Greenov

GREEN RENOVATION CLUSTER

How to Develop Energy Efficient Refurbishment on a Large Scale

A joint Study by the Greenov Partners

Table of Contents

New Eco-products for Sustainable Refurbishment: Hemp-Lime Insulation Blocks 40

Author: Cluster Eco Construction Wallonia

Introduction to Smart Buildings 52

Author: ADEC Technopole Bas-Rhin

Case Study: High-Performance Urban Energy Renovations 68

Author: Impulse, Brussels

The Issues of Sustainable Renovation in Non-Residential Buildings 89

Author: Paris School of Engineering

Case Studies: Ashford Gateway & St Mary's Church, Ashford, UK 101

Author: Ashford Borough Council

Case Study: Sports Complex in Zoetermeer Municipality 122

Author: Zoetermeer Municipality

Case Study: Cinema Renovation, Noisiel, France 142

Author: Val Maubée

Introduction

Existing infrastructures and buildings represent a major issue in the reduction of our CO_2 emissions. Whereas most new buildings and infrastructures are now built in energy efficient ways and the market has started adapted to it, it is still much more complicated to renew old buildings to make them energy efficient and to do it on large scales (e.g. housing buildings, public infrastructures,…). In Europe buildings represent 40% of EU Energy consumption, and 36% of EU CO_2 emissions and therefore on of the sectors where most efforts should and can be done.

Local authorities, existing clusters and universities have an important role to play to face the key challenge of sustainable renovation on a large scale. They are significant investors and key actors to involve the private sector and mainly SMEs in the sector of sustainable renovation by encouraging supply chain management.

The Greenov project aims at increasing strategic cooperation between the public sector and economic actors, to improve sustainable renovation and accelerate the innovation cycle. This is why the past 5 years' experience in the field of energy efficient refurbishment is shared in the publication of this Joint Study.

First chapter is treating the general aspects of ***Energy Efficient Refurbishment*** from three different angles: the barriers and potentials for involving SME's in the public procurement (Procurement & Unlocking Potential), the Energy use and regulations in an Irish versus European Context (Energy Efficiency) & the benefits and impacts from District Heating (Refurbishment through District Heating)

The Second & Third chapters concentrate on available techniques and products within sustainable refurbishment. In the chapter of ***New Eco products available for Sustainable Refurbishement***, you'll find a complete introduction to *Hemp-Line Insulation Blocks*. In the following chapter ***Introduction to Smart Buildings*** is introducing the possibilities of various soft-wares used to survey the consumptions in refurbished buildings.

The issues in sustainable renovation on non residential buildings takes a European overview to the challenges facing the renovation sector and the policy and regulation that both helps and hinders its progress with particular reference to SME's in the sector

The last chapters describe the case studies: the Greenov exemplary investments of sustainable refurbishments in the public sector: *The St Mary's Church in Ashford, UK*, the transformation of an historical monument into a multifunctional space, heated by a special ground-source-heating system from the floor; *The Sports Complex De Veur in Zoetermeer, NL*, showing how one of the technology transfer methods, the BTA, developed within the Greenov project has been used to find the most efficient solutions; *The Cinema Ferme du Buisson in Noisiel, Val Maubuée, FR* with the challenging solution to transform the interior of an old farm into a modern cinema, offering best comfort without touching the interior wooden structure.

Energy Efficient Refurbishment

Author: Codema

Introduction

In order to contribute to low carbon cities and sustainable economies in North-West Europe (NWE), it is essential to implement large scale improvements in the energy efficiency of the existing building stock. The transnational cluster developed through Greenov has enabled the pooling of knowledge of a group of experts in sustainable renovation in NWE. This transnational knowledge transfer capacity will encourage and support large scale energy efficiency projects with potential of having a large impact on overall energy use of cities in NWE.

Identifying the scope of refurbishment needed for large scale energy efficient upgrade of the existing building stock allows Small and Medium Enterprises (SMEs) to find innovative and effective solutions to developing sustainable cities. Although there is much focus on increased energy efficiency in new builds, existing infrastructures and buildings still represent a major issue in the reduction of CO_2 emissions. Energy efficiency is constantly improving, and we are now at a stage in the developing world where growth in economy and growth in energy consumption are no longer inextricably linked; however, this mostly affects new builds, new services, and new industries. There is still a great need, particularly in cities and built up urban areas, to initiate large scale refurbishment of ageing building stock and look at more innovative energy efficient ways to supply traditional goods and services. There is great opportunity for SMEs to take advantage of the low efficiency and fossil fuel based heating systems currently in place, and implement new innovative systems, services, and technologies.

This chapter seeks to share Codema's knowledge and experience of large scale refurbishment, from an Irish perspective, with those in NWE with a common interest and commitment to energy efficiency. This chapter is part of Work Package 1, Action 6 'Technology transfer and research on sustainable renovation', and provides a guide on Energy Efficient Refurbishment.

Firstly, the chapter highlights the issue of how SMEs can tender for works in the area of Energy Efficiency (EE). Large scale EE initiatives will likely fall under public sector procurements procedures, and so this chapter investigates the current procedures for procurers and tenderers for EE contracts in the public sector, seeks to identify the barriers, and suggest ways these barriers can be overcome. Gathering clusters of SMEs and enabling communicative pathways between all stakeholders in the process of procurement of energy efficient contracts is an important step in breaking these barriers.

This chapter also seeks to show the need for refurbishment in Dublin and the current policies surrounding EE. In Dublin, there is a need to focus on the efficiency of current space and water heating practices in particular. This is a common factor in many of the countries in NWE which share similar climates and have large percentages of building energy consumption attributed to heating/cooling requirements. Co-generation of both heat and power where the heat produced can be utilised in buildings allows vast energy savings in comparison to conventional thermal power production and individual heating systems.

Ireland has very low levels of co-generation and a negligible amount of District Heating (DH) in use, and instead utilise large amounts of oil, coal and peat for heat, which are typically consumed at lower efficiencies than gas. Other countries in the Greenov NWE cluster have higher penetrations of DH, like Germany's 7.1% and the Netherland's 3% of residential final energy use coming from DH sources (SEAI, 2013 (b)), but this still lags behind other countries like Denmark (36%) and China who have taken full advantage of this energy efficient technology. Increasing DH levels in NWE would allow this region to reduce its reliance on imported fossil fuel resources of coal, oil and gas, which currently make up a large part of the fuel used for energy needs.

Case studies from Ireland are used to show how large scale DH EE refurbishment can be developed. The NWE cluster can learn from these case studies and this will enable replication of the work in their own towns and cities. A large scale DH system in the city of Dublin has the potential to not only contribute to the transition to low carbon cities, but also improve the knowledge and expertise in sustainable renovation. Implementation of large scale DH would boost the sustainable renovation economy in NWE, and have a major impact on the SMEs involved in the construction sector, which were most affected by the recent recession.

The report is structured as follows;

1. **Procurement and Unlocking Potential** – This section looks at the current situation of procurement for public sector works, and how to overcome the barriers in the procurement and tendering process in order to achieve the levels of energy efficiency refurbishment needed.
2. **Energy Efficiency** – Introduction to energy use in NWE, with a focus on Dublin, and need for refurbishment, and the policies surrounding EE in buildings.
3. **Refurbishment through District Heating**– This section outlines the potential for large scale EE refurbishment in the building stock through the use of DH, and examines 2 case studies of planned large scale DH systems in Dublin.

Procurement & Unlocking Potential

Introduction

Codema began gathering SMEs together to form a Sustainable Renovation Supply Chain cluster under the Greenov project at the Energy Trade Show, Dublin, in April 2010. A call was launched for suppliers to become part of a cluster network of European sustainable renovation suppliers which would provide networking services, knowledge transfer, training and support through the Greenov project. 28 SMEs expressed interest in joining the Greenov cluster, more information is available at http://www.codema.ie/procurement-portal.

Images: Codema's Emma Collins & Dr. Gerry Wardell at the Codema Greenov Stand of the Energy Show with Minister for Energy Eamon Ryan

In March 2011, Codema hosted a Greenov Seminar called *'Clustering SMEs for Renovation Jobs'* in Dublin. The purpose of the seminar was to introduce Greenov to an Irish audience

of stakeholders from SME representative groups, SMEs, construction industry groups and local authorities. There were 58 representatives present at the seminar all of whom have vested interests in sustainable renovation and public procurement processes. A transnational panel of experts presented issues and experiences in creating clusters, energy efficiency and in public procurement.

Codema presented the ways in which Greenov will benefit Ireland and increase jobs for SMEs. For SMEs, collaboration with other companies is becoming increasingly important in the face of market globalisation. Multinational companies are investing in strategic procurement programs with a view to reducing their supply bases and focusing on increased spending with a smaller number of strategic partners. The creation of the Greenov sustainable renovation cluster would enable an increase in market share by developing relationships which lower prices, and increase quality of products and services. Company income can be increased by sharing investment costs, reducing inventory, sharing risk and eliminating duplication and waste. The trans-national element will offer great scope for SMEs to develop their skills and increase knowledge of products and techniques.

There were also presentations made by international representatives, including Birmingham Chamber of Commerce Group, who explained 'The Birth of Clusters'. The presentation revealed the reasons why collaborations are effective; offer one complete solution, offer greater capacity, create better leverage with suppliers and raise overall standards.

The municipality of Zoetermeer, The Netherlands, presented their cluster policy, which they established in 2007. It was a municipality initiative set up to create innovation, knowledge exchange and cooperation. The cluster policy was highly successful and resulted in the city branded as an ICT hotspot, created a glass-fibre network, and created connections between the labour market, education and research. The cluster policy developed by Zoetermeer strengthened the economic structure through focus, visibility and long lasting commitment.
Links to the presentations are available at http://www.codema.ie/procurement-portal

Images: Greenov Seminar, Dublin, March 2011

This section now goes on to examine the current state of procurement processes in the EU and Ireland based on desktop based research. The knowledge acquired from this research was then used to inform the structure of interviews carried out by Codema with procurement representatives. These interviews seek to obtain deeper insight into public procurement issues related to SMEs.

Public Procurement Procedure

Public Procurement legislation in the EU is structured in such a way that if a central government requires supplies or services above a threshold of €130,000, or works to be carried out above a cap of €5m, the tender must be published in the Official Journal of the EU (OJEU) and follow all applicable requirements of the directives. The European Directive 2014/24/EU provides 4 procedures: open, restricted, negotiated and competitive dialogue procedures for procurement of goods, works, or services. The legislation covers organisations and projects that receive public money, such as Local Authorities, NHS Trusts, MOD, Central Government Departments and Educational Establishments. OJEU.eu (http://www.ojeu.eu/Default.aspx) is the online portal for suppliers to search for business opportunities within the public sector and this increases competitiveness.

EU member states then have their own thresholds set for government, local, regional and utilities procurement spending which require different procurement approaches. In Ireland, any works and services are conditioned as follows;

- <€5,000 - Seek verbal quotation from one or more competitive suppliers
- €5,001 to €25,000 - Award on the basis of responses to specifications sent by fax or e-mail to at least 3 suppliers or service providers

- €25,001 to European Threshold - Advertise on e-tenders[1] as part of a formal, competitive procedure

France has a similar structure with higher thresholds and numerous websites for the advertisement of tenders. The Procurement Innovation Group established by the Department of Enterprise, Trade and Employment in Ireland published a guide to promote innovation in public procurement while also encouraging SME participation (DETE, 2009). It advises public sector entities on how to support innovation in Ireland through SMEs participation in public procurement and describes SMEs as a source of innovative solutions. There is a general trend that the smaller the tenders the fewer rules that govern their reward. Ireland has a free online portal for tendering public sector works and services, and although all information required in order to put forward a tender is available on these sites, there are also private sector websites existing which charge to make the process of tendering simpler. Codema carried out interviews with procurement experts which would seek to find what they consider barriers to tendering, biggest issues for those writing tenders, what makes a good tender, and what is the success rate on tenders. The results of these interviews are discussed later in this section.

Barriers to SME participation in public procurement and possible solutions

A European code of best practices regarding SMEs public tendering participation identifies the principal difficulties for SMEs in participating in public procurement and proposes some solutions which could help them. This information is completed by the inclusion of a Tenderscout report on barriers to SME participation, which will be discussed and potential solutions suggested.

SMEs perceive that their contracts are regarded as risky by contracting authorities. They often conclude that there is a lack of transparency in the tendering process, and contracts are reserved for larger companies. This can be reinforced by the tendering pre-qualification stage i.e. three years of audited accounts which often excludes smaller companies or start-ups.

The first difficulty identified is the large size of contracts. They are not adapted to SMEs which do not have enough resources to tender for these contracts i.e. they can only provide

[1] E-tenders is the website for public tendering in Ireland, found at http://www.etenders.gov.ie/.

one part of the tender. This could be overcome by a sub-division of contracts into lots. Procurers could take advantage of the possibility for SMEs to form groups and rely on their combined economic and financial standing and technical ability. They should make sub-contracting an option and ensure equal terms for subcontractors. They could also make use of the possibility to conclude framework agreements with several economic operators and not just with a single supplier. But it takes time to build partnerships between SMEs. In addition to this, SMEs usually do not have sufficient administrative capacity to prepare a quality tender response but by coming together they may be able to manage this better.

It is hard for SMEs to access the relevant information because they do not have enough resource to allocate to information collection. To increase this access, e-procurement website could be improved to offer more information, contracting authorities should work on information centres, and on feedback to tenderers which can help SMEs.

SMEs find it difficult to understand the information provided. This could be improved by developing more training and guidance for contracting authorities, and training and guidance for SMEs on drawing up tenders.

SMEs present a lack of awareness of public procurement. Most of them do not know where opportunities are published. They only know about a public sector opportunity when a tender is advertised, and by this stage it can be too late for SMEs to make an adequate response to tender. This could be solved by establishing contact with public bodies to understand their needs in advance in order to prepare a better proposal when the official tender process starts.

Procurers ask for disproportionate qualification levels and financial and certification requirements. To help SMEs to participate to public procurement they should keep selection criteria proportionate, take advantage of the possibility for SMEs or a group of SMEs to prove their combined economic and financial standing and technical ability. Then they should require only proportionate financial guarantees.

SMEs rate the importance of price over value for money. This trend could change by creating more scope for qualitative solutions thanks to the possibility of awarding contracts on the basis of the most economically advantageous offer. More scope should also be provided for innovative solutions thanks to the possibility of defining technical specifications in terms of performance or functional requirements.

There is a disproportionate administrative burden which should be alleviated. SMEs do not have enough time to draw up tenders and so this time frame needs to be prolonged. The difficulties stem from the legal obligation of transparency and fairness of contracting authorities which are following a highly structured process that SMEs have to learn while preparing their tender within limited time.

Preparing tenders represents a high cost. Most fixed costs are too high for SMEs in comparison with larger companies. Moreover SMEs also face late payment time. It should be ensured that payments are made on time.
Finally, it is hard to find foreign cooperation partners. Often there is a discrimination against foreign tenderers and favouritism towards local or national companies.

References: (Commission of the European Communities, 2008) (Tenderscout, 2010)

Interviews with Procurement Representatives

To get more details on the public procurement issues related to SMEs Codema carried out interviews with four procurement representatives of Dublin City Council and South Dublin City Council in May 2012. Three of them relate to setting procurement whereas the fourth is more an overview of the procurement system within all departments of the council. These interviews focused on finding the issues the people setting out procurement encounter, including:

- whether or not SMEs fail in public procurement more than larger enterprises,
- advantages or disadvantages of e-Tendering,
- whether procurement hinders innovation,
- how public bodies integrate green public procurement

The interviews were organised into 6 sections – general information, procurement issues, SMEs and public tendering, innovation and Green Public Procurement (GPP). The interview results will be discussed under these sections.

General Information

The procurement professionals interviewed come from diverse professions including engineering, architecture, and those working in finance. Training seems to be a learn-as-you-go process while working on actual projects. There is generally a senior department

expert who is responsible for overseeing how procurement documents are set. Two of the interviewees had also studied procurement in university. Depending on the department and of the degree of specialization of the projects, there are one or more persons working on the procurement aspects of a project.

Procurement Issues

The high degree of bureaucracy in procurement was listed several times as a predominant issue. Procurement procedures must follow a strict process in order to be transparent. This process is “too legalistic to be efficient”, according to one interviewee.

The drafting of procurement is often the most important stage in the entire procurement process. For this reason, procurement documents need to be written very precisely, anticipating possible issues which could arise during the project. Therefore procurers need to have a certain level of experience to anticipate such issues. Another issue which was highlighted is that procurement rules change all the time, so procurers have to constantly keep up-to-date what the current rules and policies are. The interviews showed that ‘open’ and ‘restricted’ procurement procedures are the most used.

The time provided for companies to respond to procurement can vary depending on the complexity of the project but two of the interviewees said their department usually gives 4 to 6 weeks after advertisement of jobs for companies to come back with the necessary documentation. They also allow a period of one or two weeks for companies to ask questions. They send the answer of these individual questions to all candidates so that the process remains fair.

Procurers debrief unsuccessful bidders by giving them their marks to explain where they failed. This is done through the post and if unsuccessful bidders want more information following that, procurers can call them to give more details. In debriefing, the name of the winning tenderer is provided. Unsuccessful tenderers can use this information to try to be more successful in next project.

SMEs and Public Tendering

The most common reason for the failure of candidates when tendering is that they do not put the relevant experience on tendering application documentation. Also, procurers also want to know other criteria, such as; what kind of resources candidates have in their company, what level of damages insurance they carry, if they have an ISO certification or a quality management system in their office, if they received an award for any of their design project

and if accidents happened during a project in the last two years. One interviewee suggested that failure to include relevant information is linked with the fact that companies do not understand the system. When applying, some companies simply put the information available on their website instead of submitting the information which procurers are looking for.

Secondly, candidates often fail to use the official form to apply and in this case their application cannot be accepted. They also make simple mistakes such as not including VAT in price and failing to answer the questions properly. Candidates are often unsuccessful on Pass/Fail questions such as those which ask about insurance, health and safety etc. without these the company is immediately unsuitable.

Another reason of the failure of SMEs is their lack of capacity to carry out the tender i.e. the company is too small to carry out the work. This is why for bigger projects, procurers prefer to work with larger companies to make sure they have the resources needed to complete the project. Nevertheless, in comparison with two or three years ago, since the building sector has contracted in size, it is a majority of smaller companies that are now awarded contracts. Experience is generally more important than the size of the company. It should be noted that one interviewee highlighted that the jobs with the largest budgets often go to foreign companies because there are not so many big companies with adequate resources in Ireland.

In conclusion, elimination of candidates is generally not a matter of lack of competence. Instead the principal reasons to eliminate candidates are:

- when the company experience is not relevant enough,
- when the company does not meet the competences or standards required by the procurement entity,
- when the products are not conformed to what procurers need

Innovation

The interviews have shown that, in general, public sector authorities do not want to try new products and services unless it has been proven to be successful in another project. They cannot take the chance on risky financial ventures unless there is proof the technology has been tried and tested. Innovation can be promoted by procurers by setting out a more open procurement document which sets minimum standards, but does not set specific products to meet requirements.

Green Public Procurement

Public procurements become green public procurements when they propose solutions with a reduced impact on the environment and the economically useful life-cycle is taken into account. Green Public Procurement (GPP) integrates more environmental criteria in comparison with basic public procurement. GPPs are recognized to have better value for money in the long term but budgetary constraints in the short term can make contracting authorities hesitate in opting for the sustainable solutions. More information on GPP can be found on European Commission website http://ec.europa.eu/environment/gpp/index_en.htm.

Two interviewees suggested that about 1000 buildings have been built under the green criteria in Dublin. They also pointed out that being involved in projects where green aspects have been included did not cost any extra in comparison with what was forecast without these green aspects.

Dublin City Council is involved in GPP. Both procurers and suppliers are made aware of sustainable and green solutions, and highlight how it makes economic sense to use GPP criteria. It is difficult to measure the amount of GPP criteria incorporated in contracts. For example, CO_2 emissions are easy to quantify so it is easy to quantify its price, but other GPP criteria may not be so easy to quantify and calculate their price.

Unlocking Potential: Energy Clusters

Some of these barriers are being overcome through the use of clusters of stakeholders with an interest in the area of energy efficiency and innovative cleantech products and services. SMEs, academia, and public sector bodies are working together in Dublin to generate innovative solutions to the issues surrounding EE in the current building stock. Clusters such as 'The Green Way' and 'Emerge' are leading the way by facilitating collaborations between the supply and demand sides of EE refurbishment in Dublin.

emerge
Sustainable Energy Community Dublin

THE GREEN WAY
DUBLIN'S CLEANTECH CLUSTER

Images: Dublin's Sustainable Renovation Clusters

‘Emerge’ is part of the SEAI’s Sustainable Energy Community initiative, set up in 2011, which saw the formation of three exemplar sustainable energy communities around Ireland to demonstrate best practice in sustainable energy. The Dublin Sustainable Energy Community positions itself within the largest Local Authority in Ireland, in the centre of our capital city and at the heart of the nation’s government and business centre. In 2012, the Sustainable Energy Community concentrated on a 4km^2 zone in Dublin City Centre. Projects under Emerge represent energy-efficient improvement measures specifically in public buildings and social housing. The project commissioned a study to identify best practice in green refurbishment in the zone, once identified the projects were documented and the project managers interviewed to establish barriers and opportunities for future cluster refurbishments. In 2013, the geographical focus of the initiative was in the Strategic Development Zone (SDZ) in the Dublin Docklands. Codema organised an Emerge workshop in the DDDA building in April 2013, which aimed at formulating ideas to a formal submission on energy to the SDZ in order to influence construction practice in the zone, these were incorporated into the planning parameters of the zone. Another Emerge workshop was held in May 2014 in the Convention Centre Dublin on district heating in Dublin and how it could be rolled out to future and existing building stock. The Emerge cluster has brought together stakeholders in the area of DH in order to bring the project forward and realise the predicted energy savings.

Read more at: http://www.codema.ie/media/gallery/sustainable-energy-community-emerge/

Another cluster, ‘The Green Way’, is Dublin’s clean-tech cluster, which aims to stimulate growth and employment in the green economy. Dublin City Council are a founding member of this cluster, and along with other public, private and academic partners, this cluster connects organisations that have developed energy efficient technology and solutions with organisations which require these goods and services.

Read more at: http://www.thegreenway.ie/

The suppliers of EE goods and services involved in these clusters have an insight into the needs and expectations of the market, particularly within the public sector, as the municipalities in Dublin play a large role in these groups.

Procurement & Unlocking Potential – Conclusion

The interviews outline the need for procurers to be highly experienced in order to write procurements due to the high level of specificity required. The main difficulties encountered are the level of bureaucracy and the regular and numerous procurement rule changes involved in procurement/tendering, and these issues are echoed in the desktop study findings. Bureaucracy generates an administrative burden which has been analysed as a barrier to SMEs becoming involved in public procurement. Finally, the lack of understanding of SMEs of the tender procedures leads to mistakes in applications. The results show the main solutions are to streamline the procurement process, simplify the process to allow new SMEs to be involved, set minimum standards but not specifics to allow innovation, and set concrete procedures which can only be subjected to change at set periods. Potential to use procurement effectively can be improved through communication in clusters of stakeholders operating in the supply and demand chain of energy efficiency refurbishments.

Energy Efficiency

Energy Use in Europe

The EU has committed to a reduction in energy consumption by 20% by 2020 and is therefore addressing issues of import dependency, emissions and energy costs. The European Commission's Energy Efficiency Plan 2011 aims to establish a common framework for energy efficiency and to implement the proposals outlined in the plan. The elements of this plan most relevant for this chapter are;

- "Trigger renovation process in private buildings and improve the energy performance of buildings"
- "Improve efficiency of power and heat generation"
- "Promote role of the public sector and propose binding target to accelerate refurbishment of public sector building stock"

Source: (Eurostat, 2014)

Together, the countries in NWE, that is Germany, France, The Netherlands, Ireland, Belgium and the UK, accounted for 54% of gross energy consumption in the EU-28 in 2012. Within this area there are many territories with high GHG emissions, but also high mitigation potential. Transnational cooperation can enable this potential to be realised in these regions. For instance, Ireland had the lowest levels of energy intensity in the EU-28 in 2012 and the UK was ranked 3rd, meaning other NWE countries can learn from the experiences of the UK

and Ireland in dissociating GDP growth from increasing energy demand and therefore increasing energy efficiency on a national level.

In a study carried out for the European Energy Commissioner on the '*Energy Efficiency Investment Potential for the Building Environment',* it is shown that pre-1960's building stock, particularly those in NWE, make up more than 40% of the total potential for energy savings in the EU residential sector (ECORYS/ECN, 2012). The study also finds the majority of energy savings in existing buildings in the EU is related to space heating. The energy efficiency investment needs up to 2020 estimated for the building sector in the EU amount to €587 billion. This huge investment need shows the size of the potential market that is open for SMEs involved in the clusters developed under the Greenov initiative.

Energy Use in the City of Dublin

Dublin is the capital city of Ireland and has the highest level of economic activity in the country. There have been significant changes in the economic climate in Ireland since 2008, and this has had a major effect on energy consumption, particularly in the commercial and transport sectors, and has also had an effect on available funding for energy efficiency retrofitting. Nationally, energy use per household fell by 18% in 2011 from 2006 levels (SEAI, 2013 (b)).

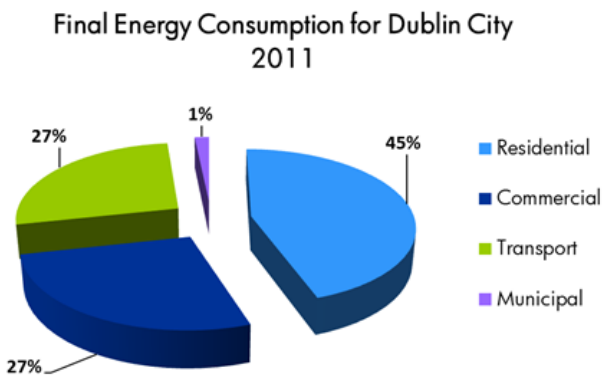


Figure 1: Share of Final Energy Consumption (10.14 TWh/year) used in Each Sector in Dublin City

The economic crisis has also had the adverse effect of reducing the amount of equity available in the public and private sector to invest in energy saving and renewable energy initiatives, and this is a common problem which can also be seen in other NWE countries. The number of applications for grants for energy efficiency upgrades through the Irish Government's 'Better Energy Homes' scheme dropped by over 50% in Dublin in 2012/2013 in comparison to 2010/2011 (SEAI, 2014).

The majority of the housing stock in Dublin City was constructed pre-1970, and was therefore not built to the stringent building standards for energy efficiency that are in place

today. This ageing housing stock has very poor energy efficiency ratings and is in need of major renovation in order to decrease the energy consumption of the residential sector, and this issue is found to be common to other NWE countries, as previously discussed. The residential sector is now the highest energy consuming sector in the city, as shown in Figure 1. Space heating is responsible for 65% of the residential energy demand (Gartland, 2013), and this energy could easily be decreased with energy efficient renovations like innovative window and door design, internal/external insulation and highly efficient heating systems.

Public sector bodies in Ireland are required to report annually on their energy use in order to monitor their progress to the 33% energy reduction target set by the government for the public sector. Dublin City Council has decreased their own energy consumption by 22% over the period 2006-2011, and is on the right path to meeting the 33% reductions by 2020. Even though there has been much improvement, there are still many areas the council can improve on, such as public lighting and increasing the efficient use of heating in municipal buildings.

Policy and Regulatory Environment for Energy Efficiency and Retrofitting

European Context

The EU Energy Performance of Buildings Regulations 2012 mostly deals with regulations for new buildings, but does encourage the consideration of high efficiency energy systems during refurbishment works;

"Where an existing building is to undergo major renovation, the person who commissions such works may, on his or her initiative, consider and take into account the technical, environmental and economic feasibility of installing high efficiency alternative energy systems in the design of the renovation works."

"The alternative energy systems that may be considered for the purposes of paragraph (above) *may include—*

(a) decentralised energy supply systems based on energy from renewable sources,
(b) cogeneration,
(c) district or block heating or cooling, particularly where it is based entirely or partially on energy from renewable sources, or
(d) heat pumps."

The above regulations are not enforced and are more suggestions as to what should be done rather than what must be done. The EU Energy Performance of Buildings Directive (2010/31/EU) (European Union, 2010) applies more rigorous measures to energy in buildings within member states, but these relate to new builds rather than retrofits.

Article 4 of the EU Energy Efficiency Directive (2012/27/EU) (Europe Union, 2012) deals with building renovation and ensures that member states establish strategies for investment in the renovation of the national level stock of residential and commercial buildings. The most relevant strategy for this chapter, which must be included in member states energy efficiency plans, deals with policies and measures to stimulate deep renovations of buildings. Article 5 addresses the role of public sector buildings and requires that;
"*3 % of the total floor area of heated and/or cooled buildings*[2] *owned and occupied by its central government is renovated each year to meet at least the minimum energy performance requirements that it has set in application of Article 4 of Directive 2010/31/EU*".

The directive also specifies that an inventory of the energy performance/energy data for the above mentioned government buildings be made publicly available. This means SMEs can initialise proceedings for contracts to carry out works based on estimates of potential energy efficiency upgrades they could provide in order that these buildings meet EU regulations. These requirements for public sector buildings open up the market for SMEs and are some of the few enforced rather than suggested regulations for the renovation of buildings.

The promotion of efficient heating and cooling in the Energy Efficiency Directive means that member states must comprehensively assess the potential for high efficiency cogeneration and DH in their respective countries. In particular the directive states;

"Member States shall adopt policies which encourage the due taking into account at local and regional levels of the potential of using efficient heating and cooling systems, in particular those using high-efficiency cogeneration. Account shall be taken of the potential for developing local and regional heat markets."

This must be implemented by December 2015, and this concentration on DH means that the market for large scale DH energy efficiency projects will be supported by EU directive. This

[2] where total floor area is above 500m^2, lowered to 250m^2 in 2015

directive will see a boost in the need for refurbishment of current building stock in order to connect to future DH systems.

Irish Context

Ireland has aligned national policies and regulations in order to achieve the EU '20-20-20' targets. In terms of energy efficiency in buildings, there have been many improvements to building standards for new and existing dwellings in order to improve the energy efficiency of the housing stock. Part L of the Irish Building Regulations 2011 deals with the conservation of fuel and energy. Under these regulations, all existing dwellings must;

- limit heat loss and, where appropriate, maximise heat gain through the fabric of the building;
- control, as appropriate, the output of the space heating and hot water systems;
- limit the heat loss from pipes, ducts and vessels used for the transport or storage of heated water or air;
- provide that all oil and gas fired boilers installed as replacements in existing dwellings shall meet a minimum seasonal efficiency of 90% where practicable.

These regulations apply to all works to existing dwellings that are covered by the requirements of the Building Regulations, including extensions, material alterations, material changes of use, and window and door replacement (Department of Environment Community and Local Government, 2011). Regulations for new dwellings include requirements to include renewable energy technologies to meet a minimum 10kWh/m^2/annum heating requirements or 4 kWh/m^2/annum of electrical requirements.

The building requirements for buildings other than dwellings are similar to those for existing dwellings but also include;

- ensuring that the building is appropriately designed to limit need for cooling and, where air-conditioning or mechanical ventilation is installed, that installed systems are energy efficient, appropriately sized and adequately controlled;
- limiting the heat gains by chilled water and refrigerant vessels, and by pipes and ducts that serve air conditioning systems;
- providing energy efficient artificial lighting systems (other than emergency lighting, display lighting or specialist process lighting) and adequate control of these systems

As part of the National Energy Efficiency Action Plan (NEEAP), grants for energy efficiency upgrades were introduced. These grants are available from the Sustainable Energy Authority of Ireland (SEAI) through the Better Energy Homes Scheme, the Better Energy Communities Scheme, and the 'Accelerated Capital Allowance' (ACA) which is a corporate tax refund scheme. The ACA allows companies to write off 100% of the cost of qualifying energy efficient equipment against their profit in that year.

There is great opportunity for newly evolving and innovative energy efficient technologies and services to take advantage of the need for large scale refurbishment of the building stock in the NWE. Matching this supply and demand would have a major impact on energy efficiency while increasing SME competitiveness. In order to implement such a scheme there needs to be more engagement between the supply and demand chains. The following section looks at the current potential for refurbishment in Dublin as a case study for cities in the NWE region. The following studies of planned large scale energy efficiency upgrades in Dublin, through the use of large scale District Heating, are applicable to other areas in NWE with a similar climate and demand for heat.

Refurbishment through District Heating

Introduction to District Heating in Ireland

District Heating (DH) is an established method of increasing energy efficiency, lowering fossil fuel use, and utilising waste heat sources. It has been successfully implemented in many other European countries, particularly in Scandinavia. DH can potentially contribute toward meeting national level targets of energy efficiency and renewable energy in the heating sector in Ireland, but as yet, large scale DH has not taken a foothold in the Irish market. It has been estimated by expert research in Denmark that around 30% of heat demand in Ireland is currently feasible for DH. This research has also shown that it is cheaper to implement sustainable heating supply rather than further energy savings after approximately 30-50% of heat savings have been achieved, meaning DH will still play a key role in a future with low heating demands. (Connolly, et al., 2013) (Connolly, et al., 2012)

Codema have been working to encourage and promote the use of DH at a large scale in Dublin as the city has the ideal attributes for successful implementation; high heat density, a diversity of building purposes in close proximity, and industrial scale waste heat sources. Much of the building stock in Dublin City, particularly the housing stock, pre-dates 1970, and

is highly inefficient. The majority of heating systems are gas fired and many in the housing sector are old and have low efficiencies. A more efficient heating system, powered by a variety of fuel sources including renewable and waste heat sources, could greatly reduce the energy needs of the city, while also allowing new innovative heat technology, like large scale heat pumps, to be incorporated into the system. Because DH is new to Ireland, development of this sector will require working closely with innovative SMEs, especially those from outside of Ireland who have much experience with DH systems. This will expand the knowledge base and expertise required to implement this type of sustainable renovation of existing individual building-based heating systems.

Dublin City District Heating System: A Market Assessment

Codema carried out an assessment of the potential market for a planned large scale urban DH development in the Dublin Docklands area. The *Dublin District Heating System* project is an initiative by Dublin City Council to bring a large scale DH system to a developing area in the City, which is to be fed by a large waste-to-energy plant.

Market Assessment

The aim of the market assessment was to identify a customer load which would enable the feasibility of such a project. A zone was identified for analysis, followed by the development of an inventory of buildings in the area. Buildings were then prioritised based on their estimated heat demands. The marketing approach adopted targeted the organisations with the highest heat demands, and involved meeting with customers to present the project and its benefits.

A key objective of the assessment was to not only identify potential customers for DH, but to also generate a local demand for DH, which will in turn be a supporting driver towards developing sustainable renovation. 18 letters of interest were submitted by organisations in the Docklands. Codema identified 20.58 MW average heat load and 55.17 MW installed boiler capacity within the initial customer zone. As there were many buildings in the area which were not part of the initial target market, there is great potential to further increase the customer base and overall demand for district heating in the area.

The marketing assessment also identified a number of emerging themes among the larger organisations operating in the area. There was a very good response to the District Heating System proposed by Dublin City Council for the Docklands. Using a more sustainable source

of heat, increasing energy efficiency and reducing the demand for oil and gas was seen as something very positive for the businesses, residents in the area, and for Dublin City as a whole. Some customers queried details on cost of the heat exchanger and additional retrofitting. They also conveyed an interest in the availability of grants to finance the heat exchangers and other retrofits.

These queries need to be addressed in order to further the progress of the DH retrofit in these premises. This can be achieved through clusters like Emerge, which can bring together experts in the field of DH in order to answer these queries and to show the potential customers examples of real working large scale DH systems from other countries to alleviate concerns surrounding disruption, reliability and costs.

(More information at http://www.codema.ie/projects/local-projects/dublin-district-heating-system)

Large Retrofit DH System in South Dublin

Although it is easier and cheaper to implement DH during the initial development stage, the areas most suited to DH, i.e. those with high heat densities, mixed use of buildings and close to waste heat sources, are often in already established urban areas which would need to have DH retrofit in order to benefit from higher energy efficiencies from a centralised system. This is the case for Dublin city, and from this perspective, Codema carried out a techno-economic analysis of a potential retrofit DH system in an established urban area in south Dublin. The proposed system will link the heat demands of several large existing heat consumers; a large regional hospital, municipal buildings, a large shopping mall and a college. These buildings are included as they have high heat densities and have all shown an interest in connecting to a potential DH network, but there are many other large heat consumers in the area which could potentially connect to the grid in the future. The heat density in the area is 93.1TJ/0.17km^2, or 549TJ/km^2, and could potentially be higher if other heat demands along the proposed network were also taken into account. Heat densities which would be considered highly feasible for DH systems from a Danish perspective are heat densities of 150TJ/km^2 and above, meaning this area is a very attractive prospect for DH.

Refurbishing the Existing Buildings for DH

There may be costs incurred by the need to adjust the existing heating systems in the consumer premises in order that the flow and return temperatures of the new DH system provides the correct amount of heat. This is the case when the DH system operates at lower temperatures and the existing systems are designed for higher temperatures. To maximise the efficiency of a DH system, the return temperatures would be much lower than those of a typical existing wet system installation, and so to be incorporated effectively, the heat transfer needs to be maximised (COWI, 2012). In buildings with wet systems this usually involves some combination of installing radiators with larger surface areas, adjusting the building management settings, and changing setting on bypass valves (COWI, 2012).

In Ireland there are typically many individual electrical heating systems installed in apartments, which would incur much higher costs to retrofit to DH, but would benefit from higher savings due to the high price of electricity, even on night rate. In large retail and office buildings there may be Air Handling Units (AHU) installed, which can potentially be retrofit to connect to DH, but this depends on space available in the AHU to change the heating coils (COWI, 2012). The problem of retrofitting can be overcome in other ways, such as allowing for higher return temperature heat so the existing systems can operate as normal, or put in place heat saving measures at the same time as the DH system so there will be a lower demand and a lower supply and return temperature will suffice. Typically costs for the consumer side meter and heat exchanger will be met by the consumer, and this case assumes all measures will be taken in order to reduce the need for retrofit of existing heating systems and therefore reduce further costs to customers.

There are potentially sites in the area under study which dump surplus industrial heat, which could contribute to the DH system, but an investigation into this was outside the scope of the study. The inputs used in the case study that are particular to this case study site are the heat density of the area and the heat demand profiles of the consumers. Therefore the results of this study are applicable to many other potential sites in Ireland with similar heat densities and demand profiles.

Results of Analysis

The techno-economic analysis carried out used the energy system analysis software tool EnergyPRO to simulate the proposed DH system. Many data sets were input into the EnergyPRO software in order to represent, as accurately as possible, the conditions

surrounding a proposed DH system at the site previously described. 7 scenarios, as seen in Table 1 below, were analysed with differing combinations of energy production units.

Unit Combination in Each Scenario Examined						
	Baseload 4MW				Peak 9.6MW*	
Project	Gas CHP	Biomass CHP	Gas Boiler	Biomass Boiler	Gas Boiler	Biomass Boiler
Scenario 1	X				X	X
Scenario 2		X			X	X
Scenario 3		X				X
Scenario 4		X			X	
Scenario 5				X	X	
Scenario 6			X		X	
Scenario 7	X				X	

Table 1: Combination of Production Units Analysed in Each Scenario

The results show the choice of unit combination is crucial to economic feasibility. Firstly, Table 2 shows the results of a financial appraisal for each scenario. As can be seen, only one scenario has a positive Net Present Value (NPV) and is paid back within the lifetime of the production units, which is Scenario 4; the combination of biomass CHP and gas boiler for peak demand. The reason this scenario is more profitable is the combination of the lower investment costs of a gas boiler over a biomass boiler, the Renewable Energy Feed In Tariff (REFIT) available in Ireland for electricity produced by biomass CHP, and, to a lesser extent, no carbon tax associated with the use of woodchip fuel and the lower cost of woodchips over gas per kWh. The Internal Rate of Return (IRR) is 7.5% and has a payback period of 15 years.

In terms of procurement, this project is a planned municipality venture and so the €8.5m investment for works required would need to go through the public procurement process outlined by the government and EU directives.

Financial Appraisal of Each Scenario			
	Project Lifetime (20 years)		
	Financial Indicators		
Project	NPV (all payments)	Payback (yrs)	Total Investment (000s)
Scenario 1	-€6,515,215	not within Lifetime	10280
Scenario 2	-€645,103	not within Lifetime	11520
Scenario 3	-€4,624,998	not within Lifetime	15250
Scenario 4	€2,286,864	15	8530
Scenario 5	-€8,039,836	not within Lifetime	6190
Scenario 6	-€5,792,794	not within Lifetime	3340
Scenario 7	-€4,280,033	not within Lifetime	7240

Table 2: Results of Financial Appraisal of Each Scenario

A comparison of the currently installed individual heating system's investment and running costs for all consumers, compared to the total investment and running costs for all consumers if on the DH network are shown in Table 3. Due to lack of data on the actual systems currently installed, there have been assumptions made regarding size and efficiency; it is assumed the units are gas boilers sized at 120% of peak load, and with 90% efficiency. The installation and maintenance costs of the DH heat exchangers at the customer premises are taken from the Danish Energy Agency (Danish Energy Agency & Energinet.dk, 2012). Investment costs for the consumer on a DH network include a heat exchanger, meter, and connection pipeline to the main network, but do not include any costs incurred by potential retrofitting needs as this could only be estimated with detailed inspection of the buildings current systems.

Comparison of Consumer Costs			
Total Consumer-Side System	Individual	DH	Difference
Heat Demand MWh	25,864	25,864	
Investment	1,060,000	742,000	318,000
Annual Fuel/Heat Costs	1,262,434	1,208,000	54,434
Annual O&M	139,667	53,000	86,667
Total Annual Costs	1,402,101	1,261,000	141,101

Table 3: Comparison of Consumer Costs

The difference in costs for the consumer shows that connecting to the DH network will cost €318,000 less in up-front investment and annual cost savings of over €141,000. It is worth noting that annual cost savings are not evenly distributed between all consumers as the shopping centre had higher individual system fuel costs for heat due to the use of electrical heating, and therefore see more savings from the DH system than the other users. These savings could be potentially higher if there are back-up units installed in the consumer's premises, the investments for which have not been taken into account, or if the current efficiencies are lower than 90%. The difference between the annual fuel and heat supply costs are based on the heating being provided at the same price per MWh as the consumers were already paying for gas, so this saving only really represents the difference in efficiency, with the customer heat exchanger assumed to be 100% efficient.

The results of the overall analysis have therefore shown that, under short term, current market based economics, there is a DH scenario, scenario 4, which is feasible while retaining a competitive price for the commodity. The same scenario also has a large proportion of its fuel needs covered by renewable sources, which increases to nearly 100% by year 20, meaning very low emissions from the system over the period analysed. This

biomass is most likely to be sourced from Ireland, which leads to a higher security of supply and more capital staying inside the country and contributing to the Irish economy. The customers will also benefit from lower fuel prices than they would have had traditionally when using individual gas and electrical heating systems, assuming the DH company is run as a not for profit organisation by the municipality.

Comparing emissions to the current situation, the current total gas fuel consumed by the customers amounts to CO_2 emissions of approximately 5,280 tonnes annually, meaning scenario 4 offers between 80% and 92% emission reductions annually over the 20 year period. Implementing this level of DH in south Dublin is only the first step in creating a sustainable city. With these large customers connected, more businesses and residential units in close proximity can be connected and the system can be expanded further. This is an essential step for Dublin to become a low-carbon city.

(Access full report at http://projekter.aau.dk/projekter/en/studentthesis/developing-district-heating-in-ireland%284ec7cbfe-bcf9-4eb8-876e-3949186102b8%29.html)

Refurbishment in Ireland – Conclusion

There is a great need to refurbish the current building stock in Dublin in order to increase energy efficiency and lower energy consumption and associated CO_2 emissions. There are many opportunities for SMEs to take advantage of energy efficiency requirements of national and EU regulations, and particularly the energy reduction requirements for the public sector. The planned DH system shows the potential to drastically reduce energy requirements through a retrofit of existing buildings to connect to a centralised DH system, while also providing heat at a competitive price to gas. Advancing DH in Ireland will allow a more SMEs to become involved in the EE sector, and because DH can incorporate so many different heat production technologies; solar, heat pumps, waste-to-energy, industrial waste heat etc., there is much scope for innovation in the heat supply industry. The next step is then to engage and involve SMEs in the procurement of contracts for the development of such projects.

Energy Efficient Refurbishment – Conclusion

Procurement and Unlocking Potential

This chapter has also shown the strengths and weaknesses afforded by the current procurement structures in place. It has been shown how these structures can be improved in order to allow more SMEs into the market, and the procurement portal established by Codema under the Greenov project will seek to help SMEs to overcome some of the barriers identified. The use of clusters has already proved invaluable through the use of the Emerge Dublin-based cluster for creating impetus and innovation in the energy efficiency refurbishment market in Dublin.

Energy Efficiency

As has been shown, there is huge market potential for sustainable renovation in NWE, due to ageing housing stocks coupled with stimulus from EU regulations for energy efficiency in existing private and public sector buildings. The transnational cooperation offered by the Greenov cluster will help to achieve this potential and see more SMEs involved in both public and private procurement for renovation. Energy efficiency in existing buildings can be achieved in many ways, including the use of up-coming innovative technologies developed by SMEs, and also technologies which have been well established in other countries, but have not had a major impact in NWE, like DH.

Refurbishment through DH

This chapter has shown how cities in NWE, which experience similar climatic conditions and have high heat demands, can greatly reduce energy and emissions through the use of DH. DH also requires a large customer base to be feasible, meaning once established, DH would facilitate large scale refurbishment of city areas and has the capacity to easily spread into additional neighbouring areas. This one energy efficiency strategy, which would have a large impact on heat use in NWE, would pave the way for the establishment of low-carbon cities.

Works Cited

Works cited (full documents and links) can be found on the Codema online Portal at: http://www.codema.ie/procurement-portal.

Commission of the European Communities, 2008. *The European Code of Best Practices facilitating access by SMEs to Public Procurement,* Brussels: European Commission.

Connolly, D. et al., 2014. Heat Roadmap Europe: Combining District Heating with Heat Savings to Decarbonise the EU Energy System. *Energy Policy,* Volume 65, pp. 475-489.

Connolly, D. et al., 2012. *Heat Roadmap Europe 2050: First Pre-study,* Brussels: Euroheat & Power.

Connolly, D. et al., 2013. *Heat Roadmap Europe 2050: Second Pre-study for the EU27,* Aalborg: Department of Development and Planning, Aalborg University.

COWI, 2012. *Conversion of Heating Installations into District Heating (Draft Oct 2012),* Dublin: RPS/Codema.

Craven, K. 2012. *Tender and Portal access in the Greenov Partner Countries.* 2010

Danish Energy Agency & Energinet.dk, 2012. *Technology Data for Energy Plants,* Copenhagen: Danish Energy Agency.

Department of Environment Community and Local Government, 2011. *Part L Building Regulations 2011: Conservation of Fuel and Energy - Dwellings,* Dublin: Government of Ireland.

DETE, 2009. *Buying Innovation - The 10 Step Guide to SMART Procurement and SME Access to Public Contracts,* Dublin: Department of Enterprise, Trade and Employment.

ECORYS/ECN, 2012. *The Energy Efficiency Investment Potential for the Building Environment,* Rotterdam: DG for Energy of the European Commission.

Europe Union, 2012. *EU Energy Efficiency Directive (2012/27/EU),* s.l.: EU.

European Union, 2010. *EU Energy Performance of Buildings Directive (2010/31/EU) ,* s.l.: European Union.

Eurostat, 2014. *Consumption of Energy.* [Online] Available at: http://epp.eurostat.ec.europa.eu/statistics_explained/index.php/Consumption_of_energy [Accessed 27 August 2014].

Gartland, D., 2013. *Dublin City Sustainable Energy Action Plan; Monitoring and Progress Report 2014,* Dublin: Codema.

Greenov Seminar Proceedings. *Clustering SME's for Renovation Jobs.* 16th March 2011.

His, C. *A Focus on Public Procurement and Green Renovation..* 2013.

McCarthy, A & Wagner, V. Dublin District Heating Marketing Assessment. 2012

RPS/COWI, 2007. *Dublin District Heating Project 2007 Feasibility Study,* Dublin: Dublin City Council.

SEAI, 2013 (b). *Energy in the Residential Sector: 2013 Report,* Dublin: SEAI.

SEAI, 2014. *Better Energy Home Scheme Statistics.* [Online] Available at: http://www.seai.ie/Grants/Better_energy_homes/Better_Energy_Statistics/ [Accessed 19 August 2014].

Tenderscout, 2010. *Public Sector tendering: Barriers to SME participation,* s.l.: Tenderscout.

Interreg IVB, *Main Report: SWOT analysis for the Smart, Sustainable, and Inclusive Growth Objectives*, 27 May 2013.

Other reports that were used in the report that do not have references because they are not public;

New Eco-products for Sustainable Refurbishment: Hemp-Lime Insulation Blocks

Author: Cluster Eco Construction Wallonia

Introduction

The ecobuilding/renovation sector is changing rapidly, and this is especially true for insulation. New innovative products and new companies are appearing on the market at an increasing rate, particularly in Wallonia. These include ChanvrEco in Tinlot near Liege - producing thousands of tonnes of hemp granules for the insulation market since January 2006 – or Argio in Tubize who make bricks with very impressive intrinsic properties from clay and raw earth, Dolcea who produce cellulose wadding, Stabilame whose solid walls are nailed together layer by layer, Paille-tech who make prefabricated panels from wood and straw with earth coatings, and many more.

And now IsoHemp has joined the list. This is a young company in the province of Namur (Fernelmont) specializing in manufacturing and marketing ecological, sustainable insulation blocks made from hemp and lime, which are both natural, fully recyclable products. In short, this is a remarkable product for reasons which will become clear in the following pages.

The manufacturing of hemp-lime blocks in context

In 2009, the turnover of the building industry in Belgium was €46.3 billion (source INS). At current prices, the gross value added of the building sector represents nearly 5% of the

Belgian economy, which shows how important it is. As compared to other sectors, construction is labour intensive, drawing on local labour, with little possibility of delocalizing. The turnover of the sustainable building sector in Belgium was estimated at €810 million in 2008 or less than 2% of the total construction market (for the framework of the building, this refers to the use of renewable raw materials including those for insulation) (source: Stratellia, data for 2008).

General Market Trends

Price trends for building lots as compared to income: the price of building lots has almost tripled between 2000 and 2011 (source: www.statbel.fgov.be)

Price of real estate as compared to the general price index: since 1975, the average price of a residential home has increased tenfold, whereas, over the same period, the general level of prices has grown by a factor higher than 3. Consequently, over thirty-five years, the value of property has risen almost three times faster than that of other products.

Rationalization of costs: home ownership by households whose income grows more slowly than the price of building lots has caused two major trends:

- Optimization of the use of available land by creating developments which increase the built-up area compared to the area of available lots;
- Rationalization of costs by building several housing units in the same development by the same company.

Growing demand for buildings with low-energy consumption, passive housing and zero energy housing: until recently, wood seemed to be the most economical alternative to meet the criteria of passive housing. The dynamic concrete industry is now working to respond to this trend.

In fact, we don't know enough: in order to respond to the new economic, ecological and demographic issues, the players in the building sector are turning increasingly to new innovations. Professionals in the sector mention a strong tendency to combine building techniques to maximize the advantages of each type of material, for example, using wood for mezzanines because of its relatively light weight and thermal efficiency.

Hemp lime: an Eco-building material

Hemp lime is not a new material. The first hemp lime house was built in 1986 in France: an Alsatian insulated his half-timbered house with hemp concrete or “hempcrete”. Since then, the material has gained in popularity and is being used in thousands of construction projects across Europe. Still, the general public is not very familiar with the material, essentially because hemp lime houses were erected by craftsmen who no doubt were talented, but were unable to standardize the production of blocks, and standardization of materials is a prerequisite for wide scale adoption by the building industry.

Launching the IsoHemp product

Despite the very good performance of hemp lime blocks, no manufacturing operation existed in Belgium. The only company capable of producing them was set up near Avignon in France, some 1,000 km from Namur. In these times of minimizing transport and compliance with environmental requirements, it would make no sense to import this kind of product into Belgium because shipping costs are and will remain high. IsoHemp's goal is to put an industrialized product on the market, respecting building standards and specifically all the European and national standards (particularly the energy performance of buildings).

IsoHemp, a new venture

IsoHemp SA emerged in early 2012 as the first Belgian and Walloon company to produce this type of insulation block. It set up in the industrial park at Fernelmont, in the province of Namur, where it manufactures an innovative product, prefabricated industrially, with its own specific characteristics. It fits perfectly into the hemp industry, revived by ChanvrEco (Liege) in 2006. Hemp has been known and used for millennia – across Europe it played a role in the textile, rope, paper industries, as well as in construction - but it disappeared from our region in the 1960s. Today, thanks to the drive of several Walloon entrepreneurs, the crop has made a comeback, providing a raw material used in products which are produced on an industrial scale.

IsoHemp is the result of the joint efforts of two young engineers and entrepreneurs who met when doing their dissertations at the end of their studies. One is skilled in technical aspects, the other is the financial specialist and they are both convinced of the need to offer high-performance, high-quality local products which are not made by the petrochemical industry.

- Olivier Beghin holds a Master degree in Management Engineering from the Catholic University of Leuven, specializing in Entrepreneurship at the Louvain School of Management. He has been the managing director of IsoHemp since April 2012.

- Jean-Baptiste de Mahieu is a civil engineer (UCL) who won the Best Sustainable Development Project Award from Start Academy in 2011 and was also a prize winner in the “1, 2, 3, Go” contest.

A project conceived in 2011

IsoHemp took root in early 2011 when the founders met Arnaud Evrard, a civil engineer in architecture from the Catholic University of Leuven, who specialized in building applications for hemp. For several years, a number of European universities had been conducting numerous research projects and scientific studies on this building material (lightweight, airy, super insulating). An additional year-long research and development phase in collaboration with several scientific centres resulted in this high-performance product.

Production of hemp lime blocks at IsoHemp started on a small scale, but given the very positive reaction from the market, after a little over a year it was decided to move on to automated industrial manufacturing using a hydraulic press - so as to become operational in early 2014 at twenty times the production capacity (+/- 1,000,000 blocks/year), a quantity that could provide insulation for the construction of roughly 1,000 houses a year. This is quite a challenge, since the installation requires a large amount of raw materials along with several new contractors to implement it on construction sites.

For years, the techniques used remained very small scale – components were mixed on the construction site itself and poured into frames, or a sprayer was used. The response to these challenges was to develop a product that could be laid like a brick by any contractor or bricklayer and be distributed by anyone selling traditional construction materials.

The number of reports of constructions using hemp lime blocks is growing daily. Applications exist in 3 fields: new free-standing constructions insulated with hemp blocks, indoor and outdoor insulation of existing buildings, and partitions. Soundproofing projects have also been completed already in both Wallonia and Brussels.

Indoor insulation (Photo: IsoHemp)

Outdoor insulation (Photo: IsoHemp)

Financing the company

Thanks to a subordinated loan from Namur Invest, and another loan from the Walloon Region (investment bonus, subsidy for experimental development) plus funds provided by the founders themselves, the company in Namur managed to raise a million Euro to finance development of the plant.

In addition to obtaining a pre-activity stipend and a subsidy from the European BatiD2 programme to develop the equipment, along with a budget to finalize the business plan of the start-up via the cross-border programme ‘1,2,3 Go’, the founders of IsoHemp took part in a call for projects organized by the Walloon Region for "Sustainable materials". Sustainable building materials offer potential for the emergence and growth of new industries that can help bolster the local economy and reduce the need for transport. Along these lines, the "Green Marshall Plan 2" provides for the launch of several calls for projects to promote the growth of businesses in sustainable construction materials (production, distribution and implementation).

This drive is at the core of the Walloon Employment-Environment Alliance dedicated to sustainable construction and renovation. A budget of 3 million Euro has been earmarked for the programme that fully meets the objective of this innovation policy: making the improvement of the environment a source of economic opportunities and job openings. The indicative budget set aside for the first call for projects is €1.5 million. 16 projects were retained - 4 of them entail the use of hemp, and IsoHemp was one of them: the project will provide financing for the construction of two "model" houses in Walloon Brabant in 2014, insulated using IsoHemp blocks.

It's all Belgian!

IsoHemp blocks are 100% natural products, and, in addition, they are 100% national and local because the lime comes from Belgian quarries located near Namur and the hemp is grown in Wallonia before being transformed into insulation blocks at IsoHemp in the Fernelmont industrial zone. We mentioned the ChanvrEco and Argio companies, and for a good reason, since ChanvrEco is one of IsoHemp's main suppliers. Both companies have decided to give priority to short-distance transport. All the stages - from the field, to cutting the hemp and manufacturing blocks for the building industry – are done within a radius of 100 km. In the same spirit, on the initiative of Innova Tech, a partnership has also been established with Argio. All three companies now propose common solutions to consultants, contractors and architects and share the cost of canvassing the market.

Belchanvre is another IsoHemp supplier. For the most part, the members of this Walloon cooperative society founded in 2012 are farmers, pioneering the growing of hemp in Wallonia. Its approach to its activities focuses on the entire supply chain, from the hemp crop to marketing processed products, particularly fibres. The cooperative grows 200 hectares of hemp and, unlike ChanvrEco, it supplies defibered hemp (2,000 tonnes /year. The crop harvested in Wallonia is currently processed in a hemp processing plant before it is transferred to Carmeuse which plays a two-fold role in the process of creating the product: it is both a supplier of hemp and the co-developer of the block. The product is then mixed with a "magic powder" developed by IsoHemp, and transformed in the facilities in Fernelmont. The maximum capacity of the plant in Namur is one million blocks per year, which can insulate some 1,000 homes every year. The company has perfected a manufacturing process that requires very little energy (5 to 10 times less than most kinds of synthetic insulation or cellular concrete).

Already a reputed company

In addition to the two founders, the company employs three people: a sales manager who works exclusively on recommending the products to architects and engineering and designing offices, a production manager and a technician. IsoHemp has already trained nearly one hundred contractors and architects in the theory and practice of applying and laying hemp blocks. Training programmes are organized every 3 to 4 months at the plant. Visits to local construction sites are also organized, particularly for professionals like architects, engineering and design companies or contractors, but also for interested individuals. Since last July, IsoHemp blocks have been registered on the Building Energy Performance list, and at the end of 2013, IsoHemp was nominated for the Greenov Award in the "Innovation" category. During the same period, the Company won the "Young Enterprise" and "Sustainable Development" Awards at the Walloon Entrepreneurship Grand Prix initiated by ASE (Agence de Stimulation Economique – Economic Stimulation Agency).

GPWE.be
GRAND PRIX WALLON DE L'ENTREPRENEURIAT

Hemp lime: a remarkable product

The products are used for three different types of applications:

- *New buildings:* In combination with a wooden frame, beam-column construction or a clay brick wall, hemp blocks can be used for the building envelope (self-bearing, but not bearing walls!) of any new building, which needs no additional insulation. The blocks must be laid on a waterproof bed at least 20 cm off the ground outdoors (2 cm off the floor indoors), because they must be protected from rising damp capillary action. "*The blocks don't like wet feet* …"

- *Indoor masonry*: The excellent acoustic properties of IsoHemp blocks make for high-performance, economical, distribution partitions (in thicknesses of 9, 12 or 15 cm).

- *Insulation of existing buildings from the interior or exterior:* In the case of renovation, hemp blocks are an effective, natural solution for thermal insulation and soundproofing of your home.

5 in 1 insulation

Combined with a bearing frame, IsoHemp blocks form the building envelope, grouping together all the desired qualities in a single material. Choosing hemp block insulation is a choice for a "global solution", for 5 in 1 insulation:

- Thermal insulation to reduce daily heat consumption
- Acoustic insulation for a positive influence on the quality of daily life
- Regulation of damp for a wall that breathes and is permeable to steam
- Considerable thermal inertia for a warm interior in the winter and pleasant temperatures during the rest of the year
- Backdrop for finishing coats inside or outside

IsoHemp blocks also provide very good resistance to fire, insects and rodents.
Hemp blocks are made from a combination of hemp and lime (an excellent binder) for excellent, long-lasting performance.

(Photos: IsoHemp)

Technical characteristics

This is a multi-purpose block with the following features

- Thermal conductivity: 0.076w/m K
- Acoustic resistance: 40 db for a thickness of 15 cm (when coated on both sides)
- Fire resistance: 2h for 30 cm (thanks to the non-hydraulic lime, it never ignites, and burns very slowly)
- Density: 350 kg/m³ (good inertia, because it is not too light)

- Specific heat capacity: 1600 j/kgK (large capacity for energy storage)

Considerable thermal inertia

Thermal inertia is the characteristic that describes the capacity of a material to store heat and diffuse it. The great advantage of an IsoHemp wall lies in this feature for thermal comfort.

In hot weather, just a few centimetres thickness of the material stores and keeps heat, while leaving the inside cool and dry. When the weather cools down, at night for example, it rejects the heat outdoors, in order to cope with a new wave of heat the next day. A hemp block wall can maintain a constant temperature indoors and eliminate the variations due to the day/night cycle.

In the winter, when cold sets in, less heat is needed because the IsoHemp wall stores it. As soon as the temperature falls, it complements the heating system by distributing the heat it has retained, and helps keep the house warm.

Overcoming the problems of damp with a wall that breathes

Hemp blocks are effective in maintaining a healthy atmosphere, particularly by regulating humidity in the air (they are airtight – but let steam out). They continually manage damp. The lime in the blocks has the advantage of stabilizing the level of humidity in the air at about 50%. This feature means that the air is continually healthy and comfortable to breathe.

An environment-friendly product

Manufacturing hemp blocks requires very little energy. In addition, during the rapid growth phase of hemp, it captures an enormous quantity of CO_2 from the air by means of photosynthesis. Because the CO_2 used to manufacture it is less than the quantity captured by growing hemp, the overall impact on the environment is positive. Another significant aspect is that hemp blocks that have reached the end of their useful life are 100% biodegradable and consequently have no impact on the environment.

The product is manufactured cold, using a simple process: mixing machines combine the various raw materials, a press moulds the blocks and they dry quickly in the open air.

A life-cycle analysis of IsoHemp products is underway on the entire production cycle, transport, processing and manufacture of raw materials, placement of the products up to the

destruction of the building. It is intended to show that hemp blocks can store and capture more CO^2 than is produced in the entire life cycle. In other words, its carbon balance is negative, thus responding to the technical and environmental issues that will become a priority in future years! (The results obtained thus far are as follows: 1m³ of hemp blocks (= 110 kg of hemp chaff + 220 kg of binder) = storage of 135 kg of CO_2/m³!).

Insulation that protects your health

Since hemp blocks are a natural product, they do not give off or contain toxins or harmful products. They are also non-allergenic and non-irritating. They consist of lime and hemp chaff, providing a long-lasting, healthy environment as this combination naturally repels insects and rodents, and moreover is totally non-flammable.

Laying and management of stock

Laying the blocks is quick and easy, thanks to their large size and light weight. They are easy to cut and create very little waste. In fact, a skilled labourer or even an amateur building his own construction can lay several square meters per hour.
IsoHemp blocks (thicknesses from 9 to 30 cm) are ideal for use in all construction using traditional materials and do not require any special familiarity with the product. The blocks are made in male-female profiles to facilitate laying and prevent thermal bridges. The laying of IsoHemp blocks is similar to "Ytong" blocks, which are very well known in the building sector. They are mounted horizontally and vertically with staggered joints, using a quick-setting mortar (such as lime milk) spread uniformly at 3mm, for maximum insulation. They can be coated or plastered indoors or outdoors, using any of the products in current use today, and particularly coatings that are permeable to steam like natural plaster, or clay or lime coatings. Lime is particularly recommended for exterior coatings!

The blocks are not sensitive to wind or water damage (as long as they are not directly in contact with the soil or subject to very heavy vertical rain), or to salt and they can be stored outside for up to a year before they are used on the construction site.

(Photos: IsoHemp)

(Photos: ChanvriBloc)

Financial benefits of hemp-lime blocks

"The product is no more expensive than others", confirms the managing director of IsoHemp. Our price range is similar to other types of ecological insulation. The price of the product is competitive compared to materials currently on the market. A homeowner will pay the same price as for a traditional synthetic insulation with the same insulating coefficient for the interior or exterior of his house. Hemp-lime blocks are more expensive than fibreglass for example, but the contractor saves time installing them as compared to any other product range. Even when he uses unskilled labour, hemp-lime blocks will still be properly installed, which is not always the case for fibreglass and other materials. With hemp-lime blocks there is also an easy way to "verify" that the insulation is watertight: simply put on the finishing coat.

What progress has been made on standardization?

IsoHemp hemp-lime blocks have recently been approved by the Walloon Region. Recognition is well on the way from CSTC Centre Technique et Scientifique de la Construction (*Technical and Scientific Construction Centre)* as a "building product like any other".

Bonuses are awarded to contractors for using blocks at least 12 cm thick indoors and 15 cm thick outdoors.

Contact

Olivier Beghin

Managing Director

jb@isohemp.be

0032 (0) 474/57.78.26

0032 (0) 81/39.00.13

IsoHemp S.A.

Rue du Grand Champ, 18

Z.I. Noville-Les-Bois

B - 5380 Fernelmont

www.isohemp.be.

Introduction to Smart Buildings

Author: ADEC Technopole Bas-Rhin

What is a smart building?

A smart building can be defined as a building that integrates an IT infrastructure so that different smart systems within the building such as PLC's (Programmable Logic Controller) and control systems, can communicate between each other. A green smart building, in addition, integrates an energy management system whose objective is to improve the energy performance of the building. The system operates by matching energy consuming, energy producing, and energy storage units to consumer behaviour.

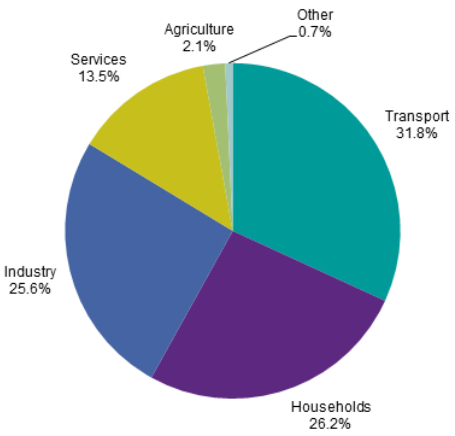
Why develop smart buildings?

Energy context

In recent years, the problem of energy management has become a global issue and it has been placed at the centre of the European Commission strategy "Europe 2020".[3] Indeed, the triple "20-20-20" objective of the initiative shows the need to increase energy efficiency measures by 2020. This means a 20% reduction in the European Union's primary energy consumption, in greenhouse gas emissions, as well as a 20% increase in renewables within the energy consumption share.

Moreover, with the prospect of increasing scarcity of fossil fuels in coming years, it is important not only to better manage our consumption but also to avoid unnecessary utilisation of energy and this through focusing on the energy efficiency of buildings.

[3] Europe 2020 strategy: http://ec.europa.eu/europe2020/index_en.htm



Source: Eurostat (online data code: tsdpc320)

Final energy consumption, EU-28, 2012 (% of total, based on tonnes of oil equivalent)

In the above chart we can see that the combined share of energy used by households and industry is extremely important, as together these two sectors account for half of the energy consumption of the European Union[4]. It is in this perspective that smart buildings have an important role to play. The concept of smart building concerns the integration of energy management solutions into housing and tertiary buildings, in particular to obtain positive energy buildings, which are buildings that produce more energy than they use.

Regulations for smart buildings

The recent enthusiasm for smart buildings coincides with European regulatory requirements. Indeed, the third European Union climate and energy package[5] requires member countries to improve their energy efficiency and thus the energy performance of buildings. This objective is confirmed in Directive 2012/27/EU of 27th October 2012[6] and more specifically with regard to buildings in the Directive 2010/31/EU of 19 May 2010[7] on the energy performance of buildings. For more information on this legal instrument, the European Commission has devoted several pages on its web site.[8]

---

[4] Final energy consumption, EU-28, 2010: http://epp.eurostat.ec.europa.eu/statistics_explained/index.php/Consumption_of_energy

[5] Climate action: http://ec.europa.eu/clima/policies/package/

[6] 2012/27/EU of 27 October 2012: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2012:315:0001:0056:EN:PDF

[7] 2010/31/EU of 19 May 2010: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2010:153:0013:0035:EN:PDF

[8] European Commission on energy efficiency of buildings: http://ec.europa.eu/energy/efficiency/buildings/buildings_en.htm

Similarly to help monitor the national adoption of the directive and exchange best practices between each of the EU Member States, the Commission launched the Concerted Action (CA) Energy Performance of Buildings Directive (EPBD)[9] a forum promoting dialogue and exchange which, includes detailed information by country. Some examples of actions taken include:

- In France, the thermal regulations resulting from the "Grenelle Environnement 2012"[10] require new builds to be more energy-efficient in order to reduce energy consumption.
- In Ireland, the 2010 Directive was transposed by the 243[11]statutory instrument in 2012 which strengthens an entire legal arsenal already present. Following the directive of 2012, the country has established a second national action plan on energy efficiency.[12]
- In the Netherlands, after implementing the first Directive 2002/91/EC[13] on energy efficiency in buildings, the country has decided to set up an action plan for energy efficiency in the built environment.[14]
- In Germany, the Energy Saving Act "Energieeinsparungsgesetz (EnEG)"[15] has been passed on a federal level to reduce German dependency on imported energy carriers. The 2010 and 2012 Directives have been integrated into the Energy Saving Act through amendments, notably the "Fourth Law amending the Energy Saving Act" of 4th July 2013.

---

[9] Concerted Action Energy Performance of Buildings Directive: http://www.epbd-ca.eu/

[10] Réglementation thermique du grenelle de l'environnement 2012: http://www.rt-batiment.fr/fileadmin/documents/RT2012/06_07_2010_-_generalisation_des_batiments_a_basse_consommation.pdf

[11] SI 243 of 2012: http://www.environ.ie/en/Legislation/DevelopmentandHousing/BuildingStandards/FileDownLoad,31049,en.pdf

[12] Ireland's second national energy efficiency action plan: http://www.dcenr.gov.ie/NR/rdonlyres/B18E125F-66B1-4715-9B72-70F0284AEE42/0/2013_0206_NEEAP_PublishedversionforWeb.pdf

[13] Directive 2002/91/EC: http://www.infomil.nl/onderwerpen/integrale/handboek-eu/

[14] Plan of action Energy saving in built environment: http://www.government.nl/files/documents-and-publications/reports/2011/02/25/plan-of-action-energy-saving-in-built-environment/plan-van-aanpak-energiebesparing-gebouwde-omgeving-webversie-en.pdf

[15] EnEG: http://www.bbsr-energieeinsparung.de/cln_032/nn_1024204/EnEVPortal/EN/EnEG/eneg__node.html?__nnn=true

- In Belgium, the implementation of the Directive on the energy performance of buildings is the responsibility of the Regions (Brussels, Wallonia and Flanders). Since 2006 - 2007 many decrees and ordinances have been adopted.[16]
- In the UK, regulations on the energy performance of buildings have been the subject of several statutory instruments and amendments since 2007.[17]

ICT: An Advantage in any Green Building Project

The European Commission pushes forward research in Smarts Buildings as a response to European and national regulations. It has funded many projects during the 2007-2013 period under the Seventh Framework Programme for research and development.[18] Under the new programme Horizon 2020 which runs from 2014 to 2020, the Commission aims to stimulate SME innovation in research and demonstration of more energy-efficient technologies and solutions.[19] The recently launched Public-Private Partnership "Future internet"[20] also targets "smart" energy as one of its priority areas.

The European bodies are not the only ones to pay close attention to Smart buildings: in the United States, the development of smart homes is a government priority, and the LEED platinum[21] programme is one of the most intelligent buildings so far constructed. In Sweden, the smart lifestyle home project “One tonne life”[22], aims to demonstrate that a family can radically cut their CO^2 emissions (from 7 to 1 tonne) notably with a climate-smart house.
These different projects show that information and communication technology (ICT) are essential tools for improving energy management in every kind of building, house, apartment

---

[16] Regulations in Belgium: http://www.cstc.be/homepage/index.cfm?cat=services&sub=standards_regulations&pag=norm_energy&art=regulations&niv01=energy_performance

[17] UK energy performance of building regulations: http://www.legislation.gov.uk/title/energy%20performance%20of%20buildings

[18] Projects financed by the Seventh Framework programme: http://ec.europa.eu/information_society/activities/sustainable_growth/funding/prj_buidings/index_en.htm

[19] Funding of Energy efficiency projects under Horizon2020: http://ec.europa.eu/easme/energy_en.htm

[20] Future Internet: http://www.fi-ppp.eu

[21] LEED platinum: http://www.smart-buildings.com/uploads/1/1/4/3/11439474/2012aprsmartestgreen.pdf

[22] One tonne life: http://onetonnelife.se

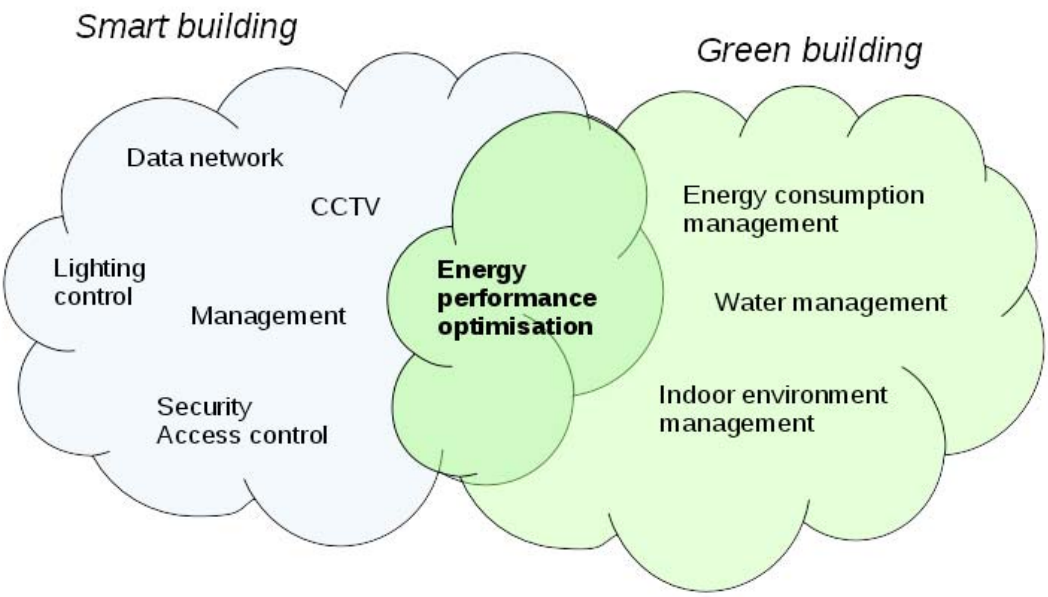
and office block. Integrating ICT into the private electricity network enables smart management of energy flows, through extraction and injection.

The role of ICT in a smart building project

The introduction of computers and new technologies (home automation and building management for non-housing facilities) would enable intelligent management of all electrics, from heating to lighting, through household equipment and surveillance systems. Programming, communication and integration are the hallmarks of this smart management.
However, managing the electrical applications of a building is not enough for optimal energy efficiency. Indeed, it is essential to integrate intelligence right from the beginning of the project taking into account eco-design in construction techniques, such as insulation for example. Many additional solutions exist, such as:

- Better insulation of buildings
- New techniques for energy generation
- The development and strengthening of ventilation systems
- More virtuous heating and cooling systems
- Better consideration of the location of the building
- The development of home automation, home equipment with lower energy consumption and energy management systems.

Similarities between a “Green” and a “Smart” building:



This diagram shows that to obtain a Green Smart building, it is necessary to take into consideration green building issues, meaning a building that is environmentally friendly and add control processes and programming from the smart building.

*The **Green Office®** programme from **Bouygues Immobilier**[23] is such an example, being the first large-scale positive-energy office building in France. Through only exploiting renewable energies and by combining eco-conception and technical building management, the building produces more energy than it uses: 64 kWh/m²/year produced for an estimated consumption of 62 kWh/m²/year all uses combined.*

The introduction of ICT and home automation into the home is designed to help manage energy, improve comfort and make life easier for users.

Home automation for improving intergenerational quality of life

Home automation can be defined as all, more or less interoperable, electronic technologies, allowing the unification of different home control systems (heating, electric shutters, garage doors, entrance gates, electrical plugs, etc..). It aims to provide technical solutions to improve the comfort of those living at home in various fields such as energy management, optimisation of lighting and heating, as well as home security (alarm) through communication technologies (remote controls, visual or audio signals, etc.).

*Today, with the same objectives, it is also possible to install home automation in the garden: comfort, energy savings and a good energy performance. This type of automation, through the example of the **Legrand** Company, allows a smartphone to programme an automatic sprinkling system, to mow the grass, or to manage lighting.*[24]

This is why home automation has wide public outreach and can be adapted to the needs of each of us.

[23] Green Office de Bouygues Immobilier: http://www.bouygues-immobilier-corporate.com/en/activites/energy-performance-office-buildings

[24] http://www.legrand.fr/particuliers/j-equipe-ma-terrasse-ou-mon-jardin_2526.html

Home automation suitable for elderly persons

Europe today has to face the challenges of an ageing population[25] with the increasing need to focus on home care for the elderly. For example in 2050 in France, 31% of the population will be aged 60 and over, and according to the National Union of institutions and private residences for the elderly 15.6% of people will be aged 75 or over (SYNERPA).[26]

Senior citizens are a population segment that should not be neglected. Indeed, a smart building network can help them by making their life easier.

The main idea is to combine home automation with specific services linked to the onset of frailty in the elderly such as through remote controlling of the systems.

Within the Strategic Implementation Plan of the European Innovation Partnership "Active and Healthy Ageing"[27], adopted in 2011, the European Union states that “innovative approaches, methods and solutions including those enabled by … ICT are essential for enabling new ways of organising society around active ageing”.[28]

The Homes programme led by Schneider Electric from 2008 to 2013,[29] aimed to make energy performance accessible to all. It gave several examples of how automation can give the elderly greater autonomy, such as:

- Integrated control software for a computer or tablet, capable of controlling lighting, blinds, heating etc.;
- Automation of doors, electrical appliances, and bedding;
- Placing all the home’s light switches in one place in order to check that everything is turned off;
- Risk prevention thanks to the installation of alarms or cameras able to alert medical personnel or family members when something unusual occurs.

---

[25] The greying of the baby boomers: http://epp.eurostat.ec.europa.eu/cache/ITY_OFFPUB/KS-SF-11-023/EN/KS-SF-11-023-EN.PDF

[26] France faced with the challenges of its ageing population: http://www.synerpa.fr/content/les-personnes-âgées-en-france.html

[27] European Innovation Partnership on Active and Healthy Ageing (EIP on AHA): http://ec.europa.eu/health/ageing/innovation/index_en.htm

[28] http://ec.europa.eu/research/innovation-union/pdf/active-healthy-ageing/steering-group/implementation_plan.pdf#view=fit&pagemode=none

[29] HOMES programme: http://www.schneider-electric.fr/documents/Presse-France/dossier-presse/20130213_DPF_HOMES_FR.pdf

An example of this growing need to adapt housing to the needs of elderly people is shown in the call for projects for senior residences launched by the Lower Rhine Council in France in 2012[30]. In the specifications, this housing must contain Information and Communication Technology capable of improving the quality of elderly peoples' lives.

Legal obstacles to home automation

The use of new technologies may infringe individual liberties. Indeed, these technologies are able to collect personal data (number of daily showers, time of use of equipment, etc.) and thus may infringe on the privacy of the building's occupants. The crucial issue is knowing how these personal data may be stored and/ or used, by whom and for what purpose. In an attempt to address these concerns, a legal arsenal exists in Europe protecting both privacy and personal data.[31] In 2012, the European Commission proposed a major reform of the EU legal framework on the protection of personal data. The new proposals will strengthen individual rights and tackle the challenges of globalisation and new technologies. In terms of smart buildings, the Commission Recommendation of 9th March 2012 on preparations for the roll-out of smart metering systems (2012/148/EU)[32] gives a framework for smart metering and home automation services.

Technical aspects

Overview

At a crossroads between power supply, information and communication technology and new expectations from users, buildings nowadays have become much more complex entities:

- Building power supply comes from more and more diverse renewable energy sources (wind, geothermal, photovoltaic and solar thermal, biomass, etc.). In addition, new construction standards even foresee positive energy buildings, that is to say buildings producing more energy than they use;

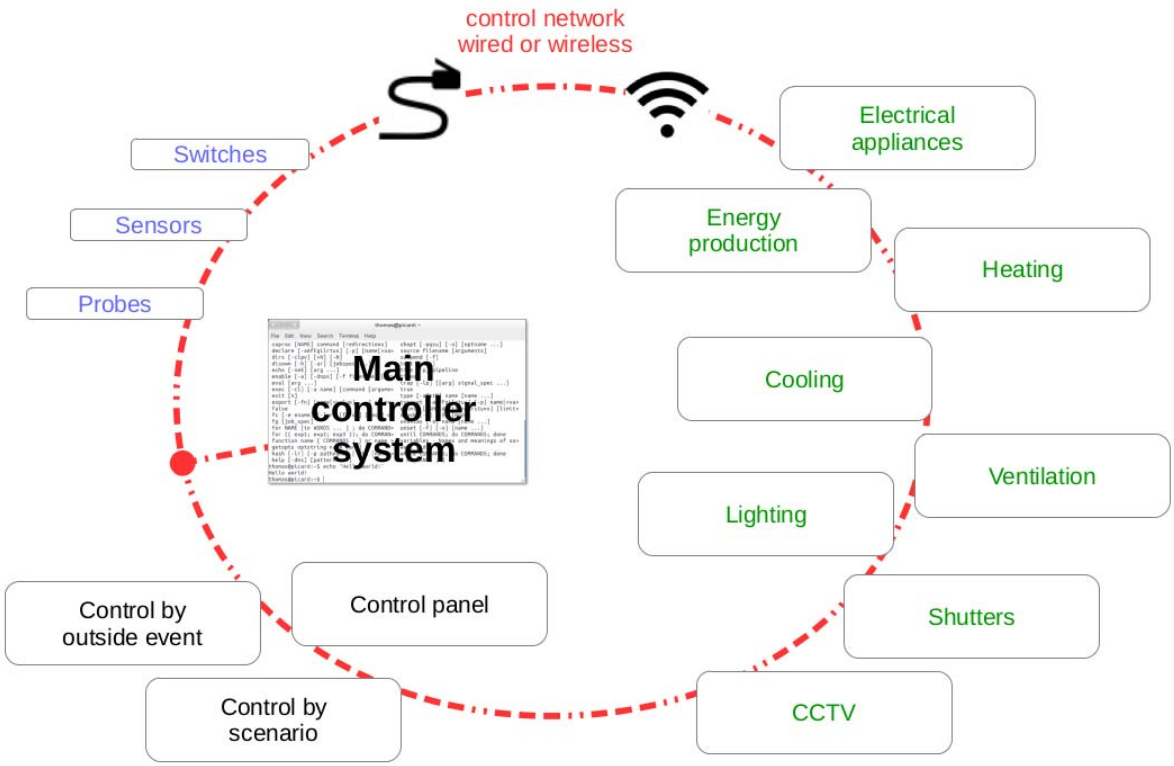
[30] Résidence Senior 67: http://www.bas-rhin.fr/eCommunityDocuments/E34C4D98-631D-459B-AA4E-61C91D2F7BA0/1751/document_conseil-general-bas-rhin-appel-a-projet-residences-seniors.pdf

[31] Legislation on Data protection: http://ec.europa.eu/justice/data-protection/law/index_en.htm and http://conventions.coe.int/Treaty/EN/Treaties/Html/108.htm

[32] http://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1395832740940&uri=CELEX:32012H0148

- Information and communication technology provide tools to measure better and to control more efficiently energy consumption;
- As a major emitter of $C0^2$, expectations towards buildings are evolving, as users look for ways to regulate energy consumption while at the same time guaranteeing and improving comfort.

How a home automation system works



Copyright: Philippe Offenbroich and Emmanuel Jacquet

The application of ICT in non-housing facilities is referred to as building management systems (BMS), however applied to homes it is called home automation.

The BMS is a computer system implemented in large buildings or industrial facilities to oversee the different installed systems (power supply, lighting, air conditioning, ventilation and heating, security access, video surveillance, etc.). The BMS provides an overview of the building in order to know what is going on in particular concerning the status of operations (functioning of equipment, position, return commands, etc.), measurements (temperature,

operation time, number of failures, etc..) and alarms (breakdown, abnormal stopping, measurements exceeding thresholds, etc.).

Home automation offers occupants the possibility to centralise the control systems that make up a building (sockets, doors, heating, etc.). Three different elements must be implemented together to achieve this:

- a **control interface** through which the user can select, activate, suspend, or control elements;
- the **automation system** that will process the operations received from the interface and distribute the information to the devices;
- the **devices,** that is all the items that the user wishes to control remotely.

Sensors and controllers

The technical management of buildings is based on a set of sensors and controllers communicating the status of appliances (operation), measurements (temperature, humidity, etc.) and alarms (network failure).

The communication between appliances and controllers is bi-directional. At first data is transmitted to the centralised system. In a second step, this system will transmit commands (on/ off, open/ close) or configuration changes (reduction in temperature in one area of the building, etc.) to the appliances.

The opening and closing of blinds and shutters can thus be controlled by the intensity of light or solar radiation, thereby giving life to an uninhabited house. In the same way, energy can be controlled with automatic triggers for heating in function to a temperature threshold or by reaching a given hour, allowing energy to be saved.

*On a European level, even if many projects are underway, one is particularly interesting: the objective of "**Sounds for Energy Efficient Buildings (S4EeB)**"* [33] *is to use audio sensors to evaluate whether a building is occupied or not and consequently automatically adjust the heating, air-conditioning, ventilation, lights and other systems.*

[33] S4ECoB Project "Sounds for Energy Control of Buildings": http://www.s4ecob.eu

In buildings equipped with smart meters, two models of home automation systems can be envisaged: one using the meter and its downstream remote-access information protocols [4.c] and a second using in addition, the upstream component of the meter, completing the system by a third-party service that is the information coming from the electric grid [4.d].

The smart meter and "downstream" home automation systems

In this configuration, the smart meter is the lifeblood of the home automation system since it can control lights, security devices, thermostats, etc. According to information received from energy suppliers, the user can also set its devices to automatically qualify for the best rate with a much greater precision than before.

LG Electronics Inc. has filed two patents[34] enabling devices connected to the electricity grid to automatically use the best rates offered by suppliers. The General Electric Company has also patented a system,[35] ensuring the communication between a home network and the grid via a smart meter, which also takes into account electricity tariffs in the activation or pausing of devices.

The smart meter and "upstream" home automation systems

An "upstream" home automation system allows other interesting possibilities to be considered. Through its patent "Systems, methods, and apparatus for providing security services utilizing a smart utility meter"[36] the General Electric Company proposes to pass the building security service through a smart meter. This option is first of all advantageous as subscription fees and costs to a telecommunication service relaying the security system to the service provider can be saved.

Until the market offers these smart meters opportunities, decision making tools are currently partly managed by the building occupants.

Decision making tools

[34] EP2525471 – Auxiliary power supply device of home appliances using smart grid: https://register.epo.org/espacenet/application?number=EP10843231 and Vaccum cleaner using smart grid: https://register.epo.org/espacenet/application?number=EP10843232&tab=main

[35] EP2456226 - System and method of communication using a smart meter: https://register.epo.org/espacenet/application?number=EP11188868&tab=main

[36] EP2472231 - Systems, methods, and apparatus for providing security services utilizing a smart utility meter : https://register.epo.org/espacenet/application?number=EP11195550

At the heart of the system is the decision making tool which can be partially automated. Indeed, the building occupant should be able to choose a certain number of parameters, such as the ideal temperature, through the control interface.

After processing the data collected by the network, the controllers can set consumption targets that will be adjusted and refined in order to achieve optimum energy efficiency. It is thus possible to programme and adapt one's system to one's own pace of life or to programme certain parts according to given hours.

For example: through the MyHOME automation system[37] from the Legrand group, all the home building functions can be automated and piloted locally or remotely: lighting, electric shutters, heating, air conditioning, display of consumption, security alarms, technical alarms, audio and video interphones, sound diffusion …

An Irish study: "Monitoring Smart building Performance Using Simulation and Visualisation",[38] provides details about the decision making tools available for managing energy performance.

The human machine interface

The main goal of a human-machine interface is to assist in the efficient management of the indoor environment of a building taking into account external parameters (season, weather conditions) and occupant comfort. It can manage the temperature control, airflow, use of lighting... Therefore an effective human machine interface must be easy to use and ergonomic.

For example, the software Domogik[39] makes home control possible through any internet browser and through different platforms such as a smartphone, a tablet or a computer. Another example, being the software Indigo[40] developed by the American firm Perceptive Automation.

[37] MyHOME automation: http://www.legrand.fr/professionnels/la-technologie-my-home_2514.html

[38] Monitoring Smart building Performance Using Simulation and Visualisation: https://www.cs.tcd.ie/publications/tech-reports/reports.10/TCD-CS-2010-08.pdf

[39] Logiciel Domogik: http://www.planete-domotique.com/blog/2011/10/12/premiere-version-officielle-de-domogik-0-1-0/

[40] Logiciel Indigo: http://www.indigodomo.com/

The smart building, a doorway to other concepts

Interactions between smart buildings, the smart grid and smart cities

Smart grids

Developing smart buildings opens up the possibility of integrating them in a near future into other more or less large scale networks, such as smart grids or smart and sustainable cities. According to the French Energy Regulatory Authority (CRE), the smart grid is an electricity distribution network using multiple technologies to optimise the production and distribution of electricity in order to create greater coherence between electricity producers and consumers. Moreover, the smart grid integrates decentralised renewable energy sources as well as household electricity production into the grid. Smart grids could also interconnect electricity grids from different countries allowing, overtime, collaboration at a European level.

As an example, the Building smart grid project [41] in Brittany, France is one of the first smart grids implemented in a tertiary building with energy storage. In the same way, the moma - Model City Mannheim project in Germany[42] has the goal of creating an intelligent power supply system with lots of decentralised power and heat generation plants and tariffs governed by supply and demand.

A smart building is connected to a smart grid through a smart electricity meter. This meter, in addition to reading electricity consumption, should send back detailed but anonymous consumption information to the power supplier or to automated regulation systems. This means that the consumer or the building can receive live information on fluctuating energy prices.

[41] Building smart grid project: http://www.parolesdeclients.schneider-electric.fr/video/experimentation-grandeur-nature-du-%E2%80%9Cbuilding-smart-grid%E2%80%9D/

[42] Moma: Model City Mannheim: http://www.modellstadt-mannheim.de/moma/web/en/home/index.html

In France, after the transposition in 2011 of the European directive 2009/72/CE, the Energy Regulatory Authority (CRE) issued a favourable opinion to the generalisation of the smart meter Linky[43]. The deployment strategy was proposed by ERDF and validated by the CRE and has the objective in a first stage of deploying 7 million meters between 2013 and 2015 and setting up further deployment between 2015 and 2018.

The ADDRESS project,[44] a large-scale project co-funded through the European Commission 7th Framework programme, and coordinated by the Italian company Enel Distribuzione, is made up of a consortium of 25 partners from 11 European countries. It is a project concerning the energy distribution network with full integration of demand and distributed energy resources in order to obtain the active participation of consumers in power system markets and provision of services. The project is currently in a test phase in different sites in Spain, Italy and France in order to identify the potential benefits for the different power system participants and to study and propose accompanying measures to deal with societal, cultural and behavioural aspects in different countries.

Smart and sustainable cities

Smart cities are micro networks across a city, where energy exchanges between buildings are favoured, and where mutualisation and energy cooperation are established to improve overall energy performance. Thanks to ICT, smart cities optimise not only city management and power supply management, but also transport, waste management etc.

For instance, the programme Amsterdam smart city (ASC) [45]is a vast collaborative and open platform project bringing together businesses, research institutions, local authorities, and the people of Amsterdam to collaboratively test new

[43] Linky: http://www.erdf.fr/Linky/

[44] ADDRESS project: http://www.addressfp7.org/index.html

[45] ASC: http://amsterdamsmartcity.com/?lang=en

initiatives, transforming the programme into a real incubator for smart projects. The city of Dublin can also be classed as a model smart city.[46]

Focus: The Directive 2009/72/EC[47] *concerning common rules for the internal market in electricity and repealing Directive 2003/54/EC*[48]*, which encourages the introduction of smart grids within the Member states, was adopted on 13th July 2009.*

Through these smart grids it becomes imaginable for individual buildings to be integrated into a local, national or even European network. Going further, it is even possible to imagine a building interacting with other systems, such as an electric car.

The "vehicle to grid": Interaction smart house / electric car

The "vehicle to grid" is a concept whereby the energy stored in an electric car is used to support the power grid during consumption peaks or in emergencies (storms, cut cables). The energy stored in the vehicle battery could also supplement the electrical requirements of the house. This technology requires that both the vehicle recharger and the interface between the power grid and the vehicle are bidirectional (the power circulates both ways). The "Vehicle to grid" would also allow a connection with the smart building since the electric energy stored in the vehicle could feed the building and the energy produced by the building could feed the electric car.

For example: the MeRegio Mobil[49] *project aims to conceive a smart house where innovative electric vehicles are integrated into the future energy system as mobile electric storage devices. Europe is not the only continent to be interested in the interaction between smart buildings and electric cars. Toyota is developing in Japan the project Toyota Smart Center,*[50] *a smart housing estate where the car manufacturer associates two smart houses, equipped with an energy management automation system, and six electric cars.*

[46] Dublin Experience – Fostering a SMART City where Creativity & Innovation Thrive: http://www.majorcities.eu/conferences/2012vienna/presentations/vienna2012_wednesday_brian_curtis.pdf

[47] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32009L0072:EN:NOT

[48] http://europa.eu/legislation_summaries/energy/internal_energy_market/l27005_en.htm

[49] MeRegio Mobil project: http://meregiomobil.forschung.kit.edu/english/index.php

[50] Toyota Smart Center: http://www.toyota-global.com/innovation/smart_grid/

Conclusion

The rise of the smart building is possible today, thanks to evolutions in Information and Communication technology, environmental objectives and their resulting regulations. The opportunities offered by ICT, allow the smart building to simplify user daily life, and at the same time become a tool to serve energy efficiency and network reliability. While, technologies coming out of research and development and innovation centres are tested through smart building projects, the rise of the smart meter, as an interface between the power grid suppliers and private building networks, opens up new perspectives for key innovations. The smart building thus becomes a cornerstone for the development of future smart grids. In the end, consumers, grid managers, and electricity suppliers can all gain benefits from these improvements.

Useful documents and websites

In English

- **Beaware EU funded project** (Boosting energy awareness): http://www.energyawareness.eu/beaware/
- The **Digital Environment Home Energy Management System** (EU funded project): http://www.dehems.eu
- **Smart Buildings: Ten Trends to Watch in 2012 and Beyond** (Pike Research, 2012): http://www.pikeresearch.com/wordpress/wp-content/uploads/2012/05/SB10T-12-Pike-Research.pdf

In French

- Compte-rendu de conférence « **Bâtiments intelligents : comment allier confort des occupants et réduction des charges ?** »:

http://www.maintenanceandco.com/files/avis_experts/Batiments_intelligents_comment_allier_confort_des_occupants_et_reduction_des_charges.pdf

- **File on smart buildings** by the French Regulatory Commission of Energy (CRE): http://www.smartgrids-cre.fr/index.php?p=smarthome-maison-batiment-intelligent
- **Information page for consumers on smart buildings** by French Regulatory Commission of Energy (CRE): http://www.smartgrids-cre.fr/index.php?p=decouvrir-batiment-intelligent
- **File on technical building management** (Le portail expert de la performance énergétique – Expair.com): http://conseils.xpair.com/consulter_savoir_faire/gestion_technique_batiment/domotique_gtc_gtb/934.htm
- **Home automation for independent living for all** (CNRSanté, 2011): http://www.cnr-sante.fr/2011/12/la-domotique-au-service-de-l-autonomie-pour-tous/
- **Press pack from the company Itron**: http://www.smartgrids-cre.fr/media/documents/1009_Itron_Dossierdepresse.pdf

Case Study: High-Performance Urban Energy Renovations

Author: Impulse, Brussels

Introduction

The building industry today faces two major environmental challenges:

1) To develop building materials and technical elements in order to reduce their impact on the environment in all building phases, "from the cradle to grave". These impacts include the exhaustion of natural resources (raw materials used in the material, energy raw materials, water, etc.) and the intensification of weather phenomena harmful to the planet (global warming, acid rain, erosion of the ozone layer, etc.).

2) To create buildings that enable the occupants to tend towards a neutral environmental impact in terms of water, electricity and heating consumption. Nearly 75% of the overall energy of a household (excluding transport) is devoted to heating the house.

This publication focuses on the energy challenge of reducing heating needs and targets **urban renovation** projects, which, by definition, have a head start in terms of reduction of environmental impact. Indeed, a **renovation** recovers a lot of the elements present *in situ* and limits the use of materials and new elements. The **urban** dimension concerns compact buildings with a big energy potential. The urban context limits transport energy needs because of the accessibility of public transport and local services.

Reducing heating needs is a priority!

This publication describes the method for achieving an ambitious energy objective stage by stage:

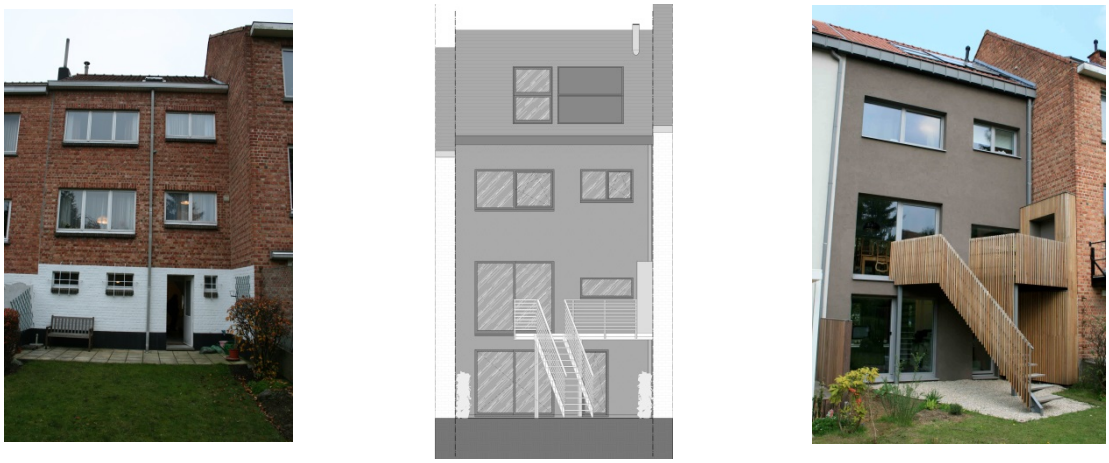
- Stage 1: Building diagnosis: what are my building's potentials and limitations?
- Stage 2: Preparing the renovation properly: defining the renovation programme, the budget and above all getting the right support.
- Stage 3: What energy and environmental objective to choose?
- Stages 4 to 8: Design the renovation: optimise the solar inputs and the building's compactness; insulating, managing building nodes and air tightness; providing and sizing the ventilation and heating systems.
- Stage 9: Lastly: doing the accounts!

These stages will be illustrated by a case study: the first house renovated to the passive standard in Brussels, by the architect Raphaël Tilman.

In 2009, Hélène and Raphaël Tilman bought a house in Brussels. The young couple, both architects, already concerned by the environmental footprint, decided to stay in town, near to their workplace, public transport and, as far as possible, urban infrastructures.
The house, built in 1960, is of the *bel-étage* type and is organised in a very simple, reproductive layout. This type of house is found in many parts of Brussels.
The state of the house before works offers the chance to plan major work on the building envelope. The property's dilapidation and its very noisy location (beside the railway line) are two factors that also affect the price of purchase.

These weak points are at the root of the project's conception and development.

Figure2 : Rear façade before and after the renovation



Stage 1: Complete building diagnosis: what are my building's potentials and limitations?

Doing the building diagnosis before embarking on a renovation is a must. This involves identifying the building's potentials and limits. Ideally, the choice of building must be made on the basis of this diagnosis and its value must incorporate these strengths and weaknesses.

Specifically, the building diagnosis covers the following points:

- *The structural elements*: roof, foundations, electricity, joinery: what is their general state and what work is required in the short, mid and long term? Particular attention must be paid to the elements of the exterior envelope: does the roof have an underlay? Does the building have foundations? Down to what depth can you dig to insulate the floors?
- *The architectural quality:* does the building's orientation allow the natural light input to be improved? Can the compactness be improved? Which architectural elements can be kept and/or enhanced during the renovation?
- *The energy performance:* an energy advisor will help you evaluate the building's overall performance and especially the improvement potentials: is the floor slab accessible by a ventilated cavity? Are the roof overhangs sufficient to take exterior wall insulation? Is the air tightness of the joinery correct and improvable?
- *The administrative elements:* do you have an accurate survey of the building? Is it located in an area where specific aids are available? Are some of the architectural features classified? Do urban planning regulations allow the street façade to be insulated on the outside?

Case study

This house with four levels is mainly fitted out on the first and second floors (kitchen, living room, bedrooms and bathroom). The attic is not fitted out and the ground floor is devoted mainly to a garage space. The organisation and assignment of the rooms is to be changed as they do not meet modern lifestyles.

The roofing is in terracotta tile and an underlay in a bad condition (to be replaced). There is expanded polystyrene insulation (2 cm) between the roof layers. The roof structure does not allow the space to be used as a living area; a beam located in the centre of the space takes a part of the roof loads.

Located in the city, this house benefits from its **terraced position**[51] and has only 59% thermal loss walls, the other 41% being shared walls protected by the adjoining homes. The solid construction has a significant **thermal inertia**, the brick walls have no runners. The wooden frames were adapted for the fitting of double glazing in the 1980s. The floor slab is formed by a cement layer and paving.

In addition to a **zero thermal envelope**, the house's **technical elements** are to be improved: the central heating only covers two of the four levels, the hot water, decentralised, is produced by an electric boiler in the kitchen and an old instant gas water heater in the bathroom. The latter no longer meets standards, the boiler being atmospheric.

Stage 2: Preparing the renovation properly: defining the renovation programme, the budget and above all getting the right support

Defining **the programme** involves identifying your needs (and your wants) in the future use of the building: what are my short-term needs and wants and how will they change in the short and long terms? The programme concerns the interior fittings (number of bedrooms, work spaces, modification of walkways, etc.) but also the qualitative objectives: what energy objective? What types of materials to choose?

[51] No lateral heat loss because the adjoining homes are inhabited and heated.

The budget will be an essential element of the renovation project. Identifying the different funding possibilities and also the financial aid for which your project may be eligible, may enable you to enlarge your initial budget, subject to these data being incorporated in a phasing of the renovation.

Preparing your renovation project means **getting the right support**, i.e. pooling all the skills you need for a renovation project that is "ambitious" in energy terms. Depending on the situation, these skills will be provided by a big or a small team within which the said skills and therefore the responsibilities of each member will be clearly identified and known by all:

- *The client*: what times will he be available in the design and execution phases, does he want to be involved in the building and if so, in which stages?
- *The architect*: apart from his architectural skills, is he proficient in guiding the client towards the right energy objective? Does he know how to use an energy needs simulation tool? Does he have experience in a high-energy-performance project?
- *The energy advisor*: the latter may complement the architect's work at various key stages: in the project's design: thermal study and confirmation of the energy objective; drafting of the specifications for the items relating to energy performance, execution of technical details, etc.; advice on the choice of company, support in the site follow-up for the delicate points: air tightness and construction nodes.

Case study

The assignment of the spaces has been revised, the garage was eliminated in order to create an office space, the first floor walls were demolished to create an open space allocated to the living room and kitchen, a staircase was built from the first floor to the attic. The roof structure was modified in order to fully use the space and facilitate blown insulation.

Figure3: Drawings of the house after renovation

First floor	Third floor
Ground floor	Second floor

The entire project (architectural design, PHPP studies[52], building energy performance, technical detail drawings, etc.) was executed by the couple, who already had training in renovation and in the various energy calculations.

Furthermore, after participating in the "Exemplary Buildings" competition[53] the couple set their sights on a passive house: *"This competition gave us the freedom to think in energy terms. We decided to try to go beyond what was already there, to do Brussels' first passive renovation."*

Meetings with the skilled entrepreneurs and craftsmen involved combined with the level of client interest enabled us to build this project and carry it out.

---

[52] PHPP is a construction validation tool that serves as a basis for the awarding of the low energy or passive energy certification by the Passive House platform.

[53] http://www.bruxellesenvironnement.be/Templates/Particuliers/Niveau2.aspx?id=4626&langtype=2060

Stage 3: Choosing the energy objective

The various technical choices for a building renovation must incorporate the energy objective the client wishes to achieve right from the preliminary design stage. This objective represents the building's heating needs after works (kWh/m²).

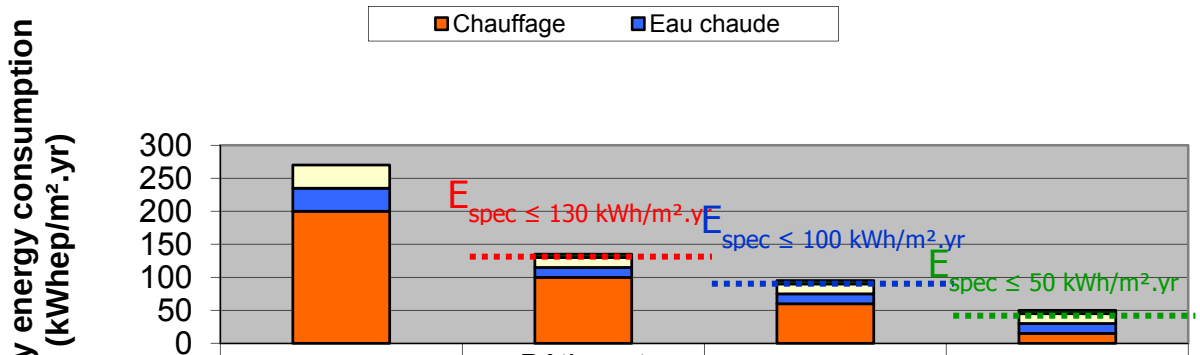
Initially, the energy objective can be approached by type: are we seeking a passive, very low energy or low energy building? The choice will depend on what the client wants and on the budget and can be influenced by current regulations and the accessible premiums. It is advised to go beyond the regulations in progress, which often fall well short of meeting current energy challenges.

On this basis, a thermal study will be carried out in order to fine-tune this energy objective; a tool like the PHPP will enable the design office to simulate different energy improvement and performance scenarios for the building in order to guide the client in his choice. Each scenario includes construction data (surface area and orientation of heat-loss walls, type and thickness of insulation, type of glazing and of frame, degree of air tightness and management of construction nodes, etc.).

The assessment of the costs and financial aids related to each scenario, and the calculations of the amortisation time will guide the client in his decision.
Once the improvement scenario has been chosen, the various data will be specified according to the choice of technical elements and materials. Every change made to these initial choices must be incorporated in the thermal study in order to guarantee that the project achieves the energy objective.

Figure4: Overview of consumption items per building type

Overall energy consumption scenario - Housing



	Bâtiment construit sans réglementation	Bâtiment norme actuelle PEB - 2013 (E≤80)	Bâtiment basse énergie	Bâtiment passif
Ventilation	0	5	5	5
Auxiliaires	35	15	15	15
Eau chaude	35	15	15	15
Chauffage	200	100	60	15
	20 m³	10 m³	6 m³	1.5 m³

		$E_{spec \leq 130}$ kWh/m².yr	$E_{spec \leq 100}$ kWh/m².yr	$E_{spec \leq 50}$ kWh/m².yr
	Building built without regulation	Current BEP standard building – 2013 (E<80)	Low energy building	Passive building
Ventilation	0	5	5	5
Auxiliaries	35	15	15	15
Hot water	35	15	15	15
Heating	200	100	60	15

Table1: Target values per type of energy objective

Low energy	< 60 kWh/m² per year
Very low energy	< 30 kWh/m² per year
Passive	< 15 kWh/m² per year

Good to know: As of 2015 in the Brussels Capital Region, new BEP (Building Energy Performance) requirements inspired by the passive standard will appear. See http://www.brusselpassief.be for details of the requirements and the regulatory context.

Case study

As the renovation requires work on all walls and technical elements (except for shared walls), our leitmotif was to insulate each wall as much as possible in order to minimise the size of the technical installations. The PHPP code determined that a passive renovation was feasible. Along with the PHPP, the BEP (Building Energy Performance) calculation was also carried out, but only for legal purposes.

The house, renovated like this, will still be thermally high-performance in several years.
As all these works are quite costly, we were careful to use materials with a long lifetime (for example zinc for cornices).

Along with the passive aspect, we installed thermal solar panels and calculated an input of 60% of the domestic hot water production.
The return on investment is calculated over twelve years (thanks to the various subsidies received), i.e. well before the house is amortised; the reduction of the energy required to heat the building is evaluated as twelve times less.

Raphaël explains: *"But before receiving these payments, before making these return on investment calculations, we had already started work to make the building very low energy, as we weren't sure it would be possible to make it passive..."*

Stage 4: Designing the renovation - Solar inputs and compactness

The first stages of the design must transpose the renovation programme into an interior layout proposal and also optimise the building's compactness and the passive solar inputs.
A building's compactness coefficient is the ratio between the protected volume and the total heat-loss surface area. The higher this coefficient, the more advantages the project has in terms of heat loss.

In a building renovation in an urban area, improving a building's compactness can involve modifying, where appropriate, the volumes at the back of the building: eliminating annexes, integrating these in a more compact volume or adding a floor to the main building.

In order to optimise the passive solar inputs, the orientations and surface area of the openings are to be studied meticulously. Two references are important to keep in mind from the initial sketches stage:

- *The ratio between the glazed surface area (all orientations together) and heated surface area*: the point here is to optimise the solar inputs and the natural light inputs. A larger proportion of glazing will penalise the project (too much heat loss) even if very efficient glazing and frames are used; too small a proportion of glazing will mean greater use of artificial light and will limit the passive solar inputs from which the building can benefit.
- *The distribution of the glazing according to the different orientations*: although it isn't always easy to optimise this in renovation, it is useful to focus on this distribution when planning an extension. Shade (adjoining buildings, trees, enclosing wall, etc.) with an impact on the different openings will be taken into account in the thermal study.

Table2: Target values for compactness and glazing proportions

Good compactness (volume/heat-loss surface area ratio)	> 1.5
Glazing/heated surface area ratio	Between 20 and 25%
Distribution of glazing	South: 60% East – West: 15% North: 10%

Case study

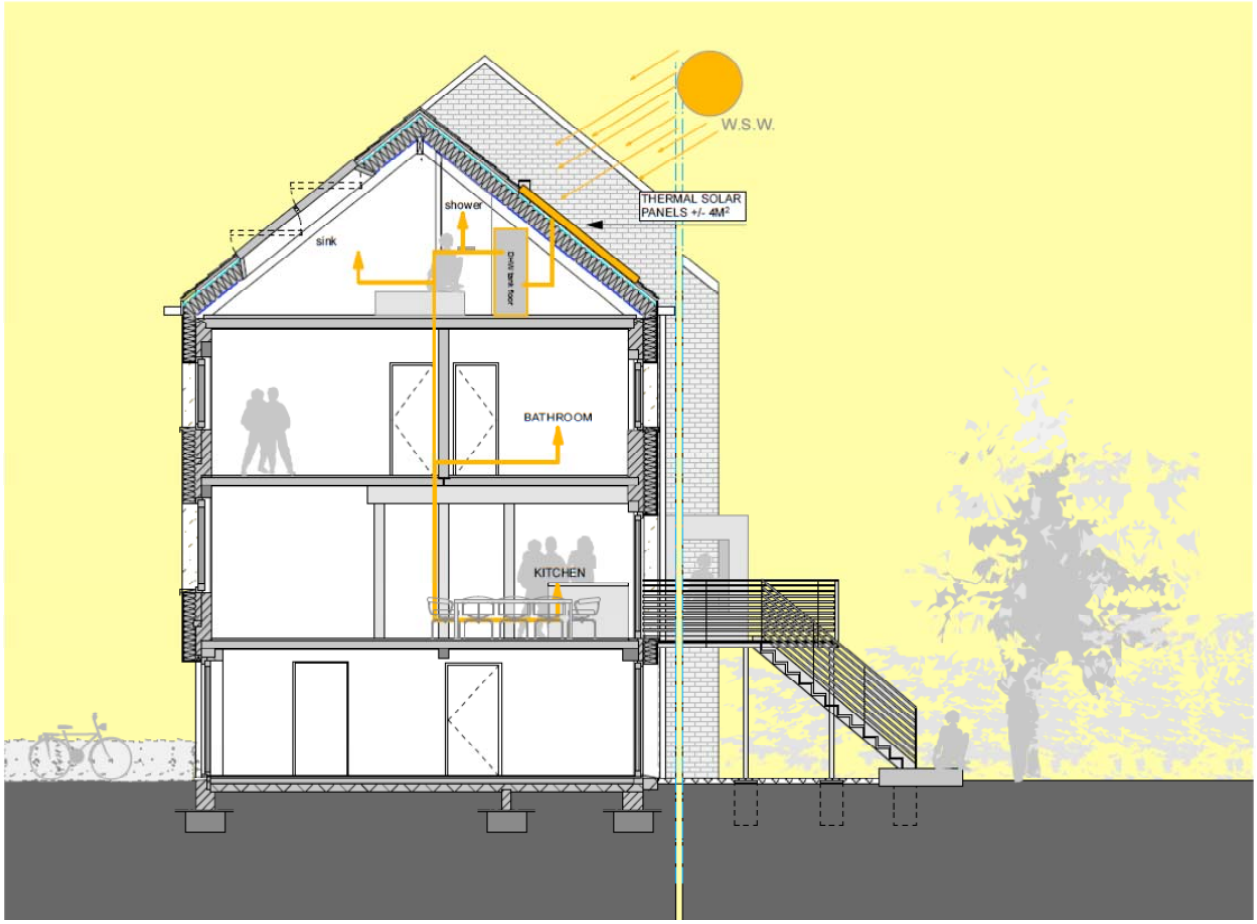
The favourable orientation of the two façades does not require any great changes, except for the big openings on the garden side. The solar input is very pleasant and the house is always bright.

While Brussels lacks parking spaces, the garage function has been eliminated. The position of an unheated space would have represented an increase in the heat-loss surface areas more costly to manage. The garage would then have cost more per m^2 than the living spaces! For similar reasons, we opted for a more ambitious roof layout than just slopes.

Finally, the entire built volume is insulated.

The house is partially heated by the solar inputs. Although they are welcome in winter, they may lead to overheating in the summer period and particularly if the sun shines for a whole week. Such periods are infrequent, once or twice a year; the house has never got up to more than 27 ºC. In these heat waves, we cool the house at night by opening the windows at the bottom and at the top.

Figure5: Schematic cross-section of the solar inputs



Stage 5: Designing the renovation - Insulation of the envelope

The insulation of the building envelope is a primordial stage in improving a building's energy performances: adhering to current regulations is the first stage; going further by drastically reducing heating needs with an ambitious insulation strategy appears to be a vital requirement today!

An insulation strategy will be designed on several levels:

- *The choice of insulation technique*: to insulate a wall on the inside or on the outside? To insulate the floors through the cellar or on top of the slab? To insulate the attic floor or the sloping roof? Each project will have its own constraints that will exclude certain techniques. The ideal thing to do is to prioritise technical features that limit breaks in the insulation to a minimum (reduction of construction nodes); these breaks are often present at the connections between two walls.

The most effective insulation technique is exterior insulation for walls and the roof ("sarking" type insulation). However, insulation on the front façades giving onto the street, aligned with the public highway and the adjoining buildings, is often rejected outright by the authorities due to the impact on the public highway and conservation of architectural heritage.

- *The choice of insulating materials*: a material's physical characteristics, such as its thermal conductivity, thermal diffusivity and thermal effusivity, influence a building's energy performances and also the comfort of its occupants. The choice of materials must also incorporate an impact on occupants' health criterion: the more the material is going to be in contact with the interior air, the fewer harmful substances it should contain.

The choice of an insulating material has an impact on the building's overall behaviour: certain insulators cannot be installed without a "vapour barrier" membrane, while others withstand the throughput of a controlled quantity of water vapour and can be installed behind a "vapour retarder". This creates "perspiring" walls, which enable vapour exchanges between the inside and outside in order to regulate the humidity level. "Impermeable" or "perspiring" building: two types of installation that will greatly affect comfort inside the building.

Good knowledge of the building before renovation will enable the building's "historical" behaviour to be adhered to by opting for materials that will not radically change the building's original properties.

- *The choice of insulation thicknesses*: the choice of insulating thicknesses will differ according to the energy objective. Whatever its thickness, the purpose of insulation is always to achieve a balance in the performance of the different heat-loss walls, a balance that will guarantee optimum comfort. The U value expresses a wall's thermal

transmission coefficient. It is calculated for each wall delimiting the protected volume and is expressed in W/m²K. The weaker the U value, the more insulating the wall is.

Table3: Target values of the walls' transmission coefficient (U value)

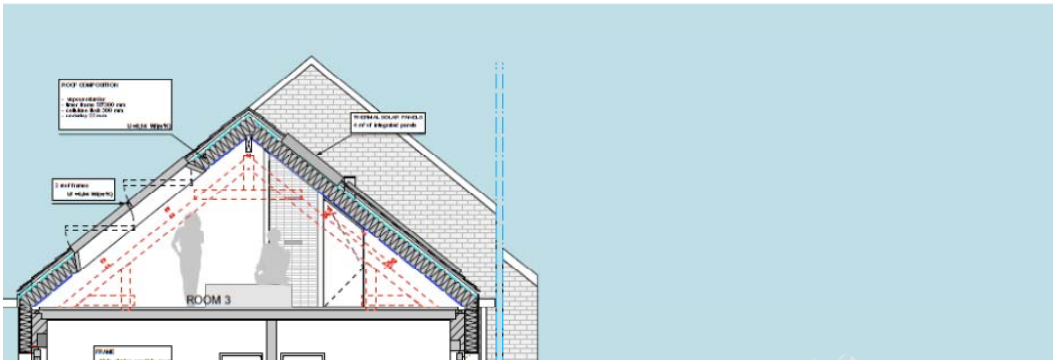
"Very low energy" building	< 0.15 W/m²K
"Passive" building	< 0.10 W/m²K

Case study

All the exterior walls (except the heated shared walls) had to be insulated to meet the passive objective. Several options have been studied regarding the costs, the technical possibilities and the energy performance of the materials used, following this priority order. Certain points were also optimised as far as the energy performances but also the ecological performances are concerned.

The new roof frame enabled us to insulate the roof with 30 cm of blown cellulose and also manage the thermal bridge of the connection between the wall and the roof.
The walls were packed on the outside with 20 cm of graphite-coated expanded polystyrene except for the ground floor street façade, insulated on the inside, planning prohibiting the alignment of houses at this level.
In view of the low ceiling height of the ground floor, it was not possible to insulate the existing complex from above. A new complex was installed (after demolition of the existing one and having dug out the ground) to do the insulation. Polyurethane (12 cm) was chosen for its high thermal capacity, its good resistance to compression and humidity.

Figure6: Technical cross-section of the house



Stage 6: Designing the renovation – Managing the construction nodes

A thermal bridge or "construction node" is an insulating break in a wall. This break represents an area of heavy heat loss that can be responsible for a number of problems: overconsumption of heating, condensation leading to humidity problems, mould development, etc.

Managing a construction node means firstly identifying the "risk" areas (connection between two walls, balcony anchoring, etc.) and then studying them on a case-by-case basis and eliminating the thermal bridge or reducing its impact.

In a new build, no thermal bridge can be tolerated; in a renovation, their number and impact can be limited but they cannot always be eliminated. The presence of a thermal bridge after a renovation may be the result:

- of an irremediable situation such as the impossibility of linking an externally insulated wall's insulation connection with a floor insulation. This type of situation is very common. The shared walls also constitute breaks in the insulation layer.
- of a failing in the design: some designers are today still unaware of the impact construction nodes have on a renovated building and do not take the initiative to

identify and solve them. A change during works can also be the cause of a little managed or poorly managed thermal bridge.

- of bad placement during works: just like for air tightness, special care must be taken in placing the wall connections. An even minimal break in the insulation can have serious consequences; it will be difficult to remedy this once the finishing has been completed. A site inspection must be carried out.

There are a number of tools for assessing a construction node's impact. There are catalogues that propose standard values, but we recommend using software in which the precise details of the project have been entered and then measuring the impact. With reference to the internal condensation risks (in the event of a break in the insulation or a significant difference in thermal resistance between two materials in contact) we advise using "dynamic" software to simulate the wall's behaviour throughout the year in order to identify the real condensation risks. This will not just be influenced by the thermal resistance and the thickness of the materials used but also by their "water vapour diffusion properties".
The infra-red camera will enable us to identify the construction nodes in a building that are not visible to the naked eye: lintels, chainage beams or other features hidden by the finishing.

Table4: Average impact of construction nodes on the consumption of energy for heating

Average-insulated building – Unmanaged construction nodes	+/- 10% of total heat loss
Building renovated to "very low energy" – Unmanaged construction nodes	+/- 25% of total heat loss
Building renovated to "very low energy" – Well managed construction nodes	+/-10% of total heat loss

Case study

In general, as the insulation has been done on the exterior, most of the thermal bridges have been eliminated.
The roof is formed by L-shaped wooden beams (OSB - Oriented Strand Board - web, glue-laminated flanges) placed on the ridge purlin. In this way, the thermal weakness of the

structure is reduced to a minimum. Above this structure, a rigid insulating panel closes the roof complex (serving as underlay) while the insulation is blown in between the roof layers.
The walls are insulated where possible on the exterior. Only the street façade ground floor is executed on the interior. A thermal weakness is present, therefore, between the shear walls.
The wall / roof and frame / wall junctions have been drawn and controlled.
The floor insulation also has some weaknesses, no insulation having been inserted under the existing walls.
The junctions at the shared walls have not been dealt with and also represent small weaknesses.

Stage 7: Designing the renovation – Ensuring good air tightness of the building

Ensuring that a building has good air tightness means limiting air infiltrations through the protected volume's envelope. Uncontrolled infiltrations could have serious consequences affecting:

- *Occupants' comfort* by creating air currents and poor acoustic insulation quality. In summer, the infiltrations will contribute to the overheating of the building, accelerating the entry of hot air.
- *Energy consumptions for heating*: losses due to exfiltration of air can be up to 25% in a renovation in which the air tightness has not been tackled.
- *Occupants' health and the building's durability*: the areas subject to exfiltrations are cold areas likely to develop internal condensation problems that could affect occupants' health and the building structure (corrosion, damp, mould, etc.).

Managing the air tightness means ensuring the air renewal by means of a "controlled" ventilation system. This is compatible with the principles of a "perspiring" building that enables water vapour transfer between the interior and the exterior to regulate the humidity level (see stage 5).
The designer must focus on the type of material to be used to create the airtight barrier and on the connections between walls:

Installation of an "airtight barrier": there are several types of airtight materials:

- "Membrane" or "tape" type materials: vapour retarder membrane to protect the insulation (e.g. closed caisson into which the cellulose is blown); membranes to

ensure a good connection between two walls: either to be stuck (onto a frame, a wooden board) or to be plastered.

- Wood-based materials: OSB (Oriented Strand Board) mainly, provided that sealed joints are created between sealed panels, it is a material used simultaneously as a vapour retarder, an airtight barrier and to brace a wooden structure where applicable;
- Closed-cell mineral-based materials: plastering, concrete, etc.

Management of the connections between walls: the main delicate connections encountered in a renovation are

- *The wall-frame connections*: today it is no longer conceivable to install frames without first fitting a sealing strip on them. The air tightness of the joinery features themselves depends on their quality of manufacture.
- *Wall-roofing or wall-floor connections*: guarantee continuity between, for example, the wall plastering and the vapour retarder used to insulate the roof. Floor beams anchored in a brick shared wall can be a source of exfiltration as plastering cannot be done at the anchoring.
- *The bottom of exterior doors* or doors towards a cellar are extremely weak points that must be fitted with a sill that comes up against the door ("Swiss type" sill).
- *Service ducts* crossing the protected volume's envelope are delicate points to study in detail before installation.

To evaluate the air tightness of a building before or during the works, an infiltrometry or blower door test can be performed. For major renovations, we strongly recommend performing a test before installation of the finishing in order to identify any leaks and remedy them.

Table5: Level of air tightness and impact on energy consumptions for heating

Building renovated without special attention	Between 3 and 6 Vol/hour – 20 to 25%
Building renovated to "very low energy"	< 1 to 1.5 Vol/hour – 10 to 15%
Building renovated to "passive"	< 1 to 0.6 Vol/hour – 10 to 15%

Case study

Special attention was paid to the project's air tightness.

As the house is masonry type, the volume's limits were made tight by plastering, concrete and, in the roof, by a vapour barrier. At the junction of these different materials, we installed airtight profiles and followed the manufacturer's instructions to the letter. As this item of the

renovation is difficult to quantify and requires detail, we executed this job ourselves, with the help of a professional.

With regard to the utilities layout, most of the technical elements run inside the technical envelope through two vertical ducts. Water pipes, discharges, gas and air ducts were installed after the plastering. The technical elements are hidden by caissons.

An error was made with the electricity network, placed in an old rainwater down-column and after the plastering. The electricity was done shortly before making the decision to make the house passive. Major corrective measures had to be applied at a significant cost. The duct had to be cased and filled with epoxy (a choice to be revised in future), the electrical blocks' air leaks had to be sealed with silicon products.

Another source of concern was the concrete blocks, which due to their shape are veritable air ducts.

The main cause of this difficulty was lack of foresight and control of the problem. This issue must be resolved before starting work. *"In 2009, we couldn't find any professionals in this field."*

In practice, ten or so tightness tests were performed at the start, per zone, and then overall, in order to understand the issue and resolve the different problems described above.

Stage 8: Designing the renovation – Planning the ventilation and heating technical elements

After the detailed study of aspects relating to the improvement of the building's envelope, it was time to focus on the technical elements to be installed for the building's heating, domestic hot water production and ventilation.

In order to choose the appropriate technical elements, it is important to gather together the various items that could influence these choices:

- To correctly size **a boiler or any other of the building's heating systems**, the needs after works must be precisely defined. The net needs (expressed in kWh/m² per year), must be transposed into gross needs, taking the efficiency of the future installation into account. This efficiency will take into account the type of generator, the type of regulation (valves, probe, regulator?), the insulation of the hot water pipes and the type of heat emitters (convectors, floor heating, radiators?).

Other elements to take into consideration on choosing the best installation are the available fuel, the space for the boiler room, any storage of fuel and also the heating needs. A heat

pump is only recommended for very low needs, this system consuming a large amount of electricity.

- In a high-energy-performance renovation, **the needs for the production of domestic hot water** are greater than those for heating. An example is a combination between a boiler fed by thermal solar sensors coupled to a gas boiler, which enables the boiler to be turned off in the summer. It is always recommended to use instant hot water production rather than a storage system and to avoid electrical systems.

- **The building's ventilation system** is, just like the boiler, an essential element for the building's comfort and durability. This system must be studied in detail and will require consideration of the layout of the different spaces. The more ambitious the energy objective is, the more appropriate it is to opt for a dual flow ventilation system (controlled, mechanical air supply and evacuation). When a renovation aims to achieve a high-performance air tightness level (air renewal below n50 < 1.5Vol/hour), a dual flow ventilation system with heat recovery is a very economical choice; air entering the building is preheated by the calories transmitted by the outgoing air.

Case study

As the house is located in town and there is no space available for storing fuel, gas, already installed in the house, is used.
A wall boiler linked to a hot water tank offsets heating needs (in the winter) and enables you to back up the domestic hot water tank when the solar energy is not sufficient to heat the required water volume. This tank is preheated by 4 m^2 of thermal solar panels.
This system proves simple, is known to technicians and is cheap.
Supplied by the boiler, the house's two radiators (on the ground floor and in the bathroom) have a heat zoning problem. The ventilation unit is not sufficient to correctly redistribute the heat. This impulse unit, passive certified, supplies the various living rooms with air and collects the waste air from the bathrooms, toilet and kitchen. In these rooms, a switch control enables us to increase the ventilation power for a few minutes.
Controlled mechanical ventilation is vital for maintaining a healthy climate in any airtight house.

Table6: Calculated consumptions

Heating	2300 kWh/yr
Domestic hot water (4 persons)	3400 kWh/yr

Stage 9: Making the calculations

Although the financial criterion is not the most comfortable or the fairest way to tackle the concept of high energy performance, due to the many unknowns relating to fuel prices and the difficulty of putting a value on a building's "comfort", the costs issue is still at the core of the client's decision making.

This issue should be studied at all stages of a renovation project: building acquisition costs, renovation costs and use costs before and after works. Control over the renovation project's overall budget will enable the client to set short- and mid-term objectives and, if needed, to study the phasing of the renovation time: making quality investments rather than squandering his budget on an array of items in a superficial and cheap fashion. This will also help him in his choices aimed at high energy performance.

On the acquisition of a building or before a renovation, it is useful to put a figure on the cost of the works and evaluate the building's use charges before and after the works.
A renovation's costs can be estimated very roughly[54] to define the budgetary allotment it requires:

- "Major" renovation[55] of a very low energy or passive nature: cost from 1200 to 1600 €/m² ex VAT and fees.
- "Major" renovation of a low energy nature: cost from 900 to 1300 €/m² ex VAT and fees.

The reduction of use charges can be estimated

- at 80 to 90% for a project of a very low energy or passive nature and
- 60% for a low energy project.

The evolution of the building's market value due to the high energy performance of the renovation is not possible to put a figure on today; it is nevertheless evident that taking the

---

[54] The costs depend on the companies, the company's order book, the location in town (easy or complicated) and the architectural or structural complexity.

[55] We consider a major renovation to be: replacement of installations, including electricity, modification of interior spaces and renovation of the envelope.

energy performance into account in buildings' value will develop further over the coming years and also that fuel prices will continue to rise over the next few years. An optimistic scenario for the evolution of the price of energy takes into account a constant increase of 5% per year.

Once the preliminary design has been defined, the costs can be refined and any phasing of the works can be a way of choosing an ambitious energy objective while remaining within the client's budget. The change from one phase to another can indeed be related to receipt of financial aid or a recovery of liabilities from a mortgage loan.
All of these data will enable you to evaluate the approximate real costs of a high environmental quality installation. However, it appears useful today to open the issue of the short-term economic aspects up to more long-term ecological values[56]:

How, with the resources I have today, can I do everything possible to reduce my renovation's environmental impact? What reasonable choices can I make to safeguard the health of the future occupants?

Case study

At the start, the project must be phased, but it is not advisable to phase the air tightness envelope. The project, which couldn't be passive at the time, needed a more costly heating system which would undermine the efficiency of the ventilation system.
The project presented, having received several awards and subsidies, is probably no more expensive than a project with no particular thermal ambitions, which wouldn't have had access to these awards.

The decision-making was strongly linked to the awards and subsidies, without which this project would not have been undertaken. The cost of the project (except finishings) is €135,400 ex. VAT, the awards and subsidies financing about a third of it.

[56] In his book "maisons passives" (passive houses), Adeline Guerriat tackles this issue of short-term economic aspects moving towards a long-term ecological view.

The Issues of Sustainable Renovation in Non-Residential Buildings

Author: Paris School of Engineering

Introduction

Concerns about sustainable renovation have come to the political agenda in the last ten years across Europe. Sustainable renovation encompasses many aspects of the building, from heating to sound and air comfort, but the main driver of the political concern towards renovation has been primarily energy performance. The security of energy supply and rising prices of fuel and electricity have proven that energy input cannot be taken for granted . In addition, the issues of climate change, environment disorders and the opportunities of the green economy have also been factors of mobilization by the actors related to the building sectors (firms, public authorities, clusters, development agencies, activists, etc.). Several initiatives such as the Kyoto Protocol, the Climate change Plan have been launched at different governance level in order to improve, among other things, the energy performances and reduce the ecological footprint of our societies. Based on documentary research and interviews made with SME's and key actors, this paper addresses the issues, opportunities and bottlenecks of the implementation of sustainable renovation highlighting in particular energy performance issues. The first section presents some general considerations on buildings, the second section addresses more specifically the issues of sustainable renovation regarding climate change and energy issues.

General consideration on building

As Ó BROIN, (2007) explains, buildings are, along with industry, transport and agriculture, the main sectors of energy consumption. Also, "of these three sectors, buildings are the most heterogeneous because *they are significantly affected by weather, because of their seasonal cooling and heating needs. Furthermore, the diverse habits, norms and income*

levels of building users add to this heterogeneity" (Ó BROIN, 2007, p.1). It therefore can appear quite complex to tackle. Improving energy performance of buildings can be achieved in two ways: building new energy efficient buildings or renovate existing ones. The purpose of this working paper is to provide some understanding on the issues related to the energy performance of existing buildings which improvement constitutes one of the targets of the Greenov project.

The building and its functions

« *Buildings are our third skin* » ROAF ET AL. (2005) , the Authors recall the primary role of building as being shelter: shelter for people and their goods against, among others, climate constraints. Over time buildings have become more than shelter. Based on Maslow's hierarchy of need (physiologic needs/health, security, belongingness, esteem and self-transcendence), CLUZEL (1986) declares that dwellings today have functions that are essentially related to health and security needs (home-shelter) but also to esteem which is directly related to belongingness, esteem given by others and self-accomplishment. This decomposition of the functions of dwellings is developed by GOBIN (2006) and extended to all types of building (Figure 1).

Figure 1 : The different functions and uses of buildings

Provide space for one's activity	Service provided by the building which allows the user to have the necessary space to accomplish different actions made inside or outside family.
Protect people, goods and tools as well as Human being	Service provided by building that allows the user to preserve (and also use) its tools and goods regardless of diverse aggressions (climate, environmental, or related to voluntary actions of other people.
Provide goods and tools	Service provided by the building that allows the user to use the necessary tools for their activities and to take advantage of their goods.
Provide an atmosphere/ambiance	Service provided by the building that allows the user to adjust the inside atmosphere with the outside atmosphere.
Control relationship	Service provided by the building that allows the user to filter, prevent or promote its contacts with outside people and with the organic elements of its environment.
Take advantage of the site	Service provided by the building that allows the user to live

	in a place without spoiling it.
Semiologic function	This function refers to the quality of the user's experience in the building. That is to all that makes the difference between the building as a strict sum of technical components and the building appropriation experience.

Own traduction from GOBIN 2006, p.3

According to GOBIN (2006), a building can serve seven use functions : Providing space for one's activity; Protecting people, goods and tools as well as Human being; Providing goods and tools; Providing an atmosphere/ambiance; Controlling relationship; Taking advantage of the site and providing a semiologic function. In this perspective, the expectations regarding buildings have largely overcome the sheltering of people and goods. In particular, the semiologic function and the atmosphere/ambiance expectations combine sensible, aesthetic and technical features : the need for a nice environment will depend on the combination of colours, shapes of the interior, on the quality of climate control (heating in winter, air conditioning in summer, etc.), as well as sound and lightning quality, etc. These features will also depend, on cost and environmental constraints and on the use of the building.

Facts and figures

Today buildings are divided in two major categories related to the activities/use of the building :

- Residential buildings encompass notably individual and social housing.
- Non- residential or tertiary buildings: that gathers a great variety of buildings in terms of use and technical features.

In 2011, Europe counted approx. 210 million of buildings and more than 20 billion of square meters, 75% of them were residential (64% single family houses; 36% apartment blocks) leaving 25% of square meters of non-residential buildings (ATANASIU 2011, p.30, source BPIE).

ATANASIU et al. (2011) distinguishes, six main types of tertiary building : Whole sale and retail buildings, Offices, Educational buildings, Hotels & Restaurants, Hospitals, Sports facilities.

- **Wholesale & retail building**: gather detached shops, shopping centres, department stores, large and small retail, food and non-food shops, bakeries, car sales and

maintenance, hair dresser, laundry, service stations (in gas stations), fair and congress buildings and other wholesale and retail.

- **Offices :** encompass offices in private companies and offices in all state, municipal and other administrative buildings, post-offices, refurbishment of old farm in cultural infrastructure

  => ex: Greenov Investments, Saint Mary's Church in Ashford (UK); The Ferme du Buisson in Val-Maubuée (Cinema) (FR)

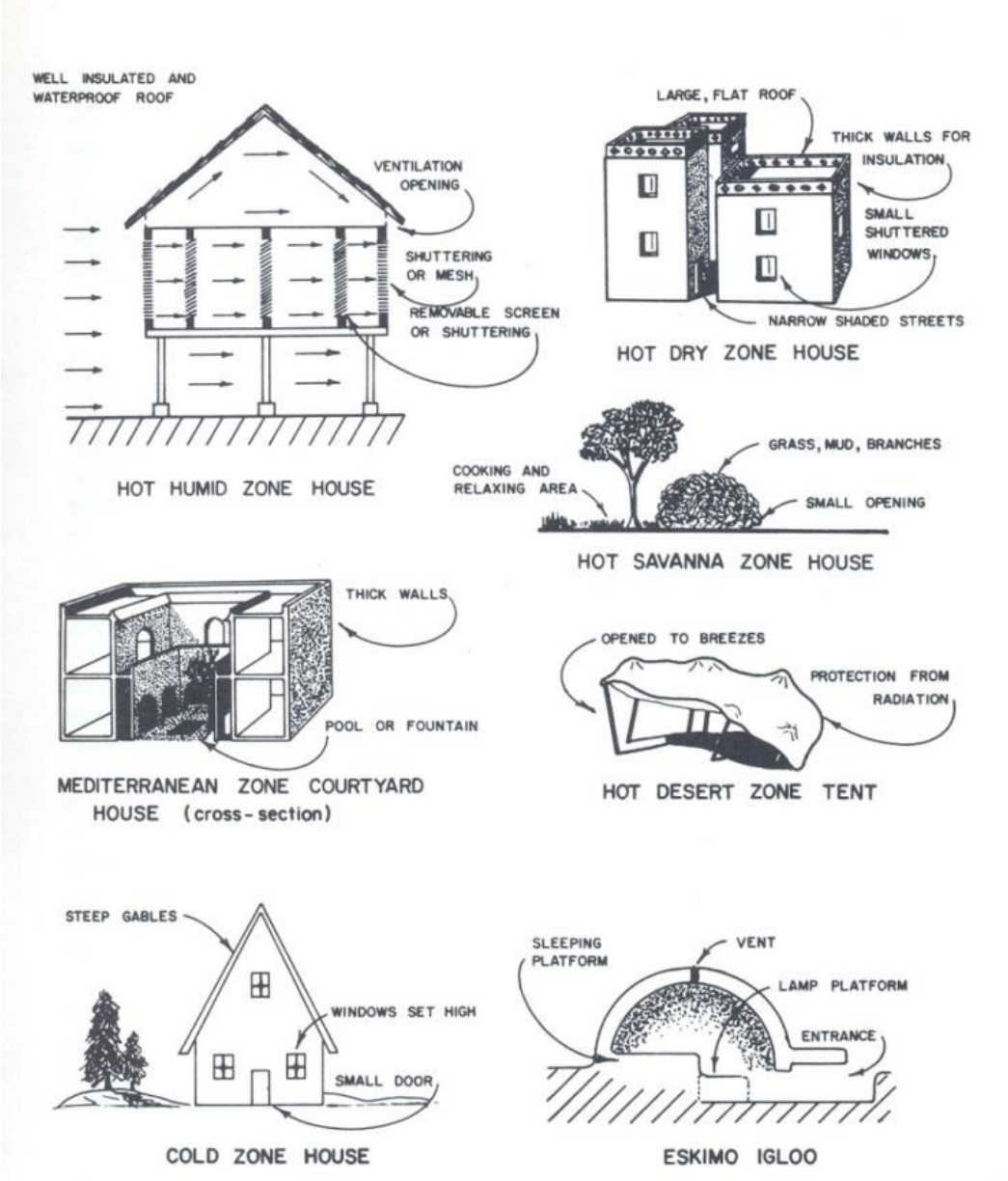
- **Educational buildings :** refer to primary and secondary schools, high schools and universities, research laboratories, professional training activities and others.
- **Hotels & Restaurants** : encompass hotels, restaurants, pubs and cafés, canteens or cafeterias in businesses, catering and others.
- **Hospitals** : are all public and private hospitals, medical care, homes for handicapped, day nursery and others.
- **Sports facilities** : refers to halls, swimming pools, gyms etc.
  => ex: Greenov Investments, Swimming pool in Zoetermeer (NL) (Cinema)
- **Other**: warehousing, transportation and garage buildings, agricultural (farms, greenhouses) buildings, garden buildings." (ATANASIU et al. 2011, p.33)"

According to ATANASIU et al. (2011), Whole sale and retail buildings represented in 2011, in most of Europe, a bit more than half of tertiary buildings. Schools, Hospitals, Sport facilities and other sorts of building constitute the second half (source BPIE, 2011). These typology and figure shows the great variety of existing tertiary buildings and provide an idea of the complexity of the sector: complexity in terms of use, features, technical requirements, energy needs, etc.

Building, climate and energy

Many aspects of the climate are taken into consideration in the conception of buildings (solar sunlight, temperature, winds, atmospheric humidity, precipitations, etc.). Every region, European or word wide has a traditional type of housing whose conception is closely related to climate (figure 2). Whether the climate is dry and warm, cold, of Mediterranean type, the choice of material, the shape of the building will be influenced by climate constraints. Local resources also largely determine the choice of material. The objective in these "traditional" building is to optimise the potentialities provided by the local environment and to minimise the constraints.

Figure 2 : Traditional building type according to world regions. (Taken from GRIFFITHS, 1976)



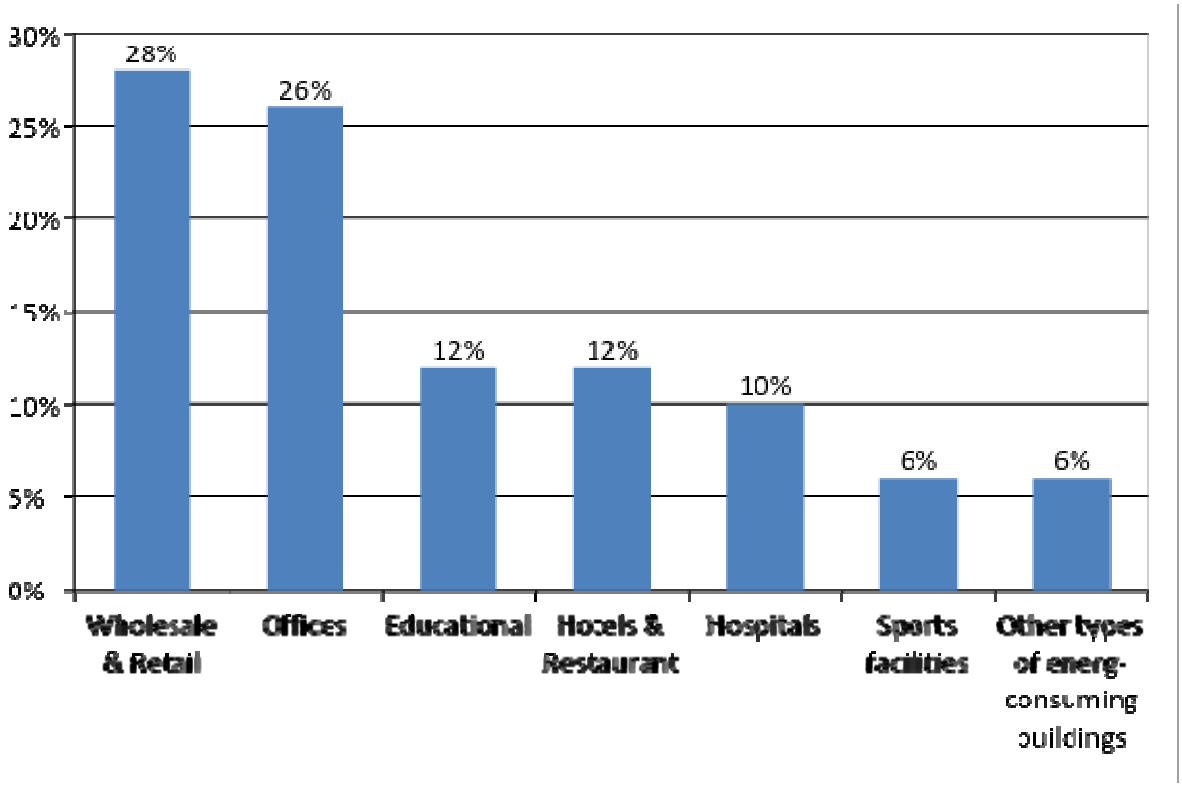
Scientific knowledge has overcome many constraints of constructions in a given climate context and more generally the local environment (use of new non local material, reproduction in diverse regions of the same kind of building, etc.). It has allowed architects and constructors to turn away from traditional know-how to conceive buildings with all season pleasant comfort. This has brought a generalisation of construction modes and therefore a standardization of the built environment. It has also led (and still leads) to incoherence such as large windows in skyscrapers in very warm or cold areas.

Buildings and Energy

Since 1970 the issue of energy efficiency has prevailed with the development of more and more ambitious thermal regulations. Today, the issues of climate change have been added to earlier economic constraints of oil price.

The building sector (residential and non-residential) is today one of the most energy consuming and greenhouse gas producing. It is also one of the sectors in which it is possible to implement solutions in order to improve significantly its performance (improving energy performances of the building and its equipment, use of less carbonated energies, etc.).

Improvement can be made on many aspects of the building and its use. Can be taken into consideration: the performance of the heating system, the building envelop, the climate conditions, the use of the building, etc. As we have seen previously, the non-residential sector represents one quarter of the building surface, and is quite complex and heterogeneous compared to the residential. The uses can be very different (wharehouses, hospitals, schools, universities, swimming pool, cinema, churches, offices, commercial centres, small shops, etc.) This implies variable energy needs as well as construction techniques. Figure 3 presents the energy use in non -residential buildings across Europe[1] in 2011 (ATANASIU et al. 2011, source, BPIE, 2011)



(ATANASIU et al. 2011, Source BPIE, 2011)

Figure 3: Final energy use in non-residential building types for different countries across Europe)

The issues of sustainable renovation

Regulation framework in North Western Europe.

Since the mid of the 20th Century regulations have been developed to insure a certain level of comfort for users, to preserve the building, to reduce noise and energy consumption and to increase fire security. In France for example, the rules defining the effects of snow and wind on buildings exist since 1965 (rules NV 65) ; the first thermal regulation was set in 1974 ; acoustic regulation appeared in 1969). Thermal regulation can take into account the differences between regions (in France for instance the expectations in terms of energy consumption will be different according to the eight climate zone defined by the law). These regulations, in particular regarding energy performances have become stricter across Europe recently regarding the issues of climate change and energy transition.

Energy efficiency is one of EU's priorities. Since the nineties many documents have informed the European policy on that matter. Some have indicated policy orientations (green papers), other have proposed common action plans (White papers, action plans), with, sometimes, obligations in terms of objectives and of means to be implemented (directives).

The European Council has adopted, at the end of 2008, the Climate and energy package whose main objectives are to increase energy efficiency up to 20% by 2020, to reduce Greenhouse emissions up to 20% by 2020 and to obtain a proportion of 20% of renewable energy in the total energy consumption in the EU by 2020.This package has given rise in 2010 to the European Directive on the energy performance of buildings (EPBD). Directive countries have implemented it in different ways according to their specific context and situation. For instance The Greenov partners' countries (Belgium, France, Germany, Ireland, the Netherlands and the United Kingdom) have addressed the EPDB directives in different ways according to countries' specificities, putting more or less emphasis on one aspect or another (PORREDON, 2012). Figure 4 presents a synthesis of the differences of the implementation of the directive in countries of North Western Europe :

Figure 4: Implementing EPDB across North Western Europe

Taken from PORREDON 2010, p.21.

		Directive 2010/31/EU *On The energy performance of buildings*					
		United Kingdom	The Netherlands	Ireland	Germany	France	Capital and Walloon region Belgium
Energy performance certificate	Indicator	++	++	++	+	++	++
	Needs	++	+++	-	-	+	+
	Cost	++	++	+++	+	+++	++
	Pages	-	+	-	++	++	-
Inspection heating system		-	++	+	++	+++	++
Inspection air conditioning system		-	++	-	+	++	-

In this table PORREDON (2010) has compared the level of “strictness” adopted by the national regulations implementing the EPDB: the stricter the regulation is, the more the regulation obtains plusses. The table is structured around the different measures of the European directive: the implementation of energy performance certificate; the implementation of inspection systems of heating and air conditioning systems. For instance Energy performance indicators (EPC indicators) appear less strict in Germany than in the other countries. All countries except Germany indicate the numerical value and use a scale from A to G to express the energy performance, Germany only uses the numerical value. Also, in all countries the emission of CO_2 must be indicated, in Germany it is optional.“ (PORREDON, 2010, p.22).

In terms of inspections of heating system, differences are also notable. In France inspections must be made every year for heating systems of 4KW to 400KW and every two years for systems of 400KW to 20MW. In Ireland no requirements exist regarding these inspections. Regarding air conditioning system: some impose inspection every five years (The Netherlands and France), whereas in others it is every ten years only (Germany) (PORREDON, 2010).

Differences also exist on aspects such as the incentives used in each country to accompany the transition towards more efficient buildings. These can be a determing factor in the decision to renovate a building. But before that, in particular in the case of non-residential buildings, remains the issue of the choice between renovation and demolition/reconstruction. As we will see many initiatives have been developed to help actor’s decision.

Renovating vs. demolishing

Thermal renovation is not neutral in terms of environmental impact (TARDIEU et al., 2011. PEUPORTIER & TRAISNEL, 2000) and has also social and economic costs. GUSTAFSSON (2000) has put forward the importance to use life cycle analysis in order to evaluate the costs of a renovation.

POWER (2008, 2010) also questions in her work the impacts of renovation and demolition/reconstruction. She shows that renovation provides many advantages: time, cost, social impacts, urban sprawl prevention, re-use of existing infrastructures and protection of existing communities. Also, renovation should help reduce significantly short and long term energy consumption in the building. Simulations of the energy savings obtained through a

renovation are a research topic on which many research teams are working on. Thus ASCIONE et al. (2011) have developed a multi-criteria and numerical approach to test different solutions to improve the energy efficiency of heritage buildings such as thermal insulation of facades, reduced infiltration due to faulty windows, replacement of the heating system, etc. KONSTANTINOU and KNAACK (2011) have notably shown the importance of acting upstream of projects, when decisions can still have a strong impact. This issue of the decision is also at the heart of YIN and MENZEL (2011) as they provide a decision model to develop improvement strategies. This tool crosses energy performance and technical and economic feasibility.

The dynamism of research on the issues of decision making reveals the complexity of a choice not always easy to make and that may also be determined by attachment to the building (heritage, or other affective or symbolic value), objectives in terms of learning and experimenting solutions (see Greenov investments projects) and also the access to the necessary competencies (technical, aesthetic, regulation, financing competencies, etc.).

Building and structuring an effective production system on sustainable renovation

The rise of energy, climate and sustainability issues, followed by policy and regulation has brought the sector of renovation to position itself, to adapt and learn. New regulation, techniques, material, constraints have come into play. An exploratory survey conducted in the frame of Greenov project has shown that if most of the enterprises interviewed, active in sustainable renovation, carried out energy efficient renovation works, most of them were related to the installation of solar panels, insulation, waste management, electricity and heating system.

But numerous enterprises have had difficulties to adapt to sustainable renovation considering payback periods of financial investments. They have also had difficulties to find the appropriate technologies and materials. Finally the conditions of works (organisation of the presence of each construction trade, thinking the articulation between the different solutions, etc.) appeared also as an issue.

We find here that is the necessity for actors to move towards the *innovative milieu* dynamic (Maillat, 1998) that is, to enter in individual and collective learning processes (develop one's know-how, competencies, share best practice, sharing information, etc.) and into interaction

dynamics (network creation, collaboration/competition processes). This would help structure efficient and innovative local networks able to face the sustainability turn and to catch the related market opportunities. In parallel it is important to develop cross boundaries and international collaboration and knowledge "pipeline" in order to confront, renew and improve local capacities through collaborations (BATHELT et al, 2005).

Conclusion

The objective of this paper was to provide an overview of the issues of sustainable renovation of non-residential buildings. Non-residential buildings constitute by nature a very heterogeneous and complex ensemble. Today's regulation requirements push firms and concerned actors towards more sustainable forms of renovation and in particular towards better energy performances of buildings. But to achieve the improvement or conversion of the renovation sector, efforts are to be made in terms of knowledge development and network development inside and across boundaries. In that respect, initiatives to foster this conversion to support innovation were and still are more than necessary.

References

AIE. *The world energy outlook*. International energy agency, 2008.

ASCIONE, F. DE ROSSI, F. VANOLI, G. P., Energy retrofit of historical buildings: theoretical and experimental investigations for the modelling of reliable performance scenarios. Energy and buildings, n°43, 2011, pp. 1925-1936.

ATANASIU, B. DESPRET, C. ECONOMIDOU, M. MAIO, J. NOLTE, I. RAPF, O. Europe's buildings under the microscope: A country-by-country review of the energy performance of buildings. Buildings Performance Institute Europe (BPIE), October 2011, 132p.

BATHELT, H., MALMBERG, A., et MASKELL, P. Clusters and knowledge: local buzz, global pipelines and the process of knowledge creation. Progress in Human geography, 2004, vol. 28, no 1, p. 31-56.

CLUZEL, D. Habitat et santé : la maison milieu de vie. Annales de l'Institut Technique du Bâtiment et des Travaux Publics, n°449, novembre 1986, p. 53-76.

GOBIN, C. Industrialisation et construction. Techniques de l'ingénieur, article C 3055, 2006.

GRIFFITHS, J, F. Climate and the Environment, The atmospheric impact on man. London: Paul Elek, 1976, 148

GUSTAFSSON, S.-I. Optimisation of insulation measures on existing buildings. Energy and Buildings, n°33, 2000, pp. 49-55

KONSTANTINOU, T KNAACK, U. Refurbishment of residential buildings: a design approach to energy-efficiency upgrades. Procedia engineering, n°21, 2011, pp. 666-675.

Ó BROIN E., 2007, *Energy Demands of European Buildings: A Mapping of Available Data, Indicators and Models*, Thesis for the Degree of Master of Science in Industrial Ecology, Chalmers university of technology, Göteborg, Sweeden.

MAILLAT, D. (1998) From the industrial district to the innovative milieu: Contribution to an analysis of territorialised productive organisations, Recherches Économiques de Louvain / Louvain Economic Review, Vol.64(1), 111-129.

PORREDON, J. Sustainable Renovation in Buildings: an analysis of the regulation framework in North-Western Europe, GREENOV Working paper, under the supervision of Morgane Colombert and Leïla Kebir, Ecole des Ingénieurs de la ville de Paris, August 2012.

POWER, A. Does demolition or refurbishment of old and inneficient homes help to increase our environmental, social and economic viability? Energy Policy, n°36, 2008, pp. 4487-4501.

ROAF, Sue. CRICHTON, D. NICOL, F. Adapting buildings and cities for climate change, a 21st century survival guide. Elsevier, 2005, 363 p.

TARDIEU, C. ABOUT-DE-CHASTENET, C. COLOMBERT, M. DIAB, Y. GOBIN, C. HERFRAY, G. JARRIN, T. PEUPORTIER, B. TROCME, M. (2011) Analyse de cycle de vie et aide à la décision : cas des bâtiments parisiens. Colloque « la modélisation de la ville : du modèle au projet urbain », Marne-la-Vallée, 23-24 février 2011.

TER MINASSIAN, H. « La réhabilitation thermique des bâtiments anciens à Paris : comment concilier protection du patrimoine et performance énergétique ? ». *Cybergeo : European Journal of Geography* [En ligne], document 536, mis en ligne le 30 mai 2011, http://cybergeo.revues.org/23737 [01/12/2011]

YIN, H. MENZEL, K. Decision support model for building renovation stratégies. World Academy of Science, Engineering and Technology, n°76, 2011, pp. 269-276.

Case Studies: Ashford Gateway & St Mary's Church, Ashford, UK

Author: Ashford Borough Council

Background

Ashford is a town of 75,000 people in southeast England that has overseen a long period of sustained growth, with a population increase of over 25% between 1994-2014. This has seen many changes in resident needs and public service use. Sustainable development is a priority for the town as it moves into the 2010s, as the area is forecast for a further 30% increase in population over the next 20 years. With numerous development projects already underway to increase job creation, improve leisure and shopping facilities, and boost the town's commercial offering, Ashford Borough Council is also working as a partner in the Greenov Project to boost sustainable development and the local sustainable development economy.

The Greenov Project: Ashford's role and actions

Ashford led on the inclusion of environmental retrofit features in two key projects:

- The refurbishment at St Mary's Church to provide an increased arts performance space
- The renovation of the library to provide increased public services, a wedding venue and café

These projects were planned to include sustainable technologies and techniques to reduce carbon emissions: sustainable heat and electricity generation; water reuse; flood attenuation; and resource-efficient fittings. Both buildings were to act as beacon projects to raise awareness of the importance of sustainable renovation.

Objectives and expectations

- To deliver sustainable refurbishment in municipal projects, showcasing innovative sustainable technologies that reduce carbon emissions and running costs.

- To contribute to developing a transnational supply chain cluster that will increase the capacity to deliver sustainable renovation.

- To increase the knowledge, skills and effectiveness of Small and Medium Enterprises (SMEs) involved in the cluster.

These case studies will particularly focus on the first objective; the sustainable development of St Marys Church and the Ashford Gateway.

Case Study 1: Ashford Gateway

Architectural Diagnosis & the Challenges

The original Ashford Library was a 1960s building in the town centre, outdated in terms of exterior design and accessibility. The library design did not make efficient use of existing spaces and could not be made DDA compliant without significant investment. Overall, it was felt that the building did not provide a good platform from which to provide a service to the community and would fail to cope with an expansion in population: the facility had 267,073 annual visits in 2008 and it is expected that the redeveloped Gateway Library Plus will receive over 400,000 visitors a year. Because of this, and because it would be a suitable initiative for the Greenov Project, it was decided in 2009 to improve community facilities by updating and redeveloping the library site, and to incorporate sustainable features.

The Ashford Gateway was felt to be a good choice to be a flagship sustainable development project for the area as it is a widely-used community facility and is located in a very sustainable location:

- It is at the centre of the town, allowing the development to be open to the majority of the population through the library and other facilities.
- Public transport is available at frequent intervals
- The building complex faces all four directions, allowing the redevelopment to make good use of orientation in controlling heating and lighting.
- The area has a low annual probability of flooding or facing other natural problems.

The site lies within the Ashford Town Centre Conservation Area opposite the War Memorial and Memorial Gates, both of which are Grade II Listed. Therefore, the redevelopment of the library would inevitably have an impact on the setting of these Listed structures and the special character and appearance of the conservation area. The ability of the building to fit seamlessly into its setting was crucial and the design was based on a thorough understanding of the sensitive local context.

When redeveloping the library, clear aims were set out to guide the process:

- Make a positive, innovative and compatible architectural statement about Ashford that reflects the character and spirit of a growing and changing town.
- Complement the Church Road area of Ashford, developing good links with the Memorial Gardens.
- Provide an asset to Ashford for many years that will attract visitors to the area
- Create a building that is energy-efficient and makes use of opportunities to reduce its carbon footprint.
- Fit into the wider development framework for Ashford
- Provide a hub for Kent County Council service provision in Ashford
- Provide a flexible building where consideration has been given to its future-proofing

Technical Diagnosis and Solutions

The growth delivery agency for Ashford, Ashford's Future, worked with architects Burns Guthrie and Partners to produce a sustainability plan for the Gateway in 2009. This was intended to allow sustainability to be built into the structure from the start, and contribute to an orderly, organised development process. This would allow a suitable building to be put into place, with a capacity for 159 people on the ground floor, 166 people on the first floor and 207 people on the second floor.

An environmental assessment carried out by GE Solutions graded the site as low-risk, but recommended that piled foundations were used rather than conventional shallow pad type foundations due to the potential for high differential settlements caused by the presence of two soil profiles in different areas of the building site; dense sandstone and clayey sand in one location and stiff clay in another. An archaeological investigation by the Canterbury Archaeological Trust confirmed there would be no damage to significant historical remains.

Programme Budget

The total budget for the project was £7.56 million, with a construction contract cost of £5.86 million. The building has a gross internal floor area of 2,871 square meters, resulting in an average total cost of £2,633/square metre.

Project Progress

Construction began on the 26th April 2010 and the building was water tight by end of November. Sustainability elements were included in the fit-out during January and February 2011. Building completion was achieved on the 4th July 2011, a period of just over a year. The project took the opportunity to offer learning opportunities for young people as two apprentices were employed on site by the electrical contractor Maybourne and Russell. In addition, the site team worked with the local colleges to inform students about the construction process and sustainable energy, encouraging young adults to engage with sustainable development in the future.

Structure and material

The building structure comprises a braced steel frame with a mixture of composite and non-composite steel beams to the upper floors. The lateral wind load (and notional horizontal loads) has been braced with predominantly flat steel wall braces, and circular hollow sections placed horizontally in the roofs of the building. On one area there was an architectural requirement to use a circular steel bar as wall bracing. The composite RC slab construction provides diaphragm action through the suspended floor areas. Many of the steel beams have had specific holes placed through the webs to allow service pipe placement beneath the floors. The roof beams are all simply supported and carry light gauge steel purlins.

Exterior walls are typically lightweight cladding supported off steel vertical stud frames to the inner leaf. The floor build-up comprises a composite roof build-up supported off steel purlins.

In some areas of the roof green roof finishes have been placed along with further areas with concrete tile walkways.

Green rated material was used for the basic building materials and other material was procured from certified companies. The thermally-efficient curtain walling provided by Leay, incorporating, Kawneer 600 Series Casement Tilt turn and Pivot Windows, Framing Systems 400/451PT, 190/350 Doors, and AA100/110 Curtain Wall. The use of rated material helps in reducing the embodied energy of the materials and in a way it mitigates the carbon emissions through the whole life cycle of the material used. Similarly, the re-use of existing materials helps in curtailing the transportation costs and vehicle fuel emissions.

Heat insulation was promoted through the use of double-glazing, for example in the use of Komfort Double-Glazed Screens and Doors. To maximise efficiency a 'passive approach' was taken by the design team, with glazing reduced on the South and West elevations to avoid solar gain. The building is designed to use natural ventilation, where possible assisted by the circulation of air through the Atrium design.

Water usage

Permeable paving in the service yard and an attenuation tank are features of a sustainable urban drainage system. A Bauder XF301 sedum roof has been included – the first in Ashford. After an initial temporary artificial-irrigation period of one month, the low-maintenance roof absorbs 40% of the annual rainfall, storing water and reducing flow rates during storm events, contributing to reduce flood risk and reducing current surface water runoff by 20%. In addition, Armitage Shanks Contour 21 BTW and accessible Geberit Aquaclean 8000 Care WC dual flush toilets and Armitage Shanks Contour 21 basin mixer sequential flow restrictor taps contribute to water savings.

Heating

Auron DF solar thermal technology provides hot water, linked to an Ultramax WM Wall Mounted Condensing Boiler system that is highly efficient, at 95% seasonal efficiency. A GEA Air Treatment air-cooled water chiller/heat pump provides a sustainable source of space heating and cooling for the building and is coupled with Grundfos TPE pumps that assist with air circulation and heat recovery, all of which reduce the carbon footprint of the building. In addition, the use of Tormax automatic swing doors and a Tormax Revolvedoor Turn System revolving door at the front entrance ensuring that heat loss from open entranceways is minimalized.

Lighting

Natural light was a key element in the sustainability plan. A glazed atrium plays an important role in helping to add character to the building. Internal support columns were avoided where possible to ensure that a clear open space was achieved. Views onto the street are important to ensure effective levels of natural surveillance, and views over the street and Memorial Gardens were used to keep the café area attractive, open and well-lit.

Wherever it was possible, the glazing on the south and east orientation was optimised to maximize the benefits of passive solar gain in the rooms. Window areas in the rooms were designed to provide good day lighting and that reduces the demand for lighting and other loads. In addition to natural light, the Gateway uses energy-efficient systems to reduce electricity consumption and limit carbon emissions, including:

1. High efficiency Thorn Lighting lamps, incorporating both fluorescent and LED technology, provide a high light output for each unit of energy used

2. High frequency ballasts increasing the efficiency of the fluorescent lamps in that flicker effects are reduced, creating a more comfortable visual environment
3. Buss photocells and MK Electrics intelligent switches are used to dim or switch off artificial lights in response to the amount of daylight available

Overall Outcomes

The project was very successful, providing a sustainable new community facility and demonstrating the strengths of sustainable development to the public and the council. It also allowed the council and its partners to better understand the processes and challenges involved in this type of development.

A key target for the building was to achieve BREEAM Very Good status, and ideally to achieve Excellent status. The options explored in the sustainability plan were implemented, though due to the need to balance sustainability with costs some compromises had to be made. For example, energy-saving measures were not applied to the lifts as their expected frequency of use was too low for this to be economic. Nevertheless, the building was able to meet BREEAM 'Very Good' standards, and achieved this with a certification score of 58.05 in the 'bespoke' category (2008 rating scheme).

Overall, changes to the heating and insulation of the building gave energy savings of 36% and a carbon emission reduction of 33%, even though heat demand through increased use of the building is anticipated to rise.

Before renovation	kWh/year	Kg CO_2/year	*After renovation*	kWh/year	Kg CO_2/year
Heating	200,000	38,800	Heat pump	7,000	2,954
Hot water*	unknown	unknown	Boiler	119460	23,175
Total	**200,000**	**38,800**		**126,460**	**26,129**

*Hot water previously supplied through local water heater. Hot water will be heated by new boiler plant.

The agreed target for overheating was not to exceed 28ºC for 5% of the occupied hours, to be achieved without the benefit of mechanical cooling. This has been largely achieved with the exception of one space which exceeded 28ºC for 7.4% of the occupied period.
In addition:

- The insulation (u value) of the new floor is 40% lower than the previous floor slab. The new gas boiler replacing the cast iron boiler will increase efficiency from 80% to over 90%.
- The air source heat pump and underfloor heating reduce carbon emissions by 75%.
- Lighting scheme increases energy efficiency and reduces maintenance requirements.
- Rainwater harvesting system and efficient fixtures reduce potable water consumption.

Continued Monitoring and Performance

A continuing challenge is the efficient management and monitoring of the building, to maximise the benefit of the sustainable technologies used.
Activity to monitor efficiencies in energy and water use at the Ashford Gateway is being put in place. The aims are to be able to examine efficiencies and return on investment to inform future Gateway management and other sustainable development projects, and potentially to advertise efficiencies through displays within the public area so that the public are engaged in the approach to managing the energy and water usage.

Lessons to be learned from this case study include the need to continue to review the technologies and specifications used during the design period to take account of changes to the building structure and use; to ensure widespread training of staff within the building on how to manage the heating and cooling systems within the building to maximise efficiency and temperature control; to incorporate ways to monitor and display the building

performance to users of the building as part of the delivery of the development, ensuring that these are able to excite and inform users about the technologies used and the financial and environmental benefits they achieve.

The delivery of the Ashford Gateway building has been a great success and provides a flagship example in a high profile community building that has embraced environmental technologies to lower energy and water use, and provide financial savings in the medium and long-term.

Case Study 2: St. Marys Church

Global Presentation: Needs, Budget, Targets

The recent re-ordering works at St Marys the Virgin, Ashford were conceived to enable the church to function as a badly-needed community arts venue without compromising the community's spiritual needs. The re-ordering also presented the opportunity to greatly improve the churches energy and water consumption and improve access for the physically disabled. Joint workshops hosted by Ashford Borough Council Arts Project Office and the St Mary the Virgin Ashford PCC along with wider stakeholders explored the options. Feasibility studies were commissioned and a budget requirement of £1,000,000 identified. The contract sum was £1,134,290 plus fees, audio-visual works and loose furniture.

Architectural Diagnosis and Project Synopsis

Date of building

Like most English parish churches, the building has a complex history which has developed over many centuries. The earliest reference to a church on the site is in the Domesday Book, which records “A church and priest at Essestisford” in 1086. The first significant recorded structure on the site was a twelfth century Norman church, expanded to a building of the approximate current cruciform plan in the late thirteenth century. The church was considerably enlarged in height between the years 1470 and 1490 under the auspices of Sir John Fogge, when it gained a tall Perpendicular tower, raised nave, transepts and chancel, all with large windows. In the early nineteenth century the aisles were widened and the eighteenth century galleries re-constructed, re-using much earlier material. The 1860’s saw a re-construction and extension of the west end, a new organ being installed in the north transept. A vestry extension and mortuary to the east of the north transept in 1873 completed the current footprint of the building. Most of the pews existing at the time of the recent re-ordering dated from the late 1870’s. New north and west entrance vestibule screens were added in the early years of the twentieth century and the last bay of the west end was enclosed in 1986 to provide toilets, office and meeting room.

Description of the project and relevant dates

Lee-Evans Partnership were interviewed in Autumn 2008 and engaged as Project Architects. Following a lengthy development of the scheme and obtaining the necessary consents the works commenced in October 2010, Practical Completion being achieved in late July 2011. The works comprised the following:

- Removal of the majority of the nave pews and their replacement with loose chairs on a new limestone floor with underfloor heating.
- Creation of new west-end meeting room, toilets and kitchen.
- Creation of new west end meeting room and toilets at first floor level in self-contained oak “Pods”.
- Elimination of any steps in the floor to the nave, transepts and west end to make the building as fully DDA compliant as possible, within the constraints of the Historic fabric.
- Relocation of the pulpit and font.
- Creation of a new timber dais with a heavy-duty stage lift and portable staging.

- Alterations to chancel pews to make them semi-mobile.
- New glazed automatic glazed inner doors at the west end and new glazed inner doors to the north transept.
- Relocation of the organ blower to enable new WC's adjacent to the vestry, which will double as a green room.
- New energy-efficient lighting system, making the best use of current LED technology.
- New audio-visual system with drop down screens, projectors and sound systems, all controlled by a large purpose-made sound desk on the west gallery.

- Fundamentally, a new underfloor heating system powered by a ground source heat pump with radial boreholes in the churchyard plus the replacement of the existing elderly gas fired boilers, which would continue to supply the existing and new radiators also present in the church.
- New rainwater harvesting tank in the churchyard with pumped supply to the new toilets.

Particular qualities of the existing building

The building itself is a Grade I Listed church containing many features of Historic and architectural importance including hidden archaeology, notable early and Victorian stained glass, memorials, galleries and Great War memorial screen by Caroe & Sons

Insertion in the urban landscape

The church is situated in an urban setting, within an ancient church yard containing many graves. The archaeological constraints and tight urban setting lead to the need for a highly sophisticated and inventive ground source heat pump system as well as very careful location of the new rainwater harvesting tank. Other external works were very minimal, consisting of a modest extension to the vestry area, to match the church.

Legal obligations and patrimonial constraints

The building is much-loved and greatly in the public eye and therefore many of the works required great sensitivity in their design and implementation in order to reassure the local residents, the church authorities and the statutory amenity groups, such as the Victorian Society, the Church Buildings Council and the Society for the Protection of Ancient Buildings. All of the works required certification from Canterbury Diocesan Advisory Committee and a full Faculty and the external works also were under the jurisdiction of the local authority planning department. Removal of the pews was one of the more contentious proposals and Lee Evans Partnership were fortunate to gain acceptance of English Heritage and the DAC who concluded that removal of the pews was central to the project's ambitious proposals for securing the building's long-term future. However the removal of the pews was contested by the Victorian Society but won at a consistory court.

Architectural Choices

New building works

Whilst the outside of the building is almost completely un-changed, the internal alterations are much more extensive, and are contemporary in design. The entrance lobby to the church has been extensively remodelled to improve access and space for welcome and fellowship and can be combined with the adjacent Crothall meeting room too to make a larger space when needed. The former heavy Edwardian panelling and doors leading from the lobby into the church have been moved to the North transept and replaced with glazed doors, enabling the fine fluted oak columns from the late Victorian re-ordering to be seen once again.

Two new staircases with mouldings echoing the style of the lobby entrance's columns lead up to first floor level. At the foot of each staircase is a discrete glass sliding door which can be locked to close off the first floor galleries when not in use.

Four simple, dark stained vertical boarded oak 'pods' have been created. At ground floor level one pod provides kitchen facilities which serve both the church and the adjacent Crothall meeting room. The other provides extensive storage for the stacking chairs. At first floor level a pod provides toilet facilities and the other an additional meeting room.

The existing central aisle flooring which dates from around 1826 has been extensively restored. New flexible seating is provided by the classic Howe 40/4 chair renowned for its elegant and spare aesthetic - at least one in 20 chairs will have arms, for the comfort of older occupants.

Social appreciation

The architectural focus has centred on reordering the church to create a flexible building which can accommodate the 'shared space' requirements, first and foremost to improve and facilitate the delivery of religious sermons and ceremonies, and secondly, to host music, drama and arts events. So far public reaction has been overwhelmingly positive. The successful realisation of this 'shared space' initiative' will be the core of the church family's mission, and enable people from across the age and social spectrum to be brought together in shared, creative activities.

Technical Diagnosis

Heating

The formerly-existing big bore heating system and old-fashioned gas boiler were very inefficient, nearing the end of their life and needed replacing. This provided hot water, distributed via large iron pipes to a pipe coil heating system in the nave and mid 19thC radiators positioned around the church. Heating a large building in this way is an in-efficient method as the air in the building is warmed via convection. With the high space of the nave, this meant that often the air closest to the ceiling was a lot warmer than the air closer to the congregation.

Structure and material

The building fabric is made up predominately of Kentish Ragstone for the external walls and a timber roof structure finished in either clay tiling or lead. Due to the historical nature of the building it was not feasible to insulate these elements as this would dramatically change the visual appearance both internally and externally. However, there was an opportunity to lift the existing floor and lay insulation and a new under-floor heating system. The typical existing floor construction for the church consisted of compacted earth with a thin bed of lime mortar on which floor tiles are laid. Throughout the church there were significant artefacts

and tombstones buried within the floor, but these were located principally in the chancel and north and south transepts, therefore it was only feasible to insulate the nave floor.

Lighting & Audio

The natural light in the church was poor and this was exacerbated by the presence of large deep Georgian galleries which loom over the nave on three sides. In addition, the existing lighting system consisted of inefficient incandescent fittings installed back in the 1950's which provided inadequate levels of light. Installation of new lighting was essential and a new audio visual system would also be needed to meet the differing requirements of a sacred and a "shared" space.

Water usage

The existing facilities in the church were limited and consisted of a small kitchenette and a single lavatory vestry and a small meeting room. Therefore, water usage by the church and congregation was relatively low prior to the refurbishment of the church. However, now the building was to be used as a performance space and a functioning church, additional facilities were required to ensure building regulations were met. This led to a small commercial kitchen being provided and an additional 12 lavatories. The only other water usage by the church was that used for flower arranging or watering of the graveyard. With a large increase in water consumption expected the incorporation of a rainwater harvesting tank was investigated.

Hot water

Due to the limited supply of water within the church there was also a restricted supply of hot water being supplied by two instant electric hot water boilers, one located in the small kitchenette and the other in the vestry.

Health and comfort

The nave will be used for performances and exhibitions in addition to its conventional use by the church congregation. The introduction of underfloor heating to this part of the church combined with an enhanced low energy lighting system which will make a huge improvement to the comfort of the space.

Technical Choices

CO_2 bill

Although the historic nature of the church limited the works that could be carried out, there were opportunities that could be implemented to reduce carbon emissions. It was estimated that enhancements to the heating system and building fabric could provide a potential reduction in CO_2 emissions of up to 33%. In additional to this, calculations were carried out to indicate the saving that could be achieved by using a Ground Source Heat Pump to provide heating to an underfloor heating system in the nave in lieu of the existing gas boiler. The results indicated that there was a potential reduction in carbon emissions of 75% for the nave area.

Material

As previously discussed, there were limited opportunities to enhance the fabric of the church. However, being able to lift the floor in the nave allowed the existing floor to be replaced by a new screedless floor system comprising 150mm recycled foamed glass aggregate, crushed slate levelling material, 20mm Fermacell board, 50mm high density insulation, 30mm EPS insulation incorporating rebated underfloor heating pipes on aluminium diffusion plates, 20mm tongue and grooved terracotta tile and on top of this 20mm limestone tiles as floor finish. It was estimated that this would improve the u-value of the new floor by 40%. Lee Evans Partnership and Jupiter Systems have pioneered this flooring system to be use in historic buildings due to the many benefits it provides. Not only does the system improve thermal performance it also removes any wet trades from the associated with a standard floor construction. In turn this removes any of the associated risk with introducing large amounts of water into a building with a significant historic fabric.

Heating

The existing gas fired boiler was replacing with a highly efficient gas boiler which provides heating to all areas of the church where it was not possible to install underfloor heating. The underfloor heating installed in the nave provides radiant heat to this space, a much more efficient and appropriate way of heating the high space as heat is provided at the occupancy zone to a height of around 3m unlike the previous convective heating system which lead to large temperature gradients across the space with the higher temperatures being closest to

the ceiling level. This meant that just the area used by the congregation would be heated rather than heating the whole volume of the church.

With a more efficient method of providing heat to the nave a decision was made to investigate a more sustainable method of providing heat to this area. An options appraisal concluded that a ground source heat pump (GSHP) was only appropriate low/zero carbon technology for this application due to the many site constraints associated with the churches central location and its local surroundings. However, without European Union funding, awarded to the project through the Green Renovation Cluster Programme (Greenov), the installation of this technology would not have been able to go ahead.

Renewable Energy

A GSHP was the ideal and efficient choice to power the church's new under floor heating as it complements the relatively low temperature levels an underfloor heating system demands. The chosen heat pump was an innovative system that used a radial bore hole. A radial borehole uses a 1.1m diameter chamber excavated to a depth of 1.2m and from this hole radial boreholes are then installed at approximately a 45 degree angle to a depth of approx. 50m. This system was ideal for the situation presented at the church as it limited the amount of disturbance to any archaeology. Being the first time this system has been used in the UK it would become a demonstration of this technology and show how the radial array would minimise the damage to archaeology and potential heritage assets hidden in the ground.

Hot water

With a new heating system the hot water provision was enhanced to provide hot water via the gas boiler to the west end where the kitchen and majority of lavatories where located, To the east end there's a small electric water heater to provide hot water to two lavatories located backstage for use by performers. It was calculated that hot water consumption would increase to 34m^3 per year.

Electricity

The major consumption of electrical energy within the church following its refurbishment is associated with the enhanced lighting and audio visual system. However, these were essential to ensure the building could function both as a sacred space and a shared community space for arts and performance. Implementation of both was challenging as it was important to keep fastenings to the historic fabric to an absolute minimum to ensure heritage bodies found the proposals acceptable.

Water Usage

The reordering of the church included a large extension to the sanitary facilities for the church to cope with the increased capacity when used as a performance venue. This put an increased demand on the water consumption of the church. In order to reduce the reliance on mains water a rainwater harvesting tank was installed. Water is now collected from a total of 224m² of roof over the south half of the nave and fed to a 6500 litre rainwater harvesting tank buried underground in the south west corner of the grave yard. To further reduce water usage washroom taps were specified as automatic aerated taps which can provide a 50% saving of the water over conventional taps.

Health and comfort

Following the reordering works the health and comfort within the church have been significantly enhanced.

The principal nave ceiling has been restored and painted white and gold with colour changing LED lights incorporated into the flexible scheme for mood change. Theatrical and LED spot lighting has been mounted on gantries providing high levels of light. Both lighting systems combined provide high quality levels of light for all possible occasions. The new light coloured limestone flooring combined with freshly painted walls and the advanced

lighting system has significantly enhanced the poor level of daylight in the church prior to the works being carried out.

The new heating system has made a huge improvement to the comfort of the space. Winter temperatures within the church prior to the reordering rarely reached above 12-14°c. However, following the installation of the heating system the church has been experiencing average winter temperature of about 18 ^{o}c. It has been reported by the church that at one point the internal temperature was reaching 22°c at which point the heating temperature had to be turned down to provide a more comfortable level of heat.

Post Audit

Environmental audit

To establish how the church was performing in terms of energy and carbon savings following completion of the project, a heat meter was installed on the GSHP which measured the kilowatt/hour consumption on a monthly basis. In order to calculate the electrical energy used by the GSHP against the total electrical energy consumed by the church monthly readings were taken from the electrical meter. As heating was provided by both the GSHP and a new gas boiler, gas meter reading were also taken on a monthly basis to ascertain how much energy was being used by the separate heating systems.

Comparing producing CO_2 before and after

Comparing the CO_2 emissions of the church before and after the refurbishment would not provide a realistic comparison as the use and activities within the church were expected to increase dramatically. Therefore it was decided that a comparison would be made between the predicted CO_2 emissions derived from calculations provided by the services engineer and the actual readings taken. Table 1 below demonstrates the predicted energy consumption and CO_2 emissions before and after the renovation. However, it must be noted that although these figures only take account for the heating system they do allow for a conservative increase in use of the building by 13%.

Before renovation	*kWh/year*	*Kg CO_2/year*	*After renovation*	*kWh/year*	*Kg CO_2/year*
Heating	200000	38,800	Heat pump	7000	2954
Hot water*	unknown	unknown	Boiler	119460	23175
Total	200000	38,800	**Totals**	126460	26129

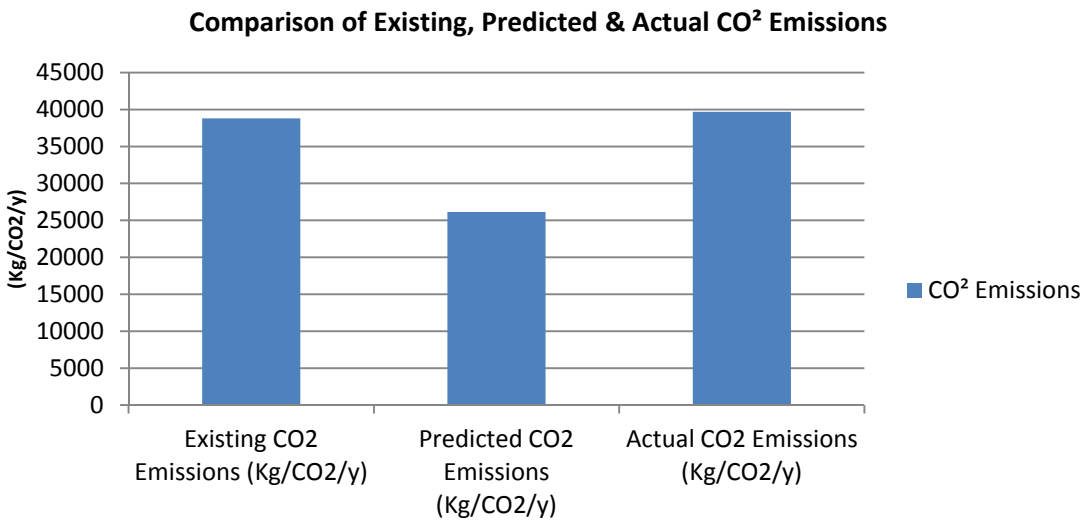
Table 4: Predicted Energy & CO_2 Savings Pre and Post Renovation.

The table above indicates that with a new highly efficient heating system there should be an overall reduction of CO_2 emissions associated with heating to the church of 33% and overall energy savings of 36%.

The table and graph below compares the actual carbon emissions against the predicted pre and post carbon emissions.

	Existing CO_2 Emissions (Kg/CO_2/y)	*Predicted CO_2 Emissions (Kg/CO_2/y)*	*Actual CO_2 Emissions (Kg/CO_2/y)*
GSHP	N/A	2954	3027
Gas Boiler	38800	23175	36660
Total	38800	26129.24	39687

Table 5: Existing Predicted & Actual Carbon Emissions Arising from Heating System



Graph 1: Comparison of Existing, Predicted & Actual CO² Emissions

Graph 1 above shows the reduction in actual CO_2 emissions following the completion do not match the predicted emissions and are actually more akin to the existing emissions prior to

the reordering. There are a number of explanations for this. However, it is believed that the higher emissions may be due to a number reason including; the hours the heating system has been on, the temperature being reached in the church and the temperature is also at a more constant level. Further investigation into how much longer the heating system has been running at peak load than originally predicted and also the temperatures being reached in the church is required to truly understand the difference between the predicted and actual CO_2 emissions. However, with this information the gap between the predicted and actual CO_2 emissions would be seen to decrease.

Project Budget & Costs

The total building contract was £1,134,290. The building is about 1,129 m2 giving a refurbishment cost of £1,004/m2. The cost of the key sustainability features where as follows: Ground Source Heat Pump £197,977, Grey water £21,437 (with additional archaeological costs for the tank), Automatic Water saving Taps £1881, Low Energy Lighting £106,590.

Awards

Following completion the project has been entered in to a number of competitions and to date has won awards for:

- **RTPI South East Planning Awards 2013:** Best Planning for Natural & Built Heritage for St Mary the Virgin, Ashford
- **Ashford Borough Council Building Design Awards 2012:** Sustainability for St Mary the Virgin, Ashford
- **Ashford Borough Council Building Design Awards 2012:** People's Choice for St Mary the Virgin, Ashford
- **Green Apple Award 2012:** Green apple Environment Award 2012


© Lewis J Brockway

Case Study: Sports Complex in Zoetermeer Municipality

Author: Zoetermeer Municipality

General Introduction

This chapter starts with a general introduction of Zoetermeer experiencing this New Town movement. How the city turned out to be one of the largest cities of her county and how this growth has consequences for modern tasks such as energy reduction.

City of Zoetermeer

Around 1950 the character of Zoetermeer was still similar with that in the beginning of the 17th century. A small town with a couple of thousands inhabitants, surrounded by arable land with a few main roads. This all started changing around the year 1962 when Zoetermeer was selected to be a centre of urban development.

Zoetermeer was designated to accommodate citizens from the overflowing adjoining city 'The Hague'. Within not more than fifty years all the polders in Zoetermeer disappeared and the city turned out to be an urban area filled with buildings. The small village that Zoetermeer once was now growth out to be the third biggest city of the county 'South-Netherlands'. Zoetermeer experienced such an enormous growth in a relatively short period that the city was titled as 'New Town'. The city now counts more than 122.000 citizens on a territory of 37,06 km^2.

Image 1: New Town Zoetermeer (source: www.nesciohoven91.nl)

City Ambitions

Most buildings in Zoetermeer were built in those years that energy consumption was not yet a primary concern. This resulted in the presence of many energy inefficient buildings which are responsible for a great amount of the Zoetermeer CO_2 emissions. To prevent the city from the effects of climate change and to guarantee long term energy supply the municipality of Zoetermeer invests in CO_2 reduction. And now that available space in Zoetermeer is getting scarcer this ambition needs to be fulfilled in a life phase of redevelopments, renovations and in the maintenance of buildings.

The growth of Zoetermeer was experienced as sustainable and the municipality wants to maintain this feeling by providing in the needs of the current generation without endangering the possibilities for coming generations to provide in theirs.

The city ambition is to reduce the CO_2 emissions with 30 percent in comparison to the emissions in the year of 2007. The ambition for 2030 is to have an energy-neutral city where all the energy that is needed in buildings is from renewable energy sources and with a zero CO_2 emission (CO_2 neutral).

Project Description

The city ambition for Zoetermeer has a strong resemblance with the objectives of the Greenov project (For a description of the Greenov objectives see chapter three 'Objectives & Constraints'). Zoetermeer therefore decided to make use of her position as one of the

Greenov investing partners. During the Greenov project Zoetermeer is not only working on fulfilling the Greenov objectives but also working on an approach to fulfil her own city ambition for the reduction of CO_2 emissions.

As a Greenov investing partner Zoetermeer works on the renovation of a building she selected. The process of renovating this 'exemplary project', hereafter called 'the Greenov investment project', or ' investment project', will be used by the municipality of Zoetermeer as a pilot and case study to stimulate a further reduction of energy losses in her own municipal buildings. The next chapter 'Greenov investment' is about the building that Zoetermeer selected for this project and why this building is considered a suitable example for the city.

Greenov Investment

The municipality of Zoetermeer selected sports complex 'De Veur', which is located in Zoetermeer, to be her Greenov investment project. Within this sports complex there is a swimming pool with a sports and recreational function and a sports hall. Also there are dressing rooms, multi-functional spaces, offices and a bistro inside the complex (all part of the 'main building'). Attached to the building there is a children's day-care and a community centre (part of the 'building extension').

Image 2: De Veur sports complex (source: S. van der Tas – municipality Zoetermeer)

During the Greenov project (2010-2014) Zoetermeer works on the sustainable renovation of this sports complex which dates from 1991 and has almost all his original components. The renovation of the sports complex is specifically focusing on reducing the energy consumption

in the sports- and swimming area (main building). Since these two functions are mainly responsible for the enormous energy consumption each year.

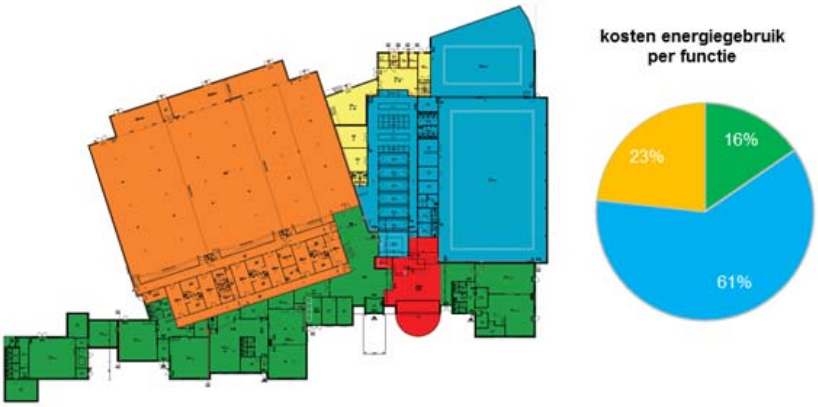


Image 3: Energy costs per building function (source: BBN Adviseurs, 2013)

With an energy label 'G' this building is one the most energy inefficient and expensive to manage buildings owned by the municipality. The energy consumption of this building is around the 650.000 kWh for electricity and 150.000 m^3 for gas per year.
Around 77 per cent of the yearly energy costs are from the main building functions 'sports' and 'swimming' (see image 3, page 5). 50 till 60 per cent of these costs are from their need for gas and 40 till 50 per cent from their need for electricity.

Ownership

De Veur sports complex is one of the properties owned by the 'Municipal Real Estate Company Zoetermeer' (MRECZ). This central, and self-standing, real estate department of the municipality of Zoetermeer develops, operates and manages the municipal buildings. During the several phases of renovating the investment project MRECZ operates as principal in charge to meet the requirements of the project.

Building selection

The municipality of Zoetermeer considers De Veur sports complex to be an suitable example for its city. Selecting De Veur sports complex as the Greenov investment project knows a number of reasons:

- This object knows a high level of energy consumption. Compared to the other properties of MRECZ it is one of the most energy consuming buildings. Renovating the building can highly contribute to the ambitions of sustainability;
- It is concerning a public building with a high number of visitors. This gives the Municipality the opportunity to stimulate awareness for energy saving opportunities. Presenting the results of renovation to the building tenants and it visitors could stimulate them to take measures themselves;
- Among the other Greenov investment projects this is the only building with a swimming-/ sports function. That gives Zoetermeer and the other Greenov partners the opportunity to gain knowledge and learn from new experiences.

Objectives & Constraints

The ambition for the reduction of energy losses and CO_2 emissions were translated into four project objectives. During the Greenov project (2010-2014) the municipality of Zoetermeer works on achieving these objectives which needs to be done within the set constraints.

Objectives

As was said before there is a strong resemblance between the Local and European ambitions and the objectives for the Greenov project. Zoetermeer gathered the ambitions and objectives in four main goals she will be working on;

1. Creating awareness for energy saving opportunities and stimulate the public and (local) SME's to take measures themselves;
2. Renovate the Greenov investment taken into account the city ambitions, the project objectives and the set constraints;
3. Work on an approach to inventories lucrative sustainable measures;
4. Develop policy for stimulating the transformation of buildings into very low energy buildings and to reduce CO_2 emissions.

The four main goals for this project were set based on the ambitions and objectives that stimulate sustainability and the reduction of CO_2 emissions on European and Local level. As are described in the following subparagraphs.

European objectives

The revision of the 'European guidelines for energy efficiency in buildings' (EPBD) took effect in 2006. This so-called 'Recast EPBD' is the main instrument at European level in the field of energy performance. The objective of the European directive is to make people aware of energy saving opportunities and also to stimulate them to take measures themselves.

The EPBD is a directive under which all European countries are required to improve the energy performance of buildings. There are no specific targets for the renovation of existing buildings, but local authorities should develop policies to stimulate the transformation of buildings into very low energy buildings and reduce CO_2 emissions.

Local Objectives

With the EPBD, high sustainability objectives have been set. However, due to the economic crisis, government policy and coalition agreements, there is less money to spend. The stricter focus on energy savings and the diminishing budgets resulted in an increasing need to review the Zoetermeer policy for building renovations.
The local council decided that MRECZ should work on an approach to inventories lucrative sustainable measures and prioritize them by return of investment. Also should be researched if alternative forms of financing are necessary to realize these sustainable measures and which methods for finance there are available.

Constraints

The constraints which apply while working on the Greenov project and the renovation of De Veur sports complex are divided under three different aspects; 'Economical', 'Time' and 'Users & Occupancy'.

Economical

The Greenov project is co-financed by the European development fund from the INTERREG IVB program Northwest Europe. For the Greenov investing partners there is an extra budget. The renovation work will be co-financed for 50% with a maximum of € 300.000,-.
If there is a direct relation between the considered energy reducing measures and planned maintenance measures MRECZ could enlarge her renovation budget by including budgets that were set aside for these planned activities.

For deciding which sustainable measure is lucrative, and which are not, the principles of Total Costs of Ownership (TCO) will be taken into consideration. Which means that next to investing costs all the costs which come with owning and or managing a building will be part of future calculations.

Time schedule

Because of its public function De Veur sports complex has to do with certain opening times. During the day, but also in the evening and the weekend the building tenants practice their activities and it is not possible to cancel any of these. The only time that the sports complex is closed for a consecutive period of time is during the summer vacation. During this vacation De Veur sports complex is closed for five weeks.

Sustainable measures that have consequences for the continuing building processes, or which can bring the continuity of building processes at risk, can only be carried out during the summer vacation when the sports complex is closed.

In the year of 2014 De Veur sports complex will be closed for an extra four weeks. This are the weeks for the start of the summer vacation 2014. In the period of July and August 2014 the activities in De Veur sports complex will be cancelled for nine straight weeks.

Users & Occupancy

The renovation of De Veur sports complex focuses on these parts of the building were the most energy is consumed. Which is in the main building were the activities sports and swimming take place.

The building extension will be considered as 'not a part of the renovation' and will be opened during the nine weeks that the rest of De Veur is closed. Also the building managers will be using their offices during these nine weeks. They are located in the main building nearby the building entrance.

The tenants in the building extension make use of the same central facilities for electricity and gas as the tenants in the main building. The contractor has to apply temporary arrangements to ensure the tenants of the presence of these facilities during the nine weeks of renovation.

Project Approach

Zoetermeer translated the long term ambitions for the reduction of energy losses and CO_2 emissions into four project objectives (see former chapter three 'Objectives & Constraints'). During the several phases of Greenov and the renovation of the investment project Zoetermeer worked on achieving these objectives. To give a clarify description of how this is done the actions were divided to the project phases as described in the next paragraphs.

Design Phase

In the designing phase Zoetermeer worked with a structured program on creating a scenario for the sustainable renovation of De Veur sports complex. From this scenario the municipality developed a preliminary design and started the tender process.

BTA

In the year of 2012-2013 Zoetermeer organized two 'Business Technology Accelerator (BTA) sessions'. For participation in these sessions Zoetermeer invited project developers, consultancies, engineers, institutes, and other parties with an expertise in the field of sustainable renovation. For two days Zoetermeer and the experts brainstormed on the different aspects in the preservation of buildings and energy reduction and projected it on the Greenov investment. In this two day session the participants created five scenario's for the renovation of De Veur sports complex.

The experts attended the BTA sessions for free and approached this issue without any guarantee of further involvement in the Greenov project. For some this approach is experienced as odd and unusual. Because in the traditional working processes people are

not used to sharing knowledge for free. However, this method does have a certain added value. Corporation forces the experts to start thinking outside their own frame of reference. The exchange of ideas, knowledge and experiences creates awareness for energy saving opportunities, and is also a change for the experts to network, gain information and learn from others.

- By stimulating the exchange of knowledge and expertise during the BTA sessions the MRECZ created awareness for energy-saving opportunities. Not only did the MRECZ worked on fulfilling her ambition for creating public awareness. During these sessions Zoetermeer and the experts created five scenarios for the energy-efficient renovation of De Veur sports complex.-

Image 4: BTA Session (source: S. van der Tas -Municipality of Zoetermeer)

LEAN

MRECZ selected a group of experts from the BTA for further participation in the designing phase as a part of the 'LEAN designing team'. These experts got the task to take these five scenarios from the BTA as a basis to create one final scenario for the sustainable renovation of De Veur sports complex.

When deciding which measures should became a part of the final scenario the experts needed to consider the balance between the '3 P's'. People, Planet, Profit (The 3 P's) is a term used in the sustainable development. Its definition is that in each project the three elements should be in balance to make a development sustainable.

To create this balance between the three P's MRECZ decided to start a 'LEAN' procedure with the BTA experts. LEAN is a management philosophy and a project approach for creating value and eliminating waste. The idea behind LEAN working is that when a problem gets centralized and the initiator is getting rid of the fences between the parties involved the quality of a product improves, the execution times gets shorter, and support for chosen solutions will be created.

The experts that were chosen for participation in the LEAN designing team all have a various profession. Their knowledge was combined with that of the municipality of Zoetermeer who also had some employees participating in the designing team. Internal and external involvement in one team so that all the relevant subjects as techniques, energy reduction, occupancy, managing and maintenance, tender procurement, and the (long term) costs effects could be considered in the process of decision-making.

Zoetermeer and the LEAN designing team created a preliminary design for the final scenario for the sustainable renovation of De Veur sports complex. Measures of this scenario will be described in the following chapter five 'Sustainable renovation'.

Image 5: LEAN designing team (source: S. van der Tas – Municipality of Zoetermeer)

- With the LEAN designing team Zoetermeer developed the final scenario for the renovation of De Veur sports complex. Because of the corporation between the involved parties also a lot of knowledge and expertise was shared. Leading to more awareness of energy saving opportunities.-

Total Costs of Ownership

In traditional working methods most construction projects are driven by investment budgets with almost no interest for the cost effects of choices on the long term. In practice this often led to higher costs in owning a building (operational costs). Because if the operational costs are considered over the total life span of a building they are about five times higher than the initial construction and design costs. A misleading fact which starts to explain itself when one starts looking at the life cycle costs effects when considering which scenario is less expensive (on the long term).

Approaching a construction project while taking into account the costs effects before, during and after the construction process is according to the principles of 'Total Cost of Ownership (TCO)'. Zoetermeer applied the TCO principles in her LEAN designing procedure to calculate the long term costs effects of the sustainable measures which were recommended in the BTA and that of the planned maintenance measures. The calculation was set out over a timeline of 25 years. This is when the next large-scale renovation takes place.

The LEAN designing team and Zoetermeer calculated the long term costs effects of measures and prioritized them by return of investment. In which the reduction of operating (energy) costs was leading. During the design phase the team created a sustainable scenario for renovation of the sports complex which is a combination between the suggested sustainable- and the planned maintenance measures.

-Besides creating an energy-efficient scenario for the renovation of De Veur sports complex, Zoetermeer also experienced the benefits of applying the TCO principles in her project. With this tool Zoetermeer fills in the local objective to inventories lucrative sustainable measures and prioritizing them by return of investment.-

Tender procurement

With the advice from the experts of the LEAN designing team Zoetermeer choose for applying 'the Best Value Procurement' in the tender process. In the process of Best Value Procurement men goes for the highest value for the lowest price. The concept is about valuing a task first on its quality and then on its price.

Zoetermeer invited four contractors with and overall expertise to bring out an offer for the sustainable renovation of De Veur sports complex. The tenderers were selected through a non-price based process. The tenderer with the 'most suitable' operating procedure was granted the task. The party which was considered to have the most suitable operating procedure was the one who:

- offered the best procedure for managing the short implementation phase;
- had the best results for recognizing and dealing with risks and changes;
- had the best procedure for dealing with the presence of building tenants during the construction phase.

Zoetermeer selected the party 'Hellebrekers Technieken' for the renovation of De Veur sports complex and started a so called 'concretisation phase' with Hellebrekers Technieken. During this phase Hellebrekers Technieken works on finalizing the design for building renovation.

-The importance of the set constraints were a reason for Zoetermeer to choose for the process of Best Value Procurement. The presence of the building tenants and the short

implementation phase are so important that Zoetermeer chosen to prioritize these constraints over the investment budget.-

Concretisation Phase

In the concretisation phase knowledge and expertise of the contractor was combined with that of Zoetermeer and the LEAN designing team. One of the benefits of early contractor involvement is that the contractor's unique understanding of construction processes was used to optimise the design for renovation. Together with Zoetermeer and the LEAN designing team Hellebrekers Technieken worked on finalizing the final design during this phase.

-Involving the contractor in the designing phase and making him part of the designing team results in shorter construction periods and reduces impacts during construction. This gives Zoetermeer more guarantee that the renovation work is done in time and that it has the less possible impact on its tenants as is described in the constraints.-

Construction Phase

In the construction phase the contractor implements the sustainable measures from the final design. The contractor works with an 'UAV-gc' contract. In this corporation form the contractor works on the realization of the work and has the responsibility for a correct performance of implementing his task.

In the construction phase the contractor applies temporary arrangements to ensure the facilities for gas and electricity. This is done so that the tenants in the building extension and the building managers in the main building can continue to practice their activities during the nine weeks of renovation.

During the construction phase the contractor implements energy meters on several places in the sports complex. The energy meters are used during the operational phase to make energy flows manageable (see 4.4. 'Operational phase').

- The construction phase is all about putting all of the results from the earlier phases into practice. The contractor works on fulfilling one of the Greenov objectives; 'The sustainable renovation of the Greenov investment project'. During this phase all the other objectives and constraints are relevant.-

Operational Phase

By implementing energy meters and data loggers it becomes possible to get more information of the buildings energy performance (also from another location). Applying tools for energy monitoring gives Zoetermeer the capacity to analyse the buildings performances, intervene in processes when necessary, communicate building performances and manage the building performances through the years.

When the renovation of De Veur sports complex is finalized the results of the renovation will be presented on location with an application named the 'Energy dashboard'.
Screens in the sports complex will present the building performance and show information about the reduction of energy and CO_2 emissions and give insights in the amount of energy that is produced by renewable energy sources.

The results on the energy dashboard will not be presented in kWH or m^3 but in percentages, number of households or light balls and driven km's in an electric car. So that the information on the energy dashboard is also understandable for the non-technical, the elderly and/ or children that visit De Veur sports complex.

Image 6: visualizing the sustainable results of renovation (source: INNAX)

- Energy monitoring gives the municipality the tools to work on reducing the energy use of her buildings, reduce energy costs and reduce CO_2 emissions. It is a practical tool that Zoetermeer can use in achieving her ambitions for reducing energy and working on a sustainable city. Also there is the possibility to use the results of energy monitoring to create public awareness. Visualizing the results of the project results will make building tenants and it users more aware of the benefits of investing in sustainable renovation and increases the change for more public investments. –

Following chapter five 'Sustainable renovation' describes the measures that were chosen for the sustainable renovation of the Greenov investment project; De Veur sports complex.

Sustainable renovation

Energy measurements inside De Veur sports complex have shown that the swimming pool is responsible for approximately 61 per cent of the yearly energy consumption of this building. This, and in combination with the TCO calculations, shown that investments for this object are most cost efficient when they are invest in the replacement of installations for heating and climate control. Therefor most of the measures which are chosen for the final design are investments for replacement of technical installations.

Construction & Roof

Image 7: Heat pipes placed at the roof of a swimming pool (source: DWA)

In order to place 100 square meters of 'heat pipes' on top of the swimming pool the roof will be constructively adjusted. Adjusting the roof was a necessary investment because earlier

calculations shown that the roof had no overcapacity for placing these type of solar system. The solar system generates warmth which will be used for preheating the water for the showers of the sports- and swimming hall. When there is not enough demand for the use of produced warmth the residual warmth will be led to the heating system. Pre-heating the water with renewable energy reduces the use of fossil fuels and CO_2 emissions.

In the sports hall there is more of a demand for cooling. To reduce the energy this is needed for cooling this part of the building Zoetermeer chosen for a white reflecting roofing material. The reflecting capacity has several advantages in contrast to the traditional waterproofing. The new material reflects the warmth from the sun with a reflecting efficiency of 91%. This has a cooling effect on the rooms underneath, reduces the need for cooling and lowers the building energy consumption.

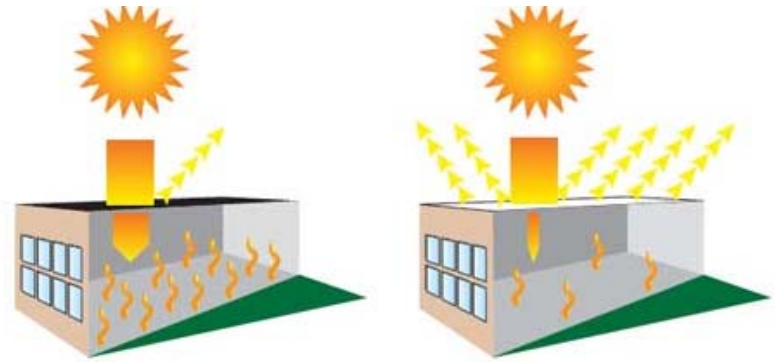
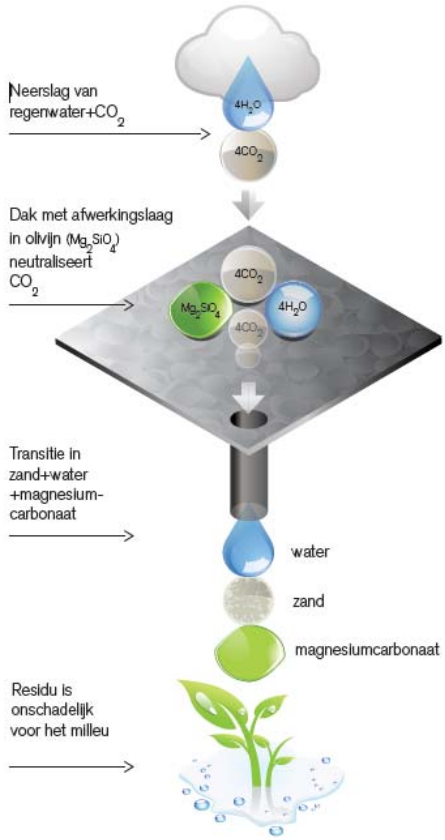


Image 8: Reflecting capacity roofing material (source: Derbigum)



The roofing material that is placed over the sports hall exists of Olivine and has the capacity to contribute to a better climate by neutralizing CO_2 from the atmosphere.

When it rains CO_2 from the atmosphere comes in contact with the roof. This causes a chemical reaction that neutralize the CO_2. The residual product that is left over is not harmful for the climate.

Image 9: Process Derbicolor FR (Source: Derbigum).

Heating & Ventilation

During renovation Hellebrekers Technieken works on several tasks in relation to replacing the existing installations for heating and ventilation. In the nine weeks that the sports complex is closed they will be working on replacing the central boiler for heating for a high efficiency version. Also all the necessary adjustments, to the pipe system, gas exhaust, and other, is a part of their task. As so, for the renewing of the circulation pumps and all its components. The new more sustainable versions are high efficient, frequency regulated, circulation pumps.

The six existing Air Handling Units get replaced for high efficiency variants. Also all the necessary adjustments to the ventilation shaft and the central facilities for heating will be done by Hellebrekers Technieken. The installation needs to be operated directly after finalizing the construction work (from week 10 – the 25th of August).

Efficiency of the Air Handling Units old vs. new

AHU 1 – Efficiency: 49,7%	AHU 1 - Efficiency: 85 %
AHU2 – Efficiency: 57,8 %	AHU 2 – Efficiency: 85 %
AHU 3 – Efficiency: Recirculation on CO_2	AHU 3 – Efficiency: 80%
AHU 4 – Efficiency: 53.5 %	AHU 4 – Efficiency: 75%
AHU 5 – Non	AHU 5 – Efficiency: 85%
AHU 6 – Non	AHU 6 – Efficiency: 75%

Image 10: Air Handling Unit (Source: S. van der Tas - Municipality).

Control Technology / Lightning

With the replacement of the climate control system there was chosen for a variant that has more switching capabilities and extended software packaged for a better managing of the energy use. The new control system has frequency controllers and there is an option for future additions to the system. The software system provides in a more efficient way in the need for warmth and ventilation.

The control panel and control systems of the water treatment were replaced for a more efficient variant. Also here Zoetermeer chose for a better controlling system that is extendable for future additions. With these investments the water treatment systems can be regulated in a more efficient way in addition to the old systems. This results in a lower and more efficient use of energy.

With a more efficiency controlling of the air systems less energy is used during the business processes. This investment also has a positive effect on lowering the level of CO_2 in the building which improved the staying in the building for the building tenants and its visitors.

Zoetermeer invests in the replacement of the conventional lightning. Through the whole sports complex the conventional lightning will be replaced for LED with moving sensors. The more efficient lightning results in a lower energy- use.

Image 11: Conventional lightning Veur sports hall (Source: Municipality Zoetermeer)

Evaluation

This chapter contains a first evaluation of the still in process project Greenov. How Zoetermeer worked on achieving the project objectives and what the results are so far. This final chapter ends with a 'look-trough' to see how this project could be an example for a sustainable, CO_2 neutral Zoetermeer in the future.

6.1 Project (first) results

TCO calculations in the designing phase shown that there was a potential for reducing the building operating costs by optimizing some of the planned maintenance measures to a sustainable scenario. The investment budget which is required for implementing this sustainable scenario is higher but when TCO calculations were used to compare both scenarios over a timeline of 25 years, until the next large scale renovation, they shown that the scenario is less expensive on the long term.

With the TCO calculations Zoetermeer and the experts effective managed to reduce the yearly energy cost with 38%.In the new scenario the energy costs reduced that much that Zoetermeer earns back her investment for the sustainable renovation of the sports complex within seven years.

For the realization of the sustainable scenario there is an additional investment needed. This additional investment is directly covered by the subsidy for investing partners. Which makes the sustainable renovation of the sports complex cost neutral.

Results into Practice

Zoetermeer achieved most of her project objectives during the early phases of the Greenov project (as is described in chapter four 'project approach'). In chapter four there is one objective which was mentioned but remained underexposed. This objective was especially selected to be described in this final chapter since there is no specific project phase it belongs to. This is the objective which is referred to:

"Develop policy for stimulating the transformation of buildings into very low energy buildings and reduce CO_2 emissions";

As described in paragraph 1.3 'Project description' the ambition for the Greenov project is more than just renovating De Veur sports complex by renewing its components and achieve an energy reduction. The Greenov project should be an example for sustainable renovation in general. Therefor the municipality of Zoetermeer approached the renovation of the sports complex as a pilot and case study to create new policy on how to fulfil the city ambitions for sustainability.

During her years of participation in the Greenov project Zoetermeer researched the approach she chosen for renovating De Veur sports complex. After putting it into practice the results were evaluated and knowing that the project is not finished yet the municipal council decided in October 2013 that the Greenov approach should become new policy for building renovations. With that decision the Greenov approach became the new vision for building renovations and part of the 'Note Real Estate'.

This notes states that when existing buildings owned by MRECZ will be adjusted, because the maintenance planning indicates it is time to, the Greenov approach will be applied. This means that in future projects applying the TCO principles becomes a standard and that issues will be approached with the attendance of market players. Not only to make use of their precise knowledge about certain cases, but also to stimulate a further development of sustainability in this working field.

Working on a CO_2 free city is a task in which the municipality is for an important part independent of the willingness of other actors. Therefor the municipality decided to stands out as an role model to create awareness for energy saving opportunities among (local) organizations and her citizens and stimulate them to take their own. The municipality decided to start sustainable renovating her municipal buildings, involve the market and show the positive results to the people involved.

In the year of 2014-2015 Zoetermeer starts with analysing the savings potential of all her buildings with a sports function. Based on its success this could result in the sustainable renovation of several municipal buildings at once, and possibly be one of the first steps of sustainable renovating the whole municipal property portfolio.

Case Study: Cinema Renovation, Noisiel, France

Author: Val Maubée

General Introduction

The Val Maubuée public engagement consists in raising the awareness for sustainable construction, through the renovation of the cinema in La Ferme du Buisson in Noisiel. The urban community "Communauté d'Agglémoration de Marne-la-Vallée / Val Maubuée" (hereafter CA Val Maubuée) is owner of the building and contractor for this operation. The CA Val Maubuée is a community of 6 municipalities in a New Town area, 30km east of Paris: Noisiel, Lognes, Torcy, Emerainville, Croissy–Beaubourg & Champs-sur-Marne. CA Val Maubuée has a rich heritage of historical and temporary architecture from various, famous architects such as Dominique Perrault, Chaix-Morel, Jean Nouvel, Christian de Portzamparc, Reichen et Robert and Bernard Huet. The maintenance of this patrimony is an important role for CA Val Maubuée and this is why the renovation of the Cinemas in the historical "Ferme du Buisson" is an obvious decision.

Time frame:

The studies started already in 2011, the construction is planned to start in January 2014 and to be completed in May 2015.

Project composition:

The project consists of a renovation of an existing cinema and an extension.

Budget:

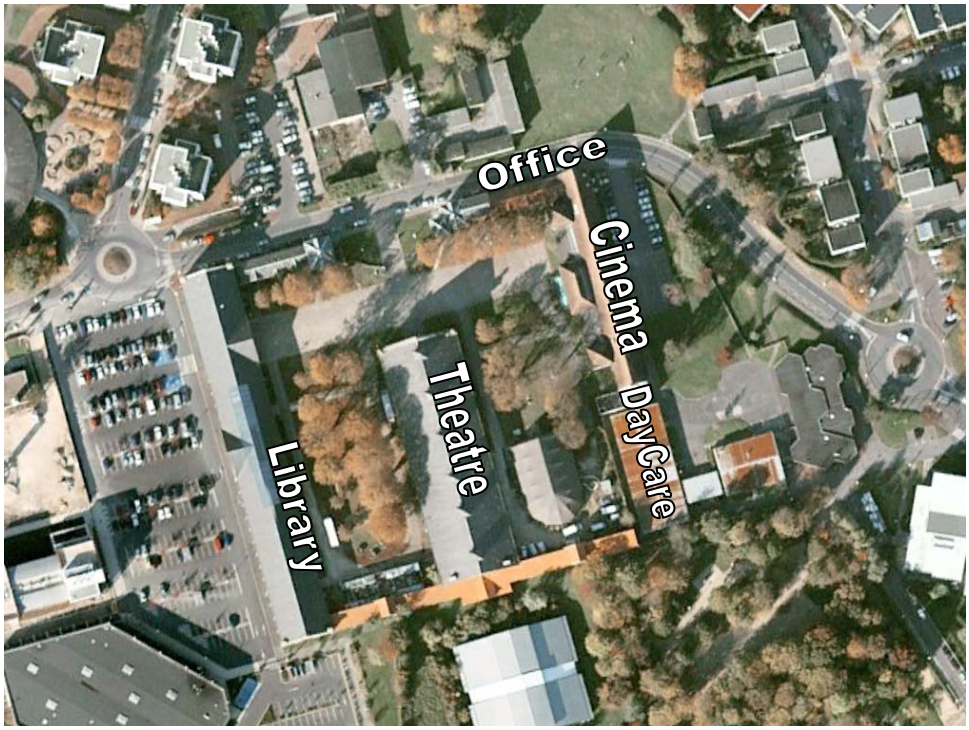
The budget voted for the construction works is 3 000 000 € and it will partly be financed by European funds.

Sustainable objective:

The project intends to reduce the Energy Consumption with 50% and the CO^2 Emissions with 75% for the renovation.

Public awareness:

An exposition open to public will be installed on site and go on during the whole construction phase.



Arial view of “La Ferme du Buisson”

Background & Context

The Cinema is located in the “Ferme du Buisson”, a historical farm building, renovated and transformed into a cultural complex with cinemas, library, exhibition hall and a theatre in 1986.

The Art and Cultural Centre is part of “Scène Nationale” (French label for public theatres and cultural centres) and the site is on the list of the Historical Monuments Patrimony since 1986. Today the cinema has got two 2 rooms for 120 and 200 seats, showing more than 200 movies during 2 500 sessions per year. With a constantly increasing public, the need for a new configuration is obvious, as well as the need to adapt the building to today’s standards regarding energy efficiency, acoustics, security and accessibility. To satisfy all the demands above, a simple renovation was no longer possible without an extension to the existing, historical building.

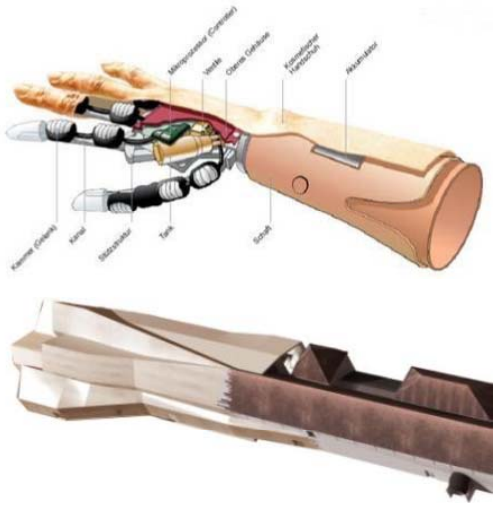
Due to political ambitions and with the aim of mixing functions, this project has also been combined with the reconstruction of a day-care centre, for children between 3 and 11 years. This project is not a part of Greenov and the building is physically and functionally separated from the Cinemas and in this chapter we are only describing the renovation of the Cinemas.
In 2011, an architectural competition was organised to generate a multiple choice of adequate projects and 4 laureates were chosen and represented to a jury. The winning

proposal "*Greffe*" was conceived by the Paris based office Randja architecture, represented by Farid Azib.

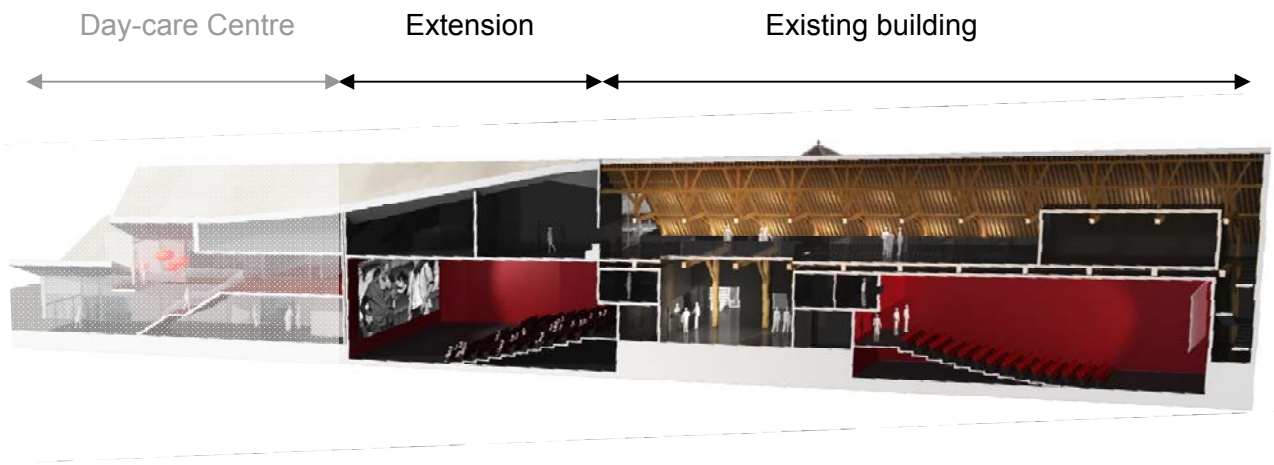
View of the cinema today

Brief Description of the Project

The winning proposal's architectural concept is based on the transplantation (="*Greffe*" in French) of a missing part of the "body" (in this case the farm building). The missing part is the "arm" (in this case the cinema extension and the new day-care centre), which is added in form of a five white "fingers", reaching out from the existing building towards the green area in the south.

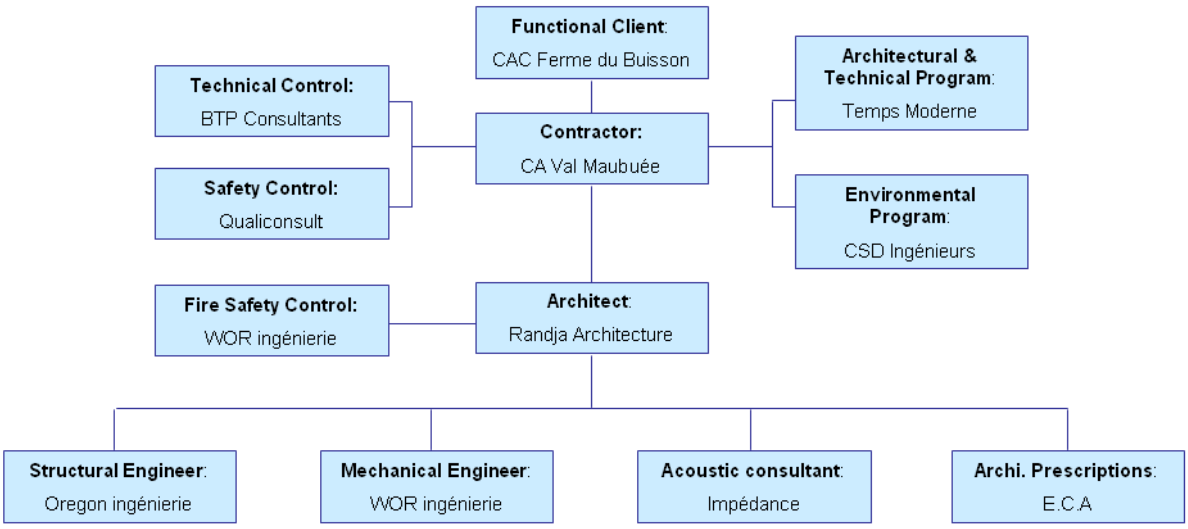


In the following section you can see how the project is composed:



The complex still contains 2 cinemas, but for 125 seats (instead of 120) and 260 seats (instead of 200), including 11 places for disabled people. The entrance hall is offering a spacious and comfortable place with a view on the historical, wooden framework.

A mezzanine will be added within the existing volume under the wooden frames, to create a space for meetings and events. The total usable area will increase from 420 to 1363m² (extension included).



Team Involved

A number of experienced people and companies have been involved during the design process. CA Val Maubuée, as a contractor has been assisted by “Temps Modernes” to set the architectural program for the Cinémas and “CSD ingénieurs” to set the environmental goals. The architect, Farid Azib (Randja Architecutre) is accompanied by a number of competent consultants and engineers (see organization chart above).

View of the cinema in the future

Sustainable Objectives

The main objective for the operation has been to proceed with an exemplary renovation from an environmental and architectural point of view, responding to the demands of the contractor and of the Greenov action plan. The energy consumption should be considerably reduced, and for the heating this corresponds to a factor 7.

Also, the CO^2 reduction is one of the main objectives, as written in the Greenov action plan. Global investment cost, sustainable materials and maintenance have also been keywords throughout the process. All objectives have been clearly expressed for the following fields for the project;

- Functional,
- Technical
- Environmental

Constraints

All building projects have to deal with a certain amount of constraints beyond the client's program and objectives. The economical budget, a fixed time frame and national & international laws are something all projects have to treat. For a renovation project, there are some extra constraints, such as the existing building volumes, the architectural & historical value and the occupancy and ongoing activities in the building.

Economical

The budget for construction works has been one of the major constraints in the project. The initial budget voted for the construction costs was estimated to 2 445 000 € (taxes excluded). A first call for tender end of 2012, resulted in a construction cost at almost 4 000 000 €. Therefore the project had to be structurally and technically optimised and the reviewed project proposal was estimated to 3 000 000 €. It turned out that the cost-optimisation also increased the sustainability of the project: less construction material is used, resulting in a less heavy construction and optimised foundations. A Ground Source Heat Pump has replaced the former proposal based on air and electricity….

Time Schedule

The initial aim was to finish the construction before the local elections 2014. This was quite a big pressure for the initial design process, leaving little time for reflection and analyse.
After poor and costly results of the first call for tender the autumn 2012, this time schedule was abandoned in order to redefine the technical solutions in the project.

National, Regional and Local Regulations (accessibility, fire, energy, visual & acoustic norms)

The refurbishment of the Cinema is officially considered as a renovation in the point of view of the thermal regulation, which means that the latest norms are not required and the Thermal Regulations :« Réglementation Thermique du 24 mai 2006» are applied (in France the standards for a new construction should follow RT 2012).

On the other hand, from a structural point of view it is considered as a new construction since the foundations are modified (a concrete slab is replacing the existing one, to assure the loads from the renovated project). This means that the latest norms are required for security, accessibility and audio-visual.

Existing Building, Layout and Available Space

The narrow, existing building shape is impossible to transform into a cinema of 250 seats, due to constraints of visual comfort and today's accessibility norms.

Therefore, the functional program has planned for an extension. This study is concentrating on the renovated part of the Cinema.

Function – Cinema

The cinema function limits the possibility of façade openings, and is making it very difficult to develop a natural cooling of the building:

- The risk of intrusion is strongly limiting the possibilities of natural ventilation during the night.
- The possibility of natural ventilation is limited because of the lack of windows and openings in a cinema, and also the acoustic constraints.
- The equipment and activity, as well as the presence of a lot of people in the cinema is increasing the need of ventilation and cooling.

Historical Values

Listed in the National List of Historical Monuments since 1986, it has been very important to minimize the impact on the existing building.
As a result, an exterior insulation of the walls has been excluded, as well as an interior insulation of the roof, in order to keep the exterior façades and the interior wooden frameworks visually intact.

Users & Occupancy

The weekly cinema program must continue during the whole construction process. A temporary Cinema has been installed in the Theatre, within the “Ferme du Buisson”, and one of the projectors will be installed there. The other projector must be packed and stored safely during the construction work, planned for a year and a special place has been found for this reason.

Initial Construction

The old farm building is constructed of 500mm rubble stone walls (plaster coated) and a beautiful wooden framework. This framework has an architectural value and shall be kept visible, in its' original condition. The foundation is a 300mm thick non insulated concrete slab and the roof consists of slate-tiles and 40mm expanded polystyrene as insulation. The entrance consists of single glazed aluminium framed doors; these glazed doors are the only external glazing in the building.

Heat losses are important in the existing building and are caused particularly by ventilation and airflow (68%), but also from bad insulation: walls (14%), roof (12%), slab (4%), glazed doors (1%), thermal bridges (1%). Improving the capacity of heating and ventilation is therefore a very important part of the renovation.

The existing equipment for heating and ventilation is consisting of a series of Air Handling Units, supplied by a gaz boiler room, which is common for all the buildings in "La Ferme du Buisson".This boiler room is situated next to the cinema building and will be demolished due to the renovation works. A new boiler room has already been constructed to supply the other buildings.

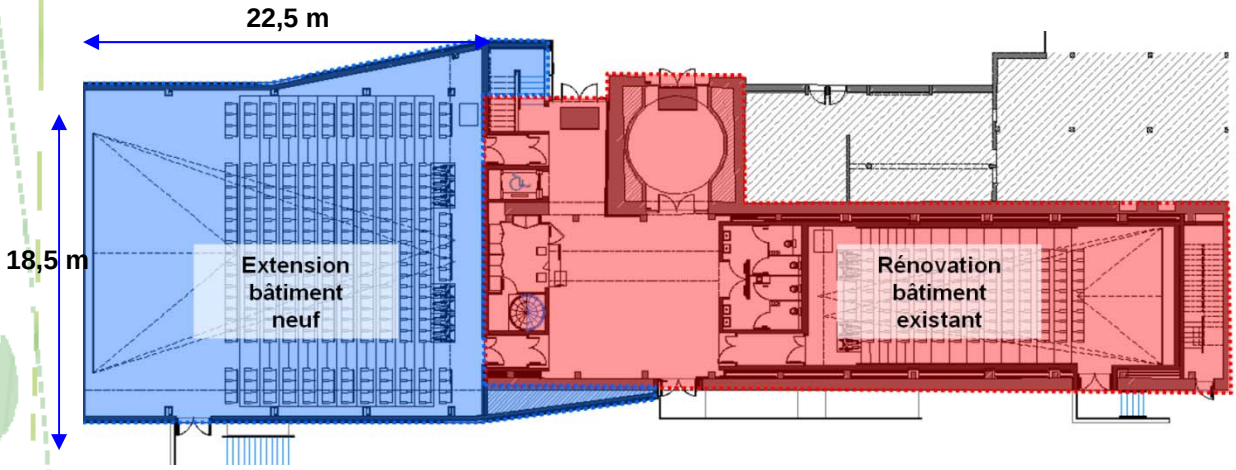
For lighting, halogen lamps are installed and for the cinema, 2 projectors of 2 kW.

- Net Gross Floor Area: - **580** m²
- Usable Area: - **420**m²
- Energy consumption: - **199.7** kWhep/m²/year (Net Gross Floor Area)
- Gas emissions: - **8** kg CO_2/m².year. (Net Gross Floor Area)
- Coefficient U: - **1.14** W/m².K (Net Gross Floor Area)
- Electricity for lighting: - **19,34** W/m².(Net Gross Floor Area)

Sustainable Renovation

In this section the project is described, as in the call for tenders, April 2013.

Architectural Layout



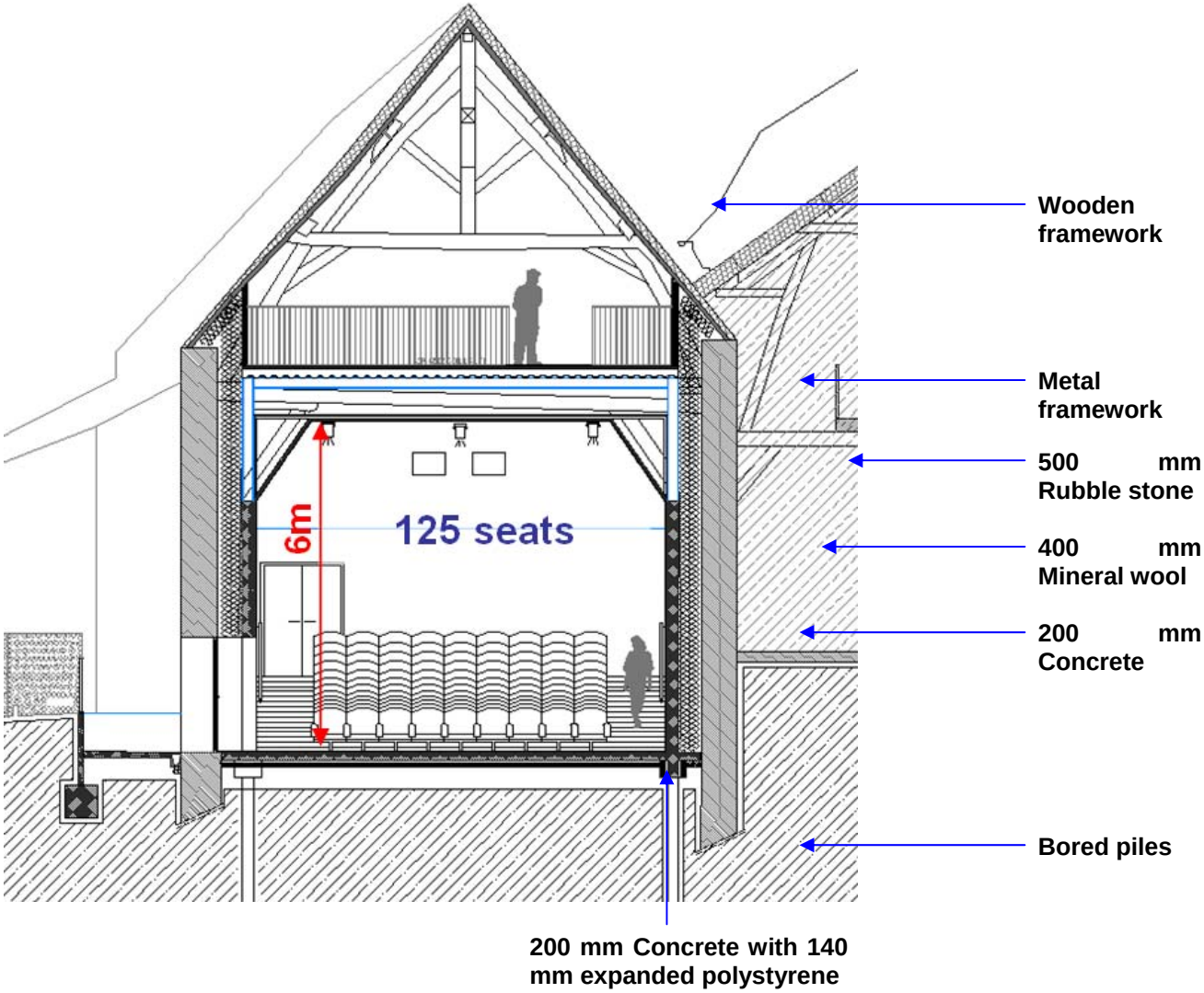
Renovation

The floor and foundations have been lowered in the whole building, to increase the height. Within the existing building volume the small cinema theatre of 125 seats is situated together with a large entrance hall. There has also been an additional mezzanine added above the cinema, to optimise space and create a lounge space. The mezzanine, offers a comfortable space, with a view of the historical, wooden frameworks. This also permits to free some space on the ground floor to increase entrance and lobby areas.

Extension

The extension consists of a building of 22,5 m (length) x18,5 m (width) x 14m (height). The extension hosts the big cinema theatre of 261 seats on the ground floor and auxiliary spaces as kitchenette, plant rooms, storage and workshops on the upper floor.

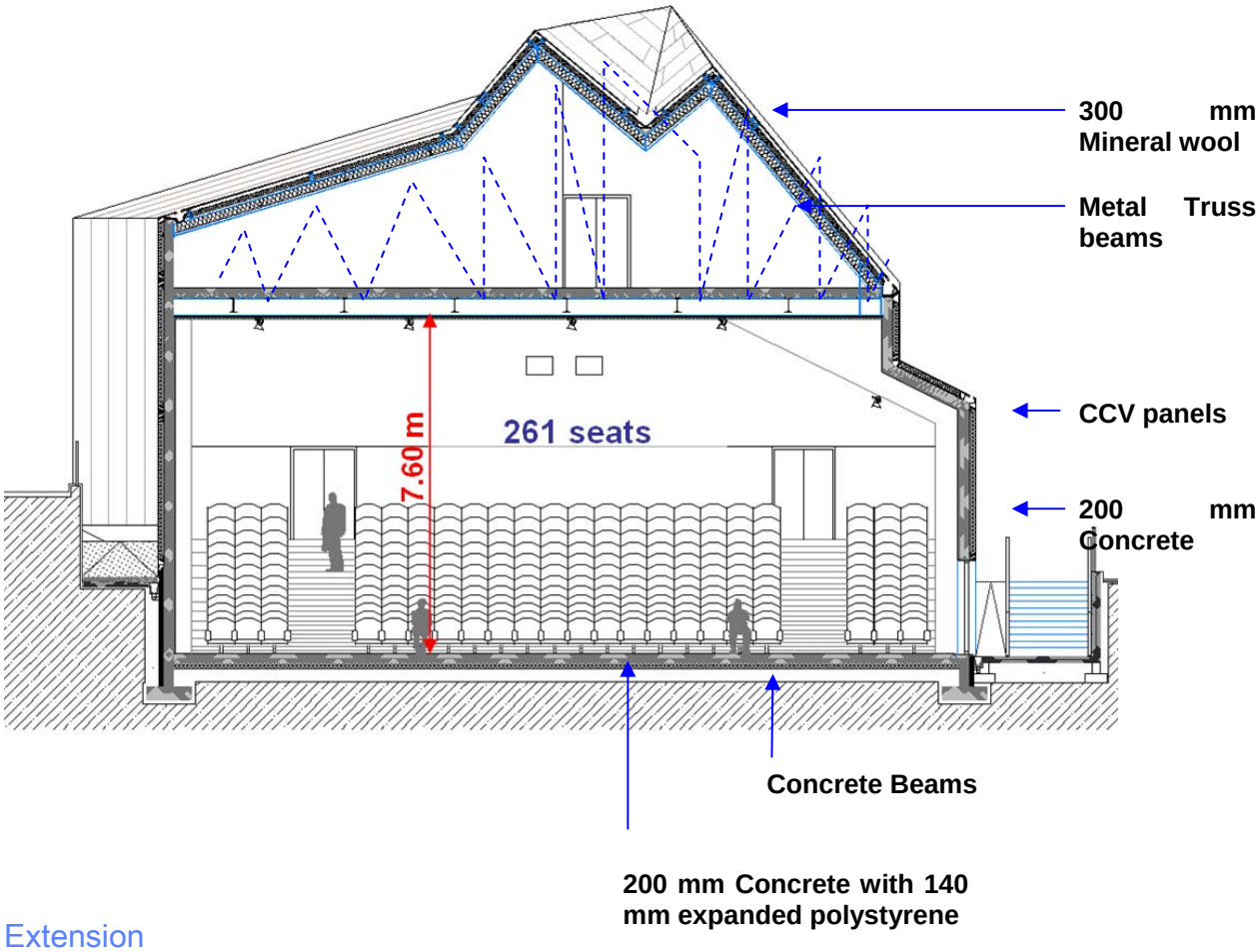
Structure & Foundations



Renovation

The existing construction of rubble stone walls (500mm) and wooden framework has been reinforced by concrete walls (200mm) and mixed concrete / metal slab, creating a “box in the box” system. This construction is completely independent from the original structure and the existing structure does not need to support any extra loads from the mezzanine added above the cinema.

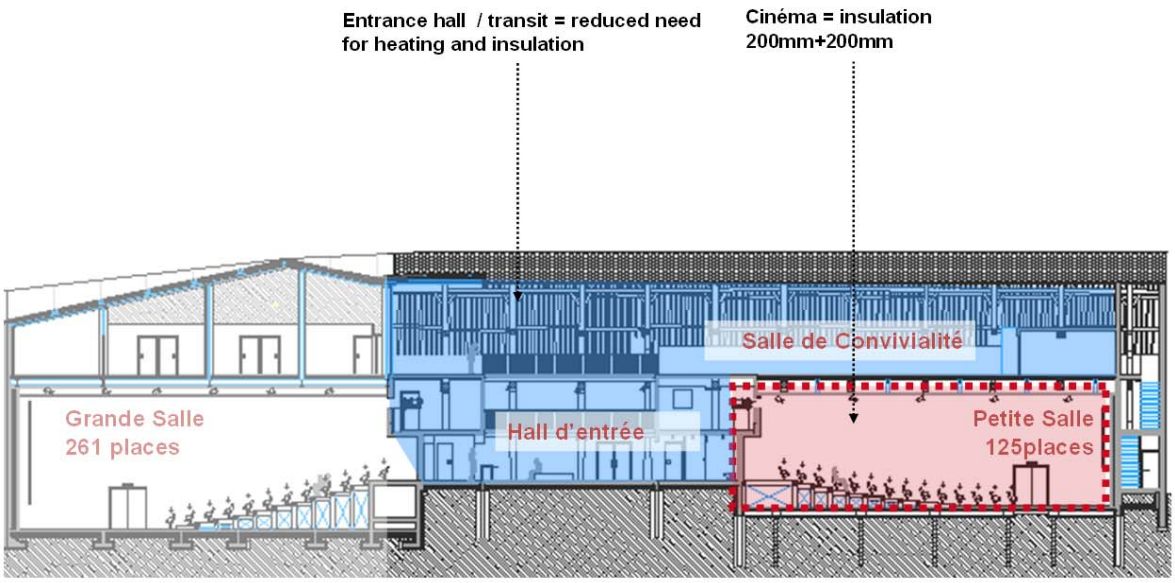
A special system with bored piles under the existing construction has been developed to support the loads of the added elements and the new ground floor slab of 200mm concrete has been created.



Extension

The extension is made of 200mm concrete walls and a metal framework to support the roof and the upper floor. The roof framework is conceived as big-size truss beams, supporting the load for the whole roof width of 18,5m. The foundation is a 200mm concrete slab on a set of bearing concrete beams.

Insulation & Glazing



Renovation

The need for insulation is very important within the cinema space, whilst the entrance hall and lounge are transitional spaces where people are moving and the need for heating / insulation is less important.

Insulation of exterior walls within the cinema will be reinforced by 200mm + 200mm mineral wool and the new foundation slab will be protected by 140mm of expanded polystyrene.
The roof insulation is a complicated issue, since insulation is most easily done from the interior and in this case this is prohibited, because of the visual aspect of the wooden framework.

An option has been studied to insulate the roof from the outside, which means that all tiles have to be disassembled and reassembled. The extra cost for this is estimated to about 200 000 €.

The glazed entrance doors have been replaced by double glazed doors with U value = 2.2w/m²C°, and completed with a second set of doors to create an airlock at the main entrance. An extra roof window has been added for fire security reasons in the entrance hall and the U value is = 1.7w/m²C°.

Extension

All walls are insulated via the CCV composite cladding panels, which includes 140mm of Polyurethane insulation. The ground floor slab is protected by 140 mm of expanded polystyrene and the roof by 200+100 mm of mineral wool.
The stairwell wall, next to the entrance is a double glazed façade with U value= 2.5w/m²C°.

Energy & Heat Source:

The existing gaz boiler room, supplying the entire Ferme du Buisson, has been removed from the cinema building and replaced by a water-based, Ground Source Heat Pump (GSHP), covering the need for heating. The GSHP is connected to vertical sensors, capturing the calories in the ground, heating up a closed loop of pipes. The system is reversible, with the possibility to evacuate calories during summer to cool down the building.

- The power to capture during winter is: about 101 kW.
- The power to evacuate during supper is: about 100 KW.

This Ground-coupled heat exchanger has a CoP (Coefficient of Performance = Quantity of produced heating / Quantity of consumed electricity) of 4.13.

Heating & Ventilation:

The GSHP is supplying radiators and the Air Handling Units (AHU), situated on the upper level. Traditional radiators have been chosen instead of a low temperature system (as for example floor heating), which often turns out to react to slow to temperature changes and could be a problem for well-insulated buildings. The existing AHU's are replaced by more efficient units, with heat-exchangers. The units are connected to a system of perforated ductwork in the ceiling, permitting to "softly" distribute the air into the different spaces. The air is captured and extracted into a ductwork situated under the seats. All devices are connected to a monitoring system, perfectly parameterized to fit and reduce the energy need and CO_2 detection will be a part of the system.

Capacity of Air Handling Units;

- AHU Cinema 1 (new extension) :
    - Flow rate : 5000 m³/h

    - Efficiency : 90.2 %
- AHU Cinema 2 (renovation):
    - Flow rate : 2250 m^3/h
    - Efficiency : 90.8 %
- CTA Entrance Hall (renovation):
    - Débit : 4000 m^3/h
    - Rendement : 90.2%

Additional radiators are installed in auxiliary spaces.

Electricity and Lighting:

The building is connected to the public electricity network to supply all systems, except for heating. All devices are equipped with low consuming fluorescent lamps and connected to motion detectors. The light and energy needed is also varying on the presence of natural daylight.

Installed Power;

- Cinemas : 6.53 W/m²
- Entrance Hall : 3.97 W/m²

Figures

Renovation

- Net Gross Floor Area: - **862** m²
- Usable Area: - **645** m²
- Energy consumption: - **90.3** kWhep/m²/year (Net Gross Floor Area)
- Gas emissions: - **2** kg CO_2/m².year. (Net Gross Floor Area)
- Coefficient U: - **0.563** W/m².K (Net Gross Floor Area)
- Electricity for lighting: - **5.25** W/m². (Net Gross Floor Area)

Extension

- Net Gross Floor Area: - **802** m²
- Usable Area: - **718** m²
- Energy consumption: - **99.1** kWhep/m²/year (**based upon usable area**)
- Gas emissions: - **2** kg CO_2/m².year(**based upon usable area**).
- Coefficient U: - **0,293** W/m².K (**based upon usable area**)

- Electricity for lighting: - **5.25** W/m².(Net Gross Floor Area)

Evaluation

Since the project is not constructed yet, it is impossible to make an evaluation of the final output. What we can do at this stage, is an intermediate evaluation between the initial building and the architectural project as it is in the call for tender.

In order to do the final evaluation between the objectives and the constructed building, a follow up will be done during 3 years after the construction is completed.

According to recent follow-up studies, the real energy consumption is almost always superior to the predictions made during the project studies. This can depend on many factors, such as construction failures & consumption behaviour.

To deal with this, we will aim to educate the construction companies in air sealing of the building, and to create a special post for monitoring the building and its consumption.

Improvements Before / After

- The Usable Area of the building is increased with +324% (+943m²)
- The Capacity of the cinema has increased with +20% (+66 seats)
- The Energy consumption is supposed to be reduced with - 55% (-109.4 kWhep/m²/year).
- The CO_2 and other gas emissions are supposed to be reduced with - 75% (-6 kg CO_2/m².year)
- The U value is supposed to be reduced with - 51% (-0.577 W/m².K)
- The electricity consumption for lighting is supposed to be reduced with -73% (-14.09 W/m²)

Conclusion

Today we have the techniques to implement sustainable, efficient refurbishment, but we still have to make economical and administrational efforts to be able to do it on a large scale.

This study presents a range of technical, mechanical and software solutions available to reduce energy consumption and CO^2 emissions in a significant way. It also evokes some of the difficulties on developing this in practice and how we are limited depending on; procurement regulations, financing, technical regulations, human factors and political decisions.

As stated already in the beginning of the Greenov project 5 years ago, local authorities still need to continue to play the role as a generator of exemplary actions and put in the money to spread the existing techniques.

With this project and the joint study, we hope that our experience will spread via the Greenov cluster and that the actors: SME's, local authorities, institutions, will continue to advance together in the field of improving buildings capacities.

VAL MAUBUÉE
AGGLOMÉRATION DE MARNE-LA-VALLÉE

adec
Technopole

gemeente
Zoetermeer

ASHFORD
BOROUGH COUNCIL

ENTP

codema
Dublin's Energy Agency

CLUSTER ECO CONSTRUCTION

EIVP
ECOLE DES INGÉNIEURS DE LA VILLE DE PARIS
ECOLE SUPÉRIEURE DU GÉNIE URBAIN

impulse.brussels
never stop asking

This project has received European Regional Development Funding through INTERREG IV B.

nwe
INTERREG IVB