EUROPEAN UNION

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France (Channel Manche) England

BIO-CIRC Project

European Regional Development Fund

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Bio(and)**C**ircular **I**nsulation for **R**esourceful **C**onstruction

Summary Report on NRFI Market Shares and Perspectives

30th June 2022 – Final Version

EUROPEAN UNION
European Regional Development Fund

nomadéis

ASBP The Alliance for Sustainable Building Products

therma fleece Nature's finest insulation

backtoearth

Abstract of the project

The BIO-CIRC Project, Bio(and)Circular Insulation for Resourceful Construction, intends to tackle the building sector's high carbon, energy and resources dependencies while taking advantage of an unused waste resource: polyester from waste bedding.

The project aims to conceive, develop and deploy 3 prototypes of innovative low-carbon thermal insulation material made from polyester and combined with natural fibres. It intends to promote the emergence of a bespoke waste polyester valorisation industry and the use of virtuous Natural and Recycled Fibre Insulation products.

This project is carried out by a cross-channel partnership of 4 key and complementary links in the building sector's value chain:

- Nomadéis (lead partner)
- Alliance for Sustainable Building Products
- Eden Renewable Innovations
- Back to Earth

Planned over 2 years, the BIO-CIRC project receives funding from the European Regional Development Fund (ERDF). The ERDF's contribution amounts to €399,600 for a total budget of €499,500.

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Executive summary

This study aims to analyse the structure of the insulation market in France and the UK in order to identify the main trends and thus position the natural and recycled fibre insulation prototypes developed within the BIO-CIRC project. This study also has a prospective dimension: it looks at forecast market trends in order to estimate the market share that the prototypes could occupy.

The main findings concerning the French insulation market are

- The insulation market appears very dynamic until 2019 with 250 million m² of insulation products sold;
- Attic and roof insulation remains the main outlet for insulation products and represents 50% of the total surface area of insulation installed in 2019;
- A slowdown and then a decline in the growth of the insulation market is observed from 2019 onwards, potentially linked to the drop in the number of residential and tertiary buildings under construction, exacerbated in a context of health crisis;
- Thus, for the first time in 2020, renovation becomes the primary outlet for insulation products, encouraged through state aid, containment and rising energy prices;
- The market is still dominated by mineral and synthetic products, but the share of bio-based and recycled products is growing (87% increase in the volume of bio-based insulation sold between 2016 and 2020). This trend is very likely to continue, especially with the entry into force of the RE2020. According to Ademe's Bioeconomy scenario, biobased insulation could reach a 30% market share by 2030;
- The insulation market is dominated by multinationals such as Saint-Gobain, Knauf Insulation and Soprema. It is possible to observe the creation of franchises by multinationals in order to specialise in a specific segment of the insulation market. Biobased insulation is often developed by SMEs;
- Insulation products are distributed by general distributors (e.g. Point P) and specialised distributors (e.g. Panofrance) which target professionals and DIY shops targeting individuals;
- Concerning the prices of insulation products, bulk products are cheaper than panels and rolls. Biobased and synthetic insulation products are more expensive than mineral-based products for the same performance;
- The carbon footprint of an insulation product varies greatly from one producer to another (notably due to different calculation methods and assumptions). It should be noted that excluding biogenic carbon storage, the carbon emissions of biosourced products are globally equivalent or higher than mineral wools. There are therefore challenges in optimising the industrial processes and value chains of biobased and recycled products.
- The analysis of the French market makes it possible to define an achievable penetration rate for BIO-CIRC prototypes at 5% of the biosourced insulation market. Thus, it is possible to estimate a development potential of approximately 134,000 m3 (equivalent to 2150 t for prototype 2 for example). The market is large enough for industrial lines to be developed. Production will be more limited by the available recycled duvet fibre than by demand.

Regarding the UK market, the following points should be noted:

- The overall insulation market in the UK is worth around £4 billion and that the largest markets are owner occupiers for refurbishment and private/special developers for new build.
- In 2015, the market for building insulation products slowed down due to a significant drop in government subsidies, which had previously been an important end use sector. A recovery is estimated from 2022 onwards due to the strong demand for new housing, the recovery of non-residential work and the stimulation of the renovation market through increased government subsidies;
- To date, it is estimated that the insulation market for new construction is equivalent to the renovation market;
- Two manufacturers of insulation products account for more than 40% of the market by value;
- Two manufacturers account for more than 40% of the market value; Under government subsidised programmes, cavity wall and loft insulation have proved to be the most commonly installed products;
- RIP/PUR products now have the largest market share. Polystyrene foam products are the second largest product group, consisting of EPS and XPS boards, blocks and spray foam;
- The current market share of NRFIs in the UK is not as large as in France (around 1%), but it is the fastest growing insulation segment in the UK, with a CAGR of 10-20% over the last 3 years, and its market share is expected to increase significantly over the next few years;
- Projections show a potential pool of 500,000 homes for loft insulation.

In both countries, the barriers to the development of the biobased and recycled insulation market currently appear to be the lack of knowledge/acculturation and the additional purchase cost.

1 Context and objectives

1.1 Favourable congruent conditions for the development of the natural and recycled fibre insulation market

1.1.1 A large pool of buildings with poor energy ratings…

Both in France and Great Britain, **the energy performance** (Energy Performance Certificate, EPC) of **existing domestic dwellings is quite poor**[1]. Indeed, in both countries, on average, a **house or a flat have a D rating** (Figures 1 and 2 below), indicating poor energy performance, **which translates into higher heating and cooling costs**.

At the France (Channel) England (FCE) regional level, the situation is even worse. Indeed, on the English side, the data shows that the median energy rating of existing houses and flat at local authority levels is more likely to be under national averages[2]. Similarly, on the French side of the FCE region (green bars in Figure 2), it shows **EPC also tend to be on the lower end of the label's spectrum**.

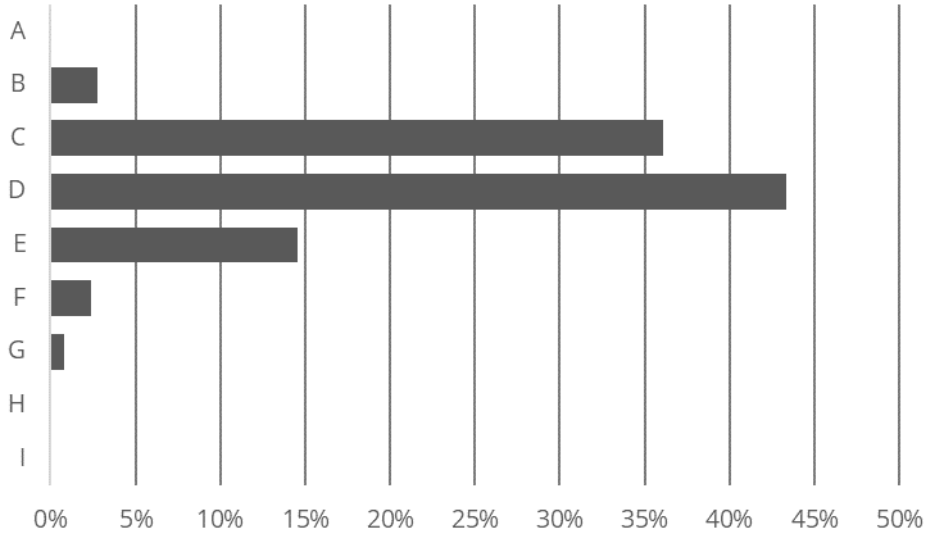


Figure 1 : Distribution of the Energy Rating in England and Wales for existing domestic dwellings (Source: Ministry of Housing, Communities and Local Government, 2020).

[1] At the EU level, the situation is comparable with most countries (notable exceptions being Slovakia and the Netherlands) have 50% or more of their housing stock with a label D or less as shown in Volt, J. et al (2020) Energy performance certificates :assessing their status and potential. Buildings Performance Institute Europe (BPIE)

[2] Ministry of Housing, Communities and Local Government (2020) Energy Performance Certificate data on Open Data Communities. Figure 3: Energy efficiency of dwellings in your area.

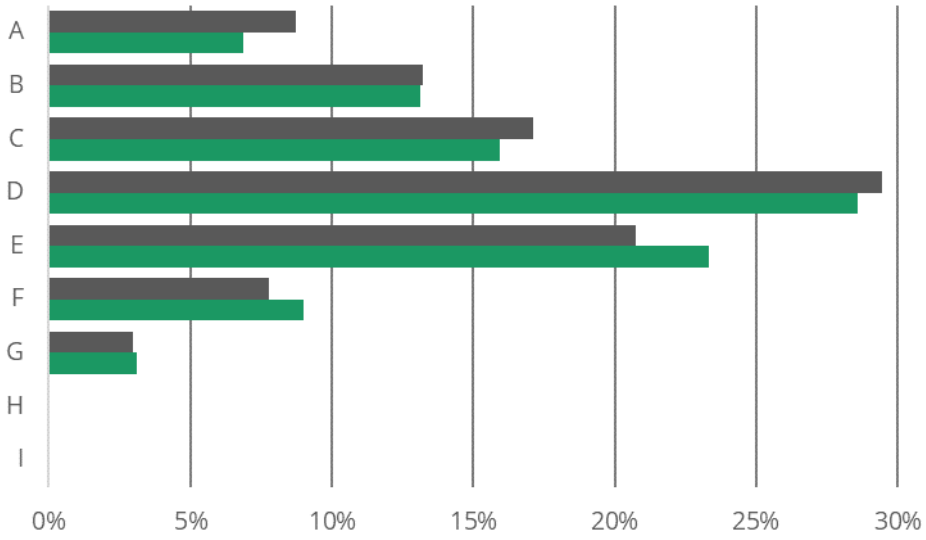


Figure 2 : Distribution of the domestic building Energy Rating in France (Black) and on the French side of the FCE region (green) (Source: Observatoire DPE, ADEME, 2021).

Poor energy ratings may be improved in three different ways[3]:

1. Increasing the efficiency of the heating/cooling technologies used (using solar water heating for example).
2. Increasing the thermal resistance of the building's envelope (walls and roof).
3. Decreasing the structure's permeability to air (also called air tightness).

Increasing a building's energy rating benefit the owner/renter who will see a decrease in energy bills and an improvement of their indoor thermal comfort at the cost of a renovation, added costs at the building or increased investments to acquire more efficient heating/cooling. In addition, as improving a building's EPC equates to lesser heating and cooling, it contributes to decreasing the building's sector dependency to energy and thus reduce its associated energy-related carbon emissions.

1.1.2 … and a buoyant new construction market

In France, despite the COVID pandemic the construction market was still dynamic with 375,000 new housing units (individual and collective) built in 2020[4]. New non-domestic and non-agricultural buildings have taken a hit from the sanitary crisis but still maintain a high level of dynamism with 18,1 million m^2 started in 2020 (-15% compared to 2019).

Similarly, Great Britain has seen an increase in the construction output (for all types of work) during the 2009-2019 period[5] but the sanitary crisis has affected it with Total Work output

[3] See for example: Evergreen Energy.

[4] Fédération Française du Bâtiment (2020) Bilan 2020 et prévisions 2021.

[5] Office for National Statistic (2021) Construction statistics, Great Britain: 2019.

amounting to £171,478 million in 2019 versus £147,449 million in 2020[6]. This translates to new build for the July 2018 – June 2019 year of around 164,000 newly started buildings and 120,000 for the July 2019 – June 2020 year[7].

Assuming all new builds require insulation, the buoyant new build rates create a large market in either country for insulation products.

1.1.3 A favourable evolution of policies in the United Kingdom and France for natural and recycled fibre insulation

In both countries, governments have set targets to reduce national greenhouse gases emissions (of which the building sector is a significant contributor) and increase the energy efficiency of the existing housing stock (Energetic Transition for a Green Growth law from 2015 in France and the Climate Change Act 2008 Order 2019 from 2019 in the UK for example). These laws are accompanied by governmental schemes such as the Green Homes Grant in the UK and the E+C- experiment in France which are set up to provide technical and financial support to public and private promoters or owners to construct energy efficient building or renovate their homes.

The recent aforementioned legislations act upon the building construction practices in two major ways. Legislation first push for a dramatic reduction of the energy expenditure of the building during its usage phase. Energy efficiency of a building may notably be achieved by increasing the thermal resistance[8] of the walls and roof and the thermal capacity[9] of the building. The thermal resistance of a building envelope is itself controlled by the amount and efficiency of insulation products deployed and will prevent heat transfer between the inside and outside environments. The higher the thermal resistance of the envelope the less energy will be required to raise or lower the indoor temperature and therefore maintain occupants' thermal comfort. Thermal capacity, on the other hand, will provide inertia to a building's interior environment and dampen external fluctuations. In summer, the mass will absorb heat but raise temperature more slowly and inversely, in winter, it will lower the temperature slowly despite losing heat. This inertia also adds a phase shift whereby the effects of a temperature change will only be felt hours later: in winter the mass will heat up during the day and maintain some heat during the colder night and in summer the heat will take more time to reach the inside environment and enable the building to radiate this additional heat during the night. Depending on design, the higher the thermal mass the less cooling or heating will be necessary to adjust to external temperature variations.

It is currently estimated that 60% to 70% of the energy spending of the building sector is linked to heating and cooling needs. This translates to the emission of 71% of the building and construction sector carbon emissions during the operational phase[10] Thus, increasing the thermal resistance

[6] Office for National Statistics (2021) Output in the construction industry – 13 April 2021.

[7] Ministry of Housing, Communities and Local Government (2020) Housing supply: Indicators of new supply, England January to June2020 – Housing Statistical release.

[8] Thermal resistance may be defined as the capacity of a given surface/volume to prevent heat transfer. When applied to a building, it refers to the capacity of the structure to maintain its own internal climate and resist changes due to external variations of temperature, humidity, and solar radiations.

[9] Thermal capacity, also called thermal mass or heat capacity, is defined as the amount of heat needed for an object to change its temperature by one unit (Kelvin or Degree Celsius). The thermal mass of a building is partly dictated by the choice of materials (their density and specific heat capacity) and the amount used (mass, volume, or area).

[10] World Green Building Council (2019) Bringing embodied carbon upfront: Coordinated action for the building and construction sector to tackle embodied carbon.

and optimising the thermal mass of buildings represents a major margin of improvement of the sector's environmental footprint.

Policies and government objectives are, secondly, pushing for the reduction of the embodied carbon content[11] of building materials. Conventional insulation products (such as mineral and glass wool) usually have high carbon footprint (2.1 and 1.38 $kgCO_2eq$ for $1m^2$ at R=1)[12] due to the high energy intensity necessary for their manufacture and their mineral or petrochemical origin. In contrast**, products from biological resources** (linen, hemp, straw, wool, etc.) **usually have carbon footprints that are 20 to 50% or less than conventional products' ones[13]**. If carbon sequestration is accounted for, that is the carbon absorbed by the plants during the growth phase, some products have negative footprints: this translates into a net capture of atmospheric carbon. As a point of comparison, a maize pith product has a carbon footprint of 0.91 $kgCO_2eq$ for 1 m^2 at R=1 without carbon sequestration and -2.88 $kgCO_2eq$ for 1 m^2 at R=1 accounting for sequestration. A straw insulation product has a footprint of 0.83 $kgCO_2eq$ for 1 m^2 at R=1 without carbon sequestration and -11.9 $kgCO_2eq$ for 1 m^2 at R=1 accounting for sequestration[14].

1.1.4 A market ripe for the penetration of natural and recycled fibre insulation products

Due to:

1. Poor insulation of the existing building stock in France and Great Britain.
2. Buoyancy of the construction market, which is recovering from the sanitary crisis.
3. Increasing legislative pressure to reduce the building sector's carbon footprint which may be achieved through:
    a. The increase in energy efficiency via increased thermal resistance and optimised thermal mass.
    b. The use of low embodied carbon products.

In this context, it appears that natural and recycled fibre insulation (NRFI) products have ample opportunities for growth. Indeed, these products that present, on average, lower embodied carbon and similar thermal properties **are bound to gain shares within the growing insulation markets of Great-Britain and France**.

1.2 Aim and context of this market analysis

1.2.1 Increasing the market prospects of the BIO-CIRC prototypes

The BIO-CIRC partners are committed to the development of new low-carbon insulation products utilising waste polyester (PET) from bedding and upholstered items either by itself or in combinations with natural fibres. The partners' aim is to transfer an existing technology, refiberisation, into the manufacture of polyester-based insulation. Refiberisation has been chosen

[11] The embodied carbon content of a product refers to its carbon footprint over its whole lifecycle, including all the energy that was required from extraction of raw materials to the ultimate disposal within a recycling or a landfill facility.

[12] Sustainable Bio&Waste Products for Construction (SB&WRC) Project (2019) Life Cycle analysis: Prototype 1.

[13] See for example : Nova-Institute (2016) Carbon Footprint and Sustainability of Different Natural Fibres for Biocomposites and Insulation Material - Study providing data for the automotive and insulation industry.

[14] Sustainable Bio&Waste Products for Construction (SB&WRC) Project (2019) Life Cycle analysis: Prototype 3.

for its potential to decrease the recycling process' energy requirements compared to traditional PET recycling methods which involves melting plastic waste to create new fibres.

Since a majority of natural and recycled fibre insulation (NRFI) still require some form of plastic coating or fibre in their manufacture (for added tensile strength, or durability, etc.), refiberisation of polyester fibres provides a way to produce 100% virtuous products.

1.2.2 A commitment to the development of NRFI market

Furthering their *pro bono* goal of knowledge sharing for the development of greener products, the BIO-CIRC partners are making this market intelligence paper freely available. It is the BIO-CIRC partner's belief that a strategic understanding of the opportunities and potential hurdles of the insulation market will increase investors and manufacturers' trust in these materials and encourage investments in these low-carbon products and thus participate to the building's sector green transition.

The end goal of this paper is thus to encourage investment in NRFI products' value chains by providing investors with insights on the market's development, dynamics, and growth potential and into how they can position themselves.

1.2.3 Structure of this market analysis

In order to better understand the market prospects of the BIO-CIRC prototypes, the project partners aim to analyse both countries' (France and Great Britain) and the FCE[15] area's market structure.

This paper intends to synthesise current knowledge of the building insulation products market (volumes, value, diversity of products, etc.). Then a particular focus will be made on a subset of products that will be in direct competition with the BIO-CIRC prototypes and notably analyse their pricing structure and competitive edge.

[15] Interreg FCE: Map of the France (Channel) England area.

2 Methodology and perimeter of the market analysis

2.1 Study Perimeter

2.1.1 Materials

For the purpose of this paper, materials are categorised as being:

1. Natural: a product directly transformed from a biological raw material (sheep for wool or trees for wood fibres, etc.).
2. Recycled: a product which used a secondary raw material in its manufacture whether bio-based or not (PET from bottle or cork from the bottle stoppers of the wine industry for example). If necessary, to make a distinction between categories, BIO-CIRC partners consider a product in the "recycled" category if it includes more than 50% of secondary raw material.
3. Mineral: a product derived from geological resources (glass from sand for example).
4. Petrochemical: a product derived from the transformation of petroleum into plastic.

Note: in this study, products that are not bio-based and have less than 50% recycled content will be placed in either the mineral or petrochemical category.

The raw materials included in the study are presented in Table 1 below.

Table 1 : Raw materials included in the study scope

Origin	Natural	Recycled	Mineral	Petrochemical
Materials	Wood fibre and wool Sheep wool Hemp Straw	Cork Cellulose wadding PET from bottles Textile	Glass wool Rock wool	Extruded polystyrene Polyurethane Expanded polystyrene

➔ *We will need to agree on the exact products that we aim to describe. See all propositions in the next sections*

2.1.2 Geography

The main aim of this paper is to obtain a national level of understanding of the market figures and dynamics. For ease of understanding, both markets are treated separately in this paper. Comparisons between France and Great Britain will also be made where relevant to highlight good or poor practices and teachings that may be drawn by the two countries' practices and perceptions.

Where relevant, a specific focus will be made of the FCE zone (as previously defined) since it is the zone of interest to this project. The data used and analysed for the FCE focuses are either drawn from fine-grained resources (local councils or *Département* level) or have been estimated from the national data sets. Proxies or estimation methods used have been described where relevant.

2.1.3 Products / uses

This paper focuses on the general insulation market which includes, in French nomenclature, three main types of uses:

1. Outdoor thermal insulation: products that are installed on the side of the wall facing the external environment.
2. Indoor thermal insulation: on the side of the wall facing the internal environment.
3. Distributed thermal insulation: insulation that is included as part of the structure-bearing materials.

A **focus on attics' insulation** has been made as it is the targeted market for the BIO-CIRC recycled polyester prototypes. Therefore, finer data and more in-depth analysis is provided of the products, players and positioning on this segment. Generally speaking, products included in this category come in the forms of:

1. Rolls that may be laid overtop a ceiling, rafters, or beams.
2. Loose particles (wool, wadding, etc.) that may be blown.
3. Panels to be laid.

2.2 Methodology

This paper was written on the base of:

1. A thorough desk-based review which included data from observatories, market analyses from various consultancy companies, government, and NGO papers, etc.
2. Qualitative interviews with representatives of the different players within the market (manufacturers, professional federations, etc.).
3. Focus groups in France and Great Britain which assembled a variety of stakeholders from multiple sectors (construction, manufacturing, architects, etc.).

3 France

3.1 Building insulation products market

3.1.1 Structure and value of the market

3.1.1.1 The insulation market: an important and dynamic market but facing structural and situational challenges

The **global insulation market** is quite dynamic and has increased about **5.4% between 2015 and 2016** at the worldwide scale. In 2016, the turnover of the global insulation market was about **39.5 billion**[16] **of US dollars**[17].

The **French insulation market** has been following the same trend and represents a **2.678 million of euros turnover in 2016**. In 2019, **250 million square metres of insulation products have been sold**, which equates to **41 million cubic metres** [18].

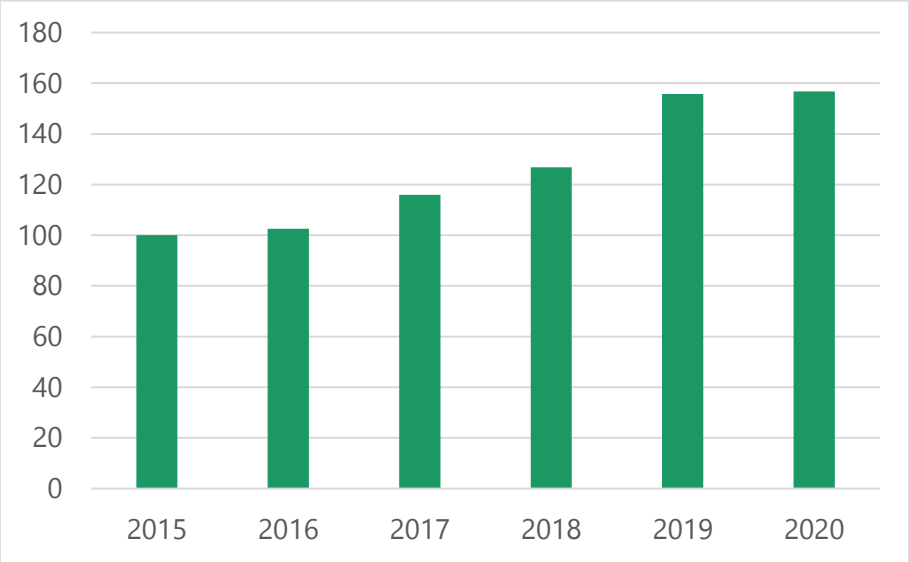


Figure 3 – Evolution of the French insulation work market turnover index (Insee, base index 100 in 2015)

However, it appears that the French market is now facing a **downwards trend**, due to situational and structural factors. After a **limited growth of 1.4% in 2019**, the French insulation market **decreased by 4.5% in 2020.** It can partly be explained by the fact that **the number of housing and tertiary buildings put under construction is decreasing since 2018 and 2019 respectively,** reducing the need for insulation products.

[16] Here billion is referring to 10^9.

[17] Businesscoot (2021) Le marché de l'isolation de bâtiments |France.

[18] TBC Conseil & Innovation (2020) Les isolants thermiques pour le bâtiment en 2019.

Figure 4 – Number of private and collective housing put under construction yearly between 2015 and 2020 (Nomadéis, 2021, data from *Ministère de la Transition Ecologique*)

Moreover, this decreasing dynamic has been accentuated by the **sanitary crisis**: construction works have been stopped for several months and insulation products sales have slowed down consequently[19]. During the first three months of the French lockdown (March 2020 to May 2020), the number of building permits delivered dropped by about 46% compared to the three previous months. Despite a resumption of 95% of the construction work at the end of May 2020, the sanitary requirements had several impacts on the building sector, including **supply issues** due to the slow down or cease of production lines worldwide[20].

3.1.1.2 Structure of the French insulation product market

3.1.1.2.1 A market dominated by synthetic products

The insulation market remains dominated by **mineral materials** (glass wool and rock wool) **which represent 50% of the market** and by **petrochemical materials** (extruded polystyrene, polyurethane, expanded polystyrene) **which take up 40% of the market** (see *Figure 5*). Thus, **biobased, and recycled materials only represent 10% of the insulation market in 2020**[21]**.**

[19] TBC Conseil & Innovation (2021) Les isolants thermiques pour le bâtiment en 2020

[20] Businesscoot (2021) Le marché de l'isolation de bâtiments |France

[21] TBC Conseil & Innovation (2021) Les isolants thermiques pour le bâtiment en 2020

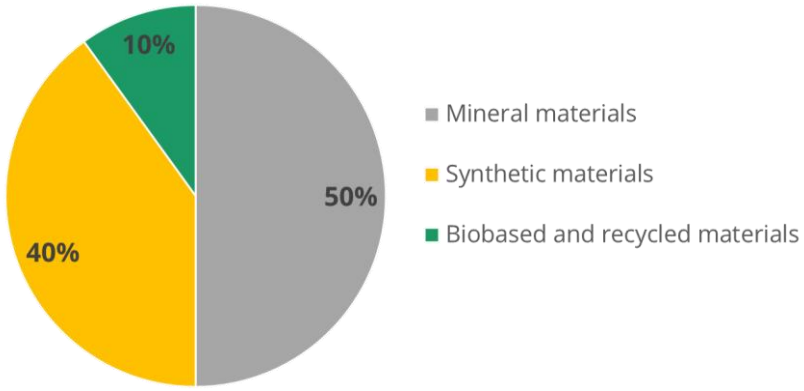


Figure 5 – Market distribution of insulation products according to their origin.
(TBC Conseil et Innovation, 2020)

Yet, the biobased products market is particularly dynamic, and the **volume of biobased insulation products sold has increased by about 87% between 2016 and 2020**, corresponding to a **58% increase of the turnover** during this period[22]. Thanks to this continuous growth – about 15% yearly - it is estimated that the equivalent of 84 000 houses have been integrally insulated with biobased materials in 2020[23]. **Wood fibre and cellulose wadding are the most frequently bought biobased products**, but hemp and recycled cotton represent an increasing market share[24].

Regarding the evolution perspectives of the insulating products market, ADEME's projections anticipate **biobased products could take up to 30% of the market by 2030 in a favourable scenario** (named the Bioeconomy scenario[25]).

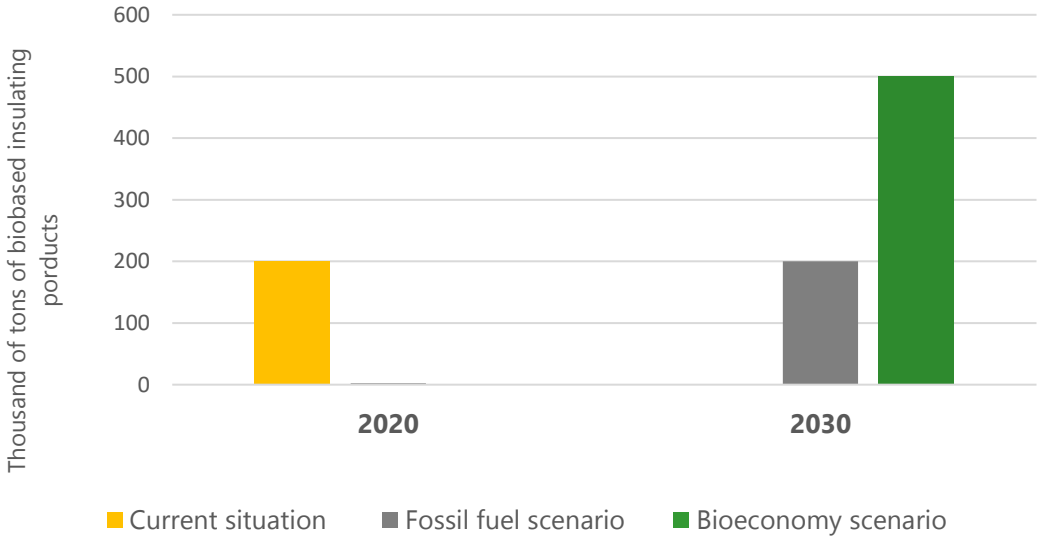


Figure 6 - Volume of biobased insulating products sold in 2020 and projections for 2030 according two scenarios (ADEME)

[22] Batiweb (2021) Forte croissance du marché des isolants biosourcés.

[23] Ibid.

[24] Batirama (2021) Isolants biosourcés : plus que jamais dans la course.

[25] ADEME (2015) Marché actuel des produits biosourcés et évolutions à horizons 2020 et 2030

THE NEW ENVIRONMENTAL REGULATION "RE2020" AND ITS IMPACTS ON BUILDING MATERIALS[26]

Effective date: *January 2022 for residential buildings, July 2022 for offices and education buildings, January 2023 for other building categories*

RE 2020 RÉGLEMENTATION ENVIRONNEMENTALE

Objectives:

1/ Reach energetic sobriety and decarbonise buildings' energy sources
1. Improve buildings envelopes thermal performances
2. Favour less carbonated energies and getting out of fossil fuel (e.g.: no more gas heating by 2022 for individual housing and by 2025 for collective housing)

2/ Reduce building embodied carbon
3. Encourage products' decarbonation and
4. Encourage the use of recycled and reused materials and materials storing carbon

3/ Ensure building coolness during heatwaves
- Foster the use of passive solutions to ensure summer comfort

⇨ 6 indicators + mandatory means to implements

Several adjustments have been made compared to the RT2012 (previous thermal regulation)**:** addition of new indicators, new uses considered, updated weather scenarios, new occupation scenarios, evolution of calculation methodology.
Paradigm shift: from energy efficiency (RT2012) to environmental impacts (RE2020)

Energy performance indicators

Primary energy consumption (Cep) (kWhep/m²/year)

Primary energy consumption of the building, including renewable energy and recovered energy.

Indicator already included in the RT2012

Thresholds:

Individual: 75 kWhep/m².year

Collective: 85 kWhep/m².year

Non-renewable primary energy consumption (Cep,nr) (kWhep/m²/year)

Building's energy consumption excluding renewable energy share.

New indicator

Threshold:

Individual: 55 kWhep/m².year

Collective: 70 kWhep/m².year

Thresholds are modulated according to location, accommodation, and buildings' average area, converted attics' area and other external factors.

Different energy transformation's coefficients are used to calculate the Cep and the Cep,nr indicators.

New parameters considered: cooling expenditure, inclusion of peripheral energy uses (elevators, parking's' lights and ventilation, common area's lights) and additional energy production photovoltaic energy (auto consumption only).

Bioclimatic needs

Converts the final energy need (in kWhef/m²) of a building to remain at a comfortable temperature. This indicator evaluates the energy efficiency of the building with respect to heating, cooling and lighting needs.

Thresholds: the threshold value ($Bbio_{max}$) is modulated according to the location, height, and average area of the accommodations. It has been reduced by about 20-30% compared to the RT2012 value.

Bbio = 2 x heating needs + 2 x cooling needs + 5 x lighting needs

[26] CEGIBAT (2021) RE2020 : les grands principes.
CEREMA (2021) Présentation de la réglementation environnementale 2020.

Thresholds:

$Bbio_{max}$ for individual houses: 63 points

$Bbio_{max}$ for collective accommodations: 65 points

Indicator already included in the RT2012

New parameters taken into account: cooling needs.

IC energy: impact on climate change of buildings' energy consumptions

Corresponds to the impact on climate change of greenhouse gases emissions related to building's energy consumption during its exploitation (50 years horizon). This indicator is calculated thanks to a dynamic Life-Cycle Analysis.

*IC energy = (∑ final energy consumed * emission factor) * 0,79*

0,79 is the average ponderation coefficient of the impacts on climate change and emission factors vary according to the energy source[27].

Thresholds:

IC energy for individual houses: 4 $kgCO_2/m^2$.year

IC energy for collective accommodation: 14 $kgCO_2/m^2$.year in 2022, 6,5 $kgCO_2/m^2$.year in 2025

Thresholds are modulated according to location, accommodation and buildings' average area, converted attics' area and external factors.

IC construction: impact on climate change of buildings products and equipment

Corresponds to the impact on climate change of greenhouse gases emissions related to building products and equipment over the entire building's life cycle (50 years horizon). This indicator is calculated thanks to a dynamic Life-Cycle Analysis of each component of the building (based on INIES data[28]).

Thresholds:

IC construction for individual houses: 640 $kgCO_2/m^2$ over 50 years in 2022, 530 $kgCO_2/m^2$ over 50 years in 2025, 475 $kgCO_2/m^2$ over 50 years in 2028 and 415 $kgCO_2/m^2$ over 50 years in 2031

IC construction for collective accommodation: 740 $kgCO_2/m^2$ over 50 years in 2022, 650 $kgCO_2/m^2$ over 50 years in 2025, 580 $kgCO_2/m^2$ over 50 years in 2028 and 490 $kgCO_2/m^2$ over 50 years in 2031

Thresholds are modulated according to location, accommodation and buildings' average area, converted attics' area, impacts of the foundations, parking and other underground areas, road and building networks' impacts and the percentage of environmental default data used.

Hour-degree (DH)

Evaluates the duration and the intensity of summer discomfort periods over a year when the indoor temperature of a building is supposed to be uncomfortable.

*DH = ∑ h *(Indoor felt temperature – Adaptive comfort temperature)*

Adaptive comfort temperature: 26°C during the night for residential buildings and 26-28°C for nonresidential buildings according to the outdoor temperatures of the previous days.

Thresholds:

[27] More details on emission factors : https://cegibat.grdf.fr/reglementation-energetique/re-2020-grands-principes

[28] INIES is the national platform gathering all environmental and sanitary data of building products and equipment https://www.base-inies.fr/iniesV4/dist/consultation.html

Maximum value: 1250 DH (2600 DH for air-conditioned buildings located in specific zones)

→ Above this threshold the building is considered uncomfortable and is thus non-reglementary

Low threshold: 350 DH

→ Under this threshold, the building is considered comfortable

If 350 < DH < 1250: comfort criteria is fulfilled but there is a risk of adding air-conditioning facilities thus, fixed penalties are applied (fictive energy consumption for cooling will be added to Cep and Cep,nr calculation).

The mandatory means to implement

The RE2020 maintains the RT2012 requirements and adds the need to prove compliance with natural lighting and thermal bridges thresholds.

Thermal insulation

Thresholds:

• **Coefficient of thermal transmission of walls** between premises with continuous occupation and walls with discontinuous occupation: U ≤ 0.36 W / (m².K) on average

• **Overall average linear heat transmission ratio of the building thermal bridges**: RatioΨ = < 0.33 W/(m².K) This ratio is the sum of linear heat transmission coefficients multiplied by their respective lengths. In RT 2012, this threshold was 0.28 but with another reference surface, which is still equivalent.

• **Average linear heat transfer coefficient** of the connections between intermediate floors and walls in contact with the outside or unheated premises: Ψ9 ≤ 0.6 W/(m.K)

Airtightness

Thresholds:

This requirement applies only to residential buildings. The air permeability under 4 pascals related to the surface of the walls excluding low floors is limited to:

• 0.6 $m^3/(h.m^2)$ for single-family houses or attached houses

• 1 $m^3/(h.m^2)$ for collective accommodations

Access to natural light for residential buildings

Thresholds:

To ensure adequate daylighting and views to the outdoors, residential buildings must meet one of these two requirements:

• Each dwelling unit shall have all the following characteristics:

- An illumination level of at least 300 lx on 50% of the living rooms, in more than half of the hours lit by daylight in the year

- An illuminance level of at least 100 lx in 95% of the living areas, in more than half of the daylight hours in the year

- In at least one living room, the occupant has at a distance of at least 1 meter from the facade, a view of the outside allowing to see both the sky and the horizon.

• The total area of the openings, measured in table, is greater than or equal to 1 / 6 of the reference area.

Summer comfort

Thresholds:

In addition to the requirement on Degree-Hours mentioned above, two requirements of mean thermal comfort in summer are added.

• The premises must be equipped with movable solar protections to limit the solar factor of the bays and respect certain values, depending on the geographical area, altitude, exposure to noise and the premises' function as sleeping quarters or not. A table giving these values can be found in Article 24 of the decree. In RT2012, only premises intended for sleeping were concerned by this requirement.

• The bays of a single room other than temporary occupation must open on at least 30% of their total area, with an exemption to 10% for bays of great height (equal to or greater than 4 m).

Air permeability of the envelope under 4PA

Thresholds:

• Q4Pa-surf < 0,6 m³/(h.m²) for individual houses

• Q4Pa-surf < 1 m³/(h.m²) for collective accommodations

A penalty of the measurements is introduced in 2 cases:

• When the measurement in collective buildings is carried out by sampling: a coefficient of 1.2 is applied to the measures obtained.

• When work that may affect the air permeability of housing remain to be carried out after the delivery: the values obtained are increased of 0,3 m³/(h.m²).

3.1.1.2.2 Main products

The following table aims to present the **most common materials used on the insulation market** (the list of materials presented in the table below is not exhaustive).

MINERAL MATERIALS	
	50 % of the market
Mineral wool:	Mineral wool is a fibrous material formed by spinning or drawing molten mineral or rock materials such as slag and ceramics[29].
– Rock wool	Rock wool is produced from transformation of basalt or blast furnace slag. After fiberization at 1,400 °C, the material is shaped by adding binders and additives[30].
– Glass wool	Glass wool is produced from sand, fluxes and recycled glass products (cullets). After fiberization at 1,400 °C, the material is shaped by adding binders and additives. As the thermal resistance and durability of glass wool is degradated in the presence of moisture, glass wools are mainly sold with a kraft vapour barrier.
Foam glass / Cellular glass	Cellular glass is made from crushed glass to which carbon is added. The material is expanded at a temperature of about 1,000°C, at which the carbon oxidises to form gas bubbles.
Others:	Theses materials are obtained by firing granules at temperatures of 1,100-1,200°C. When exposed to heat and moisture, the aggregates expand, increasing their insulating capacity. Their compressive strength and moisture resistance make these materials particularly suitable for use in flat roof insulation or as part of insulating concrete.
– Perlite	Perlite is a siliceous volcanic rock. The rocks used to make perlite insulation have a high water content, which helps to create large quantities of air pockets within the rock when heated and gives to perlite its insulation properties.

[29] European Commission (2012) Recommendation from the Scientific Committee on Occupational Exposure Limits for manmade-mineral fibres (MMMF) with no indication for carcinogenicity and not specified elsewhere.

[30] Info Energie Auvergne-Rhône-Alpes (2020) Guide des matériaux isolants pour une isolation efficace et durable.

– Vermiculite	Vermiculite is a micaceous rock. It should be noted that some vermiculite contained abestos which is highly toxical. Producers of vermiculite must now pay close attention to the quality of the product to ensure that it does not contain asbestos.
– Expanded clay (exclay)	Expanded clay is a lightweight aggregate made by heating of natural clay. The result of this heating is a hard and honeycombed structure of interconnecting voids giving clay its insulation properties.

PETROCHEMICAL MATERIALS

40 % of the market

Expanded polystyrene (EPS)	Expanded polystyrene is manufactured by expansion of styrene monomer beads (oil) with pentane and water vapour to form a closed cell filled with pentane.
Extruded polystyrene (XPS)	Extruded polystyrene is manufactured from styrene monomer beads (oil) mixed and extruded with a blowing agent: CO_2 for standard thermal performance or HFC gases for higher thermal performance. Extruded polystyrenes differ essentially from expanded polystyrenes in their greater resistance to compression and humidity.
Polyurethane (PUR)	Polyurethane insulation is manufactured by foaming a compound of polyols, methylene diisocyanate, blowing agents and additives, between two aluminium facings which ensure the airtightness of the insulation and the durability of its thermal performance. The thermal conductivity of different products varies according to the nature of the gas filling the closed cells, the production technique and the types of facings used.

BIOBASED AND RECYCLED MATERIALS

10 % of the market

BIOBASED MATERIALS

Plant based:	
– Cotton, flax and hemp	Biobased wools are made of plant fibres (cotton, hemp, flax) textured in the form of rolls or panels by adding polymer fibres (mainly polyester) and additives to ensure the products' fire and mould resistance. The inside of the stalk, called chenevotte, can also be used as plant concrete in the building sector. In combination with a binder (lime, cement, etc.) prescribed with dosages varying according to the applications, this filling material can be shaped on the building sites according to different techniques. It is particularly adapted to the renovation of old buildings.
– Wood fiber and wool	Wood fibre is obtained by thermomechanical defibration of softwood residues. Agglomerated by the dry or wet process, it forms panels of varying density, possibly with the addition of a binder depending on the application. Wood wool is obtained by mixing wood fibers with a natural binding agent and additives (such as water repellant substances). Afterwards, the wood pulp is compressed into a wood wool board, which dehydrates in an oven. The production process varies according to the type of wood fibre board, the thickness and the desired physical propreties[31].
– Wheat and cereals straw	Wheat and cereals have been used for centuries in the form of straw bales in insulation and plaster support[32].
Animal based:	
– Sheep's wool	Sheep's wool is obtained from the regular shearing of sheep's fleece, after washing, processing and shaping. This wool is textured in the form of rolls or panels by adding polymer fibres (mainly polyester) and additives to ensure the products' fire and mould resistance.

[31] Insulation-info.co.uk: Wood fibre insulation.

[32] Info Energie Auvergne-Rhône-Alpes (2020) Guide des matériaux isolants pour une isolation efficace et durable.

RECYCLED MATERIALS	
Animal and plant based:	
– Cellulose wadding	Cellulose wadding is obtained from recycled paper (new unsold newspapers and/or cuttings from new printing papers), to which additives are added to ensure the product's resistance to fire and mould[33].
– Cork	Cork insulation is made from residual cork that remains after punching cork bottle stoppers from the bark—which consumes only 25 % – 30 % of the bark. The cork granules are exposed to superheat stream in large metal forms. This heating expands the cork granules and activates a natural binder in the cork (the suberin) that binds the particles together[34]. **Cork is the only biobased insulation that is rot proof which allows it to be used in a wet environment**[35].
– Textile	Following the same process as cotton, flax or hamp wool, textile wool are also interesting because they recover a significant part of clothes that have become unusable[36].
Synthetic material:	
– PET from bottles	Plastic waste from bottles can be reused as source material for thermal insulation with mechanical and chemical processes.

LABELS

Several labels have been created to foster the development of sustainable buildings. They reward buildings presenting low embodied carbon, good energy performances and incorporate biobased products. Based on voluntary approach, they are delivered by independent organisation accredited to measure technical characteristics. Most of those labels apply to buildings (or to parts of the building) but one of them is dedicated to building products and can represent a differentiating factor on the insulation market.

Carbon footprint and energy consumption

« Bâtiments à Energie Positive et Réduction Carbone » (E+C-) label: this label has been set up by the government in 2017 and aims to highlight positive energy buildings with a small carbon footprint. It is dedicated to new buildings that respect at least the RT2012 requirements. The label is delivered after a Life Cycle Analysis gives the project it one of two energy performance grades ("BEPOS balance" indicator) and one of two carbon footprint grades ("carbon" indicator).

"Effinergie 2017" label: this label rewards buildings consuming a very low amount of energy and producing renewable energy. Created in 2013, the new version updated in 2017 is now linked to the E+C- label. A project must now first obtain the E+C- label and reach certain levels of energy and carbon performance and then demonstrate elements of energy sobriety and bioclimatic design, products' quality and comfort to receive the Effinergie 2017 label.

"Bâtiment Bas Carbone" (BBCA) label: this label certifies a building's performances in terms of carbon footprint. It applies to new buildings only and is based on a Life-Cycle-Analysis that differentiates three different levels of performance. The label considers the avoided emissions (reasoned construction, and controlled exploitation), and Climate Innovation (carbon

[33] Info Energie Auvergne-Rhône-Alpes (2020) Guide des matériaux isolants pour une isolation efficace et durable.

[34] Building Green (2012) Expanded Cork – The Greenest Insulation Material?

[35] Info Energie Auvergne-Rhône-Alpes (2020) Guide des matériaux isolants pour une isolation efficace et durable.

[36] Ibid.

storage and circular economy). The obtention of the E+C- label is also required to apply to the BBCA label.

Biobased materials

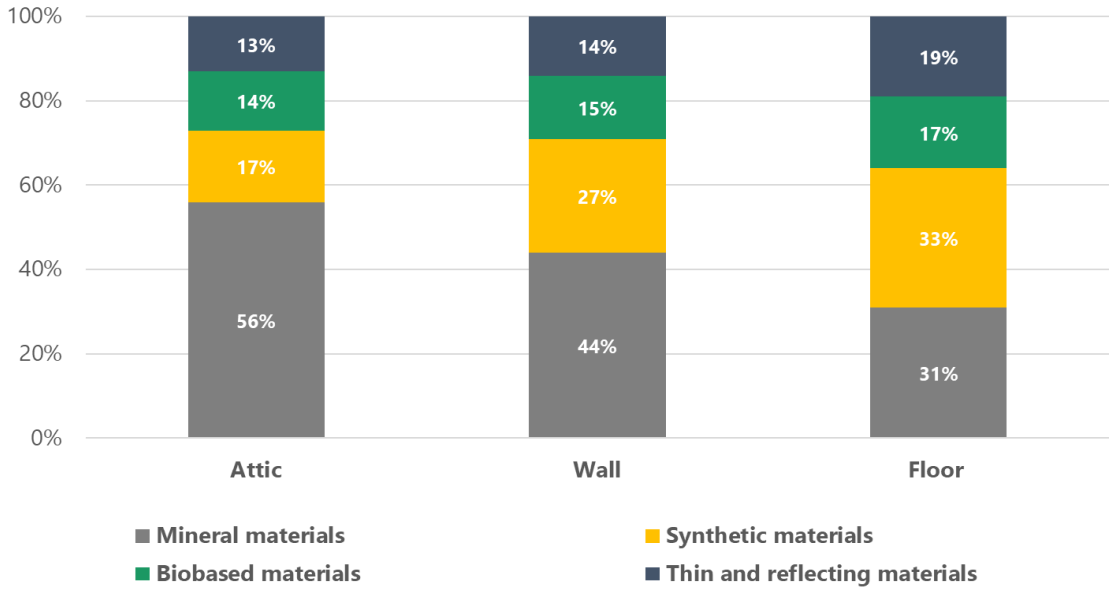
"Bâtiment Biosourcé" label: launched in 2012, this label aims to develop the use of biobased material in new non-residential buildings. The label is divided into three different levels determined by the number of biobased products, the number of products categories, the number of biobased products uses, and the total share of biobased material integrated into the construction. The procurement of a complementary certification (NF HQE[37] or NF HPE[38]) is required to obtain the label.

"Produit biosourcé" label: this label, developed in 2017, applies to the different building products. It certifies products sustainability and offers transparency regarding products origin. The label is structured by three different requirements: a minimum mass percentage of biobased raw material, the existence of a norm or certification attached to the products and transparency (products composition and origin must be detailed into a product's environmental and safety declaration).

3.1.1.2.3 A market dominated by attic insulation products

Regarding the main outlets of the insulation market, **attic and roof insulation remain in first position** since several years, representing almost **half of the total area of applied insulation products in 2019**. **Wall insulation** – interior or exterior – corresponds to the second outlet of the market and **floor insulation** appears in the third position[39].

It can be noticed that the **biobased materials are mainly used for floor insulation** (17% of the floor insulation market share). Besides, **mineral materials are the featured products for attic and wall insulation** whereas **synthetic materials are the most frequently used products for floor insulation.**



[37] NF HQE: multicriteria certification of the Hight Environmental Value.

[38] I.

[39] TBC Conseil & Innovation (2020) Les isolants thermiques pour le bâtiment en 2019.

Figure 7 – Origin of insulating materials per type of work (ADEME, 2016)

3.1.1.2.4 A nearly equal distribution between new work and renovation work

Until 2020, the insulation market was mostly driven by the new construction market: **in 2019, 52% of applied insulation products area were dedicated to new building**. However, **this trend has been reversed in 2020** and for the first time, **retrofitting market was the first outlet for insulation products**, benefitting from **54% of the applied insulation products area**[40].

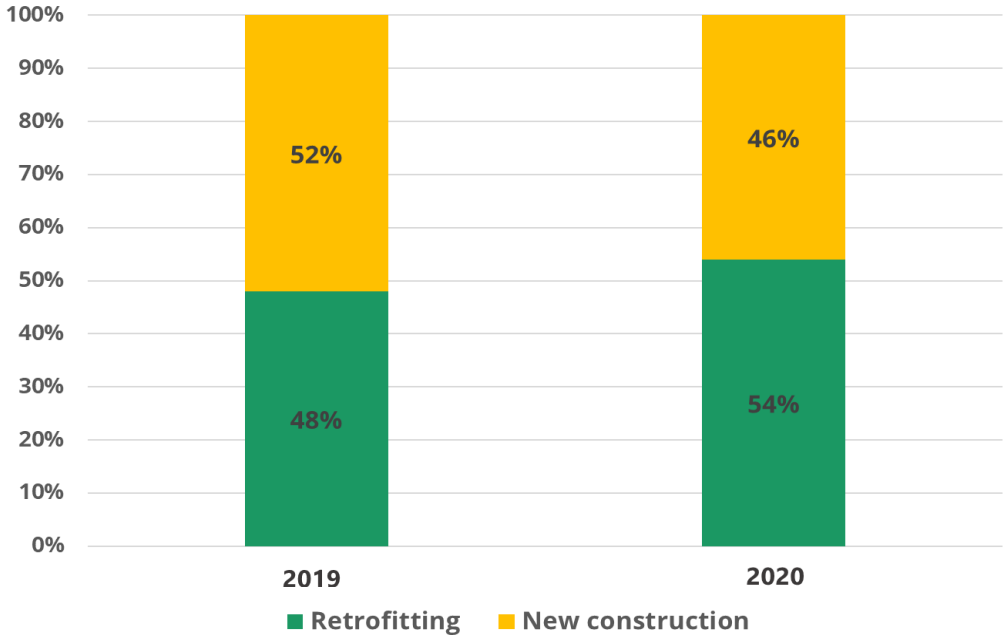


Figure 8 - Market share between retrofit and new construction in 2019 and 2020 (TBC Conseil et Innovation, 2020)

This dynamic can be explained by **different factors**: the **slowdown of the new construction market** since 2018 *(see 3.1.1.1)*, the **French government politics in favour of retrofitting** and the **lockdown due to the Coronavirus crisis**.

Several financial aids have been set up by the government to encourage households to retrofit their accommodation and make energy savings. In addition to those developed at the national level, many local authorities have launched complementary aids for retrofitting that aim to reduce the outstanding balance and to adapt to regional features.

FINANCIAL AIDS FOR RETROFITTING WORKS: A SUCCESSFUL TOOL

Several financial aids to foster retrofitting works have been set up at both the national and the local level. According to ADEME, 18% of the households that had carried out retrofitting works between 2014 and 2016 took this decision because they could benefit from financial support[41]. The study also reveals that 19% of the households have carried out additional works thanks to the financial mechanisms.

[40] TBC Conseil & Innovation (2021) Les isolants thermiques pour le bâtiment en 2020.
[41] ADEME (2018) Enquête TREMI, Travaux de rénovation énergétique des maisons individuelles, Campagne 2017. During this study, 44 921 interviews (including 29 253 interviews of individual housing owners) were conducted between April and May 2017.

"MaPrimeRénov": the main financial aids for retrofitting works are opened to all owners (occupier and landlord). The premium's amount is based on financial incomes. At the end of the second quarter of 2021, more than 380 000 requests had been submitted and more than 862 million of euros of premiums have been granted. The total budget dedicated to the program has been enhanced at 2,4 billion of euros to answer French's enthusiasm for retrofitting[42].

maprimerénov'
Mieux chez moi, mieux pour la planète

To obtain financial support to conduct insulating work, the thermal resistance (R) must reach a certain threshold:

- 3 m².K/W for floor insulation
- 3,7 m² K/W for wall insulation
- 4,5 m².K/W for insulation of roof terrace
- 7 m².K/W in lost attic and 6 m².K/W in roof slope for roof insulation work

"Certificats d'économies d'énergie" (CEE): The objective of this system is to involve energy suppliers in the massification of retrofitting. These players, known as "obligated parties", must collect a minimum volume of Energy Savings Certificates (CEE) set by period, and obtain these certificates when they financially encourage households to carry out retrofitting work. The volume of CEE issued for a work operation is defined in regularly updated "standard operation sheets" and generally corresponds to the quantity of energy that this work allows to save over the estimated period of use. The minimum thresholds to reach when insulating work are done to obtain premiums associated to CEE are similar to MaPrimeRénov' ones.

CEE Les certificats D'ÉCONOMIES D'ÉNERGIE
Ministère de la Transition écologique et solidaire

"Habiter Mieux": the national accommodation agency (ANAH) monitors a large financial aids program for retrofitting work called Live better (*Habiter Mieux*). It is divided into different mechanisms aiming to answer different situations (owner-occupier, co-owners, landlord). It is dedicated to low and very low incomes owners of at least 15 years old buildings. The Habiter Mieux program's subsidies for owner-occupiers and condominiums are conditioned by the work's performance, which must allow a reduction of at least 25% in energy consumption. In addition to this subsidy, a complementary bonus (dedicated to buildings of energy classes F or G) and a zero-interest loan can be added.

HABITER MIEUX
Rénovation énergétique, tout un programme d'aides

"Chèque éco-énergie Normandie": this financial mechanism has been set up by the Normandie Region to encourage house owners or more than 15 years old to conduct energy efficiency works in order to achieve the Low Consumption Building (*Bâtiment Basse Consommation*) level. To obtain the cheque, the annual energy consumption of the building should be inferior to 330kWh/m².year once the work is done, and the household's incomes below a certain threshold[43].

RENOVATEUR BBC Chèque ÉCO énergie NORMANDIE

Besides, due to national lockdown, households have remained locked in their dwellings for several months and have thus decided to invest to make it more comfortable; **the extended attendance at home highlighted the need for insulation and retrofitting**[44].

[42] ANAH (2021) 2e bilan trimestriel MaPrimeRénov' : plus de 380 000 dossiers déposés en 2021. Communiqué de presse.
[43] Région Normandie (29/11/21) IDEE ACTION "Chèque éco-énergie Normandie / Aide travaux" https://www.normandie.fr/idee-action-cheque-eco-energie-normandie-aide-travaux
[44] TBC Conseil & Innovation (2021) Les isolants thermiques pour le bâtiment en 2020.

Energy prices having been increasing since 2008, spurring households to commit to retrofitting works, to make energy savings and to reduce their energy bills[45]. Indeed, **energy prices (without taxes) have almost increased by 50% between 2008 and 2019.**

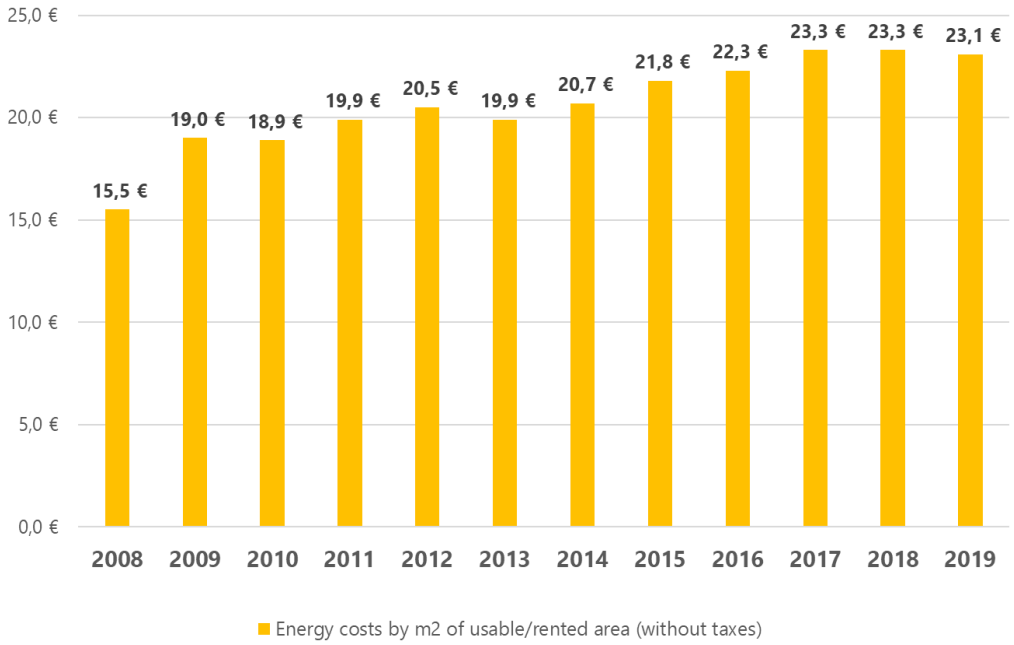


Figure 9 - Energy price evolution between 2008 and 2018 in France (Businesscoot, 2021)

[45] Businesscoot (2021) Le marché de l'isolation de bâtiments |France.

3.1.2 Main players

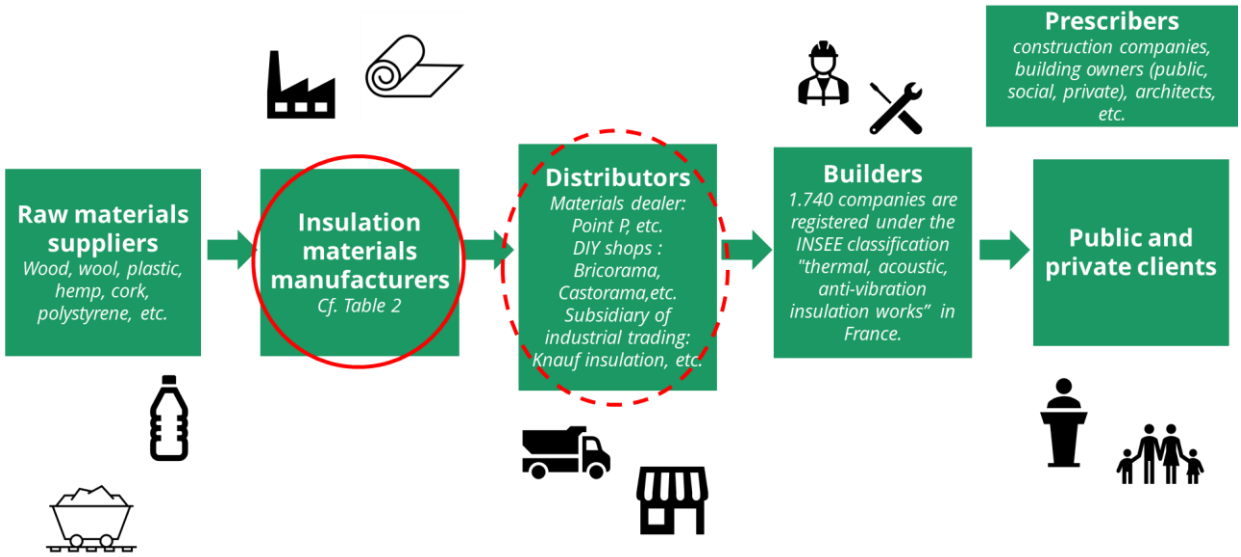


Figure 10 - Insulation market player types (Nomadeis, 2021)

3.1.2.1 Insulation materials manufacturers

Different kind of insulation manufacturers can be noticed on the market:

- **Big international companies**, that are dominating a large part of market, such as Saint-Gobain[46] (28 billons of euros of turnover in 2020), Knauf Insulation[47] (6,5 billons of euros of turnover in 2016) or Soprema[48] (1 billon of euros of turnover in 2020). They are offering a **large range of products**. They are characterised by their commitment to **increase productivity** and thus **improve their price competitiveness**: in 2017, Knauf Insulation invested €100 million to create a new production line that aims to produce 110,000 tonnes of rock wool per year[49]. Likewise, just after having been bought by Soprema, Pavatex benefited, in 2020, from a €27 million investment to increase by 50% the production capacity of its factory located in the Vosges region and thus reach 75,000 tonnes of wood fibre panels produced yearly[50].
- **Franchises developed by large companies**, that are **specialised in a specific segment** of the building and insulation market[51]. For instance, ISOcomble[52], the subsidiary of ISOweck, has become the first company on the French attic insulation market.
- **Small manufacturers**, that are often **family businesses**. So far, a majority of the **biobased insulating products** are developed by small manufacturers.

[46] Saint-Gobain's website.
[47] Knauf Insulation's website.
[48] Soprema's website.
[49] AC Presse (2017) Knauf Insulation annonce la construction d'une nouvelle usine.
[50] L'Usine Nouvelle (2020) Pavatex investit 27 millions dans sa production d'isolants biosourcés.
[51] Businesscoot (2021) Le marché de l'isolation de bâtiments |France.
[52] Isocomble's website.

Table 2 - Main producers of insulation products (Nomadéis, 2021)

		Rockwool	Cellular glass	Expanded polystyrene (PSE)	Polyurethane (PUR et PIR)	Extruded polystyrene (XPS)	PMR	Natural and recycled fibres				
								Recycled fibres	Wood fibres and wood wool	Hemp	Flax	Cellulose wadding
Knauf		x	x	x	x	x			x			
Saint-Gobain	Isonat								x			
	Saint-Gobain Isover	x	x	x		x						
Soprema group	Pavatex France								x			
	Soprema Iberia (ex Topox)	x	x	x	x	x	x		x			x
Ursa France												
Rockwool France		x										
Hirsch Isolation		x		x								
Pittsburgh Corning France			x									
Siniat				x								
Iko Insulations					x							
Poliuretanos					x							
Recticel Insulation					x							
Unilin Insulation					x							
Jackon Insulation France						x						
RBS France (former Ravatherm + XPS activity of Dow France)						x						
Actis							x					
ATI France							x					
PEG							x					
Sapronit							x					
Winco Technologies							x					
XL Mat												
Buitex Industries								x				
Cavac Biomatériaux										x	x	x
Métisse (Le Relais)								x				
Gutex									x			
Steico France									x			
Igloo France Cellulose												x
Isocell France												x
Ouateco												x
SEMI												x

3.1.2.2 Distributors

Insulating products can be sold **directly by the manufacturers**, **indirectly thanks to manufacturers' subsidiaries** such as Point P (*see below)* that is part of the Saint Gobain group, or by **independent distributors**.

3 different kinds of insulating products distributors can be found:

- **General suppliers**: their main clients are professionals. They offer a large range of construction products and thus have different kind of insulation materials. Point P[53] (more than 800 point of sales, 3,4 billion of euros of turnover in 2015), GEDIMAT[54] (490 points of sales and 1,8 billion of euros of turnover in 2017) or Chausson Matériaux[55] (350 points of sales, 1,5 billion of euros of turnover in 2021) are among the biggest one set up in France. They can also be online distributors, like TP Matériaux[56].
- **Specialised suppliers**: besides general suppliers, some distributors are positioned on a more specific segment but also targeting professionals. For instance, Biosource distribution offers only biobased products. Some of the general suppliers have launched subsidiaries specialised in one kind of products: GEDIMAT opened GEDIBOIS, in 2008, dedicated to wood products whereas, Chausson Matériaux bought Panofrance, in 2021, that sells only wood products and panels[57].
- **DIY stores:** they are mainly targeting private clients and are selling some insulating products among many kinds of products (decoration, gardening, etc.). The main groups in France are:
    - **ADEO group[58]** : Leroy Merlin[59] (141 points of sales and €7.9 billion of turnover in 2020), Weldom[60] (211 points of sales, €343 million of euros of turnover in 2019).
    - **Kingfisher group[61]** (Castorama and Brico dépôt): 214 points of sales in France, €5 billions of turnover in 2021.
    - **ITM EM[62]** (Les Mousquetaire group' subsidiary for house equipment that includes since 2018 Bricorama, Bricocash and Bricomarché): 675 points of sales and €607 million of turnover in 2019).
    - **Mr. Bricolage group**[63] : 854 points of sales, €274.6 million of turnover in 2020.

  At the international level, **those 4 groups are sharing 95% of the DIY market**.

[53] Point P's website.
[54] GEDIMAT's website.
[55] Chausson Matériaux' website.
[56] TP Matériaux' website.
[57] Les Echos (2021) Distribution : Chausson intègre Bois & Matériaux.
[58] ADEO group's website.
[59] Les Echos (2021) Leroy Merlin s'approche de la barre des 8 milliards d'euros en France,
[60] Weldom: Company Information.
[61] Kingfisher group's website.
[62] Les Mousquetaire group's website.
[63] Mr. Bricolage group's website.

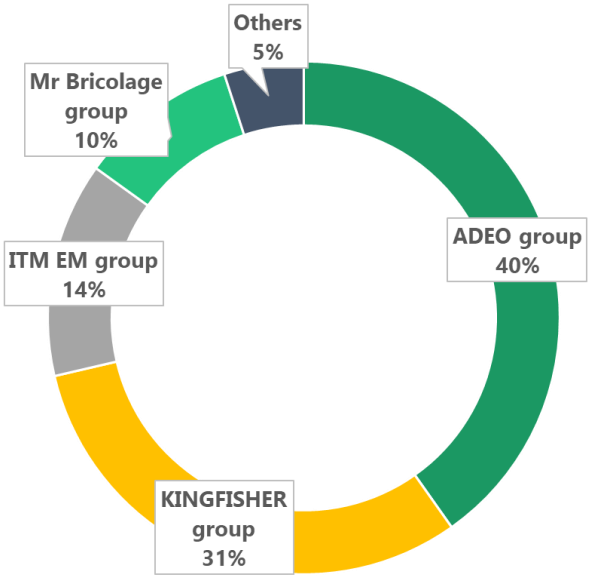


Figure 11 - Market share of the DIY international market (ITM EM group, 2021)

3.2 Focus: Attic insulation

3.2.1 Market opportunities: demand estimation

Objective of the section: to estimate the **attic area** that needs to be insulated, based on the retrofitting goals set by the French government, to quantify the attic insulation market.

The attic insulation market for new buildings is quantified using the following process :

- Estimation of the insulated area from the area of roof built:
- The area of roof built is taken from the French observatory of new construction BatiEtude[64]
- Share of bio-sourced in the insulants market (from TREMI survey[65])
- Maximum share of the market that the product can reach
- Maximum thermal conductivity aimed
- Required thermal resistance for attics
- Density of insulant

The retrofitting market was then estimated based on the respective shares of the insulation market for new construction (46 %) and retrofitting (54 %)[66].

Parameters	Unities	New Construction				Total construction	Total construction + retrofitting
		Housing			Service and industry		
		Isolated individual housing	Grouped individual housing	Collective housing	All		
Year of the data	-	2016-2020	2016-2020	2016-2020	2016-2020		
Floor area	m²	1,59E+07	3,94E+06	1,44E+07	-		
Roof area / Floor area	-	1,04	0,84	0,34	-		
Roof area	m²	1,65E+07	3,29E+06	4,97E+06	1,43E+07	3,91E+07	
Insulant area	m²	1,32E+07	2,64E+06	3,98E+06	1,14E+07	3,13E+07	
Share of biosourced insulants	%	11%	11%	11%	11%		
Share of BIO-CIRC prototypes reachable	%	5%	5%	5%	5%		
BIO-CIRC prototypes area	m²	72783	14 496	21 875	62 764	1,72E+05	
R needed (RE2020)	$m^2.k.W^{-1}$	10	10	10	5		
Required thickness	m	0,44	0,44	0,44	0,22		
Total volume reachable	m^3	32 025	6 378	9 625	13 808	61836	134427

[64] BatiEtude (2020) Observatoire de la construction neuve
[65] ONRE (2021) La rénovation énergétique des logements – Bilan des travaux et des aides entre 2016 et 2019
[66] TBC Conseils et Innovation (2020)

Total weight reachable	t	512	102	154	221	989	2151

The service and industry category contains shops, teaching, sports and hobbies, health, lodging, industry and storage buildings.

This computation is done using the following data and hypothesis:

- The resistance needed taken is **R = 10 for attics in housing** to anticipate the new regulation of 2021 (RE2020) for new construction that establishes higher standards in terms of insulation.
- The insulant area is computed as 80 % of the roof area to take into account that roof area is larger than the attics floor's in traditional houses. Even if the differences of area are more of the order of 40 %, it is considered that approximately half of the new construction has a horizontal roof.
- The insulants characteristics are fixed to **a thermal conductivity of $\lambda = 0,044 W.m^{-1}.K^{-1}$ and a density of $\rho = 16\ kg.m^{-3}$.**
- **The share of bio-sourced isolation is taken to be 11 %**, from the TREMI survey which reports the retrofitting acts in the individual housing sector. The underlying hypothesis is that this number is representative of the isolation market in general.
- **The reachable penetration rate for BIO-CIRC prototypes is here set to 5 % of the bio-sourced insulation market.**

With a total of 134 000 m^3 (equivalent to 2150 t for prototype 2 for instance) reachable, the market is large enough for industrial lines to develop. The production will be more limited by the recycled duvet fiber available than from the demand.
Moreover, the market is set to grow whether it be from new standards in construction or from the acceleration of retrofitting.

3.2.2 Presentation of the main products used for attic insulation

Several products produced from different resources and packed under different forms can be used to insulate attics**. Attics that can be converted into dwelling rooms**, can be insulated with **rolls or panels** whereas **attics that are not convertible** ("lost attic"), can also be insulated thanks to **flakes (injected or spread) or foam products**.

		Flakes (injected)	Flakes (spread)	Foam	Rolls	Panels
Mineral	Cellular glass	X			X	X
	Rockwool	X			X	X
Biobased	Hemp		X		X	X
	Flax		X		X	X
	Cork		X			X
	Sheep wool		X		X	X
	Wood fibre		X		X	X

	Cellulose wadding	X			X	X
Synthetic	Expanded polystyrene					X
	Extruded polystyrene					X
	Polyurethane					X
Recycled	Recycled textile				X	X

3.2.3 Technical performances of attic insulation products

This section aims to compare the technical performances of biobased, recycled or from mineral or petrochemical sources attic insulation products.

In the following diagrams, the products will be distinguished depending on the type of material (wood wool, sheep wool, cork, rock wool, etc.) and the type of packaging: 1. Flakes and foam and 2. Rolls and panels. Moreover, it should be noticed that data was not available for all products and packaging studied. Finally, the technical performances presented thereafter are a synthesis of the scientific literature on the subject, of the Environmental and health declaration form (FDES) available on the French public database INIES and of the data provided by material producers[67].

3.2.3.1 Thickness

In this first section, the thickness of the different materials is compared for a given thermal resistance R of 5 m².K/W. In this way, it is possible to know, for each product, the thickness of insulation required to achieve the same thermal performance.

→ **Focus on thermal resistance (R)**

Thermal resistance is a heat property translating the resistance of a material or an object to a heat flow.

This concept can be used in a variety of engineering branches including buildings and especially insulation. In this sector, the R-value (thermal insulance factor) is a measure of the thermal resistance: the higher the R-value is, the greater the insulating effectiveness is.

[67] Bibliography used for the section 3.2.2.1 *Technical performances of attic insulation market*:

- Info Energie Auvergne Rhône Alpes (2020) Guide des matériaux isolants.
- Chambre de Métiers et de l'Artisanat, Interreg ALCOTRA et ECO BATI (2020) Guide régional des matériaux eco-durables.
- Technichanvre®: Fibre de chanvre en vrac.
- SCIC LANATURAL: Fiche technique isolant en laine de mouton.
- Matériaux-naturels.fr: Laine et fibre de bois, un isolant performant et polyvalent.
- STEICO: Fibre de bois en vrac.
- Base INIES: Fiches de Déclaration Environnementale et Sanitaire (FDES).
- Matériaux-naturels.fr: Panneau ouate de cellulose
- Tout le liège: Caractéristiques du liège d'isolation thermique.

Thermal resistance is expressed in $[m^2.K]/W$. Indeed, the thermal resistance depends on the thickness of the product (called "e" and expressed in meters) and the thermal conductivity (called "λ" and expressed in $W/[m.K]$): $\boldsymbol{R} = {}^{\boldsymbol{e}}/_{\boldsymbol{\lambda}}$

R = 5 represents[68] :

- ➔ A larger thermal resistance than recommended by the old thermal regulation (RT2012) (R ≥ 4.4 for converted attics, with variations on localisation, and R ≥ 4.8 for lost attics);
- ➔ A smaller thermal resistance than recommended by the new and more demanding thermal regulation (RT2020) (R ≥ 10 for roofing of buildings constructed after 2021).

In the following graphs (Figure 11 to Figure 18), due to the slight variability of the physical characteristics of different products based on the same material, are shown for each parameter: the minimum and maximum values identified in the literature. An average is provided if a sufficient data set could be obtained

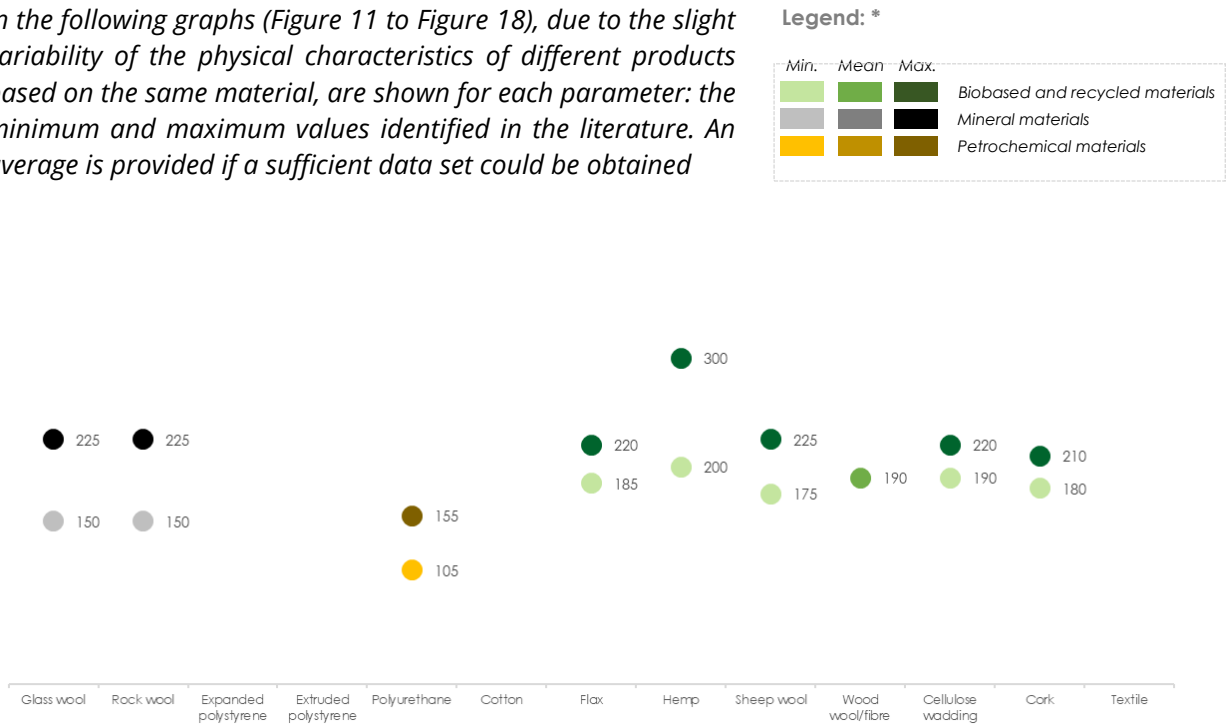


Figure 12: Thickness values in millimetres (minimum and maximum) of attic insulation packaged in flakes and foam formats necessary to achieve a thermal resistance R = 5 m².K/W (Nomadeis, 2021)

[68] IZI by EDF: Les coefficients thermiques à respecter selon les types d'isolation

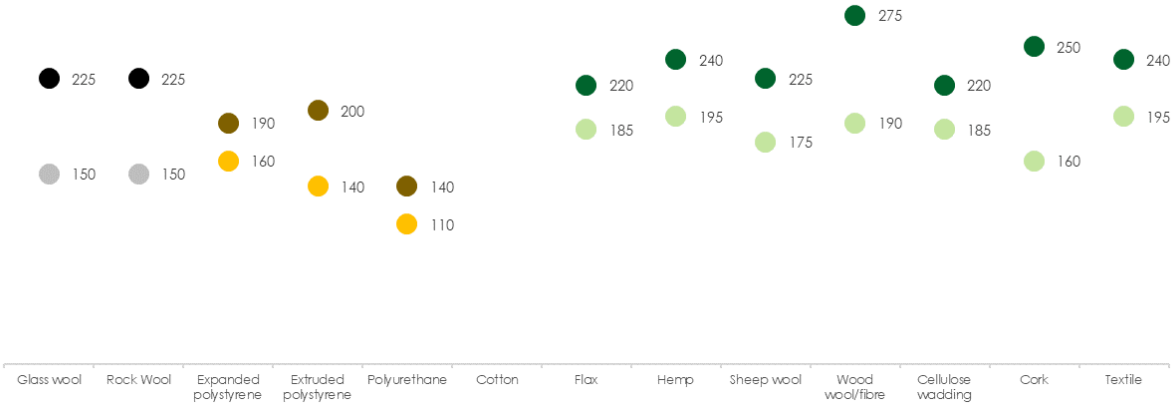


Figure 13 : Thickness values in millimetres (minimum and maximum) of attic insulation packaged in rolls and panels formats necessary to achieve a thermal resistance R = 5 m².K/W (Nomadeis, 2021)

Based on this data, it is possible to conclude as follows:

- For a same thermal resistance, **petrochemical insulations, and especially polyurethane (PUR), are slightly thinner** than mineral, biological or recycled insulations;
- On average, mineral insulations (for flakes and panels) are slightly thinner than biological and recycled insulations;
- Despite being slightly thicker (in particular wood wool, hemp wool and recycled textile), **biobased or recycled insulations remain very close to mineral or petrochemical insulations in terms of conditioning and are very well adapted to attic insulation (less constraining in terms of thickness);**
- Finally, it should be noted that insulation thickness can vary greatly, for the same material, from one product to another. Moreover, no significant difference is observed between flakes/foam and panels/rolls.

3.2.3.2 Thermal properties

This section aims to present the thermal performances of biobased, recycled or from mineral or petrochemical sources attic insulation products, and especially their thermal conductivity and capacity.

→ **Focus on thermal conductivity (λ)**

The thermal conductivity (λ) of a material is a physical quantity that characterizes its ability to diffuse heat in media without macroscopic displacement of matter. The higher λ is, the more heat the material conducts and the lower it is, the more insulating the material is.

Thermal conductivity is expressed in $W/[m.K]$. Insulating materials generally have a λ between 0.025 and 0.050 $W/[m.K]$ [69].

[69] Les réglementations thermiques et environnementales, https://re2018.fr/accueil/reglementations-et-labels/rt2012/isolation-rt2012/

→ **Focus on thermal capacity**

Thermal capacity is the amount of heat a material can store relatively to its mass. It is defined as the amount of heat required to raise the temperature of 1 kg of material by 1°C. It is expressed in $J/[kg.K]$.

Thermal inertia depends on the thermal capacity of the insulating material. A concrete, brick or stone wall that is insulated has thermal inertia. Thanks to the thermal inertia, the wall will store heat or coolness and thus regulate temperature differences between day and night.

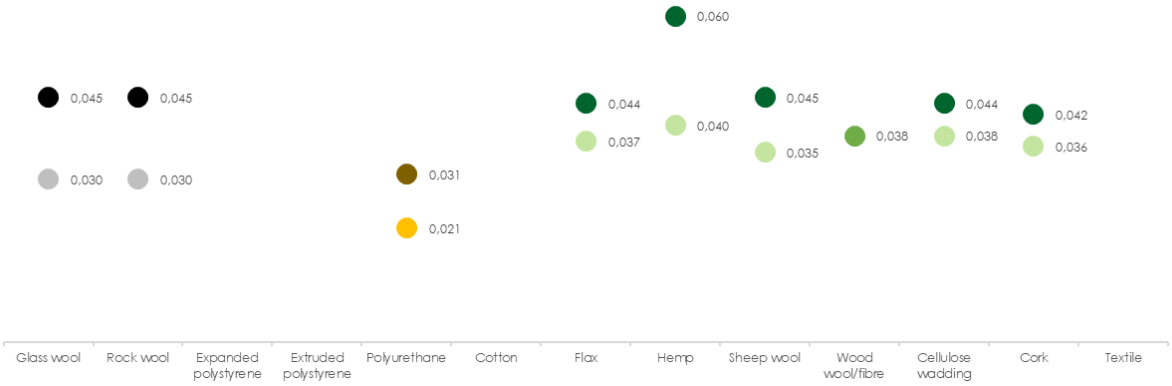


Figure 14: Thermal conductivity (minimum, maximum) in $W.m^{-1}.K^{-1}$ of attic insulation packaged in flakes and foam (Nomadeis, 2021)

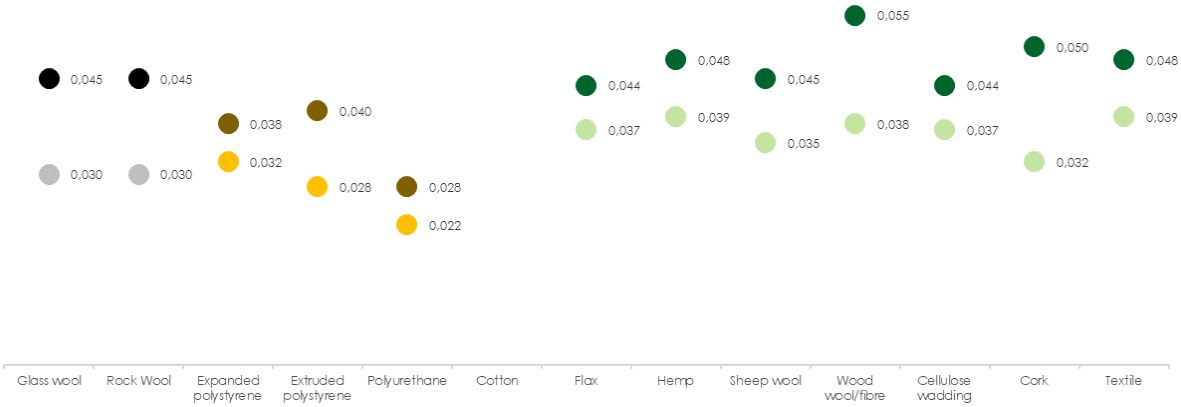


Figure 15: Thermal conductivity (minimum and maximum) in $W.m^{-1}.K^{-1}$ of attic insulation packaged in rolls and panels (Nomadéis, 2021).

Concerning the thermal conductivity, on the basis of this data:

- **Petrochemical insulations (and especially polyurethane) present in average a smaller thermal conductivity than mineral, biobased and recycled insulations;**
- **Biobased and recycled insulations present in average a thermal conductivity slightly higher than mineral and petrochemical insulations**, included between 0.038 and 0.050 W/m.K for flakes and foam and 0.040 and 0.047 W/m.K for panels and rolls.

Figure 16: Thermal capacity (minimum and maximum) in $J.kg^{-1}.K^{-1}$ of attic insulation packaged in flakes and foam (Nomadeis, 2021). Note: data was limited on this range of products.

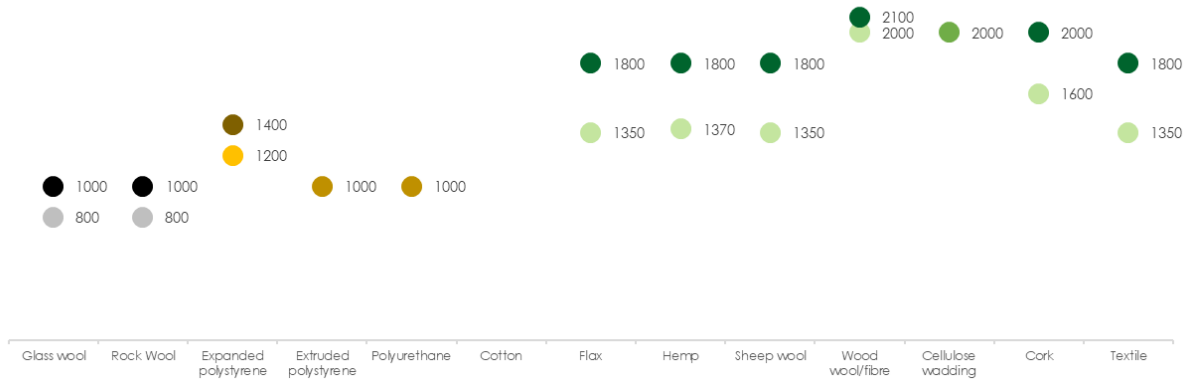


Figure 17: Thermal capacity (minimum and maximum) in $J.kg^{-1}.K^{-1}$ of attic insulation packaged in flakes and foam (Nomadeis, 2021).

Concerning the thermal capacity, based on this data:

- Biobased and recycled insulations (and especially wood wool, cellulose wadding, and cork) present a higher thermal capacity than petrochemical and mineral insulations;
- Based on the data available, mineral insulations seems to have the worst thermal capacity of all the types of insulations studied.

Finally, about the thermal properties of the insulation materials, it is possible to conclude as follows:

- In general, **all the insulation materials studied have a fairly low and similar thermal conductivity, which indicates their good insulating properties**. Polyurethane differs from the other materials by a very low thermal conductivity and thus better insulating properties (when the focus is only on the thermal conductivity);
- **Biobased and recycled insulations clearly differ from petrochemical and mineral materials through their ability to store energy** (quite high thermal capacity). This physical property allows a better regulation of the temperature between day and night thanks to the staggered diffusion of heat in time. Indeed, materials with a high thermal capacity are more capable of limiting the internal variations of the temperature guaranteeing a better thermal inertia and thus a better summer and winter comfort;
- Finally, it should be noticed that insulation thermal properties can vary greatly, for the same material, from one product to another.

3.2.3.3 Hygrometric performances

This section aims to present the hygrometric performances of biobased, recycled or from mineral or petrochemical sources attic insulation products, and especially the vapour permeability of the materials.

→ **Focus on vapour permeability (μ)**

Important exchanges of water vapour take place between the interior and exterior of a building due to differences in temperature and humidity. Humidity management is complex and requires special attention. Indeed, a bad management of wall humidity can quickly lead to degradation of the building (cracks, mould, etc.) or even in the long term to endanger the structure of the building. Two parameters need to be monitored to ensure the durability of a building but also the comfort of its occupants: the walls' capacity of drying and of evacuating moisture. The management of water vapour flows in a wall is mainly characterized by the water vapour diffusion resistance coefficient (μ).

The vapour permeability coefficient (μ) has no unit. The higher the μ, the more water vapour tight the material is. By convention, it is considered that still air has a vapour permeability of μ = 1[70].

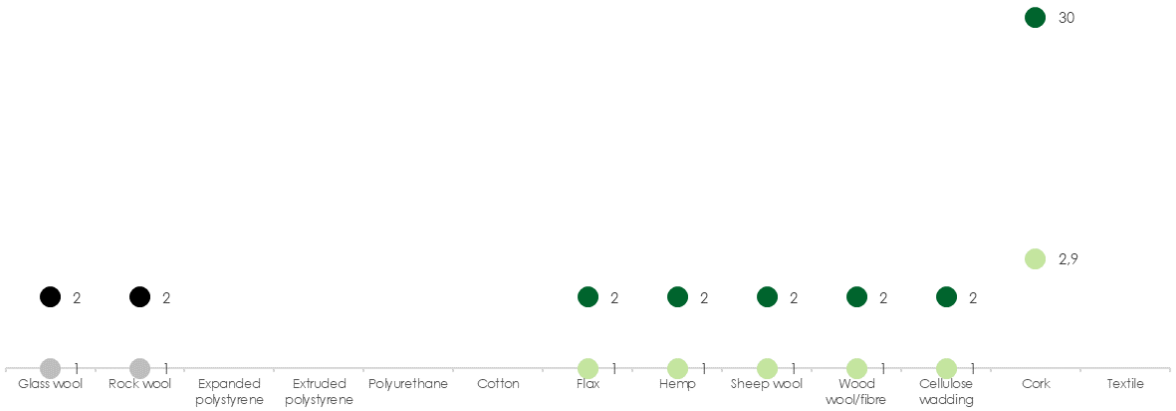


Figure 18: Vapour permeability (minimum and maximum) of attic insulation products packaged in flakes and foam (Nomadeis, 2021).

[70] Info-Energie Auvergne Rhône Alpes (2020) Guide des matériaux isolants.

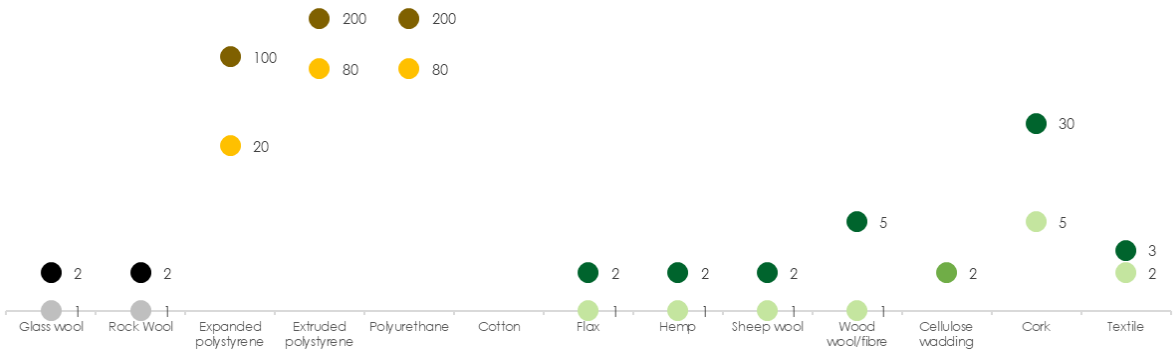


Figure 19: Vapour permeability (minimum and maximum) of attic insulation products packaged in panel and roll formats (Nomadeis, 2021)

On the basis of this data, it is possible to conclude as follows:

- Petrochemical insulations have, on average, a higher vapour permeability coefficient than biobased, recycled, and mineral-based materials;
- Among biobased and recycled insulations, several stand out as having a higher vapour permeability coefficient: cork, wood wool, recycled textile, and cellulose wadding;
- Finally, it should be noted that vapour permeability can vary greatly, for the same material, from one product to another. Moreover, no significant difference is observed between flakes and foam, and panels and rolls (except for wood wool).

3.2.4 Carbon footprints of attic insulation products

This section aims to compare the carbon footprint of common insulation products derived from the various raw materials studied. The chosen products reflect a range of use and format (rolls, loose aggregates, foams, etc.). The data presented below was mostly obtained from the French Environmental Product Declarations (*"Fiche de Déclaration Environnementale et Sanitaire")* which usually comprise a life cycle analysis and some health and safety declarations (composition, presence of REACH substances, etc.). Not all marketed products had a formal environmental sheet available (ex. sheep wool products), in such cases, the footprint was calculated using information such as average volumetric mass density, average thermal conductivity to achieve a thermal resistance of 5 m².K/W.

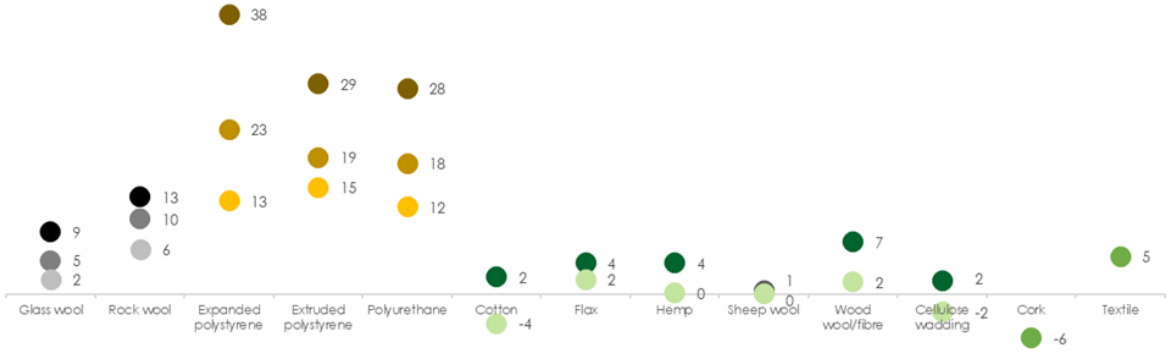


Figure 20 - Carbon footprint values with carbon storage (minimum, average and maximum when available) in kgCO2eq for 1m² of product and a performance of R = 5 m².K/W. Single values indicate that only 1 data source was found, means were derived when data sets incorporated more than 5 values.

The carbon data indicates that mineral material have relatively low carbon footprint, this is usually due to efficient transformation processes which have been honed over the decades these products have been put on the market. Petroleum-derived materials usually have much higher carbon footprints as their transformation processes includes refining crude oil and transforming its chemical composition to suit the products' bill of specifications. Biobased and recycled materials have overall the lowest carbon fooprints of the market.

Caution must be exercised when considering the carbon footprint of valorised and natural insulation materials. Indeed, the norms (NF EN 15804 and NF EN 15804/CN) that govern the rules of the life cycle analysis allow some flexibility in the way certain parameters are accounted for and reported. When examining LCA results, the following must be considered:

1. While manufacturers must provide an overview of the transformation chain and the perimeter of their analysis, they are not obligated to provide detailed information of the footprint of each of the processes and their stages.
2. **There exists a range of practices to account for biogenic carbon** within the analysed products **and, generally, manufacturers choose accounting rules that diminish the total footprint**:
    a. Natural and recycled fibres or materials often hold biogenic carbon, that is carbon that has been captured from the atmosphere and stored within the material (paper, wool, etc.). It is therefore **common practice for manufacturers to consider that the incoming raw material has a negative carbon footprint** given it has stored carbon.

i. Given that all production steps are usually regrouped, this means that third parties may not understand how much biogenic carbon has been deducted and what is the actual carbon intensity of the production processes.

b. **Manufacturers usually choose favourable end of life scenarios that prevent biogenic carbon remineralisation** (degradation of solid carbon into carbon dioxide and methane by microorganisms). To varying degrees, manufacturers consider that the products they sell will be landfilled at the end of their lifecycle. While this may be in line with current practices, they also usually take the hypothesis that none or only a small fraction of the biogenic carbon will be degraded in the landfill. As an example, wood wool and fibre producers consider that only 15% of landfilled wood products will be degraded[71]. There are two consequences to this practice:

   i. **Manufacturers consider that their product participate in a net capture of biogenic carbon**: the latter is considered stored permanently within the landfill ground.

   ii. The end-of-life section of the LCA does not include the re-emission of the biogenic carbon considered stored in the production phase of the product's life cycle. As such, the overall footprint of the process tends to be very low.

While recycled and natural fibre manufacturers may be embellishing their carbon footprint results using aforementioned permitted rules within the life cycle analysis, it must be noted that manufacturers of petrochemical and mineral insulation products also choose an end-of-life scenario where all the matter is landfilled and not degraded thus effectively achieving a storage of the embodied carbon.

If the estimated biogenic carbon is deducted from existing DEPs (see Figure below) then it turns out that some bio- or waste-based materials have higher carbon intensities than their conventional counterpart. It remains that NRFI products usually have a clear advantage over conventional products in that the carbon contained within these products is extracted from the atmosphere (through photosynthesis of cellulose or lignin molecules or consumption of plants for animal-derived products) and even the release of CO_2 within the landfill simply completes the carbon cycle. On the other hand, petroleum-derived or mineral material usually emit carbon dioxide which was previously stored within rock or oil deposits and therefore constitutes a net atmospheric carbon gain.

The Figure below also highlights the need for the natural and recycled fibre insulation industry to improve (through upscaling notably) their transformation process which may currently be too carbon intense compared to more mature value chains (such as those of the glass and rock wool industries).

71 FCBA, Synerbois & CSTB (2012) Rapport d'étude : Prise en compte de la fin de vie des produits bois. Phase 3 : modélisation ACV et calculs d'impacts pour le recyclage matière et la réutilisation.

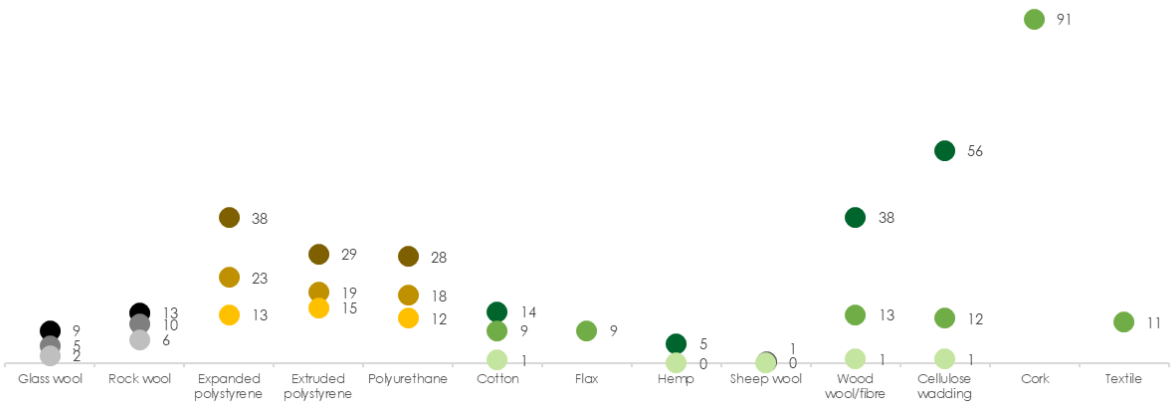


Figure 21 - Carbon footprint values without carbon storage (minimum, average and maximum when available) in kgCO2eq for 1m² of product and a performance of R = 5 m².K/W. Single values indicate that only 1 data source was found, means were derived when data sets incorporated more than 5 values.

3.2.5 Prices of attic insulation products

Attic insulation products' prices can **strongly fluctuate** depending on the materials used, the technical characteristics, the supplier but also on the economic situation. Therefore, it appears difficult to determine specific values. Nonetheless, two trends can be noted:

- **Bulk products are cheaper than panels and rolls**;
- **Biobased insulating products and synthetic products are more expensive than mineral ones for equivalent performances.**

The table below shows the average prices of the different products used for attic insulation, in €/m² for an equivalent thermal resistance (5m².K/W). The benchmark of 42 different insulting products for attics has been conducted among major French insulating products distributors.

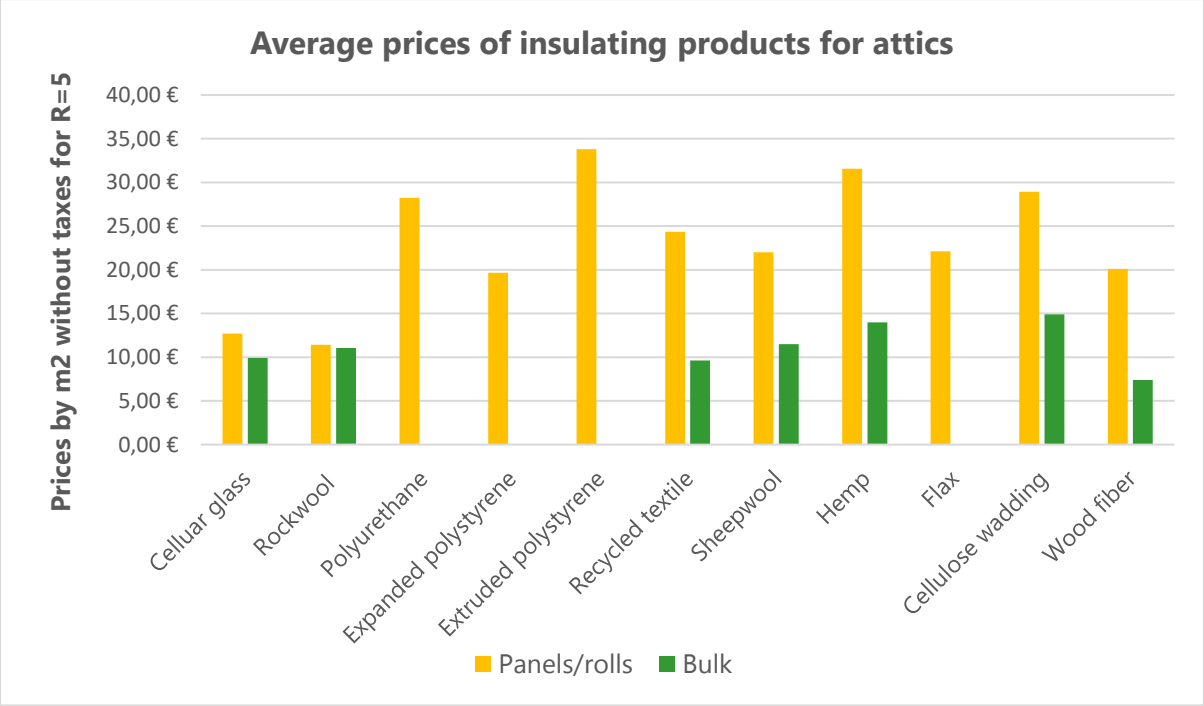


Figure 22 - Average prices of insulating products for attics for R = 5 – excluding cork (Nomadéis 2021)

Minimal thermal resistances required to obtain financial aides (CEE and MaPrimeRénov')[72]:

- Lost attics: R=7 m².K/W
- Converted attics: R=6 m².K/W
- Walls: R=3,7 m².K/W
- Floors: R=3 m².K/W

[72] https://media.castorama.fr/is/content/Castorama/3596262005305_ran_FR_CFpdf

3.3 Market insights: perceptions, needs and perspective

Although the general trend is towards the development of biobased and recycled insulation materials, encouraged in particular by French regulations, many obstacles need to be overcome.

During a workshop with *ARPE Normandie*, an association for the promotion of biobased materials, on 20/04, several factors for the development of the market were discussed.

They are summarised below, enriched by the feedback from other actors involved in the development of biobased insulation materials and from recycling, met in the framework of parallel studies.

1. **Achieving more competitive selling prices**: Insulation made from natural and recycled fibres currently represents an additional cost compared to conventional insulation, which may make it less attractive. Industrialisation of production is one of the levers to reduce the costs associated with biobased and recycled insulation;
2. **Educating building owners and project managers**: lack of knowledge about the properties of biobased and recycled insulation materials remains a barrier to their use. Awareness-raising and educational work would help to change their image and thus increase their use. In particular, it would be interesting to make the link between regulatory changes and the properties of biobased and recycled insulation, which provide a convincing response.
3. **Increasing the distribution network for biobased and recycled insulation**: biobased and recycled insulation is currently not frequently distributed by conventional product retailers and is therefore more difficult to source. They are mainly distributed through specialised shops or direct sales and their accessibility is therefore more limited. It would be advisable to increase the number of distributors of bio-based and recycled insulation products in order to make them more accessible.
4. **The issue of training craftsmen in order to guarantee the correct implementation of the products**: the cost of installing biobased and recycled insulation generally represents an additional cost compared to conventional insulation (craftsmen may seek to protect themselves from an installation time that they consider more important by charging higher prices than for conventional insulation, whereas in reality, once trained in the appropriate gestures and precautions, the installation time is equivalent). The training of craftsmen is one of the essential levers to make them financially more attractive and facilitate their implementation.
5. **Change the regulations to facilitate the certification of insulation made from natural fibres and from recycling**: the costs of certification and the time needed to bring it to market are currently holding back the development of bio-sourced insulation and insulation made from recycling. Few small producers are currently able to bear the cost of certification. Collective approaches (professional rules) can in some cases make it easier to obtain the necessary accreditations. Individual certification procedures should be simplified to encourage the deployment of biobased and recycled insulation.
6. **Strengthen raw material traceability and local processing**: In order to ensure a competitive carbon footprint and thus preserve resources, it is important to ensure local sourcing and processing of bio-based and recycled insulation. In addition, the transport of materials and products between the different stages of the production chain adds to the cost of production. The establishment of local labels and the deployment of processing facilities throughout the country are important levers.

4 Great Britain

4.1 Building insulation products market

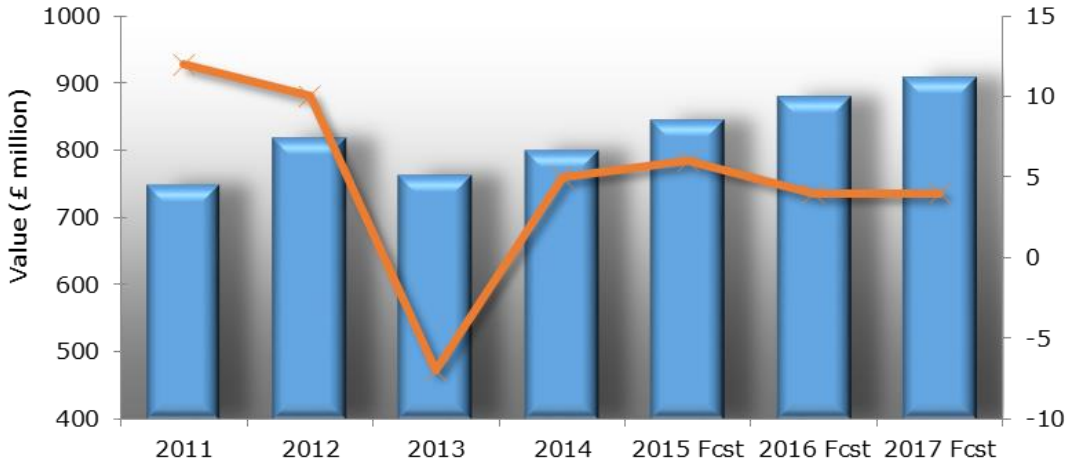
4.1.1 Structure and value of the market

4.1.1.1 Size

As noted previously in this report, the global insulation market is quite dynamic and has increased about 5.4% between 2015 and 2016 at the worldwide scale. In 2016, the turnover of the global insulation market was about $39.5bn.

Global Market Insights[73] predict considerable growth for the worldwide insulation market as a whole over the coming years, mostly driven by high construction spending and more demand for energy efficient buildings.

In the UK, in 2015 the market for building insulation products experienced a downturn, driven by a significant fall in government-subsidies, which had previously been a large end use sector. [74]



UK building insulation market by value: 2011-2017, £m at MSP (Building Insulation Products Market Report – UK 2015-2019 Analysis, AMA Research, 2015)

AMA Research[75] has recorded a 16% year-on-year decline in UK insulation demand to €1.62bn in 2020 from €1.93bn in 2019. They forecast a 3% year-on-year decline in 2021 to €1.57bn. It said the demand would not recover to 2019 levels before 2025.

Mintel[76] predicts the thermal insulation market will return to growth in 2021, with an estimated 6% increase in real terms, followed by stronger growth of 9% in 2022. Growth is set to be primarily driven by a buoyant housebuilding market.

[73] Global Market Insights, Inc. (2017, June 26). Building Thermal Insulation Market worth over $34bn by 2024: Global Market Insights, Inc. GlobeNewswire News Room. Retrieved 2022, from https://www.globenewswire.com/news-release/2017/06/26/1028870/0/en/Building-Thermal-Insulation-Market-worth-over-34bn-by-2024-Global-Market-Insights-Inc.html

[74] AMA Research. (2022, February 3). Building Insulation Products Market Report - UK 2021-2025. Retrieved 2022, from https://www.amaresearch.co.uk/report/building-insulation-products-market-report-uk-2021-2025/

[75] Global Insulation. (2021, April 8). UK insulation demand fell by 16% to Euro1.62bn in 2020. Retrieved 2022, from https://www.globalinsulation.com/news/item/1684-uk-insulation-demand-fell-by-16-to-euro1-62bn-in-2020

[76] Mintel Reports Store (n.d.). UK Thermal Insulation Market Report 2021 | Mintel.com. (n.d.). Mintel Store. Retrieved 2022, from https://store.mintel.com/report/uk-thermal-insulation-market-report

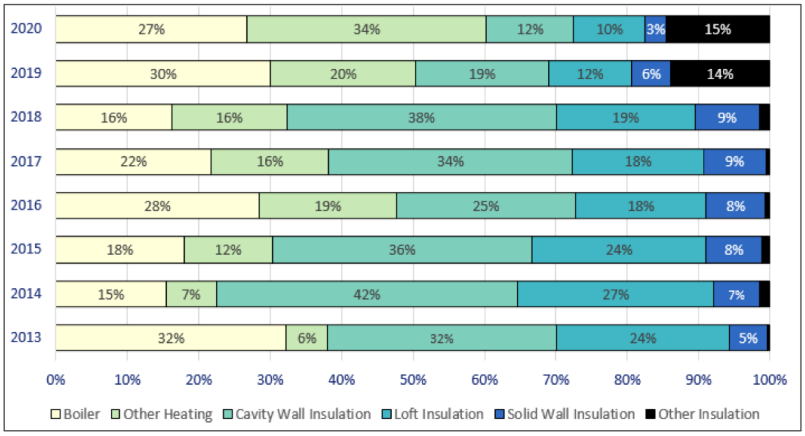
As has been the case across the construction sector, COVID-19 had a significant impact on the insulation market in 2020, with an estimated 16% fall in market value. Mintel states the market started to recover in the latter part of the year, supported by a rebound in construction activity and pent-up demand.

"The market is likely to decline by a further 3% in 2021, but will recover from 2022 onwards, with growth rates of around 4-6% per annum through to 2024. This recovery is likely to be driven by strong demand for new housing, recovering levels of non-residential new work and the prospect of an improved retrofitting market through increased ECO funding from 2022".[77]

Alex Blagden Editor of the Building Insulation Products Report

4.1.1.2 Structure

In the UK under Government-subsidised schemes, cavity wall and loft insulation have proven to be the most commonly installed products. Under the ECO scheme, around 3 million measures have been installed in around 2.3 million properties to the end of December 2020.[78]



ECO measures installed up to December 2020 (Household Energy Efficiency Release, BEIS, March 2021)

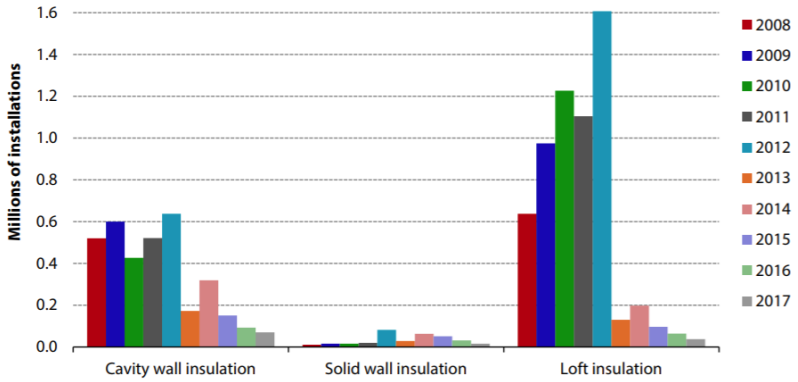
At the end of 2020, 14.3 million properties had cavity wall insulation (70 per cent of properties with a cavity wall), 16.6 million had loft insulation (66 per cent of properties with a loft) and 772,000 had solid wall insulation (nine per cent of properties with solid walls).

Data from the UK's Committee on Climate Change[79] shows that under Government programmes, loft insulation had by far the largest share of the market until 2012. Loft insulation installations reduced dramatically in subsequent years and in 2019 was 95 per cent lower than what was delivered in 2012.

[77] AMA Research. (2021, June 30). Building Insulation market estimated to have fallen by 16% due to Covid-19. AMA Research. Retrieved 2022, from https://www.amaresearch.co.uk/building-insulation-market-estimated-to-have-fallen-by-16-due-to-covid-19/

[78] Department for Business, Energy & Industrial Strategy, National Statistics 2021, Household Energy Efficiency detailed release: Great Britain Data to December 2020. Retrieved 2022, from https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/970064/Detailed_Release_-_HEE_stats_18_Mar_2021_FINAL.pdf

[79] Climate Change Committee (n.d.). UK housing: Fit for the future? (2019, July 10). Climate Change Committee. Retrieved 2022, from https://www.theccc.org.uk/publication/uk-housing-fit-for-the-future/



Annual insulation installation rates under Government programmes: 2008–2017 (Committee on Climate Change, UK Housing: Fit for the future? Feb 2019, p.29)

4.1.1.3 Dynamic

The building insulation market in the UK has been volatile since 2013[80]. In 2013 the market experienced a sharp decline in value following the end of the Carbon Emissions Reductions Target (CERT) and the Community Energy Savings Programme (CESP), which incentivised the retrofitting of insulation, in 2012.

In 2015, reduced funding to deliver the Energy Company Obligation (ECO) resulted in far lower levels of domestic installation activity compared to under previous government initiatives. More recently, the Government's much-maligned Green Homes Grant came to an end in March 2021.

The building insulation end user market shares have also changed over recent years. The dramatic fall in installations under Government schemes means that the domestic retrofit market no longer represents the largest end use sector, now accounting for less than a third of insulation installed by area. This has resulted in the non-domestic market having the largest share by end user, mainly flat roofs and site-built metal cladding and roofing systems.

Additionally, new housebuilding has a larger share than in recent years, accounting for approximately the same amount of the market as domestic retrofitting, due to steadily rising numbers of housing starts and completions.

The key supply route for insulation products is the specialist (interiors) distributor channel. Builders merchants account for just below 20% of the market, the remainder being split between direct sales to installers, direct sales to external wall insulation systems companies, converters and DIY stores.

The installation market for insulation is polarised between a small number of national companies and many regional and local independent firms, with the leading contractors typically provide additional energy efficiency services.

In recent years there has been issues in regard to the short-term availability of insulation materials, due to the Covid pandemic and the effects of 'historically' high raw materials costs on production.[81]

[80] AMA Research (2017) Building Insulation Market set to stabilise and grow. (2001, May 15). Retrieved 2022, from https://www.barbourproductsearch.info/building-insulation-market-set-to-stabilise-and-blog000423.html

[81] Global Insulation. (2021, March 11). Construction Products Association and Builders Merchants Federation warn of UK polyurethane and polyisocyanurate insulation shortages. Retrieved 2022, from https://www.globalinsulation.com/news/item/1676-construction-products-association-and-builders-merchants-federation-warn-of-uk-polyurethane-and-polyisocyanurate-insulation-shortages

Almost every sector of the economy has been affected in some respect by the Covid pandemic, the building market for insulation products is no exception. As mentioned previously, the insulation market is estimated to have fallen by around 16%, this is mainly due to the impact of the imposed Covid-19 restrictions on newbuild and domestic retrofit activity.[82]

4.1.2 Main products and players

Similar to the landscape in France, there are a couple of large international companies that dominate the market. Market supply remains highly concentrated, with two manufacturers accounting for over 40% by value, as they have for several years now even with their market share falling slightly in the last 2 years.

The product mix within the insulation market has seen change in recent years.[83] PIR/PUR products now hold the largest market share, this is in large part due to a combination of thin profiles balanced by high thermal performance and ease of handling on site.

Arguably, the largest building market for PIR boards is flat roofing where they have the dominant market share. The market value of mineral wool products has reduced due to the fall in demand for such products under the Green Deal and ECO, but they still account for just under a third of the insulation market by value.

Polystyrene foam products represent the next largest product group consisting of EPS and XPS boards, blocks and sprayed foam.

The remainder of the market is made up of phenolic foam boards, which are widely used on technical and industrial applications but less so for building fabric, and 'other' insulation products including foil sheets, nitrile rubber sheets, cellulose and natural fibre insulations.

4.1.2.1 Distributers and merchants

Two of the largest distributors of insulation in the UK are SIG and Encon. The two largest merchants are Travis Perkins and Saint-Gobain Building Distribution. [84] The UK builders merchants market has seen many developments in 2021, with Grant & Stone, Huws Gray, Lords Group Trading and the National Timber Group all buying other companies.

4.1.2.2 Manufacturers/labels

Glass fibre	Stone wool	Expanded polystyrene (EPS)	Polyurethane (PUR and PIR)	Extruded polystyrene (XPS)	Multifoil	Natural and recycled fibers
Owens Corning Superglass Knauf Insulation	Rockwool	Jablite BASF Springvale	Kingspan Celotex Recticel Ecotherm Mannok	Unilin/ Xtratherm	YBS TLX	Eden Renewables Ltd (sheep's wool, hemp, rPET)

[82] AMA Research. (2021, June 30). Building Insulation market estimated to have fallen by 16% due to Covid-19. AMA Research. Retrieved 2022, from https://www.amaresearch.co.uk/building-insulation-market-estimated-to-have-fallen-by-16-due-to-covid-19/

[83] AMA Research (2017) Building Insulation Market set to stabilise and grow. (2001, May 15). Retrieved 2022, from https://www.barbourproductsearch.info/building-insulation-market-set-to-stabilise-and-blog000423.html

[84] Professional Builders Merchant. (2021, March 24). UK merchant sector Top 20 – 2020 calendar year. Professional Builders Merchant. Retrieved 2022, from https://professionalbuildersmerchant.co.uk/news/uk-merchant-sector-top-20-calendar-year-2020/

Saint-Gobain						Indinature (hemp)

News: Xtratherm to acquire Ballytherm's Ireland and UK operations (23 July 2021)

Ireland: Xtratherm has agreed to acquire Ballytherm's Ireland and UK operations. The businesses include one polyisocyanurate (PIR) insulation plant in Ballyconnell, County Cavan and a new production unit that the company is preparing to open at Ross-on-Wye in the UK. The expansion is intended to expand the operations of Unilin Insulation, the owner of Xtratherm, in the UK and Ireland.

Barry Rafferty, the managing director of Xtratherm, said:

"The acquisition of Ballytherm, along with additional investment in new technologies will allow Xtratherm to deliver on operational excellence, new product innovations and improved service that will contribute towards a stronger and more sustainable future for our employees, customers and the construction sector in the UK and Ireland."

At present Xtratherm operates two foam insulation plants in Ireland and the UK respectively.

4.2 Focus: Attic insulation

4.2.1 Market opportunities: demand estimation

The UK has the least energy efficient housing stock in Europe. The UK's 30 million homes account for 21% of the country's total carbon emissions.[85] More than 80% of the homes that will be occupied by 2050 have already been built and the majority will require upgrades to reach required energy efficiency standards.

The Scaling Up Retrofit 2050 report[86] suggests that 26 million UK properties need to be retrofitted in order to meet the UK's net zero targets. The Green Finance Institute (GFI)[87] suggests the challenge is even tougher, with 29m homes in need of retrofit by 2050 to reach net zero emissions goals – 1 million homes per year.

To meet its climate targets, the UK has an ambition to retrofit all homes to EPC band C standard by 2035.[88] However, only 29% of UK homes today meet this standard, and the Government's current policy approach is not ambitious enough to tackle the remaining 71%. In fact, government-backed energy efficiency improvement schemes have stalled in recent years.

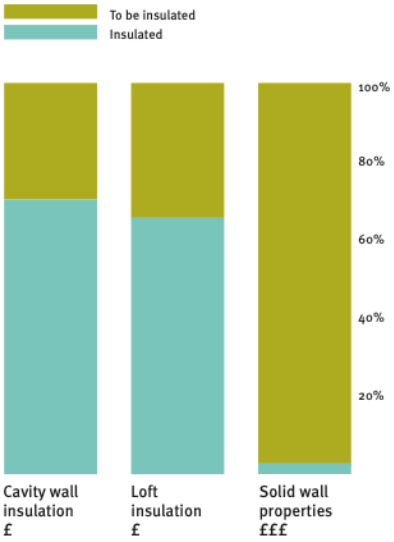
Studies show 60%+ of UK homes have some type of cavity wall or loft insulation. This presents a huge opportunity, and challenge, for the retrofitting of UK homes using natural fibre and recycled fibre (NRFI) insulation, such as those developed during the BIO-CIRC project.

[85] Energy Saving Trust. (2021, November 11). Retrofitting the UK's housing stock to reach net zero. Energy Saving Trust. Retrieved 2022, from https://energysavingtrust.org.uk/retrofitting-the-uks-housing-stock-to-reach-net-zero/

[86] The Institution of Engineering and Technology, & Nottingham Trent University. (n.d.). Scaling Up Retrofit 2050. The IET. Retrieved 2022, from https://www.theiet.org/impact-society/factfiles/built-environment-factfiles/retrofit-2050/?utm_source=redirect&utm_medium=legacyredirects&utm_campaign=2019relaunch

[87] Green Finance Institute. (n.d.). UK retrofit industry must grow 10X to address 23% of UK emissions. Retrieved 2022, from https://www.greenfinanceinstitute.co.uk/news-and-insights/uk-retrofit-industry-must-grow-10x-to-address-23-of-uk-emissions/

[88] Green Alliance (n.d.). Reinventing retrofit. How to scale up home energy efficiency in the UK. Retrieved 2022, from https://green-alliance.org.uk/wp-content/uploads/2021/11/reinventing_retrofit.pdf



An ideal opportunity is attic insulation, with c.30% of attics in need of insulating. If following the GFI's figure of 29 million homes to be insulated, this represents nearly 9 million homes in need of attic insulation.

The current market share for NRFI in the UK is not as significant as in France (c.1%), but it is the fastest growing insulation segment in the UK achieving CAGR of 10-20% for the past 3 years, and its share of the market is expected to grow significantly over the coming years. At its current market share of 1% this represents nearly 100,000 attics within homes to be insulated with NRFI.

If the NRFI market grows as expected over the next 5-10 years, this figure could be nearer 500,000 homes. This is not taking into account the attics that have been poorly insulated over the years and may need to be re-insulated with a better quality of workmanship and higher performing materials, such as NRFI. The actual figure of attics to be insulated could be 50%+, again providing further opportunities for the NRFI market.

In addition, NRFI have a range of advantageous benefits which lend themselves for use in solid wall properties which require a vapour open, breathable building fabric. Only a small percentage of solid wall properties in the UK are insulated.

4.3 Market insights: perceptions, needs and perspective

On Wednesday 27th January 2021, BIOCIRC project partner ASBP, alongside partners Back to Earth and ERI hosted an online roundtable workshop with members of the ASBP Natural Fibre Insulation Group.

The Natural Fibre Insulation Group (NFIG) is a collective of ASBP members who are the leading manufacturers and suppliers of natural fibre insulation in the UK. The purpose of the group is to work collaboratively to better communicate the many benefits of natural insulation products and systems.

The meeting was facilitated by Jon Bootland, Chief Executive of the Sustainable Development Foundation. The questions posed to the workshop attendees were:

- Target markets - What segments do you see the most potential?
- Barriers - What do you think are the main barriers to increased uptake of NFIs?
- Enablers - What are the enablers and how to increase demand?
- Actions – Proposed actions to increase demand.

4.3.1 Target markets - What segments do you see the most potential?

The UK market for insulation can be broken down by:

Number of projects & number of projects per annum

Market analysis 1a - numbers

Sustainable Development Foundation

	Housing					Public Sector Non-dom				Comm-ercial
	Local Authority	RSL	PRS	Owner Occupier	Spec developer	School/ college	University	Health care	Cultural	
Existing stock	1.6M	3M	4.5M	14.3M	n/a	320k (est)	5000 (est)	5000 (est)	???	
New build	2500 pa	27500 pa	?	10k pa	130K pa	300 pa	50	50		
Likely uptake										
Notes										

Market analysis 1a – Numbers per year

Sustainable Development Foundation

	Housing					Public Sector Non-dom				Comm-ercial
	Local Authority	RSL	PRS	Owner Occupier	Spec developer	School/ college	University	Health care	Cultural	
Existing stock (10% pa)	160k	300k	450k	1.4M	n/a	32k (est)	500 (est)	500 (est)	???	
New build	2500 pa	27500 pa	?	10k pa	130K pa	300 pa	50	50		
Likely uptake										
Notes										

Project value by sector and value of insulation on projects.

Market analysis 1b – Project costs by value

Sustainable Development Foundation

	Housing					Public Sector Non-dom				Comm-ercial
	Local Authority	RSL	PRS	Owner Occupier	Spec developer	School/ college	University	Health care	Cultural	
Existing stock (10% pa)	£1.6Bn	£3.Bn	£4.5Bn	£14Bn	n/a	??	??	??	???	
New build	£250M pa	£2.75 Bn pa	?	£100M pa	£13Bn pa	£2Bn pa	£1Bn	£1Bn		
Likely uptake										
Notes										

Assumptions: £10,000 per dwelling for retrofit costs; 10% of stock every year
£100,000 per dwelling for newbuild costs; £6.6M per school; £20M per university/ healthcare building

Market analysis 1c – Insulation value

Sustainable Development Foundation

	Housing					Public Sector Non-dom				Comm-ercial
	Local Authority	RSL	PRS	Owner Occupier	Spec developer	School/ college	University	Health care	Cultural	
Existing stock (10% pa)	£160M pa	£300 Mpa	£450 Mpa	£1.4Bn pa	n/a	??	??	??	???	
New build	£25M pa	£275 Mpa	?	£100M pa	£1.30Bn pa	£200M	£100M	£100M		
Likely uptake										
Notes										

Assumptions: £1000 per dwelling for retrofit insulation; 10% of stock every year
£10,000 per dwelling for newbuild insulation

These show that the overall market for insulation in the UK is approx. £4bn and that the largest markets are owner occupier for retrofit and private/spec developer for new build.

4.3.1.1 Workshop attendee comments

There was some discussion around the proposed market segmentation; many of the group felt that this might not be that useful, as they often simply aimed to increase their sales through existing customers and channels, for example through "route to market" exercises and often do not have much information on where their sales finally end up.

There were also several comments about natural fibres having such a small share of the market that even a 10% increase year on year would not make a noticeable dent in the overall market. It was therefore suggested that it might be more useful to look at specific sectors and building types where natural fibres have an in-built advantage and focus on those instead. This led to the next exercise.

4.3.1.2 Assessing the likely uptake of different groups

The following views were gathered around the different sectors:

Market analysis 1d – Likely uptake

Sustainable Development Foundation

	Housing					Public Sector Non-dom				
	Local Authority	RSL	PRS	Owner Occupier	Small to medium developer	School/ college	University	Health care	Cultural	
Interest/ Likely uptake	High/ Low	High/ Low	Low	High Among Eco	Low except Eco					
Notes	Fire is a barrier Need to regulate? Embodied carbon moisture & health drivers	Fire is a barrier Need to regulate?	Don't care	High amount of 1-2-1 support needed Price focussed	Price focussed Some – lifestyle focus					

Effectively, the conclusions were:

1. Large-scale/major housebuilders and the Private Rental Sector (PRS) are not interested in natural fibre insulation (NFI).
2. Eco-specialists among the small to medium developers are interested.
3. The eco-conscious self-build (new build) / owner occupier (retrofit) markets are also interested, but need a lot of technical advice/ support, which is time-consuming as it needs to be on a 1-2-1 basis.
4. Social housing providers (local authorities and housing associations) should be interested but often do not adopt NFI, particularly because of fire risk concerns.

4.3.1.3 Most likely target markets

- Local Authorities and Housing Associations
- Eco/small developers if promoting associated lifestyle, health + wellbeing benefits

4.3.2 Barriers - What do you think are the main barriers to increased uptake of NFIs?

There was a short discussion about the main barriers to increased uptake of NFIs, and a poll was held to identify the most significant of those:

The top-ranking results were:

1. Current practice/culture (lack of education and understanding and awareness raising) – 55%
2. Fire concerns – 55%
3. Clients seeking low-cost approach/cheapest products – 45%

There was also some subsequent discussion about supply-side questions:

4. There is currently over-demand, the market is over-heating, and the supply chain has not yet expanded to increase supply.
5. The Natural Fibre section of the market needs to develop simple systems that are as easy to instal as standard market offerings, and then provide the training/ tech support needed to help building clients use these systems. Who would provide the investment to deliver this?

And finally, comments were raised about a specific current barrier:

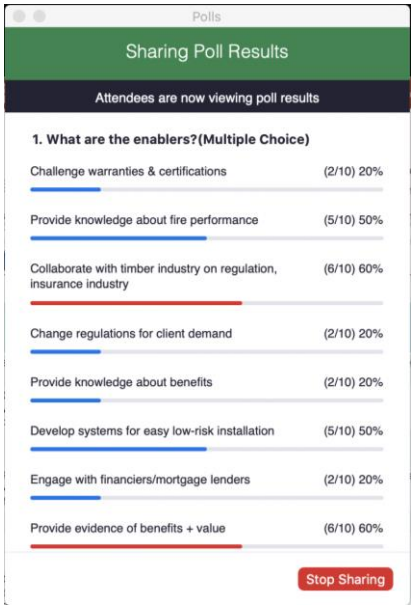
6. the requirement for 25-year guarantees on Green Home Grants projects.

4.3.3 Enablers - What are the enablers and how to increase demand?

The group then discussed potential enablers that could address two challenges:

1. To increase the demand/ uptake among the chosen key potential markets
2. To overcome the barriers that prevent such uptake at the moment

A poll was then held to identify the most significant of those enablers:



The top-ranking results from this survey were:

1. Collaborate with timber industry (and others?) to influence regs, educate insurers and provide knowledge, particularly about fire performance
2. Provide robust evidence on benefits and value of NFIs.
3. Develop systems for easy, low-risk installation.

4.3.4 Actions to increase demand

Problem/barrier	Action
1. Current practice/culture (lack of education/ understanding)	Awareness raising campaign, including robust evidence on performance of NFIs: a. Promote exemplar projects e.g. Makar, Goldsmith Street (esp. using architects to promote) b. Find 10 social housing clients/ architects who might be willing to adopt NFIs c. Topic-based sessions (e.g. moisture, IAQ) to develop arguments/ outputs/ marketing materials
2. Fire concerns	Collaborate with timber industry (and others) to influence regs, educate insurers and provide knowledge, particularly about fire performance
3. Clients seeking low-cost approach/cheapest products	Not discussed
4. There is currently over-demand, the market is over-heating, and the supply chain has not yet expanded to increase supply.	Who would provide the investment to deliver this? Seek Government support/ funding linked to Social Housing Decarbonisation Fund? Note that Mark commented on this in the ASBP Environment Audit Committee response.
5. Develop simple systems that are as easy to instal as standard market offerings, and then provide the training/ tech support needed to help building clients use these systems.	Who would provide the investment to deliver this? Seek Government support/ funding?
6. The requirement for 25-year guarantees on Green Home Grants projects.	Join forces with other organisations to influence regs & requirements for GHGs

4.3.5 Additional workshop notes

1. Timber frame is a particularly useful market but needs to move away from the traditional 140mm CLS studs, as U value targets cannot be met on a section for section switch from PIR/PUR to naturals.
2. Lack of recognition for sequestered carbon is a barrier. Woodknowledge Wales are piloting the carbon storage contract with housing associations in Wales. More information can be found here - which includes an estimation of value to help with your maths https://woodknowledge.wales/wkw-resource/carbon-storage-contract.
3. Awareness-raising should include education & training for installers & specifiers.
4. It is beneficial to target a vertically integrated market i.e. clients with multiple properties.
5. The ASBP is involved in a Laudes Foundation funded project aiming to counter the fire arguments that are currently curtailing the use of structural timber, which could help enable collaboration with the timber industry on this - https://asbp.org.uk/asbp-news/job-tah.
6. Working with others to influence regulations etc should include lobbying the new products regulator.
7. Access to social housing clients could be facilitated through the Good Homes Alliance, which has a network of nearly 20 forward-thinking LAs, set to build 50,000+ net zero homes over the coming years. We could arrange a workshop with them - they would be interested to hear about NFIs - https://goodhomes.org.uk/vanguard-network.
8. Similarly, Wood Knowledge Wales has a cluster of Welsh social housing clients, and NFIG have organised training with them in the past: https://woodknowledge.wales/events/insulating-with-wood.

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BIO-CIRC Project

European Regional Development Fund

The BIO-CIRC project is part of the cross-border European Territorial Cooperation (ETC) Programme Interreg VA France (Channel) England and benefits from financial support from the European Regional Development Fund