# Annex 65 Text

# Long-Term Performance

# of Super-Insulating Materials

# in Building Components & Systems

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# Background

In the Building Sector, Space Heating (SH) and Domestic Hot Water (DHW) remain the most important energy users. Moreover, refrigeration & freezers (RF) account for around 25% of the whole household appliances. Finally, SH, DHW and RF represent about 80 % of the total energy consumption of household used to fulfil their needs for comfort, sanitary conditions and food storage and unfortunately most of this energy is wasted through heat losses and not used on purpose. Since the first oil crisis, the implementation of Building Regulations[[1]](#footnote-1) through a combination of higher efficiencies of equipment’s and improved thermal performance of building envelope leads to a significant reduction in the per capita energy requirement for SH. Unfortunately, these efforts do not balance the increasing of energy consumption of appliances (especially small ones) and air-conditioning in a few countries.

The potential of energy saving has been estimated to be close to the energy consumption in the transport sector[[2]](#footnote-2) and the current challenge is to make this potential a reality. The first target is to ensure that new buildings do not place additional strain upon energy resources. This goal should be reached by developing NZEB (Net Zero Energy Building) as defined in the Annex 52[[3]](#footnote-3) and promoted in the new EPBD [[4]](#footnote-4). But in most industrialized countries new buildings will only contribute between 10 % to 20 % additional energy consumption by 2050 whereas more than 80% will be influenced by the existing building stock and 75% of current buildings in OECD will still be standing in 2050. Accordingly, building renovation has a high priority in many countries, and it plays an important role in the building related IEA R&D programmes. Hence, the big challenge is existing buildings as these represent such a high proportion of energy consumption and they will be with us for many decades to come. According to the IEA BLUE map scenario, two-thirds of the energy savings come from the residential sector and the improvements in the building envelope coupled with energy savings in electrical end-uses dominate total CO2 reductions.

Furthermore, several studies[[5]](#footnote-5),[[6]](#footnote-6),[[7]](#footnote-7) have shown that the most efficient way to curb the energy consumption in the building sector (new & existing) remain the reduction of the heat loss by improving the insulation of the building envelope (roof, floor, wall & windows).

A step beyond the current thermal performance of building envelope is essential to realize the world wide intended energy reduction in buildings. For example, in Europe, it appears[[8]](#footnote-8) that the optimum U-values lie between 0.15 W/m².K to 0.3 W/m².K, with an average value close to 0.2 W/m².K. Using traditional insulating materials such as mineral wool or cellular foams, it means a thickness from 15 to 20 cm. For retrofitting and even for new buildings in cities, the thickness of internal or external insulation layers becomes a major issue of concern. For systems (DHW or RF) the reduction of thickness is essential. Therefore, there is a growing interest in the so-called super-insulating materials (SIM), such as VIP (Vacuum Insulation Panel) or Aerogel.

The former Annex 39 HIPTI[[9]](#footnote-9) have shown that VIP’s products have reached a level of quality that customers can trust in for specific applications under well-defined conditions. However, there is still a need for test methods and evaluation procedures to characterize the suitability of SIM for wider applications in praxis. Actually, overall performance and durability of SIM must be investigated when the working life conditions are more severe (high/low temperature, high humidity, mechanical load …). Moreover, new types of SIM appear on the market and their durability and applicability needs to be answered on a scientific level.

# Objectives

An extensive renovation of existing buildings & NZEB appear as the future tracks for 2050, in the building sector and the thermal performance of the envelope is a top priority to make both objectives a success.

SIM should greatly contribute to this challenge if reliable data (properties & durability) and secure implementation techniques are provided to the supply chain (designers, engineers & builders).

The sustainability study of SIM (LCA, LCC, Embodied Energy …) will be complementary aspect of the study.

Therefore, the current research proposal has the following objectives:

– to make a state of the art of a decade of development of SIM by the industry and of applications in the building sector

* to develop experimental & numerical tools in order to provide reliable data (properties & durability) for manufacturers and designers.
* to write guidelines for secure installation
* to support standardization and assessment procedures
* to improve knowledge and confidence of the supply chain regarding SIM, thanks to sustainability analysis
* to foster a wider public acceptance of SIM in the future by communication

# Scope

The scope of the Annex65 will cover the following topics:

Two types of SIM:

* Vacuum Insulation Panel
* Advanced-Porous Materials (APM), such as Porous Silica & Aerogel

Three scientific & technical issues:

* Performance & Durability
* Installation Techniques
* Sustainability (LCA, LCC, Embodied Energy)

# Means

The Annex will be organized in four Subtasks with one leader for each of them.

## SUBTASK 1: State of the Art on Materials & Components - Case Studies

**Subtask Leader: ZAE Bayern (Ulrich Heinemann)**

This subtask will be split in three actions:

Action 1A: Characterization Methods

Action 1B: Materials, Components & Systems

Action 1C: Case Studies at the Building Scale

The main objective of this task is to provide an up-to-date catalogue of commercially available materials & components. This catalogue will provide technical description of each product with technical data and information about the application domains and the implementation rules.

Furthermore, during the last decade, basic research and first demonstration projects[[10]](#footnote-10),[[11]](#footnote-11) have shown that SIM can be applied in buildings. First European Technical Approvals (ETAs) have been issued for VIP and Aerogel for the use in buildings in the recent year (see References). However, a large use of these components is still hindered by scepticism on the reliability in practice. In order to improve the confidence in these new components, this task will make a detailed analysis of these components offered by manufacturers. An overview on all the application areas such as external & internal wall insulation, roofs, floors, ceilings …will be investigated through a few case studies.

All the materials & components manufacturers will contribute to this task.

## SUBTASK 2: Characterization of materials & components - Laboratory Scale

**Subtask Leader: FIW Munich (Andreas Holm)**

This subtask is divided in two actions:

Action 2A: Materials Assessment & Ageing Procedures (Experiments & Simulation)

Action 2B: Components & Systems Assessment (Experiments & Simulation)

As their structure and microstructure are completely different, SIM cannot be compared directly to traditional insulating materials, but worldwide acceptance of these materials will be improved, if the hygro-thermal and mechanical properties of SIM can be declared clearly and reproducible In particular, nano-structured materials used to manufactured SIM are characterized by a high specific area (m²/g) and narrow pores (smaller than 1 µm) which make them very sensitive to gas adsorption and condensation, especially with water molecules.

Therefore, the methods of characterization must be adapted and even in some cases; new methods have to be developed to measure microstructural, hygro-thermal and mechanical properties of materials and barrier films.

In parallel, modelling methods to describe heat, moisture and air transfer through nano-structured materials and films will be developed (adsorption and desorption models, diffusion models, freezing-thawing …).

Of course, a few methods will be common to all SIM, but due to their structural difference some specific methods have to be developed.

SIM can offer considerable advantages; however potential drawback effects should be known and considered in the planning process in order to optimise the development of these extraordinary properties and to prevent negative publicity which could be detrimental to this sector of emerging products. It’s why ageing tests will be defined according to the conditions in use (temperature, moisture, pressure, load …) defined in SubTask 3A. One objective of artificial ageing is to understand potential degradation processes that could occur. The durability of the hydrophobic treatment is one of these processes and will also be subject of discussion and investigation.

At the component scale, additional characterizations are needed as in general panels or rolls are sold by manufacturers. In particular, thermal bridges will be carefully investigated, as the extraordinary thermal performance of SIM is sensitive for the influence of thermal bridges.

##### **SUBTASK 3: Practical Applications – Retrofitting at the Building Scale – Field scale**

**Subtask Leader: Chalmers University (Bijan Adl-Zarrabi)**

This subtask will be separated in three actions:

Action 3A : Mapping of the Use Conditions (Components & Systems)

Action 3B : Performance at the Building Scale (Experiments & Simulation)

Action 3C : Practical Applications focused on Retrofitting

The objective of this task will be to define the application areas of SIM and to describe the conditions of the intended use of the products. Indeed, it’s clear that the requested performance of the SIM will strongly depend on the temperature, humidity and load conditions.

For building applications, storage, handling and implementation requirements will be also described.

Common and specific modelling methods will be also developed at the building scale in order to understand the impact of SIM on the performance of wall, roof and floors an even the whole envelope with regards mainly to thermal insulation, airtightness and risk of condensation.

This task will be carried out in conjunction with the Annex 58 devoted to the “Reliable Building Energy Performance Characterisation based on Full Scale Dynamic Measurement” (<http://www.kuleuven.be/bwf/projects/annex58/index.htm> ) and with the Annex 61 (Business and Technical Concepts for Deep Energy Retrofit of Public Buildings (<http://www.iea-ebc.org/projects/ongoing-projects/ebc-annex-61/> )

For building applications, special attention will be paid to:

* Thermal Performance such as Uvalue, including thermal bridge
* Heat, Air and Moisture Transfer Air & Water Tightness
* High temperature & Low temperature (condensation & freezing risk), especially for façade applications

##### **SUBTASK 4: Sustainability – LCC, LCA, EE – Risk & Benefit**

**Subtask Leader : Chalmers University (Holger Wallbaum)**

Subtask main contributors: Oxford Brookers University (OBU) and Brunel University (BU). Data will be provided by manufacturers.

This subtask will be separated in two actions:

Action 4A: Life Cycle Assessment (LCA), including Embodied Energy (EE)

Action 4B: Life Cycle Cost Analysis (LCC)

The goal of this task is to assess the overall sustainability of SIMs through the evaluation of LCA, and LCC of superinsulation materials over the entire life cycle (production, use and end-of-life).

Life Cycle Inventories for the production step will be established relying on input from material and component producers. The in-use phase will be modelled in various climatic contexts and several building types, taking into account results from Task 2 and 3 alongside taking into account the fact that SIMs are expected to allow larger living or commercially usable areas in a building whilst achieving a lower or equivalent U-values. Current and potential future end-of-life treatment processes will be analyzed and corresponding inventories established.

Inventories for all three phases will not only include material and energy flows but also economic flows, thus allowing evaluating the environmental profile of the materials, components and systems at the same time with costs over the whole life cycle.

This task will be carried out in conjunction with the Annex 57 Evaluation of Embodied Energy & Carbon Dioxide Emissions for Building Construction (<http://www.iea-ebc.org/projects/ongoing-projects/ebc-annex-57/> )

# Deliverables and Target Audience

The deliverables from Annex 65 will be a well-defined set of documentation, as:

* A report on the state of the art on SIM, available on the market, as well as components and systems integrating SIM.
* Recommendations on how to characterize SIM
* Recommendations on how to perform reliable testing of components and building integrating SIM
* Guideline of appropriate applications and installation methods
* A synthesis report and a summary for larger dissemination.

The target audience and Annex beneficiaries are:

* ISO, CEN, UEATc, EOTA
* The Building Research Community
* The supply chain : material, component and system
* Engineering offices and consultants
* Building contractors with an interest in high performance systems

The specific deliverables and related subtask are listed below:

|  |  |  |  |
| --- | --- | --- | --- |
| Ref. | **Deliverables** | Related subtask | Target Audience |
| *D1* | *State of the Art and Case Studies report* | ST1 | Supply Chain |
| *D2* | *Scientific Information for Standardization Bodies dealing with Hygro-Thermo-Mechanical Properties & Ageing report* | ST2 | CEN, ISO, EOTA, UEATc, Testing laboratories  Materials Manufacturers |
| *D3* | *Guidelines for Design, Installation & Inspection with a special focus on Retrofitting* | ST3 | Designers, Engineers, Contractors, Builders |
| *D4* | *Report on Sustainability Aspect (LCC, LCA, EE …)* | ST4 | Engineers & Designers |

The foreseen outreach activities with corresponding target groups are:

|  |  |  |
| --- | --- | --- |
|  | Outreach Activities | Target Group |
| 01 | Internet Site & Annex New letter | Building Research Community  IEA-EBC program |
| 02 | Network of Excellence on Measurement Methods | Building Industry & Research Community |
| 03 | International Workshop | Building Industry Stakeholders |

# Management

The management of the Annex is done by the core team, consisting of the Operating Agent assisted by the Task Leaders. The Operating Agent is responsible for the overall performance and the time schedule of the Annex, for reporting and for information dissemination activities. The Task and Subtasks Leaders are participants who provide a high level of expertise to the task and subtask they manage and undertake substantial research and development in the field of the subtask. Duties of the Task and Subtask Leaders are: co‐ordinate the work performed under the subtask; assist the Operating Agent in preparing the detailed work plans; direct the technical workshops of the subtask and provide the Operating Agent with the workshop results; coordinate the technical reports resulting from the Subtask; assist the Operating Agent in editing the final reports of the Annex.

# Link with EBC Strategy Plan

Looking at the global mission of IEA EBC (to develop and facilitate the integration of technologies and processes for energy efficiency and conservation into healthy, low emission and sustainable buildings and communities, through innovation and research) as well as to the strategic plan 2007‐2012 ‘Towards near‐zero primary energy use & carbon emissions in buildings and communities’, the proposed research project is clearly in line with the defined objectives. By introducing a strategy to measure and characterise the super-insulating materials and to evaluate their long term performances, the Annex‐project will contribute to reduce the energy consumption of existing and new buildings.

The IEA EBC strategic plan foresees three focus areas of R&D activities to impact the building industry to realise near‐zero primary energy use and carbon emissions in buildings and communities: dissemination, decision‐making and building products and systems. The proposed Annex‐project is active on the latter one. Furthermore, the Annex will help to develop and improve performance information mechanisms.

# TIME SCHEDULE

After the workshop in Brussels (April 27 – 2012) an international expert meeting has been organised, in Paris (April 18-19 2013) involving participants from Belgium, France, Germany, Republic of Korea, Netherlands, Spain, Sweden, Switzerland, Turkey, UK. Canada, China, Greece, Italy, Norway and USA were not able to attend the meeting but have expressed interest to participate in this new Annex.



Figure 6: Picture taken at the expert meeting

(PARIS, 18-19 of April 2013).

A second meeting has been organised in Zurich, the day before the IVIS Symposium on September 17. The objectives of this second symposium were to revise the Annex Text according to the recommendation given by the ExCo at the meeting in Rome on June. In Zurich, Canada, China, Italy & Norway have joined the working group.

An overview of the preparation phase and the proposed time schedule of the project are given in the next Table.

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Preparation Phase | | | Working Phase | | | | | | |
| Task | 2013 | 2013 | 2014 | 2014 | 2015 | 2015 | 2016 | 2016 | 2017 | 2017 |
| T1 (ST1A, 1B, 1C) |  |  |  |  |  |  |  |  |  |  |
| T2 (ST2A, 2B) |  |  |  |  |  |  |  |  |  |  |
| T3 (ST3A, 3B, 3C) |  |  |  |  |  |  |  |  |  |  |
| T4 (ST4A, 4B) |  |  |  |  |  |  |  |  |  |  |
| Meeting | April | Sept. | ExCo | sept | april | sept | april | sept | april |  |

# FUNDING AND COMMITMENTS

During both preparatory meetings (Paris & Zurich) several countries showed interest in participating in the proposed Annex. Most of them have already a lot of expertise and know how within some of the topics of the Annex.

Each participant commits to work in at least one of the subtasks and takes it responsibility in writing the final reports. Each participant shall individually bear its own costs incurred in the annex activities. Funding is expected to cover labour costs, consumables and investments associated with the execution of the subtasks. Also travelling costs should be covered to participate in at least two expert meetings per year during the four year working phase of the annex.

All participating countries have access to the workshops and results of all subtasks. Each participating country must designate at least one individual (an active researcher, scientist or engineer, here called the expert) for each subtask in which they decide to participate. It is expected that the same expert attends all meetings and acts as technical contact regarding the national subtask contribution.

## 8.1: Funding

*Semi-annual meetings:* The working meetings shall be hosted in turn by one of the several participants. The costs of organizing the meeting shall be borne by the host participant.

*Task sharing activities:* Each participating country shall commit a minimum of six person-months of labour for each year of the Annex term. In addition, the Operating Agent shall commit a further three person-months per year and the attendance at the semi-annual Executive Committee meetings.

*Individual financial obligations:* Each participating country or, in case the country is not a member of the Executive Committee, the participant, shall bear all costs it incurs in carrying out the Annex activities. Funding is expected to cover labour costs, consumables, investments, reporting (included eventual overhead costs) and travelling for participation in two expert meetings per year during the four years working phase of the Annex.

*Publications:* The costs of publishing the final reports shall be met by the Operating Agent.

## 8.2: Specific obligations and responsibilities of the participants

Each participant shall work in at least one of the task of the Annex.

Each participant shall provide the Operating Agent with information and written material on the work carried out in the task she or he is working on.

Each participant shall participate in reviewing the final report of the work package she or he is working on.

Each participant shall attend the semi-annual Annex working meetings. If several people from the same country participate, that country should designate at least one expert to act as a technical contact regarding the national contribution.

## 8.3: Specific obligations and responsibilities of task and subtask leaders

Tasks are managed by a task leader whose task is to:

* Coordinate work
* Assist the Operating Agent (OA) in preparing detailed work plans.
* Chair the task and subtask discussions of the semi-annual Annex meetings and provide the OA with the results.
* Secure coordination of the work packages.
* Coordinate the final reporting resulting from tasks.
* Assist the Operating Agent in editing the final reports of the Annex.

The task leader is a participant who provides a high level of expertise to the work they manage and undertake substantial research and development in the field of the work packages. They are confirmed by the Annex participants.

## 8.4: Specific obligations and responsibilities of the Operating Agent

The additional duties of the Operating Agent are:

* Preparation of a detailed working program for the Annex in consultation with the Annex participants and submit the program for approval to the Executive Committee
* Providing the participants with the necessary guidelines for the work they have to carry out.
* Coordination of the efforts of the participants and the flow of information.
* Preparation and chairing of the Annex working meetings
* Reporting the results of the Annex meetings to participants and the Executive Committee
* Preparation of the reports, together with the participants
* Publication of the reports, after approval by the Executive Committee. That approval should be gained at the latest six months after completion of the Annex
* Providing semi-annual reports to the Executive Committee on the progress and the results of the work performed under the Annex
* Performing such additional services and actions as may be decided by the Executive Committee, acting by unanimity

## 8.5: Information and intellectual property

All Annex related information will be stored in an Annex website. Each participating country and each participant has access to a password protected part of that website through a password. The site will be managed by the Operating Agent. For the duration of the Annex, all specific Annex documents, except published reports and general Annex information, are considered not to be public domain.

All Annex participants have the right to publish congress and journal papers that report on Annex related work. When doing so, the Annex shall be acknowledged as one of the vehicles that assisted in carrying out the work. All final reports will be public domain.

## 8.6: Operating agent and work package leader

The designated Operating Agent is: Daniel Quenard, Head of the Division “Envelope and Innovative Materials”, CSTB - France. He is mandated by the French Energy Agency ADEME.

## 8.7: Participants

Belgium, France, Germany, Republic of Korea, Spain, Sweden, Switzerland, Turkey, UK, Canada, China, Greece, Italy, Norway, Japan

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