Thermal Insulation Market in Lebanon

Le Marché de l'Isolation Thermique au Liban

Prepared by Fady Georges Comair
Adel Mourtada
Said Chehab
Tony Matar
Christophe Sebrini

Bulletin de l'Association Libanaise pour la Maitrise de l'Energie et l'Environnement

The following survey examines the Thermal Insulation Market in buildings in Lebanon and covers the years 2008 through 2010. Twelve importers and/or manufacturers were identified as working in the local market (see the detailed list below). The data and figures mentioned in this survey come from information provided by surveyed businesses.

The survey helps identifying the major characteristics and trends of the thermal insulation material used and/or available in Lebanon. Stakeholders from the public and private sectors can use this information to determine how best to operate in Lebanon. Important trends in thermal insulation for buildings include the following:

- An appreciable expansion of this market with a growth rate of 21% over the last three years. Despite that, the country lags behind almost all the neighboring states.
- Insulation materials manufactured in Lebanon have a bigger market share than the imported materials. Otherwise, the thermal characteristics of each importer are related to different standards. As for manufacturers, there is no certification or guarantee for any characteristic except for few where a local specimen test was established.

This guide was produced to sensitize the general public as well as professionals about the importance of thermal insulation for buildings, while providing the necessary information on the available products in the Lebanese market.

Finally, we would like to thank the "Agence de l'Environnement et de la Maîtrise de l'Enérgie" (ADEME France), as well as the Order of Architects and Engineers of Beirut – Mechanical Section, without whom this survey could not be achieved.

Company	Contact	Address	Phone	Fax	E mail
Alphachem s.a.l.	Khalil Assie	Fanar	01900079	01900079	alphachm@cyberia.net.lb
CMC	Bassel Abi Chakra	Boushrieh	01497416	01510132	cmc@cmclb.com
Est. Joseph Hajjar	Joanna Nemr	Dora	01256389	01243973	hajjarest@yahoo.com
GLASS MASTER	Nabil Kalayli	Boushrieh	01883758	01893341	info@fesconoubisol.net
Insulite Blocks co.	Dr. Assad Abdul-Baki	Shouwayfat	03773559	05490409	assad_baki@hotmail.com
KAPPA System	Marleine Seif	Zouk mosbeh	09215899	09215899	info@kappa-system.com
KILZI & CO s.a.r.l.	Nagi Kilzi	Ainsaadeh	01872133	01872133	n.kilzi@kilzico.com
MIC CO s.a.r.l.	Ahmed Al Hajj Ali	Airport Sideway	01452555	01455495	ahmed@hajjali.net
MYTCO	Charbel KHOURY	Nahr el mott	01902011	01902012	mytco@idm.net.lb
SODAMCO s.a.l	Geoffroy Palpied	Jbeil	09790920	09790924	geoffroy@sodamco.com
STAR FOAM s.c.s.	Taleb EL-KHATIB	Damour	05601398	05601398	taleb.starfoam@gmail.com
TA Group s.a.r.l.	Hassan Saab	Hamra	01350271	01343708	info@tagroup.com.lb

Table of Contents

List of Figures

List of Tables

List of Graphs

The construction sector is growing in a fast way, especially in the habitation segment. Due to this growth, this sector has experienced some deep modifications in terms of energy demand. Energy consumption has increased due to remarkable improvements in the overall standards of living. These changes in consumption are followed by a transformation of the consumptions' structure for certain uses such as heating and air conditioning. Unfortunately, in most Lebanese houses, heating and AC are treated individually making every house and even every room have its own separate installation. And by that, the energy demands are increasing, meaning that if there is a big installation for buildings, or even for residential streets, one would be able to reduce energy consumption by considering a non-simultaneous factor of usage.

To reduce the energy consumption and increase the thermal comfort of a house, many criteria are taken into account. In this document, many effective measures will be explained. Among these measures, there will be the installation of thermal insulation of walls, roofs, and floors providing the basis in order to reduce energy consumption of a house.

In fact, the insulation allows consumers as well as the government to significantly reduce energy costs and bills. The results in reference (1) show that the cost-effective measures may reduce the thermal cooling energy needs by 23 to 41% and the heating energy needs by 47 to 70% according to building type and climatic zone. The payback time of proposed requirements in reference (1) will be from 2.7 to 8 years for residential buildings according to the climatic zone for end users.

The Lebanese Weather

Lebanon has Mediterranean climate weather with about 300 sunny days per year, but its climate varies considerably from one region to another. So it is divided into four climatic zones presented in Figure1.

In general, it barely rains between June and September, yet in July and August the temperature reaches 35 °C at low altitude. Winters are relatively mild on the coast, but pretty rough in the mountains with heavy snowfall. Winter remains dotted with beautiful sunny days that make the ideal climate for practicing winter sports. In the plains, the dry summer heat takes over the cool, rainy winters, but the mountains enjoy a moderate climate.

Zone 1 – Coastal plain (littoral)
Zone 2 – Western Mid-Mountain
Zone 3 – Inland Plateau
Zone 4 – High Mountain

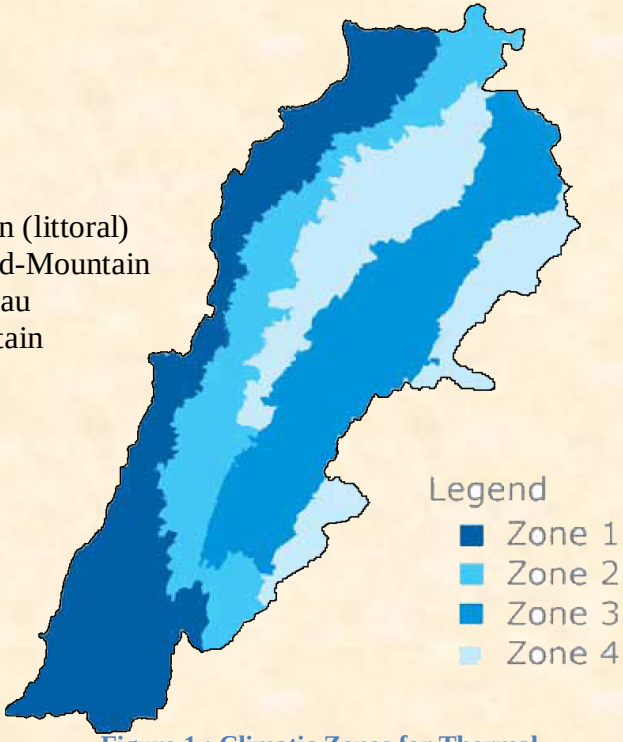


Figure 1 : Climatic Zones for Thermal Standards for Buildings in Lebanon (Source: DGL 2005)

The general characteristics of the climatic zones are presented in Table 1.

Climatic Zones	Climatic Sub-Zone	Winter	Summer	Daily Gap
1 Coastal	**1A** Altitude < 400 m	Warm and short	Hot and humid	Small all year
	1B Altitude > 400 m	Cold and long increasing with altitude	Hot and Humid with maximum daily temperatures differing slightly from 1A	
2 Western Mid Mountain	No Sub-zone	Cold and long Increasing with altitude	Cool and Moderate	More pronounced than the daily gap of Zone 1
3 Inland Plateau	No Sub-zone	Colder and longer than winter at the same altitude in zone 1 & 2 (min temperatures lower than zones 1 & 2)	Hot and dry summer, but cool at night. The min temperatures are lower than zones 1 & 2 and the max temperatures are higher. Very low humidity.	In summer the daily gap is high and varies according to the year
4 High Mountain	No Sub-zone	Long and rigorous	Cool	Moderate to high in Eastern Mountain

Table 1 : General Characteristics of climate zones and sub-zones (Source TSBL 2010)

In this context, it is possible to get a better thermal comfort in homes while saving energy consumption for heating and cooling. To achieve that, a number of measures have to be applied in the aim of improving the thermal and energetic qualities of the building.

General Terminology

Thermal conductivity (λ-value)

Thermal conductivity is the ability of materials to transmit heat by conduction, knowing that each material has its own thermal conductivity. The λ-value is used in order to classify materials according to this criterion. It is expressed in watts per meter per Kelvin degree or Celsius degree (W/m.K) and represents the amount of heat in one square meter of material with a thickness of one meter or one cubic meter with a one degree temperature difference between the two faces; in a given time, it is a constant characteristic for each material. The higher the value of this coefficient, the lower the material is insulating.

U-value

U-value indicates the quantity of heat transferred through 1 m^2 in the outer surface of a building element with a temperature difference of 1°C or Kelvin (°K) between the inside and outside. The unit is the watt per square meter and Kelvin ($W/m^2.K$). The smaller this value is, the better the thermal insulation of the component and the less heat is lost.

Thermal Resistance (R value)

The thermal resistance of a wall depends on its thermal conductivity and thickness. The greater the R value is ($m^2.K/W$), the more the wall is insulating. We can increase the thermal resistance (R value) by increasing the thickness of the material.

Thermal diffusivity

It is the speed at which heat flows through a material, typically measured in mm^2/s. With a greater heat capacity and better summer comfort, the thermal diffusivity gets smaller.

Thermal inertia

The thermal inertia is the ability of a material to store heat/cold or to recycle them. Bioclimatic and green designs, depending on the climatic zone, should encourage or discourage the manufacturer to take advantage of this physical characteristic. For instance, in some regions, like Zone 1, the thermal inertia has a negative effect in residential buildings because it stores heat in the building during the day and delivers them by night, but this is not the same for all the climatic zones. Thermal inertia is a combination of two effects: firstly, to increase comfort in both winter and summer and, secondly to reduce the share of energy of heating and cooling.

Thermal bridge

Thermal bridges are places in the building envelope where there is a higher heat loss compared to surrounding building components. This is an insulation fault. It occurs when there is a gap between insulation materials and structural surfaces. Usually, they are located at the junction points of different structures; due to that, the main thermal bridges in a building are found at the junctions of walls and floors, walls and cross walls, walls and roofs, etc. They also occur each time there is an opening (doors, windows, etc), balcony slab of concrete, or reinforced concrete lintels. We distinguish the geometric thermal bridges such as angles and corners and thermal bridging material, in which a material conducts heat through the insulating layer. These are structural thermal bridges. These thermal bridges vary in importance according to the type of wall or roof (insulated or not).

At the design level, it is imperative to choose construction processes and components that reduce surface losses as much as possible and integrate the smallest possible losses in the junctions of these surfaces.

Thermal phase shift

It is the time required for a flow of heat to pass through a material.

Steam diffusion

The external water (rain, snow, trickle, etc) must be completely stopped by the walls and the roof of a building. In winter, the indoor air is warmer and more humid than outside, causing a steam flow which tends to escape through the walls outward. The steam passes mostly by convection with the airflow, and by diffusion it also transits through the walls. In summer, the migration is reversed, from outside to inside of the house. If the steam gets in contact with a cold element, condensation occurs, and with time this causes mold. This occurs in a dwelling not isolated and badly ventilated.

Air sealing

It is important for the functioning of a house in terms of energy efficiency that the building envelope is impermeable to air, meaning that there is no air exchanged between inside and outside. With regard to energy losses, the consequences are significant. That's what justifies the usage of a Blower Door to measure the air tightness accurately.

Vapor barrier

This is a material added to prevent water vapor from entering the interior parts of the insulation product to prevent water condensation and thus causing damages to the insulation due to humidity. Specified wall papers and wood-based materials are used

as vapor barriers, set on the insulation towards the room side. It is essential that the vapor barrier has no holes. You can also use a vapor barrier for an airtight.

Heat transfer and Thermal insulation

Thermal insulation is defined as a material or combination of materials which delay and reduce the flow of heat. The insulation materials can be adapted to any size, shape, or surface. A variety of finishing touches are used to protect the insulation from mechanical and environmental damage and also to enhance appearance.

In fact, heat is transferred in three ways: conduction, convection or radiation, (or by a combination of all three). It always moves from warmer to colder areas, seeking a balance. The greater the temperature difference, the faster the heat flows to the colder area.

Conduction: Heat energy is passed through a solid, from molecule to molecule in the material. In order for the heat to be conducted, there should be physical contact between particles and some temperature difference. Therefore, thermal conductivity is the measure of the speed of heat flow passed from particle to particle. The rate of heat flow through a specific material is proportional to the difference of temperature between both sides of the material and to its thermal conductivity.

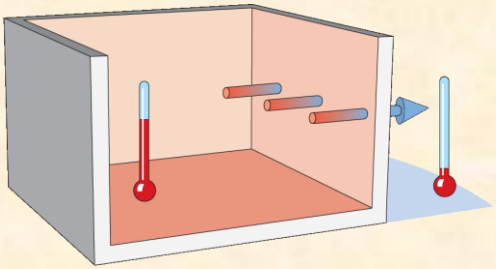


Figure 2 : Heat transfer by Conduction

If there is no difference in temperature between both sides of the material, no heat exchange takes place. In winter, the heat moves directly from all heated living spaces to the outdoors and to the adjacent unheated areas. The less the materials are thermal conductors, the less slow is the heat propagation. For this reason and to maintain comfort, the heat lost in winter must be replaced by a heating system, as for the heat gained in summer to be removed by a cooling system. Therefore, by insulating ceilings, walls, and floors, one would be able to decrease the amount of heating or cooling needed by providing an effective resistance to the flow of heat.

Convection: Heat energy is transferred when a heated fluid, gas, or liquid moves (forced or by natural movement) from one place to another carrying its heat with it. The rate of heat flow will depend on the temperature of the moving gas or liquid and on its rate of flow.

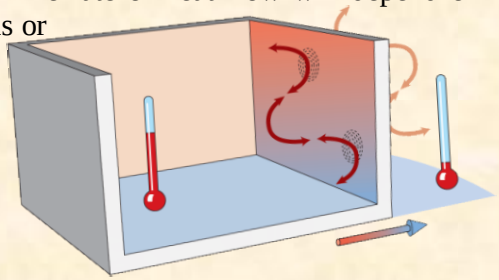


Figure 3: Heat transfer by Convection

Radiation: Heat energy is transmitted in the form of light as infrared radiation or simply as electromagnetic waves. This energy emanates from a hot body and can travel freely only through completely translucent media. The atmosphere, glass, and translucent materials transfer a significant amount of radiant heat, which can be absorbed when it falls on a surface. Light-colored or shiny surfaces reflect more radiant heat than black or dark surfaces; therefore, the former heats more slowly.

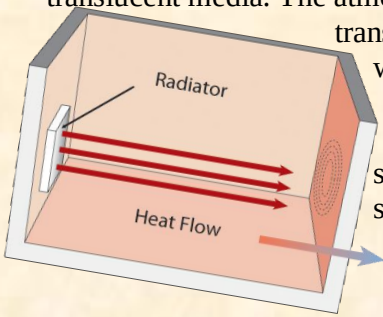


Figure 4: Heat transfer by Radiation

In practice, the exchange of heat in almost all the buildings is the result of a mixture of the three modes mentioned above, but the most significant mode is by conduction through walls, roofs, and floors. A house is made of various materials in contact with a more or less hot or cold temperature depending on the season, time of the day, or weather. If the environment of a building was constant and moderate, the internal temperature would be equal more or less to the external temperature. Yet as this is not the case, heat exchange should be regulated in an attempt to restore the ideal conditions of comfort. To do so, it is necessary to expend energy or control flows.

Heat losses in a habitation

Depending on the characteristics of materials, structure and, building envelope, there is continuous heat loss. A habitation is subject to different ways of heat losses. As we can see in Figure 5, heat loss isn't limited to walls. Heat losses come in different forms:

- Losses through the walls
- Losses through the roof and floor
- Losses through doors and windows
- Losses due to the ventilation of the house
- Losses due to thermal bridges

In winter, in an un-insulated house, the most significant thermal losses are from windows and walls. In fact, the heat generated by the heating system finds its path to the outside through different routings as listed above. Otherwise, in summer, it may be necessary to lower the temperature inside the buildings for assuring thermal comfort. For this reason, cooling and drying the air can also be a major energy consumer. Thus, thermal insulation is highly requested to reduce energy consumption and heat losses or gains.

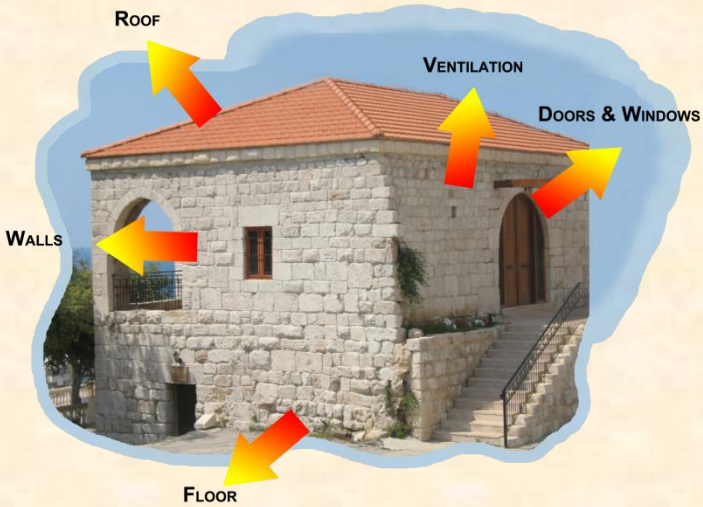


Figure 5 : Heat losses in a Habitation (in winter)

Thermal insulation and Lebanese habitation
(from history till now)

Since ancient times, the Lebanese used to build their houses according to the geographical, geological landscape, considering the thermal insulation with the materials that were available around in the construction land. The stones were cut and stuck together with sand mixed and plaster and were built as:

- Limestone wall plaster
- Or as double wall filled by sand, known as “kallin” wall

Figure 6: “Kallin” Wall

The windows were installed along the direction of the wind and small openings were put high on the walls to ventilate the house. The roof varied by socio-economic status:

- Roofing clay is a remarkable formula for the thermal insulation of the house by 20 to 30 cm thick, very compact. It maintains a pleasantly cool air in summer and retains heat in winter.
- Roofing stone called "Aadseh" is a 10 cm thick river-stone, white sand, and white plaster mixed well and spread on a carpet of crushed stone framed by a thick frieze. In the summer, people painted this roof with lime water for the “cooling effect”.
- Red tiles roof and wood called "Kotrane".

Accordingly since ancient times, Lebanese people have been taking thermal insulation into consideration. At that time and due to the lack of technology for cooling, for example, it was an important need to ensure thermal comfort in their homes. But with the industrial renewal, the last problem was solved, and the public has been striving for the use of air conditioners and heating systems. Due to that, the use of thermal insulation has decreased a lot. But nowadays, few people are trying to reduce their energy bills because of the economic inflation. So in a period of time, buildings have been constructed by reinforced concrete frames filled by hollow blocks, in other words, constructed by one single wall with the double wall feature kept for the prestigious buildings.

Knowing that double wall insulation, also known as cavity walls, is not the best solution in terms of thermal insulation, it's a good way to start. For that and to encourage the double wall installation, a modification to the construction law was declared in September 2003 for this purpose:

"In case of the presence of a double wall, the area of external walls (including the insulation material thickness, if any) is not counted within the superficial investment rate and the general investment rate." [*Part from the Amend Legislative Decree No. 148 Date 16/09/1983, construction law, article 14 - alinea 7*]

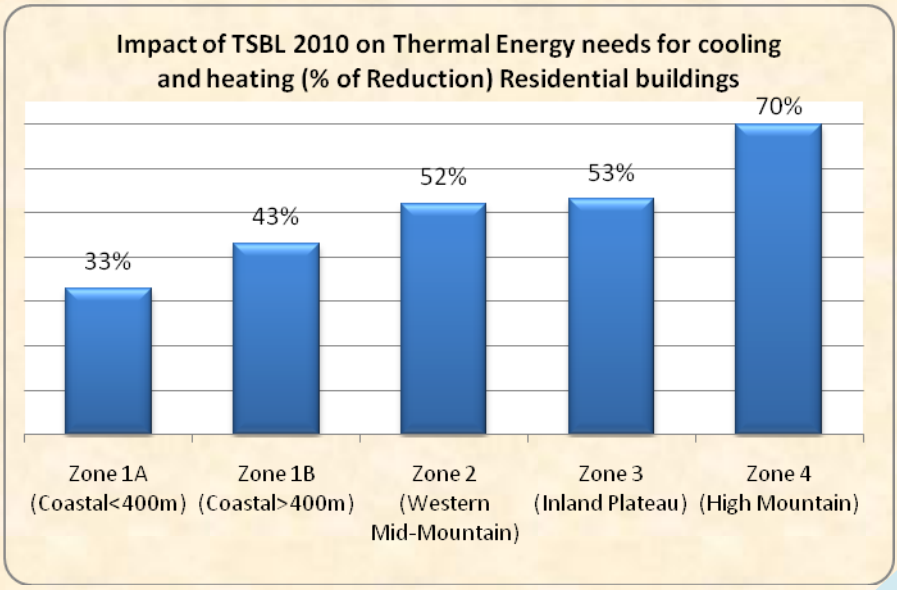
Otherwise, adding thermal insulation material for insulating the walls is still a recommendation from the Lebanese Order of Architects and Engineers for new buildings. This second solution has a better insulation performance and increases the general first payment of the building. Yet, while considering the heat losses in a habitation (cf. paragraph below) and as mentioned in reference (1), it will be a feasible solution with a payback time that varies between 2.7 and 8 years according to the climatic zone, as proposed in reference (1).

Benefits of Insulation

Insulation is used to perform one or more of the following functions:

- Reduce heat loss or heat gain
- Achieve energy conservation
- Prevent or reduce condensation on walls
- Increase operating efficiency of heating, ventilation, and cooling
- Protect indirectly the environment through the reduction of CO_2, NO_x emission

As for energy conservation, as mentioned in (1), if the thermal insulation has the reference characteristics, it reduces energy consumption from 33% to 70% depending on the climatic zones (cf. Table 1 and Figure 1 above).



Graph 1 : Impact of the TSBL 2010 on the percentage of reduction of the global heating and cooling needs of residential buildings in different climatic zones

(Source: A. Mourtada/ALMEE)

Qualities of thermal insulation materials

The thermal conductivity is not the only property to consider when selecting an insulating material. The following characteristics are as important as the first one and can be crucial depending on the application:

- Acoustic qualities
- Air tightness
- Dimensional stability and behavior in heat
- Fire resistance
- Low water absorption by immersion by flotation and by diffusion
- Mechanical resistance (tension and compression)
- Price
- Resistance to steam diffusion

Acoustic qualities

In addition to their thermal characteristic, some insulation materials are used either to reduce impact noise or noise-absorbing air. First, they should be soft but with a certain resistance to compression. Second, they shouldn't be air tight and provide some resistance that can absorb the sound waves by air friction against the components (fiber, open walls of bubbles) of the material.

Air tightness

The air tightness is not a principle expected of an insulating material, since this function should generally be filled in another layer of the envelope namely the supporting structure of the wall (concrete, masonry), a sealing sheet, or lining (plaster, for example). Even if the insulation is air tight, the joints between the panels seep air, unless they are joined by a specified product by the supplier.

Dimensional stability and behavior in heat

The insulating materials used in flat roofs must withstand long term and short term high temperatures (70°C and above) caused by bright sunshine. They must withstand even higher temperatures that are used to fuse the waterproofing complex set on the insulating layer. Second, they must not be deformed (expand or shrink) due to changes in temperature or humidity.

Fire resistance

For security reasons, it is forbidden to use highly flammable building materials. Therefore, insulating materials must not be a source to facilitate fire. One of the characteristics of such a material is to be fire resistant depending on its degree of flammability and temperature. Knowing that some insulating materials can't resist to fire, but once the flame is removed they will auto-distinguish their selves.

Low Water absorption

A moist material loses its insulating characteristics. In other words, insulation should not absorb water even if it is in contact with water, as the case is in inverted roofs. The absorbency of insulation is measured either by immersing samples in water, immersing samples by flotation on a water tank, or finally by diffusion of steam in a gradient and humid temperature.

Mechanical resistance

The insulation slabs, floors, or underground structures require materials that resist to compression. Insulation resistance to compression is measured by the stress required to reduce the thickness of a sample of 10%. Some insulation, as the insulating concrete, is not elastic and does not compress very much. For such cases, we use the breaking stress. The external insulation requires an insulator which is resistant to tension, so that the insulating layers do not separate under the influence of the wind.

Resistance to steam diffusion

Steam diffuses through material, especially if they are porous and condense in cold areas creating steam condensation on the cold side of the insulating layer. To reduce the risk of damage due to condensation, we can decrease the flow of steam by placing the material that offers strong resistance towards steam diffusion.

Insulation solutions: How to insulate our Home?

Multiple options are possible to thermally insulate a house depending whether or not it's a new construction or a renovation. The materials used and techniques to insulate differ between the above two cases.

Firstly, we will discuss the existing solutions in Lebanon, so we can make the right choices for insulating performances depending on the wall types. Secondly, we will explain the main criteria for selecting the proper insulation. We present a matrix to facilitate the selection of the proper product based on the nature of the walls that need isolation and the nature of the project (new construction or renovation).

Just one criterion to consider: insulating walls, floors, and roofs is not enough for having an insulated house. One has to also insulate the windows, the doors, and also eliminate the thermal bridges caused by their frames and by the corners.

Insulation cannot exist alone, it needs protections. The most important protection needed is protection against humidity and UV radiation.

Roof and floor insulation is similar to wall insulation, but it differs by means of protection since they are exposed to nature as well as mechanical constraints. Reducing thermal bridges is a requirement for thermal insulation. All the areas in the house (walls, roof, floor, corners, openings, and windows) must be covered.

Before thermally insulating an exterior wall, it is important to make sure that the wall is well made showing no signs of humidity leakage. In these cases, the thermal insulating materials are degraded. That's why a pre-treatment for those areas is essential before starting any kind of thermal insulation.

External wall insulation can be done in different ways: external insulation, internal insulation, a cavity wall (double wall), or by a new technology called "mono-wall".

The most common method is the **Cavity Wall** technique. The insulation is gained by the stability of the air trapped between both walls, the inner wall and the outer wall, with a thickness of 3 to 5 cm. To increase the performance of the thermal insulation, some people replace the air gap with an insulation material. This technique is very interesting when one considers its performance in terms of thermal conductivity and thermal inertia. The cost is high, but it is very durable if one takes care of the probable humidity leakage. Some people keep an air gap distance between the exterior wall and the insulating material to allow the walls to "breathe" properly in order to reduce humidity. Thus, some openings are created to encourage air circulation, distributed one near the roof and another near the floor built in a way to prevent water entry into the gap between both walls.

Figure 7: Cavity wall insulation

The **External Thermal Insulation** is the most effective solution because builders can profit from the thermal inertia of the wall to ensure thermal comfort. However, its installation is difficult, and it requires advanced technical skills due to several constraints that will be explained below.

The most important constraint is the water (or Humidity) that reduces the thermal insulation characteristics. For that, the insulation has to be covered by a tiling or waterproofing membrane to reduce vapor contact with the insulating material. This type of insulation is very durable if the vapor barrier is well installed.

In addition to the latter, this method of insulation reduces the thermal bridges completely. It is the ideal technique for a renovation project of an existing building. Unfortunately, not all the facades of existent constructions, such as traditional houses, can be simply changed to thermally insulate the walls. For these cases, we recommend the internal thermal insulation method that will be explained in the next paragraph.

Figure 8: New rise building insulated with XPS (External Insulation)

The **Internal Thermal Insulation** is related to the way the household is treated including the current practices for cleaning (water) and the paint or the layer that covers the insulation material. It also has other disadvantages such as the thermal bridging and the risk of internal condensation. Depending on the climatic zone there are other advantages and disadvantages related to the fact that internal thermal insulation replaces the effects of the original wall's thermal inertia. For instance, in the coastal zone, the thermal inertia has a negative effect in residential buildings. However, for other zones, thermal inertia is an important criterion. That's why this method is rarely recommended in some climatic zones.

Unlike the double wall strategy of insulation, the **mono-wall** concept consists of a wall that has a thermal insulation characteristic without requiring any filling material or covering material that insulates thermally. This concept is used for new established buildings/projects and cannot be applied for existing projects. This type of construction uses insulating construction elements, such as the Sandwich block, a composite element that contains polystyrene. Another way is by building the wall using polystyrene blocks (EPS blocks) and then filling the frames with the normal cement. This method, on the other hand, needs to have humidity/water/vapor proofing from both sides of the wall.

Other ways to reduce the heat transfer in a construction is to use lighter concrete. This solution is preferable over normal concrete although its thermal characteristics cannot be considered as thermal insulation material. This will be more thoroughly explained in the next couple paragraphs.

General characteristics of available product

Polystyrene (EPS and XPS)

Polystyrene is a material that has a high insulation performance and has many benefits such as its excellent moisture resistance.

Expanded Polystyrene (**EPS**) is manufactured by means of hydrocarbon (Styrene) foam to water vapor and pentane, and is therefore an open pore structure, known as the white polystyrene.

Extruded Polystyrene (**XPS**) is known as blue polystyrene because when subjected to a blowing agent under pressure it gives a closed pore structure.

They are used in commercial buildings and residential housings. Expanded polystyrene (EPS) has a low to medium density for insulating vertical walls. Extruded polystyrene (XPS) is recommended for roof insulation as well as for double walls.

Product Overview:

- Additives to lightweight concrete
- Composite panels
- Expanded and Extruded Boards

Benefits	Disadvantages

• **Excellent mechanical properties** • **High dimensional stability (XPS)** • **High thermal performance** • **Low cost of this material (EPS)** • **Rot proof (not biodegradable)** • **The ease of implementation**	• Degradation characteristics in case of long exposure to UV radiations (EPS) • Energy required to produce the material is big • Non-recyclable • Non-renewable resource • Poor long-term dimensional stability (EPS) • Sensitive to water

As for the TSBL 2010, there is an optimal thickness of an insulator (in centimeters (cm)) for each product per usage, as shown in Table 2 for the EPS and in Table 3 for the XPS. These thicknesses are calculated by considering the climatic zone.

Climatic Zone	Roof	Walls	Groud Floor	
			Exposed	Semi-exposed
Zone 1 Coastal	4.0	1.5	1.3	1.1
Zone 2 Mountain	4.5	3.6	3.6	2.1
Zone 3 Inland Plateau	4.5	3.6	3.6	2.1
Zone 4 High Mountain	5.3	5.1	4.3	2.7

Table 2: Reference Thickness (in cm) for EPS per component Vs. Climatic Zone for Residential (refer to TSBL 2010) (0.032 W/m.k)

Climatic Zone	Roof	Walls	Groud Floor	
			Exposed	Semi-exposed
Zone 1 Coastal	3.2	1.2	1.1	0.9
Zone 2 Mountain	3.7	2.9	2.9	1.7
Zone 3 Inland Plateau	3.7	2.9	2.9	1.7
Zone 4 High Mountain	4.3	4.1	3.5	2.2

Table 3: Reference Thickness (in cm) for XPS per component Vs. Climatic Zone for Residential (refer to TSBL 2010) (0.026 W/m.k)

As we will be seeing in Graphs 5 through 8 and justifying the difference in their prices, the thermal performance of the XPS is better than the EPS.

Physical Characteristics	
Density (Kg/m^3)	EPS 16-24 XPS 26-75
Thermal Conductivity (W/m.K)	EPS 0.03 - 0.038 XPS 0.026-0.037
Fire Resistance	Moderately flammable

As listed below, these products are available in the Lebanese market.

Product Providers (not exhaustive list)	
For EPS: • **KAPPA System**	For XPS: • Alphachem

• **Kilzi & Co. s.a.r.l.** • **STAR FOAM**	• CMC • Est. Joseph Hajjar • KAPPA Systeme • Kilizi&Co. s.a.r.l. • Mic & Co s.a.r.l. • SODAMCO s.a.ly

Fiberglass

The fiberglass is a relatively fire resistant material used for thermal and acoustic insulation. Yet, it is completely permeable to water vapor, as well as a fire resistant. It is made from silica and large numbers of extruded fibers that have a very tiny diameter, which can cause skin and blood problems if manipulated without any precaution. Therefore, during the installation process, special clothes are required. But once installed and covered with tiling and/or protection mesh, no more contact with the fiberglass installed, so the skin/Blood problems won't persist, and that's because of the covering/tiling that prevent the direct contact with this insulation material.

Fiberglass is used in commercial and residential buildings. Fiberglass is sold in the form of rolls and panels. Low and medium density fiberglass are used for wall insulation. As for boards with high density, they are used for roof insulation.

Product Overview:

- Board of Fiberglass
- Rolls of Fiberglass

Benefits	Disadvantages
• **High acoustic insulation** • **High resistance to compression** • **High thermal behavior** • **Material not combustible and fire-resistant** • **Resistant to aging and deterioration** • **Resistant to chemicals**	• Degradation of thermal performance when subjected to humidity • Great amount of energy is required during production

Fiberglass has a better performance than the EPS in comparison with the XPS knowing that the price increase is not proportional to the thermal characteristics. This is due to the fact that fiberglass holds not only thermal characteristics but also acoustic and mechanical ones.

Climatic Zone	Roof	Walls	Groud Floor	
			Exposed	Semi-exposed
Zone 1 Coastal	3.8	1.4	1.3	1.0
Zone 2 Mountain	4.4	3.5	3.5	2.1
Zone 3 Inland Plateau	4.4	3.5	3.5	2.1
Zone 4 High Mountain	5.1	4.9	4.2	2.6

Table 4: Reference Thickness (cm) for Fiberglass per component Vs. Climatic Zone for Residential (refer to TSBL 2010) (0.031 W/m.k)

Physical Characteristics	
Density (Kg/m^3)	32 - 96
Thermal Conductivity (W/m.K)	0.031 – 0.032
Fire Resistance	Not very combustible but flammable

As listed below, these products are available in the Lebanese market.

Product Providers (not exhaustive list)

- **GLASS MASTER - FESCO NOUBISOL**
- **Mytco**
- **Est. Joseph Hajjar**

Rockwool

The Rockwool is a natural fire resistant material produced from volcanic activity and is used for different aspects in a building such as thermal and acoustic insulation. Rockwool is derived from basalt, a black volcanic rock found in many parts of the world. The manufacturing process of Rockwool is similar to the natural activity of a volcano. Volcanic rock melts in an oven heated at 1500°C. The molten rock is then turned into fibers under the pressure of wheels rotating at high speed. To make the product stable and waterproof, it is fiber bound and impregnated with oil before transforming it into different finished products.

Rockwool is used in commercial and residential buildings. The boards of Rockwool that have a vapor barrier are applied in the double walls. However, the boards of Rockwool that are covered with a different type of layer are used to provide waterproofing of the roof.

Product Overview:

- Rockwool board
- Roller with a vapor barrier

Benefits	Disadvantages
• **Acoustic insulation** • **Fire resistant** • **Resistant to compression** • **Resistant to aging and deterioration** • **Resistant to chemicals** • **Resistant to microorganisms and insects** • **Thermal behavior**	• Degradation of thermal performance when subjected to humidity • Great amount of energy is required during production • Settling important durable double walls can be costly

The performance of Rockwool is not better than the EPS, XPS, and Fiberglass; on the contrary, it gives the same amount of performance. However, the only major difference lies in its high capacities of fire resistance.

Climatic Zone	Roof	Walls	Groud Floor	
			Exposed	Semi-exposed
Zone 1 Coastal	4.6	1.7	1.5	1.2
Zone 2 Mountain	5.2	4.2	4.2	2.5
Zone 3 Inland Plateau	5.2	4.2	4.2	2.5
Zone 4 High Mountain	6.1	5.9	5.0	3.1

Table 5: Reference Thickness (cm) for Rockwool per component Vs. Climatic Zone for Residential (refer to TSBL 2010) (0.037 W/m.k)

Physical Characteristics	
Density (Kg/m^3)	40 – 100
Thermal Conductivity (W/m.K)	0.033 – 0.038
Fire Resistance	Incombustible & flammable

As listed below, these products are available in the Lebanese market.

Product Providers (not exhaustive list)

- **CMC**
- **GLASS MASTER - FESCO NOUBISOL**
- **Kilzi & Co. s.a.r.l.**
- **Mic & Co s.a.r.l.**

Cork

The Cork is a natural thermal insulation material found in the bark of some trees, more specifically in the Oak trees. Cork is a product of low density, relatively resistant to fire, good thermal insulation, sound and vibration, and water resistant with suberin which permeates through the cells. It is flexible and decomposes slowly. It also has a strong resistance to the effects of varying temperature and humidity levels. Crushed into granules, it is transformed into insulation boards, wall or floor coverings.

It is used in different types of buildings. Yet, it is used the most for vibration insulation. It can be placed in areas with risk of moisture such as basements.

Product Overview:

- Cork boards

Benefits	Disadvantages
• **Compressive strength** • **Little energy consumed in manufacturing** • **Humidity and heat resistant** • **Non toxic** • **Renewable material, natural, and recyclable** • **Resistant to insects** • **Sound and vibration insulating material** • **Thermal inertia is good**	• Relatively high price • Tree source availability

The performance of Cork is not better than the EPS, XPS, and neither better than fiberglass. But what justify the price of the Cork are the other characteristics, such as the acoustical insulation, vibration absorption, fire resistance…

Climatic Zone	Roof	Walls	Groud Floor	
			Exposed	Semi-exposed
Zone 1 Coastal	4.8	1.8	1.6	1.3
Zone 2 Mountain	5.5	4.4	4.4	2.6
Zone 3 Inland Plateau	5.5	4.4	4.4	2.6
Zone 4 High Mountain	6.4	6.2	5.2	3.2

Table 6: Reference Thickness (cm) for Cork per component Vs. Climatic Zone for Residential (refer to TSBL 2010) (0.039 W/m.k)

Physical Characteristics	
Density (Kg/m^3)	80 - 140
Thermal Conductivity (W/m.K)	0.032 – 0.045
Fire Resistance	Hardly flammable

As listed below, this product is available in the Lebanese market.

Product Providers (not exhaustive list)

- **Kilzi & Co. s.a.r.l.**
- **Est. Joseph Hajjar**

Sandwich Block

The Sandwich Block is a composite insulating material made to replace the double wall concept by having the wall itself as an insulator (mono-wall). Thus, instead of using Hollow Blocks of concrete to build a home and installing an insulating material on top of them, the sandwich block is used to imitate the double wall. In fact, these blocks are made from concrete with some waterproofing additives, with Expanded Polystyrene between the blocks. The dimension of these blocks is usually 20 cm x 40 cm x 25 cm, and the 25 cm is divided into three parts of 10 cm of concrete each, then 5 cm of Expanded Polystyrene and then 10 cm of concrete simultaneously.

Physical Characteristics	
Density (Kg/m^3)	1300
Thermal Conductivity (W/m.K)	0.07
Fire Resistance	Hardly flammable

Benefits	Disadvantages
• **Comparable price with having a normal block + Thermal insulator** • **Reduction of the all in all weight of the building, which means reduction in the structure cost**	• Thermal bridges between blocks

As listed below, this product is available in the Lebanese market.

Product Providers (not exhaustive list)
• **Insulite Blocks co.**

Spray Polyurethane Foam (SPF)

The SPF is a spray and insulating foam that is installed as liquid and then expands its original size when spread in the air. It can also be poured or injected. Sprayed-in-place Polyurethane is self-adhering, seamless, closed cell foam with an excellent compressive strength. It can be tapered to improve water drainage on an existing roof.

It is used in many types of buildings especially as an insulator to fill in the gap inside a cavity wall. As the SPF expands with air, it has the advantage of filling the entire zone between the two walls stopping air infiltration. Knowing that this method of insulation is not limited to the cavity wall application, it is used for ceiling as well.

Product Overview:

- Spray liquid

Benefits	Disadvantages
• **Long lifecycle** • **Recyclable** • **Stops air and moisture infiltration** • **Very good thermal insulation** • **Adds strength to the building structure** • **Humidity resistant** • **Easy installation, especially for spaces that are hard to access with irregular surfaces**	• Combustible • Moderately flammable • Weak resistant to UV sun light • A protection layer is needed

Polyurethane is the best insulation material between the listed materials, having the lowest λ-value which means the best thermal resistance performance.

Climatic Zone	Roof	Walls	Groud Floor	
			Exposed	Semi-exposed
Zone 1 Coastal	2.4	0.9	0.8	0.6
Zone 2 Mountain	2.8	2.2	2.2	1.3
Zone 3 Inland Plateau	2.8	2.2	2.2	1.3
Zone 4 High Mountain	3.2	3.1	2.6	1.6

Table 7: Reference thickness (cm) for SPF per component Vs. Climatic Zone for Residential (refer to TSBL 2010) (0.019 W/m.k)

Physical Characteristics	
Density (Kg/m^3)	30 à 50
Thermal Conductivity (W/m.K)	0.017-0.022
Fire Resistance	Combustible and moderately flammable

As listed below, this product is available in the Lebanese market.

Product Providers (not exhaustive **list)**

- **Kilzi & Co. s.a.r.l.**

Light concrete

Light concrete is not considered a thermal insulating material, but it has better thermal propriety than the normal concrete. It is found in three different ways: First, there are some aggregate materials that have thermal insulation characteristics that can be added to the cement used for reinforced concrete or for roofs and floors. Second, there is a mixture of cement and aggregate already done; all it needs is some added water in order to be used. Finally, the walls can be built using a light weight concrete hollow blocks that mimics the effect of double walls filled with air gaps. This technique is not difficult to implement, but it differs radically from traditional masonry. So by using a special masonry block, thermal diffusion can be significantly reduced.

Product Overview:

- Aggregates, sold separately
- Light cement bags
- Light weight concrete Hollow Blocks

Physical Characteristics		
Density (Kg/m^3)	1300	
Thermal Conductivity (W/m.K)	Aggregates	0.095
	Light cement	0.63
	Light weight Blocks	0.32
Fire Resistance	Not flammable	

Benefits	Disadvantages
• **Mono-wall** • **Not flammable** • **Waterproofing solution** • **Easy to install** • **Reduction of the all in all weight of the building, which means reduction in the structure cost**	• Low thermal insulation characteristic

Product Providers (not exhaustive list)	• Insulite Blocks co. • TA Group s.a.r.l.

Slight comparison between thermal insulation products

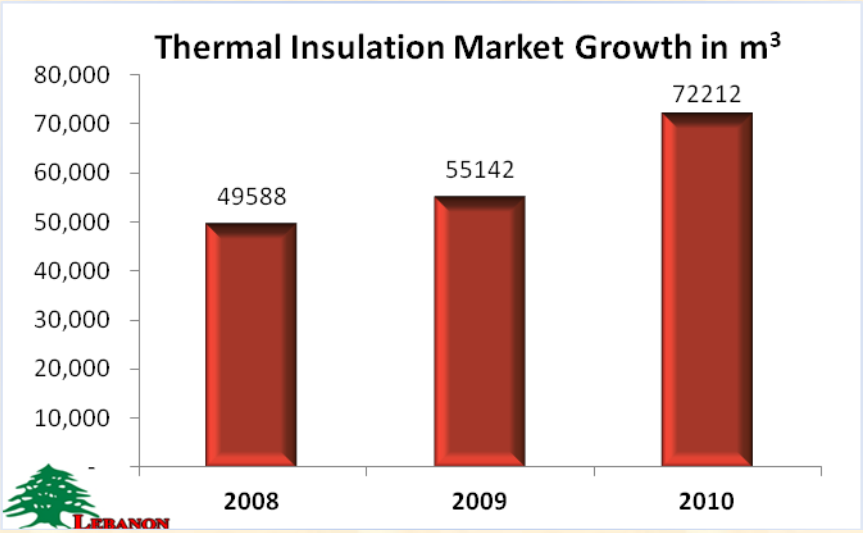
Here is a simple comparison for all the available products in the Lebanese market, as provided to us by the manufacturer/importer.

	Density (Kg/m^3)	(W/m.K)	Fire Resistance
EPS	16 – 24	0.03 – 0.038	Moderately Flammable
XPS	26 - 75	0.026 – 0.037	
Fiberglass	32 – 96	0.031 – 0.032	Not very combustible but flammable
Rockwool	40 - 100	0.033 – 0.038	Incombustible and flammable
Cork	80 - 140	0.032 – 0.045	Hardly flammable
Sandwich Block	1300	0.07	Hardly flammable
SPF	30 - 50	0.017 – 0.022	Combustible and moderately flammable
Light concrete Aggregate	1300	0.095	Not flammable
Light weight Blocks	1300	0.32	
Light cement	1300	0.63	

Thermal Insulation Market for buildings in Lebanon

The thermal insulation market for buildings in Lebanon is still a newly rising concept in the market. Knowing that this market is growing at an average rate of 21.1% per year and as shown above, only a few numbers of companies in Lebanon import and/or manufacture products related to thermal insulation specifically designed for buildings. This booklet compares the insulation procedures and materials with the quantity installed in cubic meter per product per year for the past three years. Previously stated, an insulator is defined as a material that has a thermal conductivity lower than 0.07 W/m.K.

The graph below represents the total of installed insulators in the last three years in cubic meter (m^3), and it shows that this market is growing in a fast way year after year. The Lebanese people and engineers are encouraging the insulation as a source of reducing energy consumption. Therefore, in the last year this market did register a growth of 31%, with a higher increase for the following years to come.

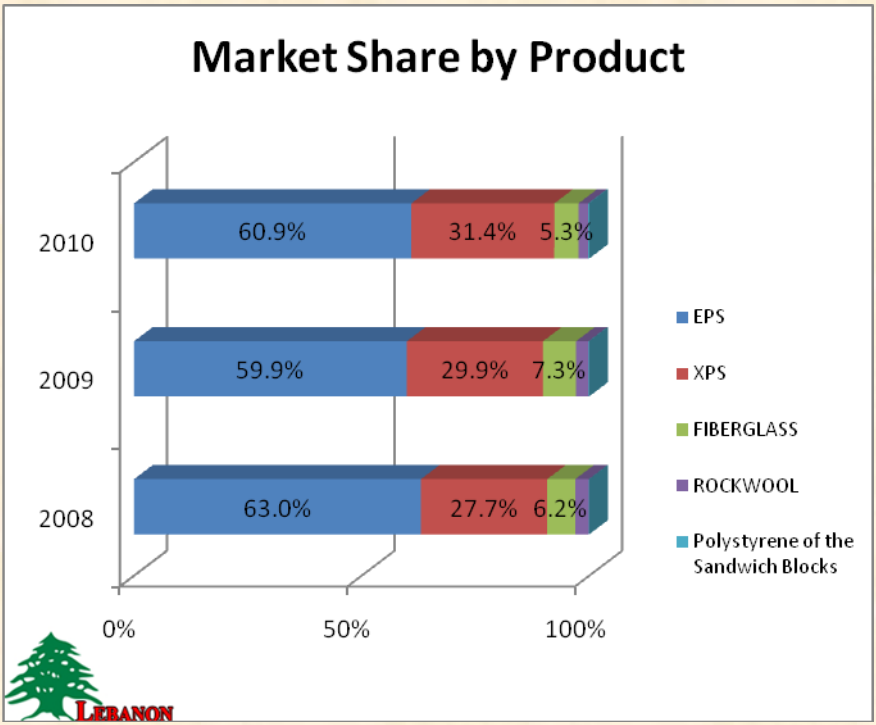


Graph 2 : Thermal insulation Market Growth in m^3 per year (2008, 2009 and 2010)

The survey targets the available materials in Lebanon, as well as their source of supply. Thus, many types of insulation that are used in Lebanon have been discovered as listed below:

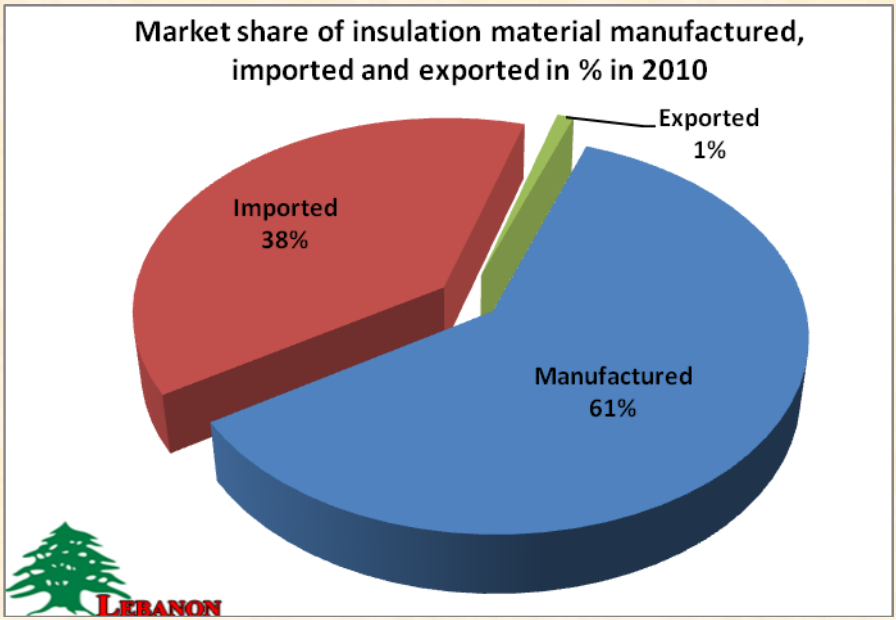
- Expanded Polystyrene (EPS)
- Extruded Polystyrene (XPS)
- Fiberglass insulator
- Rockwool insulator
- Polystyrene of the Sandwich Blocks insulators

These are the main existing products that have been sold in the last three years. In this section, there is a full discussion of the market share of each product in the last three years (Graph 3 below).



Graph 3: Market Share by thermal insulation product during 2008, 2009 and 2010

Graph 3 above shows that the market share of each product is approximately stable during the years, yet the EPS (expanded polystyrene) has been the most in demand with an average market share of 61.3 % and for the XPS (extruded polystyrene) 29.7 %. As for the Fiberglass, it represents only 6.2% of the market and the Rockwool represents just 2.6%. One has to take into account that these statistics and surveys are based solely on thermal insulation only in residential areas and housings. Finally, the light weight sandwich blocks with polystyrene (mono-wall) correspond to just 0.2 % of the market share.



Graph 4: Market share of insulation material manufactured, imported and exported in % in 2010

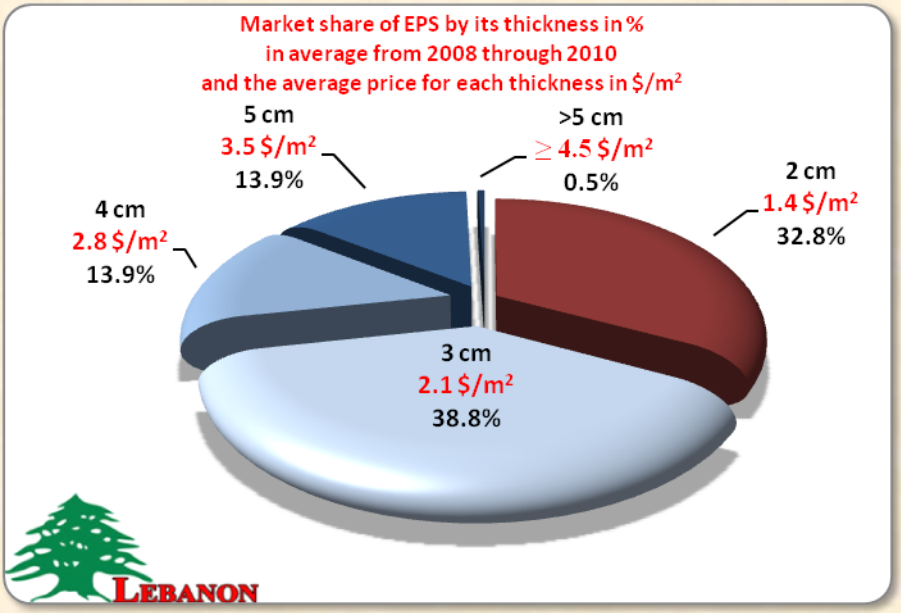
The insulation material manufactured in Lebanon has a greater market share than the imported one, as shown in Graph 4 above. In addition, 1% of the total of insulation material is exported. Exports are only of the manufactured products, thus showing that the Lebanese production has a certain minimum of specification that suits foreign

countries. Also, all the manufactured products don't have any international or national quality certifications.

Expanded Polystyrene (EPS)

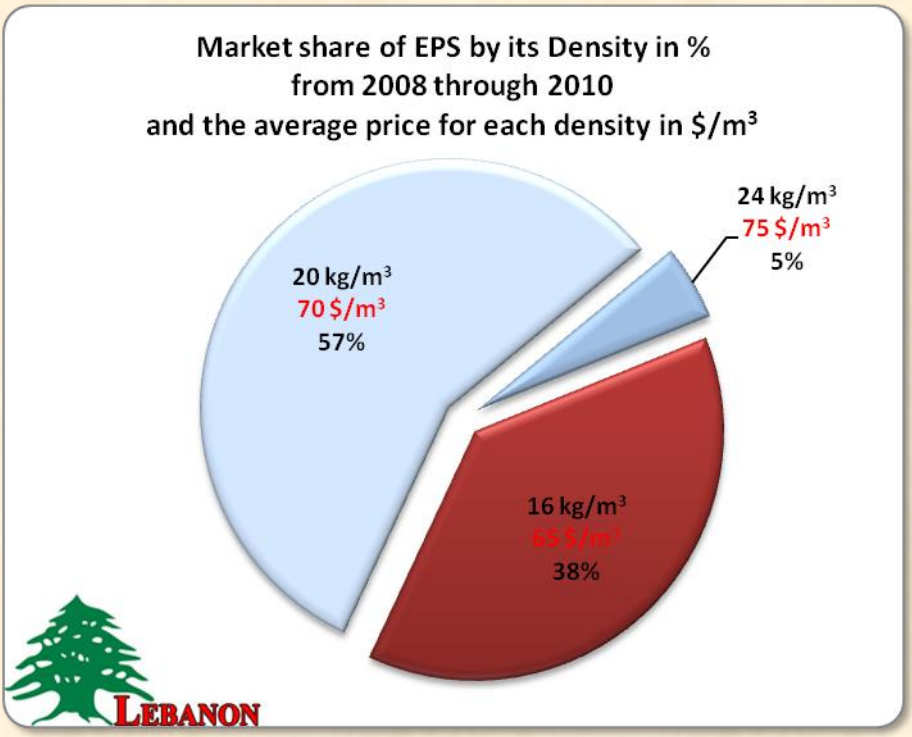
The Expanded Polystyrene (EPS), known as the white polystyrene, has more than the half of the market-share, with an average of 61.3% of the thermal insulation market in Lebanon. In addition to that, the available EPS in the Lebanese market are only manufactured in Lebanon; we didn't recognize any importation for this product. EPS is sold by board, in general they are 200 cm x 100 cm or 120 cm x 60 cm, but it has different thicknesses and different densities.

As shown in Graph 5 below, there are different thicknesses available in the market, and the demand for those thicknesses differs depending on the application and the performance needed. Graph 5 below represents the average price of the variation between price change with density change and thickness changes. In addition, not all the densities are available for all thicknesses.



Graph 5: Market share of EPS by its thickness in % in average from 2008 through 2010 and the average price in $ for each thickness per m2

Furthermore, not all the densities have the same demand repartition. The higher the density, the lower the λ-value is, and the thermal insulation will be. So in the choice of the density enters other criterion than just the thermal insulation characteristic, for example we have the mechanical constraints, which justifies the difference in the demand repartition. Graph 6 shows the different densities available in the Lebanese market and their respective market share. The most used density is 20kg/m^3.

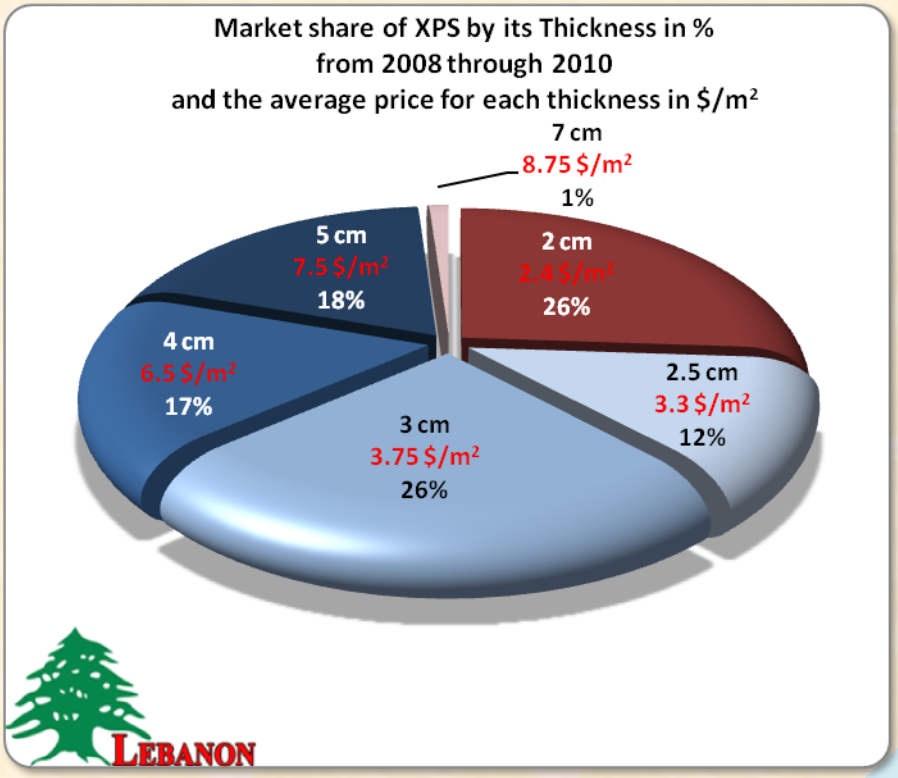


Graph 6: Market share of EPS by its Density in % in average from 2008 through 2010 and the average price in $ for each density per m3

NB: All the prices shown in this book are the average prices provided by all the manufacturers and importers that we contacted. But a general idea about the product has been provided to point out that these prices could vary with different criteria (density, thickness, and their inter-correlation).

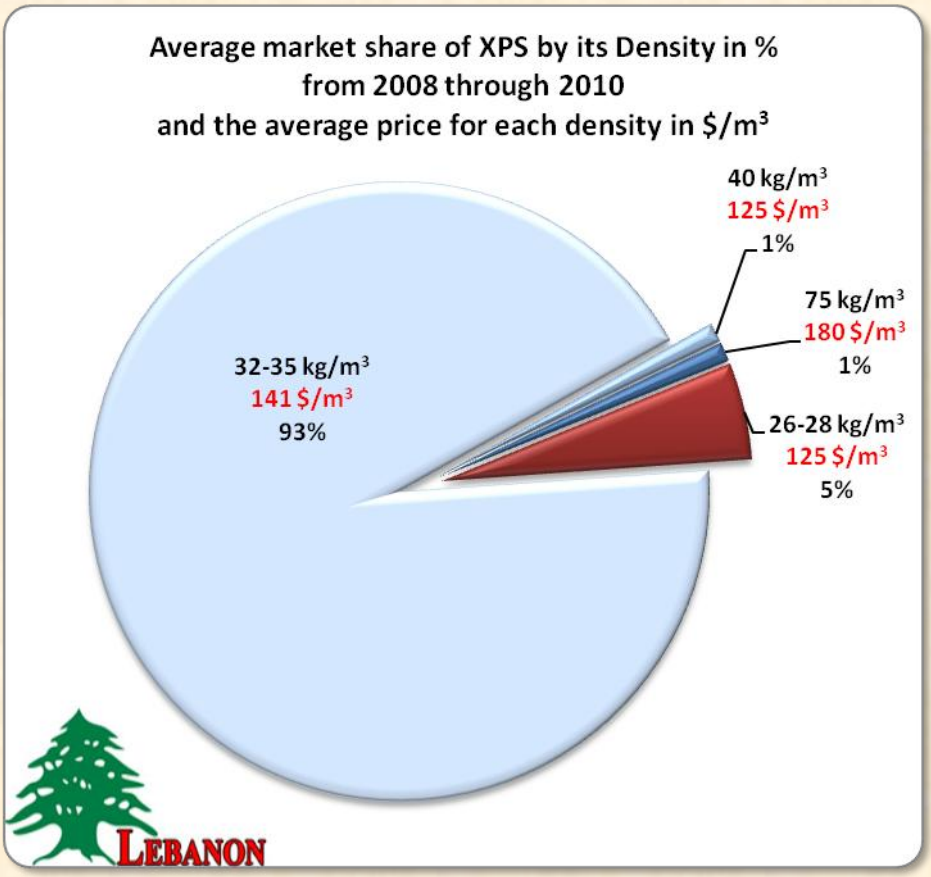
Extruded Polystyrene (XPS)

The Extruded polystyrene (XPS), known as the blue polystyrene, has so far an average of 29.7% of the market share of the thermal insulation market in Lebanon. XPS is imported but newly manufactured in Lebanon. Same as the EPS, the XPS is sold by individual boards (120 cm x 60 cm) and come in different thicknesses and densities. As shown in Graph 7 below, the demand for different XPS thicknesses is generally equal for all thicknesses ranging from 2 to 5 cm. The thermal performance of the XPS is better than the EPS, however; the price of the XPS is much higher than the other.



Graph 7: Market share of XPS by its thickness in % in average from 2008 through 2010 and the average price in $ for each thickness per m2

As for the density demand repartition, we distinguish the fact that the density, 32-35 Kg/m^3, is the most used density in the Lebanese market.

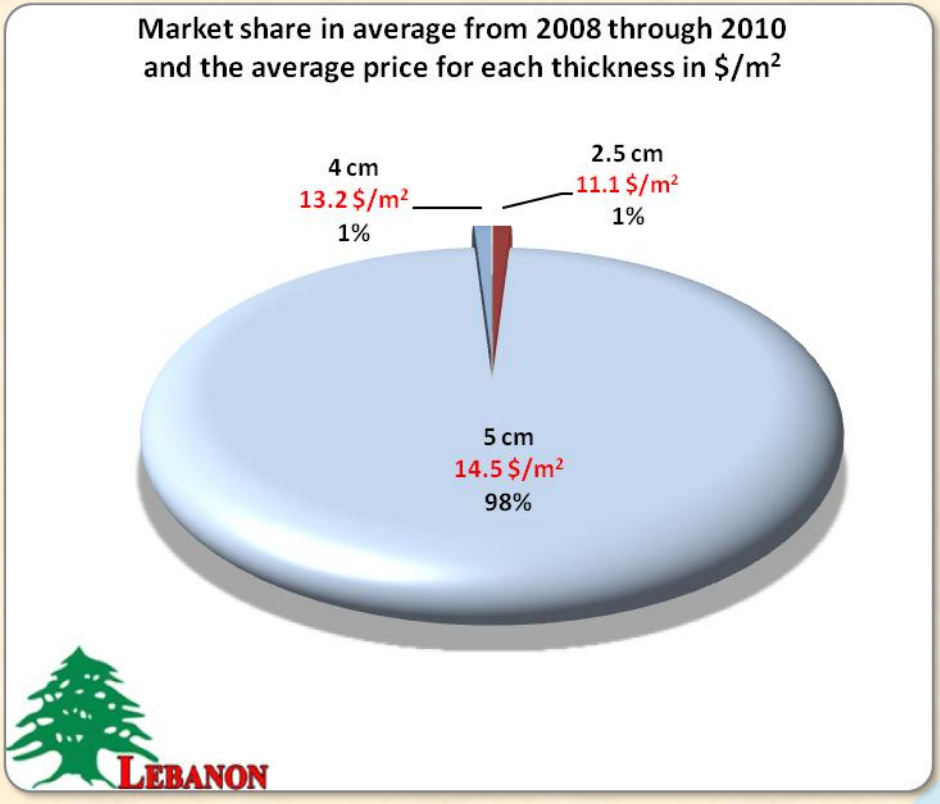


Graph 8: Demand repartition of XPS by its Density in % in average from 2008 through 2010 and the average price in $ for each density per m^3

NB: The prices shown in the graph above were given by different providers and are subject to different criterion; that's why some of the prices might sound illogical.

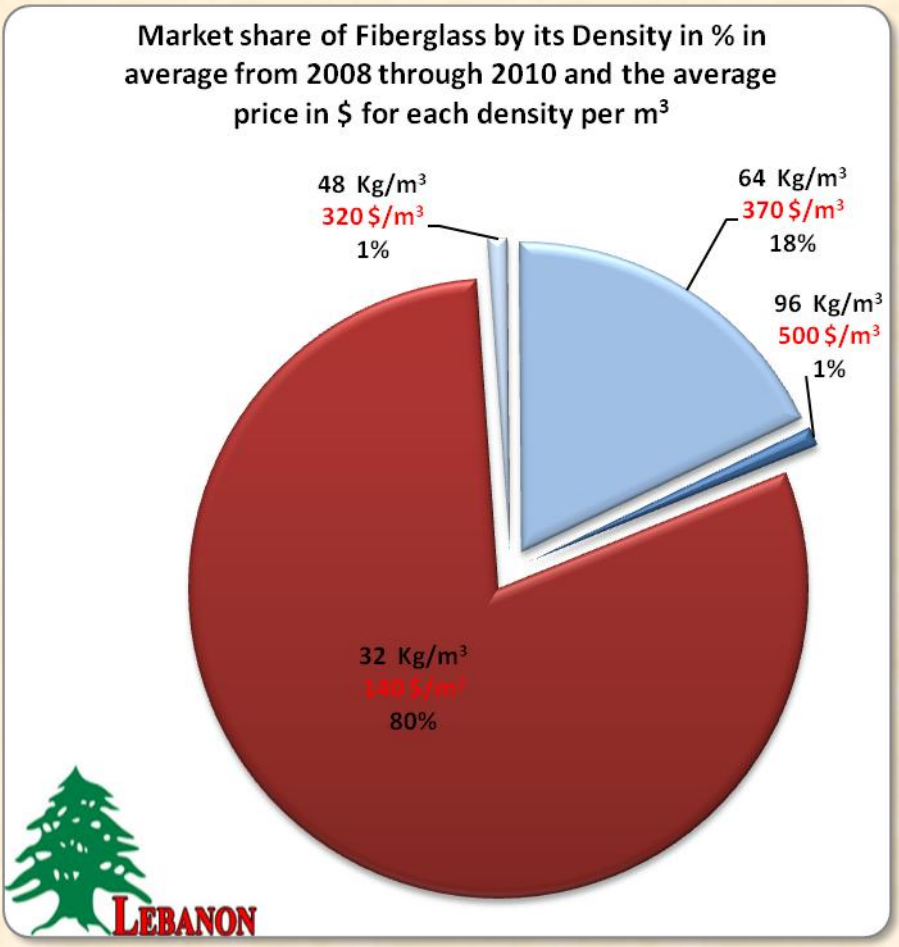
Fiberglass

The Fiberglass has 6.2 % of the total share market in the thermal insulation field. It is sold by board. As represented in Graph 9 below, one dominant thickness is at 5cm while all the others are almost nonexistent. In addition to that and since the price of a certain thickness depends on the density used, the prices given in this graph are the average prices and/or the range of prices (Graph 10).



Graph 9: Market share of Fiberglass by its thickness in %, in average from 2008 through 2010, and the average price for each thickness in $/m^2

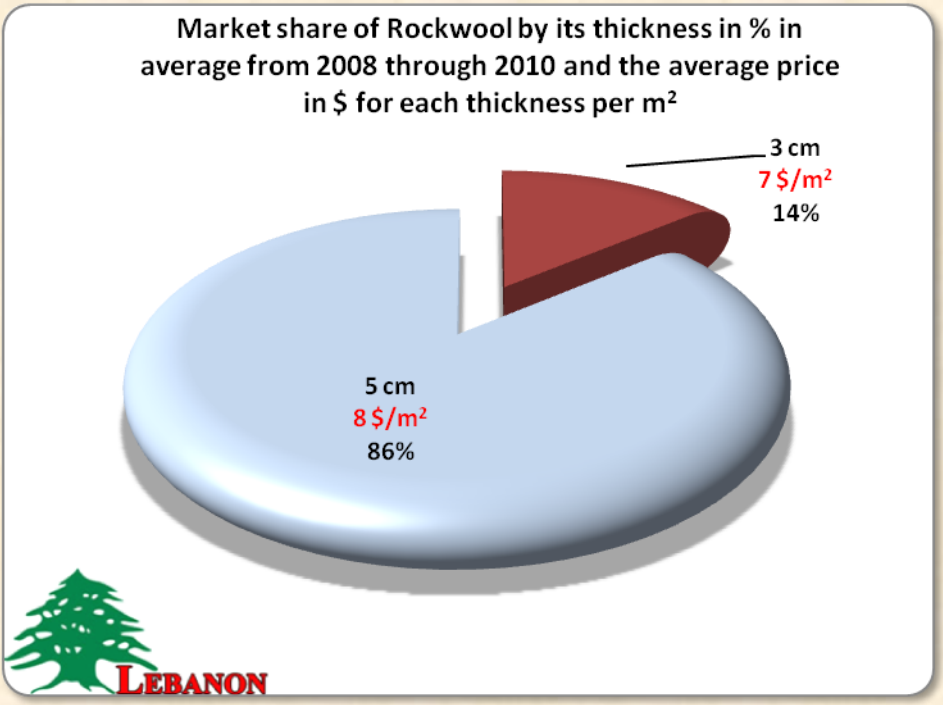
The two most common densities that are used specifically for thermal insulation are 32 Kg/m^3 and 64 Kg/m^3. Other densities are used for not only thermal insulation but also for acoustical insulation.



Market share of Fiberglass by its Density in % in average from 2008 through 2010 and the average price in $ for each density per m^3

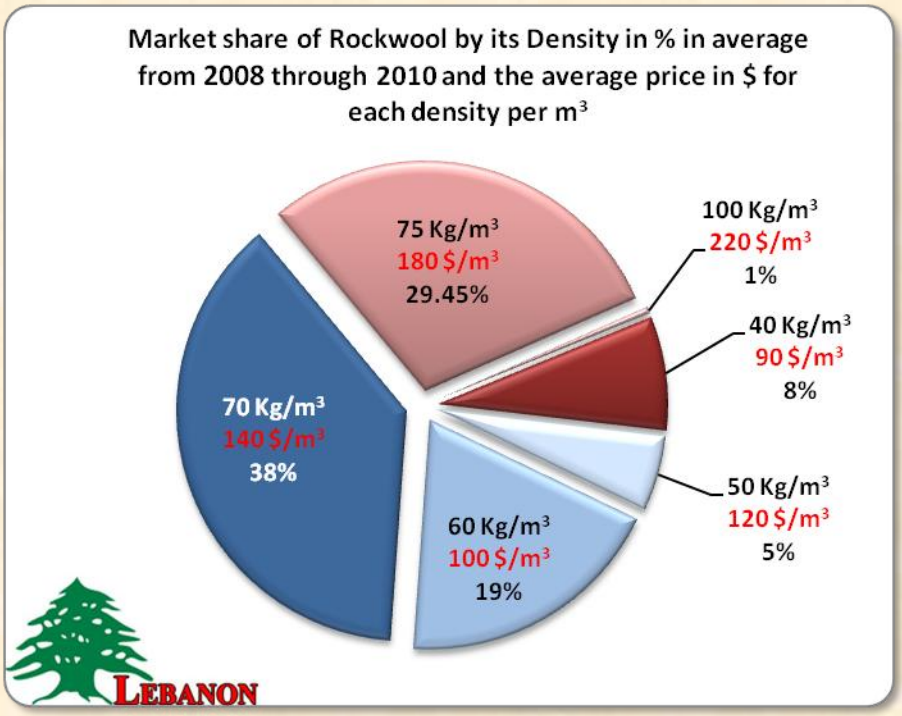
Rockwool

The Rockwool is mainly used in residential buildings or houses for roof insulation or double wall insulation with a gypsum board as the internal wall. It is only 2.6 % of the market share of the thermal insulation market in Lebanon. It is sold as. As shown in the Graph 11 below, the Rockwool insulation has different thicknesses and densities. However, the major thickness sold is the 5 cm boards. The prices in the below graph represent the average price for the mentioned thickness and the price variation with the change in density.



Graph 10: Market share of Rockwool by its thickness in % in average from 2008 through 2010 and the average price in $ for each thickness per m2

The demand repartition of the Rockwool insulator has two major densities, the 70 Kg/m^3 and the 75 Kg/m^3, and both make up around 68% of the Rockwool share market. Lower and higher densities are requested for special purposes.



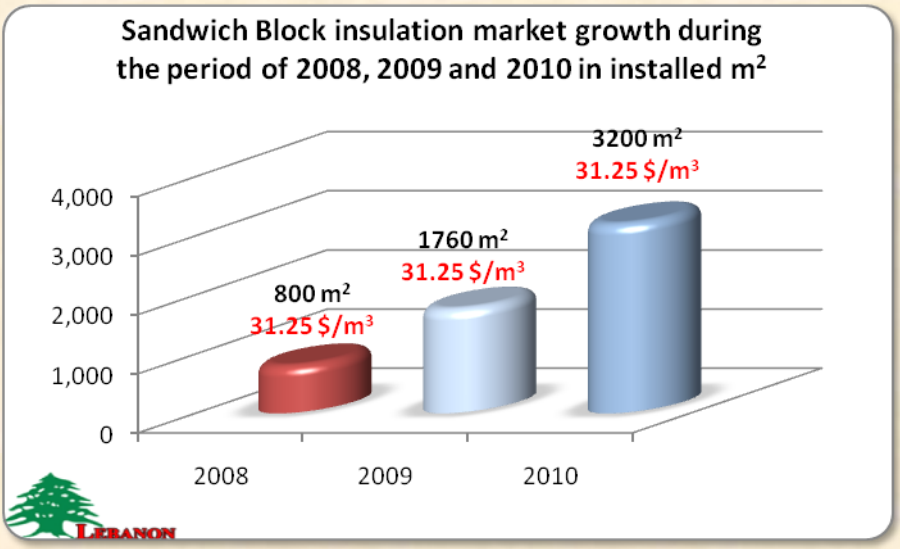
Graph 11: Market share of Rockwool by its Density in % in average from 2008 through 2010 and the average price in $ for each density per m^3

NB: The prices shown in the graph above were given by different providers and are subject to different criterion; that's why some of the prices might sound illogical.

Sandwich Block

In opposition to having an additional layer for insulation on the built wall, this product creates a thermal insulation by imitating the double wall concept. For the last three years, this mono-wall insulator has an average of 0.2% from the insulation market in Lebanon.

As we can see in Graph 13 below, the demand on this composite material increases in a high rate as the sales double each year.



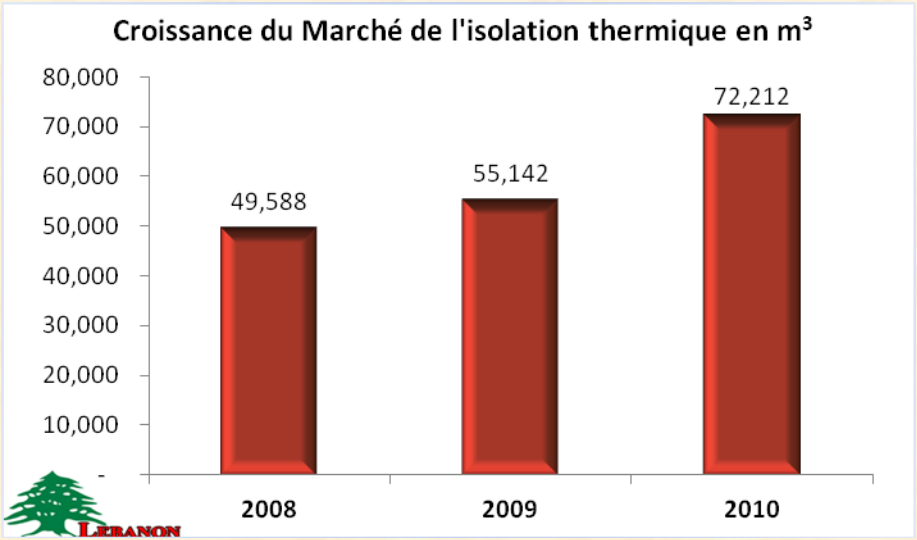
Graph 12: Sandwich Block insulation market growth during from 2008 through 2010 in installed m^2

NB: The prices provided in Graph 13 above should not be compared with the prices provided in previous graphs. This is caused by the presence of the concrete in this composite material, which increases the prices. However, if we retrieve the price of a normal concrete block from these prices, it would be comparable.

Marché de l'isolation thermique pour les bâtiments au Liban

Le marché de l'isolation thermique des bâtiments au Liban est un nouveau marché. Nous nous sommes aperçus que peu d'entreprises au Liban importent et/ou fabriquent des produits liés à l'isolation thermique. Ces produits sont censés être utilisés dans la construction des bâtiments; il est à noter que le taux moyen de croissance de ce marché est de 21.1% par an, calculé comme étant la croissance moyenne durant les trois dernières années. Dans cette étude, nous avons considéré, à titre de comparaison, les procédures et les matériaux d'isolation par la quantité installée en M^3 par produit et par an; cela sera fait pour les trois dernières années (2008, 2009 et 2010). Pour la classification des matériaux isolants, nous avons pris comme critère la conductivité thermique qui doit être inférieure à 0.07 W/m.K pour que le matériau soit considéré comme une matière thermiquement isolante.

Le diagramme 14 ci-dessous représente le total des mètres cubes d'isolants installés durant les trois dernières années. Il montre que ce marché est en croissance rapide, de plus en plus accélérée; cela est dû au fait que les Libanais, simples citoyens ou ingénieurs, encouragent de plus en plus l'isolation thermique comme étant un moyen de réduire leur facture énergétique. Nous devons souligner que, l'année dernière, ce marché a enregistré une croissance de 31% et que les fabricants / importateurs prévoient que, dans les prochaines années, ce marché sera de plus en plus florissant.



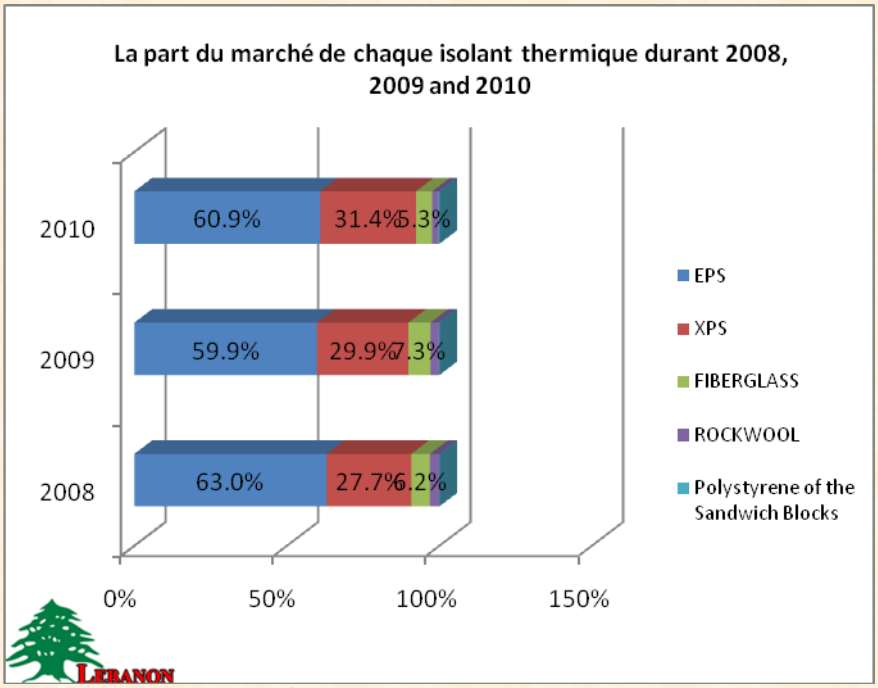
Graph 13: Croissance du Marche de l'isolation thermique en m^3 durant les trois dernières années (2008, 2009 et 2010)

L'enquête à pour but d'identifier les matériaux disponibles sur le marché libanais, ainsi que leur provenance locale. En effet, nous avons identifié plusieurs types d'isolants thermiques utilisés au Liban, mais les principaux produits sont :

- Polystyrène expansé (EPS)
- Polystyrène extrudé (XPS)
- Isolant en laine de verre
- Isolant en laine de roche
- Polystyrène contenu dans Block de béton en sandwich

Ce sont les principaux produits existants sur le marché libanais et vendus au cours des trois dernières années au Liban. Dans ce chapitre, nous allons analyser la part du marché de l'isolation thermique pour chaque

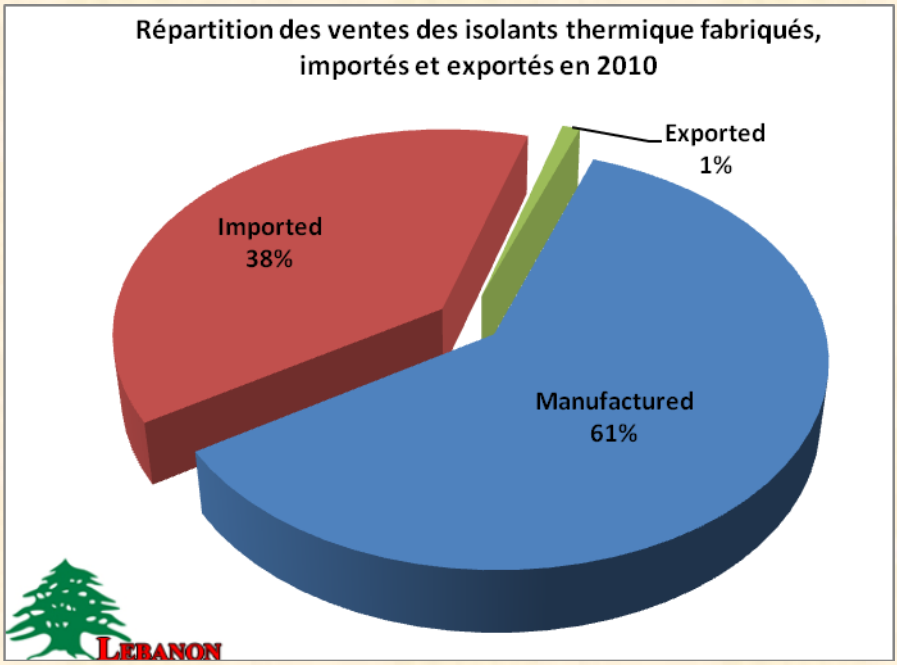
produit durant les trois dernières années, en se reportant au diagramme 15 ci-dessous.



Graph 14: la part du marché de chaque isolant thermique durant 2008, 2009 and 2010

Comme nous le remarquons dans le diagramme 15 ci-dessus, la part du marché de chaque produit isolant est approximativement stable au cours des années, sachant que l'EPS (polystyrène expansé) représente plus que la moitié du marché, soit 61.3 % en moyenne; et pour le XPS (polystyrène extrudé), 29.7 % en moyenne de ce même marché. En ce qui concerne la laine de verre, seulement 6,2% en moyenne constitue la part de ce produit dans le marché de l'isolation. Tandis que la laine de roche représente seulement 2,6% de celui-ci, sachant que nous limitons l'enquête au domaine de l'isolation thermique des parois (murs, toits et sols), qui sont liés directement au bâtiment; nous ne couvrons pas les autres usages l'isolation thermique. De plus, nous avons un produit composé qui est considéré comme étant un isolant thermique ou mono-mur. Ce produit correspond au Sandwich Block contenant du polystyrène, il représente 0.2 % en moyenne comme part du marché de

l’isolation thermique.



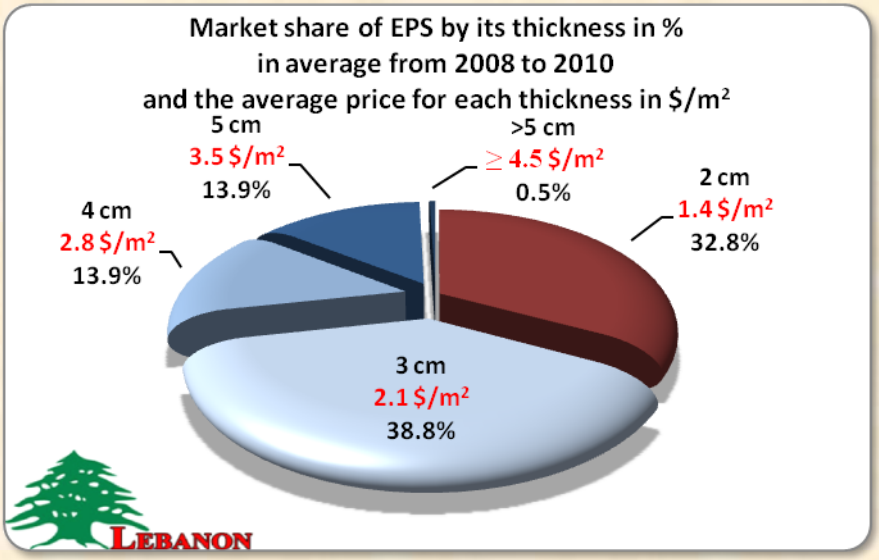
Graph 15: Répartition des ventes des isolants thermique fabriqués, importés et exportés en 2010

Notons que les matériaux isolants fabriqués au Liban ont un impact plus important sur le marché que ceux importés, comme le montre le diagramme 16 ci-dessus; de plus, nous remarquons que 1% du total des matériaux isolants est exportée. Les exportations sont de fait des produits manufacturés et l'on pourrait considérer que la production libanaise répond à un minimum de spécifications qui conviennent à d'autres pays importateurs, sachant que tous les produits fabriqués au Liban ne possèdent pas de certifications de qualité internationales ou nationales (sauf quelques tests réalisés sur des spécimens, à titre indicatif)...

Polystyrène Expansé (EPS)

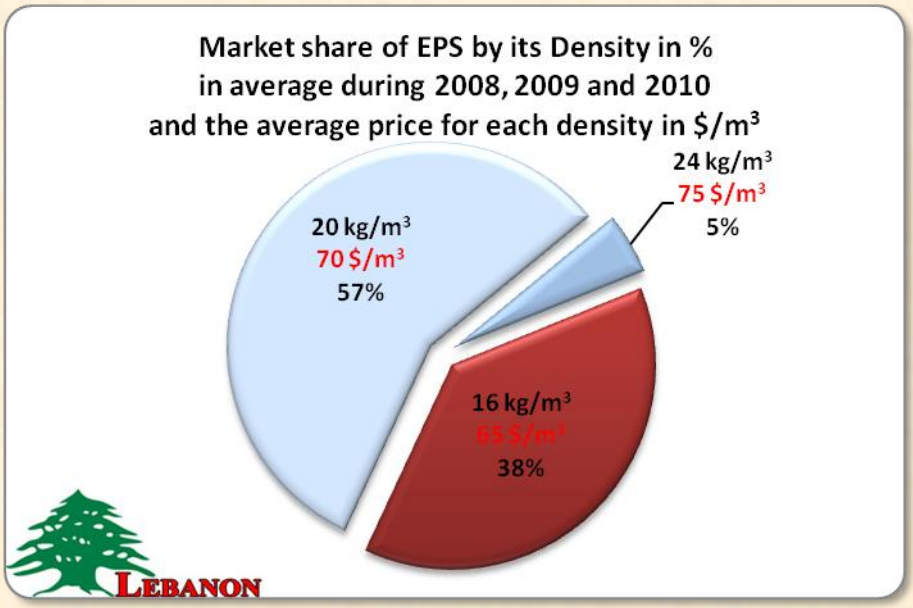
Comme mentionné précédemment, le polystyrène expansé (EPS), connu sous le nom de polystyrène blanc, constitue un peu plus que la moitié de la part du marché, soit une moyenne de 61.3 % du total du marché de l'isolation thermique. De plus, l'EPS disponible dans le marché libanais est fabriqué localement, comme nous n'avons pu identifier aucune importation de ce produit. L'EPS est vendu par panneaux. En général, ils ont une dimension de 200 cm x 100 cm ou bien 120 cm x 60 cm, mais on distingue plusieurs densités et de même plusieurs épaisseurs.

Comme le diagramme 17 ci-dessous montre, on remarque la présence de différentes épaisseurs disponibles sur le marché, et la demande sur ces épaisseurs diffère selon l'application et les performances demandées. Pour les prix indiqués dans le diagramme 17, ils représentent le prix moyen, sachant que le prix varie en fonction de la variation de la densité et d'autres propriétés, comme indiqué précédemment. De plus, nous avons remarqué que les densités ne sont pas disponibles pour toutes les épaisseurs.



Graph 16: Demand repartition of EPS by its thickness in % in average during 2008, 2009 and 2010 and the average price in $ for each thickness per m^2

Par ailleurs, nous avons remarqué que la demande varie d'une densité à une autre. En rappelant que la densité du produit isolant est inversement proportionnelle à sa conductivité thermique (λ-value): plus la densité est grande, moins l'isolation thermique sera efficace. Mais dans le choix de la densité, il entre plusieurs facteurs dont les contraintes mécaniques sur le matériau, ce qui justifie la différence de la demande, comme le montre le diagramme 18 ci-dessous. Trois densités différentes sont disponibles sur le marché, mais la dominante est la 20 kg / m^3.

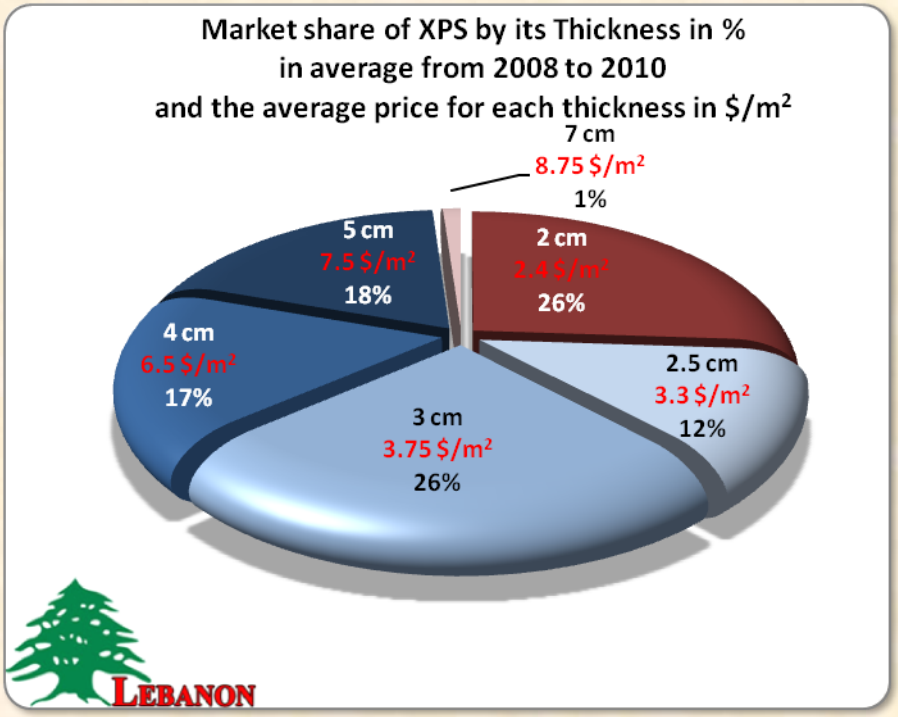


Graph 17:Part de marché du EPS en fonction de la densité moyenne en % durant 2008, 2009 et 2010, avec la visualisation du Prix en $ pour chaque densité par m^3

NB: les prix indiqués dans cette étude sont les prix moyens fournis par tous les fabricants et importateurs que nous avons contactés. Mais nous soulignons que ces prix pourraient varier selon différents critères (densité, épaisseur et leur inter-corrélation ...) et par suite ceux montrés dans les diagrammes, ils sont donnés à titre indicatif pour avoir une idée générale sur le produit.

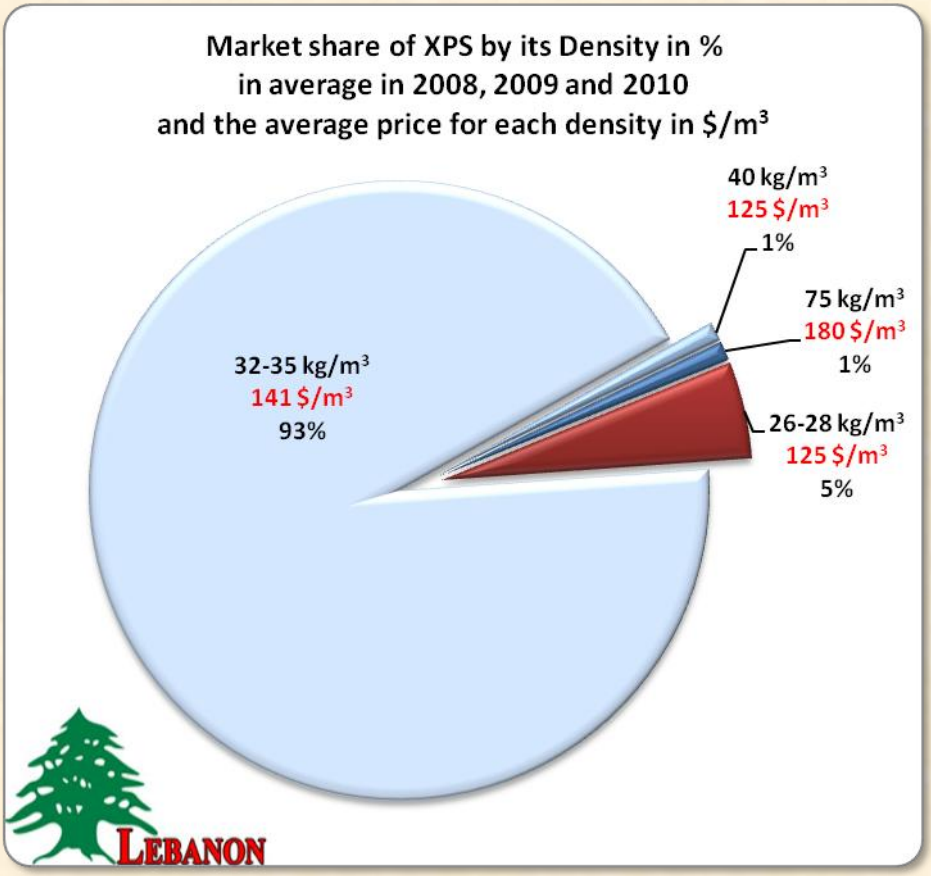
Polystyrène extrudé (XPS)

Le polystyrène extrudé (XPS), connu également sous le nom de polystyrène bleu, constitue 29.7% en moyenne du marché de l'isolation thermique au Liban. L'XPS est importé, mais la fabrication locale de ce produit a récemment commencé. Comme pour l'EPS, le XPS est vendu de la même manière ; des panneaux de 120 cm x 60 cm, en différentes épaisseurs et densités. Nous remarquons que la demande des différentes épaisseurs du XPS est plus ou moins égale, comme le montre le diagramme 19 ci-dessous. Sachant que la performance de l'isolation thermique en utilisant le XPS est meilleure que dans le cas de l'usage de l'EPS, mais en contrepartie le prix de l'XPS est plus cher que celui de l'EPS, il atteint presque le double prix de ce dernier.



Graph 18 : Demand repartition of XPS by its thickness in % in average during 2008, 2009 and 2010 and the average price in $ for each thickness per m²

Pour la répartition de la demande de densité, on distingue le fait que la densité de 32 à 35 kg/m3 est la plus utilisée sur le marché libanais.

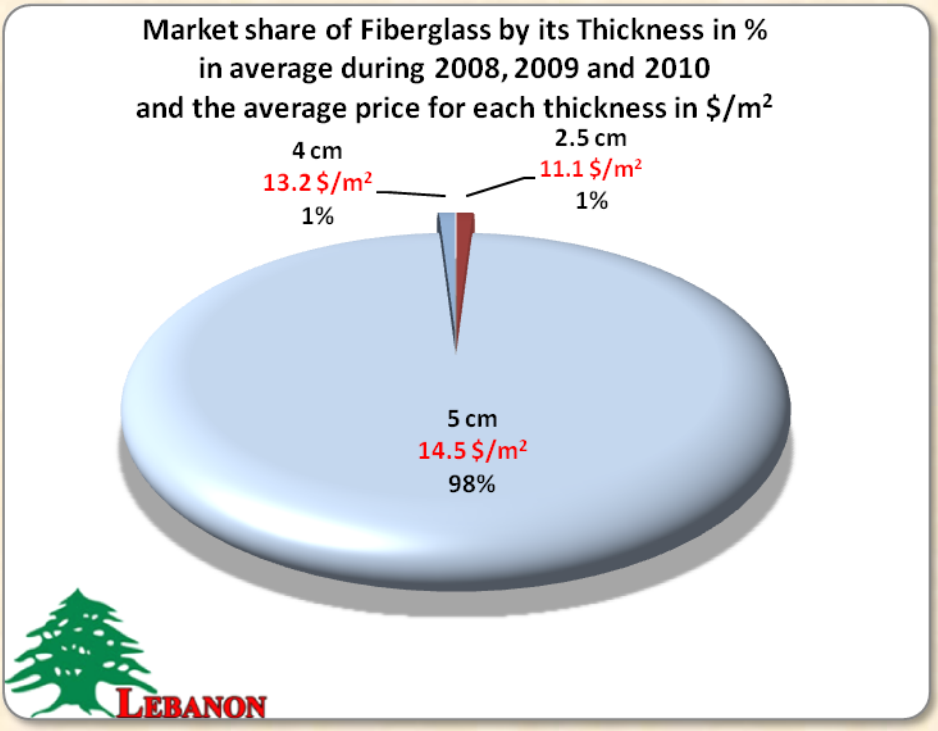


Graph 19 : Demand repartition Market share of XPS by its Density in % in average during 2008, 2009 and 2010 and the average price in $ for each density per m^3

NB: les prix indiqués dans le diagramme ci-dessus ont été donnés par différents fournisseurs et suivent différents critères, c'est pourquoi certains prix peuvent paraître illogiques.

Laine de Verre

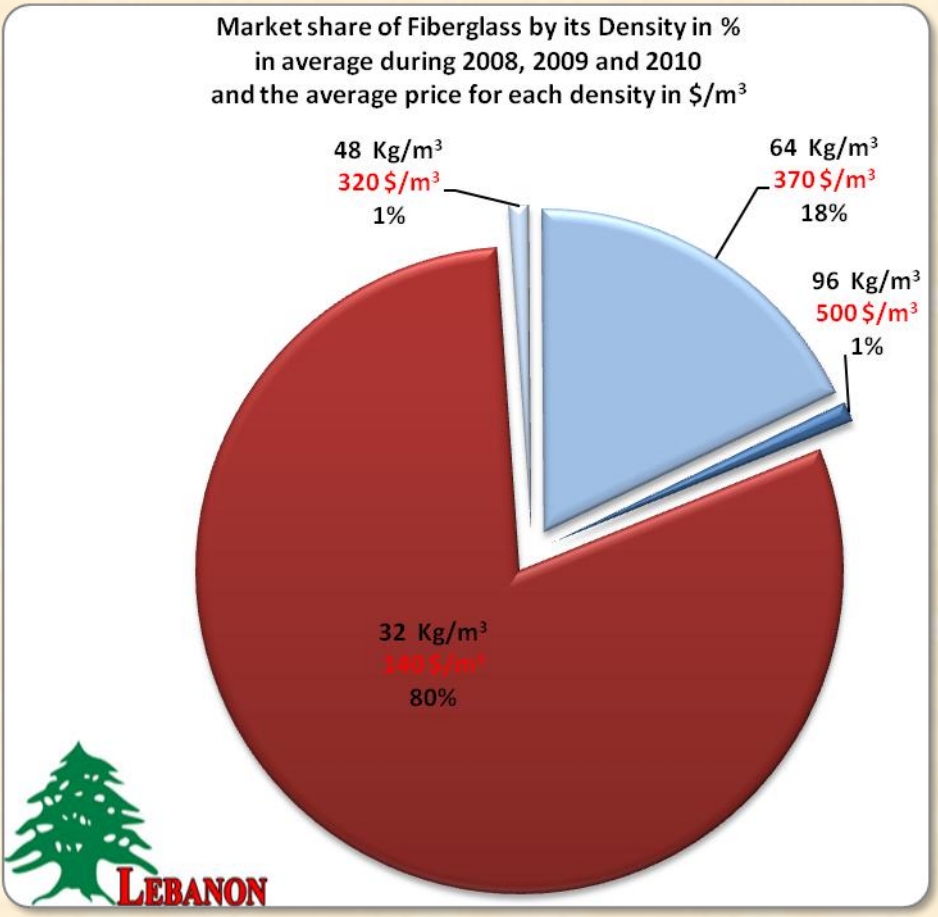
La laine de verre possède 6.2 % du marché total des matériaux d'isolation thermique. Il est vendu soit par rouleau soit en panneau. Comme représenté dans le diagramme 21 ci-dessous, nous avons une épaisseur dominante (5cm), tandis que pour les autres épaisseurs, elles sont quasi inexistantes. De plus, les prix indiqués dans ce graphe sont les prix moyens, sachant que le prix d'une certaine épaisseur est fonction de la densité utilisée, comme vous le constaterez dans le diagramme 22 ci-dessous, la présence de plusieurs densités disponibles



sur le marché pour ce produit.

Graph 20: Demand repartition of Fiberglass by its thickness in % in average during 2008, 2009 and 2010 and the average price in $ for each thickness per m²

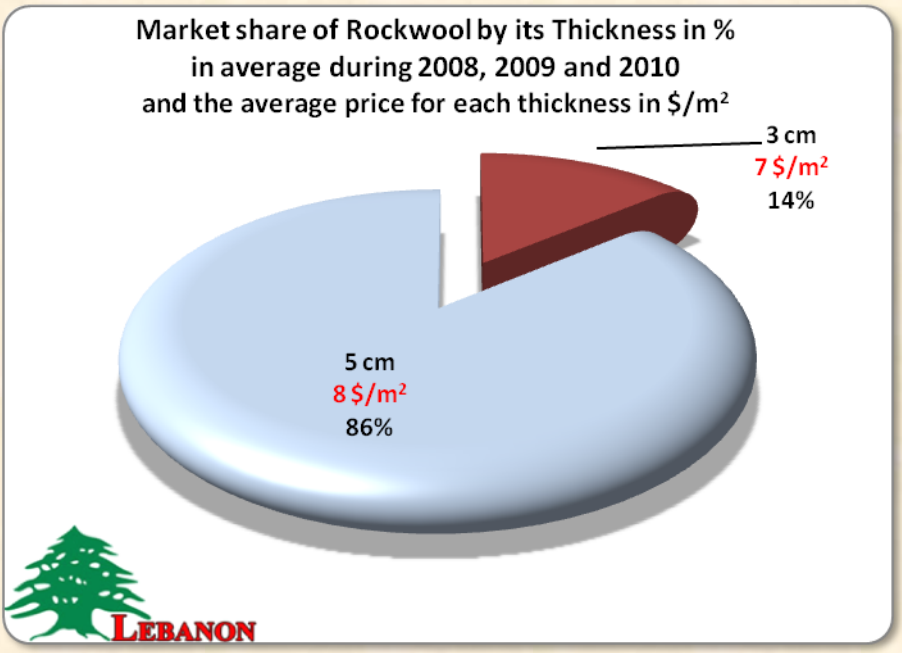
Les densités utilisées les plus courantes sont respectivement de 32 Kg/m^3 et de 64 kg/m^3. Ce qui justifie l'utilisation d'autres densités, ce sont les exigences d'isolation multitâche pour une application donnée; ainsi nous pourrions à peine séparer l'isolation thermique de l'isolation acoustique pour certaines applications, comme deux isolations en une.



Graph 21: Demand repartition of Fiberglass by its Density in % in average during 2008, 2009 and 2010 and the average price in $ for each density per m^3

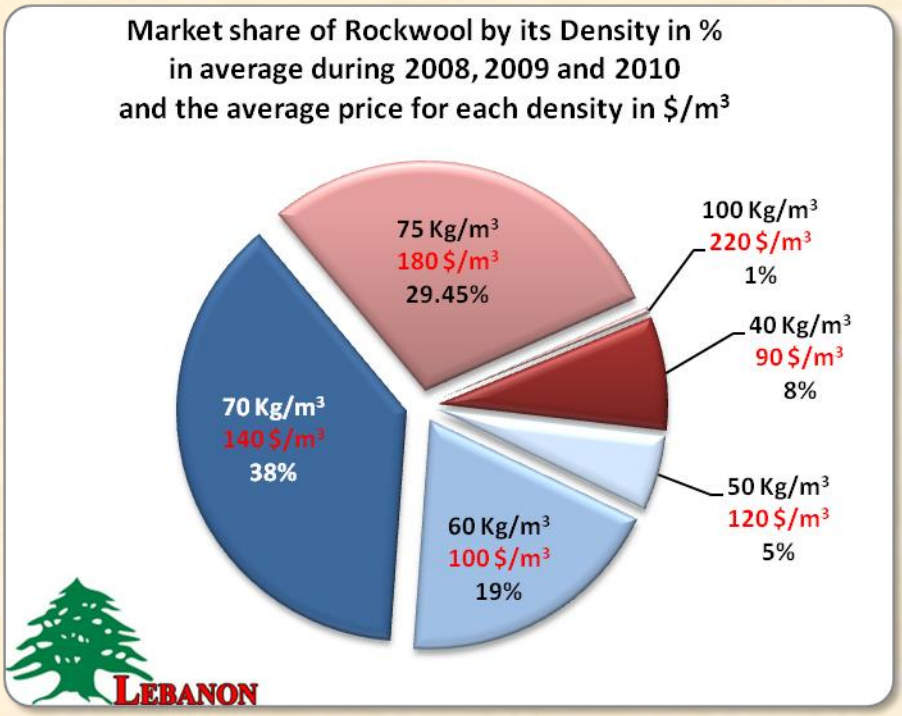
Laine de Roche

La laine de roche est principalement utilisée dans les bâtiments résidentiels ou dans les maisons pour l'isolation en double cloison (double murs) avec une plaque de gypse formant la paroi interne (ou mur interne), et même pour l'isolation du toit. Il a jusqu'à présent 2.6 % du marché de l'isolation thermique au Liban. Il est vendu soit en rouleau, soit en panneau. Comme le montre le diagramme 23 ci-dessous, l'isolation par la laine de roche admet plusieurs épaisseurs et plusieurs densités. Mais l'épaisseur majeure qui domine le marché est l'épaisseur de 5 cm. Quant au prix mentionné dans les diagrammes ci-dessous, ils représentent le prix moyen pour l'épaisseur mentionnée qui varie avec la variation de la densité.



Graph 22: Demand repartition of Rockwool by its thickness in % in average during 2008, 2009 and 2010 and the average price in $ for each thickness per m^2

La répartition de la demande de la laine de roche selon la densité fait ressortir que deux densités majeures, le 70 Kg/m^3 et le 75 Kg/m^3, dominent le marché en accaparant ensemble environ 68% du marché de la laine de roche. Les densités inférieures et supérieures aux deux déjà cités sont demandées pour des usages spéciaux.



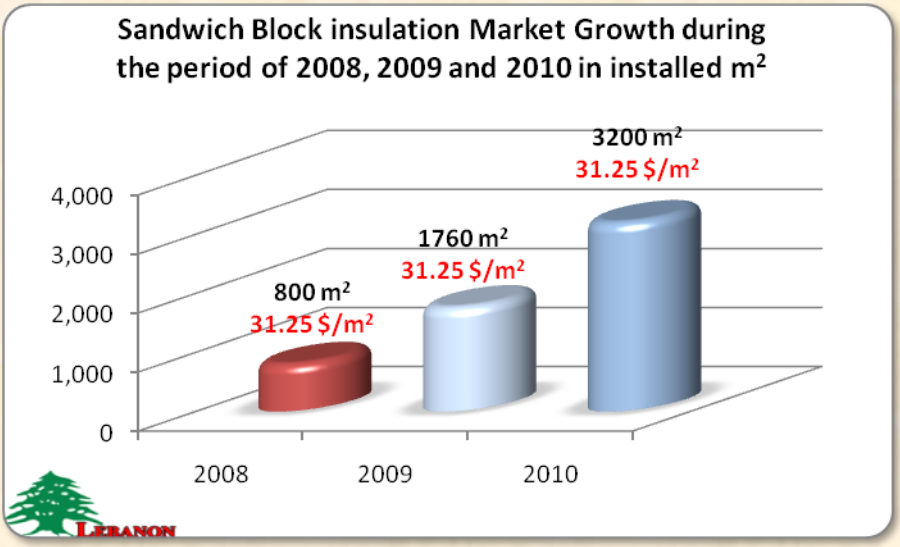
Graph 23: Demand repartition of Rockwool by its Density in % in average during 2008, 2009 and 2010 and the average price in $ for each density per m^3

NB: les prix indiqués dans les diagrammes ci-dessus ont été donnés par différents fournisseurs et ont été soumis à différents critères, c'est pourquoi certains prix peuvent paraître illogiques.

Bloc de béton en Sandwich

Contrairement à l'isolation en double mur ou en ajoutant une couche d'isolation sur le mur construit, ce produit crée une isolation thermique en imitant le concept de double paroi. Cet isolant, qui se classe dans la catégorie des mono-murs, occupe en moyenne sur les trois dernières années une part très faible soit 0,2% du marché de l'isolation au Liban.

Comme nous pouvons voir dans le diagramme 25 ci-dessous, la demande pour ce matériau composite augmente à un taux élevé, la quantité vendue double presque tous les ans.



Graph 24: Sandwich Block insulation Market Growth during the period of 2008, 2009 and 2010 in installed m²

NB: les prix fournis dans le diagramme 25 ci-dessus ne devraient pas être directement comparés avec les prix fournis dans les diagrammes précédents, car cette différence est causée par la présence du béton dans ce matériau composite, ce qui rend les prix mentionnés dans ce graphe

très élevés par rapport au autre produit, mais si on retranche le prix du béton de ces prix, cette différence sera plus faible.

Annex 1:

Questionnaire form

Thermal Insulation Market in Lebanon

Submit by E-mail | Print

ALMEE

Almee
Beirut, Lebanon
www.almee.org

Company : _____

Contact : _____

Address : _____

Tel / Fax : _____

E-mail : _____

Web site : _____

☐ Importer ☐ Manufacturer ☐ Exporter

I/M/E	Product	Certification	Usage Mode	Density*	Thickness	Thermal conductivity	Price*	Quantity Sold		
Details			(internal, external, double wall)	Kg/m3		W/m.K		2008*	2009*	2010*

Comments and vision for the future:

*** All numerical values should be followed by there units**

All the information given above are exclusive for this survey on the "Thermal Insulation Market in Lebanon"

Bibliography

1. **Dr.Fadi Georges Comair** « étude thermodynamique et mécanique des parois des bâtiments en régime sinusoïdale, application a la région du Moyen Orient-thèse Doctorat Université Claude Bernard de Lyon I »
2. **A. Mourtada, S. Chehab, A. Jouni, A. Karaki, R. Khairallah, T. Matar.** *Energy and Economic impacts of Energy Efficiency Measures and the Thermal Standard of Buildings in Lebanon.* s.l. : ALMEE - RESSOL - MEDBUILD, June 2011.

3. *Thermal standard for buildings in Lebanon - For new Residential and Non-Residential Buildings.* s.l. : ALMEE, ADEME, Order of Architects and Engineers of Beirut, 2010.

4. www.acc-ps.com
5. www.cmclb.com
6. www.fibran.gr
7. www.hajjali.net
8. www.insuliteblocks.com
9. www.izocam.com
10. www.josephhajjar.com
11. www.kappa-systems.com
12. www.kilzico.com
13. www.kimmcoinsulation.com
14. www.saudirockwool.com

15. www.sodamco.com

16. www.tagroup.com.lb