

THE MOST SUSTAINABLE ENERGY IS SAVED ENERGY

Rockwool® insulation products¹ are probably the most sustainable solution

Summary

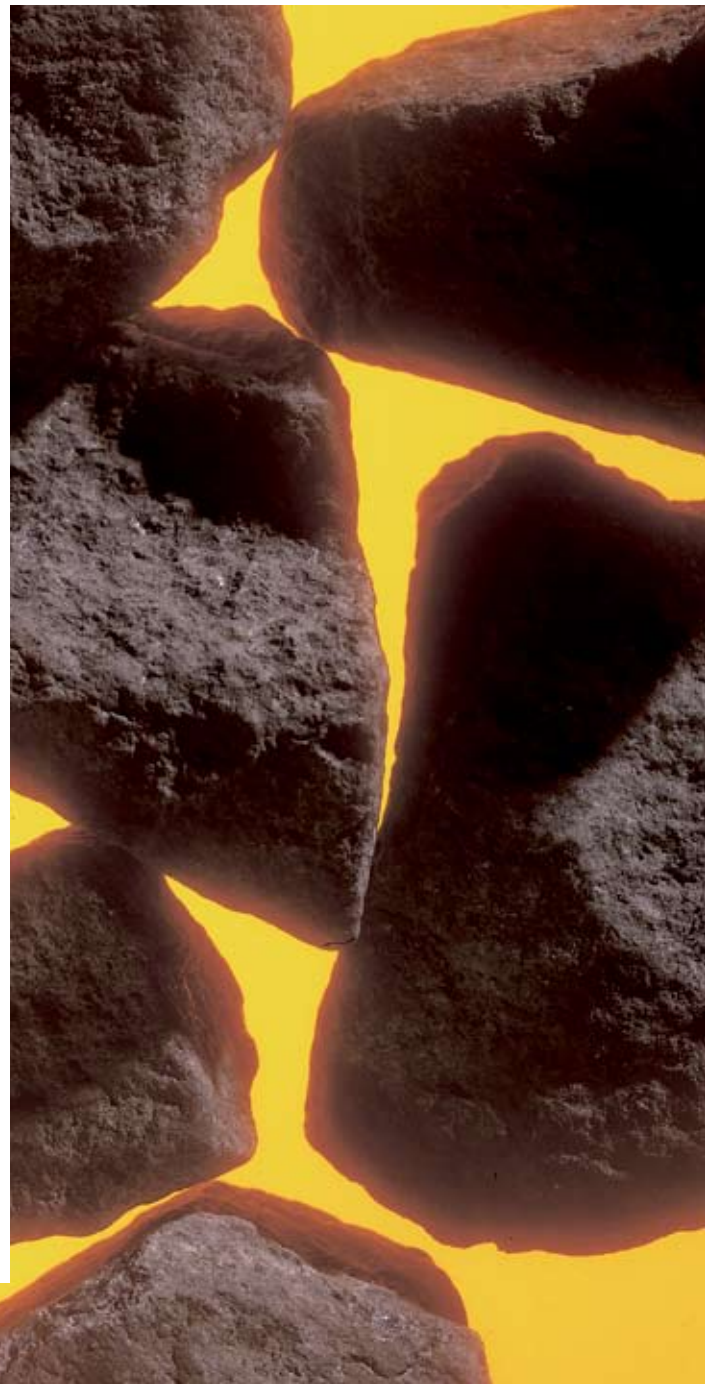
In 1987, the Brundtland Commission defined sustainability as 'development that meets with the need of the present without compromising the ability of future generations to meet their own needs' (Brundtland, 1987). For insulation materials, this means that they should be produced and used in a manner that saves the most resources with the smallest possible impact on resources, humans and nature over the full life cycle of the product.

The most sustainable energy is *saved* energy. Rockwool insulation products are probably the most sustainable solution for a long list of reasons:

- The use of abundant natural and renewable raw materials in producing Rockwool insulation.
- Rockwool insulation's unique fire-retardant properties combined with long-term thermal performance, dimensional stability, sound absorption/insulation and water repellence.
- The unique feature of durability externally (in insulation, external façades and roofs) and bio-solubility in the body.
- No hazardous classification(s).
- The fact that Rockwool uses no raw materials nor contain substances that are carcinogenic, mutagenic or toxic to reproduction (CMR substances) or 'Very High Concern' or ozone-depleting substances.
- Even when no longer in use, Rockwool insulation can be recycled when a building is deconstructed at the end of its life.

Rockwool insulation products are probably the most sustainable solution.

¹ High-alumina, low-silica stone wool (see section on health aspects below).



Rockwool products – made of sustainable raw materials

One of nature’s most spectacular phenomenon – the volcanic eruption – is imitated every day when the Rockwool Group’s factories in Europe, North America and Asia produce stone wool.

In nature, stone wool is formed when molten lava is thrown into the air and resolidifies as glassy fibres. In Rockwool factories, stone wool is made by melting raw materials at 1,500 °C. The resulting viscous stone melt is spun into fibres. Binder and refined mineral oil are subsequently added to make the material both stable and water repellent. The treated stone wool is then heated to 200–250 °C in order to cure the binder.

Stone wool’s primary raw materials are basalt, anorthosite, and cemented briquettes – the accessible reserves of these materials are large enough to supply current human demand for millions of years. They are essentially inexhaustible (Dahl et al.).

The stone wool manufacturing process is very well suited to the recycling of specific waste products. At Rockwool Group, we recycle our own waste, stone wool building-site waste, and secondary raw materials from other industries into new stone wool insulation products (Dahl et al.).

Each year, some 400,000 tonnes of inorganic or combustible residue materials from other industries are used in the manufacture of Rockwool products. Rigorous selection and abatement procedures are maintained to ensure control of emissions. Combustible waste and coke are burned in a cupola to melt the raw materials – coke itself is made from coal, which is the most abundant fossil fuel in the world (International Energy Outlook).

Low environmental impact of Rockwool production

Believing that the most sustainable energy is saved energy, the Rockwool Group is also committed to a continuous process of reducing the negative impacts of its production activities. This is achieved by investing in cutting-edge technologies (for instance, high-efficiency filter systems and after-burner plants) to minimise the use of resources and to curtail emissions of pollutants into air, water and soil. By fulfilling the EU Clean Air Directive’s limits, it is ensured that the emissions from our factories will not cause any risks to the health of the local population.

The Rockwool Group has defined Minimum Requirements for Environmental Abatement Equipment at all its factories. The requirements for abatement technology follow the indications of the EU IPPC BREF for Best Available Technology.

The production and distribution of Rockwool products are planned and coordinated carefully, using a collaborative planning system with professional carrier companies to maximise efficiency and minimise environmental impact. Wherever feasible, the most sustainable transport mode (train or boat, for instance) is used. Rockwool is also behind efforts to promote the European Modular System (EMS), which uses energy-efficient large-volume trucks and is currently undergoing testing in the EU.

Energy savings

Table 1. Energy savings and CO₂ savings for 100 m² attic insulation for a building in a Danish climate.

Construction U-value* W/m ² K	Heat loss 50 years/100 m ² attic in litres of heating oil**	Energy saved in litres of heating oil/ 100 m ² attic insulation/50 years	Tonnes of CO ₂ saved for 100 m ² attic in 50 years
1.54	55,400	0	0
0.42	15,100	40,400	108
0.14	5,200	50,300	135
0.10	3,700	51,700	139
0.072	2,600	52,800	142

* Here the U-value refers to an attic construction, measured in W/m²K.

** 1 litre heating oil = 36 MJ = 10 kWh.

Thermal insulation products save energy and diminish the harmful emissions associated with production of energy for heating and cooling. On examining Rockwool’s environmental costs, it becomes very clear that the amount of energy spent in producing Rockwool insulation is more than offset by the vastly greater amount of energy saved by using Rockwool insulation over its whole life cycle.

Table 1 shows how using Rockwool to insulate an attic in a Danish home can save enormous amounts of energy over 50 years. Column 1 gives the ‘U-value’ (the heat transmission value of a building component) according

to each level (or not) of insulation. Row 1 shows what happens if an attic is not insulated at all; here, the heat loss over a 50-year period comes to a massive 55,440 litres of heating oil, and there is no energy or CO₂ saved throughout that time. Row 3 shows that if 250 mm of Rockwool insulation is installed, this heat loss is reduced ten times, resulting in savings of 50,300 litres of heating oil, compared to the uninsulated attic. This investment results in a saving of 135 tonnes of CO₂ for 100 m² of attic over 50 years.

To produce 100 m² of 250 mm Rockwool insulation, 390 litres of oil are used (Schmidt et al.). This means that almost 130 times the amount of oil used in producing the insulation is saved once the insulation is in place. And even if there were a 50% variation in the life-cycle energy cost of producing the insulation (± 50% of 390 litres of oil, equal to 195 to 585 litres of oil), it has a barely discernible effect on the net energy savings.

Rockwool does not change thermal performance during use; the importance of this is illustrated in Figure 1 below. A 5% reduction in the long-term thermal performance results in a far higher energy loss than the energy used to produce the Rockwool insulation. Figure 1 shows the impact of an average 5% decline in thermal performance over a 50-year period compared to the life-cycle energy cost of producing and disposing of the Rockwool product used to insulate the 100 m² attic.

Schmidt et al.'s comparative Life Cycle Assessment (LCA) of stone wool and two organic-based insulation materials (paper wool and flax) emphasised that quality and fitness for use over a 50-year time span are vital. Their research indicated that a reduction in the insulation capacity will have a much larger impact on energy usage than that associated with the production and disposal of insulation products. As explained below, a key feature of Rockwool insulation products is its robust long-term insulation capacity.

Other key benefits of Rockwool products

Fire safety

A unique feature of Rockwool stone wool products is their fire-resistant properties. Rockwool insulation is made up of at least 95% stone wool and it has a melting point above 1,000 °C. Because of its non-combustibility, there is no contribution to the fire load within buildings. As a result, using Rockwool insulation products in a building allows for improved fire safety. Because of these fire-retardant characteristics, a wide range of Rockwool products are used for fire safety in, for example, industrial installations and in marine or off-shore constructions.

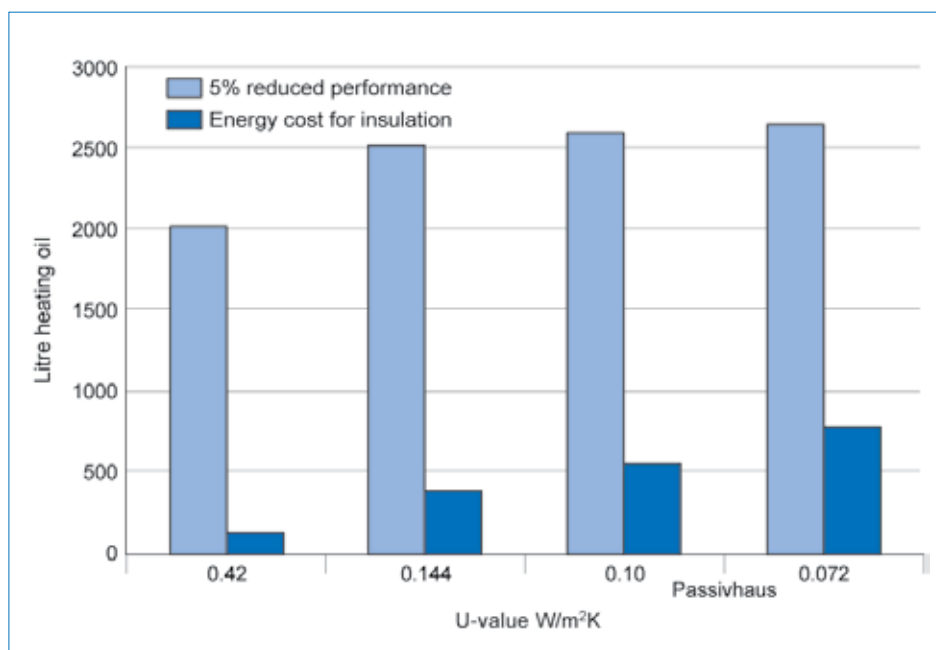


Figure 1. Energy cost (lost) due to a 5% reduced thermal performance compared to the energy cost of making the insulation.



Fire-retardant properties of Rockwool stone wool

High durability

Rockwool insulation products last. They are highly durable because they maintain their mechanical properties, have a high dimensional stability and stiffness, which is unaffected by changes in temperature or humidity. As a result, whether used internally or externally, Rockwool insulation retains its original thickness throughout the lifetime of a building. This is true even under sustained and heavy loads – millions of m² of concrete floors have been laid on top of Rockwool insulation all over the world, with no evidence of long-term creeping.

High ability to fit

For indoor use, lightweight Rockwool products are manufactured with slightly flexible edges. This allows

them to knit together at the joints and fit closely into internal building structures without leaving gaps and voids. Their long-term dimensional stability means that they stay in place, and keep their shape when installed internally. Even after 50 years, Rockwool insulation products maintain the same performance levels.

Noise reduction

Rockwool products can provide a very high level of sound absorption (Laboratoire du Trois), a property which is utilised efficiently in Rockfon® acoustic ceilings. Rockwool insulation in walls, roofs and under floors prevents noise from outside – or from adjacent rooms – penetrating the building.



Classroom at A.P. Moller School, Schleswig, Germany, using Rockfon® ceiling tiles

A good wall construction using Rockwool insulation will help reduce noise transmission by more than 50 decibels (dB) – approximately 20 dB more than a construction *without* insulation. To put this in context, to humans, a 10 dB difference is heard as a doubling (or halving) of the audible sound (Climate & Environment).

Water repellence and fungal growth

Rockwool insulation products are both water repellent and moisture resistant. The diffusion resistance of Rockwool insulation materials corresponds to that of still air. Because of this, Rockwool insulation does not trap moisture, but helps release it.

Moisture and nutrients are necessary conditions for mould growth. Since more than 95% of Rockwool insulation products are made up of inorganic fibres, there is little nutrient source to allow fungal growth. Because of this and the product's water repellence, there is no need to add fungicide (Klamer et al.).



Water-repellent properties of Rockwool stone wool



Innovation Centre Lincoln, UK equipped with Rockpanel® chameleon cladding



Warsaw, Poland – Rockwool based ETICS solution

Permeability

Drying out of new walls takes half the time when Rockwool permeable insulation is used rather than a closed insulation product. This means that there is far less risk of the development of micro-organisms or other deteriorating factors. External thermal insulation composite systems (ETICS) benefit particularly from Rockwool insulation because of its low tendency towards condensation. This is why stone wool is recommended particularly for outer wall insulation.

Weather resistance

Rockpanel board materials are used in rain-screen cladding constructions and illustrate the weather-resistant properties of stone wool fibres.

Examples of key benefits of Rockwool products

The world's largest cruiser, *Oasis of the Seas*, is insulated with stone wool materials. An amazing 2,000 tonnes out of 100,000 tonnes of the ship is made

up of stone wool! The unique combination of non-combustibility, a high melting point, superior sound insulation and heat insulation in one specific product was the reason for the extensive use of stone wool in this modern and innovative construction.

Stone wool fibres are the base material for anti-vibration mats (RockDelta®) used in today's railroad track designs. Based on past experience with anti-vibration mats of stone wool and extensive investigations, railways and train companies in many countries now use anti-vibration mats based on stone wool: investigations have shown that anti-vibration mats based on stone wool fibres display unique long-term fatigue resistance, eliminate unwanted functional performance and exhibit a very high degree of resistance to all naturally occurring chemical, biological and environmental factors, including exposure to sunlight (RockDelta®).

To assure excellent sound absorption, Norway's Oslo Opera House uses non-combustible stone wool products externally in the walls and roof construction as well as in the internal construction of the theatre.



Oslo Opera House – using Rockwool stone wool



Oasis of the Seas – insulated with stone wool



Copenhagen Metro – using RockDelta® anti-vibration mats



Passivhaus, Hjørring, Denmark

The way forward

The enormous potential for energy savings has been the motivation for authorities' strengthening demands for better insulation in buildings. Rockwool plays a central role in responding to these requirements.

One example is the 'Passivhaus', which uses increased insulation as a key feature. The Passivhaus is an affordable low-energy building with optimal indoor comfort that can achieve an 80–90% heating energy saving in comparison to the average European building stock. The Passivhaus can have an annual heating (or cooling) demand up to 1.5 l heating oil/m² (<http://www.passiv.de>). This is achieved with thick insulation, simple but optimised construction details (such as ventilation with heat recovery), an airtight building envelope to prevent drafts and triple glazing to diminish heat loss through windows (www.architekturbuch.de/media/docs/101709_innen1.pdf).

As the name implies, measures necessary to achieve a Passivhaus are mainly passive. Once installed, they perform throughout the lifetime of the building without needing maintenance, except for a change of ventilation filter once or twice a year.



**Renovated multiple family home, Basel, Switzerland
(Viridén + Partner AG, Zurich)**



**Newly built double family house, Riehen, Switzerland
(Setz Architektur, Switzerland)**

Two examples from Switzerland illustrate even further reductions in energy demand. The first example from Basel shows how a multiple family home was renovated so that it needs zero energy for heating, hot water and air ventilation system with heat recovery.

The renovation involved additional insulation, a stone wool external facade (20 cm thick), and extra stone wool in the attic (U -value $< 0.10 \text{ W/m}^2\text{K}$). Thermal collectors, large 40 m^3 water storage, a heat pump and photovoltaic cells were also installed.

The second example is a newly built double family house in Riehen, near Basel. This 'Plus energy' or 'Active' house produces more energy than it needs. The house was insulated with stone wool, and a sun-water heat pump and photovoltaic cells were also installed. The U -value for the roof is $0.109 \text{ W/m}^2\text{K}$.

Rockwool stone wool insulation against heat was used on external façades and the roof at the Malaysian Energy Centre building in Bangi, Malaysia. Other measures such as double-glazed windows, energy-efficient lighting, cooling and ventilation systems, and photovoltaic cells

were also used, resulting in a total energy consumption of 6.5 l oil/m^2 a year, a quarter of a conventional building's energy consumption.

Health aspects of Rockwool products

Durable in use – bio-soluble in the body

Rockwool has developed a high-alumina, low-silica stone wool to replace traditional stone wool (Guldberg et al.; IARC Monograph). When tested on animals, this type of stone wool is found to be non-carcinogenic (IARC Monograph; IARC Press Release; Kamstrup et al.): its chemical composition increases bio-solubility and results in a fast elimination

of the fibres from the lungs. High-alumina, low-silica wool dissipates approximately 10 times faster from the lungs than traditional stone wool (Guldberg et al.; IARC Monograph).



Malaysian Energy Centre Building, Bangi, Malaysia (Images courtesy of Pusat Tenaga Malaysia)

Guldberg et al. found that the bio-solubility of high-alumina, low-silica fibres occurs only in the body (because of the presence of polyvalent carboxylic acids). So, although fibres disappear quickly from the lungs, they are nevertheless very durable outside the body.

In addition, during laboratory testing, Rockwool insulation products have been characterised as 'non-dusty' when compared with other insulation materials (National Institute of Occupational Health).

In some circumstances, coarse fibres can cause temporary itching on the skin. In order to minimise exposure to dust, recommended work practices, including pictograms, are provided on the packaging of all Rockwool insulation products.

Regulations

In accordance with REACH and the Global Harmonized System (GHS) (Commission Regulation (EC) No. 790/2009 of 10 August 2009), Rockwool products are exempt from any hazardous classification.

Furthermore, Rockwool insulation products do not use as raw material(s) nor contain:

- Substances on the candidate list of Regulation (EC) No. 1907/2006 of the European Parliament and of the Council of 18 December 2006 concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH), establishing a European Chemicals Agency.
- Substances that are persistent, bio-accumulative and toxic (PBT) according to REACH Regulation (EC) No. 1907/2006.

- Substances that are very persistent or very bio-accumulative (vPvB) according to REACH Regulation (EC) No. 1907/2006.
- Substances that are carcinogenic, mutagenic or toxic to reproduction in Category 1 or 2 (CMR)² according to Council Directive 67/548/EEC on the approximation of laws, regulations and administrative provisions relating to the classification, packaging and labelling of dangerous substances.
- Ozone-depleting substances.

EUCEB trademark

The European Certification Board for mineral wool products certifies that the chemical composition of Rockwool insulation products is within the acceptable chemical range with respect to bio-solubility (www.euceb.org). Rockwool's high-alumina, low-silica wool also complies with the German RAL quality mark (www.mineralwolle.de).

Indoor environment

Comprehensive full-scale investigations of emissions from stone wool 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 (Mentese et al.). In addition, Finnish Emission Classification of Building Materials tests on Rockwool insulation products for formaldehyde and volatile organic compounds emissions categorise them as Class M1 (the best quality) 'low-emitting building materials' (www.rts.fi).

² In GHS category 1A and 1B

Eco-toxicological and environmental evaluation

Aquatic tests have shown that stone wool fibres have no toxicity towards algae, daphnia and fish (DHI).

Rockwool product waste is categorised as 'waste accepted at landfills for non-hazardous waste' in accordance with 2.2 of EC Decision 2003/33/EC ('Landfill Acceptance Criteria'), pursuant to Landfill Directive 1999/31/EC. Furthermore, Rockwool products have a chemical composition similar to average crustal rocks and participate in the natural rock cycle (Dahl et al.).

An example of the eco-friendliness of stone wool is further documented by the use of stone wool (Grodan®) as a substrate for greenhouse-grown vegetables.

The Rockwool Group (www.rockwool.com)

The Rockwool Group is a global leader within the insulation industry. Together with other building-related products, such as acoustic ceilings and cladding boards, the group ensures energy-efficient and fire-safe buildings with good acoustics, quality façades and a comfortable indoor climate.

Business areas outside the building industry include substrates for the agriculture industry, special stone wool fibres for brake linings and gaskets, and vibration control systems for roads and railways.

The Rockwool Group has approximately 8,000 employees in more than 30 countries – and customers all over the world. The group has been producing stone wool for more than 70 years and has currently 21 factories across Europe, North America and Asia (Climate & Environment).



Greenhouse using Grodan® products for growing cucumbers

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