EcoShopping - Energy efficient & Cost competitive retrofitting solutions for Shopping buildings

Co-funded by the European Commission within the 7th Framework Programme.
Grant Agreement no: 609180.
2013-09-01…2017-08-31 (48 months).

Appendix 10.

Insulation SWOT Analysis

1 Introduction

This document aims at analysing the Strengths, Weaknesses, Opportunities and Threats (SWOT) of the insulation materials categorized and listed in Table 1. Due to the great variety of insulation materials, and most of them are available on the market with similar physical or technological properties, thus not all the materials are included in this study.

All the analysis toward the listed materials will be presented in tables in the following sections.

Table 1 Insulation materials

INSULATION MATERIALS		
MATERIAL	**TYPICAL FORMAT**	**CATEGORY**
Wood fiber	Panels	Organic
Polystyrene	Panels	Inorganic
Polyurethane	Panels	Inorganic
Rockwool	Panels, rolls	Organic
Aerogel	Panels, rolls	Innovative
Vacuum Insulating Panels (VIP)	Panels	Innovative
Cellulose	Panels, flocks	Organic

2 SWOT analysis

2.1 SWOT analysis for wood fiber

SWOT ANALYSIS	WOOD FIBER[1]
Strengths	• High acoustic performance • Low to zero toxins, easy to reuse/dispose of, significant health benefits throughout life cycle • Offers some thermal mass • Protective clothing and masks not needed, more comfortable for installers and others coming into contact with it • Vapour permeable, works well with other low-impact materials • Concern about indoor pollution and allergies is particularly high. • Renewable • Low energy input • Biodegradable • Absorbs VOCs • Non-flammable • Breathable
Weaknesses	• Most products manufactured overseas and imported • Price currently significantly higher than oil- or mineralbased competitors (this may reduce as demand and supply increase) • Suitability of rendered external finishes limits application • Use limited to above damp-proof course or equivalent level • Few producers • Maybe treated with pesticides, fungicides, and flame retardants • Poor ranching practices
Opportunities	• Renewable materials store carbon throughout usable lifespan • Robust in handling, transportation and onsite construction • It is available as loose fill, flexible batts and rigid panels for all thermal and sound insulation uses. • It can be used as: 1) internal insulation: between studs, joists or ceiling rafters, under timber floors to reduce sound transmittance, against masonry walls; or 2) externally: using a rain screen cladding or roofing, or directly plastered/rendered, over timber rafters or studs or masonry structures as external insulation to reduce thermal bridges. • It is 100 percent recyclable, so it helps to reduce overall landfill waste
Threats	• Requires thicker walls

[1] http://www.bre.co.uk/filelibrary/pdf/projects/low_impact_materials/IP18_11.pdf

2.2 SWOT analysis for polystyrene

SWOT ANALYSIS	POLYSTYRENE[2]
Strengths	• It can be cast into molds with fine detail. • It can be transparent • Very economical. Low Cost • Can be aerated (with CO_2) to make excellent insulator • Can be foamed between card to make lightweight rigid panels • Available in several forms. • In its various forms it is usually easy to work • It is versatile -uses range from cutlery to explosives • Can be recycled - thermoplastic so can be remoulded indefinitely • Non Hygroscopic • Good Optical Clarity • Easily Processed • Good Thermal Stability • Good Property Retention • Good Creep Resistance • Easily Decorated • Easily Bonded • Good Toughness (HIPS) • Chemically inert, it does not pollute the environment
Weaknesses	• Older types of Expanded polystyrene contain CFCs • Flammable (especially if oil painted) • It takes a long time to decompose. • Expanded foam is uneconomical to collect for recycling • Poor resistant to organic solvents. • It isn't bio-degradable and like all plastics is made from oil. • Low Impact Polystyrene (the usual type) breaks very easily and isn't very strong. • Thick Sooty Smoke • Poor Weatherability • Highly Flammable • Highly Notch Sensitive • Poor Resistance to Petroleum Solvents
Opportunities	• It can be produced in lots of colours.
Threats	• It can cause health concerns if ingested

[2] http://swot.advisorgate.com/swot-p/30600-swot-analysis-polystyrene-foam-product-manufacturing.html

2.3 SWOT analysis for polyurethane

SWOT ANALYSIS	POLYURETHANE[3]
Strengths	• High Abrasion Resistance, Impact Resistance and Toughness • Low Viscosity • High Elongation • Good Flexibility • Good Tear Strength • Low Shrinkage • Hydrolytically Stable • Good Chemical Resistance • Minimizes air flow • Helps eliminate drafts and provides for comfortable, even heat • Provides better humidity control • High Insulation Value. Best R-value per inch of any readily available insulation allows you to fix more insulation in a tighter space • Moisture Resistant. Stops moisture driven elements due to its closed cell salability • Rigid. Adds structural strength • Seals cracks from unwanted gas and odor penetration • High degree of strength to weight ratio • Excellent Adhesion. Does not need fasteners to hold it into place • Code Approved. Materials meet building code requirements and are accepted nationwide
Weaknesses	• Poor thermal capability • Poor weatherability • Attacked by most solvents
Opportunities	• Performs in hot as well as cold temperatures • Quick, easy application by professionals • Provides a seamless layer of insulation • Adds very little weight to ceiling or roof areas
Threats	• Utilize toxic isocyanates • Flammable

[3] http://swot.advisorgate.com/swot-u/40180-swot-analysis-urethane-and-other-foam-product-except-polystyrene-manufacturing.html
http://plastics.ides.com/generics/45/polyurethane-pur
http://www.dwyersspecialty.com/knowledge_spfbenefits.htm

2.4 SWOT analysis for rockwool

SWOT ANALYSIS	ROCKWOOL[4]
Strengths	• Higher R-Value than traditional fiberglass insulation. • Better thermal barrier then fiberglass leading to less energy consumption. • Soundproofing qualities reducing noise pollution from noisy neighbors or noisy machinery. • More fire resistant than traditional fiberglass insulation, making for better protection against fires. • Holds water: Rockwool holds an incredible amount of water, which gives a "buffer" against power outages or pump failure. • Holds air: The consistency allows plenty of air, which supplies the root zone with plenty of oxygen. It's practically impossible to over-water Rockwool. The fibers of rockwool make it highly porous thus allowing a high air-porosity ratio in the root zone. • Variety: From 1" cubes to 3"x12"x36" slabs capable of holding the root systems of huge plants, Rockwool comes in dozens of shapes and sizes making it a versatile growing medium. It also comes "loose" so you can fill pots or containers of any size. • Neat and clean: Rockwool holds together very well so it can't spill. It's easy to handle and does not leave a residue like soil does. • The production process involving heat makes rockwool completely free of pathogens. • Rockwool is inert and contains some silica that can be available to plants.
Weaknesses	• Health concerns: The fibers and dust from Rockwool are bad for the lungs. Dust mask shall be worn when handling to prevent problems. • Long pre-soak period: Rockwool must be pre-soaked for 24 hours before use, which other growing media do not require. • Disposal and cost of rockwool make it less than sustainable in long term production. • Typically pH values of rockwool are high and will need to be reduced to maintain optimal pH values for plant growth. • Buffering capacity of rockwool is low and can be difficult to manage pH due to water retention characteristics of the fibers used.
Opportunities	• Lower health risk to humans versus fiberglass insulation.
Threats	• Not environmentally sound: Rockwool is hard to dispose of; like Styrofoam, it does not break down.

[4] http://swot.advisorgate.com/swot-r/32726-swot-analysis-rockwool-international.html

2.5 SWOT analysis for aerogel

SWOT ANALYSIS	AEROGEL[5]
Strengths	• High thermal resistance, achieve a relatively high level of thermal insulation with a limited insulation thickness. This makes it possible to save interior space (on walls or floors). • Can be easily cut to shape and are flexible enough to be fitted around complicated details. Mechanical resiliency accommodates thermal cycling and vibration without loss of performance • Reduced sensitivity to mechanical damage. • Variety of particle sizes • High surface area • High particle porosity • Surface chemistry: Completely hydrophobic • Resistance to moisture and UV ensures long-term performance even in harsh environments • Good for acoustic insulation applications, especially at low frequencies
Weaknesses	• The material can be dusty, and it is advisable to wear gloves, safety glasses and dust masks when handling it. • Since aerogel blankets are still very new and energy intensive, their cost may be high (appr. €20/m^2).
Opportunities	• Choice of product forms provides maximum flexibility in system design and installation methods • Low density offer space and weight savings in transport applications • It is an emerging technology that has a large energy saving potential. As this new emerging technologies go cheaper, the common insulation material will lose its interest and become obsolete.
Threats	

[5] http://www.one-stop-shop.org/sites/default/files/FORM_11_aerogel%20insulation.pdf

2.6 SWOT analysis for Vacuum Insulating Panels (VIP)

SWOT ANALYSIS	Vacuum Insulating Panels (VIP) [6]
Strengths	• Increased energy efficiency • Reduction in greenhouse gas emissions • Faster building times and better buildability of structures • Lighter weight materials may offer safety advantages in construction • Potential cost savings • Improved health and wellbeing
Weaknesses	• High cost • Material availability • The set views of trades
Opportunities	• Implementation of new techniques and synergistic systems • Opportunity to adopt a more professional approach to managing construction sequences (instead of haphazard methods) • Opportunities to implement leading-edge technologies and to reduce substantial greenhouse emissions
Threats	• Not mainstream building materials • Resistance to change • Not mainstream techniques • Distribution and supply • It is an emerging technology that has a large energy saving potential. As this new emerging technologies go cheaper, the common insulation material will lose its interest and become obsolete.

6 http://issinstitute.org.au/wp-content/media/2011/04/ISS-FEL-REPORT-S-WEST-Low-Res.pdf

2.7 SWOT analysis for cellulose

SWOT ANALYSIS	CELLULOSE[7]
Strengths	• Increased energy efficiency • Reduction in greenhouse gas emissions • Faster building times and better buildability of structures • Lighter weight materials may offer safety advantages in construction • Potential cost savings • Improved health and wellbeing
Weaknesses	• Possible cost • Material availability • The set views of trades
Opportunities	• Implementation of new techniques and synergistic systems • Opportunity to adopt a more professional approach to managing construction sequences (instead of haphazard methods) • Opportunities to implement leading-edge technologies and to reduce substantial greenhouse emissions
Threats	• Not mainstream building materials • Resistance to change • Not mainstream techniques • Distribution and supply

[7] http://en.wikipedia.org/wiki/Cellulose_insulation

3 Key properties and summaries

The studied insulation materials can be divided into two categories:

1) Traditional thermal building insulators: **Wood fiber, Polystyrene, Polyurethane, Rockwool and Cellulose**. Their thermal conductivity is around 30-40 mW/(m·K), decreasing to 20-30 mW/(m·K) only in PUR. It varies with temperature, moisture content and mass density.
2) New thermal building insulation materials are called "super-insulator": Aerogel and Vacuum Insulation Panels (VIP).
   - **Aerogel** is a low-density solid-state material in which the liquid component of the gel has been replaced with gas. Silica aerogels consist of a cross-linked internal structure of SiO2-chains (0.2%) with a large number of air filled pores on a micro and nano size scales (99.8%). Commercially available aerogels have a thermal conductivity between 13 and 14mW/(m·K).

     Aerogel applications have also important disadvantages: High production costs and the low tensile strength.
   - **Vacuum insulation panels (VIP)** consist of an open porous core of fumed silica enveloped of several metalized polymer laminate layers. These components are made by panels of solid material with a high porosity level and a very small pore dimension on which a technical vacuum is produced and maintained by enveloping the solid core with a plastic and/or metallic sheets.

     Vacuum insulation panels disadvantages: Puncturing the VIP envelope, which might be caused by nails and similar, causes an increase in the thermal conductivity to about 20 mW/(m·K). Moreover, the initial thermal conductivities increases from 3-4mW/(m·K) to typically 8mW/(m·K) after 25 years ageing.

Table 2 shows the main characteristics of the studied insulation materials. In order to be able to calculate the price of materials with different thermal conductivity, an assumption is made by fixing the thermal resistance to 3.5 m^2K/W. This assumption allows.

Table 2 Properties and costs of insulation materials

The table includes a selection of materials available on the market that are typical for each category.

Material	**Typical format**	**Category**	**Thermal conductivity** *(W m^{-1} K^{-1})*	**Specific heat** *(J Kg^{-1} K^{-1})*	**Density** *(Kg m^{-3})*	**Fire resistance**	**Water vapor resistance**	**Price for thermal resistance = 3.5 m^2 K W^{-1}** *(Euro/m^2)*
Wood fiber	Panels	Organic	0.038-0.058	2000-2100	55-140	Bad	Bad	20-37
Polystyrene	Panels	Inorganic	0.032-0.045	1200-1500	10-80	Bad	Good	8.60-17.35
Polyurethane	Panels	Inorganic	0.022-0.035	1300-1500	30-160	Bad	Good	25-35
Rockwool	Panels, rolls	Organic	0.030-0.040	1000-1100	25-200	Very good	Bad	20-50
Aerogel	Panels, rolls	Innovative	0.013-0.021	900-1100	100-150	Very good	Good	70-200
Vacuum Insulating Panels (VIP)	Panels	Innovative	0.008	700-900	180-210	Good	Very good	140-170
Cellulose	Panels, flocks	Organic	0.038-0.040	2000-2100	30-70	Bad	Bad	25-30