/PIR insulation lambda 23 with traditional beam construction**
2. **45 mm new loft insulation class 37 with vapour barrier**
3. **Subroof with tiles etc.**
4. **Traditional beam construction 45x200 mm with 200 mm traditional insulation**

**ENERGY REQUIREMENTS:**

| | |
|---|---|
| **BR2010 Min. requirement (BR08)** | **U=0.11 W/m² K** |
| **BR2010** | **U=0.08 W/m² K** |
| **BR2010 class 1/2015** | **U=0.06 W/m² K** |
| **Passive house** | **U=0.06 W/m² K** |

**NB! The insulation thickness can vary according to the heat loss calculation and selected energy solution.**

**NB! The roof covering is for reference only!**

# NEW CONSTRUCTIONS, EXTERNAL WALL CONSTRUCTIONS

## CONSTRUCTION EXAMPLES OF EXTERNAL WALLS

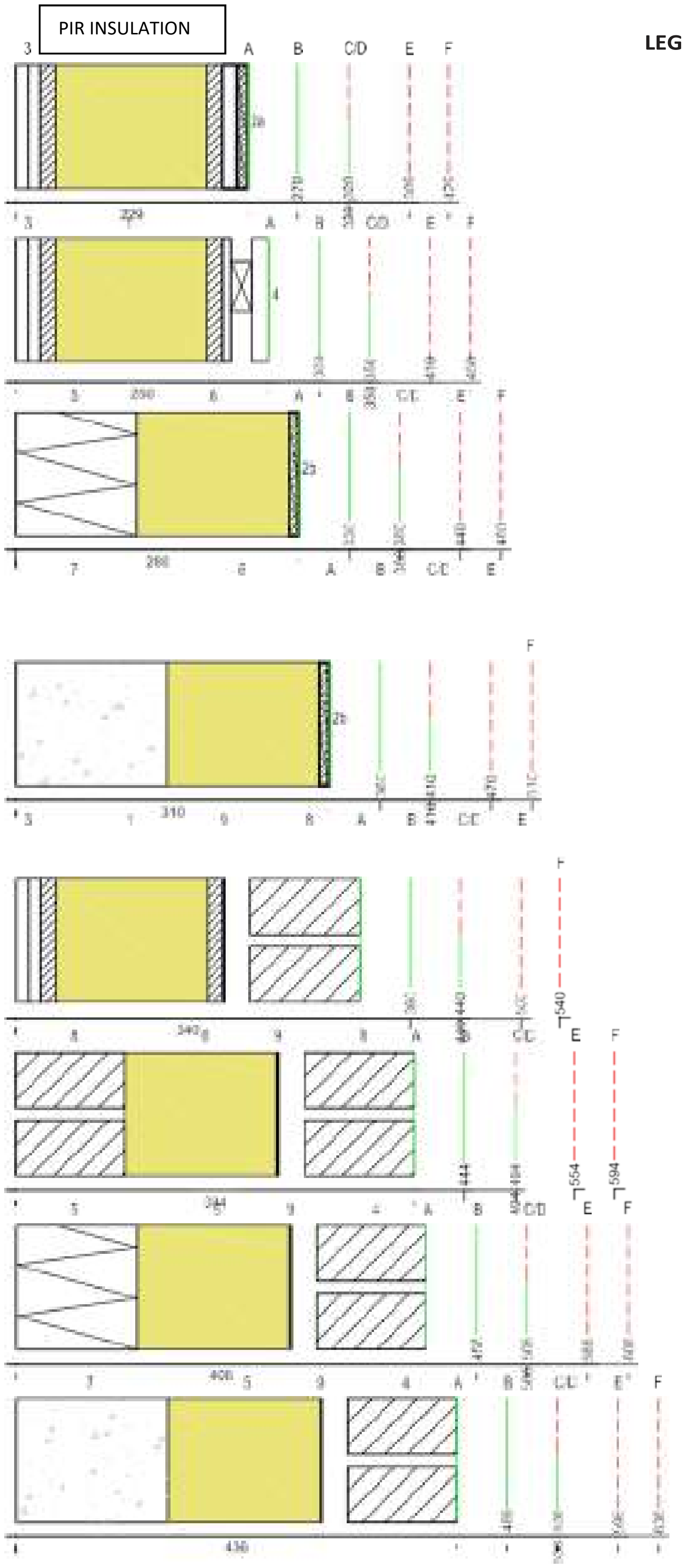



Figure 3: New constructions, external wall constructions

**LEGEND: BR10**

**_ _ _ _ _ Traditional insulation**

**________ PUR/PIR insulation**

**A** **BR10 PUR/PIR insulation**

**B** **BR10 class 1/2015 with PUR/PIR insulation**

**C** **BR10, traditional insulation**

**D** **Passive house requirements with PUR/PIR insulation**

**E** **BR10 class 1/2015 with traditional insulation**

**F** **Passive house requirements with traditional insulation**

1. **Light sandwich element (PUR/PIR + 2x15 mm veneer boards)**

2a. **15 mm fibre plaster board + 10 mm system plaster**

2b. **10 mm system plaster**

3. **Plaster board**
4. **Light cladding - wind shield + cladding**
5. **120 mm pore concrete wall**
6. **150 mm PUR/PIR insulation lambda 23**
7. **150 mm concrete reverse wall**
8. **108 mm standard bricks**
9. **Wind membrane**

**ENERGY REQUIREMENTS:**

| | |
|---|---|
| **BR2010** | **U=0.15 W/m² K** |
| **BR2010 class 1/2015** | **U=0.11 W/m² K** |
| **Passive house** | **U=0.09 W/m² K** |

**NB! The insulation thickness can vary according to the heat loss calculation and selected energy solution.**

**NB! Cladding is for reference only!**

# NEW CONSTRUCTIONS, EXPLOITATION OF CONSTRUCTED AREA

## CONSTRUCTION EXAMPLE OF EXPLOITATION OF CONSTRUCTED AREA

**HOUSE NEW CONSTRUCTION - BR10, U = 0.15 W/M2 K**

**INSULATED WITH PUR/PIR**

**Gross area: 140 m2**

**Net area: 124 m2**

**Wall thickness: 406 mm**

**Construction, BR10:**

**120 mm pore concrete reverse wall**

**150 mm PUR/PIR lambda 23**

**30 mm vent. channel**

**108 mm brick**

**ADDITIONAL OPTIONS:**

**BR2015: 456 mm / Net area: 118.9 m2**

**Passive house: 506 mm / Net area: 116.7 m2**

**WITH TRADITIONAL INSULATION**

**Gross area: 140 m2**

**Net area: 116.7 m2**

**Wall thickness: 506 mm**

**Construction BR10:**

**120 mm pore concrete reverse wall**

**250 mm class 37 insulation**

**30 mm vent. channel**

**108 mm brick**

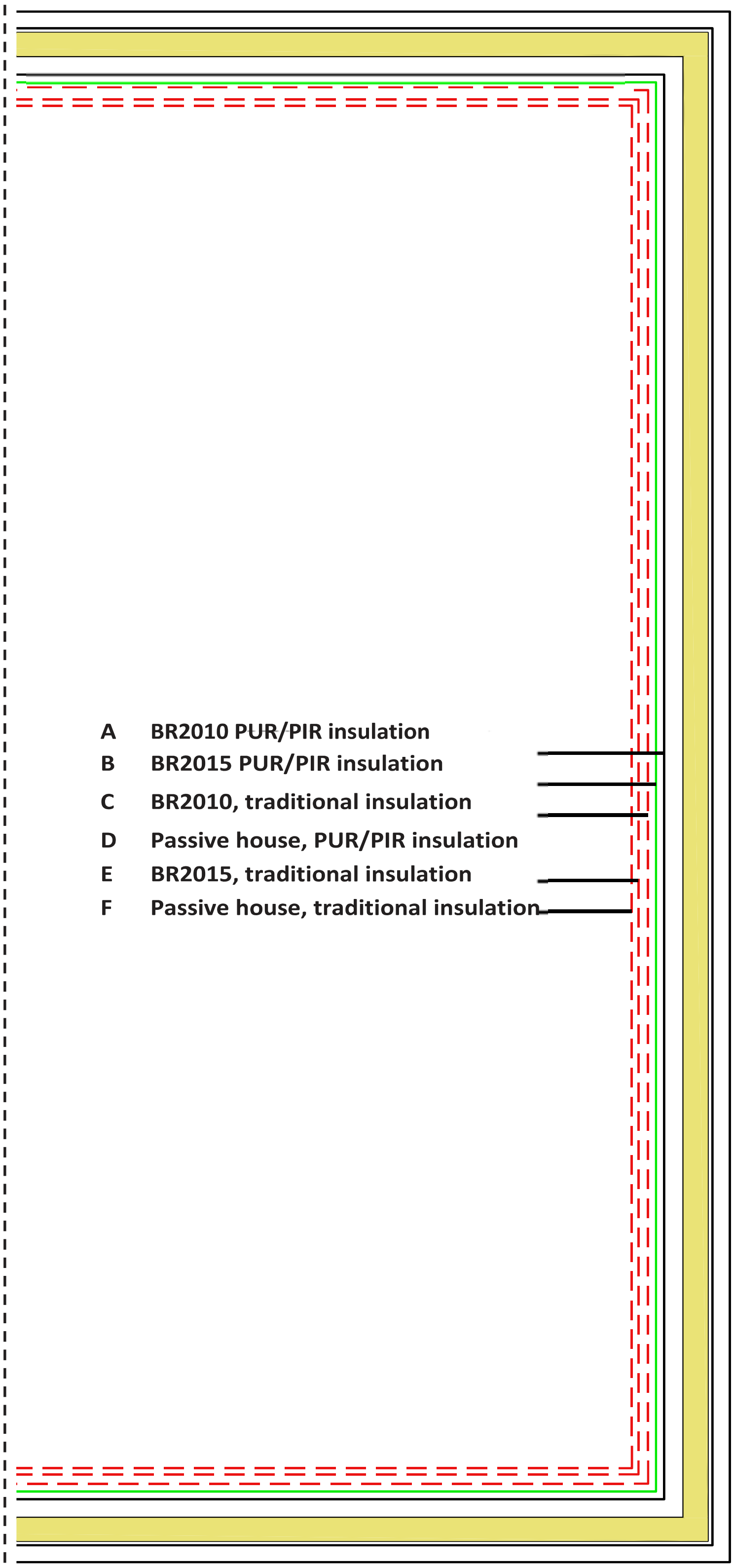
**ADDITIONAL OPTIONS:**

**BR2015: 566 mm / Net area: 114.1 m2**

**Passive house: 606 mm / Net area: 112.4 m2**

**NB! The insulation thickness can vary according to the heat loss calculation and selected energy solution.**

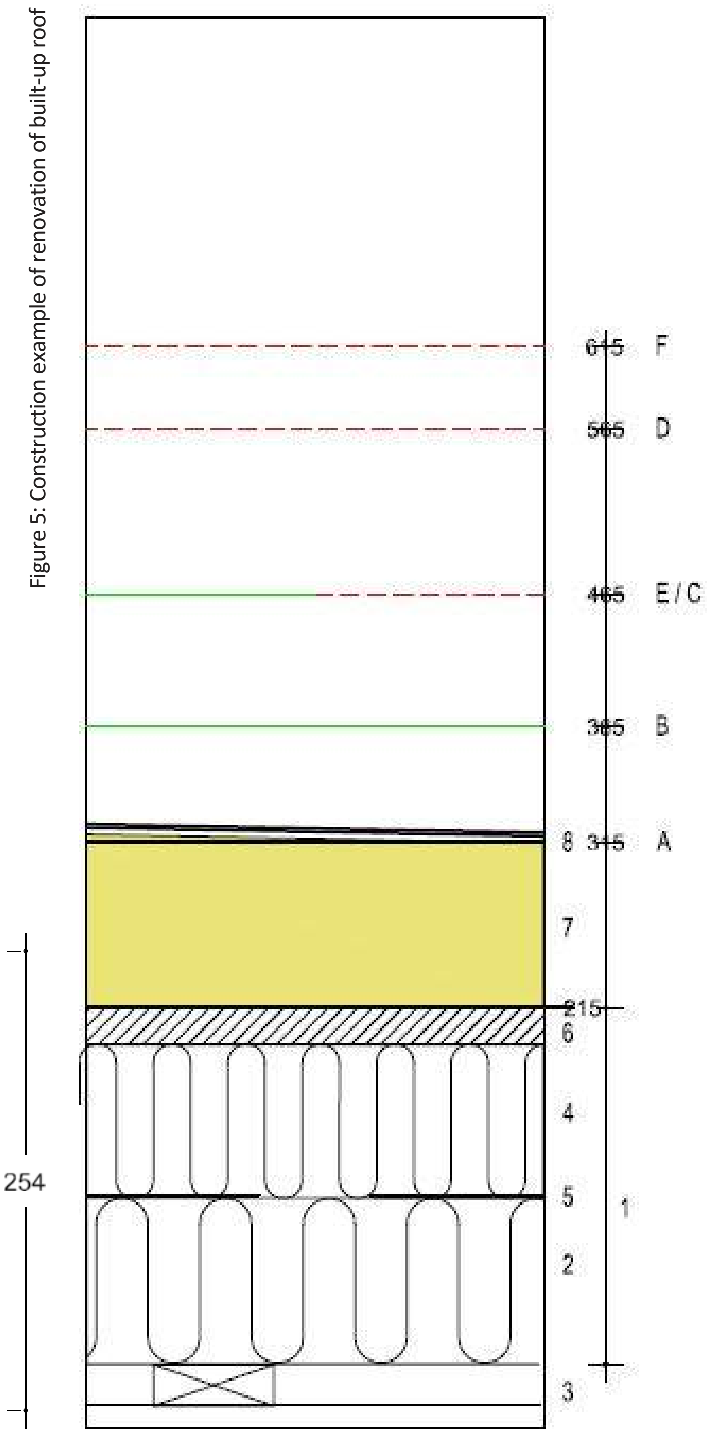
Figure 4: New construction, exploitation of constructed area



# RENOVATION AND INSULATION OF EXISTING ROOF CONSTRUCTIONS

## CONSTRUCTION EXAMPLES OF FLAT ROOFS

Figure 5: Construction example of renovation of built-up roof




LEGEND: BR10

_ _ _ _ _ Traditional insulation

________ PUR/PIR insulation

A BR10 min. requirements=BR08, PIR/PUR insulation

B BR10 PUR/PIR insulation

C BR10 min. requirements=BR08, traditional insulation

D BR10, traditional insulation

E BR10 class 1/2015 with PUR/PIR insulation

F BR10 class 1/2015, traditional insulation

1. Existing built-up roof - 45x200 mm beam rafters
2. 100 mm existing insulation
3. Existing loft sheathing - furring, vapour barrier, plaster
4. 100 mm new injection insulation class 37
5. New vapour barrier over existing insulation*
6. 25 mm existing roof rafters
7. Min. 100 mm wedge-formed PUR/PIR lambda 23
8. 2x roofing felt

*) location of the vapour barrier in relation to heat loss frame and dew point

ENERGY REQUIREMENTS:

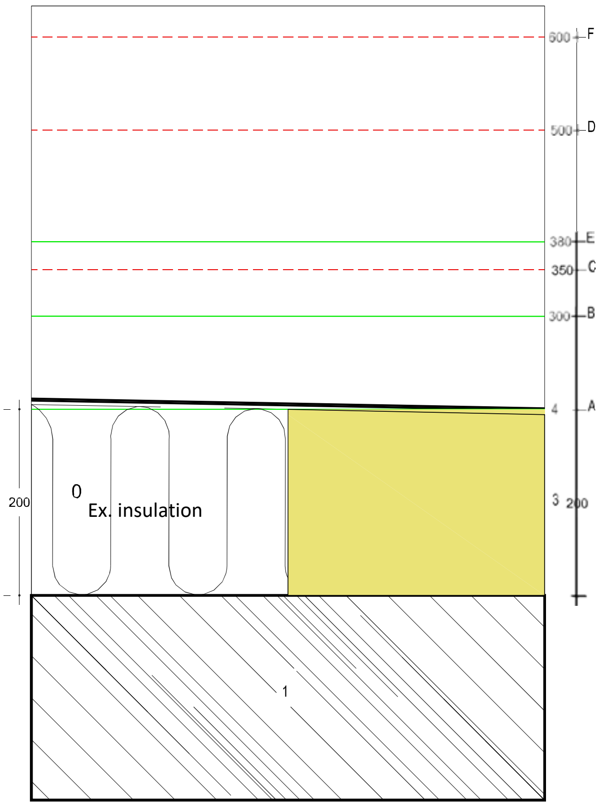
| | |
|---|---|
| BR2010 Min. requirement (BR08) | U=0.11 W/m² K |
| BR2010 | U=0.08 W/m² K |
| BR2010 class 1/2015 | U=0.06 W/m² K |
| Passive house | U=0.06 W/m² K |

NB! The insulation thickness can vary according to the heat loss calculation and selected energy solution.

NB! The roof covering is for reference only!

# CONSTRUCTION EXAMPLES OF HOLLOW CORE ROOF

Figure 6: Renovation and construction of hollow core roof




**LEGEND: BR10**

_ _ _ _ _ Traditional insulation

________ PUR/PIR insulation

**A** BR10 min. requirements=BR08, PUR/PIR insulation

**B** BR10 PUR/PIR insulation

**C** BR10 min. requirements=BR08, traditional insulation

**D** BR10, traditional insulation

**E** BR10 class 1/2015 with PUR/PIR insulation

**F** BR10 class 1/2015, traditional insulation

**O** U-value corresponding to max. U=0.20 W/m² K

1 Existing hollow core roof - 220 mm hollow core element

2 200 mm existing wedge-formed insulation 1:20

3. Min. 100 mm new wedge-formed 1:40 PUR/PIR insulation lambda 23

4. 2x roofing felt

**NOTE:**

In traditional retro-fitted insulation, the new insulation is laid over the existing one. When using PUR/PIR insulation, the existing insulation is replaced entirely.

**ENERGY REQUIREMENTS:**

| | |
|---|---|
| BR2010 Min. requirement (BR08) | U=0.11 W/m²K |
| BR2010 | U=0.08 W/m²K |
| BR2010 class 1/2015 | U=0.06 W/m²K |
| Passive house | U=0.06 W/m²K |

NB! The insulation thickness can vary according to the heat loss calculation and selected energy solution.

NB! The roof covering is for reference only!

# RENOVATION AND INSULATION OF EXISTING EXTERNAL WALL CONSTRUCTIONS

## CONSTRUCTION EXAMPLES OF EXTERNAL WALLS RENOVATION WITH PUR LIGHT EXTERNAL WALL

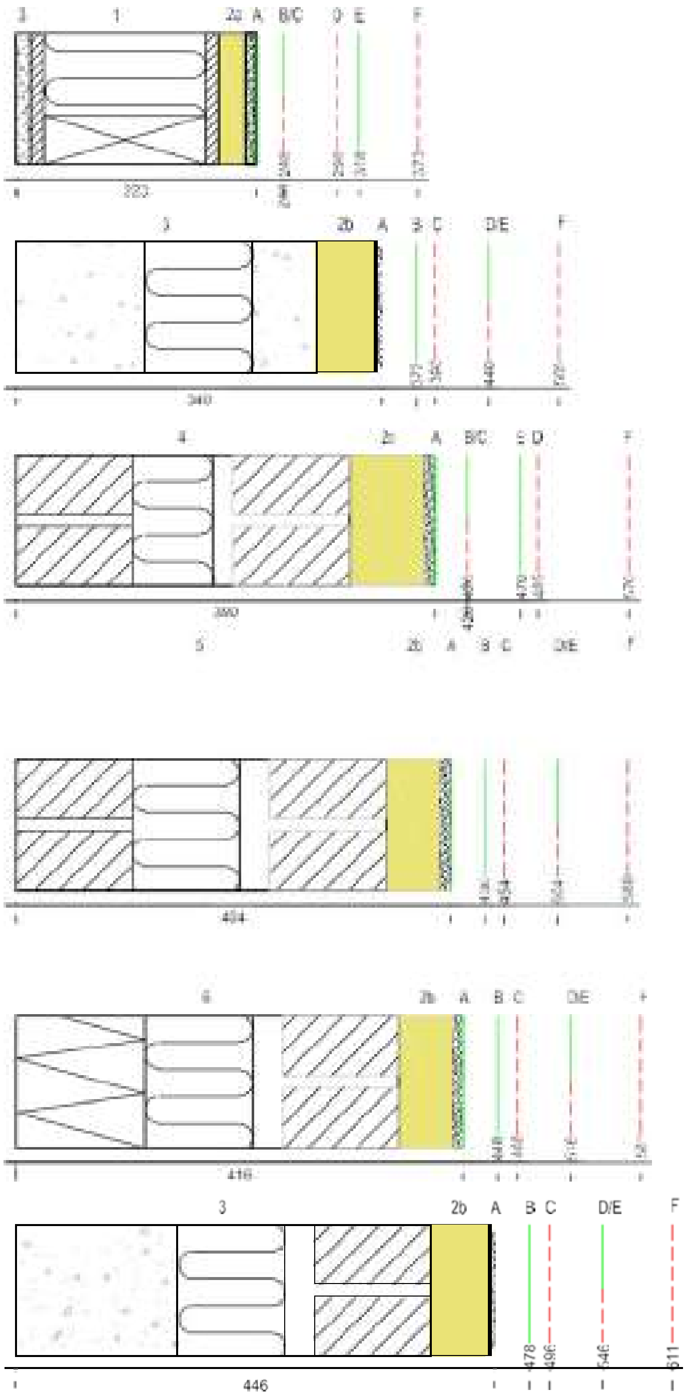



Figure 7: Construction examples of renovation of external walls, light external wall. Seen from above, wooden house, element construction from 80s-90s, 30s-50s house, 60s-70s house, standard house from 80s-90s and 80s-90s storey buildings

**Legend: BR10**

**_ _ _ _ _ Traditional insulation**

**_______ PUR/PIR insulation**

| | |
|---|---|
| **A** | **BR10 min. req.=BR08, PUR/PIR insulation** |
| **B** | **BR10 PUR/PIR insulation** |
| **C** | **BR10 min. req.=BR08, traditional insulation** |
| **D** | **BR10, traditional insulation** |
| **E** | **BR10 class 1/2015 with PUR/PIR insulation** |
| **F** | **BR10 class 1/2015, traditional insulation** |

| | |
|---|---|
| **1** | **Wood framed construction/150 mm insulation** |
| **3** | **15 mm plaster fibre/13 mm plaster board** |
| **2a** | **Min. 25 mm PUR/PIR insulation lambda 23 with 20 mm soft insulation + 10 mm system plastering** |
| **2b** | **Min. 50 mm PUR/PIR insulation lambda 23 with 20 mm soft insulation + 10 mm system plastering** |
| **2c** | **Min. 70 mm PUR/PIR insulation lambda 23 with 20 mm soft insulation + 10 mm system plastering** |
| **3** | **Sandwich element construction** |
| **4** | **Cavity wall with 75 mm existing insulation** |
| **5** | **Cavity wall with 100 mm existing insulation** |
| **6** | **120 mm pore concrete wall** |
| **7** | **150 mm concrete reverse wall** |

**ENERGY REQUIREMENTS:**

| | |
|---|---|
| **BR2010 Min. req.(BR08)** | **U=0.20 W/m² K** |
| **BR2010** | **U=0.15 W/m² K** |
| **BR2010 class 1/2015** | **U=0.11 W/m² K** |
| **Passive house** | **U=0.09 W/m² K** |

**NB! The insulation thickness can vary according to the heat loss calculation and selected energy solution.**

**NB! Cladding is for reference only!**

# RENOVATION AND INSULATION OF EXISTING SLAB AND FOUNDATION

## CONSTRUCTION EXAMPLES OF EXTERNAL WALLS

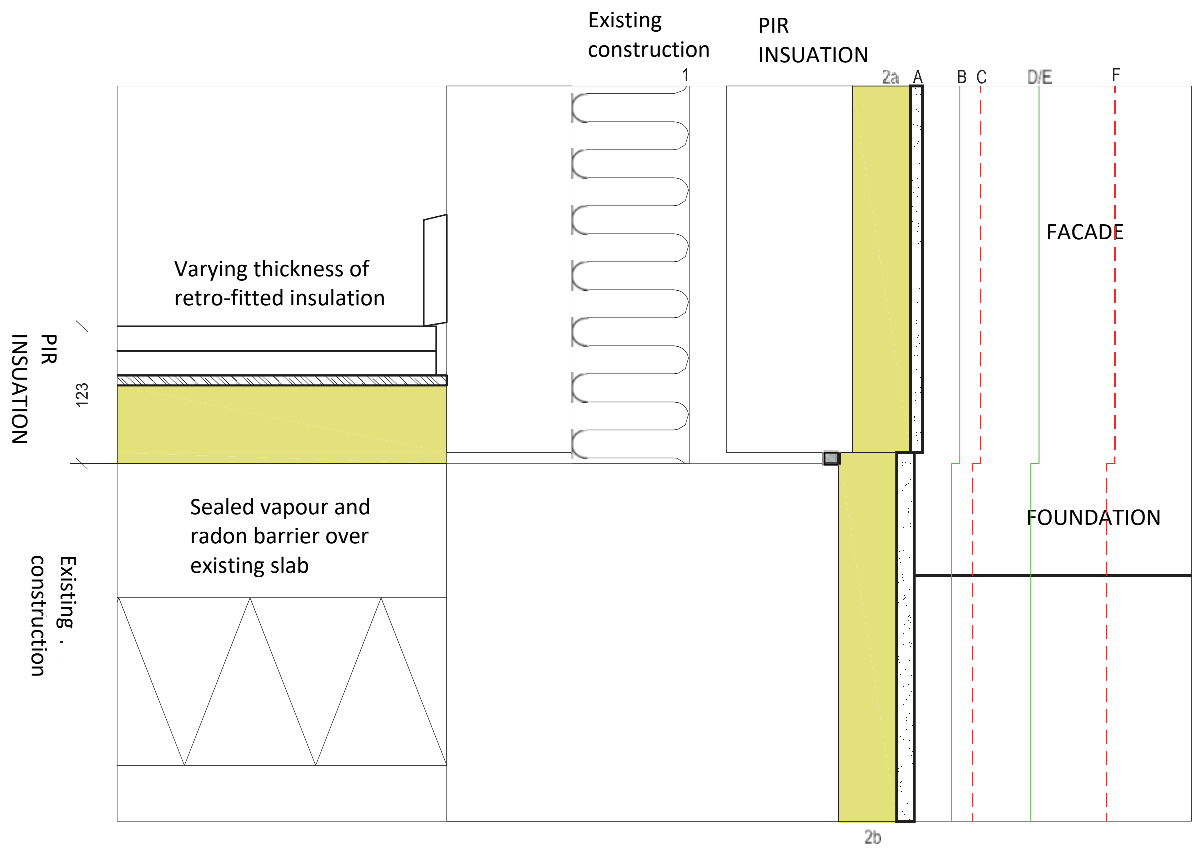



Figure 8: Construction example of renovation of slab and foundation

**LEGEND: BR10**

**Traditional insulation** (red dashed line)

**PUR/PIR insulation** (green line)

| | |
|---|---|
| **A** | **BR10 min. req.=BR08, PUR / PIR insulation** |
| **B** | **BR10 PUR/PIR insulation** |
| **C** | **BR10 min. req.=BR08, traditional insulation** |
| **D** | **BR10, traditional insulation** |
| **E** | **BR10 class 1/2015 with PUR/PIR insulation** |
| **F** | **BR10 class 1/2015, traditional insulation** |

**1.** **Existing construction:**

**2a.** **Min. 50 mm PUR/PIR insulation lambda 23 with 20 mm soft insulation + 10 mm system plastering**

**2b** **Min. 50 mm PUR/PIR insulation lambda 23 with 20 mm soft insulation + 15 mm reinforced system plastering**

**NOTE: Due to large condensation risk when retro-fitting insulation to ground slab using traditional insulation, make sure to seek advice about retro-fitted insulation. PUR/PIR's airtightness and moisture rejection makes it easier to retrofit insulation, but a completely sealed vapour barrier is recommended over the existing slab. Reservations are made with regard to specific renovation situations.**

**ENERGY REQUIREMENTS:**

| | |
|---|---|
| **BR2010 Min. req.(BR08)** | **U=0.20 W/m² K** |
| **BR2010** | **U=0.15 W/m² K** |
| **BR2010 class 1/2015** | **U=0.11 W/m² K** |
| **Passive house** | **U=0.09 W/m² K** |

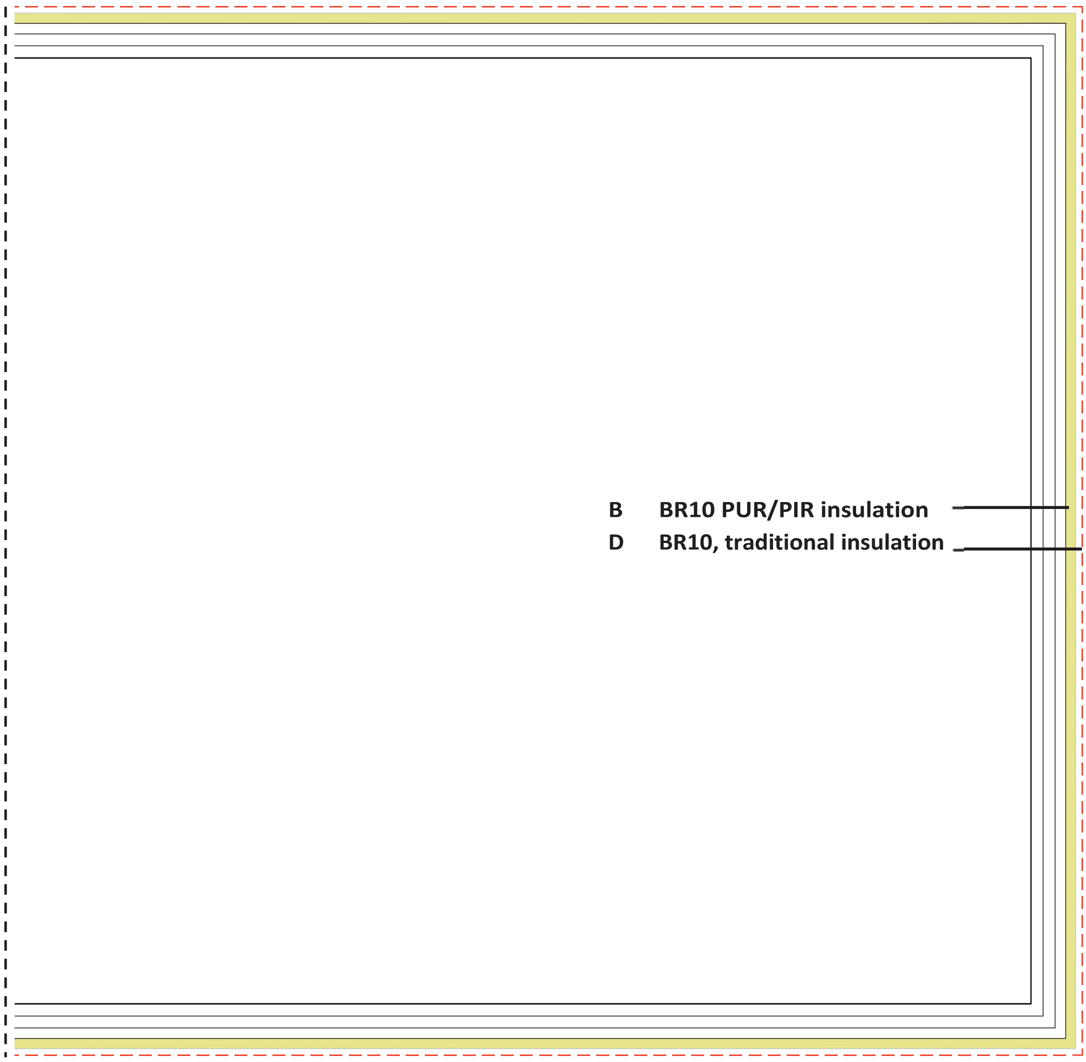
**NB! The insulation thickness can vary according to the heat loss calculation and selected energy solution.**

**NB! The existing facade must be level and cleaned.**

**NB! Cladding is for reference only!**

# RENOVATION OF EXISTING CONSTRUCTIONS

## CONSTRUCTION EXAMPLE OF EXPLOITATION OF GROSS AREA




**HOUSE RENOVATION**

**Existing gross area: 140 m2**

**Existing net area: 123.9 m2**

**Existing wall thickness: 345 mm**

**Existing construction:**

**120 mm pore concrete reverse wall**

**100 mm mineral fibre, class 39**

**108 mm brick**

**RETRO-FITTED INSULATION - BR10, U = 0.15 W/M2 K**

**WITH PUR/PIR INSULATION + PLASTER**

**82 mm PUR/PIR lambda 23+ system plastering**

**New wall thickness: 437 mm**

**New gross area: 144.5 m2**

**WITH TRADITIONAL INSULATION**

**150 mm mineral fibre, class 37+ system plastering**

**New wall thickness: 505 mm**

**New gross area: 148 m2**

**NB! The insulation thickness can vary according to the heat loss calculation and selected energy solution.**

# RECYCLING AND POLYURETHANE

In 2004, Rambøll Denmark in cooperation with the Plastics Industry, the PUR section, completed the project "Survey of waste products containing polyurethane (PUR)". The project was funded by the Programme for Cleaner Products and the Plastics Industry in Denmark.

The project has specifically focused on describing current and future regulations both nationally and at EU level, also, on the one hand, mapping manufacturing waste from the production of products made of or containing PUR in Denmark, on the other, surveying the extent of worn-out products made of PUR or containing PUR in Denmark. Finally, Danish companies' costs for waste management of PUR were estimated and available recovery and recycling technologies for manufacturing waste and worn-out products made of or containing PUR were described.

Reference to sources:
http://www2.mst.dk/Udgiv/publikationer/2005/87-7614-607-3/pdf/87- 7614-608-1.pdf

Other literature about the recycling of polyurethane can be found on the ISOPA website:
http://www.isopa.org/isopa/index.php?page=useful-documents

ISOPA: Co-combustion of Building Insulation Foams with Municipal Solid Waste (2001)

ISOPA: Recovery of Rigid PU Foam from Demolition Waste (2001)

ISOPA: Energy Recovery (2001)

# SUSTAINABILITY AND POLYURETHANE INSULATION

The three "pillars" of sustainable development: environment, economy and society are sometimes referred to as "the threefold result". Each pillar is crucial to our ability to continue to thrive and even survive as a species.

## EFFECT ON THE ENVIRONMENT

This is probably the pillar that is easiest to measure and to act upon. The environmental impact has until recently also been the most high profile in relation to global warming, and instead of using the word in its highly holistic sense, people often talk about sustainability in a context that is entirely environmental.

Within Europe, more than half of our energy consumption is used in buildings for heating and cooling. Much of this energy involves using the burning of fossil fuels, resulting in $CO_2$ emissions. The simplest and most cost effective way in which we can reduce energy requirements and emissions of $CO_2$ is by making our buildings more energy efficient.

PUR is currently one of the insulation materials on the market that has the highest thermal efficiency. It is necessary to use only minimal thicknesses to achieve maximum energy efficiency in a building envelope. PUR as a material can be used in all types of buildings, and it is just as easy to use in existing buildings as in new buildings. The material is also highly durable, so it will continue to have the same high performance for the lifetime of the building, enabling excellent energy savings in the long term.

## EFFECT ON ECONOMY

The economic effect can be assessed on two different levels: direct savings to investors, builders and tenants as well as macro-economic benefits. Let us start by looking at the direct savings.

It is not possible to further insulate an existing building in order to meet ambitious performance requirements without making a significant investment. In the case of new construction, the additional expense of providing the building envelope with good insulation is considerably lower, but even in this situation, it is rare that the insulation is sufficient.

In comparison with other solutions, which are designed to increase a building's energy efficiency or generate renewable energy, investment in insulation is in many cases the type of investment that is fastest to recoup once again. In other words, the investment will be recouped again after just a few years, due to the reduced energy costs. PUR insulation constitutes the best investment in connection with many uses.

## EFFECT ON SOCIETY

Although the last of the three pillars undeniably is the most difficult to quantify, there are however clear benefits to society in the use of PUR insulation.

The effects of global warming are potentially devastating and affect millions of people every year. Energy supply security has been the subject of growing concern, since dependence on imported energy can be threatened by political agendas. Energy costs are rising, and fossil fuel resources are being depleted. Energy poverty with all the related health and welfare risks mean that those most vulnerable in society will be at risk.

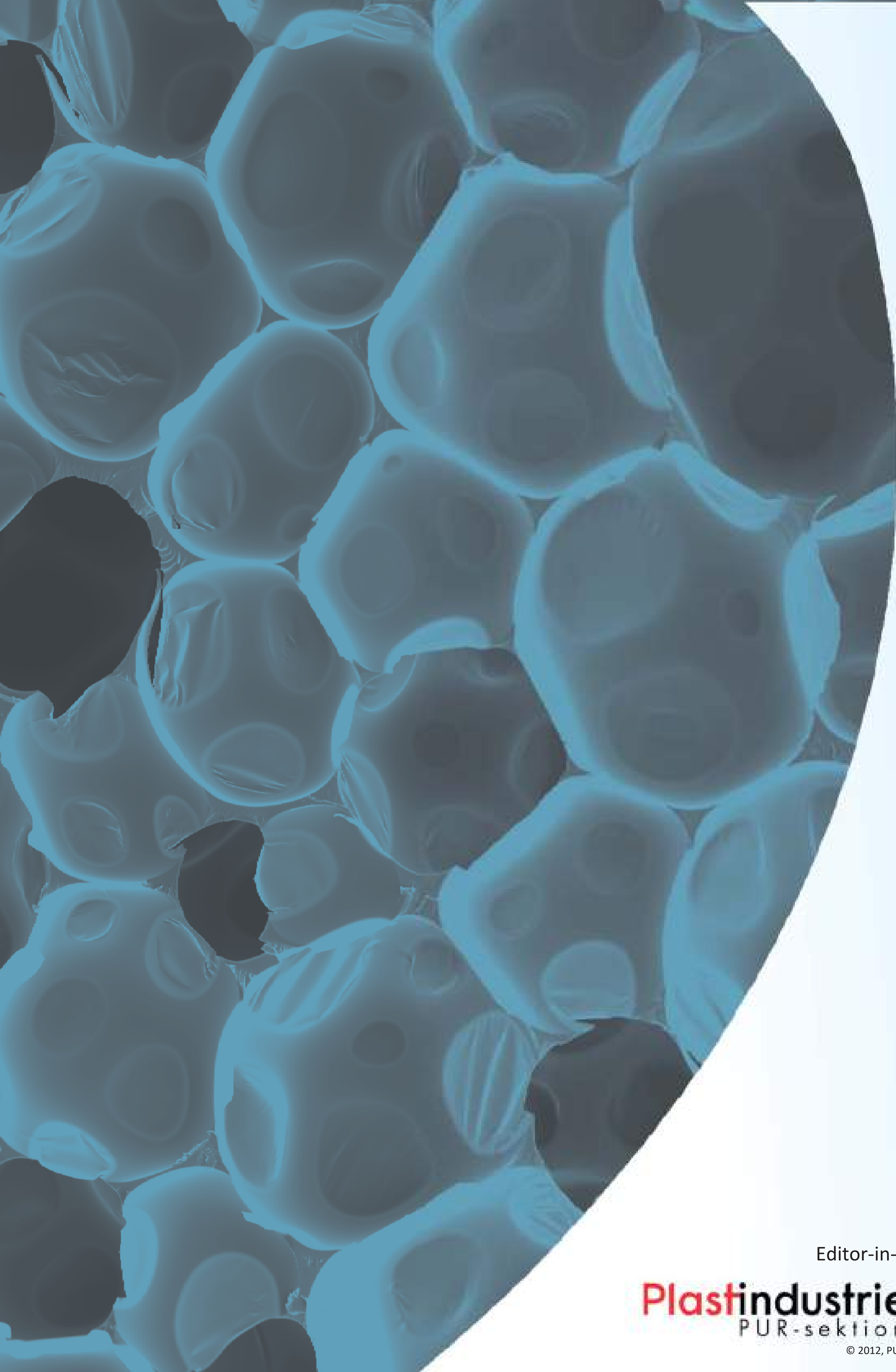
Insulation cannot solve all the world's problems, but as we have already seen, we can make our buildings more energy efficient and thus help to significantly reduce $CO_2$ emissions, combat global warming, reduce our energy costs and make our living and work environments more comfortable. Insulation also helps to solve the problem of energy poverty, improve health and create a large number of jobs.

Reference to sources: http://www.pu-europe.eu/site/

Sustainability and polyurethane insulation.
Today's solution to the needs of tomorrow (June 2010)
Other literature on the same website:

PU Europe: Environmental product declaration for PU in insulation boards and energy saving potential calculation (December 2010)

PU Europe: Life Cycle Environmental and Economic analysis of Polyurethane Insulation in Low Energy Buildings (December 2010)



Editor-in-chief

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