INNOVATIVE CHEMISTRY

FOR ENERGY EFFICIENCY OF BUILDINGS IN SMART CITIES

SusChem
European Technology Platform For
SUSTAINABLE CHEMISTRY

Authors

LASZLO BAX
(Partner, Bax & Willems Consulting Venturing)

JUDITH CRUXENT
(Consultant, Bax & Willems Consulting Venturing)

JACQUES KOMORNICKI
(Innovation Manager, European Chemical Industry Council)

Credits

Graph 3: BASF

Figure 1: Shutterstock image

Figure 2: MAPEI brochure

Figure 3: article reference 06

Figure 4: Shutterstock image

Figure 5: Arkema

Figure 6: akzo nobel

Figure 8: dowcorning

All other images: Shutterstock

Examples

Pictures demonstrate the real life application of the Key Innovations presented

Edited by

Esther Agyeman-Budu, Lorenzo Marchese and Tim Reynolds

Design, Layout and Illustration

Global Concept Consulting

Copyright

TABLE OF CONTENTS

1 INTRODUCTION

Cities are crucial to the social, economic and entrepreneurial development of the European Union[1]. Today, almost 75% of European citizens live in cities and this trend will continue to increase during the coming decades. Modern and sustainable cities should be viewed as large complex systems in which both existing and new infrastructure and technologies are integrated into urban ecosystems (citizens, transport, buildings and green areas).

Covenant of Mayors

To support the creation of sustainable and healthy cities, the Covenant of Mayors [2] was launched in 2008 to assist local authorities to implement sustainability policies. Currently, an impressive 5 074 cities have committed to meet the EU's 20-20-20 objectives (20% reduction in emissions, 20% renewable energies and 20% improvement in energy efficiency) by 2020. City Officials hope to achieve this objective through improvements to the performance of their buildings, equipment and facilities as well as their transport system and energy supply and distribution systems, and by working with citizens and other related stakeholders.

Cities are key to achieving the sustainability objectives of the EU; however, they face several challenges in meeting these targets. The major challenges include a growing urban population, a forecast increase in energy consumption per capita and the ageing of Europe's building stock, which was built predominantly between the 1960's and 1980's when installing building insulation was not common and the concept of sustainable living was not a societal concern. Additionally, most policy makers are not fully aware of the available technologies for energy efficiency or the energy efficiency issues in the current building stock. Concurrently, solution providers are developing sustainable technologies that are not always fully suitable for the reality of today's cities. To help bridge this gap the Smart Cities Stakeholder Platform was established[3].

The Smart Cities Stakeholder Platform

The Smart Cities Stakeholder Platform promotes innovation as part of the Smart Cities and Communities European Innovation Partnership (EIP on SC&C) of the European Union. It aims to accelerate the development and market deployment of energy efficiency and low-carbon technology applications in the urban environment. The main focus is to integrate technologies, available funds and value chains to offer viable solutions to the challenges that European cities face. The Platform brings together municipalities, technology providers, financiers and specialists to work together to implement smart city strategies at a local level.

Within the EIP on SC&C, stakeholders[4] working in several expert Working Groups (Energy Efficiency and Buildings, Energy Supply and Networks, Mobility and Transport Information and Communication Technology (ICT), and Financial Issues) have submitted very promising solutions, referred to as Key Innovations (KI), to address the challenges facing city officials and accelerate their objective of meeting EU2020 targets. Key Innovations will be an integral part of the recommendations in the roadmap being drafted by the Smart Cities Stakeholder Platform. This document presents one such KI proposed by the European Technology Platform (ETP) on Sustainable Chemistry: SusChem which has been adopted by the Smart Cities Stakeholder Platform.

1·EU (2011):CITIES OF TOMORROW. CHALLENGES VISIONS, WAYS FORWARD: HTTP://EC.EUROPA.EU/REGIONAL_POLICY/SOURCES/DOCGENER/STUDIES/PDF/CITIESOFTOMORROW/CITIESOFTOMORROW_FINAL.PDF
2·WWW.CONVENANTOFMAYORS.EU
3·HTTP://EU-SMARTCITIES.EU/
4·SOLUTION PROPOSALS ARE PUBLISHED ON THE WEB: HTTP://EU-SMARTCITIES.EU/SOLUTION-PROPOSALS

ETP on Sustainable Chemistry: SusChem

Chemistry is at the root of many innovations and has often been a driver for change, even though its innovation accomplishments are often not highly visible to the consumer. The chemical sector strongly believes that it can help Smart Cities to achieve their objectives by collaborating closely along the entire value chain and with the cities themselves.

SusChem represents all stakeholders from the chemical sector including large international companies together with SMEs, research centers and academic representatives. Through this KI document, SusChem and the chemical sector intend to draw attention to a selection of currently available chemistry-enabled products that can improve energy efficiency in buildings and, in particular, enable the refurbishment of existing buildings.

Purpose of this document

Our aim is to provide city officials a first introduction to the proposed Key Innovations by describing their performance and technical characteristics. We also detail the conditions for optimal use such as the availability of technical expertise, adequate regulatory frameworks and the required investment.

We also hope to encourage the adoption of the Key Innovations described in this document by identifying and dispelling the barriers to their deployment. It is intended as a starting point for further dialogue between the demand side (the cities) and the supply side (the chemical industry working together with the entire building value chain).

It is important to stress that the recommendations in this document are not a technical proposal or a full evaluation of the described innovations. Its purpose is to help city officials identify potential solutions, allowing them to take subsequent steps to envisage the possibilities for future actions in their specific situation and outlook. This document does not substitute for a detailed cost-benefit analysis or an implementation plan that would need to be developed for city officials who wish to introduce the proposed innovations in their cities. Following, we review the current status of Europe's building stock.

1.1 Review of Europe's building stock

According to the European Construction Technology Platform (ECTP) there are around 180 million buildings in Europe. However, only around 65 000 are currently estimated to be so-called Passive House buildings[5] (0.04% of the total amount). Although a building can be labeled 'sustainable' without reaching the rather stringent Passive House[6] requirements, only a small percentage of the present building stock in Europe can be considered to be really energy efficient.Every year approximately 1.6 million new buildings are constructed in the EU-27, which is the equivalent of around 1% of the total building stock. Simultaneously, around 1.7% of the existing building stock is refurbished (including all kinds of refurbishments, from 'light' to 'deep' interventions). On the contrary, most studies supporting policy-making in the sector suggest that the refurbishment rate needs to rise to at least 3% of existing building stock annually to reach the building and energy efficiency related objectives outlined in the Europe 2020 vision.

That would mean roughly doubling the present rate of 1.7%. Such an increase in refurbishment rates will not only require substantial regulatory streamlining but also the selection of easy-to-implement technologies like the KI described in this document.

A recent study[6] by the Buildings Performance Institute Europe (BPEI) has made an inventory in terms of total m² of buildings. The results are summarized in GRAPH 1.

5·Refers to a voluntary standard for labelling energy efficiency in buildings
6·Refers to houses designed to have ultra-low /near zero energy efficiency

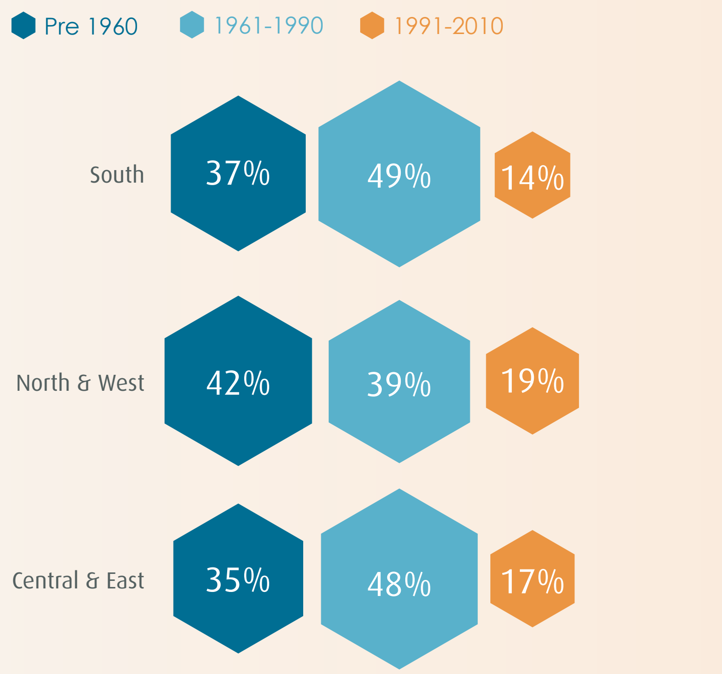
In general, buildings have improved over the years in terms of energy efficiency; consequently older (not previously renovated) buildings have more potential for improvement than newer buildings. BPEI has examined the age distribution of the buildings in Europe (GRAPH1)

From the graph, we can see that the vast majority of buildings date from before 1990. But, more importantly, 40-50% of the existing buildings are pre-1960 and would benefit substantially from the adoption of energy efficiency measures such as the ones proposed in this document.

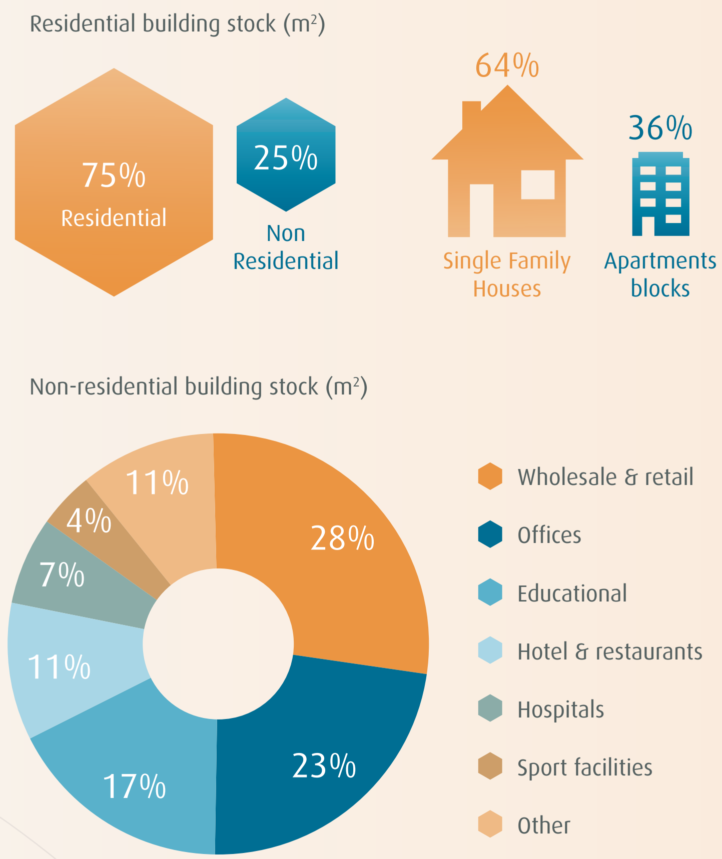
With an average energy consumption of 280 kWh per m² in non-residential buildings (with floor space of 6.25 billion of m² in Europe) and with residential buildings (with 18.75 billion m² of floor space) consuming 40% less (170 kWh/m²/y), it is easy to calculate how much energy is consumed, and also how much could be saved if we could reduce energy consumption by 40% across Europe.

It is interesting to note that while energy consumption in residential buildings has dropped across Europe, the energy consumption of commercial buildings has actually increased by 74% over the last 20 years. The breakdown between residential and non-residential buildings is shown in GRAPH 2.

GRAPH 1 • Age Categorisation of Housing Stock in Europe into three regions



GRAPH 2 • European Buildings at a Glance



2 PRESENTATION OF THE KEY INNOVATIONS

2.1 DESCRIPTION OF THE KEY INNOVATIONS

When assessing the key challenges for cities, energy efficiency in buildings should be addressed by taking into account the fundamental differences between new buildings and the existing other building stock. For new buildings, many assessments and projects exist that show that the added cost of 'near zero emission' buildings does not usually exceed the cost of 'normal' buildings by more than 8%. This limited difference in price is compensated, in most markets, by the higher value that building owners (and developers or tenants) put on such new buildings. For this reason, experts have predicted that market dynamics, in combination with regulatory pressure on new buildings, will drive the industry to predominantly produce 'near zero emission' buildings from 2016 onwards. However, as stated before, only 1% of the current total amount of buildings is constructed every year.

Clearly we do not wish to wait for the natural lifecycle of new buildings replacing old ones to achieve all or most of our buildings at 'near zero emission' (it would take 100 years at 1% annual replacement). As a result, we need to address the refurbishment of existing buildings. Especially since the evaluation of the business case for the refurbishment of existing buildings is often more challenging.

The costs of deep refurbishment of buildings, including substantial energy efficiency measures, can range from a few hundred euros/m² up to almost €1000/m². The latter cost estimation is actually close to (or greater than) the cost of constructing a new building from scratch in some parts of Europe (for example, in medium sized cities in Spain). Thus, in order to address the huge challenge of affordable building refurbishment, in order to achieve both substantial energy savings and reduce costs to a more affordable investment, we need to select interventions very carefully, looking for ideas which are cost effective. This is exactly where the chemical industry can play a part and offer some very attractive solutions that, when combined together, can really offer substantial energy savings at an acceptable cost and with minimal inconvenience to building occupants.

In this document, we propose combining five solutions developed by the chemical industry that can bring significant energy savings:

1. Reflective indoor coatings
2. High reflectance and durable outdoor coating
3. Phase Change Materials (PCM)
4. Advanced insulation foams
5. Vacuum insulation panel (VIP) modules

1. Reflective indoor coatings

By reflecting light more effectively than conventional paints, these coatings maximize the feeling of space and illumination. These coatings optimize the use of natural and artificial lighting and can help trap the radiative heat energy of the sun inside the building during the winter. Consequently, a lower consumption of energy is needed for artificial lighting due to the perceived increase in illumination (increased perceived light can be up to 20%, equivalent to a 20% reduction in energy consumption due to optimized light perception).

In recent tests, these new reflective indoor coatings have shown a life expectancy of at least 5-10 years without any decline in performance and their production cost is only marginally higher than that of common good quality paints. The effect of using these coatings is most evident in climate zones which suffer from limited daylight intensity and duration (North and Central Europe).

2. High reflectance and durable outdoor coatings

These coatings reflect sunlight radiation both from the visible and from the infrared parts of the spectrum. When they are applied to roofs and walls, the reflection of the sun's energy reduces roof and wall temperature and as a result reduces the heat in the spaces underneath the roof and inside the walls.

The outdoor application of these innovative and resilient coatings can save up to 15% of energy required for air conditioning, while also allowing for the downscaling of your air conditioning system itself. Life expectancy of this technology is between 12 and 15 years depending on the local climate.

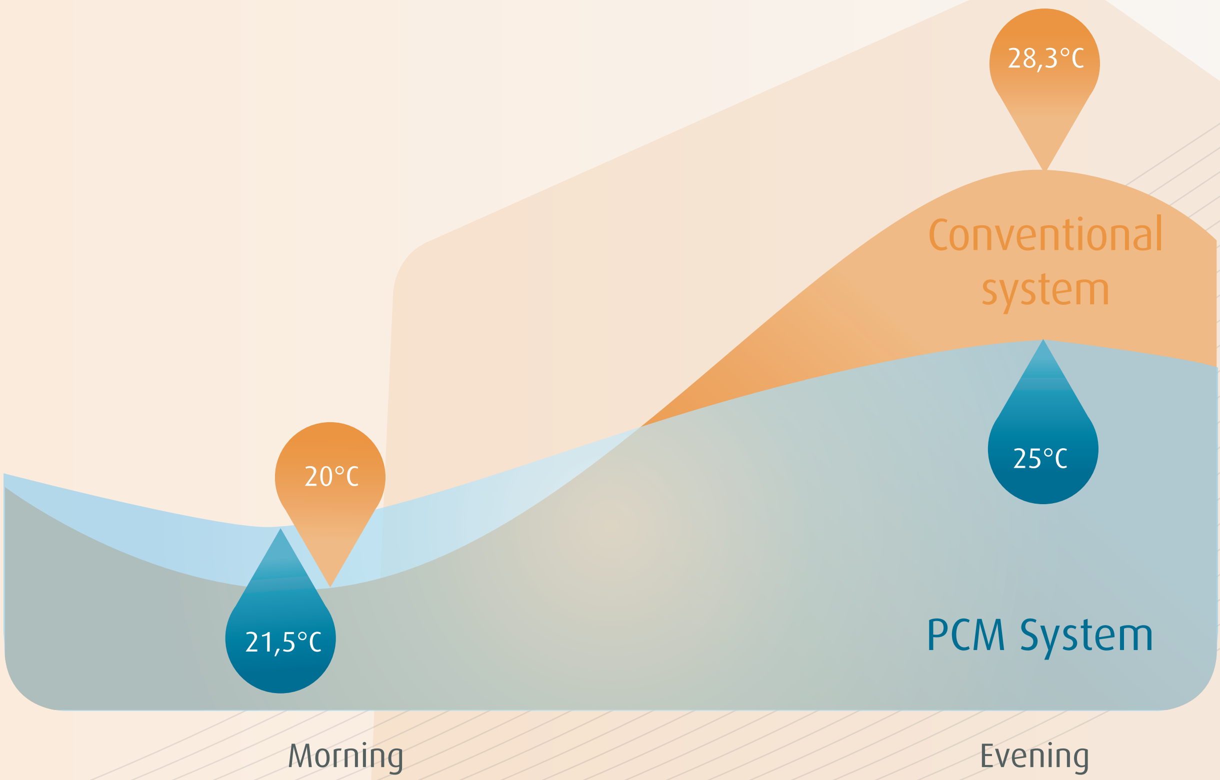
These coatings can be applied at reasonable costs and offer reasonable payback times. If maintenance and renovation is needed, the choice of a high quality, low LCA (life cycle analysis) solar reflecting paint is a safe and smart investment, especially in sunny, Southern European cities.

3. Phase Change Materials (PCM)

PCM are available on the market as an active ingredient in a range of semi-finished materials: plaster, cement, plasterboard and multifunctional wall and roof modules.

When used in interior walls and/or ceilings, PCM enables the walls and ceilings to absorb and store excess heat during the day and then dissipate it during the night when air temperatures have dropped. Basically, PCM increases the thermal inertia of the walls and ceilings and reduces variations in the internal temperature (especially by reducing the amount of time that the internal temperature exceeds 26°C – the normal threshold to initiate active cooling) and thus save energy (see GRAPH 3), in an effect comparable to the old-fashioned thick stone walls found in buildings from previous centuries. Examples of PCM use have shown that up to 10% of the energy required for cooling can be saved.

In recent tests, PCM has also demonstrated a life expectancy of 30 years without any decline in performance.



GRAPH 3 • PCM system make temperature more constant

4. Advanced insulation foams

Advanced insulation foams allow for significant energy savings and can be adapted to different building configurations. It is estimated that these high performance foams can reduce the energy costs for heating by 30% to 80%.

1 INSULATION IN WALL CAVITIES

Cavity wall insulation fills the space (cavity) between the two layers of the external wall of a building.

As illustrated in Figure 1, an existing building's wall cavity can be injected with foam as part of an energy efficiency refurbishment. In the case of new construction, normally the cavity is filled using rigid pre-foamed panels attached to the wall.

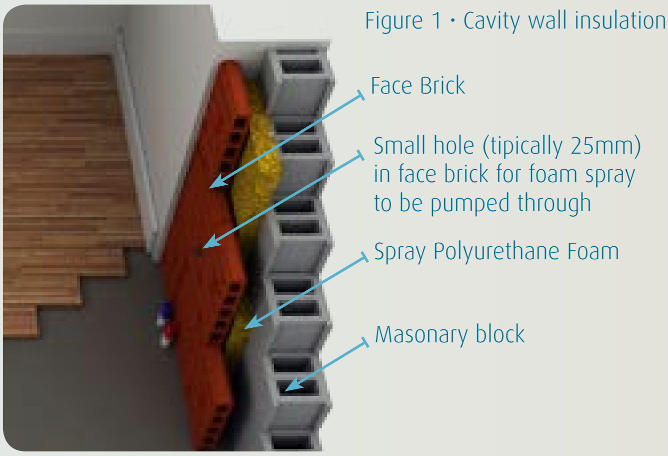


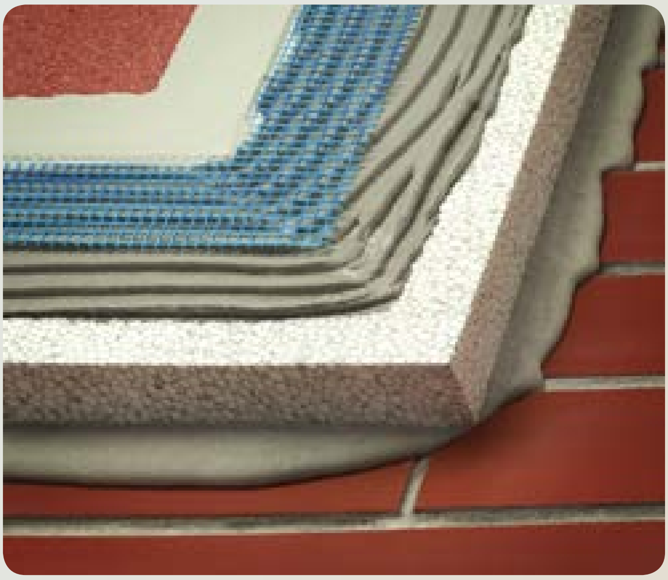
Figure 1 · Cavity wall insulation

2 EXTERNAL INSULATION

In cases where no wall cavity is present, it is possible to insulate the external walls of the building from the outside. This approach maintains the thermal storage capacity (thermal inertia) of the building's external walls, thus keeping temperature fluctuations at acceptable levels.

Each insulation 'stack' is composed according to the specific characteristics of the wall, local climate and the orientation of the building. Apart from the level of thermal insulation, other selection criteria for the choice of insulating material include fire resistance, mechanical strength, stability, water absorption, permeability and cost. For most applications, the life expectancy of these insulation facades is up to 20 years (see Figure 2).

Figure 2 · External wall insulation



3 INTERNAL INSULATION

In the case of historical buildings, as often found in Europe's older cities, it is also possible to insulate from the inside. By applying a layer of high performance insulation foam covered with, for example, plaster or plasterboard, the same effect as external insulation can be obtained without altering the external appearance of a building. On the other hand, obvious disadvantages include loss of net interior space (due to the thickness of the insulation layers) as well as an effect the reverse of that for PCM: by insulating the interior space from the dampening effect of the stone walls, the thermal inertia of the building is reduced, making it susceptible to greater temperature fluctuations under certain climate conditions.

5. Vacuum insulation panel (VIP) modules

Vacuum insulation panel (VIP) modules provide a degree of design freedom when refurbishing buildings with glass facades. Their insulation performance is almost three times higher than conventional insulation materials. Until recently, VIP were seldom used in buildings due to their fragility (the risk of damaging the vacuum by perforation). However, recent products encapsulate the vacuum inside a double glazing package. This new development makes the use of VIP possible in building facades that need a significant improvement in their thermal insulation performance.

At the moment VIP is still substantially more expensive than conventional insulation materials, partially because this innovation is still in its market introduction phase. Therefore, with an increased market uptake the price can be expected to come down [7].

In Figure 3 the main components of a VIP can be seen:

A VIP with fumed silica core has an average thermal conductivity of 0.004 W/(m·K). Thermal bridges created by the panel edges made with aluminized films increases the mean thermal conductivity of VIP. These technologies provide long-term insulation performance, with very limited loss of efficiency (~20%) over the first 30 years of use.

The combination of these five technologies could, on average, result in overall energy savings for heating and air-conditioning up to 40%. The exact amount of savings will depend, of course, on the type and location of the actual project building.

NOTE: It is important that these technologies are integrated within the global (re)design of buildings; for instance a building with issues of thermal bridging will only benefit fully from these high performance materials if the thermal bridges are addressed during refurbishment.

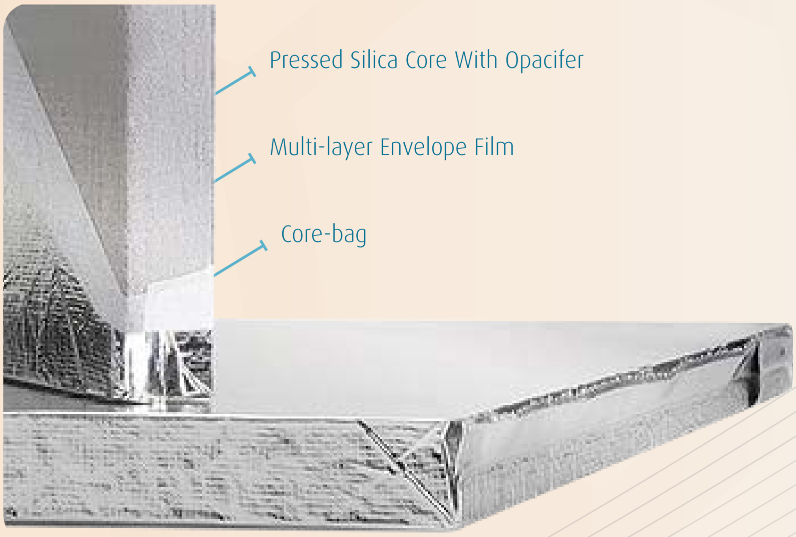


Figure 3 · Vacuum Insulation Modules

2.2 Technical feasibility

These five innovative solutions to the problem of energy efficiency in buildings are already available for large-scale use, as shown by their technical feasibility and maturity. They have reached a high ratio of reliable performance, have shown resilience under normal operating conditions and are also sufficiently easy to handle enabling trained construction workers to apply them successfully.

The application of thermal reflection coatings and/or light reflection coatings is a fairly straightforward process. The application of PCM usually involves using plaster, aerated cement or plasterboard that incorporates PCM particles, and thus the application process is equivalent to that of normal plaster application: a traditional skill in the construction industry. The insulation systems described have been applied for decades in certain countries and efficient application methods are available for any type of building.

The application of VIP panels packaged in double pane glass modules is the least wide-spread of the technologies; however for this product several success cases are also available to demonstrate the technical feasibility and viability of this innovation.

7· VACUUM INSULATION IN THE BUILDING SECTOR: SYSTEMS AND APPLICATIONS.
INFORMATION CAN BE FOUND IN: HTTP://WWW.ECBCS.ORG/DOCS/ANNEX_39_REPORT_SUBTASK-B.PDF

3 IMPACTS

3.1 EXPECTED IMPACTS

LEVEL OF DEPLOYMENT

Since 2012, these five technologies have been deployed in many hundreds of buildings all over the world, both for new buildings and in refurbishment projects. In terms of the use of insulation foam solutions, the numbers probably run into hundreds of thousands of buildings. For each of the solutions presented here, substantial production capacity is already in place to allow for large scale adoption. On the contrary, market uptake has been slow due to general inertia, an attachment to the use of traditional materials in the sectors involved and a lack of awareness among decision makers. In addition to these factors, the low market demand is presently limiting production volumes and as a result the price levels in the marketplace are less than ideal. Consequently, this situation creates the further inconvenience of longer payback times for the additional investment related to the use of these advanced materials and coatings. As such, a typical chicken and egg situation exists: until market demand grows, prices will remain higher than if mass production were possible; until prices drop, market demand will be sluggish unless specific measures are taken to address this (temporary) market failure.

In Figure 4, an example is shown of a 1980's residential building being treated with wall cavity insulation. This type of intervention has been common practice for many decades now in Northern European countries, where the lower winter temperatures and longer heating season result in a shorter payback time on the investment. Nonetheless, with present energy costs and the anticipated further rise in energy prices in the future this intervention is also becoming financially more attractive in the southern parts of Europe. The chemical industry is promoting these measures using its own traditional communication channels with the market, but an active promotion by local and regional governments could speed up adoption substantially.

Focusing on 'cool roof' coatings, relentless R&D activities by the chemical industry has now delivered coatings that reflect solar radiation energy much better than conventional roofs, and provide a reliable performance for at least two decades after application. The last generation of these coatings has, especially, improved on durability compared to earlier products, which often could not withstand the severe climate conditions found on rooftops. Figure 5 illustrates the typical before-and-after situation and also demonstrates the ease of implementation. Building inhabitants confirmed a very noticeable temperature reduction after the reflective coating had been applied.

Roof coatings have been used for the last 12 years in a wide range of buildings, especially in US. One of the first well documented application in Europe was in a warehouse in the South of Spain about eight years ago.

Interior coatings are still primarily applied for esthetic reasons. Interior designers of offices and private homes alike seek freedom to select from a range of colours. Once again, the chemical industry has spent decades of substantial R&D effort to devise products that optimize the use of available light (either natural or artificial) while also providing the freedom to choose the colour that fits best with esthetic demands of the particular space. The illustrations in the next page (see Figure 6) show both the natural light case (allowing for a window 20% smaller than planned while offering the same perceived light inside) as well as the artificial light case (where the coating allowed a reduction in lighting energy consumption of 20%).

A more factual illustration (see Figure 7) exemplifies the difference between a 'normal' white wall coating and a typical light reflective coating in a lighting research setup. Both spaces are lit using a 360 lux light source, but the reflective coating is much brighter than the conventional coating.

Perhaps the least mature solution of the five technologies proposed is the VIP modules. Vacuum Insulation panels were developed a few decades ago, but their actual market application has been limited to special high performance cases in high end professional refrigerators and deep-freezers.

In the building sector VIP technology has been tried in some pilot projects, which showed that without special protection VIP is too vulnerable to survive in buildings for housing. However, the elegant solution of packaging the VIP technology into a double glazing module completely overcomes this weakness. Even though this technology has been launched in the market quite recently, more than ten VIP construction projects have already been completed.

In Figure 8 one can appreciate the complexity of the latest Architectural Insulation panels developed by the chemical industry combining the necessary esthetics for modern buildings and the energy savings benefits of VIP panels.

These examples illustrate just a few of the specific products that the chemical industry suggests for the development of Smart Cities in Europe as affordable, smart solutions to enable buildings to consume less energy while keeping investment levels affordable.

Figure 4 • Advanced insulation foams

Figure 5 • High reflectance and durable outdoor coatings (before)

Figure 5 • (after)

Figure 6 • Reflective indoor coating

Figure 7 • Differences between Conventional coating and reflective indoor coating

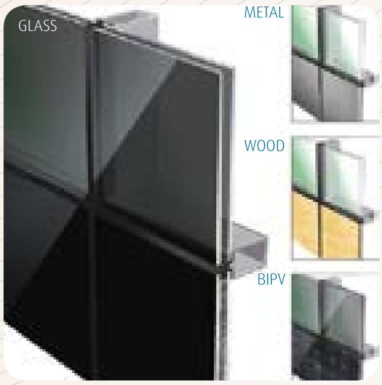


Figure 8 • VIP Inovative Design

3.2

EXPECTED ENERGY SAVINGS

As with all technologies that reduce the energy consumption of buildings, the expected savings are best expressed as a typical figure for the kilowatt hours (kWh) of energy saved per year per m². Estimating that the total energy consumption for residential buildings averages around 200 kWh/m² across Europe and factoring in a potential heating and/or cooling cost savings of 40%, the net saving in the residential segment could be up to 56 kWh/m². Given that electricity costs between 10-25 cents per kWh (EU median is €0.17) and gas prices range from three to 12 cents per kWh (EU median is €0.06) one can calculate that a typical gas heated 100 m² apartment could save 100 x 56 x €0.06 = €336 per year.

In energy terms this would amount to around 5600 kWh per apartment saved per year. Taking a European perspective rather than an individual household perspective, one could calculate the total potential savings that can be achieved if an additional 1% of the existing residential building stock was refurbished annually. This would involve 187,5 million sqm (1% of the BPEI estimates for the EU27). Saving 56 kWh per sqm then delivers some 10,5 billion kWh saved.

For non-residential buildings, a similar calculation based on the 6,25 billion m² quantified by the BPEI and the average energy consumption of 280 kWh in such buildings leads to a total annual energy savings of 4,9 billion kWh. Assuming an average energy cost of €0.10 per kWh (offices pay less for their energy, but use more electricity for substantial cooling needs) this would provide annual financial savings of €490 million. More importantly though, if the energy efficiency measures are fully integrated into a general plan for deep refurbishment, the initiative would guarantee the long-term market value of these non residential buildings, allowing them to be profitably rented out for at least another two decades by their owners.

It must be clear that for many of these buildings (especially commercial property) the option to do nothing is not a realistic one. In many parts of Europe, the last decade (2000-2010) has created an oversupply of office space that for the near future will continue to exceed predicted demand. The tendency to work from home is now more widespread and the increased mobility of the workforce is leading companies to reduce their office floor space, while at the same time seeking more sophisticated office environments. Most large scale office building owners are adjusting their property portfolios towards green and modern buildings; it is especially the local, smaller scale office space owner that needs to be supported to develop an adequate sustainable development strategy. In this scenario, municipality officials can play a key role in raising awareness and supporting concrete measures that help to keep the available occupied office space occupied thus ensuring that empty buildings do not start urban degeneration in their neighborhoods.

3.3

EXPECTED IMPACT ON GHG EMISSIONS

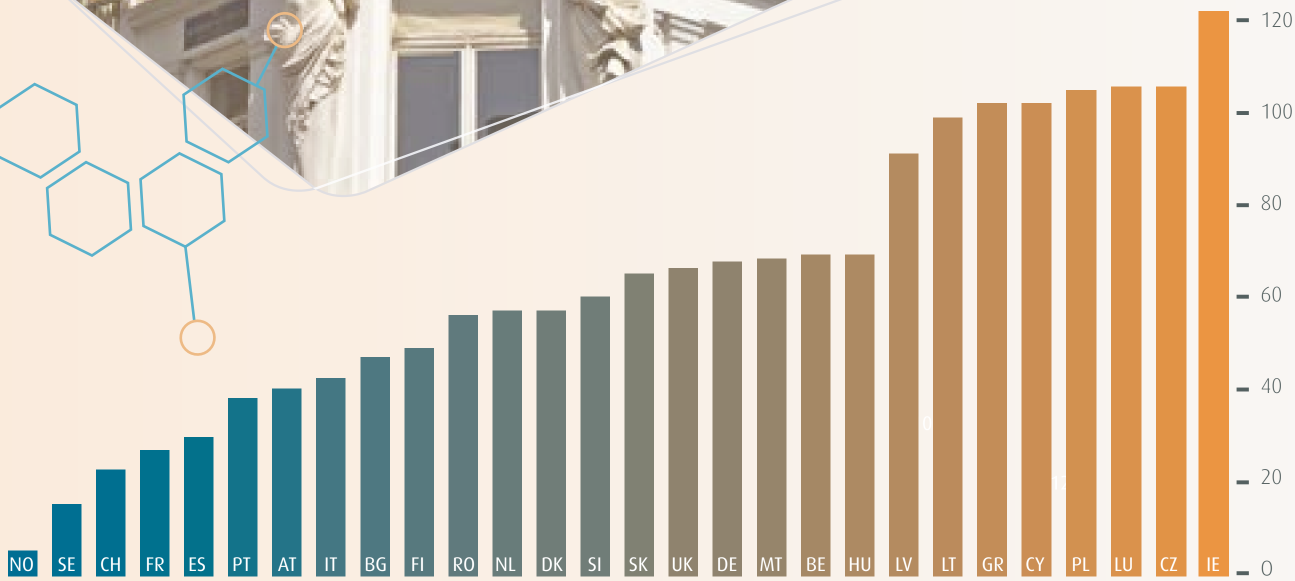
Greenhouse Gas (GHG) emission reduction associated with these energy savings depends on the chosen energy source mix. If we take the EU-27 average mix of 2011 then the relationship is around 360g of CO_2 per kWh saved[9]. Thus the energy savings in both residential and non residential buildings calculated previously would deliver a reduction of CO_2 emissions of some 5,54 million tons[10] One can make country specific calculations using available statistics regarding the estimated quantity of CO_2 each EU country emits through building use[11]. The graph opposite indicates the CO_2 emissions per m² in each of the EU countries (see GRAPH 4).

As can be seen in the graph, there is a trend for the countries with the highest economic productivity to have the best performing buildings. Also it is possible to see the impact of climate on CO_2 emissions; Mediterranean countries have lower CO_2 emissions per m² because the regional climate requires less heating energy.

Certainly, one should not only focus on the CO_2 emission numbers when evaluating sustainability. The full environmental impact is not based on GHG emissions alone but also on many other different factors including energy demand from non-renewable and renewable resources, acidification, eutrophication, abiotic resource depletion, photochemical oxidant formation, farm land use, ozone depletion and smog creation.

In order to make a balanced judgment about the 'green' credentials of a particular refurbishment, data on each of these factors must be

8•ASSUMING 70% OF OVERALL ENERGY CONSUMPTION BEING USED FOR SPACE HEATING & COOLING
9•G CO_2 /KWH (AVERAGE EUROPE): 360 G CO_2 (BY EUROPEAN COMMISSION).
10•10,5 BILLION KWH RESIDENTIAL + 4,9 BILLION KWH NON RESIDENTIAL MULTIPLIED BY 360 GRAMS PER KWH = 5,54 MILLIONS OF TONS OF CO2 FOR BOTH CATEGORIES TOGETHER, AGAIN ASSUMING 1% REFURBISHMENT BEING ADDED TO 'BUSINESS AS USUAL'



GRAPH 4 • Kg CO_2 emissions per m^2

taken into account. The chemical industry has assessed all these factors in its calculations and is now ready to offer its findings to its value chain partners, allowing for well informed choices to be made by all stakeholders.

As an example of the complexity of the issues presented here, we can compare the environmental impact of PUR foam, EPS foam, mineral wool and organic insulation products.

To draw our comparison, we will analyze two peer reviewed journal articles on the Life Cycle Analysis (LCA) of these materials . According to the authors' conclusions, insulation products can be ranked by their non-renewable energy use, abiotic resource depletion, and global warming potential. In relation to these factors, the most environmentally friendly products are organic products, EPS Foam, PUR Foam and mineral wool. However, organic products have the highest eutrophication potential and the second highest acidification potential and involve the use of farm land. Mineral products scored worst in land use related to mining. Mineral products need the highest density and thickness to reach the same thermal insulation as offered by chemical (foam) products. EPS foam has the lowest contribution to acidification and the highest contribution to photochemical oxidant formation. In contrast, PUR foam has the lowest contribution to photochemical oxidant formation. Disposal of organic and EPS foam products lead to a lower environmental impact than PUR foam and mineral products, which are normally incinerated. As it can be appreciated by this analysis, it is hard to give simple answers when it comes to all these issues.

Other studies[12] have performed a LCA on Vacuum Insulation Panels (VIP) comparing them to EPS foam and glass wool. The results show that VIP products have the same global-warming potential as EPS but perform best in their use of fossil resources. VIP has a more negative environmental impact in other categories such as acidification, photochemical oxidant formation, eutrophication and energy use. Most of the components for VIP are produced in highly energy-using processes. However, the report concludes that the overall environmental impact can be reduced with increasing market uptake of Vacuum Insulation Panels.

11•J. NOORDEGRAAF, P.MATTHIJSSEN *ET ALL* (2004): A COMPARATIVE LCA OF BUILDING INSULATION PRODUCTS. / G. SEQUEIRA (2012): ENVIRONMENTAL IMPACTS OF THE LIFE CYCLE OF THERMAL INSULATION MATERIALS OF BUILDINGS
12•VACUUM INSULATION IN THE BUILDING SECTOR: SYSTEMS AND APPLICATIONS.; INFORMATION CAN BE FOUND IN: HTTP://WWW.ECBCS.ORG/DOCS/ANNEX_39_REPORT_SUBTASK-B.PDF

3.4

WIDER POTENTIAL BENEFITS FOR CITIES

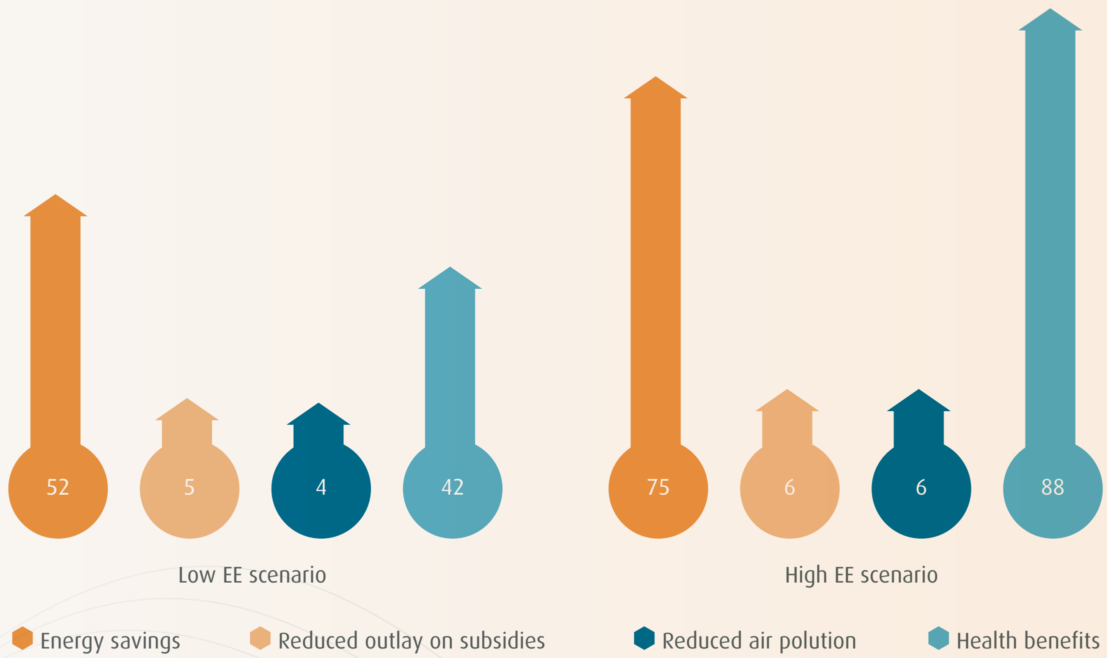
The construction industry as a whole in Europe employed approximately 14.8 million people in 2007. Since then, employment in the sector has decreased rapidly due to the economic crisis. In a little over one year (end of 2007 to early 2009) 8% of all jobs in the construction sector, the equivalent of 1.2 million jobs, disappeared. In some countries, like Spain, more than 30%of the existing positions ceased to exist over that same period. Since 2009, the economic crisis has hit the construction sector particularly hard, and by 2012 in Europe several million construction jobs had disappeared. With an average yearly added value per employee of between €30 000 and €75 000 (EU 27 average is €38 000) the full cost of losing so many jobs in terms of GDP becomes evident.

Many studies have demonstrated that the refurbishment of existing building stock can create jobs, especially for members of society hit hard by the crisis but with skills and experience in the construction sector. A recent study[13] estimates that approximately 17 jobs are created per million Euros invested in improving energy efficiency in buildings. According to the EEP Impact Assessment[14] published in Brussels in 2011, the European Commission estimates that up to two million jobs can be created in Europe by investing in energy efficiency.

It is hard to quantify the local socio-economic impact of enabling large scale refurbishment of existing city buildings. The direct benefit of project permit levies and taxes, the creation of local jobs and increased turnover for local business would be most evident consequences of the choice to invest in the sector. It must also be mentioned that energy efficiency refurbishments are seldom commissioned in isolation; they are typically packaged into a wider range of refurbishment measures to make the buildings more attractive. This contributes to a better quality of life for neighborhoods, to higher occupancy rates (reduced numbers of empty buildings) and can therefore also potencially contribute to reduced crime and social insecurity.

According to a study carried out by Copenhagen Economics[15], the refurbishment of buildings may help to create a stimulus for the European economy while bringing about related benefits such as a reduction in expenses from government subsidies, a widespread improvement in health due to better air quality in cities and a better-quality indoor climate. These last two factors should lead to fewer hospitalizations and improved work productivity.

The graph below (see GRAPH 5) compares two different scenarios (Low Energy Efficiency – Low EE – and High Energy Efficiency – High EE) considered in an extensive study performed for the European Commission's DG Energy and Transport in 2009. The 'High EE' scenario assumes a widespread use of the best technologies available that, for example, would include all windows in Europe upgraded with the most efficient technology available in the market. The less ambitious 'Low EE' scenario assumes cost-effective solutions but not necessarily the most energy efficient packages.



GRAPH 5 • Annual gross benefits to society from energy efficient renovation of buildings (billion Euro)

13•URGE-VORSATZ, D. (2011) ET AL. EMPLOYMENT IMPACTS OF A LARGE-SCALE DEEP BUILDING ENERGY RETROFIT PROGRAMME IN HUNGARY.
14•P. SWEATMAN (2012): FINANCING MECHANISMS FOR EUROPE'S BUILDING RENOVATION, ASSESSMENT AND STRUCTURING RECOMMENDATIONS FORFUNDING EUROPEAN 2020 RETROFITS TARGETS.
15•COPENHAGEN ECONOMICS (2012): MULTIPLE BENEFITS OF INVESTING IN ENERGY EFFICIENT RENOVATION OF BUILDINGS.

GRAPH 5 represents calculations of energy saving, outlay on subsidies, reduction in air pollution and increases in health benefits; the latter factors, when monetized, reach levels that are comparable to the benefits achieved in terms of energy savings. Even if the assumptions of the study might lead to some degree of over-estimation of the financial impacts of refurbishment in cities, we can safely assume that such health benefits are substantial, and that they might grow as urban populations in Europe become older on average (ageing population).

From GRAPH 5 we can see that substantial refurbishment offers the highest energy savings and health benefits. Regarding health benefits, the model takes into account the reduced air pollution due to CO_2 emission reductions from power plants, heating plants and local heating production as well as improved health outcomes from enhanced indoor air quality in well insulated houses. The improvement in air quality reduces respiratory diseases and thus reduces hospitalization and other healthcare costs. Studies have also shown that well insulated dwellings also result in reduced respiratory and circulatory problems.

Light-reflecting coatings increase the amount of natural light used over artificial light; this generally improves perceived comfort in the home and the indoor climate in office buildings alike, with a subsequent positive impact on productivity. Maintaining a pleasant, stable indoor climate also helps to increase the wellbeing of occupants.

Refurbishment when well done is a relatively safe investment; typical candidate buildings for refurbishment are found in neighbourhoods that are well situated on the city map, but which have often lost their attractiveness due to a mismatch between building performance, the arrangement of the building's interior space, and deteriorated exterior and interior finishing etc. Bringing such buildings back to a competitive quality level normally leads to better occupancy rates and higher rents (in the case of open market situations). It is clear that the adoption of smart materials in refurbishments as a key strategy offers cities energy efficiency gains, higher air quality conditions, the potential to re-develop challenged neighbourhoods, relatively low risk, bankable investment and job creation opportunities.

In addition, the large-scale adoption of 'cool roof' coatings in major urban areas can significantly reduce summer outdoor temperature. In the words of Ronnen Levinson of the Lawrence Berkeley National Laboratory in the USA:

'The citywide installation of cool roofs can lower the average surface temperature, which in turn cools the outside air. Cool roofs thereby help mitigate the "day-time urban heat island" by making cities cooler in summer. This makes the city more habitable, and saves energy by decreasing the need for air conditioning in buildings. For example, a program to install cool roofs, cool pavements, and trees over about 30% of the surface of the Los Angeles basin has been predicted to lower the outside air temperature by about 3°C. Additional annual building energy savings expected from the cooler outside air are estimated to be about half those resulting from the cool roof itself. Cooler outside air improves air quality by slowing the temperature-dependent formation of smog. Decreasing the outside air temperature in the Los Angeles basin by 3°C is predicted to reduce smog (ozone) by about 10%, worth about $300M/yr in avoided emissions of smog precursors (e.g., NOx). Cool roofs decrease summer afternoon peak demand for electricity, reducing the strain on the electrical grid and thereby lessening the likelihood of brown-outs and blackouts.'

4 ADDITIONAL REQUIREMENTS FOR DEPLOYMENT

The large scale adoption of smart materials produced by the chemical industry into refurbishment (and new building) projects requires a number of conditions to be fulfilled:

· Increased awareness throughout the value chain, from the buyer of construction materials in the contracting company, through the architect, the building manager and the building owner and including the regulator.

· Tendering procedures that take into account the lifetime cost of the building, including energy consumption.

· Selection of buildings for interventions based on performance; as an example interest should not be focused only on one factor, like ICT intensive solutions, just because this may have a perceived higher degree of 'innovation'. More 'down to earth' measures like insulating foams or reflective paints may offer better performance for the same or lower investment.

· A sufficient quantity of qualified workers that are able to use smart materials and integrate them into cost effective, durable and reliable solution packages.

· Incentive schemes that could either consist of subsidies or special loans for these specific investments or innovative financial schemes (for examples where an investor gets a pay-back based on energy savings), tax breaks or even penalties for 'bad, energy intensive' buildings; or a combination of all of those policy instruments. Obviously any incentive scheme should increase the attractiveness of refurbishing property for the owner.

· Building regulations that take into account the full Life Cycle Impact of a building (construction, use, demolition and waste recycling). Such regulations should be solution-agnostic: i.e. performance requirements should be set, but the approach to reach the required performance should be open, not referring to mandatory adoption of specific solutions that may not be optimal in the every case. For example, the obligatory incorporation of specific technologies such as PV panels or thermo solar systems can use budget that might be more effectively invested in wall insulation.

Exemples

BUILDING DATA

Type of building: Multi-family

Location: Lübeck (Germany)

Energy use before renovation: 148,7 kWh/(m²a)

Technologies used: Insulation of the exterior wall, top floor ceiling and basement ceiling, Solar thermal energy for hot water, Ventilation system without heat recovery, Replaced windows and outer doors

Energy use after renovation: 61,5 kWh/(m²a)

Energy savings: 5,72€/m²

Energy savings: 59%

BUILDING DATA

Type of building: Residential Building

Year of construction: 1975

Total m²: 4000 (wall surface)

Location: North Italy

Energy use before renovation: 130 kWh/m²

Technologies used: Thermal Insulation system on the external walls

Investments: 50€/m²

Energy use after renovation (heating): 23 kWh/m²

Payback time: 6 years

Energy savings (year): 9,50€/m²

Energy savings (heating): 80%

4.1 GOVERNANCE AND REGULATION

Any regulatory pressure on building owners to upgrade the energy efficiency of their buildings would greatly stimulate the private market uptake of smart materials for refurbishments. For example the city of Brussels is stimulating such activities both by financial incentives and by the progressive adoption of future EPBD requirements into its permit requirements for construction and refurbishment of local buildings.

For new buildings such regulatory forces are already part of the latest European Building Directive, earmarked to be converted into national laws by 2016 in most Member States. For refurbishment, regulations are not as clearly defined on a European level, as the financial consequences for building owners are harder to foresee. As a result, present regulations oblige existing buildings to be rated according to an energy efficiency labeling scheme, but do not attach an obligation to do something about inferior energy efficiency performance.

4.2 SUITABLE LOCAL CONDITIONS

Suitable local conditions for the application of smart materials can be found everywhere in Europe; in every city and in every country. Suitable local conditions include high energy prices, poor energy performance of present buildings, awareness in the general public, and local financial sources able to invest with a long term return at medium risk.

Roof top coatings are especially effective in low-rise commercial buildings such as shopping malls, warehouses, and large surface area stores; they are most effective in climate zones with abundant sunshine and hotter than average temperatures. Coatings optimizing the presence of internal light are useful in any building, especially in combination with advanced daylight-regulating windows and can also be combined very well with LED lighting.

Insulation foams come in a wide variety of shapes and application processes, allowing a solution to be found for almost any building. In the South of Europe, many buildings have no internal wall cavity insulation, a solution that has been adopted in the North of Europe to a much wider extent (although also in Northern Europe a substantial number of buildings remain without wall cavity insulation).

4.3 STAKEHOLDER INVOLVEMENT

The SusChem platform has been engaging with its value chain partners in the area of building refurbishment for more than eight years now. In order to successfully introduce smart materials for refurbishment into urban Europe we will need construction firms, contractors, specialized tradesmen, architects, building owners and building managers to commit to this venture.

Beyond the value chain actors, we need to engage the financial sector in this project to provide our final clients with the financial instruments to make these investments at an acceptable risk and a reasonable timeframe to achieve payback.

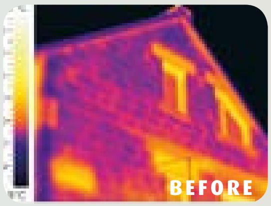
It is especially important to develop the capabilities and processes of refurbishment contractors to enable them to conduct fast and efficient refurbishments with an emphasis on quality and durability. In some cases using new materials requires some adjustment of traditional working procedures: even if these are only minor adaptations to use the new technologies.

It is also crucial to involve relevant authorities in building certification and quality control, informing them of the advantages and uses of these new materials and training them on how to perform the necessary quality control activities.

4.4 REQUIRED SUPPORTING INFRASTRUCTURE

No specific additional infrastructure is needed to benefit from the proposed innovations. Training infrastructures for the construction and refurbishment sector will be important to enable construction sector professionals to be prepared for the innovations in the sector and the work that needs to be done. However, in most Member States such infrastructure already exists, but training courses and material would still need to be updated.

Exemple



BUILDING DATA

Type of building: Residential House

Total m2: 100m² floor space

Location: Brunck District Ludwigshafen

Energy use before renovation: 210 kWh/(m²a)

Technologies used: PCM

Energy use after renovation (heating): 30 kWh/(m²a)

Energy savings (year): 10,80€/m²

Energy savings (heating): 86%

4.5 INTERFACES WITH OTHER TECHNOLOGIES

Exemple

BUILDING DATA

Type of building: Residential Building

Year of construction: 1960

Total m2: 4500 m²

Location: Terrasse (Barcelona)

Energy use before renovation: 113,5 kWh/(m²a)

Technologies used: PWall Cavity Insulation (15cm of wall cavity)

Investment: 25€/m²

Energy use after renovation: 86,6 kWh/(m²a)

Payback time: 6 years

Energy savings (year): 4,10€/m²

Energy savings: 24%

As previously mentioned, the proposed innovation package could be integrated into a larger package of building interventions targeting energy efficiency, comfort, building attractiveness, and health and safety. The interfaces between the innovations proposed here and innovations relating to other aspects for intervention do not present specific issues.

In some cases the introduction of smart materials innovation facilitates the adoption of other innovations; for example, the introduction of foam layers onto facades is often undertaken at the same time as the insertion of cable ducts so they are hidden from sight. Another example would be the balance between reflective paints reducing external heat and ICT equipment increasing the internal heat in a building.

The technologies proposed here are normally offered to building developers or owners as part of a package solution. Normally such an offer would include upgrading of facades (involving insulation, coatings, advanced glass and sunlight regulating devices or layers); upgrading of wall insulation, introduction of advanced low-energy cooling, introduction of high efficiency heating, mechanical ventilation allowing for the recovery of excess heat and advanced (LED) lighting concepts. All of these technologies are ideally managed by an advanced building energy management system that consists of a range of ICT components connected (wired and wireless) to each other, to control unit(s) and to advanced user interfaces.

The performance of the package is generally more than the mere sum of the separate components. On the other hand a very well insulated building can require so little heating energy, that in some cases quite inefficient (but fast working) heating systems can be allowed.

An example is the use of electric resistance heating embedded in the inner panel of a triple-layer glass window in order to heat a bathroom in an apartment in Ludwigshafen; as the bathroom normally just needs 20-30 minutes of warmth, the resistance heating proves to be more efficient overall than a conventional radiator.

The proposed innovations described in this document can easily be part of a bigger solution package, but an intervention combining just the five proposed technologies would already offer a substantial energy savings involving an affordable investment with an acceptable payback time.

5 FINANCIAL REQUIREMENTS AND POTENTIAL FUNDING

5.1 COST-BENEFIT ANALYSIS AND RETURN ON INVESTMENT

The cost-benefit equation for energy efficiency in building refurbishment depends very much on local conditions, which can impact the investment required (depending on labour costs, taxes, permits, cost of capital, etc.) as well as the income and benefits generated (energy savings in terms of KWh per m²/year, cost of kWh in euros, energy mix applied etc.).

The financial feasibility of energy saving measures can typically tip the balance in favour of investments made to enhance energy savings. However, energy savings are not the only benefit to take into account. Possible reductions in the size of heating or cooling equipment, increased value of the property (either for sale or rent), lower crime rates in refurbished neighbourhoods and the increased wellbeing and health of occupants are all important benefits playing a role beyond energy savings.

Several key parameters are important; for example the period needed for future savings to be taken into account. Large differences exist between countries exist with regard to the number of years that building owners are willing to consider when calculating their returns on investment.

While owners in Nordic countries are sometimes willing to calculate with a 35 year economic lifetime for a building (or of a major, deep building refurbishment), most building owners in other parts of Europe would often not consider future income horizons more than eight years into the future.

Another factor to take into account when calculating the balance between investment and savings (or future income streams) is the impact that an improved energy performance has on the value of the real estate concerned. Here again large differences can be observed within Europe. In some parts of Sweden, it has been demonstrated that residences compliant with Passive House standards command values 12% higher than equivalent buildings that are non-complaint. In the Netherlands, recent studies by MERIT assessing the impact of energy labels on real estate value put the added value created by an A-level certification (the top level – i.e. most energy efficient) at much less - just 3% of the value of the building. The substantial difference in price can be explained by the differing performance levels of the available buildings and the low level of awareness of buyers with regard to their long term energy bills – factors that this report has already highlighted as necessary conditions for the large scale implementation of smart materials innovations.

In very general terms, it must be highlighted that the average European household tends to spend between €1200 and €3000 per year on energy bills, but, of course, households in low energy efficiency buildings in cold climates will spend more. Given this level of expenditure, for a household to invest to achieve a 40% energy bill reduction will result in actual savings (in most cases) that are lower than €1000 per year. If a household considers potential future energy savings over, say, seven years this leads to an investment 'pot' of less than €7000. However, the rise in value of the property due to better energy efficiency could add an additional €7000 to this calculation (taking a conservative 5% estimate – between the 12% in Sweden and the 3% in The Netherlands - multiplied by a typical EU home value of €150000).

Of course, if the same type of calculation were made by a Nordic institutional investor into commer-

Exemple

BUILDING DATA

Type of building:
Wholesalle

Total m2: 14.000 m^2

Location: Italy

Energy use before renovation (cooling): 40,1 kWh/(m^2a)

Technologies used: High reflectance outdoor coatings

Investment: 13,50€/m^2

Energy use after renovation (cooling): 32,1 kWh/(m^2a)

Payback time: 2,8 years

Energy savings (cooling): 20%

cial real estate, the available investment budget would look very different: much longer timeframes being taken into account, a market in which poorly performing buildings suffer heavily from the presence of highly energy efficient competition, and commercial real estate in general consuming up to 40% more energy per m^2.

For these reasons, commercial real estate (including public non-residential buildings) is generally more likely to offer positive ROI (Return on Investment) for energy efficiency driven refurbishments than residential buildings. As most buildings hosting offices or shops tend to be intensively used at least 12 hours per day, they simply have a higher energy consumption level due to longer occupied 'operational hours'.

It must be added that owners of non-residential buildings can usually accept a slightly longer timeframe for return on investments than most families are able or willing to. Institutional owners (including municipalities) often have access to relatively low interest financing and can balance risks in one building as part of a portfolio of different public properties. Also, institutional building owners are more aware of the long term risks of not refurbishing, as often they actively invest in making their portfolio of buildings 'future-proof'. They do not do this out of idealism; it is rather a necessary strategy to ensure that no part of their portfolio becomes obsolete and therefore impossible to rent out at profitable rates.

Thus, the decision to refurbish a building for energy efficiency is seldom taken in isolation; typically a building owner seeks to re-position its property in many ways – not usually for energy efficiency reasons alone. Examples in the centre of Brussels have shown that an investment of around €900/m^2 in deep refurbishment of an office building on the Avenue Louise can be financially attractive. The alternative to not making the refurbishment is to own a prime location office building that stands empty due to a lack of interested tenants who can choose from a wide range of available properties in Brussels, many with excellent energy efficiency performance.

Example business case PCM

PCM, when installed in interior ceilings and/or walls, reduces the variation in temperature between day and night. As such, it works especially well in climates that have hot summer days with bright sunshine, but which have night temperatures, even in summer, below 21°C. On average, to work effectively, around three kg of PCM is required per m^2 of used space. At an average cost (including the plaster and application) of some €36/m^2, one can assume that for a 120m^2 space the investment would be €4400. This investment would then allow consumers to reduce the use of a 4kW air conditioning unit by approximately 300 hours per year. At an electricity cost of €0.17 per kWh this would lead to savings of 4 x 300 x €0.17 = €204 per year. If electricity prices rise then this saving would increase too. However, more importantly for the financial viability of the operation, applying PCM allows the possibility to downsize the capacity of the Air Conditioning (AC) system.

As large scale AC systems requiring some €2500/kWh of installed capacity, the savings in the investment in the AC system would almost compensate directly for the investment required for the PCM.

This is a significant factor also in case of a 5000 m^2 office building. Here the combined savings calculated were some €26400 with an estimated investment of €36 x 5000 = €180000. In such scenario payback would be achieved within eight years.

It is essential to highlight this additional key factor that makes PCM a profitable investment, i.e. the downsizing of the air conditioning installation, especially in larger buildings. While in small family homes, a single wall-mounted 3 kWh unit may only cost €1000 including installation, the cost of cooling capacity in bigger installations is estimated at some €2500/kWh.

In bigger buildings, the PCM investment is almost completely offset by the savings due to downsizing the air conditioning system (smaller system, smaller ducts, less vents).

5.2 POSSIBLE SOURCES OF EU FUNDING

We can identify several EU funding programmes that may be applicable to leverage investment in these technologies: in particular EU structural funds could be a means to promote investment in refurbishments using smart materials. EU funds could also be used to establish training infrastructures for value chain actors that cannot otherwise acquire the knowledge required to use these new materials effectively. Such training would also allow these organizations to determine when and how they can best be applied in a given building.

Research and innovation funding, such as the forthcoming Horizon 2020 Framework Programme, could stimulate the development of integrated packages of refurbishment interventions that can deliver high energy efficiency gains at minimal investment level and maximum economic lifetimes. The same funding could also be used to develop training material to be used in the training infrastructure.

However the viability of the proposed solutions does not depend on EU funding; the benefits make the investment attractive even when that investment is not leveraged by any external funding source.

EXAMPLE BUSINESS CASE LIGHT ENHANCING COATINGS

The added cost of the light enhancing paint compared to a 'normal' high quality paint is actually less than €0.70 per m² of wall/ceiling surface painted (reflective paint costing some €1.20/m²/layer, two layers leads to €2.40/m² excluding the cost of painting which is equal whichever paint is used). As an example, we can use a small office of 100m² of floor surface and 2.75m ceiling height. This would require some 237.5 m² of paint for an additional investment of €166.25. The confounding factor here is that modern office buildings are also migrating to low-energy lighting (LED or fluorescents), and therefore the relative achievable savings decline. However, in the case of fluorescent lighting, the 100m² office would have some 1600W of lighting installed, working for perhaps (summer and winter, not all spaces lit at any point in time) a total of four hours per day, which would consume some 1600 x 4 = 6.4 kWh per day. If the office is lit for 240 days per year this would require 1536 kWh. At €0.17 per kWh you would pay €260 in energy costs. By using light enhancing coatings, you would save 20% on energy costs which is equivalent to €52 with a payback time of around three years considering the energy savings alone.

However, in real life cases, one of the most important impacts of applying these paints is the sensation of space and light that inhabitants report, creating wellbeing and a feeling of spacious comfort, especially in smaller rooms.

One must also acknowledge that the absolute impact of costs for lighting in a traditional building, compared to the costs for heating, are not comparable; heating and cooling normally covers at least 60-70% of the entire energy consumption. However it is equally important to note that once buildings become well insulated and possess adequate measures for efficient heating and cooling, then there is a shift in the balance and lighting becomes relatively more important. Therefore, it makes sense to optimize lighting consumption especially in buildings which have good thermal performance.

5.3

FUNDING FROM FINANCIAL INSTITUTIONS

We envisage the financing of deep refurbishment interventions with long term payback periods as a key area where the European Investment Bank (EIB) could facilitate the use of private capital by acting as a co-investor or as a guarantor for the loans used in such refurbishments.

The EIB would need to develop long term lending programmes that can be associated with specific building projects possibly by extending loans beyond the duration of a single rental contract (as it happens currently for the financing of new buildings).

In the period between 2001 and 2009, Germany was successful in stimulating deep refurbishments for energy efficiency purposes using smart financing. Between 2001 and 2006 alone, an initial tranche of €4 billion of public subsidies from the German Alliance for Work and Environment was able to stimulate a private investment of €15 billion in buildings retrofits. The public bank KfW created several programmes that offered interest rates below the average market threshold to stimulate the interest of the private sector. From 2006 to 2009, KfW's financing of activities across various programmes amounted to €27 billion in loans and grants, creating a total private investment flow of €27 billion with the goal of improving energy efficiency in German houses[16].

5.4

OTHER FINANCIAL INFORMATION

It is clear that two factors will drive the demand for future deep refurbishments of existing buildings in the long term: the ongoing market trend of rising energy prices and the improving performance of new buildings. However we feel that the time needed to reach sufficiently compelling market conditions may be longer than European society is willing to wait. If we agree that national and European institutions could do more to speed up market uptake, then, for example, they could work to modify the present real estate taxing mechanisms to accelerate the growth in demand for refurbishment based on energy efficiency.

In many EU Member States, real estate taxation is based upon total surface, calculated in square meters, the cadastral value of the property, the location, or a combination of these factors. In none of the current formulas does the energy performance of the building play a role.

On the contrary, for quite a few years taxation of cars has taken into account the energy efficiency of the vehicle at purchase. The higher the energy efficiency label of the car, the lower the tax percentage applied.

It is possible to adopt a similar mechanism in the taxation of real estate, making the energy efficiency one of the key factors in determining the level of tax to be paid. When correctly implemented, the impact of such tax measures can be huge. In addition, if properly designed, such a tax scheme could shift some of the tax burden to larger scale real estate owners, while relaxing the burden on households with a lower income. This could be done in such a way that the overall tax income for the state is increased, which can at least partially compensate for the lower income from building permits.

The idea of adjusting tax schemes related to real estate is tightly connected to the transition that municipalities in many EU Member States need to make towards much more moderate rates of new building combined with increasing rates of refurbishment. This is a development to be expected (and welcomed) in the coming decades after the 'boom and bust' of real estate development in the recent past. In fact, refurbishment has steadily become a more important part of the construction industry over recent decades, even while new buildings were being built all over Europe at a great rates. What is really new is that this part of the construction business has played, up to now, a more modest part in the taxation incomes of municipalities. The current situation will probably need to change in the years to come. Another recommendation could be to establish an EU wide think tank studying the future financing of municipalities, which can study and propose alternative income schemes for municipalities that reduces their 'addiction' to real estate new build and can also make their finances as sustainable as their policies should be.

16·P. SWEATMAN (2012): FINANCING MECHANISMS FOR EUROPE'S BUILDING RENOVATION, ASSESSMENT AND STRUCTURING RECOMMENDATIONS FOR FUNDING EUROPEAN 2020 RETROFITS TARGETS.

Share of market activity
Passive market share
350
300
250

CONTACT

If you want to learn more about how the Key Innovations presented in this report can help you to construct or promote the construction of more energy efficient buildings within a reasonable investment, or if you want to discuss possible collaborations, please get in touch with SusChem by sending an e-mail to Jacques Komornicki, Innovation Manager at CEFIC: jko@cefic.org

SUSCHEM SECRETARIAT

Cefic – The European Chemical Industry Council

Avenue E. van Nieuwenhuyse, 4 box 1

B-1160 Brussels

T: +32 2 676 7461

F: +32 2 676 7433

E: suschem@suschem.org

W: www.suschem.org