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HEAT INSULATION MATERIALS FROM ENVIRONMENTAL ASPECT

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ABSTRACT

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The aim of the thesis was to do an objective opinion how different insulation manufacturers promote their products from environmental point of view. The main heat insulation materials which include in this thesis are glass wool, stone wool, cellulose, PIR and PUR, EPS and XPS.

The study used the data from the websites of companies, video materials, and data of the materials of exhibitions, trade journals and specialized publications.

The methodology is based on conduct competitive analysis and shows the main market indices, the arguments from environmental aspect and the main characteristics of demand.

The results show that for each category of material producers used almost the same environmental indicates and arguments. For mineral wool it is a renewable resource, reduced manufacturing emissions to the environment. For cellulose it is using natural materials, recycling process. In some cases, the harmful substances that may be released in case of fire or wet are taken into account. For synthetic materials (extruded polystyrene, polyurethane, polyester) it is save energy, effectiveness. But each company tries to present own material in the unique environmental side and discover new technologies.

Keywords: environment, glass wool, stone wool, cellulose, PIR, PUR, EPS, XPS

CONTENTS

1 INTRODUCTION

In the construction of housing, great attention should be paid to the quality of building materials. But special attention should be paid to environmental material that will surround us for years. Insulating materials are the most powerful tool for the designer and the constructor to achieve high energy efficiency in buildings.

The most environmentally friendly materials are natural. Now generally the most appropriate to use in construction are insulation materials, which have a greater thermal resistance and low thickness.

Construction market abounds in thermal insulation materials, which claim to be "environmentally friendly", but not all these materials are really ecological. The main purpose of this thesis work is how different insulation manufacturers promote their products from environmental point of view and to find what kind of environmental marketing message is available from different insulation materials and what are the proofs behind these messages.

Brand ISOVER belongs to the French group Saint-Gobain. Saint-Gobain is the world leader in the production of heat and sound insulation materials made of glass wool. In addition to the glass wool, the group also produces materials from basalt fiber, using the most modern technology and many years of experience. The company ISOVER SG Rakennustuotteet Oy is interested in the environmental heat insulation and improving materials from environmental aspect. ISOVER SG Rakennustuotteet Oy is commissioned the analysis of the heat insulation market.

2 HEAT INSULATION MATERIALS

It is generally known that good heat insulation not only saves energy but is not harmful to the environment. The market of insulating materials presents a wide range of insulation materials, which form the source of raw materials, structure, form and technical characteristics.

The use of efficient insulation systems can reduce energy consumption for heating up to ten times, and also helps to reduce the thickness of the external walls that leads to the increase of the internal area of the building up to 5%.
The main consumers of insulating materials are building organizations and individuals.

The most important physical properties of insulation materials, with respect to their energy behavior as part of the building, are summarized in Table 2.1. (Avgelis, Laboratory of Heat Transfer and Environmental Engineering)

Table 2.1 Physical properties of the most used insulating materials

Material	Density ρ [kg/m3]	Thermal conductivity factor λ [W/mK]	Useful life-time [Years]
Glass wool	16 – 40	0.035 – 0.050	30 – 50
Stone wool	30 – 150	0.035 – 0.050	30 – 50
Cellulose	30 – 60	0.040	40 - 60
Polyurethane foam	35 – 50	0.030 – 0.035	30 – 50
Expanded polystyrene	15 – 30	0.037 – 0.042	50
Extruded polystyrene	28 – 45	0.028 – 0.045	50

2.1 Glass wool

Glass wool consists of quartz sand, dolomite and limestone. Furthermore, adhesive materials and water-repellent oils are added, in order to increase the mechanical strength of the materials, though the use of these elements must be kept within limits to achieve a high fire resistance. Glass wool is produced in rolls or in slabs, with different thermal and mechanical properties.

Glass wool is a thermal insulation that consists of intertwined and flexible glass fibers, which causes it to "package" air, resulting in a low density that can be varied through

compression and binder content. It can be a loose fill material, blown into attics, or, together with an active binder sprayed on the underside of structures, sheets and panels that can be used to insulate flat surfaces such as cavity wall insulation, ceiling tiles, curtain walls as well as ducting. It is also used to insulate piping and for soundproofing. (Glass wool Home, 2013)

2.2 Stone wool

Stone wool consists of the same basic materials as glass-wool. Its main differences concern the higher melting temperatures during the production process and the different size of the fibers. These differences make stone wool heavier, with a higher melting point and hence better suited for high temperature applications. The final product is a mass of fine, intertwined fibers with a typical diameter of 6 to 10 micrometers.

2.3 Cellulose

Cellulose insulation is a natural insulation material made from plant-based cellulosic material such as newsprint, straw, sawdust and hemp, amongst others. However, newsprint is the most commonly used material commercially as it is the most readily available cellulosic material for the manufacture of cellulose insulation. The recycled newsprint content of the insulation is approximately 75-85%. The newsprint is dried and shredded into small pieces in the presence of a dust extractor to produce fibrous particles capable of packing tightly into closed building cavities and this high density packing results in inhibiting airflow. The remaining percentage is comprised of chemicals added to give fire resistance and resist mould, insects and rodents. The chemicals most commonly used are boric acid and magnesium/ammonium sulphate, which are non-hazardous and are not known to cause health risks. The cellulose insulation is then bagged for delivery to installation locations. (National Fiber, 2014)

Building insulation is a low-thermal-conductivity material used to reduce building heat loss and gain, and reduce noise transmission. Cellulose insulation is a plant fiber used in wall and roof cavities to insulate draught proof and reduce noise.

Cellulose insulation, which is made from recycled newspaper and treated with fire retardants and insect protection, can play an important role in achieving high energy efficiencies in buildings. In terms of paper recovery it is a high value application.

2.4 PIR and PUR

Polyisocyanurate also referred to as PIR, polyiso, or ISO, is a thermoset plastic typically produced as foam and used as rigid thermal insulation. Its chemistry is similar to polyurethane (PUR) except that the proportion of methylene diphenyldisocyanate (MDI) is higher and a polyester-derived polyol is used in the reaction instead of a polyether polyol. Catalysts and additives used in PIR formulations also differ from those used in PUR. (Pir Polyisocyanurate Boards Pir Insulation Thermal, 2012)

Rigid polyurethane (PUR) and polyisocyanurate (PIR) insulation products are highly effective, lightweight and many have the ability to bond to most materials. Their excellent thermal conductivity and high strength to weight ratio, combined with great manufacturing versatility provides a range of products. As a result, PIR/PUR insulation products are the natural choice for most construction insulation applications.

PIR is typically produced as foam and used as rigid thermal insulation. Its thermal conductivity has a typical value of 0.023 W/(m·K) depending on the perimeter: area ratio. PIR foam panels laminated with pure embossed aluminum foil are used for fabrication of pre-insulated duct that is used for heating, ventilation and air conditioning systems. Prefabricated PIR sandwich panels are manufactured with corrosion-protected, corrugated steel facings bonded to a core of PIR foam and used extensively as roofing insulation and vertical walls (e.g. for warehousing, factories, office buildings etc.). Other typical uses for PIR foams include industrial and commercial pipe insulation, and carving/machining media (competing with expanded polystyrene and rigid polyurethane foams).

Effectiveness of the insulation of a building envelope can be compromised by gaps resulting from shrinkage of individual panels. Manufacturing criteria require that shrinkage be limited to less than 1% (previously 2%). Even when shrinkage is limited to substantially less than this limit, the resulting gaps around the perimeter of each panel can reduce insulation effectiveness, especially if the panels are assumed to provide a vapor/infiltration barrier. Multiple layers with staggered joints, ship lapped or tongue and groove joints greatly reduce these problems. (Pir Polyisocyanurate Boards Pir Insulation Thermal, 2012)

2.5 EPS (Expanded Polystyrene)

Expanded Polystyrene, is a lightweight, rigid, plastic foam insulation material produced from solid beads of polystyrene (with a diameter of 0,2 to 0,3 mm). It can be seen in figure 2.1. Expansion is achieved by virtue of small amounts of pentane gas dissolved into the polystyrene base material during production. The gas expands under the action of heat, applied as steam, to form perfectly closed cells of EPS. These cells occupy up to 50 times the volume of the original polystyrene bead. The EPS beads are then moulded into appropriate forms suited to their application.

Expanded polystyrene foam (EPS) is usually white (figure 2.1). Some new innovative EPS products are grey due to the inclusion of graphite, which substantially increases the insulation performance. EPS is safe, non-toxic and inert. At any time of his life cycle does it contain any Chlorofluorocarbons (CFCs) or Hydrofluorocarbons (HCFCs). (Building Insulation, EPS and XPS foams, 2013)

Figure 2.1 The solid beads of polystyrene with a diameter of 0,2 to 0,3 mm. (Building Insulation, EPS and XPS foams, 2013)

2.6 XPS (Extruded Polystyrene)

Extruded polystyrene foam (XPS) consists of closed cells, offers improved surface roughness and higher stiffness and reduced thermal conductivity.XPS can be different colors as in figure 2.2.

In the extrusion manufacturing process, XPS does not require facers to maintain its thermal or physical property performance. Thus, it makes a more uniform substitute for corrugated cardboard. Thermal conductivity varies between 0.029 and 0.045 W/(m·K) depending on bearing strength/density and the average value is ~0.035 W/(m·K). Water

vapor diffusion resistance (μ) of XPS is around 80–250 and so makes it more suitable to wetter environments than EPS. (ISOVER, polystyrene insulation, 2014)

Properly installed extruded polystyrene (XPS) foam can also improve a building's energy efficiency by providing a complete layer of insulation on the wall. This reduces air movement through the wall that can rob energy. Insulation between studs does not necessarily offer complete insulation value because wood studs and other framing members are not insulated. This phenomenon is called thermal bridging and can dramatically decrease the thermal performance of the building.

Extruded polystyrene (XPS) foam can also have advantages due to its ability to assist with moisture management, resisting both water absorption and freeze/thaw cycles. When traditional insulation absorbs water, its thermal performance can be compromised over time.

Figure 2.2 XPS (Extruded Polystyrene) (Building Insulation, EPS and XPS foams, 2013)

3 GLASS WOOL

The mineral wool sector in the EU mainly consists of five main producers which together account for about 95% of the total production: Saint-Gobain Isover, Rockwool International, Paroc Group, URSA and Knauf Insulation. There are also several independent manufacturers. Each company has its own point of view about ecological problems.

3.1 Knauf Insulation

Knauf is a pioneer of an all-embracing company philosophy which sets great store by intelligent, environmentally friendly and energy-conserving production processes. This model leads to maximum quality. Sustainability and quality appear to be contradictory requirements, yet Knauf consistently meets them successfully.

The company is the fastest growing insulation manufacturer in the world with a wide range of insulation products to meet the growing demand for energy efficiency and acoustic performance in new and existing homes, commercial buildings and industrial applications. Products include glass mineral wool, rock mineral wool, expanded polystyrene and extruded polystyrene. (Knauf Insulation, 2010)

Now Knauf Insulation focuses on the promotion of a new ecological technology - ECOSE Technology. They also have conventional mineral wool, but they offer new mineral wool with ECOSE Technology, which delivers the same exceptional quality and guarantees superior handling and durability with an even higher level of sustainability and at the same price.

3.1.1The politics from environmental aspect

ECOSE Technology is a revolutionary binder featuring rapidly renewable bio-based materials rather than non-renewable petroleum-based chemicals such as phenol, formaldehyde or acrylics. The sustained extraction of raw materials is carried out with consideration for the existing habitats with their flora and fauna. It gives targeted support for protection of species and biotopes during and after the extraction of the raw materials. (Ecose Technology, 2010)

Knauf Insulation is committed to sustainable development and conservation of the environment manufacturing its products from recycled materials.

Key benefits of ECOSE Technology:

- Based on rapidly renewable resource
- Bio-based formulation which does not contain phenol, formaldehyde or acrylics
- Reduced impact on environment through lower embodied energy in the binder
- Lower process emission inside the plants
- Reduced manufacturing emissions to the environment.
- Improved indoor air quality (IAQ) in product-application
- Lower investment in emission abatement equipment
- Easier manufacturing permitting
- No artificial colors or dye added

Protection of the climate starts within one's own four walls. Hence, Knauf has converted all the firing installations from oil to gas or from heavy to light heating oil. Wherever possible, waste heat is used to heat the buildings. This has significantly reduced the CO2 emissions from fossil fuels. (Knauf Insulation Mineral Wool Insulation with ECOSE Technology, 2010)

While maintaining finished product tensile strength and performance characteristics, the use of ECOSE Technology eliminates formaldehyde and phenol from the process, improving worker safety and reducing emissions of regulatedpollutants. It reduces embodied energy and delivers superior environmental sustainability.

Mineral wool with ECOSE Technology delivers superior environmental sustainability using patented ECOSE Technology.

ECOSE Technology was developed during five years of research and development. During that time products have undergone a comprehensive and rigorous evaluation to determine their environmental effects and acceptability in use. Testing indicates that products with ECOSE Technology improve on the already excellent performance of conventional mineral wool products. As with all Knauf Insulation products, the new products comply to the (regional) applicable standards, like health and safety standards, quality certification for mineral wool products and CE-marking for Europe, as well as 'Underwriters Laboratories' criteria (UL) and GREENGUARD™ in North America. ECOSE Technology confirms by quality certifications and tests. (Ecose Technology, 2010)

3.1.2 Product from environment aspect

Knauf Insulation offers a full line of standard and high-density batts and blankets with a wide range of sizes and R-values such as: Black Acoustical Board with ECOSE Technology, EcoFillWx Glasswool Insulation, EcoRoll Glasswool Insulation, Insulation Board, Metal Building Insulation, Wall and Ceiling Liner M. All these materials promote with ECOSETechnology,but the main emphasis is on product EcoBatt Glasswool. On this product - Knauf Insulation EcoBatt Insulation - we can see the main advantages ECOSE Technology from environmental aspect.

EcoBatt Insulation is certified for indoor air quality (IAQ) as a low emitting product by Knauf Insulation products with ECOSE Technology. Where noted, have achieved the more stringent GREENGUARD Gold certification and verified to be formaldehyde-free. The logos can be seen in figure 3.1. Formaldehyde-free means that there is no formaldehyde used in the production of the binder for these products and there is no formaldehyde added at any time during the manufacturing process. The new ECOSE Technology binder is not made with formaldehyde. As loose mineral wool insulation is also considered formaldehyde-free. (Knauf Insulation, 2010)

Figure 3.1 The logos of GREENGUARD Gold certification and UL Environment for indoor air quality (IAQ) certification (EcoBatt, 2014)

Knauf Insulation EcoBatt Insulation is cost-effective thermal and acoustical barriers for energy-efficient construction. Their consistent quality, low dust, and clean-cutting resilient fibers make fabrication easy and installation fast. The products can be used in new and retrofit wood and metal frame applications in residential and commercial structures, as well as in manufactured housing applications. These applications include thermal and acoustical treatments to walls, ceilings, and floors.

Knauf Insulation EcoBatt Insulation is thermal and acoustical products made from highly resilient, inorganic glass fibers bonded by a thermosetting resin. The products are available unfaced or with kraft, foil, or flame-rated FSK-25 (Foil-Scrim-Kraft) foil facings. EcoBatt Insulation combines sand, one of the world's most abundant and renewable resources, post-consumer recycled bottle glass and ECOSE Technology to create the next generation of sustainable insulation naturally from Knauf. (Knauf Insulation, 2010)

Glass wool with ECOSE Technology does not look or feel like any insulation. It can be seen in figure 3.2. The main characteristic of that is naturally brown color because in Knauf Insulation mineral wool with ECOSE Technology is no artificial colors or dyes added. The natural brown color represents a level of sustainability and handling never achieved before: manufactured from naturally occurring and/or recycled raw materials, and bonded using a bio-based technology free from formaldehyde, phenols, and acrylics. The natural brown color appears during the curing process of the mineral wool. (Ecose Technology, 2010)

Figure 3.2 The glass wool with ECOSE Technology has the natural brown color(Ecose Technology, 2010)

3.1.3 Properties and benefits of material from environment aspect

Basic environmental arguments are from Knauf Insulation. It is possible to find them on the website.

High level of recycled content

Glass mineral wool from Knauf Insulation is made using up to 60% recycled content glass and is 100% recyclable.

- Achieved a UL Environment claim validation for over 50% post-consumer recycled glass content

Improves indoor air quality compared to traditional mineral wool

Glass mineral wool with ECOSE Technology products meet the industry's most stringent standards and guidelines related to Indoor Air Quality (confirmed EUROFINS Indoor Air Comfort GOLD – DerBlaue Engel, Germany – M1/RTS, Finland, Greenguard for Children and School™ / USA)

Improves sustainability of buildings

The superior environmental characteristics of mineral wool with ECOSE Technology contribute to improving the overall sustainability of buildings in which they are incorporated.

- Made primarily from sand, one of the world's most abundant and renewable resources
- Lower embodied energy than their traditional batts
- Rapidly renewable binder eliminates non-renewable petroleum-based chemicals. Binder, which is up to 70% less energy intensive than traditional binders and thus reduce the impact on the environment.

All Knauf Insulation products are inherently sustainable because of high recycled and renewable content. They save hundreds of times more energy in use than required to manufacture them.

Reduces workplace exposures and pollutant manufacturing emissions

By eliminating phenol and formaldehyde from manufacturing process, the resulting workplace exposure and pollutant manufacturing emissions are significantly reduced.

Reduces impact on environment through lower embodied energy

Binder embodied energy is reduced by up to 70% compared to traditional binder, which contributes to further lower the expected GWP (Global Warming Potential).

Renewable and abundant resources

Sand and rock are natural and one of the world's most abundant and renewable resources.

Optimized packaging

Glass mineral wool products are compressed in package up to a ratio of 9 to 1. This optimized packaging allows for reduction of packaging material usage, space saving in storage, reduced energy consumption in transport thus providing a significant overall cost saving and environmental benefit.

Knauf Insulation mineral wool with ECOSE Technology is tested in accordance with all applicable European Norms. Knauf say that their products comply with the main norm for mineral wool insulation: EN 13162:2008 "Thermal insulation products for buildings – Factory made mineral wool (MW) products - Specification". This European Standard specifies product characteristics and includes procedures for testing, evaluation of conformity, marking and labeling. (Knauf Insulation Mineral Wool Insulation with ECOSE Technology, 2010)

Knauf Insulation mineral wool with ECOSE Technology also complies with the voluntary EUCEB certification and Nota Q of Directive 67/548/EEC as amended 97/69/EC and is therefore free from suspicion of carcinogen effects and any associated hazard classification. Khauf's glass and stone fibers, which they use like raw materials, are pre-registered under the REACH regulations (EC 1907:2006). REACH deals with the Registration, Evaluation, Authorization and Restriction of Chemical substances.

In addition to testing to European Norms and Standards, Knauf products are also tested to comply with the required national certification schemes, as indicated on the product labels. The logos are shown in figure 3.3.

and others.

France Belgium Spain Switzerland

Figure 3.3 The logos of national certification schemes (Knauf Insulation Mineral Wool Insulation with ECOSE Technology, 2010)

Mineral wool manufacturing facilities are producing in accordance to the strict requirements of ISO 9001:2000.Furthermore, most of their plants are certified in accordance to ISO 14001: 2004 and OHSAS 18001:2007 reflecting strong ambition for continuous improvement with respect to the growing environmental, health and safety aspects.

Following the launch of mineral wool with ECOSE Technology new product range has received its well-deserved recognition, evidenced by several esteemed awards, endorsers and certificates from various countries. It can be seen in figure 3.4.

Figure 3.4 The main logos of esteemed awards, endorsers and certificates from various countries (Knauf Insulation Mineral Wool Insulation with ECOSE Technology, 2010)

Knauf's EcoBatt fiberglass insulation uses the company's Ecose binder, which is manufactured using corn sugars instead of petroleum derivatives. EcoBatt contains a minimum 30% post-consumer recycled bottle glass and does not contain any colorants, giving this fiberglass a mottled brown appearance. (Knauf Insulation Mineral Wool Insulation with ECOSE Technology, 2010)

3.2 URSA

The company URSA is a company of construction insulation materials and insulation systems for various constructions. URSA is the one of the leading companies in the construction market in Europe and the one of the most famous brands of construction materials. URSA offers a wide range of heat - and soundproof materials for construction of new and reconstruction of existing buildings and structures. (URSA Insulation, S.A an Uralita Trademark, 2014)

The main products are mineral insulation on the basis of fiber glass and insulation of extruded polystyrene foam is used where heat and sound insulation must be perfect. They offer high-quality and environmentally friendly products for civil engineering or technical insulation, installation of ceilings, walls or floors in a private house.

3.2.1 The politics from environmental aspect

URSA has new technology with new safety properties. It is URSA GEO.
URSA GEO - mineral insulation, fiberglass, made taking into account strict requirements for eco - starting from production and composition of raw materials to finished goods. URSA GEO is an evolution of heat and sound insulation for "green building".

Eco-technology GEO is based on the use of natural components and improved formulations. Material URSA GEO safe for human health and the environment, it cleans air and healthy climate. (URSA Insulation, S.A an Uralita Trademark, 2014)

Due to the material structure and characteristics of fibers products URSA GEO have a number of outstanding properties, high thermal capacity and low weight, the effective sound insulation in the construction and excellent sound absorption. Whether it is a pitched roof, exterior walls or walls - mineral insulation, fiberglass URSA GEO is suitable to solve any tasks in the field of heat and sound insulation in the modern construction.

3.2.2 Properties and benefits of material from environment aspect

Basic environmental arguments are from URSA website.

Eco-technology GEO
Materials URSA GEO made on eco-technologies and considers more stringent environmental requirements - from production and composition of raw materials to

finished goods. In materials URSA GEO virtually no emissions of volatile compounds - it is 10-15 times lower than the existing European and Russian standards.

Bio stability

Mineral insulation has inorganic nature, does not decay and does not contain nutrients for life insects, rodents and microorganisms.

Promotion of the product URSA geo developed as efficient energy savings. URSA GEO is a high-quality and cost-effective insulation material, produced with the most advanced technology, it offers a high level of heat insulation, coupled with outstanding sound insulation properties.

Due to the inorganic nature of its raw materials - mainly sand -, it shows an extraordinary resistance to fire, making it an ideal material for thermal and sound insulation of construction. A high amount of recycled glass is used in its production and the product itself may be recycled after use.

URSA products also contain the European Certification Board for Mineral Wool Products (EUCEB) — a means of certifying that the insulation is manufactured to standards set by Note Q of Regulation (EC) No 1272/2008.

They are a member of the Quality Association for Mineral Wool. URSA insulation products carry the RAL quality mark ‘products made from mineral wool’. This certifies they’re environmentally friendly, sustainable and high-quality products which can be handled without any health risk.

Environmentally friendly materials of URSA are confirmed by the certificates of EcoStandard. EcoMaterial is the first system on the market a full environmental certification of materials for construction and finishing of buildings, independent eco-rating of finishing and building materials.(General auditor certification - EcoStandard group; the company is accredited in the international community on green construction U.S. Green Building and is the official environmental consultant for the construction of Olympic objects of Sochi-2014).

Figure 3.5 The label of EcoMaterial certification

Standard environmental labeling EcoMaterial is developed as a system of independent certification for the identification of ecologically pure and natural building and finishing materials, safe for humans and the environment. EcoMaterial standard takes into account the influence of the material on humans and the environment throughout the product lifecycle, from raw materials extraction to disposal. The standard consists of 62 evaluation criteria that takes into account the recommendations of the world health organization, the Council of "green" construction of the US, is responsible regional European techniques.

The company also confirms the safety of their products certificate of an independent European Committee on certification of products from mineral cotton wool EUCEB received after testing products on European techniques. The presence of the certificate EUCEB confirms that materials made of fiber, which is safe for human health. The certificate can be seen in Appendix 1.

Connecting URSA to find more information about material composition, they replied:

”All products URSA GEO are made from 95% of the minerals on the basis of quartz sand and 5% polymeric binder. More detailed chemical composition and formulation of the production of our materials is a commercial secret. All materials from staple fiber URSA GEO have Expert advice and certifications, confirming their environmental safety and conformity to requirements of normative documents.
Many manufacturers of materials in addition to the certifications receive a number of other documents confirming the sustainability of their materials. Our company also confirms the safety of their products certificate of an independent European Committee on certification of products from mineral cotton wool EUCEB received after testing products on European techniques. The presence of the certificate EUCEB confirms that materials made of fiber, is safe for human health.”

3.3 Saint-Gobain ISOVER

ISOVER is the world leader in sustainable insulation solutions. Saint-Gobain ISOVER uses natural and abundant raw materials (sand or volcanic rock), using fusion and fiberizing techniques to produce glass wool or stone wool. The products obtained come in the form of a "mineral wool mat" consisting of a soft, airy structure.

They aim to create efficient thermal and acoustic insulation solutions to support energy efficient construction, to provide safe comfort to users and to help protect the environment. Glass wool is a very high-tech product. The latest innovation from ISOVER provides a unique high-performance profile: it combines safety, comfort and easy handling. ISOVER glass wool insulation is manufactured from a combination of sand and up to 80% recycled post-consumer glass that would otherwise go to landfill. On average, their glass wool contains 50% recycled glass.

Tested according to ISO 16000 standards, ISOVER glass wool products release a very low amount of formaldehyde. In several countries ISOVER glass wool products are certified by independent institutes such as GreenGuard (USA), Blue Angel (Germany) or RTS M1 (Finland). (Journal Planet, people, prosperity. Our commitment to sustainable construction, p.23)

ISOVER insulation products have a very positive eco-balance. When used in buildings they provide environmental benefits that far exceed the negative environmental impacts resulting from their production, transport and disposal.

The only standardized indicator is total primary energy taking into account the whole product lifecycle from the extraction of raw materials making up the material to its end of life (demolition).

Energy consumed to make glass wool is mainly used to melt the sand and cullet, then cooking the binder in a steam oven. The use of recycled glass reduces the consumption of energy on fusion. The life cycle analysis of glass wool compared, for example, with that of hemp wool (to choose a product sold by ISOVER) shows that the former consumes less energy than the second. The results of this lifecycle analysis show that the impact of polyester fiber is very important.

Process waste is reduced by incorporating production scrap back into the primary production process, or reprocessing it into other products.

Thanks to their resilient properties, glass wool products can be compressed by a factor of up to ten at the time of packaging and palletizing. This patented process lowers transport environmental impacts, improves handling and reduces the need for packaging materials. (Journal Planet, people, prosperity. Our commitment to sustainable construction)

3.3.1 The politics from environmental aspect

Using ISOVER mineral wool is a safe way to save energy, heating and cooling costs. Glass and stone wool products have been used for more than 60 years. They have proven themselves as popular and safe insulation materials and are probably the most well-documented and tested building materials. (http://www.isover.com/Our-commitment-to-sustainability/Our-contribution/Product-safety, 2014)

The products manufactured by ISOVER, received the sign of eco-labeling "Leaf of life" that confirms the safety ISOVER insulation materials for human health and the environment throughout its life cycle (from raw materials to packaging).

"Leaf of life" is the only Russian eco-labeling, recognized by the international community and in line with the international practice of voluntary ecological certification.

Figure 3.6 The label "Leaf of life" (ISOVER, 2013)

Also insulating materials by ISOVER received eco-label EcoMaterial Absolute and EcoMaterial. It can be seen in figure 3.7.

Figure 3.7 The logos of eco-label EcoMaterial Absolute and EcoMaterial (ISOVER, 2013)

According to the standard EcoMaterial, products marked the highest degree - Absolute comply with modern standards of ecological safety, is innovative and high-tech, and its use contributes to modernization of the construction industry.

Sign EcoMaterial Absolute issued on the basis of a series of studies conducted by independent ecological laboratory EcoStandard. According to the results of product testing and audit of production grade points - the more, the higher the score material safety and environmental responsibility of the company.

From 2011, all ISOVER products are produced in a new quality - ISOVER G3 touch. The logo of ISOVER G3 touch can be seen in figure 3.8.Thanks to the new formulation, based on the latest scientific research, mineral wool ISOVER was pleasant to the touch, without dust, while maintaining the elasticity and strength.

Figure 3.8 The logo of ISOVER G3 touch (ISOVER OY. Etusivu, Tuotteet, G3 Touch, 2013)

Materials ISOVER standard G3 touch have improved thermal insulation properties and provide reliable protection from noise. The house becomes more comfortable, while the expenses on heating are reduced. New products ISOVER guarantee safety for human health and the environment. They are non-flammable and durable. Tests have shown that when heated to high temperatures products ISOVER produce less heat, and thus reduce the risk of fire spreading. On the website it is possible to ask test results of G3 touch, but it does not work, nobody sends test information. (ISOVER OY. Etusivu, Tuotteet, G3 Touch, 2013)

The damage from the environmental point of view ISOVER KL-33 (G3 contact, which covers ISOVER KL-33, and all ISOVER light fibers of mineral wool)insulation from raw materials to more than 80% recycled glass. In addition, the product contains a new organic binder. ISOVER KL products can be squeezed in tight Multi-Pack compression packaging, which take up space, only about ¼ of the free volume. Multi-pack cartons save a substantial transport costs and emissions, since it enables the driven during the year 3500 as much as a full truck load less. Multi-pack is also easy to store. It has been calculated that an average of 50 years of its life cycle ISOVER saves more than 100

times in its manufacture, transport and disposal of energy required, as well as those arising from the C02. (http://www.isover.fi/tuotteet/g3-touch, 2014).

3.3.2 Properties and benefits of material from environment aspect

On ISOVER website the producer gives these basic arguments.

No dangerous dust

In private or collective premises, the quality of interior air is a subject of concern. In premises insulated by mineral fibers, these fibers only represent an infinitesimal share of particles and fibers present in the air.

Levels of exposure are around 0.0002 to 0.005 fiber/ml, i.e. 1/200th of the professional exposure limit. The proportion of other particles or fibers is much higher (0,172 fiber/ml).These testing results are given by ISOVER.

Managing waste and recycling

The company's focus on recycling is enabling to minimize waste and reduces consumption of primary raw materials. They are increasing the use of “secondary” raw materials created from recycled primary raw materials, such as cullet for glass wool. They are increasingly recycling production waste in the production process (75% of glass wool, 66% of stone wool and 100% of EPS production waste are recycled). As a result, waste levels have been reduced considerably.

Glass wool is made from natural sand to which recycled glass (cullet) and fluxing agents are added. The material is melted to 1100°C in an electric furnace. The fiber is formed by centrifugation through drilled disks. Fiberizing is integral. Binding products as well as elements specific to the usage are added and the wool mat is polymerised and rolled.

3.4 RESULTS

The reviewed companies present the product with a strong hand. Each company has its own special program or new technology for glass wool production from environmental aspect. All technology, all companies have similarities and differences.

Most of them show new technology with improving properties compared with traditional glass wool such us recycling, renewable and natural resources. The most overall arguments from environmental aspect are shown in the table below.

Table 3.1 Table of results

KNAUF INSULATION it's time to save energy	URSA uralita	ISOVER SAINT-GOBAIN
with ECOSE™ TECHNOLOGY	URSA GEO	G3 touch
Mineral wool with ECOSE Technology is already considered the best performing insulation in terms of its environmental impact. Testing indicates that products with ECOSE Technology improve on the already excellent performance of conventional mineral wool products. But these testing results do not open for public domain. ECOSE Technology contains no phenol, formaldehyde, acrylics or artificial colors. These products are certified by UL Environment for indoor air quality (IAQ) as low emitting products and where noted, have achieved the more stringent GREENGUARD Gold certification and verified to be formaldehyde-free. Environmental information confirmed the certifications - EUROFINS Indoor Air Comfort GOLD - Der Blaue Engel, Germany – M1/RTS, Finland, GreenGuard.	This company is more popular in Russia. They have good reputation due to high-quality and cost-effective insulation material, produced with the most advanced technology, it offers a high level of heat insulation, coupled with outstanding sound insulation properties. Also, they use raw natural materials, which has not emissions of volatile compounds but in the public domain do not have some test and results which can proof eco-facts. This material, URSA GEO, have expert advice and certifications for public inspection.	Tested according to ISO 16000 standards, ISOVER glass wool products release a very low amount of formaldehyde. In several countries ISOVER glass wool products are certified by independent institutes such as Greenguard (USA), Blue Angel (Germany) or RTS M1 (Finland). The certificate RTS M1 include in Appendix 14.

4 STONE WOOL

4.1 ROCKWOOL

ROCKWOOL insulation products contribute to energy efficient and fire-safe buildings with good acoustics and a comfortable indoor climate.

Insulation products fit all types of buildings and range from roofs, loft, walls, floors, foundation to fire stopping solutions, HVAC systems and sub-sea pipelines. (ROCKWOOL International A/S, 2012)

4.1.1 The politics from environmental aspect

ROCKWOOL stone wool is naturally spinned stone. The production process for ROCKWOOL stone wool is a technological replica of the inside of a volcano that spins and cools lava in a controlled environment.

ROCKWOOL stone wool production process uses about 97% of mineral materials – basalt, gabbro, as well as recycled materials (e.g. stone wool, briquettes, slag). The remaining 3% are binders (e.g. phenolic-formaldehyde resin) as well as impregnating oil, a coating product that increases product's water resistance. (ROCKWOOL International A/S, 2012)

The starting point for assessing a construction product is to look at its life cycle and to perform a Life Cycle Assessment (LCA) - by considering its impact on the natural environment from the moment of excavation of the raw materials up to its total disposal. The main raw material for ROCKWOOL products is a renewable and plentiful natural resource. The earth’s volcanoes and plate tectonics produce 38,000 times more stone material every year, than is used to make ROCKWOOL stone wool. (Building Insulation products, part1, LCA Case Studies, 2003)

ROCKWOOL insulation is a major energy and CO2 saver. Despite the fact that the stone melting process is energy consuming, the use of ROCKWOOL stone wool insulation ensures a positive energy balance through its lifetime. A typical 250 mm ROCKWOOL loft insulation product will save 128 times more primary energy and 162 times more CO2 and acid rain components than what was used for its production, transport and disposal. Thus the positive energy balance begins at just 5 months after the installation of the product and the ecological balance connected with acid rain and

the decrease of CO2 is restored after 4 months from the moment of installing the insulation. (ROCKWOOL International A/S, 2012)

Environmental Product Declaration

An Environmental Product Declaration (EPD) communicates verifiable, accurate, non-misleading environmental information for products and their applications, thereby supporting scientifically based, fair choices and building designs. An Environmental Product Declaration is based on Life Cycle Assessment according to the international standards, ISO 14040 and ISO 14044 and works as input for sustainable building assessments schemes such as BREEAM, DGNB, LEED and HQE. Insulation materials that are durable over the lifetime and easy to install without gaps and risk for convection (such as ROCKWOOL stone wool insulation), are a wise choice, and will help to achieve the most sustainable buildings. (ROCKWOOL International A/S, 2012)

ROCKWOOL Group is utilizing own residue materials together with residue materials from other industries in the production process.

In the ROCKWOOL Group's internal recycling system, stone wool waste and residue materials from other industries are compressed into recycling briquettes that are melted and processed into new stone wool. The ROCKWOOL process can thus solve an expensive waste problem and at the same time reduce the consumption of natural stone material and fossil fuels.

Over the years investments in recycling facilities have been significant, and today three quarters of the Group's stone wool waste from production is recycled. By introducing the Group's recycling technology into factories, waste levels have been reduced considerably. Stone wool residue is also used in other industries, for instance as raw material in bricks.

Numerous leaching analyses confirm that stone wool process waste and used products can be deposited without problems at ordinary landfill sites for mineral waste with low organic content. (Building Insulation products, part1, LCA Case Studies)

ROCKWOOL insulation is among the few industrial products that, in its life-cycle, save vast amounts of energy. Energy is a resource that is critical for future generations. By saving fuel ROCKWOOL insulation also reduces greenhouse gas emissions, acid rain and smog by more than the pollution caused during ROCKWOOL insulation production.

In total, the ROCKWOOL insulation produced this year will, in its lifetime, save more than 4000 million tonnes of CO2 (4 GtCO2) in buildings and industrial processes worldwide.

The ROCKWOOL Group is actively engaging with policy makers, advocating climate change mitigation actions, i.e. better CO2 and energy efficiency in buildings and industrial processes. (Carbon Disclosure Project, CDP 2011 Investor CDP 2011 Information Request Rockwool International A/S, p.1)

When manufacturing products they use high-quality binding - rezol resin new generation. This resin is the basis for preparation of the working solution (binder), which participates in the technological process of production of heat insulation. Binder content in the product is an average of 3.3 %. (ROCKWOOL International A/S, 2012)

In finished products of phenol-formaldehyde resin (which is part of the binder) is a solid, non-fusible and not soluble state, therefore, does not represent a hazard to human health and not released into the atmosphere.

All their products are of Expert conclusion about conformity sanitary standards and rules, in addition, the company of ROCKWOOL first certificate was granted EcoMaterial Green confirming the safety of products.

All the declared characteristics are confirmed by Certificate of Conformity. In addition, for products ROCKWOOL and have Technical Certificates of the Federal Certification Centre. Also it should be noted that the declared characteristics are confirmed by Reports about the tests.

In life cycle assessment, an environmental product declaration (EPD) is a standardized way of quantifying the environmental impact of a product or system. Declarations include information on the environmental impact of raw material acquisition, energy use and efficiency, content of materials and chemical substances, emissions to air, soil and water and waste generation. Product and company information is also included.

In this EPD we can find some interesting numbers: emissions to air and water and generation of waste, environmental impacts, resource depletion and energy consumption.

Environmental indicators are:

- Global warming potential 1449 g CO 2 eqvivalents per FU
- Total energy consumption 20.8 MJ per FU
- Recirculated materials 23 %

This information can be found on The Environmental Declaration ISO 14025 in Appendix 2.

4.1.2 Properties and benefits of material from environment aspect

Basic arguments are from ROCKWOOL website.

Environmental benefits when using waste:

- Less waste to be sent for landfill.
- Less exploitation of naturally occurring resources (rock and coal).
- Reduced energy consumption for quarry operation, coke production, transportation, and melting of slag. In addition, melting of waste often requires less energy than melting natural rock.
- Combustion of organic residues into the non-poisonous compounds CO2 and H2O during the melting/combustion process.
- 97% recyclable

Other benefits:

- ROCKWOOL stone wool is a type of insulation material that can be used under extreme conditions. It retains its insulation properties in both very low (e.g. oxygen installations) and very high (up to 1000°C) temperatures.
- For indoor use, lightweight ROCKWOOL insulation products are manufactured with slightly flexible edges. This allows them to knit together at the joints and fit closely into building structures without leaving unplanned gaps.
- ROCKWOOL stone wool hampers a fire's progress. ROCKWOOL fire-protecting insulation, thanks to its fibers' resistance to high temperatures, will limit the effects of a fire:
    - Protects flammable constructions or those susceptible to the effects of fire
    - Increases elements of building structures' resistance to fire
    - Slows down heat transfer up to high temperatures
    - Its fibrous structure does not melt away below 1000°C
- No risk of lung diseases

- No risk of diseases from volatile organic compounds
- Limited skin discomfort
    - Comprehensive full-scale investigations of emissions from stone wool insulation products at the Fraunhofer Institute in Braunschweig show that they are a negligible source of formaldehyde in the indoor environment and therefore of no concern for the inhabitants of houses insulated with stone wool products. In addition, Finnish Emission Classification of Building Materials tests on ROCKWOOL insulation products for formaldehyde and volatile organic compounds emissions categorize them as Class M1 (the best quality) 'low-emitting building materials'.

4.2 Paroc

Paroc Group is an international stone wool insulation producer. They develop and pilot building concepts, from energy saving renovations to passive houses, which reduce the energy consumption and emissions of buildings while increasing the comfort of living. Paroc mission is an innovative and trusted partner for sustainably built environment. (PAROC Group, 2014)

They have aimed at both short- and long-term environmental, social and economic sustainability by developing operations with a focus on resource and energy efficiency.

In more recent years, they have started and participated in several projects dealing with everything from products' environmental impact to knowledge on how to build energy-efficient houses and how to make energy-efficiency renovations as cost effectively as possible. Paroc claim to have pioneered both low-energy house concepts as well as cutting edge concepts for cost-effective energy refurbishments. As they develop offering, they aim to reduce the energy use in the built environment – without forgetting aesthetic values. The built environment consumes 40% of all energy in the EU. This presents a huge opportunity for solutions that make a difference. (PAROC Group, 2014)

4.2.1 The politics from environmental aspect

Environmental aspects include efficiency in the use of primary and other resources, pollution, waste, recycling. Social aspects concern the well-being of employees, health and safety, contributions to society at large, corporate citizenship and long-term viability

of business. The economic aspects are exemplified by profitability, efficiency, stakeholder added value and ROI.

Paroc is a responsible company that caters for the needs of the present generation as well as those of future generations. With insulation solutions, they provide a means of saving energy. Thus the core business of Paroc contributes to sustainability.

Sustainability in PAROC operations and offering results in:

- Better environment
- Healthier environment
- Improved long-term profitability for Paroc

Environmental sustainability is an important driver in Paroc's product management. By developing products and providing technical support, the aim to continuously enhance the energy efficiency of the built environment. In their operations they measure and improve the efficiency of resource use. (PAROC Group, 2014)

4.2.2 Properties and benefits of material from environment aspect

On website Paroc gives the following arguments.

Stone wool is a great insulator.

- One cubic meter of stone wool consists of 95 – 98 % of air, and it is well known that static air has very low thermal conductivity.

PAROC stone wool is non-combustible

- PAROC stone wool products are made of natural stone (96-98 %) and only a small amount of organic binder agent (~2-4 %) is added in the manufacturing process. The primary products are usually a good indicator of the fire properties of a material. Stone wool does not burn because it is made of inorganic materials. PAROC stone wool meets the highest European fire class Euroclass A1. A fire-partitioning wall made of PAROC panels can save lives, property and spare the environment in the event of a fire. Structural elements with PAROC panels meet the requirements for fire resistance for up to four hours in walls and up to an hour in ceilings.

PAROC stone wool is durable insulation

- Stone wool is an inorganic material which keeps it shape and dimensions in all conditions. Therefore, the durability of the mechanical properties is excellent and the degradation of the load bearing capacity during use is low.

Life-cycle impacts of PAROC stone wool

- PAROC stone wool is an environmentally friendly and efficient way of insulating a building. It also saves costs. Compared to the savings PAROC stone wool generates over its lifetime, manufacturing the material uses only one percent of the energy. PAROC stone wool can also be recycled or disposed of safely at a later stage.

The raw material of PAROC stone wool is over 95 % stone

- PAROC stone wool is made of natural stone.
- Stone wool consists of ~98 % air and ~2 % stone fibers.
- Studies show that PAROC stone wool fulfils the most stringent requirements on emissions into indoor air.
- Stone is also described as an inexhaustible natural resource: stone will be available for the entire lifetime of humanity.

Energy efficiency

- For each tone of CO2 generated in the manufacturing process of stone wool, about 200 tones of CO2are saved by its thermal insulation properties over a 50-year period. (Source: EURIMA)

Environmental management system certificate

- Paroc has been granted ISO14001 certificate. It can be seen on the Appendix 3.

Energy balance is extremely positive

- Producing stone wool requires only half of the energy needed to manufacture other types of insulation (cellulose, flax).
- The energy balance becomes positive only a few months after installation. (Source: Force Technology/ dk-Teknik)

Waste recycling

- Waste material generated by cutting boards in production is used as a raw material for new stone wool products, reducing the amount of new stone raw material needed.

Plastic waste

- Paroc has supported and contributed to the buildup of the plastics collection system in various countries.
- In most countries, there are existing systems for plastic waste collection.
- Paroc also accepts the return of plastic waste to some of its factories.

Pallet recycling

- Most of the pallets Paroc uses today are so-called one-way-pallets → Old wooden pallets can be used as an energy source in, for example, private houses or power stations.
- Specified pallets in good condition can be sent back to the nearest factory.

Wastes re-use

- Up to 5 % of the used volume becomes waste during installation.
- They recommend use of the optimal product size available.
- Waste should be used where it is generated to avoid unnecessary transportation.
- The stone wool cutting waste can be used as attic insulation together with blowing wool.

Demolition: Re-use of used material

- Used stone wool is suitable for re-use as thermal insulation at a new site, provided that the material can be extracted intact from its previous location.
- Stone wool recovered from demolition sites can also be crushed and used as frost insulation in lightly loaded soil structures (licensed).
- Paroc stone wool can be used safely as a landfill or soil structure

Figure 4.1 Paroc concept of the environmental mission (PAROC Group, 2014)

The indicates and the properties of the environmental aspects such as emissions into the air, waste handling, utilization of natural resources and energy efficiency are paid attention to at Paroc and the environmental impacts of production are constantly improved. Their politics are so widely and variety. They take for attention all kind of problems with ecology, such as non-toxic, recyclable, safety, waste reusing and so on.

4.3 TechnoNICOL Corporation

TechnoNICOL Corporation produces and delivers a wide variety of sound and heat-insulating materials, mastics, roofing and waterproof materials.

They produce heat-insulation materials based on gabbro-basalt stones in order to maintenance of comfortable temperature in buildings and constructions of any type. In addition, due to excellent acoustic characteristics, materials provide excellent heat and sound insulation of facades, foundations, roofs and interior partitions.

Stone wool produced by TechnoNICOL Corporation is divided due to the areas of application. The product range includes thermal insulation for plaster and ventilated facades, sloping and flat roofs, floors, walls, etc.

Production of TechnoNICOL is characterized by high heat retention properties, fire safety, high sound absorption and water-repellent properties, hardness and resistance

to deformation; they are all certified and environmentally friendly. (TechnoNICOL, ECO-friendly, 2014)

4.3.1 The politics from environmental aspect

The corporation has created its own Research and Development Center. The key goals of the center are in-depth analysis of raw material properties, end products, methods and processes of production, and information. Armed with the results of various researches, specialists develop most advanced and effective methods to guarantee the highest quality of production.

The company implies the principles of the total quality control management in order to achieve maximum satisfaction of both external and internal customers.

Environmental security is closely connected with production safety.

4.3.2 Properties and benefits of material from environment aspect

Basic environmental arguments are from TechnoNICOL. It is possible to find them on the website.

Stone as a raw material

Insulation materials TechnoNICOL are made of stone wool on the basis of basal starting fiber. Most standard products have a maximum operating temperature 750°C

Stone wool is not lit, has a high mechanical strength, chemical resistance and severe water-repellent properties. Stone wool possesses high heat insulation properties within a wide temperature range. This directory product describes the materials intended for use as technical insulation.

Reduce possible pollution factors

The plants have convenient geographical location to minimize transportation of materials to the final recipient. Thus they reduce the maximum delivery costs and any transport emissions.

Environment friendly production

The company is aware of its social responsibility to maintain a friendly environment, sustainable use of natural resources. In this context, the main objectives of the company are:

- to achieve the level of industrial and environmental safety, corresponding current state of science, technology and society;
- Improving industrial and environmental safety of production facilities, reducing the negative impact on the environment by improving the reliability of process equipment, ensuring its safe and trouble-free operation.

Lean production

The basic concept of the successful operation of their production facilities are:

- constant aspiration to eliminate of all kinds of losses - all sorts of expenditures and wastes;
- improving the efficiency of production control;
- All produced materials are made to order - without over-and-error.

The solution of this problem is provided by:

- qualified staff and modern equipment - excluding the possibility of the production of a spoilage or subsequent improvements;
- rational use of raw materials and natural resources involved in the production as well as being in the area of the enterprise activity.

Recycling

- All produced at plants materials, and the solutions offered by their experts, developed according to the principle wastelessness to use.
- The plants are equipped with the latest equipment to reduce fuel and subsequent secondary use of resources consumed in the production - raw materials and means of production;
- Most of produced materials are recyclable.

In advertising in TechnoNICOL there are not any arguments from environmental aspect. They have certifications but just technical certifications. For example, VTT certification: Products manufactured at the plant in Vyborg, has a certificate VTT (Technical Research Centre of Finland), which indicates that the materials meet the requirements of the Finnish National Standards. Within the period of validity of the certificate representatives VTT carried out an inspection of the plant and production control. It can be seen in Appendix 13. These pages are available only in Finnish language.

4.4 RESULTS

Stone wool has been tested and shown to be an excellent insulator and a vital component of an energy efficient building. Further, its R-value does not change over time because stone wool is not produced with blowing agents, which off-gas and result in lower thermal performance. Not only is the thermal performance of stone wool insulation maintained over its lifetime, but a building's thermal performance can be maintained because of the dimensionally stability of the material. It will not slump in stud spacing causing gaps, will not expand or contract due to temperature variances in a rain screen or roofing system, all of which contribute to the optimal thermal performance of a building envelope.

Table 4.1 Table of results

ROCKWOOL FIRESAFE INSULATION	PAROC	TECHNO NICOL CONSTRUCTION SYSTEMS
Rockwool say that their products save 128 times more primary energy and 162 times more CO2 and thus the positive energy balance begins at just 5 months after the installation of the product, but for this information it is impossible to find proofs on website. Also, Rockwool has leaching analyses which confirm that stone wool process waste and used products can be deposited without problems at ordinary landfill sites for mineral waste with low organic content. In the public domain Rockwool has some certificates, but not all of which they spoke.	Paroc has great statistic and numbers of the environmental solutions, but this number from their website is impossible to check. All their certifications are published on website. The environmental aspects such as emissions into the air, waste handling, utilization of natural resources and energy efficiency are paid attention to at Paroc.	On TechnoNICOL website it is hard to find any information about environment or ecological argument of the products. Also they do not have any environmental certifications or mentions of them. In their environmental politics TechnoNICOL just promise to improve industrial and environmental safety of production facilities. The corporation has created its own Research and Development Center. The key goals of the center are in-depth analysis of raw material properties, end products, methods and processes of production, and information. Armed with the results of various researches, specialists develop most advanced and effective methods to guarantee the highest quality of production. But the results or researches of the Center are not in public domain.

5 CELLULOSE

Cellulose Insulation was found to be competitively priced in relation to other insulating materials which make it an attractive option for installation. The cost of installation of the cellulose insulation may vary as there is the potential to self-install or to engage a professional installer. The material must be installed correctly to ensure that the required R-value is achieved. (National Fiber, An introduction to Cellulose Insulation, 2014)

Wood fiber insulation is produced from trees. Wood fibers are usually cellulosic elements that are extracted from trees and used to make materials including paper.

Cellulose Facts

- 38% stronger sealing properties, as compared to fiberglass
- 24% reduction in air infiltration
- 22-55% greater fire resistance
- superior moisture, vermin and mold resistance
- greater soundproofing and vibration-dampening

The R values between blown in cellulose insulation and fiberglass insulation are the same but the thickness varies. On average, blown in cellulose insulation is 2-3 inches thinner than fiberglass insulation when both have the same R values. (National Fiber, An introduction to Cellulose Insulation, 2014)

5.1 ISOCELL

The company ISOCELL was founded over two decades ago for the sale and distribution of blown-in cellulose insulation materials. With an innovative range of products in the field of cellulose insulation and airtight systems, ISOCELL has succeeded in making a name for itself on the building sector during the past years.

ISOCELL is a thermal insulation material made from cellulose fibers that are produced from newspapers in an optimum recycling process. The basic material used for ISOCELL is therefore wood with its excellent natural advantages that have been known for thousands of years. ISOCELL is produced in Austria, Belgium and France in plants rating amongst the most modern in Europe.

The newspapers, that are delivered pre-sorted, are turned into rough fibers, mixed with mineral salt and ground in a mill. The mineral salt protects ISOCELL from vermin and mould and makes it resistant to rotting and to fire. (ISOCELL, 2014)

5.1.1 The politics from environmental aspect

Arguments in favor of the long-fiber flock are its extremely low thermal conductivity and its ability to settle without sinking, even when the layer of insulation is very thick. ISOCELL is not toxic, contains no substances or additives that might cause harm and is soft and warm to the touch. It is kind to the skin, does not irritate and is therefore rated as a friendly insulation material. (Experience the pleasure of natural thermal insulation, 2014)

Production is subject to the most rigorous internal and external quality controls to maintain regulatory compliance for the German, Austrian and European market.

Licensed ISOCELL specialists blow the cellulose fiber into the hollow cavities using special blowing machines. The cellulose fibers mat inside the construction to form a well-fitting, joint-free and sure-settling insulating mat.

The fields of use for ISOCELL Cellulose insulation are numerous. ISOCELL's blowing system ensures a seamless insulation with no waste. It can save time and money.

ISOCELL cellulose insulation fills even the narrowest of gaps and cracks. The result is a seamless insulation mat without thermal bridges.

5.1.2 Properties and benefits of material from environment aspect

Basic ecological arguments are from ISOCELL website.

- Save energy
- Recycling process
- Natural resources
- No waste
- Protected from vermin and mould
- Save money and time by installing

From an ecological point of view the production of ISOCELL compared with other insulation materials, such as polystyrene or glass wool, the primary energy input is

much lower. It is one sixth of that required for the production of polystyrene and one third compared with glass fiber production.

Only newspaper is used for the production of ISOCELL cellulose fiber, this produces consistency in the fibers while maintaining strict quality measures.

The pre-sorted newspaper is first broken up in a shredder and then run through the so-called eddy current mill that breaks up the paper to its fiber structure.

The fiber structure is an important characteristic of ISOCELL. Only long fibers guarantee the best possible compaction and sure settling. To protect ISOCELL cellulose fiber from fire, mould, insects or vermin, it is treated with natural mineral salts.

Data sheet presents some environmental characteristics (Appendix 4):

- Primary energy from nonrenewable resources PEI ne MJ/kg - 4, 24 MJ
- Primary energy from renewable resources Pei e MJ/kg - 0, 38 MJ
- Greenhouse gas emissions / GWP - 0, 23 kg CO2 equ.
- Influence on atmospheric acidity / AP - 2,44 g SO2 equ.
- Toxicology: no medical risk (certificate existent), during work, the use of a dust mask is required.
- Disposal: the material can be restored to the producer, assumed it is not contaminated
- Disposal clue: Burning in a refuse incineration plant as mono--waste or together with other community refuse is permitted.

In the public domain it is impossible to find any certifications, but in data sheets details and exactly numbers are the confirmation of the information.

5.2 Ecocel

Ecocel is an Irish company that manufactures Ecocel Cellulose Insulation. The product is made from recycled newspapers to generate a non-toxic, fire retardant insulation product. Ecocel is Tried and Tested and has Irish Agreement Board approval. (Ecocel, 2014)

5.2.1 The politics from environmental aspect

Their advertising is placed on low embodied energy. Most of the heat in home is lost through roof. 95% of all homes have inadequate insulation in their roofs and walls. A

house insulated with Ecocel can be as much as 40% more energy efficient than current building regulations require. (Ecocel Technical Data, 2014)

Ecocel thus contains some 50% carbon dioxide. As a result, a timber framed house, insulated with Ecocel, acts as a carbon sink, sequestering many tons of CO2.

Home heat loss/emission is one of the primary environmental issues. Legislation has been brought in to ensure that all homes are ‘energy compliant’ and achieve minimum standard efficiency targets.

Ecocel is a natural fiber insulation designed to minimize energy loss more effectively than mineral fibers. Blown into walls, roofs and floors it creates a continuous draught-proof layer with excellent thermal and acoustic properties. It helps create a comfortable living environment free from HCFC’s (Hydro chlorofluorocarbons), VOC’s (Volatile Organic Compounds) or other toxic substances. (Ecocel Technical Data, 2014)

5.2.2 Properties and benefits of material from environment aspect

Ecocel is made from discarded newspaper, a major component of the waste stream, easing pressure on landfill sites and putting to good use another wise wasted resource.

Figure 5.1 The raw ingredients when its arrive in big bales from the recycling center (Ecocel’s Facebook, 2014)

Ecocel uses borate based fire retardants which have less toxicity than common salt, provides a high level of fire resistance and enables Ecocel to easily meet all fire protection standards (tested to BS5803) and in effect to act as a fire stop.

The thermal conductivity of loose-fill cellulose is approximately 0,040W/Mk, but Ecocel presents an impressive thermal conductivity value of 0.038 W/Mk at a density of 27 kg/m^3, which remains stable over a wide range of temperatures. However the real world performance is further enhanced by its superior resistance to air infiltration resulting in a 25% overall improvement in energy efficiency. (Ecocel, features and benefits)

Ecocel is environmentally benign since it requires relatively little energy in production and does not pollute water, air or soil. It can easily be removed and reused, and can ultimately be returned to the earth.

Ecocel is a non-irritant and non-hazardous product. However due to potential dust in and around the work area - it is recommended that a facemask is worn when working in confined areas.

The company positions itself as an eco-friendly home insulation product made from recycled newspapers, which compares favorably with all imported alternatives. Ecocel's cellulose is suitable for the insulation of Timber Framed Homes, Attics and Lofts.

Ecocel Loft Insulation does not carry a hazard classification. The product is a non-irritant with a pH of 6.5 – 7.5 and while no specific safety equipment is required, compliance with the Safety, Health and Welfare at Work (General Application) Regulations 1993 (S.I. No. 44 of 1993) and Amendments regarding Personal Protective Clothing should be observed together with ECOCEL Ltd. safety protocols. (Ecocel, features and benefits)

Table 5.1 Benefits of Ecocel (Ecocel, features and benefits, http://ecocel.ie/ features and benefits/)

Key Features	Ecocel
Natural	Made from natural fibres derived from recycled newspaper which might otherwise end up in landfill. Ecocel has the certification №07/0285 which proofs these words. It can be seen in Appendix 5.
Warm	Studies show that buildings insulated with cellulose show a 30% to 40% reduction in energy demand when compared to those insulated with man made mineral fibers.
Airtight	When cellulose is installed to a density of 55-60 Kg/M3 or more, it acquires a unique air-sealing ability, eliminating both conductive and convective heat loss.
Cost Effective	Ecocel provides a sustainable solution to energy efficiency without increased costs.
Sustainable	Cellulose has a very low embodied energy – the energy used in manufacturing the product. This is in contrast to man-made, mineral fiber insulations, which consume huge amounts of energy.
Energy Efficient	A U-Value is a means of measuring heat loss. A lower value means less loss. A timber framed wall with 300mm of dense packed cellulose can achieve a U-Value of 0.12 or lower.
Hygroscopic	It can absorb and release moisture, allowing the building to 'breathe', thus promoting a healthy living environment.

5.3 Ekovilla

Ekovilla is cellulose insulation on the basis of wood raw material, which offers comprehensive solutions for efficient and durable insulation.

Insulation wood fiber has a high moisture capacity, which can also be used to control humidity indoors.

Production of insulation Ekovilla uses little of not renewable raw materials and energy. On average isolated Ekovilla private house associates in its design around 35 tons of carbon dioxide.

Ekovilla: “Choosing an ecological material, you really substantially can affect leave in the construction of the carbon footprint and conserve nature.”

5.3.1 The politics from environmental aspect

Ekovilla is manufactured from wood fiber, helping to preserve the nature. The manufacturing process of Ekovilla consumes really very little energy. Additionally, Ekovilla insulation binds the carbon inside the wood fibers for its entire service life, reducing the carbon footprint created by the household.

In the event that the building is demolished and the Ekovilla insulation removed, the product may be reused as thermal insulation or, after dilution, as fertiliser.

Carbon dioxide is emitted as a result of building, everyday life and heating, the extent of which the builder can influence through his own choices. Simply by selecting Ekovilla insulation, the builder takes a significant lead in reducing household emissions. This is due to the fact that emissions created in the manufacturing of construction materials play an increasing part in the overall emissions produced by buildings, because household emissions are reduced by improved structural energy-efficiency. (Ekovilla, Ecological)

5.3.2 Properties and benefits of material from environment aspect

Warmth, security and ecology are the building blocks for comfortable living. It is an opportunity for comfortable living, while respecting the environment. Ekovilla has promoted comfortable living and sustainable insulation for many decades.

They offer an excellent product with the added benefit of comfort of living. The slogan is "comfort of living is warm and green".

Material "Ekovilla" - wood fiber is able to bind moisture and it gives without losing all their insulating properties. Humidity "Ekovilla" corresponds to the moisture in its environment, its adaptation humidity works like wood. Therefore, the building, insulated with "Ekovilla" can be built without the use of vapor barrier. (Ekovilla, Ecological, 2013)

Ekovilla has certification from M1 - Emission Classification of Building Materials. The Finnish quality label for construction products being granted in three categories - of which M1 is the best one and stands for low-emission - by the Building Information

Foundation RTS ranks among the leading quality labels of Scandinavia. These can be seen in Appendix 6.

To be granted the quality label, an emission test (ammonia, formaldehyde, and carcinogenic) and an odour test has to be performed on the construction product. The time period of testing is 28 days. The criteria of the M1 emissions classification is in table 5.2. The criteria and processes are stipulated by the Committee Indoor Air Classification (EPT 24) being appointed by the general manager of the Building Information Foundation RTS. (International Labelling , M1 - Emission Classification of Building Materials, 2013)

Table 5.2 The criteria of the M1 emissions classification

Criteria/Classification	M1(mg/m^{2}h)
TVOC Minimum of 70% of the compounds shall be identified	< 0,2
Formaldehyde (HCOH)	< 0,05
Ammonia (NH3)	< 0,03
Carcinogenic compounds belonging to category 1 of IARC monographs (IARC 1987)	< 0,005
Odour (Dissatisfaction with odour shall be below 15%)	No odour

5.4 STEICO

STEICO is a natural insulating material for healthier living.

"The insulating material that retains the heat" This is the uncommon advantage of STEICO insulating materials.

“STEICO wood fiber insulating materials can do even more than provide protection against the cold, they are multi-talented contributing more to well-being and help to provide a healthy dwelling.” (STEICO, 2014)

5.4.1 The politics from environmental aspect

STEICO products are designed to be ecological in many ways.

A well-insulated house will use considerably less energy than one which is not and consequently reduce the emissions from household. It is not only retaining the heat during a cold winter which is important but also maintaining cooler, comfortable conditions during the summer which should be considered. Steico insulation products are designed to meet both these functions, reducing energy consumption and emissions throughout the year.

In addition to reducing the energy emissions from house, the wood fiber used in STEICO products has the ability to reduce global CO2 during the plant's growth phase. As the forests from which their raw material is sourced grow, each tree will bind and withdraw CO2 from the atmosphere. Timber is a unique material in that for each 1 m^3 used, up to 1 tonne of CO2 is bound within the product. In the form of insulating materials this CO2 remains bound in the wood fibers for the entire lifetime of the product. (STEICO, The environment, 2014)

At the end of a products life, due to lack of artificial additives, STEICO products are easily recycled or may even be composted to provide a valuable soil conditioner. One of the key by products is growing bags for tomato and other agricultural producers. (STEICO, The environment, 2014)

The wood for their products originates from forests which are managed in accordance with the strict rules of the FSC (Forest Stewardship Council) or the PEFC (programs for the Endorsement OF Forest Certification Schemes). They are committed to ensuring that all the timber originates from managed forests and that all their suppliers are required to consider the impact of their farming and their social requirements.

At their manufacturing locations they protect the environment by recycling all the water used in the production process and then removing any pollutants prior to disposal.

From the raw material to the finished insulation boards, their products go through a multitude of controls and quality tests. As a result they guarantee that only the highest quality products leave their manufacturing plants. They are actively engaged with the following external bodies that provide third party control and supervision or independent accreditation.

Just as important as the performance of the products, it is their environmental credentials. All STEICO products are certified to FSC or PEFC standards with full chain of custody paperwork. This process provides with the assurance that the raw material for all their products originates from sustainable forestry.

STEICO are members of the UKTFA and are actively involved with the development of new systems to help the timber frame industry meet the demands of current and future building regulations. The UKTFA are Structural Timber Association. (STEICO, The environment, 2014)

The products are designed to provide protection for the entire life of the building. To this end, STEICO has installed a stringent quality assurance process. Both internal and external monitoring is done at the highest level. Primarily at own, modern testing laboratory to ensure consistently high quality through ongoing sampling and testing and secondly by external third party bodies.

Confirmation of the quality of monitoring is carried out by the German Materials Office Nordrhein-Westfalen (MPA NRW), based in Dortmund. MPA provide a program of external control and monitoring.

Since August 2003, production and development of wood fiber insulation materials has been certified to ISO 9001:2000 by the TÜV South Germany. STEICO was the first manufacturer to have their entire range of wood fiber insulation materials certified by the FSC (Forest Stewardship Council). Thus the products are environmentally certified from the forest to the building site.

5.4.2 Properties and benefits of material from environment aspect

Basic environmental arguments are from STEICO. It is possible to find them on the website.

Energy saving and property value increases

- With STEICO it is possible to find a comprehensive assortment of insulating materials for roof, floor, wall and facades in a new building or redevelopment projects. STEICO products can dramatically reduce energy consumption.

Sustainable and certified products

- STEICO Wood fiber insulating materials are manufactured entirely from timber or hemp. The timber is sourced from forest thinning or as sawmill by-product.
- The independent FSC certification (Forest Stewardship Council) guarantees that the timber used for STEICO products originates from managed forestry. The logo can be seen in figure 5.2. During production, no harmful additives are used. Any additives used are naturally sourced and their use minimized. All their insulation materials rely on the 'Lignin' inherent in the timber as a bonding agent, rather than artificially introduced resins. The use of STEICO products not only reduces the impact on the environment but also improves the environment in property.

Figure 5.2 The logo of FSC certification (Forest Stewardship Council)

The certification was checked in FSC website (http://info.fsc.org/), the status of certification is valid, but no documents were found.License Number: FSC-C004750, FSC-C011463, FSC-C020773, FSC-C108095 FSC-C117378.With STEICO you obtain balanced air humidity making the property particularly allergy friendly.

The hemp can be grown without fertilizers, fibers contain natural antibacterial properties. Hemp can be used as a separate material and flame retardant additives or ammonium salts for the control of rodents, such as boron, etc. If the binder is lime, hemp requires no other additives. Hemp is a renewable raw material. Very ecological culture requires no pesticides. Its packaging is a natural insulator, no chemical additives resistant to decay.

The company tries to make efficient use of raw materials and cares about the environment. Natural raw materials, which are produced materials STEICO contribute not only in the duration of construction, but also in a significant way increases the comfort of the house and its value.

5.5 RESULTS

Cellulose insulation meets all the requirements of environmental regulations, safe to use and recommended for installation in residential areas without restrictions. The positive qualities of the material is low thermal conductivity, light weight and longer working life, cellulose does not lose its properties even after prolonged waterlogging and not exposed to high temperatures. The thermal conductivity of loose-fill cellulose is approximately 0,040W/Mk, but Ecocel presents an impressive thermal conductivity value of 0.038 W/Mk at a density of 27 kg/m^3.

Plant fibers are a good alternative to mineral wool.

Usually cellulose insulation is made from recycled newspapers. It contains harmless additives (salts boron) refractory, it do not afraid of insects and mold. The ecological character of this material is controversial. If the smallest particles of cellulose are inhaled, they can cause swelling or inflammation, if you can work with it without proper protection. In addition, the pulp also contains the remains of ink from recycled paper.

6 PIR and PUR

Rigid PIR differs from PUR in that it is produced using an excess of the MDI component. In the presence of an appropriate catalyst the excess MDI reacts with itself to form isocyanurate which is characterized by greater heat stability. The resultant PIR insulation products exhibit increased fire performance and reduced combustibility and higher working temperature limits compared to PUR and when incorporated into building products, can meet some of the most demanding fire performance requirements such as those currently stipulated for some applications by the insurance industry.

6.1 SPU INSULATION

SPU heat insulation boards are made of polyurethane, which has been known as a high-quality heat insulation board for demanding applications for some 40 years.

Every product application and area of usage sets its own demands for the materials used. Therefore, SPU has developed separate specialty products and installation methods for industrial use, industrial and agricultural buildings, retail buildings and housing construction.

SPU insulation boards are considerably more efficient in terms of thermal insulation than wool but, according to the research organization BRE, there is no significant difference between the environmental loads caused by polyurethane and wool over a building's entire life span. (SPU Insulation, Ecological operations, 2014)

However, by using the more efficient polyurethane insulation material, a higher thermal insulation capacity is achieved, which means that polyurethane insulation yields substantially larger energy savings during a building's service life.

6.1.1 Properties and benefits of material from environment aspect

Basic ecological arguments are from SPU Insulation website.

SPU insulation boards enable simpler structures and the use of other building materials can be minimized as the gross area remains small. In addition, the amount of insulation material that needs to be delivered to the worksite is significantly smaller resulting in reduced environmental **effects caused by transport.**

The insulation boards are manufactured with environmentally-friendly pentane, which has a GWP (Global Warming Potential) and ODP (Ozone Depletion Potential) rating of zero.

SPU insulation boards are **pack**ed onto reusable pallets and protected with a recyclable packing hood. At the end of a building's life cycle, the SPU insulation boards can be reused as, for instance, frost insulation.

They strive towards entirely waste-free production through continuous development.
The effectiveness of SPU insulation boards has been tested in many independent studies conducted by, for instance, Tampere University of Technology (TUT) and the Technical Research Centre of Finland (VTT). SPU insulation boards were the first insulation boards to be granted the cleanest emissions classification of M1. SPU insulation boards bear the CE product marking and have a ten-year guarantee.

The care for the environment
The company SPU Oy is also a pioneer in environmental protection. As an example they can mention the fact that since 2000 they moved production to the consumption of electricity produced by wind power plants. SPU insulation boards, the first of Finnish insulation was assigned the highest class M1 (Annex II) in accordance with the European classification of issue of construction materials. The certificate can be seen in Appendix 8.

In normal buildings consumption of thermal energy for heating may reach 80-90 % of the adverse impact of buildings on the environment, so the correct application of products that conserve heat in buildings, also allows to conserve natural resources for future generations. (SPU Insulation, Ecological operations, 2014)

SPU insulation boards can easily be used in energy-saving construction, they have supplied isolation for hundreds of houses with low passive zero consumption.

6.2 IKO Enertherm

IKO Head Office is in Toronto and Head Office IKO Europe in Antwerp.

More than 30 factories worldwide including 4 PIR insulation factories:

- PIR production in Brampton, Ontario (Canada), started in 2000

- PIR production in High River, Alberta (Canada), started in 2005
- PIR production in Klundert, Moerdijk (Netherlands), started in 2006
- PIR production in Combronde, Clermont-Ferrand (France), started in 2014

6.2.1 The politics from environmental aspect

IKO Enertherm insulation has the highest efficiency per m2. In other words: IKO Enertherm insulates better with a thinner board. And that benefits the environment. The use of highly efficient insulation saves energy and thus decreases CO2 emissions. IKO Enertherm is suitable for diverse applications. Enertherm PIR insulation boards have a global warming potential of zero.

This means that, compared to other insulation materials (such as EPS, XPS and rock wool), a higher insulation value is achieved with a thinner board. In other words, with IKO Enertherm make the best possible use of the available space on the roof, in the floor, or in the wall cavity.(A system for every application, 2014)

Figure 6.1 clearly demonstrates that Enertherm insulation is 40% thinner than mineral wool for the same thermal resistance, and almost 35% thinner than EPS or XPS insulation.

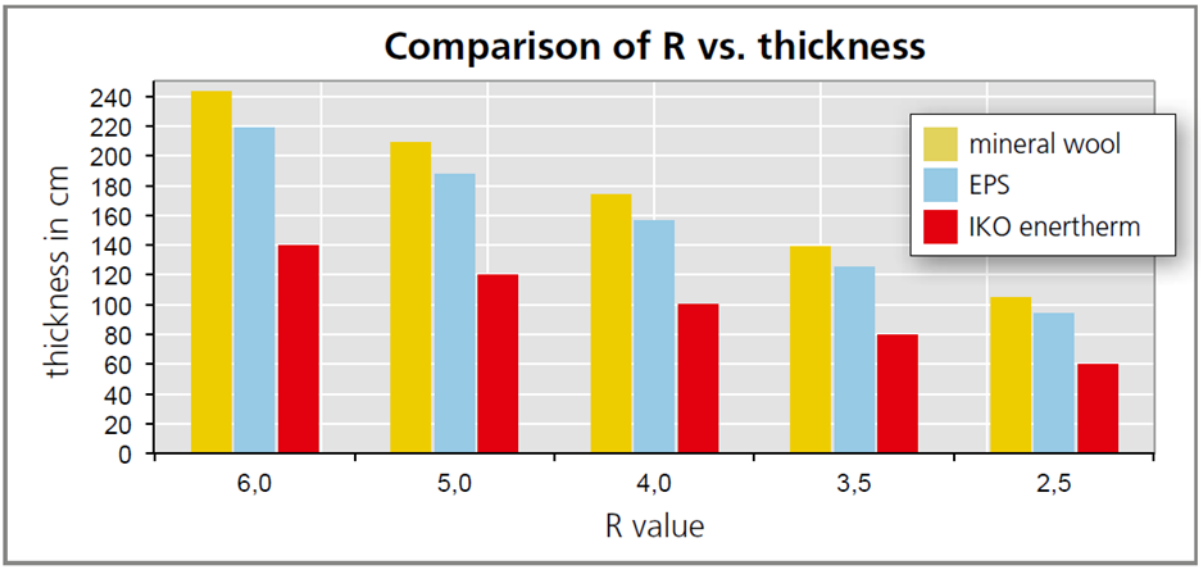

Figure 6.1 Comparison of R-value and thickness between IKO Enertherm and other insulation materials (A system for every application, 2014)

Caring for the environment

Careful consumption of raw materials means that people can achieve more with less, i.e. achieve the highest insulation values with the thinnest insulation boards. With IKO Enertherm people insulate nearly twice as well as with traditional insulation materials and therefore they can spread the insulation more thinly (lambda value 0.023 W/mK for type ALU/ALU50). A thinner sheet also means that shorter fixing screws are required. Less weight means less transport and therefore fewer greenhouse gas emissions. Furthermore, because of its light weight, the support structure of the substrate can be better designed. (A system for every application, 2014)

In practice: The weight of insulation for a 3,000 m² site (R=3.00 m²K/W)

	λD	kg/m³	R	cm	kg/m²	3000 m²/KG	3000 m²/m³	loads 80 m³
MWR	0,040	160	3	12	19,2	57600	360	4,5
XPS/EPS	0,036	35	3	11	3,8	11340	324	4,1
IKO enertherm ALU	0,023	30	3	7	2,1	6210	207	2,6

Figure 6.2 The table of raw material consumption between IKO Enertherm and other insulation materials(A system for every application, 2014)

Figure 6.2 indicates that Enertherm insulation reduces the load on the construction, or the weight that must be handled, by 51,000 kg. For this site, this also represents a reduction in traffic of 2 lorries compared to mineral wool. The content of these lorries must also not be installed. Enertherm is therefore the ideal low-energy and competitive solution. But the insulation with density of 160 kg/m^{3}is used in very limited applications and can hardly be found in some countries.

6.2.2 Properties and benefits of material from environment aspect

IKO Enertherm insulates better and offers the end user more comfort and more energy savings. The production of IKO Enertherm is less taxing on the environment and therefore better for mankind both today and tomorrow.

IKO Enertherm is a light-weight sheet. This means that it is easier to fit on the building and less back-breaking for the builders. The weight of the foam only amounts to +/- 32 kg/m^3. Due to the low weight, the Enertherm packages are easy to transport and handle.

Figure 6.3 clearly demonstrates that Enertherm insulation is 90% lighter than mineral wool for the same thermal resistance. (A system for every application, 2014)

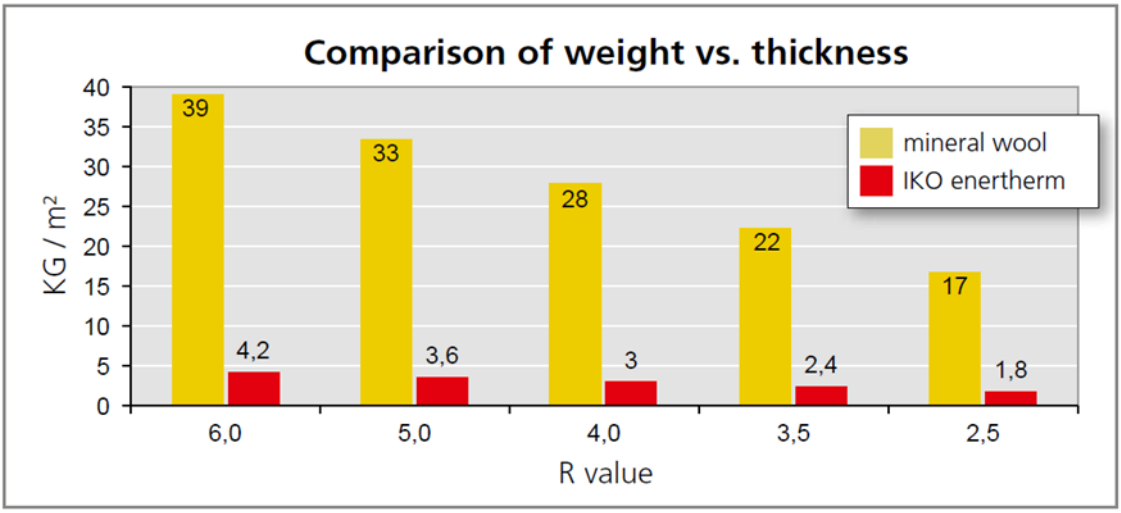

Figure 6.3 The comparison of weight and thickness (A system for every application, 2014)

IKO Enertherm has outstanding fire-resistant properties. It does not melt and therefore does not produce burning droplets.

There is no extra fire spread, which means that, in the case of fire, the emergency services have more time to extinguish the flames and evacuate people.

6.2.3 Product from environment aspect

IKO Ener-Air is a rigid, polyisocyanurate foam insulation with high thermal properties. It is constructed from closed cell polyisocyanurate foam core bonded on each side to coated glass fiber facers during the manufacturing process. IKO Ener-Air is designed to be non-structural sheathing in cavity wall, stud wall or cathedral ceiling construction. It is an air barrier with a high water vapourpermeance and it has excellent water shedding capabilities.

In Belgium, Enertherm was certified according to ATG/H 867. In addition, Enertherm has been certified in various other countries such as France, the Netherlands, Germany and England. But these certifications are impossible to see on the IKO Enertherm website.

6.3 RECTICEL

As part of the International Recticel Group and based at state-of-the-art facilities in Stoke-on-Trent, Recticel Insulation is one of the world's largest producer of PIR products. Quality is at the heart of everything they do, and excellence is ensured through continued investment and research into advancing insulation production processes.

RECTICEL insulation is a high performance rigid polyisocyanurate (PIR) foam board for use in warm flat roofs under mechanically fixed single-ply, loose-laid and ballasted synthetic and bitumen based single ply membrane waterproofing systems. It is a closed cell, CFC and HCFC-free (zero ozone depletion) rigid polyisocyanurate foam core, faced on both sides with a multi-layer coated aluminium foil. It has an exceptionally low thermal conductivity of 0.022 W/mK. (Recticel, Eco, 2014)

PIR rigid insulation products are composed of a polyisocyanurate foam core with a closed cell structure. These products deliver a high thermal performance, contributing to a substantial energy saving in building projects and in turn increasing the comfort of the end user.

All of their PIR insulation boards are heavily tested during development and before launch to ensure that this is the case. Even after a product is launched, they continually invest in product innovations and new technologies in the manufacturing process to improve them even further, as well as investing in the research and development of brand new thermal boards for the construction industry. (Recticel, 2014)

All products are manufactured to the harmonized European standard EN 13165:2013, and are CE marked accordingly. By means of the CE-label, the producer indicates that the product meets the demands required by the CPD and that it is conform the harmonised European product standards. Where stated, products have been certified by the British Board of Agrément (BBA) and as ISO 9001 system. These parts of certifications can be seen in Appendix 8 and Appendix 9. Declarations of Performance are available here as required by the Construction Product Regulations.

6.3.1 Properties and benefits of material from environment aspect.

Basic environmental arguments are from RECTICEL. It is possible to find them on the website.

- Reduces the thickness of insulation required whilst still ensuring compliance with the latest BREEAM/ Code for Sustainable Homes standards and the latest 2010 Part L Building Regulations.
- Outstanding product quality manufactured to ISO 9001 Quality and ISO 14001 Environment Systems. (ISO 14001 Environment Systems is not available to find on website)
- Zero ozone depletion potential.
- All Recticel products have a global warming potential of below 5.
- The declared thermal conductivity value of 0.022 W/mK is some 30% more efficient than most other insulation materials.

Recticel has special programs aimed at saving energy - The Energy Companies Obligation (ECO) and The Green Deal.

The Green Deal and The ECO will help reduce carbon emissions from the UK's domestic building stock, which is an essential part of the UK's plan to meet its statutory domestic carbon emission reduction targets by 2050. The UK 2008 Climate Change Act established the world's first legally binding climate change target, to reduce the UK's greenhouse gas emissions by at least 80% (from the 1990 baseline) by 2050. Moving to a more energy efficient, low-carbon economy will help us meet this target.

6.4 RESULTS

Considering PIR and PUR it is difficult to speak about environmental safety because it is a synthetic material. The producers focus on saving energy and decrease CO2 emissions to promote products, but some of them show environmentally properties such as non-toxic and packed reusable pallets and with a recyclable packing.

7 EPS and XPS

EPS (Expandable Polystyrene) is a polymer made of styrene containing pentane as a blowing agent. It is produced in the form of spherical beads. Due to its versatility EPS is the perfect raw material for various applications in construction, packaging and many special applications.

XPS (Extruded Polystyrene) begins as a solid granule of polystyrene resin. The plastic granules are fed into an extruder, where they are melted and mixed with critical additives to form a viscous fluid.

7.1 BioFoam Synbra Group

BioFoam Synbra Group has a leading position in Europe regarding Expandable Polystyrene (EPS) for Sustainable Insulation Systems and Industrial Products and Solutions for a wide diversity of markets. Synbra Technology, The Netherlands, is the in-house polymerization and R&D facility ‘Technology & Innovation' and the center of excellence in materials and product development. A recent example of the Synbra group's innovations is BioFoam®.

The raw material for BioFoam consists of biopolymers, which are made of vegetable materials (an infinite resource). The production process can be seen in figure 7.1. This makes BioFoam the first foam to have an organic base. The consequence is that BioFoam, like EPS, can be reused. In addition, it is biodegradable and it can be industrially composted at high temperatures under the influence of moisture and bacteria. BioFoam is durable and is suitable for long-term use in virtually all technical and packaging applications. (Energy requirements and CO2 emission for polymers, 2014)

Synprodo reuses both production residues and EPS that is returned from the various sectors. This means a reduced environmental load through saving raw materials and preventing waste.

They have managed to make expanded granules of foam based on Poly Lactic Acid (PLA), which originates from vegetable waste. Patented technology allows heating and expansion as a result of which a new type of foam has been developed that is completely biodegradable. The new raw material called BioFoam is as impact resistant and strong as EPS. It does not absorb water and insulates just as effectively.

BioFoam is, with respect to opportunities and properties, indistinguishable from EPS. To increase recognisability and to underline the sustainable nature of the product, the biodegradable BioFoam has a light green color.

Figure 7.1 Production process of BioFoam (Biofoam, 2014)

For a considerable time, Synprodo has operated an innovative collection and recycling system in which used EPS products are processed to become new EPS and PS raw materials. In contrast to many other materials, EPS is 100% recyclable. Synprodo carries out the entire process of recycling within the company, therefore completely closing the chain from raw material production to reuse. (Biofoam, 2014)

7.1.1 Properties and benefits of material from environment aspect

Basic arguments are from BioFoam website.

EPS consists of 98% air, with only 2% synthetic material.
EPS provides a major contribution to energy saving and the reduction of CO2 gas emissions.
Impact on Global Warming Potential & carbon Footprint: development of ‘life-cycle-analysis’ tool in cooperation with AkzoNobel.

Excellent recyclability

EPS can be mechanically recycled, melted and granulated to return to the basic raw material PS up to 5 times. Moreover, EPS can also be thermally recycled in waste incineration plants.

Synprodo largest EPS recycler in the Benelux Synprodo reuses large volumes of EPS in its products, including the garden trays (under the name SynTray). This saves precious raw materials and energy; it limits the waste flow and reduces the burden on the environment.

Safe energy recovery

During thermal recycling in waste incineration plants, EPS breaks down into mainly CO2 and water. The minimum volumes of released substances are less hazardous than the flue gases from natural materials including wood, wool and cork. No dioxins or furans are formed. Moreover, the energy released saves fossil fuels.

First to be Cradle to CradleCM certified

BioFoam is the first biological foam packaging in the world to be Cradle to CradleCM certified. This certification can be found in Appendix 10. Completely in line with the Cradle to CradleCM principle, BioFoam products can be endlessly reused without a loss of quality. BioFoam also drastically reduces CO2 emissions. The energy required to produce EPS is already the lowest of all packaging materials. For BioFoam, the total emission of CO2 during production is even lower. Further research must lead to its CO2-neutral production in the future.

This is world's first Poly-Lactid Acid (PLA) based product and world's first bio-based foamed product to receive this certification.

The product is assessed according to the following criteria:

- Material health
- Reutilization in technical or biological metabolisms
- Energy strategies of production process
- Social policies
- Water strategy in production process

Being produced from the renewable resource PLA, BioFoam is an addition to the current range of advanced EPS foam products offered today. BioFoam has a different environmental profile over traditional oil based plastics. After use, the BioFoam product

can be remolded into a new product like EPS and it has additional end of life options. It can be completely biodegraded, composted or used for feedstock for recycling. Being ‘designed for the environment' implies there is no chemical waste.

7.2 DOW STYROFOAM™

DOW combines the power of science and technology to passionately innovate what is essential to human progress. The company connects chemistry and innovation with the principles of sustainability to help address many of the world's most challenging problems such as the need for clean water, renewable energy generation and conservation, and increasing agricultural productivity.

Rigid foam insulation from Dow is highly valued for a wide range of applications, from insulating buildings and geotechnical installations to enhancing thermal efficiency of panel and composite materials. (DOW Buildings Solutions, 2014)

7.2.1 Properties and benefits of material from environment aspect

Basic environmental arguments are from DOW STYROFOAM. It is possible to find them on the website.

The process of extruding foamed polystyrene results in a material with uniformly small, closed cells, a smooth 'skin' and an unrivalled set of properties which make it the choice of specifies in a wide range of demanding insulation applications:

- low thermal conductivity - minimizing the board thickness needed to achieve a specific R-value, thus allowing the designer greater flexibility
- high compressive strength - in load-bearing applications, the closed cell structure gives the foam great rigidity and makes it highly resistant to compression
- low water absorption - STYROFOAM has natural resistance to rain, snow, frost and water vapor which makes it an exceptionally stable material, which retains its initial insulation performance and physical integrity in exposed conditions over the very long term. It was this unusual property that made the inverted warm flat roof concept possible, an idea pioneered by Dow
- user-friendliness - STYROFOAM is easily worked with normal hand tools
- Hygiene - STYROFOAM boards have low susceptibility to rot, meaning mould or fungal growth is minimized. They are clean, odorless and free from irritating dust.

- easy and simple to use
- easily cut by a simple tools
- resistant to rotting and destruction
- long-term retain shapes and sizes
- ecologically clean, odorless, does not cause skin irritation

Nominal Board Thickness[1], in	R-Value[2]	Board Size, ft	Edge Treatment	Min Compressive Strength[3], psi
2.0	10.0	2 x 8	Square Edge	60
3.0	15.0	2 x 8	Square Edge	60

[1] Not all product sizes are available in all regions.

[2] R means resistance to heat flow. The higher the R-value, the greater the insulating power. R-values are expressed in $ft^2 \cdot h \cdot °F/Btu$. R-value determined by ASTM C518.

[3] Vertical compressive strength is measured at 10% deformation (5% for STYROFOAM™ Brand HIGHLOAD 40, 60 and 100 Insulation products) or at yield, whichever occurs first. Since STYROFOAM™ Brand Extruded Polystyrene products are visco-elastic materials, adequate design safety factors should be used to prevent long-term creep. For static loads, 3:1 is suggested. For dynamic loads, 5:1 is suggested.

Figure 7.2 Typical characteristic of the one's DOW STYROFOAM products (DOW Buildings Solutions, 2014)

STYROFOAM is available in a number of different formats designed to meet the performance requirements of specific applications.

Where circumstances allow STYROFOAM can be:

- recycled
- disposed of as landfill
- Incinerated to recover the energy content.

Recycling material is preferable to disposal.

There are no certifications or any documents about environment properties on Dow website.

To get introduced to XPS products from an environmental perspective, for example a particular material STYROFOAM™ Brand UTILITYFIT™ XPS 15 PSI. Insulation is manufactured with a zero ozone depleting (ODP), no-VOC (volatile organic compound) foaming agent technology. STYROFOAM™ Brand UTILITYFIT™ XPS 15 PSI Insulation is reusable and confirmed only data sheet. It can be seen in Appendix 11.

7.3 BASF Styrodur Thermal Insulation

BASF is a chemical company.

BASF can look back on 50 years of experience in the XPS market. It was in 1964 that the company began producing this green insulation, which excels with its high quality, diverse applications, and robustness.

Styrodur C is the green extruded rigid polystyrene foam (XPS) from BASF. As a thermal insulation, it makes a significant contribution to climate protection by reducing CO2 emissions.

CO2 emissions of 1 to 14 kg are created in the production of one square meter of Styrodur C, depending on the thickness and bulk density of he board. In a number of applications, Styrodur C avoids CO2 emissions of 6 to 7 metric tons per square meter of insulated surface over a period of 50 years. (Over 45 years of trust in Styrodur Thermal Insulation, 2014)

As the largest chemical company in the world, BASF leads the pack in researching and developing environmentally friendly insulating solutions. Styrodur C contains only air as cell gas.

Environmental advantages:

- Environment-friendly due to CO2 processes with air as cell gas
- Reduction of carbon dioxide emissions (CO2) due to excellent insulating performance

Processing advantages:

- Low dead weight
- Simple and practical processing with tools suitable for woodworking
- Can be installed in all weather conditions
- No dust hazardous to health during mechanical processing
- Extensive product range
- Most diverse potential applications

As a result of years spent pursuing approvals, there are more officially approved uses for Styrodur than for any other XPS product in the market. This provides complete security for planning projects across the entire range of applications.

Styrodur®, BASF is one of the world's largest suppliers of plastics. But on open access their product XPS had neither mention of the certificates or any evidence. They have a lot of technical brochures and technical data where it is possible to find how to install insulation, how to use it, resistance and different properties, but not from environment point of view.

7.3.1 Properties of material from environment aspect

XPS has air inclusions, which gives it moderate flexibility, a low density, and a low thermal conductivity. XPS has a well established reputation for long term reliability and superior resistance to the elemental forces of nature. A 50 mm Styrodur was measured between -150°C and 20°C with the GHP 456 *Titan*®. The results are possible to see in figure 7.3. Good agreement with literature values was observed at RT.

The GHP 456 Titan® is the ideal tool for researchers and scientists in the field of insulation testing. Based on the well-known, standardized guarded hot plate technique (e.g. ISO 8302, ASTM C177, DIN EN 12939 or DIN EN 12667), the system features unrivalled performance over an unmatched temperature range. (Netzsch, Products and solutions, General, 2014)

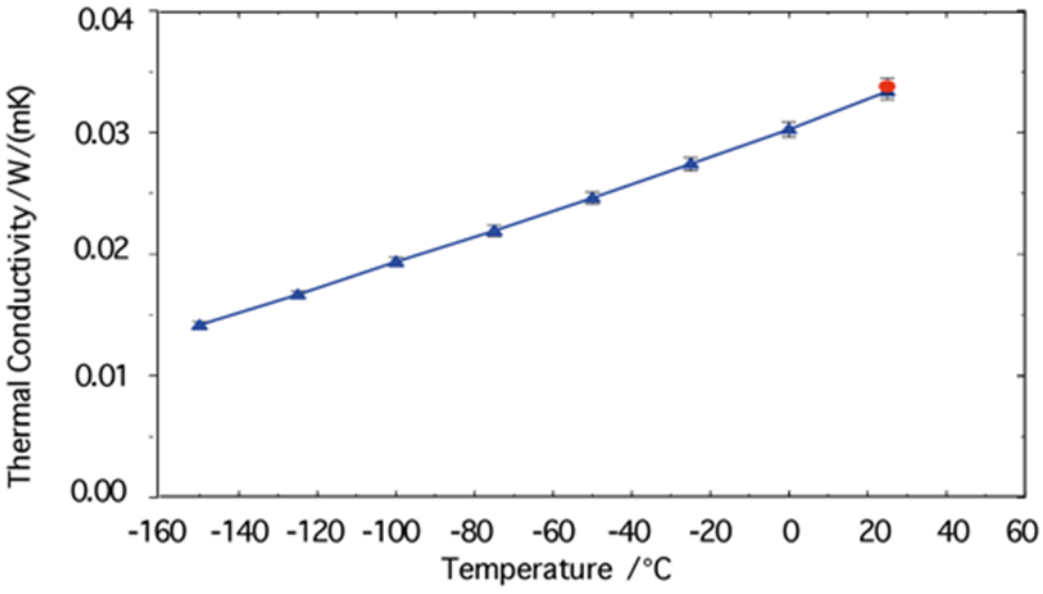

Figure 7.3 Low-temperature measurements on Styrodur (Netzsch, Products and solutions, General, 2014)

7.4 The Sunde Group

The Sunde Group is one of the leading European players in the production and conversion of EPS (expanded polystyrene) based products. The Sunde Group is a multinational company with several manufacturing plants in Europe. The raw material is marketed under the brand name Sunde. The brand name Sundolitt covers the different thermal insulation products, and Sunpack represents all the packaging products.

7.4.1 Sundolitt EPS

Sundolitt is the brand name for The Sunde Group's EPS thermal insulation products for the construction industry and void-fill blocks for the civil engineering sector.

Sundolitt EPS products are manufactured from lightweight, closed-cell, expanded polystyrene which delivers excellent thermal performance and value-for-money. (Sundegroup, Brødr. Environmental efforts, 2004)

The Sunde Group is already amongst the market leaders in Europe and Scandinavia and Sundolitt Ltd is now the UK's fastest growing manufacturer of EPS insulation.

A high-class raw material

The Sunde Group is a major manufacturer of expandable polystyrene from styrene, which is a clear colorless liquid used in thousands of everyday products.

More than 40 years of experience in producing expandable polystyrene has made Sunde EPS a refined and high-class raw material with outstanding characteristics.

Sunde EPS is mainly converted into thermal insulation and packaging. (Sundegroup, Brødr. Environmental efforts, 2004)

Economic and environmental sound product

The Sunde Group provides a wide range of product grades and qualities of EPS with different performance characteristics to meet all market requirements.

Common characteristics of Sunde EPS grades are fast production cycle, low energy consumption, good fusion and excellent surface finish. The material also has low thermal conductivity and excellent load bearing properties.

7.4.2 Properties and benefits of material from environment aspect

The Sunde Groups environmental objects are:

- The Group's operations shall not present any harm to humans or the environment.
- National permits, laws and regulations must be followed.
- Health, environment and safety are a natural part of any planning and activity.
- Continuous efforts are made to improve factors that influence the environment regarding processes, products and services.
- The employees shall be informed and motivated so they can contribute to a better environmental standard, and to achieve the above mentioned environmental objectives.

Energy saving

Installing EPS insulation means that less heating fuel or energy for air conditioning is required, conserving valuable reserves of finite natural resources.

The energy savings with EPS insulation are huge - for every kilogram of oil used to manufacture EPS products, 200 kilograms are saved in reduced heating requirements in the products lifetime. Insulating to meet the most stringent regulations can cut heat loss from the average home by more than 70% compared to the non-insulated house, and since EPS is 98% air its production accounts for only a fraction of our total oil consumption.

Fire behavior

In the event of a fire, the gases given off by EPS do not differ essentially from those released by other organic materials, consisting primarily of carbon dioxide.

Sundolitt insulation is also available in flame retardant grades which are more difficult to ignite than standard grades.

Recycling

EPS waste is versatile because it can be recycled into new products, or alternatively used as a fuel for power generation. The Sunde Group is working to ensure that the best solutions to the problem of waste management are adopted in order to achieve maximum environmental protection.

Sunpack packaging is recycled:

- Back to packaging: It is granulated and blended with virgin EPS foam beads to make new EPS moldings. It can also be blended with virgin crystal polystyrene and re-gassed to make EPS loose fill packaging.

Health and emissions

During production of EPS there is no waste which can cause harm to the ozone layer. However, the effective application of EPS can cut CO^2 emissions by up to 50%, thereby reducing consumption of fossil fuels which add to global warming. Emissions from controlled and clean burning at high temperatures are less harmful to the environment than the average garden bonfire.

The manufacturing and installation of EPS conforms to the most stringent health and safety standards. Styrene is not classified under the EC's Dangerous Substances Directive and Europe's regulatory authorities do not regard pentane, used to expand the polystyrene granules into the familiar foam, as a health hazard.

On the contrary, EPS has no nutritional value to support fungal, bacteriological or animal growth. In addition, the EPS material does not provoke any allergy and is recommended by several European countries as preferential to rock wool insulation.

The General Federation of Trade Unions in Denmark recommends that EPS insulation is installed instead of rock wool. EPS is non-toxic and has no nutritional value to support bacteriological or fungal growth; therefore it's an ideal material to work with. These characteristics, combined with the high versatility, make EPS a product for the future.

Sundolitt represents a complete system of thermal insulation. The range includes insulation for walls, roofs, floors and substructures, including roads and railroads. Sundolitt is lightweight, rigid and easy to handle, and the cell structure ensures lasting thermal insulation and resistance to moisture absorption.

Sundolitt thermal insulation is used in a wide variety of constructions. It is used in combination with concrete, wood or steel walls above grade, or on foundations where the insulation can be in contact with the soil. The rigid insulation permits the walls to be completely covered, eliminating thermal loss which can reduce the effectiveness of the insulation system. (Sundegroup, Brødr. Environmental efforts, 2004)

All Sundolitt insulation products are manufactured in compliance with BS EN 13163: 2001, the European Standard for EPS Thermal Insulation products for the construction industry.

Sundolitt operates a Quality Management System which complies with the requirements of BS EN ISO 9001:2008. This certificate can be seen in Appendix 12.

All Sunde raw materials are certified to ISO 14001:2004 quality and environmental standards. Approved by Nemko AS - Certificate Nr. 901198. The logo is in figure 7.4.

Figure 7.4 The logo of Nemko AS – Certificate (Sunde group, Brødr. Environmental efforts, 2004)

7.5 RESULTS

The thermal insulation property of EPS and XPS'S of identical densities is quite close. However, compared to XPS, EPS with the same level of density is less expensive. Moreover, XPS is usually avoided in areas where materials with less density are preferable and where XPS (since not produced below a certain density level) is not applicable. In this case, the use of EPS as a less density material ensures the required thermal insulation and offers considerable benefits in terms of cost efficiency.

Thermal conductivity in XPS foamed with EPS and CO2 is slightly increased and the thermal conductivity in the air is reduced following air contact. In addition, various gases used in the manufacture of XPS have highly different ecologic properties.

8 CONCLUSIONS

The modern market is saturated with products that claim to be "environmentally friendly». Industry insulation materials include a number of medium and big companies, as well as hundreds of smaller producers. In a larger organization the advantage can be strong corporate governance, which monitors the market requirements, but small organizations do not. It is obvious that in the confusion around the environmentally friendly building some manufacturers of insulation materials are exaggerating, perhaps unconsciously, the ecological purity of their products.

Eco-friendly goods are beneficial not only for business but also for common purchaser - by reducing the cost of production and transportation. General requirements for selection of eco-friendly products are known: local production, which minimizes transport costs, polluting the atmosphere; environment safety and cost-effective production, that reducing costs.

This thesis is a review of heat insulation market. All producers say about low thermal conductivity, light weight, thinner, higher insulation value, raw materials, renewable resources, but it hard or impossible to find some proofs of their environmental messengers.

FIGURES

TABLES

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The certificate of an independent European Committee - EUCEB

EUCEB - European Certification Board for Mineral Wool Products

CERTIFICATE N° 381
for the right to use the EUCEB Trademark

In accordance with the Constitution of the European Certification Board for Mineral Wool Products (EUCEB), the Management Board certifies that

URSA Insulation, S.A. - JLC URSA EURASIA
Plant Chudovo
Glass Wool MMVF ß

has successfully passed EUCEB's recognition procedure (Appendix N° 381) for obtaining the registered Trademark certifying the conformity of fibres produced with the requirements of Note Q of the Regulation (EC) No 1272/2008 of the European Parliament and of the Council as currently in force.

Brussels, 09/10/2013

Mr. Aymon de Reydellet
- President -

Dr. Harald Meyer
- Chairman of the Quality Board –

The validity of this certificate can be checked on the EUCEB web-site or at the EUCEB Secretariat.

www.euceb.org
Avenue Louise 375 - Bte 4, BE -1050 Brussels, Belgium
Tel: +32 (0)2 647 52 54 Fax: +32 (0)2 647 37 66 E-mail: info@euceb.org

EUCEB - European Certification Board for Mineral Wool Products

APPENDIX N° 381

The Quality Board has received for the subject:

Initial Application for the right to use the Trademark

from the company

URSA Insulation, S.A. - JLC URSA EURASIA
Plant Chudovo
Glass Wool MMVF ß

the following documents:

- Legal Undertaking of *24/03/2006*
- Manufacturers Declaration of *24/03/2006*
- Certificate of exoneration of the short term biopersistence test presented for Glass Wool MMVF ß of *12/05/1999*
- Report from RCC of the short term biopersistence test No *696453* of *03/04/2001*
- Confirmation of the External Expert – Biopersistence Testing that Glass Wool MMVF ß complies with EUCEB-exoneration criteria of *18/02/2002*
- Report of Analysis Institute on initial conformity inspection No *62-06* of *14/03/2006*
- Confirmation of the External Expert – Chemical Analysis that initial conformity inspection complies with EUCEB range of exonerated Glass Wool MMVF ß of *06/04/2006*

Examination for completeness and accuracy of the documents presented has revealed, that the requirements are complied with and that thus the right to use the EUCEB Trademark may be granted to URSA Insulation, S.A. - JLC URSA EURASIA, plant Chudovo

Brussels, 09/10/2013

Harald Meyer.

- Dr. Harald Meyer -
Chairman, Quality Board

- Mr. Steve Williams -
Vice Chairman, Quality Board

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URSA Insulation, S.A. - JLC URSA EURASIA
Plant Chudovo
Glass Wool PDT PZ II

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Glass Wool MMVF ß

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Plant Serpuchov
Glass Wool PDT PZ II

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Brussels, 09/10/2013

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- President -

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Brussels, 09/10/2013

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The Environmental Declaration ISO 14025

Environmental Declaration ISO 14025

epd-norge.no

Rockwool Products

ROCKWOOL
BRANNSIKKER ISOLASJON

NEPD no: 131E
Approved according to ISO 14025, § 8.1.4
Approval date: 01.12.2009
Valid until: 01.12.2012

Verification:
Independent verification of this declaration and underlying documentation has been carried out by Agnes Schuurmans, Rockwool Benelux, BV, the Netherlands in accordance with ISO 14025, § 8.1.3

30-11-2009

This declaration has been prepared by:
Anders Ulf Clausen: Rockwool International A/S

30-11-2009

PCR: NPCR 012 Insulation materials, approved by the Norwegian verification committee, has been applied.

About EPD: EPD's from other program operators than The Norwegian EPD Foundation may not be comparable.

Information on producer

Organisation	AS Rockwool http://www.rockwool.no
Address	Gjerdrumsvei 19,Postbox 4215; Nydalen ; Oslo
Contact person	Jens Ole Iversen , Kvalitetschef Rockwool SC
Organisation no	923828583
ISO 14001:	DNKFRC9000561B (15-10-2009))

Information about the product and the LCA

Product description	Rockwool Steinull (stone wool) is a non combustible thermal insulation material for insulation against heat, cold, fire, vibration and noise. Rockwool is made from stone raw materials [1]. The product is used in building construction, industry, rail and marine applications. The EPD applies to Rockwool stone wool according to the EN 13162.
Coverage of LCA and EPD	Complete "Cradle to grave" declaration. Energy savings during use calculated seperately. Maintenance and replacements n.a. Main processes are site-specific data from 2002; production of raw materials are literature data and specific supplier data.
Functional unit (NPCR 012)	The functional unit (FU) is 1 m^2 insulation, with a thermal resistance of 1m^2*K/W; used as insulation in a building with the expected lifetime equal to the building lifetime >>60 years. Lambda(d) =0.037W/m*K; Density 32 kg/m^3; (Weight = 1.184 kg)
Estimated durability	Building lifetime >> 60 years
Production site	EPD is based on production in Doense (DK). The environmental impacts are judged to be representative for most European production facilities. For Norwegian production, the impacts may be lower due to differences in electricity production.
Market description	The EPD is valid for products on the Scandinavian market (N, SE, DK)

Table 1. Material use per (FU) from [2]

Final product	Relative weight of components	Per (FU)
Product weight	100 %	1.184 kg
Stone wool fibres	97.8 %	1.158 kg
Binder (resin)	2.2 %	0.023 kg
Highly refined mineral oil	0.2 %	0.002 kg
LDPE (packaging)		0.021 kg
Wood (pallets)		0.050 kg

Environmental indicators

Global warming potential	1449 g CO_2 eqvivalents per FU [2]
Total energy consumption	20.8 MJ per FU [2]
Recirculated materials	23 %
Indoor climate classification:	Pass Finnish M1 indoor climate label [3] and Danish/Norway indoor climate label [3]

The ISO14001 certificate

DNV BUSINESS ASSURANCE

MANAGEMENT SYSTEM CERTIFICATE

Sertifikaatti Nro: 78125-2010-AE-FIN-FINAS

Tämän todistetaan, että

PAROC OY AB

Energiakuja 3, 00180 Helsinki

noudattaa seuraavaa johtamisjärjestelmästandardia:

ISO 14001:2004

Tämä sertifikaatti kattaa seuraavan toiminnan tai palvelun:

Raaka-aineen louhinta sekä Paroc-eristeiden kehitys, tuotanto ja myynti.

Alkuperäinen sertifikaatti myönnetty:
8. toukokuuta 2000 -
16. joulukuuta 2013

Sertifikaatin voimassaolo päättyy:
31. elokuuta 2015

Arvioinnista vastaa:
Keijo Koskinen
Pääarvioija

FINAS
Finnish Accreditation Service
S401 (EN ISO/IEC 17021)

Päiväys ja sinetti:
Espoo, 16. joulukuuta 2013

Akkreditoitu yksikkö:
DNV CERTIFICATION OY/AB,
FINLAND

Kimmo Hanrala
Johtajan edustaja

Tämä sertifikaatti on käännös alkuperäisestä englanninkielisestä sertifikaatista.

DNV BUSINESS ASSURANCE

APPENDIX TO CERTIFICATE

Tämä liite liittyy sertifikaattiin numero 78123-2010-AE-FIN-FINAS

PAROC OY AB

toimipisteet, jotka on sertifioitu, ovat seuraavat:

Energiakuja 3, 00180 Helsinki
Pitkämäentie 432, 73100 Lapinlahti
Poikkitie 1, 53650 Lappeenranta
Lovaksentie 432, 52700 Mäntyharju
Mineraalitie 14, 90620 Oulu
Ryfisuontaival 210, 90900 Oulu
Skräbbölentie 14-16, 21600 Parainen
Sysilahden teollisuusalue 4, 21600 Parainen
Yhdyntäväg 47, 21600 Parainen
Ahveniammentie 86, 25410 Salo
Talvijärventie 65, 54800 Savitaipale

Alkuperäinen sertifikaatti myönnetty
8. toukokuuta 2000 -
16. joukokuuta 2013

Sertifikaatin voimassaolo päättyy
31. elokuuta 2015

Arviointiin vastuussa
Keijo Koskinen
Pääarvioija

IAF

FINAS
Finnish Accreditation Service
S004 (EN ISO/IEC 17021)

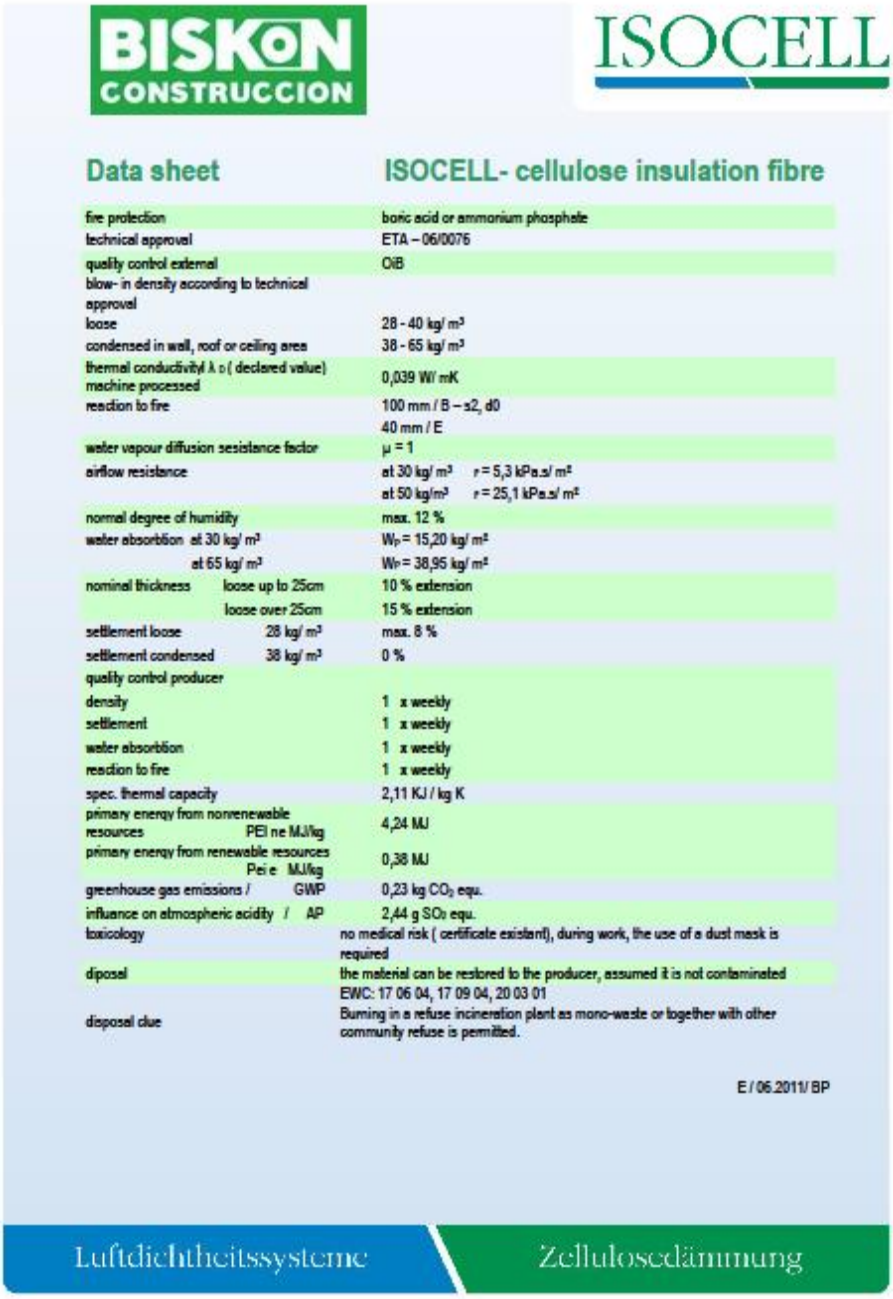
Paikka ja aika
Espoo, 16. joulukuuta 2013

Allekirjoitus puolesta
DNV CERTIFICATION OY/AB,
FINLAND

Kimmo Haarala
Johtava esimies

Tämä sertifikaatti on käännös alkuperäisestä englanninkielisestä sertifikaatista.

The ISOCELL data sheet



BISKON CONSTRUCCION

ISOCELL

Data sheet — ISOCELL- cellulose insulation fibre

fire protection	boric acid or ammonium phosphate
technical approval	ETA – 06/0076
quality control external	OIB
blow- in density according to technical approval	
loose	28 - 40 kg/ m³
condensed in wall, roof or ceiling area	38 - 65 kg/ m³
thermal conductivityl λ D (declared value) machine processed	0,039 W/ mK
reaction to fire	100 mm / B – s2, d0 40 mm / E
water vapour diffusion sesistance factor	μ = 1
airflow resistance	at 30 kg/ m³ r = 5,3 kPa.s/ m² at 50 kg/m³ r = 25,1 kPa.s/ m²
normal degree of humidity	max. 12 %
water absorbtion at 30 kg/ m³	W_P = 15,20 kg/ m²
at 65 kg/ m³	W_P = 38,95 kg/ m²
nominal thickness loose up to 25cm	10 % extension
loose over 25cm	15 % extension
settlement loose 28 kg/ m³	max. 8 %
settlement condensed 38 kg/ m³	0 %
quality control producer	
density	1 x weekly
settlement	1 x weekly
water absorbtion	1 x weekly
reaction to fire	1 x weekly
spec. thermal capacity	2,11 KJ / kg K
primary energy from nonrenewable resources PEI ne MJ/kg	4,24 MJ
primary energy from renewable resources Pei e MJ/kg	0,38 MJ
greenhouse gas emissions / GWP	0,23 kg CO_2 equ.
influance on atmospheric acidity / AP	2,44 g SO_2 equ.
toxicology	no medical risk (certificate existant), during work, the use of a dust mask is required
diposal	the material can be restored to the producer, assumed it is not contaminated
disposal clue	EWC: 17 06 04, 17 09 04, 20 03 01 Burning in a refuse incineration plant as mono-waste or together with other community refuse is permitted.

E / 06.2011/ BP

Luftdichtheitssysteme | Zellulosedämmung

Biskon Construcciones - J.M. Blanes 1128 - Montevideo +598 (0)98 65 71 28

The certification №07/0285

CI/SfB (21) K

Bord Agrément na hÉireann
Irish Agrément Board

CERTIFICATE NO. 07/0285

ECOCEL Ltd., Unit 33, Haven Hill,
Summercove, Kinsale, Co. Cork.

Tel: +353 (0)21 4706826
Fax: +353 (0)21 4706826

Ecocel Loft Insulation

Isolation de grenier
Wärmedämmung

The **Irish Agrément Board** is designated by Government to issue European Technical Approvals.

Irish Agrément Board Certificates establish proof that the certified products are **'proper materials'** suitable for their intended use under Irish site conditions, and in accordance with the **Building Regulations 1997 to 2006.**

The **Irish Agrément Board** operates in association with the **National Standards Authority of Ireland (NSAI)** as the National Member of UEAtc.

PRODUCT DESCRIPTION:
This Certificate relates to Ecocel Loft Insulation, a cellulose fibre made from recycled paper products, treated with inorganic salts to provide protection against fire, for use as a thermal insulation material mechanically blown into lofts. It is manufactured in accordance with the requirements of BS 5803-3:1985 *Thermal insulation for use in pitched roof spaces in dwellings – Specification for cellulose fibre thermal insulation for application by blowing.*

This Certificate certifies compliance with the requirements of the Building Regulations 1997 to 2006.

USE:
The product is used for the thermal insulation of new or existing lofts using a mechanical blowing system by approved installers, who are trained and monitored by ECOCEL Ltd.

MANUFACTURE AND MARKETING:
The product is manufactured and marketed by:

ECOCEL Ltd.,
Unit 33,
Haven Hill,
Summercove,
Kinsale,
Co. Cork.
Tel: +353 (0)21 4706826
Fax: +353 (0)21 4706826

Readers are advised to check that this Certificate has not been withdrawn or superseded by a later issue by contacting the Irish Agrément Board, NSAI, Glasnevin, Dublin 9 or online at http://www.nsai.ie/modules/certificates/uploads/pdf/IAB070285.pdf

The certification M1 - Emission Classification of Building Materials

RAKENNUSTIETO
The Building Information Foundation RTS

EMISSION CLASS FOR BUILDING MATERIAL
M1

EMISSION CLASSIFICATION OF BUILDING MATERIALS

Ekovilla Oy

The classification working group set up by the Building Information Foundation RTS has approved the following product:

Ekovilla AP
Ekovilla ONTELO > 60°
Ekovilla ONTELO ≤ 60°
Ekovilla SE
Ekovilla YP

as belonging to emission class M1 for building materials.

The classification is valid until 9.1.2015.

Ekovilla Oy has the right to equip its classified products with the classification mark and to use this classification mark when marketing its products.

The decision is in line with the requirements laid down in the Classification of Indoor Climate 2008 and the Classification of Building Materials: General Instructions.

THE BUILDING INFORMATION FOUNDATION RTS

Matti Rautiola
Director General

Tiina Tirkkonen
Secretary of the Classification Working Group

The Building Information Foundation RTS, P.O.B 1004, FI-00101 Helsinki, Finland
Tel. +358 207 476 400, www.rakennustieto.fi

RAKENNUSTIETO
The Building Information Foundation RTS

EMISSION CLASS FOR BUILDING MATERIAL
M1

EMISSION CLASSIFICATION OF BUILDING MATERIALS

Ekovillalevy Oy

The classification working group set up by the Building Information Foundation RTS has approved the following product manufactured by your company:

Ekovillalevy

as belonging to emission class M1 for building materials.

The classification is valid until 20.10.2014.

Ekovillalevy Oy has the right to equip its classified products with the classification mark and to use this classification mark when marketing its products.

The decision is in line with the requirements laid down in the Classification of Indoor Climate 2008 and the Classification of Building Materials: General Instructions.

THE BUILDING INFORMATION FOUNDATION RTS

Matti Rautiola
Director General

Tiina Tirkkonen
Secretary of the Classification Working Group

The Building Information Foundation RTS, P.O.B 1004, FI-00101 Helsinki, Finland
Tel. +358 207 476 400, www.rakennustieto.fi, rts@rakennustieto.fi

The certification M1 - Emission Classification of Building Materials

RAKENNUSTIETO
The Building Information Foundation RTS

EMISSION CLASS FOR BUILDING MATERIAL
M1

EMISSION CLASSIFICATION OF BUILDING MATERIALS

SPU Systems Oy

The classification working group set up by the Building Information Foundation RTS has approved the following product manufactured by your company:

SPU AL
SPU ROOF BOARD
SPU P
SPU RENOVATION BOARD
SPU SAUNA
SPU WALL BOARD
SPU ATTIC BOARD

as belonging to emission class M1 for building materials.

The classification is valid until 17.5.2014.

SPU Systems Oy has the right to equip its classified products with the classification mark and to use this classification mark when marketing its products.

The decision is in line with the requirements laid down in the Classification of Indoor Climate 2008 and the Classification of Building Materials: General Instructions.

THE BUILDING INFORMATION FOUNDATION RTS

Matti Rautiola
Director General

Tiina Tirkkonen
Secretary of the Classification Working Group

The Building Information Foundation RTS, P.O.B 1004, FI-00101 Helsinki, Finland
Tel. +358 207 476 400, www.rakennustieto.fi, rts@rakennustieto.fi

The British Board of Agrément (BBA)

Recticel Insulation Products
Enterprise Way
Meir Park
Stoke on Trent
Staffordshire ST3 7UN
Tel: 01782 590470 Fax: 01782 590497
e-mail: technicalservices@recticel.com
website: www.recticelinsulation.co.uk

BBA APPROVAL INSPECTION TESTING CERTIFICATION
TECHNICAL APPROVALS FOR CONSTRUCTION

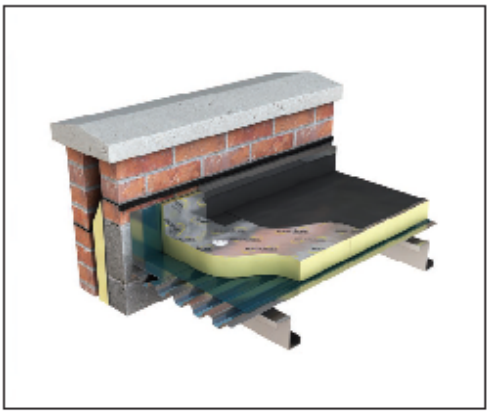
Agrément Certificate
95/3113
Product Sheet 2

RECTICEL INSULATION

EUROTHANE EURODECK

This Agrément Certificate Product Sheet[1] relates to Eurothane Eurodeck, a rigid thermoset polyisocyanurate foil-faced insulation for use as a thermal insulation layer on limited access concrete, metal or timber flat roof decks. It is for use in conjunction with a vapour control layer and a single ply mechanically fixed roof waterproofing membrane in domestic and non-domestic buildings.

(1) Hereinafter referred to as 'Certificate'.



CERTIFICATION INCLUDES:

- factors relating to compliance with Building Regulations where applicable
- factors relating to additional non-regulatory information where applicable
- independently verified technical specification
- assessment criteria and technical investigations
- design considerations
- installation guidance
- regular surveillance of production
- formal three-yearly review.

KEY FACTORS ASSESSED

Thermal performance — the product has a declared thermal conductivity* ($\lambda_{90/90}$ value) of 0.022 W·m^{-1}·K^{-1} (see section 6).

Condensation risk — the product can contribute to limiting the risk of surface condensation (see section 7).

Strength and stability — when installed on suitable substrates using appropriate fixings, the product can adequately transfer maintenance traffic loads and wind loads to the roof deck (see section 8).

Behaviour in relation to fire — the fire rating of any roof containing the product will depend on the type of deck and the nature of the roof waterproof covering (see section 9).

Durability — the product, when used as thermal insulation in the roof system described in this Certificate, will have a life at least as long as that of a roof waterproofing covering (see section 11).

The BBA has awarded this Certificate to the company named above for the product/system described herein. This product/system has been assessed by the BBA as being fit for its intended use provided it is installed, used and maintained as set out in this Certificate.

On behalf of the British Board of Agrément

Date of First issue: 20 August 2012

Sean Moriarty — Head of Approvals
Energy and Ventilation

Greg Cooper
Chief Executive

The BBA is a UKAS accredited certification body — Number 113. The schedule of the current scope of accreditation for product certification is available in pdf format via the UKAS link on the BBA website at www.bbacerts.co.uk

Readers are advised to check the validity and latest issue number of this Agrément Certificate by either referring to the BBA website or contacting the BBA direct.

British Board of Agrément
Bucknalls Lane
Garston, Watford
Herts WD25 9BA
tel: 01923 665300
fax: 01923 665301
e-mail: mail@bba.star.co.uk
website: www.bbacerts.co.uk

The certificate of approval ISO 9001 system

LRQA
Business Assurance

CERTIFICATE OF APPROVAL

This is to certify that the Quality Management System of:

Recticel Insulation
Division of Recticel
Wevelgem (Belgium) and Stoke-on-Trent (UK)

has been approved by Lloyd's Register Quality Assurance
to the following Quality Management System Standards:

ISO 9001 : 2008

The Quality Management System is applicable to:

Development and manufacturing of polyurethane panels for thermal insulation.

Approval Certificate No: ANT951267.1	Original Approval	:	8 November 1996
	Current Certificate	:	1 November 2011
	Certificate Expiry	:	31 October 2014

Issued by: Lloyd's Register EMEA, Antwerp Office
for and on behalf of Lloyd's Register Quality Assurance Limited

UKAS
001

This document is subject to the provision on the reverse
71, Fenchurch Street, London EC3M 4BS, United Kingdom, registration number 1879370
This approval is carried out in accordance with the LRQA assessment and certification procedures and monitored by LRQA.
The use of the UKAS Accreditation Mark indicates Accreditation in respect of those activities covered by the Accreditation Certificate number 001.

The certificate Cradle to Cradle CM

CRADLE TO CRADLE
PRODUCTS
INNOVATION
INSTITUTE

LICENSED MARKS:

CERTIFIED
cradle to cradle
SILVER

Cradle to Cradle Certified™ Silver

THE LICENSED MARKS IDENTIFIED ABOVE MAY BE LICENSED TO:

Synbra Technology BV

FOR THE BELOW LISTED CERTIFIED PRODUCTS ASSOCIATED WITH THE NAME:

BioFoam®

Only the following products are considered Certified Product(s) within the scope of this certification and the associated Trademark License Agreement:

Synbra BioFoam®

Cradle to Cradle Products Innovation Institute

ISSUE DATE
2 June 2014

CERTIFICATION #
1979

EXPIRATION DATE
1 June 2015

Assessor: Michael Braungart,
Environmental Protection
Encouragement Agency

EPEA

Certified under Version 2.1.1 of the Cradle to Cradle Certified™ Product Standard
Use of Licensed Marks is subject to terms and conditions of the C2CPII Trademark License Agreement and Trademark Use Guidelines.
Cradle to Cradle Certified™ is a certification mark licensed by the Cradle to Cradle Products Innovation Institute

The data sheet of XPS 15 PSI STYROFOAM Brand UTILITYFIT

PRODUCT INFORMATION . COMMERCIAL/RESIDENTIAL . UNITED STATES

STYROFOAM™ BRAND UTILITYFIT™ XPS 15 PSI
EXTRUDED POLYSTYRENE FOAM INSULATION

1. PRODUCT NAME

STYROFOAM™ Brand UTILITYFIT™ XPS 15 PSI Extruded Polystyrene Foam Insulation

2. MANUFACTURER

The Dow Chemical Company
Dow Building Solutions
200 Larkin
Midland, MI 48674
1-866-583-BLUE (2583)
Fax 1-989-832-1465
www.insulateyourhome.com

3. PRODUCT DESCRIPTION

BASIC USE

STYROFOAM™ Brand UTILITYFIT™ XPS 15 PSI Extruded Polystyrene Foam Insulation is a versatile, utility-grade product manufactured for applications that require a high R-value* and outstanding moisture resistance without the need for high compressive strength.

STYROFOAM™ Brand UTILITYFIT™ XPS 15 PSI Insulation is designed for use when a Type X, or lower-compressive-strength, product is needed. If the superior properties of a Type IV 25 psi product are not required, STYROFOAM™ Brand UTILITYFIT™ XPS 15 PSI Insulation is a good choice for your application.

4. TECHNICAL DATA

APPLICABLE STANDARDS

STYROFOAM™ Brand UTILITYFIT™ XPS 15 PSI Insulation meets ASTM C578 Type X – Standard Specification for Rigid Cellular Polystyrene Insulation. Applicable standards include:

- C518 – Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus
- D1621 – Standard Test Method for Compressive Properties of Rigid Cellular Plastics
- C272 – Standard Test Method for Water Absorption of Core Materials for Structural Sandwich Constructions
- E96 – Standard Test Methods for Water Vapor Transmission of Materials
- D696 – Standard Test Method for Coefficient of Linear Thermal Expansion of Plastics between -30°C and 30°C with a Vitreous Silica Dilatometer

CODE COMPLIANCES

STYROFOAM™ Brand UTILITYFIT™ XPS 15 PSI Insulation complies with the following codes:

- Meets IBC/IRC requirements for foam plastic insulation; see ICC-ES NER-699
- ICBO-ES ER 2257
- BOCA-ES RR 21-02
- Underwriters Laboratories, Inc. (UL) Classified, see Classification Certificate D369

Contact your Dow sales representative or local authorities for state and local building code requirements and related acceptances.

TYPICAL PHYSICAL PROPERTIES

STYROFOAM™ Brand UTILITYFIT™ XPS 15 PSI Insulation exhibits the typical properties and characteristics indicated in Table 2 when tested as represented.

Prolonged exposure to ultraviolet radiation may cause the surface of STYROFOAM™ Brand UTILITYFIT™ XPS 15 PSI Insulation to become faded and dusty. A light-colored, opaque protective covering should be used if excessive solar exposure is expected. The surface degradation will have no measurable effect on the insulating value of the plastic foam unless the deterioration is allowed to continue until actual foam thickness is lost. Since the dust would impair the performance of adhesives and finishes, the dusty surface should be brushed off before these products are applied.

ENVIRONMENTAL DATA

STYROFOAM™ Brand UTILITYFIT™ XPS 15 PSI Insulation is manufactured with a zero ozone-depleting (ODP), no-VOC (volatile organic compound) foaming agent technology. STYROFOAM™ Brand UTILITYFIT™ XPS 15 PSI Insulation is reusable in many applications.

TABLE 1: SIZES, R-VALUES AND EDGE TREATMENTS FOR STYROFOAM™ BRAND UTILITYFIT™ XPS 15 PSI EXTRUDED POLYSTYRENE FOAM INSULATION

NOMINAL BOARD THICKNESS[1], IN	R-VALUE[2]	BOARD SIZE, FT	EDGE TREATMENT
1.0	5.0	2 x 8, 4 x 8, 4 x 9	Square Edge, Tongue and Groove, Scoreboard
1.5	7.5	2 x 8, 4 x 8, 4 x 9	Square Edge, Tongue and Groove, Scoreboard
2.0	10.0	2 x 8, 4 x 8, 4 x 9	Square Edge, Tongue and Groove, Scoreboard
3.0	15.0	2 x 8, 4 x 8, 4 x 9	Square Edge, Tongue and Groove, Scoreboard

(1) Not all product sizes are available in all regions. Additional product sizes are available by custom order. Consult your Dow sales representative about other sizes and lead-time requirements.
(2) Aged R-value at 1" cured foam @ 75°F mean temperature. R-value expressed in ft²•h•°F/Btu. R-value determined by ASTM C518 using the aging process in ASTM C1289 (90 days @ 140°F).

* R means resistance to heat flow. The higher the R-value, the greater the insulating power.

The certificate of registration
Quality Management System

Certificate of Registration

QUALITY MANAGEMENT SYSTEM

This is to certify that:

Sundolitt Limited
Bath Road
Green Lane Industrial Estate
Gateshead
NE10 0JT
United Kingdom

Holds Certificate No: **FM 37631**

and operates a Quality Management System which complies with the requirements of BS EN ISO 9001:2000 for the following scope:

The manufacture of shape moulded expanded polystyrene products.

For and on behalf of BSI:

Managing Director, BSI Management Systems (UK)

Originally registered: 08/08/1997 Latest issue: 28/03/2008

Page: 1 of 2

This certificate was issued electronically and remains the property of BSI and is bound by the conditions of contract.
This certificate does not expire. An electronic certificate can be authenticated online.
Printed copies can be validated at www.bsi-global.com/ClientDirectory

The British Standards Institution is incorporated by Royal Charter.
Management Systems (UK) Headquarters: P.O. Box 9000, Milton Keynes MK14 6WT. Tel: 0845 080 9000

BSI Management Systems

VTT certification

VTT EXPERT SERVICES OY

SERTIFIKAATTI Nro 203/05

Myöntämispäivä 18.2.2005 Päivitetty 14.1.2010

TUOTTEEN NIMI

Technoelast bitumikatteet

VALMISTAJA

TechnoNICOL - Vyborg LTD.
Leningradin alue,
Pos. Kalinina
188804 Viipuri
Venäjä

TUOTEKUVAUS

Technoelast bitumikate muodostuu yhdestä tai useammasta kumibitumikermistä. Kumibitumikermit on valmistettu styreeni-butadieeni-styreeni (SBS) -elastomeeristä ja bitumista sekä tukikerroksena käytettävästä polyesterihuovasta. Järjestelmään kuuluu lisäksi liimausbitumi, jonka ominaisuudet on määritetty.

SERTIFIOINTIMENETTELY

Tämä sertifikaatti perustuu tuotteiden testaukseen ja tuotteeseen liittyvän laadunvarmistusjärjestelmän tarkastamiseen VTT:n bitumikermikattojen sertifiointiperusteiden ja tämän sertifikaatin kohdan 3 mukaisesti. Sertifioinnin yleiset menettelyt perustuvat VTT Expert Services Oy:n sertifiointijärjestelmään. Sertifiointiperusteet on kuvattu VTT Expert Services Oy:n bitumikermikattojen sertifiointiperusteissa, VTT SERT R005/01 Osa 1. Bitumikermit.
Tämä sertifikaatti on voimassa enintään viisi (5) vuotta päivittämispäivästä ja sen voimassaolon ehdot on esitetty kohdassa 14.

3.5 Valmistajalla on sertifioitu ISO 9001:2000 laatujärjestelmä (Ino Acert Bureau)

3.6 Ulkoisessa laadunvalvonnassa todetaan valmistajan sisäisen laadunvalvonnan asianmukaisuus laadunvalvontasopimuksessa ja VTT:n bitumikermien sertifiointiperusteissa määritellyn menettelytavan mukaisesti.

Taulukko 1. Bitumikermien tuoteluokkavaatimukset

	Testaus-menetelmä	Vaati-mus	Yksikkö	TL 1 [1]	TL 2	TL 3	TL 4
Vetolujuus, 23 °C; pit.s/poikkis	EN 12311-1	Min	N/50 mm	750/500	500/400	500/400	250/200
Venymä, 23 °C; pit.s/poikkis	EN 12311-1	Min	%	15	30	20	2
Venymä, - 20 °C; pit.s/poikkis	EN 12311-1[2] (mod.)	Min	%	15	30	10	2
Naulanvarren repäisylujuus pituussuunta/poikkisuunta	EN 12310-1	Min	N	300	130	100	40
Lämmönkestävyys	EN 1110	Min	°C	80	80	80	80
Vesitiiveys [3]	EN 1928 B	Min	kPa	500	300	200	100
Sirotteen kiinnipysyvyys[5]	EN 12039	Max	%	30	30	30	30
Taivutettavuus, lämpötila/halk. - Liimattava kermi, pinta/pohja - Hitsattava kermi, pinta - Hitsattava kermi, pohja	EN 1109	Max/max	°C/mm °C/mm °C/mm	 -25/30 -20/30 -10/30	 -25/30 -20/30 -10/30	 -15/30 -10/30 0/30	 -25/30 -20/30 -10/30
Pitkäaikaiskestävyys -Lämmönkestävyys (vanh. jälk) -Taivutettavuus (vanh. jälk) - Liimattava kermi, pinta/pohja - Hitsattava kermi, pinta - Hitsattava kermi, pohja	EN 1296 (EN 1110) (EN 1109)	Min Max/max	°C °C/mm	80 -15/30 -10/30 - 0/30	80 -15/30 -10/30 - 0/30	80 -5/30 -0/30 +10/30	80 -15/30 -10/30 - 0/30
Puhkaisulujuus, halkaisija - Dynaaminen (isku), - 10 °C	EN 12691	Max	Ø mm	20			
Dimensiostabiliteetti (pit.s)	EN 1107-1	Max	+/- %	0,3	0,6	0,6	0,6
Sauman vetolujuus	EN 12317-1	Min	N/50 mm	500			
Nimellispaino,[4] - Aluskermi - Hitsattava aluskermi - Pintakermi - Hitsattava pintakermi	EN 1849-1	Nimell.	g/m²	 3500 4500 4500 5500	 3000 4000 4000 5000	 3000 4000 4000 5000	 2200 3200 3800 4800
Nimellispaino (alitus nimellispainosta) [4]	EN 1849-1	Max	%	-5	-5	-5	-5
(Nimellispaksuus)	EN 1849-1	Nimell.	mm	Ilm.	Ilm.	Ilm.	Ilm.
Pituus ja leveys	EN 1848-1	Ilm	mm	Ilm	Ilm	Ilm	Ilm
Suoruus	EN 1848-1	Max	Mm/10 mm	20	20	20	20

1) TL 1 - luokassa suurempi lujuus, dimensiostabiliteetti ja puhkaisulujuus vähentävät tuotteiden venymää
2)Testausmenetelmä poikkeaa EN 12311-1 menetelmästä testauslämpötilan ja vetonopeuden osalta (20 mm/min)
3) Määritys tehdään menetelmästä poiketen yhden tunnin kokeena
4) Nimellispainon minimivaatimuksella varmistetaan kermien työstettävyys ja vesitiiviys. Arvoista voidaan poiketa, mikäli ennakkokokein, työnäyttein tai muilla hyväksyttävillä menettelytavoilla osoitetaan tuotteen työstettävyys ja vesitiviys. Muut tuoteluokkavaatimukset ovat tällöinkin voimassa. Suomessa suositellaan käytettäväksi taulukon 1 mukaisia nimellispainoja paksuuden sijaan.
5) Koskee ainoastaan pintakermejä

The certificate RTS M1

RAKENNUSTIETO
The Building Information Foundation RTS

EMISSION CLASS FOR BUILDING MATERIAL
M1

EMISSION CLASSIFICATION OF BUILDING MATERIALS

Saint-Gobain Rakennustuotteet Oy

The classification working group set up by the Building Information Foundation RTS has approved the following product:

ISOVER Puhallusvilla
ISOVER Puru
ISOVER Insulsafe

as belonging to emission class M1 for building materials.

The classification is valid until 17.10.2016.

Saint-Gobain Rakennustuotteet Oy has the right to equip its classified products with the classification mark and to use this classification mark when marketing these products.

The decision is in line with the requirements laid down in the Classification of Indoor Climate 2008 and the Classification of Building Materials: General Instructions.

THE BUILDING INFORMATION FOUNDATION RTS

Matti Rautiola
Director General

Laura Sariola
Secretary of the Classification Working Group

The Building Information Foundation RTS, P.O.B 1004, FI-00101 Helsinki, Finland
Tel. +358 207 476 400, www.rakennustieto.fi