FIW München

Forschungsinstitut für Wärmeschutz e.V. München

Annual Report 2021

Table of contents

1 Editorial

„Efficiency First“

We are once again living in extremely challenging times. We can only hope that the guns will soon fall silent and that a path towards peaceful coexistence will be found before too long. We feel for all the people and refugees who are suffering the consequences of this situation and are trying to do our part, however small, to alleviate the hardship.

The conflict in Eastern Europe is not only a wake-up call for security and foreign policy, but equally for German energy and climate policy. It has become extremely important to establish or secure a sustainable and climate-friendly energy supply at affordable prices as components of a socio-ecological market economy, and to reduce dependencies at the same time. They must continue to be an important part of future political efforts.

Let us rise to this challenge of making our contribution to saving energy and using it more efficiently in the major consumption sectors of industry, transport and buildings so that the ambitious but vital climate protection targets can be achieved. This is what future efforts need to be geared towards. “Efficiency first” is still the order of the day, and it has never been more relevant. With this approach, we are significantly increasing the range of possibilities for how rapid energy sovereignty can be achieved.

We pointed out in numerous publications at an early stage the adjustments that would be necessary, especially in the building sector, as a result of an increase in the renovation rate, renovation procedures and regulatory possibilities (normative requirements and funding possibilities).

In this respect, it is also our goal to make our building stock carbon-neutral as quickly as possible. Now more than ever, we hope that political actors and all the other stakeholders involved will incorporate an understanding of energy efficiency into decision-making processes and take the proposed measures into account. It is important to make sensible use of the lower energy capacities available and to avoid further restrictions.

We will work with optimism and scientific support to ensure that the political measures aimed at implementing the necessary and agreed change in Germany and Europe towards greater efficiency efforts are carried out, and that the quality of the building products used continues to meet the highest standards. This is what has motivated us to fulfil our statutory mission since 1918.

Klaus-W. Körner
Chairman of the Board
FIW München

Prof. Dr.-Ing. Andreas H. Holm
Managing Director
Head of the Institute

2 FIW München at a glance

The structure of FIW München

As a key driver of innovation, FIW München has taken a leading role in the new and further development of methods in the field of energy efficiency for buildings and industrial applications. The directly charitable purpose of the registered association is centered on the development of new technologies, procedures, applications and services. This aim laid down in the statute is achieved by the following in particular:

- Research into the laws on heat and material transfers, in particular the scientific principles of thermal insulation.
- Disseminating this knowledge
- Thermotechnical testing of construction and thermal insulation materials and the constructions made from them
- Cooperation with heat conservation associations, technical associations and scientific institutes

Director of the institute:

Prof. Dr.-Ing. Andreas H. Holm

Insulation materials in the construction industry

Claus Karrer

Test body

Stephan Guess

Technical insulation

Roland Schreiner

Research and development

Christoph Sprengard

Certification

Insulation materials in the construction industry

Dr. rer. nat. Andreas Schmeller

Technical insulation

Ralph Alberti

Services

EDP | Equipment manufacturing | Quality management | Administration

Within the testing and surveillance body, which complies with State Building Code, Stephan Guess is the head of the testing body and Stefan Kutschera is responsible for the surveillance body. The deputy for both positions is Roland Schreiner.

The employees of the certification, surveillance and testing body are professionally exempt from the requirement to comply with instructions issued by the institute's management within the scope of their activities according to the State Building Code and the EU Construction Products Regulation.

Core competencies and business areas

The structure and organisation of FIW München is based on both the business areas and the classical core competencies. These comprise, amongst other things, laboratory testing, open-air testing, the development of measurement equipment, in-situ demonstrations, studies, further education and standardisation.

Testing, surveillance, certification	Research and development	Transfer of knowledge and technology
Comprehensive assessment of the building envelope	Principles of thermal insulation, moisture protection and construction chemistry	National and international standards
In all aspects of thermal insulation moisture protection fire protection stability material composition	Testing of technologies and new materials to improve energy efficiency	Member of various expert committees
	Impact of influencing variables	Publications and presentations
	Durability of materials and systems	Completion of training courses and symposia
	Initial research into construction materials and the development of construction systems	Development of measurement and testing equipment
Development of testing standards, material standards, guidelines and worksheets	Energetic optimisation of the entire construction system	

Construction industry

Thermal insulation products for building equipment and industrial installations

Transport and logistics

Financial and personnel development

FIW München generated earnings of €8.7 million (7.6 million in the previous year) in the 2021 financial year.

R&D will contribute slightly more than one million euros (0.9 million euros in the previous year) to the institute's overall positive result in 2021. Its services were expanded in order to support our customers even more effectively and at short notice, in addition to our usual services (development and improvement of insulation and building materials as well as component and insulation designs), with model calculations, special tests and questions concerning the energy efficiency of buildings and systems, as well as with studies and calculations on energy savings in existing buildings, on the sustainability of materials and building designs, on the problem of "grey energy" and the current issue of circular economies.

Turnover for voluntary monitoring systems increased as a result of growing appreciation among manufacturers and (end) consumers regarding the quality assurance of using high-quality products. The Certification, Testing and Monitoring and Research and Development segments have undergone adjustments to facilitate the increasing product diversity of the insulation materials and insulation systems requiring testing. Our activities in 2021 focused on the expansion of laboratory capacities to meet demand and the further development of test methods for thermal insulation materials. For example, almost 200 new test stations were set up to measure long-term creep behaviour. In order to be able to continue to provide you with the same quality of service in the future and to shorten the throughput time of your products in our company, we have increased the number of staff we employ and will more than compensate for the (age-related) departures in terms of capacity in 2022.

Planning has begun for the short- and medium-term use of the adjoining property at Am Kirchenhölzl 5 in conjunction with possible densification measures on the site used before 2020.

The loyalty of our employees and therefore the retention of their skills and experience are both a great accolade to the employer and a high standard, and make a significant contribution to the success of the Institute.

We celebrated work anniversaries with these colleagues during the past (pandemic-affected) fiscal year:

Work anniversaries

10 year anniversaries
Lothar Boyer
Andreas Holm
Stefan Kutschera
Karin Wiesemeyer

15 year anniversaries
Jörn Michael von Hohenthal

20 year anniversaries
Christoph Sprengard

25 year anniversaries
Christian Rank
Uwe Glöß

30 year anniversaries
Astrid Fischer

35 year anniversaries
Roland Schreiner

40 year anniversaries
Sonja Preußer

Boards and committees

Networks, cooperations and committees

The success and quality of projects hinges on contributions from a large network and innovative partners. FIW München is therefore integrated into a network of national and international cooperations and is a member of several associations.

It also strives to accelerate and take an active role in shaping required changes in the field of standardisation to ensure that results are scientifically substantiated but nevertheless remain practically orientated and implementable.
This work often leads to high expenditures and typically constitutes a long-term commitment. Despite certain difficulties relating to financing, FIW München remains committed to its goal to continue to actively support standardisation work in the areas key to its customers.

Memberships of FIW München

You can find an up-to-date list of FIW München's memberships at:

https://fiw-muenchen.de/en/network-partners

An institutional link is maintained with the Munich University of Applied Sciences, where the director of the institute, Prof. Andreas H. Holm teaches.

FIW München is also engaged in a number of additional project-related cooperation and framework agreements, especially in the field of research and development, which are subject to confidentiality.

National and international bodies and committees

FIW München's employees contribute their knowledge to the various expert committees, to the industry's expert committees and to national and international standardisation committees.

For a detailed list of FIW München's current engagements, please visit:

https://fiw-muenchen.de/en/standardisation

3 Day-to-day life at the Institute

Working under pandemic conditions

The second year of the coronavirus pandemic also meant significant changes to daily work routines with its distancing, masking and disinfection rules. Measures to increase flexibility that were introduced by the Institute's management in 2020 (abolition of core and flexitime, modification of office occupancy, promotion of home working, reduction in the number of business trips) as well as raising awareness of possible means of infection, strengthening protective and hygiene measures at the Institute and voluntary on-site tests have achieved their goals: face-to-face contact was reduced to a minimum and not a single colleague tested positive for COVID-19. In the post-coronavirus era, we will maintain or expand the best measures for managing occupancy at the Institute and for working remotely, for the benefit of all.

Coronavirus vaccinations at the Institute

At FIW München, we set up a vaccination service on our own premises at a very early stage that was rolled out at speed and with minimal barriers to access, which was gratefully embraced by well over half of the workforce. Our safety officer Wolfgang Moosburger, who also heads the Coronavirus Task Force at the Institute, worked with our company doctor Dr Willerding to organise the improvised vaccination site, even allowing access for relatives of FIW employees. Even when the vaccine was still a rare commodity and getting a vaccination appointment was like a lottery, immunisation was diligently carried out at FIW München.

It was a resounding success: in addition to the general safety precautions and regular reminders issued by Wolfgang Moosburger about the necessary distancing and hygiene rules, the early delivery of vaccinations certainly contributed to the fact that no staff member at the Institute was infected with COVID-19 in 2021.

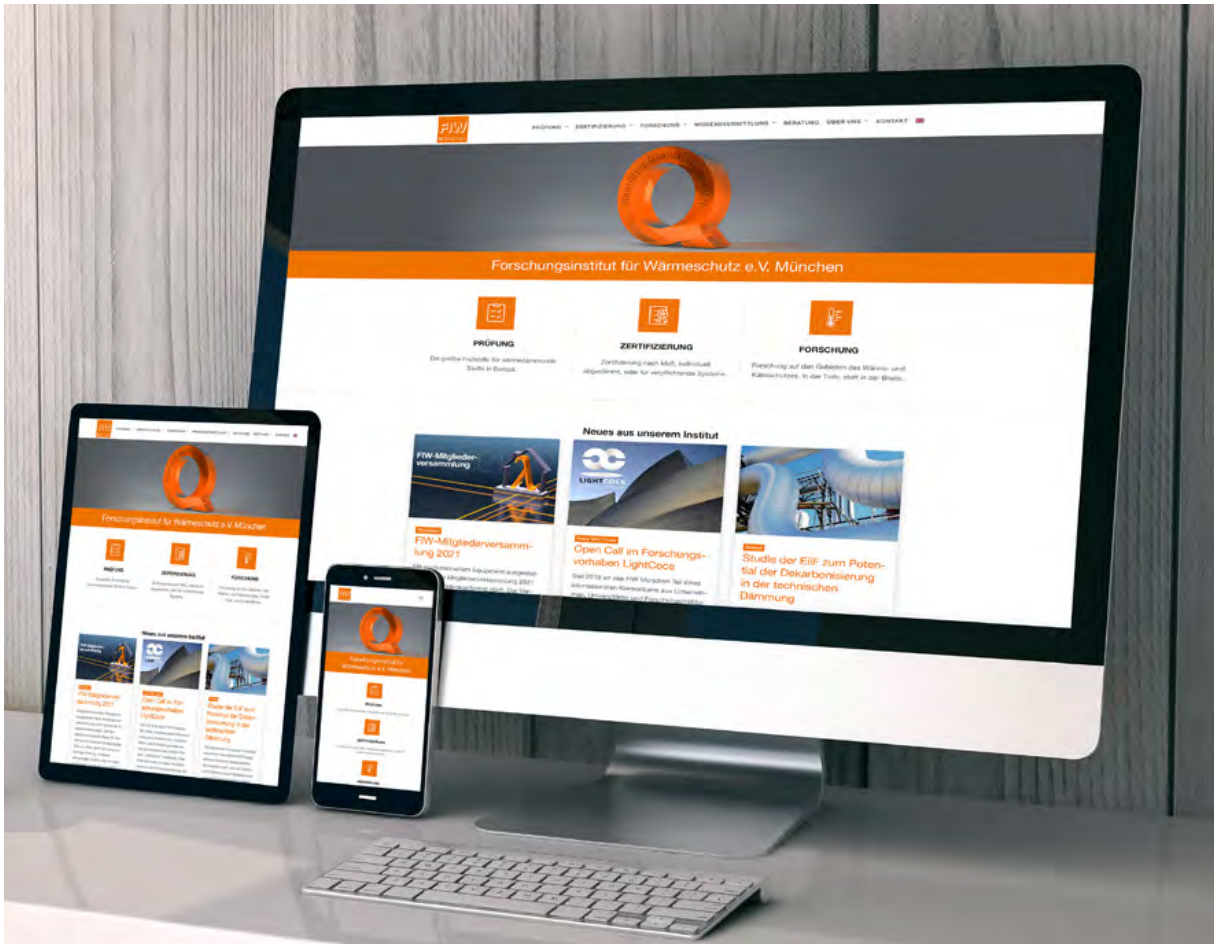
New web presence

FIW München has had a new online design since mid-2021. The content of www.fiw-muenchen.de is now easily readable on any device (smartphone, tablet, PC). We have also added a lot of content that was missing on our previous site, such as the list of all the valid certificates issued by FIW München, or the contact person in charge of the respective topic or research project.

The new design creates more clarity, meaning the desired information can be found more easily and quickly. Later this year, another project will involve adding a sophisticated search function that will allow users to find what they are looking for by keyword.

We hope you like the layout and content as much as we do, and would be delighted to receive your feedback at info@fiw-muenchen.de.

We have also set ourselves the goal of further standardising our print products in 2022 and adapting them to the new layout, which has already been introduced in the annual report.



QR code now on certificates

FIW München now uses QR codes, which are attached to the specimen, to identify the specimen with certainty and to assign it to individual measurement results. This code contains, among other things, a unique identifier under which FIW München's integrated electronic laboratory information system (LIMS) stores all the associated measurement results.

To ensure that all the various elements work together and that the goal of continuous electronic traceability that is available at all times is achieved, the unique and machine-readable codes can also be found on more and more printed materials from FIW München, e.g. the test reports. As the last document to be issued in terms of process technology, the QR code has also been included on most certificates issued by FIW München since 2021.

Our customers also help to keep the processes lean by attaching the advice note with the code sent by the engineer to the outside of their material deliveries, so that the goods can be assigned to the corresponding process easily, quickly and accurately as soon as they are received.

Laboratory work and everyday life at the Institute under heightened safety measures

Thanks to timely and prudent preventive measures, we were not in a state of shock at any time. While many colleagues largely shifted from working in the office to working from home and communicating by video call, our colleagues in the laboratories and workshops and those in administrative roles continued to rely on their workplace at the Institute for the most part.

Meeting rooms and social spaces were kept as workstations, while a number of offices were used on a rotation basis due to the requirement for single-person occupancy. Each and every individual was challenged by the need to wear the correct type of mask at all times, the additional hygiene measures, the need to stay up-to-date with the latest behavioural guidelines and particularly by how to communicate with colleagues about a shared project or piece of work. These additional challenges of working in a laboratory with distancing were nevertheless overcome with flying colours.

Personal interaction did not fall by the wayside

Things were the same for us professionally as they were in our private lives. Almost all of our events fell victim to the pandemic, starting with the members' meeting and our much-loved research day, to institute-wide events such as a company outing, a visit to the Oktoberfest and a Christmas party, to joint events in smaller groups such as the B2Run company run, the weekly exertive Institute Sports Group or the monthly culinary feast organised by the cooking group. They were all postponed initially and eventually cancelled completely.

A certain degree of routine returned in the second year of the pandemic: the Institute's management has been meeting online with the engineers every two weeks since 2020, and the management team also still convenes in video conferences. Numerous FIW colleagues meet online for a coffee and a chat or for private game evenings and in doing so contribute to a sense of cohesion at the Institute. There is a continued sense of hope for a return to more carefree times in the daily interactions that take place in the corridors of the Institute. A smile is still visible even underneath a mask.

We can look back with great satisfaction and look to the future with hope. We are confident that we will be able to return to some much-loved routines after all the sacrifices we have made and even host one or two fantastic DISTANCED events.

Viruses have no idea how contagious gratitude can be. But we do. We would like to take this opportunity to thank all our colleagues and customers alike for their valued relationship with FIW München!

Farewell to Wolfgang Albrecht

Due to the low threat level in summer 2021 and the easing of the ban on gatherings, we decided to organise a small get-together on the Institute's outdoor area. After all, as Wilhelm von Humboldt said: “Fundamentally, it is always the connections with other people that give life its value.” Alongside the desire finally to see and talk to each other again in a larger group, the main focus was on bidding farewell to Wolfgang Albrecht.

After studying Engineering Physics at university, Wolfgang Albrecht began his career at FIW München on 1st July 1981. After that, his career went from strength to strength. Head Department of Insulation Materials in Building Construction, Head of the Certification Body and Deputy Managing Director are just a few of the positions he has held during his FIW career. Besides this, he was involved in numerous standardisation bodies and committees, wrote expert opinions in court disputes, and, especially in the early days, was very active in the field of measurement and control technology, as well as carrying out several research projects from start to finish, e.g. on creep tests, inverted roofs and perimeter insulation. Mr. Albrecht was a co-contributer in shaping the orientation of the Institute, a co-sufferer when external monitoring pursuant to LBO was abolished, and a co-inventor of the Q mark.

On “his” day, Mr. Albrecht was able to tell of many a highlight from his career at the Institute. Initially, for example, he was busy improving the safety of the installations (transformers and slide resistors were replaced by power supply units) and digitising the measurement recording system.

In the early 1990s, the hole in the earth's ozone layer and the increasing UV load on the earth's surface were major political issues. One of the causes behind the decline of ozone in the atmosphere was CFC blowing agents, which were also used to produce some insulation materials at the time. The pressure on the producers of these foam plastics to switch to more environmentally friendly blowing agents was therefore considerable. At that time, FIW München was one of the first institutes in Europe to detect these blowing agents in foams. FIW München worked with DIBt and the manufacturers to develop test plans and verification methods for predicting the long-term thermal conductivity of these materials over 25 to 30 years. During the hectic phase of the transition to new blowing agents, the development was so turbulent that a new generation of insulation material with a new blowing agent was introduced at visit to remove the old material. FIW München already had a distinguished reputation over and beyond the industry at that time. As a result, Mr Albrecht was invited to co-author the submission for the then Bavarian Minister-President Edmund Stoiber on the status of the transition to CFC-free blowing agents. Ultimately, the changeover to new, eco-friendly blowing agents was achieved through combined efforts and in conjunction with the manufacturers and the Planning Inspectorate. The phase-out of CFCs is still considered to be one of the success stories of groundbreaking environmental legislation.

In about 2002 to 2003, there were signs that a major transition for all thermal insulation materials was in the offing. Until then, third-party monitoring was required in Germany in accordance with regional building regulations. The market was deregulated with the introduction of European Product Standards, which aimed to remove barriers to trade and allow manufacturers to declare the performance of their product autonomously. However, just like today, manufacturers needed an initial test to be conducted by independent institutes such as FIW München in order to be able to submit their product declaration in a proper manner. To begin with, even the Planning Inspectorate did not trust the manufacturers' declarations and reacted with approvals intended to improve the European standards and thereby give them a retrospective legal framework.

The ECJ ruling in 2014 set in motion an accelerated process, at the end of which a raft of voluntary certification schemes emerged that demonstrate the quality of thermal insulation materials on the basis of voluntary contracts. Here, too, Mr Albrecht and other FIW München comrades-in-arms promoted the rapid transition to new, voluntary certification programmes, thereby increasing the confidence of planners, craftspeople, contractors, authorities and end customers in the performance and quality of thermal insulation materials.

Professor Holm thanked Mr Albrecht for his many years of service to the benefit of FIW München, wished him all the best for his retirement and was pleased that Mr Albrecht would continue to be available to FIW München, albeit on a much more limited scale.

Thermal Conductivity Team with Mrs Ortner, Mrs Bergler, Mr Gießler and Mr Künzl

Absolute confidence: Lecture on 23.05.2019

B2Run: Top athletic performances at the company run

'Servus': summer tobogganing at the FIW München company outing

4 Testing and surveillance

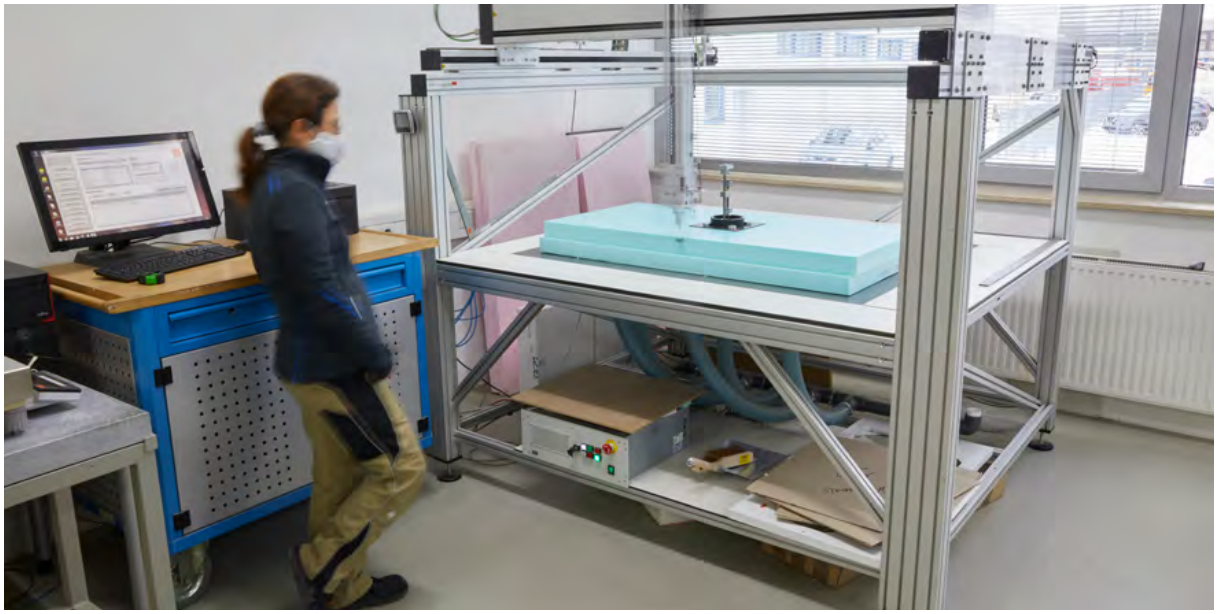
Testing and certification bodies share monitoring tasks

Only a limited number of thermal insulation materials without a European product standard or European Technical Assessment (ETA) will be subject to the separation of tasks stipulated by the State Building Code (LBO) into a testing body responsible for conducting product tests, a monitoring body responsible for audits and withdrawals in the manufacturing plant and a certification body responsible for assessing test and audit results and issuing certificates of conformity.

The conformity assessment of construction materials pursuant to the European Construction Products Regulation (EU-CPR) does not require the existence a monitoring body. All conformity tasks are carried out by a certification body and a testing body, whereby the responsibilities of the national testing body such as conducting audits of manufacturing plants and collecting product samples are assigned to the certification body. The latter furthermore reserves the right to assign a certain number of tasks to other bodies such as the testing body.

As a result, employees from the testing body responsible for supervising insulation material manufacturers often work independently in the same manufacturing plant on the same insulation material both acting as employees of the testing body pursuant to the LBO and on behalf of the certification body according to EU-CPR. On the other hand, according to the CPR, employees from the certification body are also permitted to assume the tasks of the testing body at the manufacturing plant pursuant to the State Building Code. They nonetheless remain the competent contact persons for all questions related to quality assurance and proof of conformity of thermal insulation materials on a national or European basis. This is particularly relevant since, following the ECJ ruling in Case C-100/13, thermal insulation materials subject to European regulatory framework can no longer be regulated at national level, contributing to the importance of testing and, if necessary, certification by a European notified body.

However, the senior building authorities of all federal states have issued decrees on the enforcement of the CPR permitting the continued use of general building authority approvals, provided that their ancillary conditions, i.e. compliance with self-monitoring and external monitoring by a monitoring body recognised pursuant to the LBO, are fulfilled. As a consequence there will continue to be overlaps between the tasks of the monitoring body pursuant to the LBO and the notified certification body.



Testing and trial facilities for existing buildings

FIW München is recognised and accredited as a testing laboratory pursuant to EN ISO/IEC 17025 on a national (testing, monitoring and certification body) and European (notified body) level. Its special expertise is further exhibited by its leading cooperation in the “Lambda Expert Group” for the voluntary European certification scheme CEN KEYMARK, whereby laboratories registered to determine the thermal conductivity of thermal insulations materials audit each other’s work and confirm measuring precision through interlaboratory testing. The laboratory group also additionally focuses on determining the upper application limit temperature and water-soluble chlorides in the field of technical insulation materials. We are notably proud of our discovery of a comparative insulation material (expanded glass granulate) that ensures the required European level of thermal conductivity at higher temperatures.

The energy efficiency of buildings and technical installations is, to a certain extent, contingent on the testing of materials, certification and quality assurance. In addition to our research and development work, we operate test laboratories to the highest quality standards and have gained decades of experience and a high reputation. We operate state-of-the-art testing facilities and employ a wide range of analysis techniques. Due to the increased demand for corresponding testing, our test laboratory is continuously experiencing growth in terms of both equipment and personnel. At present, the largest test body for thermal insulation materials in Europe has the following test facilities.

Testing and trial facilities for insulation materials in building construction and in technical insulation

You can find an up-to-date overview of our testing facilities on our homepage at:

https://fiw-muenchen.de/en/construction-industry

Testing and trial facilities for insulation materials in technical applications

You can find an up-to-date overview of our testing facilities on our homepage at:

https://fiw-muenchen.de/en/technical-insulation

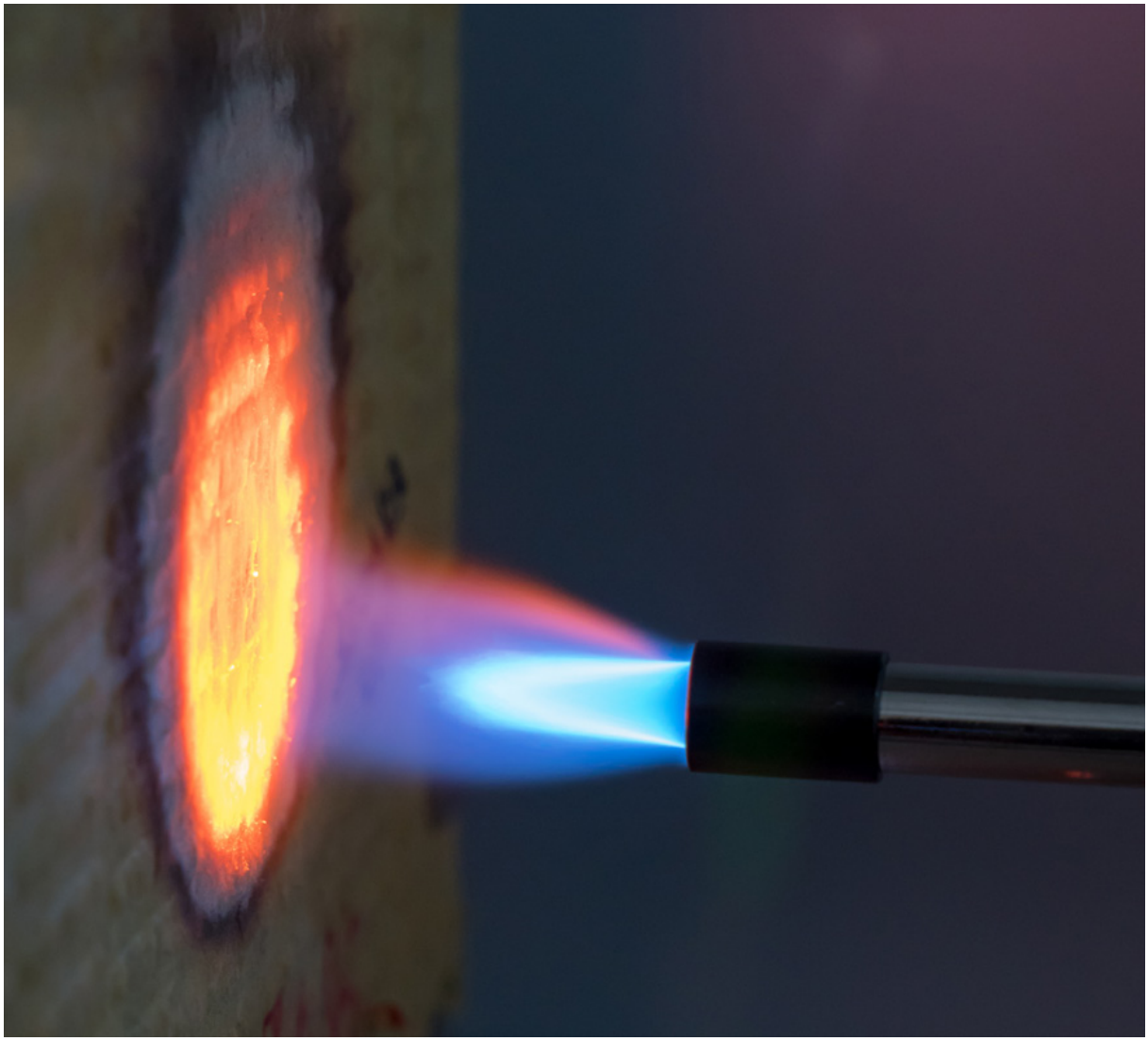
What's new in testing

Successful participation in the co-operative test “Determining the heat of combustion in line with EN ISO 1716”

FIW München participates in various co-operative tests every year. This method of external quality assurance for measurement procedures is an important element for comparing the results and assessing the measurement quality of the participating institutes.

Following the successful introduction of various fire test methods in recent years, we participated in a co-operative test in 2021 to validate the test method in line with DIN EN ISO 1716. The 10 participants were provided with a sample of rock wool, from which 3 test samples were prepared.

Our colleagues were able to demonstrate their expertise and practical experience in identifying the heat of combustion, which was rewarded with the best possible result – the Certificate of Excellence 2021.



New EU reference material for determining thermal conductivity

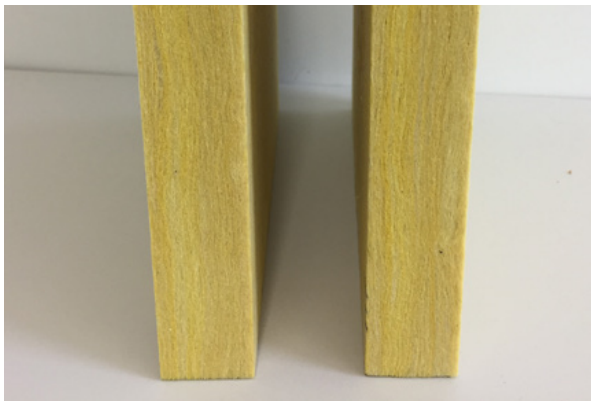
IRMM-440, the previous reference material for thermal conductivity, has guided us for many years and has even made it into the European conformity standard EN 13172 as a binding reference value. More than 20 years ago, this homogeneous batch of a fibreglass sheet was provided by the European Commission's (EC) "Unit Reference Materials". This batch is now almost exhausted.

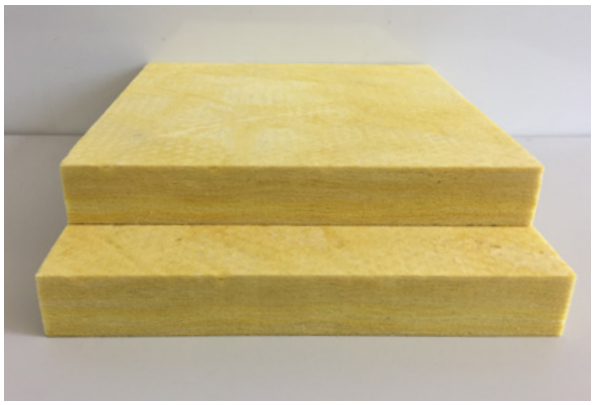
The 32 mm thickness of the IRMM-440, which is not representative for thermal insulation materials, was always bemoaned. The EC research centre therefore attempted to create new reference samples with a thickness of 70 mm, but this failed at the sample preparation stage. A sanded, resin-bonded fibreglass board with a high bulk density and a thickness of 28 mm was again selected for the new ERM-FC440 and a production batch of 300 m² was tested for homogeneity.

Five reputable test centres within the Keymark expert group for thermal insulation materials, including FIW München, were tasked with determining the thermal conductivity with the highest possible precision. The readings taken by the laboratories showed excellent consistency at 10 °C mean temperature and very good consistency in the range from 0 °C to +70 °C. Only three test centres were able to cover the temperature range from -150 °C to 0 °C.

The commercial reference samples will again be accompanied by a certificate showing the thermal conductivity in the temperature range from -10 °C to +70 °C, for which the thermal conductivity of relevance to insulation materials for buildings at 10 °C will again be around 0.032 W/(m·K). The thermal conductivity in the low-temperature range down to -150 °C is provided for the purpose of information.

Although the ERM-FC440 reference samples will soon be available from the European Commission's Joint Research Centre (JRC) in Geel, Belgium, existing IRMM plates may of course continue to be used. FIW München offers comparative samples for other ranges of thermal conductivity and nominal thickness, which were tested using our IRMM-440-calibrated instruments and can therefore be referred back to IRMM-440 (a requirement of EN 13172 Section 5).





ERM-FC440 (photo left and right): the new reference fibre at FIW München replaces the previous IRMM-440

Long-term creep behaviour under combined compressive and shear stress

Starting position

Extruded polystyrene rigid foam (XPS) and cellular glass are used as load-bearing thermal insulation due to their exceptional properties. This type of thermal insulation is often used under slab-on-grade building foundations where high compressive stresses occur over very long periods of time (usually more than 50 years). The long-term behaviour of the hard and brittle foam glass is well-established thanks to many years of experience in using it. With viscoplastic XPS, there is an increasing need for validating tests owing to new developments (multi-layer installation, new flame retardants, new blowing agents and multi-layer welded or bonded boards). The long-term creep behaviour is regularly analysed in order to avoid potentially hazardous subsidence.
In addition to the established test method for long-term creep behaviour under compressive stress, there is also the horizontal shear direction, which is particularly important for large thicknesses and panels laid in several layers or welded together. In 2005, Dr Nabil A. Fouad - a Professor of Engineering at Gottfried Wilhelm Leibniz University - investigated the differences in the creep behaviour of load-bearing XPS thermal insulation boards when pure shear stress and combined compression-shear stress conditions were applied, and developed a new test rig especially for this purpose. The test results showed a correlation between the creep strain behaviour on the compressive stress and in particular the amount of time in combined stress conditions.

Adopted testing device for determining long-term creep behaviour with shear effect and new FIW measuring technique

The requirements for such a test are listed in the latest applicable DIN EN 1606:2013-05 and by application in several ETA (e.g. EAD 040650-00-1201) and include, in addition to the aforementioned test, several preliminary tests, which FIW München also covers. Measurements taken using these documents constitute the basis for evaluation by approval, licensing and assessment bodies such as the Deutsches Institut für Bautechnik (DIBt).

Operation at FIW München

FIW München started operating its first test benches for combined compressive and shear stress in 2021 and carried out comparative measurements in collaboration with Leibniz University in Hanover. We expect to be able to offer approval tests for our customers at the institute from the second half of 2022. In the meantime, much experimentation has been done on a new type of device that is expected to complement the current testing landscape from 2023 onwards. In addition to being easier to operate, key features include higher precision and significantly greater forces that can be applied to the specimen.

With FIW München, a second strong provider will soon be on the market to meet the increasing demand in the coming years.

Three-layer prototype developed by FIW München for heavier loads

Expansion of testing capacities

Long-term creep behaviour

When it comes to the number of test stations at FIW München, the testing of long-term creep behaviour has no rival. This is because in order to increase the energy efficiency of buildings, in addition to the thermal insulation of the elements exposed to outside air, the building envelope adjacent to the ground is also insulated with low thermal bridging. Usually, a full-surface arrangement of load-bearing thermal insulation of greater thickness is installed under the foundation slabs for this purpose. In addition to the requirements with respect to minimising heat transfer coefficients, protecting the waterproofing and condensation prevention of the building components and stability-related requirements – especially with respect to the long-term load-bearing behaviour of the thermal insulation boards – are of primary importance.

The first 84 test stations were installed in the year 2000 and the specimens were tested pursuant to DIN EN 1606. Over time, the discipline developed into a success story at FIW München, and not only because of the steadily increasing customer demand. At the Institute, we were able to make a decisive contribution to the approval of new material mixes and greater insulation thicknesses by the Deutsches Institut für Bautechnik (DIBt) with several research projects and by working with other testing facilities and universities to develop test methods and assessment criteria.

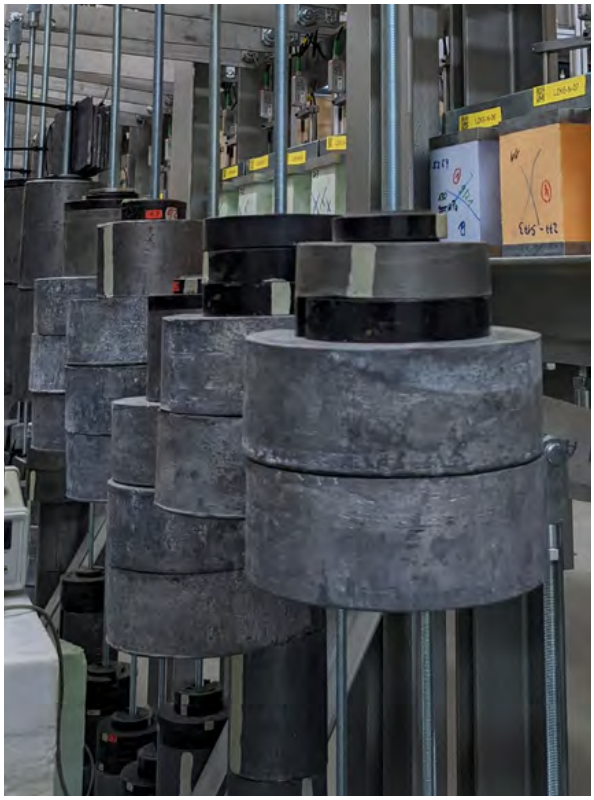
While initially only rigid polystyrene foam boards with thermal insulation thicknesses of up to 120 mm were used, thermal insulation layers made of expanded polystyrene or extruded polystyrene with significantly thicker thermal insulation layers, some with multiple layers, are now in use. In 2013, FIW München published its most recent report on the analysis of the long-term creep behaviour of XPS insulation materials under compressive stress in conformity with DIN EN 1606 (http://www.irbnet.de/daten/rswb/14019007525.pdf).

Since then, further investments have been made in building up the testing capacity. In 2021, the largest expansion to date took place: a large basement section of the building that was acquired in 2009 was modified for use as a laboratory by installing an air conditioning system with a humidification/dehumidification unit. The acquired test stands were equipped with up-to-date measurement acquisition technology, and the ongoing monitoring and evaluation of measurement results was simplified. Plans are in place to revise the reporting system in 2022.

Year	2000	2003	2006	2007	2009	2015	2017	2021
Number of new test stations	84	12	66	126	12	180	24	180

Table 1: Expansion of the test stations in order to measure long-term creep behaviour in a particular year

Determining long-term creep behaviour, new test stands with variable sample size



Long-term creep: in some cases large weights on the lever to simulate the substantial load of a building

Diffusion and freeze-thaw cycles

In addition to the increased demand, the ever greater thicknesses of insulation materials that has previously been mentioned are causing testing capacities with regard to diffusion and freeze-thaw cycling to dwindle. Where there used to be room for 2 test specimens, today there is sometimes only one with a thickness of up to 300 mm.

Even though planning and execution were started some time ago, we had to learn to accept delays due to the dreaded coronavirus-induced delivery bottlenecks. However, the new testing equipment was finally installed at the end of 2021.

In the first half of 2022, corresponding comparative tests will be carried out and the equipment will be tested for conformity and resilience, meaning that we are hopeful that we will be able to include the equipment in the testing process from the middle of the year.

Relocation and conversion of several laboratories

At FIW München, we are constantly adapting our services to the needs of our customers. If demand for certain tests increases, we make sure we boost our testing capacities accordingly, as happened, for example, with long-term creep behaviour. If tests become obsolete or if there is only very limited demand for them in the future, we will ensure that the existing laboratories are used in a sensible way.

Furthermore, we regularly review our internal processes with the aim of achieving shorter throughput times for our products and improving working conditions for our employees. In many cases, it helps to shorten the paths of the test specimens as they pass through the institute. What's more, boundary conditions such as the load-bearing capacity of the floors, floor plans and accessibility as well as existing media technology and safety concerns must be taken into account.

Several projects were also delivered in 2021 after lengthy preparation: our heavy dimensional stability furnaces moved to the basement along with their preparation area, and the cleanroom-like parts of the building where our VOC measurements used to be carried out now house the structural laboratory and our vacuum chamber (for determining the internal pressure and water vapour permeation rate of vacuum insulation panels, among other things). Several preparation areas were also modified and regrouped: fire behaviour, dowel pull-through, and sample storage in autoclaves. At FIW München, we are constantly adapting our services to the needs of our customers. If demand for certain tests increases, we make sure we boost our testing capacities accordingly, as happened, for example, with long-term creep behaviour. If tests become obsolete or if there is only very limited demand for them in the future, we will ensure that the existing laboratories are used in a sensible way.

The first dimensional stability furnace is carefully lifted out of the building opening

An FIW München employee with the fourth dimensional stability furnace

Three dimensional stability furnaces have already arrived at their new destination

5 Certification

Looking back on 2021

Mr Albrecht's retirement marks a turning point for FIW München, as he headed the certification body for decades and, following the introduction of the European Product Standards and the ECJ ruling from 2014, initiated the transformation of the certification department from third-party monitoring in line with regional building codes to a certification body and himself guided the change, the result of which was a bundle of voluntary certification programmes that is now available to customers, which regulate the monitoring of the quality of thermal insulation materials in a well-founded and independent manner.

Wolfgang Albrecht with one of his successors, Dr Andreas Schmeller

The steadily increasing demand for certificates since then and especially the strong participation of customers in the voluntary certification programmes run by FIW München, including the use of the Q mark, are proof of our success and a reward at the same time.

In Dr Andreas Schmeller and Ralph Alberti, two competent colleagues are ready to take over Mr Albrecht's responsibilities and issue the corresponding certificates after checking the protocols and measurement results.

More information is provided by Claus Karrer's field of work, working together with his engineers in structural engineering, on tests and details. The certification body also assigns the engineers of the inspection body to carry out audits and sampling in the production plants and to monitor factory production controls.

Founding of the TIAQ

The TIAQ was founded in 2021 in Belgium, with FIW München participating as a non-profit association. The aim of TIAQ is to promote the idea of quality of European thermal insulation products and systems. In this regard, the Association will further anchor and expand the operational activities of the existing quality assurance system for thermal insulation materials, known as "INSULATION KEYMARK", in particular by:

- Updating and further developing the scope of the Europe-wide voluntary certification system “INSULATION KEYMARK”
- Promoting “INSULATION KEYMARK” certification as proof of compliance with quality levels that exceed the legal minimum
- Improving cooperation between empowered certification bodies, registered laboratories, manufacturers and users of thermal insulation materials
- Developing a long-term strategy to establish the “INSULATION KEYMARK” as a European quality mark that is recognised throughout Europe.

In order to pursue these goals, the Association also intends to represent the various players in the thermal insulation market segment in one strong body at the European level and to this end will present itself on the web with easy-to-understand videos on the brand and the certification process:

https://www.youtube.com/watch?v=G6eY5dZIlh8

https://www.youtube.com/watch?v=2eaUcupz8r0

The remit of FIW München's Certification Body

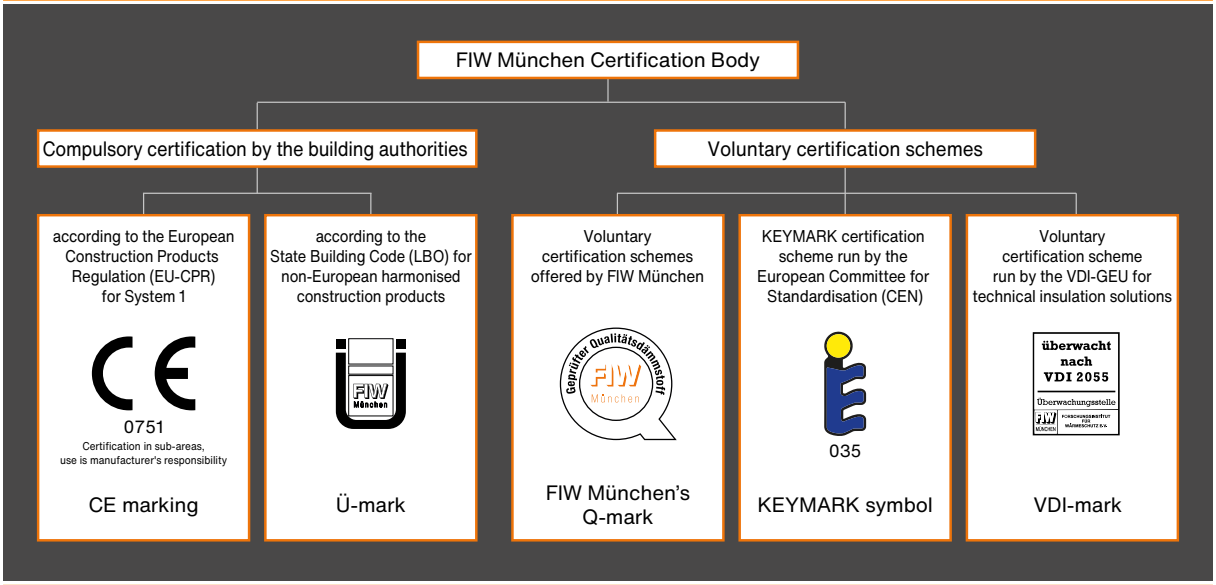
FIW München is the main body for the certification of insulation materials and building components and can look back on a 100-year tradition of product testing and assessment in the building industry as a whole.

European standards, which have been harmonised in many areas, merely form a (minimum) consensus at European level when it comes to defining the requirements for construction products. There are moreover still different national building inspection requirements. Manufacturers of high-quality products are forced to take action themselves, for example to define the interfaces between components and ensure consistent quality. Ultimately, a quality seal offers a guarantee for certain quality agreements, for example between ETICS system holders and insulation manufacturers, avoids criticism and costly recalls and creates trust among those involved in the market.

The various tasks of the certification body of FIW München are presented below, which in recent years has developed from a certification body that operates in line with the State Building Code to a certification body that complies with the European Construction Products Regulation (CPR) or voluntary certification programmes.

You can find an up-to-date overview of our testing facilities on our homepage at:

https://fiw-muenchen.de/en/certification-body

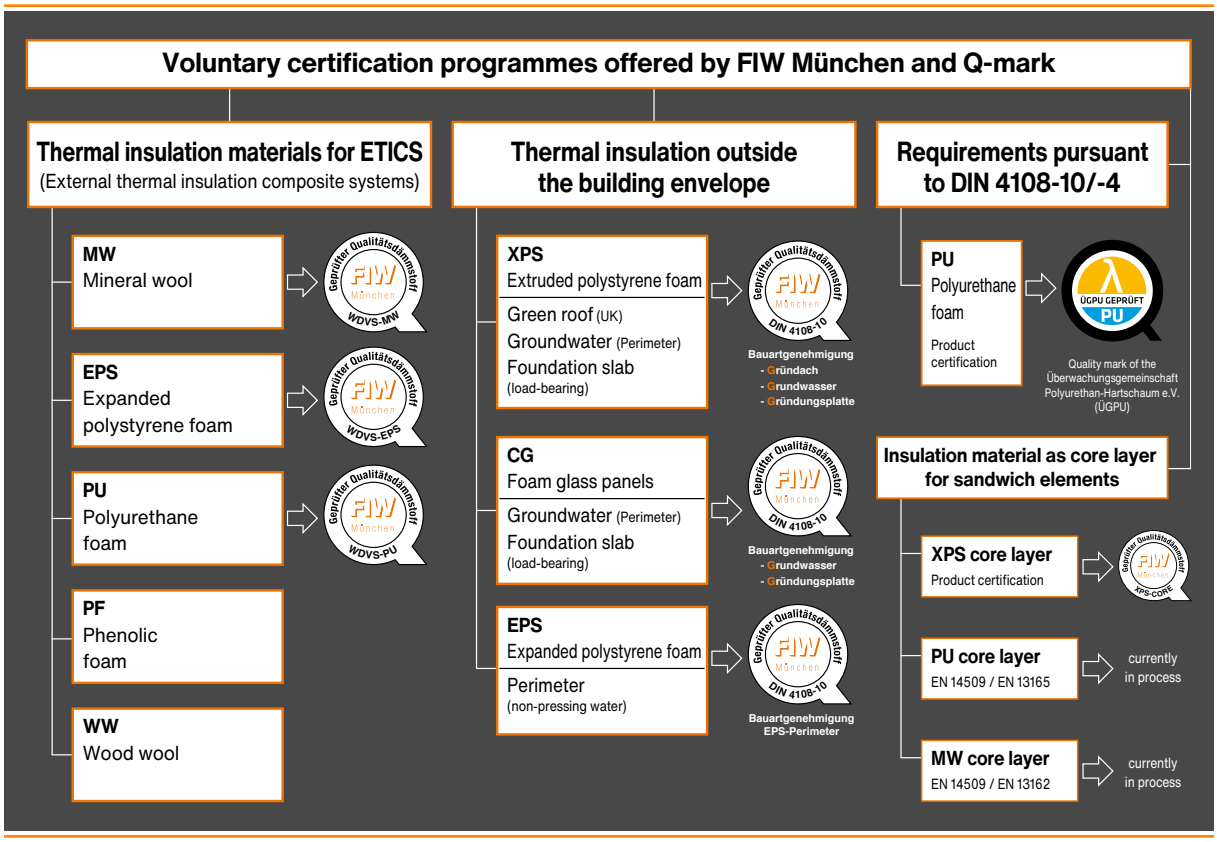


Certification: Overview of certification options at FIW München

Addition of XPS-CORE to the Q-Mark family

FIW München's voluntary certification programmes are well established on the market; almost all of the participants have decided to use the Q-Mark in order to be able to demonstrate the quality associated with it to the outside world. The underlying certification scheme sets out strict requirements for the use of the Q-Mark. Only products that have a valid certificate may be advertised with the Q-Mark.
In 2021, the certification body of FIW München issued more than 100 certificates for insulation materials for use in ETICS and around 200 certificates for insulation materials for use in applications outside of building waterproofing after assessing the audits and evaluating the test results. There are also more than 100 certificates for PU thermal insulation materials, on the basis of which the Q-Mark of the Qualitäts-gemeinschaft Polyurethan-Hartschaum e.V. (Quality Association for Rigid Polyurethane Foam) is awarded. The FIW certificate database (https://fiw-muenchen.de/en/certificates) contains all the valid certificates of the voluntary certification programmes and is updated on a daily basis.

An overview of the voluntary certification programmes and Q-Marks at FIW München is shown in the following graphic.



Overview of the voluntary certification programmes administered by FIW München including the awarding of Q-Marks, if available.

A new addition in 2021 is the "Certification programme for insulation boards made of extruded polystyrene foam (XPS) as a core layer for sandwich panels (XPS-CORE)". In addition to thermal conductivity, the focus here is on the mechanical properties of the XPS rigid foam panels, which are further processed into extremely resilient sandwich elements by gluing steel or aluminium sheet on both sides. The first Q-Mark certificates have already been awarded. Certification programmes for rigid polyurethane foam (PU) and mineral wool (MW) as the core layer of sandwich elements are being developed.

The Q-Mark for XPS insulation materials

Many applications for extruded polystyrene foam (XPS) pursuant to EN 13164 are regulated in DIN 4108-10. Demanding applications that require particularly high quality products call for a general type approval (aBG) in Germany, in conjunction with an ETA (European Technical Assessment). These cover green roof applications, perimeter insulation in groundwater and, in particular, load-bearing insulation layers under foundation slabs.

A large number of XPS manufacturers who meet these requirements participate in FIW München's "Certification Program for XPS as Thermal Insulation Outside Waterproofing" and use the Q-Mark to demonstrate their exceptional product quality.

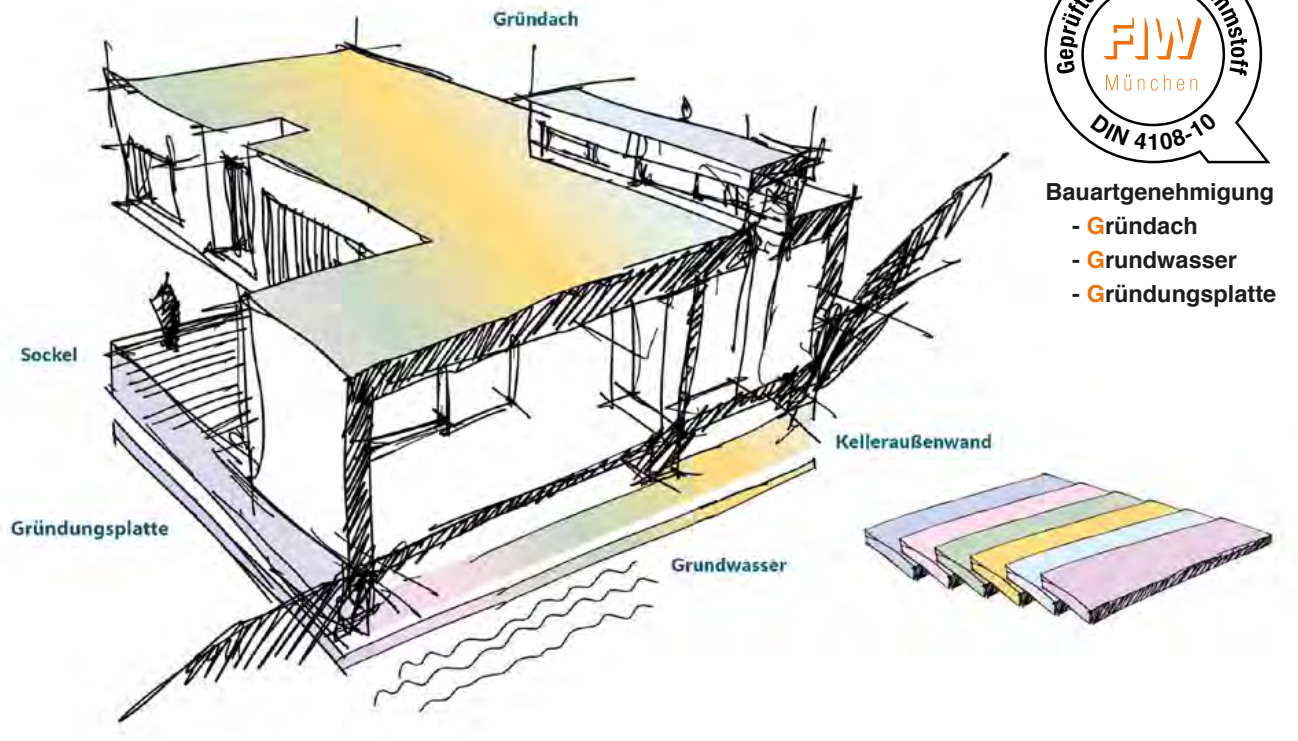
Organised by the Fachvereinigung Extruderschaum e.V. (FPX), the participating manufacturers and certification bodies (FIW München, MPA NRW and MPA Stuttgart) meet twice a year as an advisory board for the Q-Mark for XPS. In addition to sharing technical information, measures for communicating the value of Q-Marked XPS to those involved in the construction process are also discussed. Manufacturers, FPX and FIW München allocated funds in 2021 to explain the Q-Mark in the market:

https://www.xps-qualitaet.de/ and

https://youtu.be/TsTqHqqJS58

Manufacturers of XPS insulation materials with a licence agreement may apply the Q-Mark to their products if they have a valid certificate for the corresponding application. All valid certificates can be retrieved from the certificate database on the FIW München homepage:

https://fiw-muenchen.de/en/certificates



Geprüfter Qualitätsdämmstoff FIW München DIN 4108-10

Bauartgenehmigung
- **Gründach**
- **Grundwasser**
- **Gründungsplatte**

6 Research and Development

General information

The Research and Development department is responsible for the research activities of the institute with regard to thermal insulation. In the last few years, two thematic focal points of our project work and research activities have emerged. On the one hand, we focus on developing and improving insulation and building materials as well as building components and insulation constructions in terms of their thermal and moisture properties. This has been one of FIW München's classic fields of activity in applied research for more than 100 years.

On the other hand, however, there has been a significant increase in projects and questions concerning the energy efficiency of buildings and facilities. We are increasingly being asked for studies and calculations on how to save energy in existing buildings, on the sustainability of materials and building designs, and on the problem of "grey energy" in buildings and facilities. Clients in these cases include associations and stakeholders in product groups, the housing industry, systems engineering and building envelope companies, as well as institutions and ministries of the federal and state governments. We selectively complement our expertise in thermal insulation and energy efficiency of components, systems and buildings by collaborating with other institutes and research centres, for example on systems engineering for heating or ventilation and water heating in residential and non-residential buildings.

In light of German and European climate legislation, questions about greenhouse gas emissions over the entire life cycle of buildings, components and systems are currently coming to the fore. Now that the transmission heat losses of buildings and components have already been reduced to a very great extent by the various Ordinances on Thermal Insulation and energy saving ordinances, the amounts of energy required to produce the components, systems and buildings are coming under increasing scrutiny. The demand for studies and sample observations has increased once again following the revision of DIN EN 15804 in 2020. In the meantime, some countries in Europe have started to stipulate an overall limit for primary energy demand and greenhouse gas emissions for buildings, which includes not only the operational phase but also the construction of the building. In France, for example, limit values are based on the usable floor area of different building types, and these maximum values are reduced as the years go by. As a result, building materials and insulating materials for the various components are now competing for a tighter budget, which is boosting manufacturers' efforts to reduce energy consumption and environmental impacts during production.

DIPL.-ING. CHRISTOPH SPRENGARD

DR.-ING. SEBASTIAN TREML

ALEXANDRA KÖHLER

Thanks to the products developed by the construction and insulation industry, the technical issues of energy efficiency have largely been solved: tried and tested products are available for new buildings and existing buildings as well as for all technical applications. Follow-up questions now concern the economic efficiency of measures in new and old buildings - from a microeconomic perspective for investors and from a macroeconomic perspective for Germany and Europe.

By their nature, the constraints for all these studies are very volatile. Carbon pricing and speculation or further interventions in the market, for example by political actors, will result in significant shifts in energy prices for fossil energies. The ongoing decarbonisation of electricity and district heating in Germany will also have an impact on energy costs, but above all on greenhouse gas emissions for the construction sector. The use of renewable energy sources for heating buildings (especially pellet heating systems) also plays a role in the complex overall assessment.

This is precisely why it is essential to continue research into improving materials, products and systems! Both in improving the thermal and moisture properties and in reducing the environmental impact of manufacturing the products. The R & D department at FIW München is a flexible and reliable partner for measurements, simulations and expert assessments in this respect. Our particular strength lies in combining measurements and simulations at material, product and component level. The quality of the simulation results depends to a large extent on the quality of the material properties with which the programmes are "fed". This is why we are continuously expanding our material testing in order to be able to offer our customers the best possible quality.

The structural laboratory in particular has been expanded in recent years, for example with a fully automated device for determining sorption isotherms of building and insulating materials, plasters and mortars in the temperature range between 5°C and 60°C at ambient humidities of 0% to 98% and with a Helium pycnometer for measuring the pore content and the pure density of materials.

Images of the structure and surface of materials assist with product development and can be captured at FIW München using a powerful digital microscope. Special software makes it possible to combine images from different angles of inclination with an extended depth of field to map three-dimensional structures on surfaces, for example.

The R&D segment is continuously working on the expansion of characterisation possibilities for the structure and physical properties of construction and insulation materials. Further tests – especially for the fast-growing product group of thermal insulation

PIA FEHR M. SC.

CAROLIN KOKOLSKY M. SC.

DIPL.-ING. (FH) HOLGER SIMON MBP

plasters and thermal insulation mortars – have been developed and made available to manufacturers since spring 2021.

Large-scale component tests, for example in the Institute's hot boxes, are used to validate the ideas and improvements developed “on a small scale” on façade elements, windows, gates, masonry and technical insulation systems on a 1:1 scale. One focus of our materials research last year was on developing and improving insulating materials made from renewable raw materials in the context of industrial orders and a research project conducted by the Agency for Renewable Resources (FNR).

The segment's thermal and humidity engineering know-how is also used by other industries: Planners and manufacturers of chemical and power plants, manufacturers of refrigerators and freezers, air conditioning, transport containers and vehicles regularly rely on our expertise to optimise the thermal behaviour and long-term behaviour in the application of their products. Steady-state observations of heat transfers are no longer sufficient under normal circumstances for these applications, with predominantly changing boundary conditions instead required as a basis - e.g. daily or annual temperature fluctuations or climate data accurate to the hour for a variety of locations. These temperature fluctuations are often combined with realistic humidity conditions in order to analyse the moisture distribution in systems or to exclude any damage to building structures from the outset. Laboratory tests and simulations can then be validated by measurements recorded on site within the scope of monitoring, for example.
Further interesting questions of heat and mass transfer arise at higher air or media velocities, which are studied at FIW München using fluid-dynamic simulations. We have powerful computers and programmes at our disposal for this purpose and we are requested to do this frequently by chimney manufacturers, for example. Ongoing fluid mechanics investigations concern the thermal resistance of the air layers in roofs and between roller shutters and windows. The thermal resistance of still air layers is well-understood, but unfortunately this is a relatively rare special case, because almost all air layers on buildings and systems are partially ventilated or even strongly ventilated cavities.

BENEDIKT EMPL M. SC.

CHIARA CUCCHI M. SC.

WOLFGANG SCHMIDT M. SC.

Our research fields and services

Research

- Research projects on all topics concerning the thermal and moisture protection of construction elements, individual components, complete systems, structural installations and buildings
- Research on energy saving in buildings and energy efficiency
- Application-oriented research on insulation materials, construction materials, components and systems
- Research on fundamental heat and moisture-related issues such as the systematic investigation of production parameters on the heat-related properties or the influence of moisture on the thermal conductivity of construction and insulation materials
- Applications for research projects and project management for research contracts in Germany and Europe

Energy requirements of buildings

- Determination of the energy requirements of components, systems and buildings
- Holistic approach to thermal loss, taking the location, the climate and the user behaviour of the residents into account
- Assessment of potential for restructuring

Development of products and materials

- Optimisation of the thermal and moisture parameters of insulation and construction materials as well as of construction components and insulation structures
- Supporting the further development of materials, products, components, systems and parts through measurements, calculations and simulations
- Measurement of material parameters as input data for thermal engineering simulations
- Determination of the heat transfer of components and parts on a 1:1 scale up to a component size of 3.5 m x 3.5 m
- Combination of numerical calculations, simulations and laboratory investigations for the further development of established products (e.g. for insulation materials made of renewable raw materials) and for new construction products (e.g. vacuum insulation panels (VIP) and insulation materials made of Advanced Porous Materials (APM)) and scientific support from initial concept to market launch
- Calculations, simulations and measurements of thermal and moisture properties; also for industries not related to construction, i.e. for refrigerators and in the logistics sector for transport containers and refrigerated vehicles
- Support along the entire construction value chain; from material to component and from component to the complete heat-insulating building envelope

Other research and simulations

- Simulations in the transient state with increasing or decreasing temperatures
- Simulation of movement in liquids and gases (CFD)
- Measurements of components or materials with realistic moisture content in order to analyse moisture distributions in systems and better assess damage
- On-site investigations and monitoring of existing and newly constructed buildings
- Investigation and simulation of the permanent functionality of constructions and restructuring measures
- Studies and assessments of potential
- Thermal bridge catalogues
- Support with technical manuals and product documentation

Current research activities and new approvals in 2021

Here at FIW München, we have been able to increase gradually the amount of R & D that we do over the last few years. We embarked on more new projects in 2021, and many ideas have been moved on to the application stage. In addition to the public research projects mentioned below, industrial partners from a wide variety of sectors as well as local authorities have commissioned FIW München to conduct (concept) studies and (application-oriented) research, which are subject to confidentiality and therefore cannot be listed in this report.
For information on other ongoing and completed research projects and the research team, please visit https://fiw-muenchen.de/en/research.

FO-2020-01: Analysis of specific decarbonization options with a view to achieving the 2030 and 2050 energy and climate targets for different residential and non-residential building typologies

Bundesministerium für Wirtschaft und Energie

The study, which was already completed towards the end of 2020, has now been published on the website of the Ministry of Economic Affairs and Climate Action (BMWK), which at the time was the Ministry for Economic Affairs and Energy (BMWi). The results are still valid and are also highly relevant for the upcoming changes in the Building Energy Act (Gebäudeenergiegesetz GEG) and the redesign of the subsidy.

In the building sector, greenhouse gas emissions are projected to be reduced by between 66 and 67% by 2030 compared to 1990 levels. Further substantial reductions in emissions will also be required by 2050. Transforming the building sector and its energy consumption is crucial for the energy transition as a whole, because a “business as usual” strategy will not be sufficient to even come close to achieving the climate protection targets for existing buildings.

On the basis of selected typical existing buildings, various decarbonisation options were evaluated by FIW München, working together with several partners, as part of a study commissioned by the current Federal Ministry for Economic Affairs and Climate Action (contract awarded by the BMWi, project no.: 102/16-43). It outlines how the energy and climate policy targets for 2030 can be achieved for 8 selected residential and 8 selected non-residential buildings on a path that is compatible with the 2050 targets. The measures under consideration for reducing final energy and greenhouse gas emissions (GHG emissions) are evaluated on the basis of economic criteria and the impact on GHG emissions during the building’s use phase. One example is the deliberate focus on ambitious and therefore future-proof measures for building envelopes in order to avoid the need for further modernisations of the same building component until 2050, thereby preventing additional costs and lock-in effects.

The calculations for the 16 example buildings under consideration show that both the sector target for 2030 and the target for 2050 are in principle achievable if appropriate energy modernisation measures are performed on the building envelope and building technology. The 2030 target can be achieved by completely modernising a (comparatively small) proportion of the existing buildings, or by partially modernising a higher proportion of the building stock.

In order to be “2050-ready”, the partial modernisation measures must not result in any lock-in effects. The considered modernisation options achieve very high GHG savings with complete modernisation compared to the respective baseline condition – usually 70% and more. In addition to the structural changes, the exact order of magnitude depends heavily on the energy source that is chosen. Further reductions in emissions require the use of emission-free or at least largely decarbonised energy sources. The necessary decarbonisation of the building sector can therefore only be achieved in a commercially and technically viable way by improving structural thermal insulation and using energy-efficient systems technology, while at the same time choosing energy sources with the lowest possible emissions.

The study was commissioned by the BMWi under project no. 102/16-43 and can be downloaded free of charge here:

https://www.bmwi.de/Redaktion/DE/Publikationen/Studien/dekarbonisierungsoptionen-zum-erreichung-der-energie-und-klimaziele-2030-2050%20bei-wohn-und-nichtwohngebaeudetypologien.pdf

FO-2020-06: Grey energy and grey emissions of insulation materials compared to the savings potential

Grey energy is the cumulative non-renewable primary energy demand for raw material extraction, production, transport, storage and the disposal of a product. The greenhouse gas emissions released in the course of these processes are referred to as grey emissions.

In our study, the insulation of the building envelope was evaluated holistically over the entire life cycle of the insulation materials - from production to deconstruction. Such a life cycle assessment identifies all the relevant environmental impacts that are caused during the life cycle of an insulation material. The total primary energy demand and the primary energy demand from non-renewable resources (grey energy) were included in the life cycle assessment, as were the greenhouse gas emissions emitted during production (grey emissions).

It transpires that the primary energy demand, both overall and in terms of non-renewable primary energy expenditure, is very low compared to the savings that can be achieved through the use of insulation to reduce building energy consumption, regardless of the choice of insulation material. The same applies for the analysis of grey emissions. This relationship also becomes very clear when taking into account the energy payback time, that is, the length of time until the expenses for the production of the insulation material are offset by the savings that can be achieved. It is less than two years for the selected target U-value of 0.24 W/(m²·K) for non-renewable energy sources, and in many cases less than one year, depending on the stock U-value and environmental indicator (PENRT, PET and GWP).

Energy source	U-value of building [W/(m²·K)]	PENRT [kWh/m²]	PET [kWh/m²]	GWP [kgCO_2-eq./m²]
Gas	1,4	5.050,50	5.050,50	1.101,93
	0,8	2.554,11	2.554,11	557,26
	0,5	1.305,92	1.305,92	284,93
Oil	1,4	5.050,50	5.050,50	1.423,32
	0,8	2.554,11	2.554,11	719,80
	0,5	1.305,92	1.305,92	368,03
District heating	1,4	2.479,33	2.892,56	826,44
	0,8	1.253,84	1.462,81	417,95
	0,5	641,09	747,94	213,70
Wood pellets	1,4	1.033,06	6.198,34	103,31
	0,8	522,43	3.134,59	52,24
	0,5	267,12	1.602,72	26,71
Heat pump	1,4	1.859,50	2.376,03	578,51
	0,8	940,38	1.201,59	292,56
	0,5	480,82	614,38	149,59

Table 1: Summary of results for savings per m² component over 40 years with U-value improvement to 0.24 W/(m²·K) as a function of the existing U-value for the three environmental indicators PENRT, PET and GWP

These results clearly show that the primary energy input as well as the greenhouse gas emissions for the production of insulation materials only play a minor role in relation to the savings that can be achieved as a result. This ratio depends on the energy status of the building component before and after the insulation measure as well as on the energy source. However, the benefits of insulation with the insulation materials considered here always outweigh the expense. **Insulation measures in general, regardless of the choice of insulation material considered, the insulation thickness selected and the initial energy condition of the building component, are always beneficial from a sustainability and overall energy perspective.**

The decarbonisation of energy supplies (transition to mainly renewable energy sources) will also have a positive impact on the life cycle assessment of insulation materials. This is because using more renewable energy sources in production also reduces grey energy and grey emissions for the production of insulation materials.

The study is publicly available and can be downloaded here:

https://buveg.de/wp-content/uploads/2021/09/202107019_FIW_GraueEnergie_vs._Einsparpotential.pdf

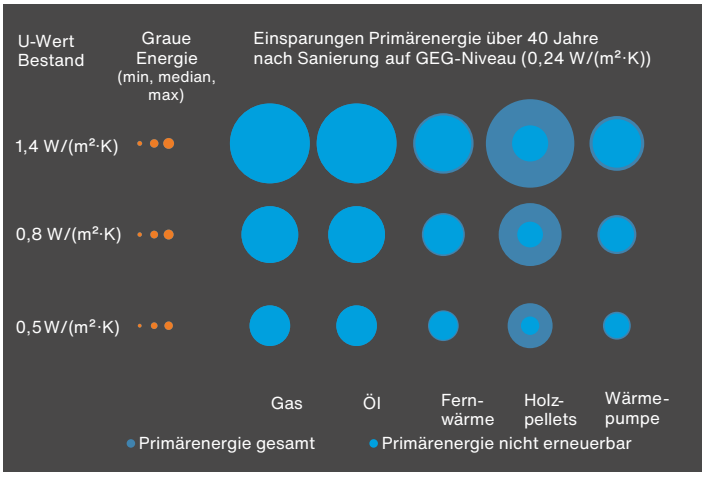


Fig. 1: Comparison of expense to achievable savings in total and non-renewable primary energy over 40 years for refurbishment to a U-value of 0.24 W/(m²·K) for various existing buildings

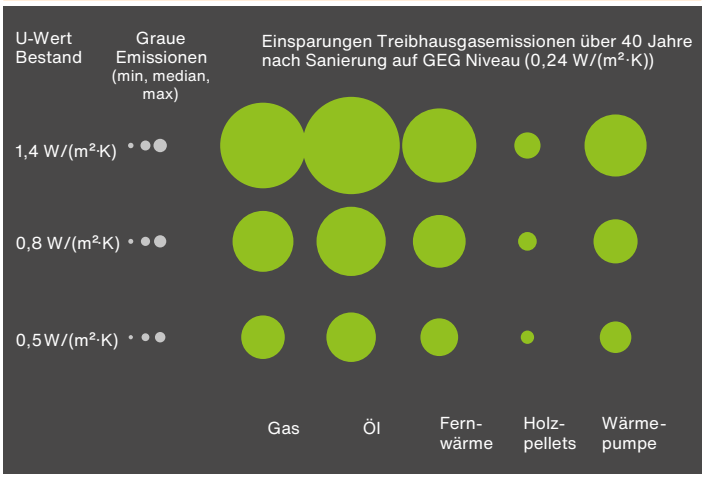


Fig. 2: Comparison of expense to achievable GHG savings over 40 years for refurbishment to a U-value of 0.24 W/(m²·K) for various existing buildings

FO-2021-01: Set of instruments for achieving the 2030 climate protection targets in the building sector

In a comprehensive report, we at FIW München joined with the Institut für Technische Gebäudeausrüstung Dresden Forschung und Anwendung GmbH (ITG) as part of a contract awarded by the former BMI (Federal Ministry of the Interior, Building and Home Affairs, award code PYP9RD) to the German Energy Agency (dena) to analyse eleven instruments from the areas of regulatory law, funding, and consulting and communication, and in doing so, we examined their effectiveness in terms of greenhouse gas savings (in the building sector and the energy sector) and the potential final and primary energy savings. The costs that will be incurred by investors, users and society over the next 25 years were also analysed.

		Promoting	Demanding
1	Obligation to retrofit the worst efficiency classes		X
2	Requirements of existing buildings		X
3	Requirements of new buildings	X	X
4	Non-residential buildings	X	
5	Combination packages	X	
6	Expansion of compensation	X	
7	Renovation work	X	
8	Fuel switch		X
9	Advice campaigns	X	X
10	Higher carbon pricing	X	X
11	Self-sufficiency		
	Regulatory Law Funding Advice & Communication		

Table 1: Overview of the selected instruments and the composition of the two sets of instruments titled “Promoting” and “Demanding”, as well as their allocation to the categories “Regulatory Law”, “Funding” and “Advice and Communication”

Not one of the instruments examined is capable on its own of achieving the GHG reduction target in the building sector. For this reason, two sets of instruments were compiled from the eleven individual instruments, both of which are target-oriented: one with a focus on promotional policy measures (promoting) and one with a focus on regulatory law (demanding).

All of the considered instruments and sets of instruments were first assessed in terms of their effectiveness for achieving the national climate targets for 2030. However, it is essential that they are designed in such a way that carbon neutrality can also be achieved by 2045. All the considered instruments and the measures initiated with them were therefore chosen in such a way that no lock-in effects are caused, and at the same time in such a way that, in combination with the expected developments in the energy sector and in land use, land use change and forestry (LULUCF) at the present time, they achieve carbon neutrality.

In order also to comply with the agreed tightening of the targets by 2030, regulatory measures will be virtually unavoidable, at least in the medium term, as their effectiveness is in some cases higher than that of purely financial incentives and they can therefore make a significant contribution to achieving the targets. Achieving the climate targets requires extensive measures in the existing building stock, whereas GHG-reducing measures in new buildings are of limited importance. Significant incentives for GHG reduction can come from carbon pricing, as this promotes the appeal (cost-effectiveness) of energy-saving and climate-protecting measures. However, it must be taken into account that a clear impact effect only occurs with high CO_2 prices. The change in the energy supply system must also take place at the speed described. If this is delayed, it will still be possible to miss the national climate targets for the year 2030, even if both sets of instruments are used.

Alongside technical measures, an attitude shift can also contribute to achieving the goal, for example through a change in values and a heightened awareness of the need to conserve resources and protect the climate. However, such behavioural changes require long periods of time; at present, they are only accepted and practically implemented by a comparatively small part of the population. Regulatory constraints on behavioural change in particular are likely to meet with fierce resistance in the medium term as well, with the result that behavioural change will only play a minor role in achieving the 2030 climate targets in the building sector.

Climate protection measures in the building sector must always be viewed in their overall context, i.e. in terms of their impact beyond the limits of the sector. The GHG emissions caused by the consumption of electricity and district heating for air conditioning in buildings are accounted for in the energy sector based on the source principle, although the causes and to a large extent also the potential for savings lie in the building sector. The increasing role of heat pumps in the supply of heating and the higher cooling demand to be expected in the context of rising summer temperatures are leading to an ever greater shift of emissions to the energy sector. On the other hand, the building sector is also directly or indirectly affected by overarching problems and obstacles faced by other sectors, such as renewable energy infrastructure (power lines, heat grids, RE generation) and the promotion of these at the building level (owner-occupancy, feed-in, etc.). The measures that have been identified as necessary if the climate targets are to be achieved will have a significant impact on the costs of construction, conversion, modernisation, occupancy and housing.

Contrary to what has often been portrayed in previous discussions, all stakeholders will be affected by this – tenants and small landlords as well as the real estate industry, owner-occupiers and investors. A frank and objective discussion about the interrelationships and a fair distribution of the burdens are vital if climate protection measures are to be accepted. Social hardship must be avoided at all costs. However, individual actors cannot be completely exempted from sharing the burden of costs, as this would eliminate the necessary incentive effect and the costs would have to be borne entirely by others.

Achieving the climate goals calls for a new balancing and evaluation of the different goals in the building sector. It may not be possible to adopt all the existing ideas unchanged; unchecked new construction or existing guarantees for very inefficient buildings are difficult to reconcile with climate protection in the long term.

Evaluating whether the targets have been achieved, breaking them down by building type and intensively examining the instruments results in recommendations for action that can make carbon neutrality a reality in building stock. A few examples are given here:

- Prompt implementation of additional measures for GHG savings in buildings in order to achieve the targets formulated for buildings in the amended Climate Change Act
- Expansion and consolidation of support, including more ambitious requirements that are more strongly geared to GHG emissions
- Focusing climate protection efforts on existing building stock
- Expansion and consolidation of funding
  Changing how calculations are made: from the source to the polluter
- Advice campaigns and training of specialists

FO-2017-07: Microstructure modelling for the optimisation of wood fibre-based thermal insulation materials - LowLambda

Gefördert durch:

Bundesministerium für Ernährung und Landwirtschaft

FNR
Fachagentur Nachwachsende Rohstoffe e.V.

aufgrund eines Beschlusses des Deutschen Bundestages

The aim of the project was to investigate the dependence of the thermal conductivity of wood fibre-based insulation materials on the microstructure of the material. The project was conducted jointly by FIW München (coordination, physical characterisation), the Fraunhofer Institute for Industrial Mathematics (µCT, image analysis and modelling) and Steico SE (industrial trials).

As part of an extensively documented sampling process, representative products as well as associated fibre samples from different manufacturing processes (dry process, wet process, flexible mats) were taken and examined with respect to their thermal, mechanical and granulometric properties. Tomographic images were taken of selected samples using µ-CT and at the European Synchrotron Facility (ESRF) in Grenoble. A special method of sample preparation had to be developed for the high-resolution images at the ESRF to enable 5 x 5 mm cross-sections to be taken from the highly porous fibre insulation materials without altering the spatial allocation of the individual particles in the fibre network (Figure 1). On the one hand, the thermal conductivity could be modelled directly on the image data, while on the other hand representative particles were isolated and used in a configurable digital model to determine sensitivities between structural parameters (particle size, orientation) and the effective thermal conductivity.

Extensive sampling was used to create a comprehensive data set that was then analysed to determine correlations between the effective physical properties, fibre size distributions based on different methods (sieve analyses, optical analyses) and production parameters. On this basis, optimisation methods were developed and tested in a series of industrial trials. In addition to large-scale production, a laboratory process for the production of flexible mats was also set up, which enables the controlled production of homogeneous test specimens from loose fibres. The influences of different fibre size distributions could be ascertained more clearly in the laboratory using a process called controlled scattering than was previously possible by using manually scattered samples.

Fig. 1 above: Sample preparation of wood fibre insulation materials of different densities (FIW); **below:** volume rendering of the variants B3 - B6 based on high-resolution tomographic images (ITWM)

The thermal conductivity is influenced in particular by the proportion and orientation of the coarse material portion of the fibres (shives). Shives oriented in the direction of the panel thickness act as thermal bridges, which increase the thermal conductivity. The influence of fibre length and thickness is of less importance overall. However, collectives that are favourable for thermal conductivity are characterised by as narrow a distribution of fibre sizes as possible. The raw density profile of the panels also has a certain influence on the thermal conductivity. In order to achieve low thermal conductivity, the raw density profile should be as flat as possible.

Fig. 2: Test specimen for determining the proportions of the heat transfer mechanisms with foil wrapping and flanged evacuation adapter

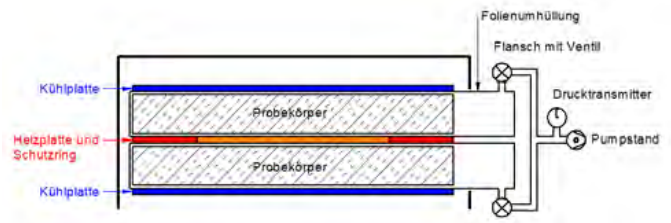


Fig. 3: Schematic diagram of the experimental set-up for determining the proportions of the heat transfer mechanisms

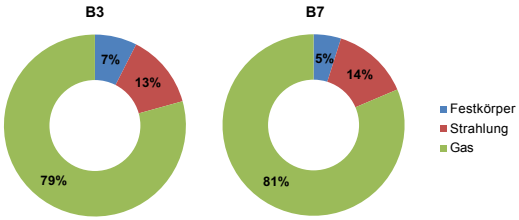


Fig. 4: Results of the proportions of the heat transfer mechanisms for two variants

An experiment to determine the proportions of the heat transfer mechanisms also yielded interesting findings. A complex metrological test was carried out for two variants. Due to the need to evacuate the air around the panel materials in a flexible film wrapping, the process was only feasible for products with a higher bulk density. The gas thermal conductivity of the air accounts for the largest share of heat transfer (approx. 80 %). Thermal radiation has an influence of approx. 13 - 14 %. Thermal conduction in the solid framework contributes approx. 5 - 7 % to the equivalent thermal conductivity (Figure 4).

Due to the inherently high optical density of wood fibre insulation materials, approaches to using radiation absorbers do not offer any improvement. The proportion of thermal radiation is therefore due to specific absorption and emission between the particles. Approaches to optimising the microstructure therefore have an impact on both pure thermal conduction and the proportion of thermal radiation. It would be desirable in this context if thermal radiation were explicitly taken into account in the modelling of effective heat conduction through fibre networks, and this could be the subject of future research projects.

The final report is available free of charge here:

https://www.fnr.de/ftp/pdf/berichte/22002717.pdf

The project on which this report is based was supported on the basis of a resolution of the German Bundestag with funds from the Federal Ministry of Food and Agriculture (BMEL) via the Agency of Renewable Resources (Fachagentur Nachwachsende Rohstoffe e.V. - FNR) as the BMEL's project management agency for the Renewable Resources funding programme.

7 FIW München events and publications

Teaching and lectures

Prof. Dr.-Ing. Andreas H. Holm

- “Fundamentals of building physics", Munich University of Applied Sciences
- "Dynamic hygric-thermal behaviour of buildings" as part of the master's programme in civil and environmental engineering, Technical University Munich
- "Energy Performance of Buildings" as part of the international master's programme "Building Sustainability", Technical University Berlin

Presentations

- A. Holm, "Wege zu einem klimaneutralen Gebäudebestand 2050" (Pathways to a climate-neutral building stock) DUH - Expert discussion on February 10, 2021, online

- C. Sprengard, “Dämmstoffe in alten Flachdächern: Einfluss von Feuchte auf die Wärmeleitfähigkeit und die Festigkeit” (Insulating materials in old flat roofs: influence of moisture on thermal conductivity and strength) 47. AACHENER BAUSACHVERSTÄNDIGENTAGE 2021 Framework theme: Investigate - Repair - Modernise: Part 2; on 19 and 20 April 2021 in Aachen.

- A. Holm, “Wärmedämmstoffe: Energiepolitische Bedeutung – Technische Eigenschaften – Innovationen” (Thermal Insulation Materials: Energy Policy Significance - Technical Properties - Innovations), presentation at the launch of the book “Nachhaltigkeit, Ressourceneffizienz und Klimaschutz” (Sustainability, Resource Efficiency and Climate Protection) on 7 June 2021, online

- A. Holm, “Potenziale der energetischen Dachsanierung – Hebelwirkung von PV-Anlagen erhöhen” (Potentials of energetic roof refurbishment - increasing the leverage effect of PV systems), presentation at a technical discussion with the BMU on 15 June 2021, online

- C. Sprengard, “Nachhaltigkeitsaspekte bei Materialien und Konstruktionen für energieeffiziente Gebäude” (Sustainability Aspects of Materials and Structures for Energy-Efficient Buildings) at the 22nd EIPOS-SACHVERSTÄNDIGENTAG BAUSCHADENSBEWERTUNG / 14th BVS-BAUSYMPOSIUM on 24 June 2021 in Dresden, Germany

- A. Holm, “Das neue Gebäudeenergiegesetz (GEG) – was hat sich geändert?” (The new Building Energy Act (GEG) – what has changed?), KS BAUSEMINARE, 28-30 September 2021 in Dresden, Berlin and Rostock

- A. Holm, “Possible GEG further development”, PR working group of BuVEG - Bundesverband energieeffiziente Gebäudehülle on 6 October 2021 in Berlin

- C. Sprengard, “THE INFLUENCE OF MOISTURE ON THERMAL CONDUCTIVITY OF TYPICAL INSULATING MATERIALS FOR FLAT WARM-ROOFS”, CEES International Conference for Construction, Energy, Environment and Sustainability, 12 - 15 October 2021 in Coimbra, Portugal

- S. Treml, “New test methods to characterize adhesive tapes for airtight layers”, Symposium: Testing and Evaluation of Adhesive Products in the Building Envelope, 26 - 27 October 2021, Sintef, Trondheim

- C. Sprengard in conjunction with M. Klempnow (DEN e.V.), “U-Value Measurements on Objects – Scientific Findings from the ‘Rapid-U Research Project’ - Investigations in the Laboratory and in Practice”, at the 31st Hanseatischen Sanierungstagen on 5 November 2021 in Lübeck

- A. Holm, “dena-Leitstudie Aufbruch Klimaneutralität - Der Gebäudesektor” (dena lead study: The dawn of climate neutrality - the building sector), Dena Congress on 9 November 2021 in Berlin

Publications

- S. Treml und A. H. Holm, „Wärmedämmstoffe. Energiepolitische Bedeutung – Technische Eigenschaften – Innovationen.“, in: Bernhard Hauke (Hrsg.) „Nachhaltigkeit, Ressourceneffizienz und Klimaschutz. Konstruktive Lösungen für das Planen und Bauen. Aktueller Stand der Technik.“, 2021 Wilhelm Ernst & Sohn, Berlin, pp. 118-128.
- C. Sprengard, S. Treml, „Dämmstoffe in alten Flachdächern: Einfluss von Feuchte auf die Wärmeleitfähigkeit und die Festigkeit“, Contribution to the proceedings of the 47th AACHENER BAUSACHVERSTÄNDIGENTAGE 2021 Framework theme: Investigate - Repair - Modernise: Part 2; on April 19 and 20, 2021, in Aachen, Germany, pp. 71-88.
- C. Sprengard, “Nachhaltigkeitsaspekte bei Materialien und Konstruktionen für energieeffiziente Gebäude” contribution to the proceedings of the 22nd EIPOS-SACHVERSTÄNDIGENTAG BAUSCHADENSBEWERTUNG / 14th BVS-BAUSYMPOSIUM on 24 June 2021 in Dresden, Germany
- C. Sprengard, S. Treml, “THE INFLUENCE OF MOISTURE ON THERMAL CONDUCTIVITY OF TYPICAL INSULATING MATERIALS FOR FLAT WARM-ROOFS”, Conference Proceedings of the CEES International Conference for Construction, Energy, Environment and Sustainability, 12 – 15 October, in Coimbra, Portugal
- C. Sprengard in conjunction with M. Klempnow (DEN e.V.), “U-Value Measurements on Objects – Scientific Findings from the ‘Rapid-U Research Project’ - Investigations in the Laboratory and in Practice”, contribution to the proceedings of the 31st Hanseatischen Sanierungstage 2021 in Lübeck, pp. 271-294.
- A. Kloss, R. Schreiner und K. Wiesemeyer, “Messung der Wärmeleitfähigkeit von Rohrdämmstoffen mit Hilfe von flüssigem Stickstoff”, in: Technische Isolierung 2.2021, Rudolf Müller

FIW München in the press

Bachelor theses

Nico Skora
“Moisture Determination in Insulation Materials using RFID Sensors,” Bachelor Thesis in Civil Engineering, Rosenheim University of Applied Sciences

Master’s theses

Benedikt Empl
“Approaches to Sufficiency for Multifamily Residential Buildings in Germany,” Master's Thesis in Sustainable Building, Technical University of Munich TUM

8 And what else is important?

For the mind, the environment and a good cause

It started as a competition amongst budding athletes at FIW München and has now evolved into a widespread campaign at the institute with half of all employees now involved: the calculation of the distance cycled to work.

More than 21,204 km were covered in 2021. This is a significant decrease compared to the year 1 BC (Before Coronavirus), which is mainly due to the roughly 3,000 home office days, rather than the sporting activities of our colleagues. The longest trip to work and back was 133 kilometers, and our kilometer champions cycle more than 3,000 km a year. Short trip champions with nearly 200 trips a year can also be found among the FIW workforce.

For 2022, all those involved have set themselves the goal of significantly increasing the total mileage again, both individually and across the institute.

They aren't just motivated by the competitiveness and target of achieving as many kilometers as possible and reduce their carbon footprint with manpower. The institute's management also honours the commitment and is committed to achieving a healthier lifestyle, sustainable climate protection and a better future. A sum linked to the number of kilometres completed will be invested towards supporting several charitable institutions. As in previous years, the sum will be supplemented by the savings from not sending Christmas cards by post.

The athletes themselves are well taken care of at FIW München. The long-awaited covered bicycle rack is in frequent use, generously equipped changing rooms and showers invite users to shorten their lunch break or finish their working day off with a run.

The fitness offers previously offered with specially purchased equipment and participation in company events such as the B2Run unfortunately fell victim to the coronavirus rules in 2021, but will be resumed once the pandemic is over.

Due to the coronavirus restrictions on communal events, the Christmas dinner, which traditionally celebrates the end of the year at FIW München, unfortunately had to be cancelled. One small sporting event did take place, however: in mid-2021, a number of (former) colleagues gathered at several ice rinks in Munich and engaged in a competition, some of which was conducted with a great deal of precision and expertise, with only winners in the end.

Electric charging stations for the FIW workforce

We at FIW München would also like to support the energy transition in the field of mobility in the best possible way and also make our contribution to reducing particulate, CO_2, nitrogen oxide and sulphur dioxide emissions in our operations.

In 2021, three charging points were installed for our workforce, and more charging points will follow in 2022. Employees can use their electric vehicles and plug-in hybrids as local emission-free commuter vehicles to make up for any home charging options they may not yet have. Furthermore, the amount of regionally generated green electricity in the grid is usually highest during the day. Extracting power at this time relieves the pressure on the long-distance power lines.

Efficiency first arrives at FIW München

In 2021, we were able to reduce our electricity demand by almost 6% compared to 2020 thanks to several measures. After all, priority is given to energy efficiency at FIW München as well. Nevertheless, we are not yet satisfied and are continuing to look for ways to save on the most important energy source for day-to-day operations, and have resolved to realise these in the next few years. We already obtain 100% of the electrical energy we still need, despite all the efficiency improvements we have made, from renewable sources. We are currently planning to generate electricity at our FIW München premises and to use it directly on site. Adjustments also need to be made in the heating sector, from renewing external envelope insulation to system technologies.

Recycling of unused insulation materials

Not all of the insulation materials received as part of our testing activities are put through their paces in destructive materials testing. Some of the surplus is already recycled by selected partners. We consult extensively with our customers and partners to achieve an even higher rate of use of the products after their FIW test life. We are also conducting joint research with our partners into sustainable products and recycling methods.

Continuing education and careers at FIW München

The career opportunities here are just as diverse as our fields of activity: we at FIW München offer a variety of personal development areas, from building up technical expertise and process know-how to expanding the spectrum of methods, research activities, experience in project management and acquisition, and building networks, for instance by working on standardization committees.

Starting at FIW München is as varied as it is challenging, whether as an intern, during your studies, as part of a Bachelor's or Master's thesis, as a guest researcher, through direct employment or by starting an apprenticeship. We publish vacancies directly on our homepage: https://www.fiw-muenchen.de/de/karriere, but we also welcome unsolicited applications at bewerbung@fiw-muenchen.de.

Internal training courses are used to prepare the skilled new technical employees for their responsibilities and specialised work at FIW München. In addition to manufacturing, servicing and maintaining our physical apparatus and measuring equipment, the evaluation and recording of physical measurements is a key part of the daily routine of our physics laboratory assistants who attend the vocational school phase near the Bavarian border in Selb. You will work closely with our engineers in testing and certification as well as in research to develop new testing and measuring methods, for example.

Legal notice

Forschungsinstitut für Wärmeschutz e.V. München
Head of institute: Prof. Dr.-Ing. Andreas H. Holm
Lochhamer Schlag 4
D-82166 Gräfelfing
T + 49 89 85800-0
F + 49 89 85800-40
info@fiw-muenchen.de
www.fiw-muenchen.de

Concept, design and realisation:
Koye-Brand GmbH
Amalienstraße 77
D-80799 Munich
www.koyebrand.de

Photos: FIW München, Ulrike Frömel, Adobe Stock,
Title: Ville de Namur, Le NID and adjustments,
Page 33: Fachvereinigung Extruderschaum e.V. (FPX)

FIW München

Forschungsinstitut für Wärmeschutz e.V. München

www.fiw-muenchen.de