3encult

EFFICIENT ENERGY FOR EU CULTURAL HERITAGE

Recommendations

for Local Governments

Integrating energy efficient retrofit of historic buildings into policy and planning

(D7.10 - Recommendations for local governments for integration into municipal policy, planning and regulation)

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0 Executive Summary

The refurbishment of historic buildings to lower energy demand is important, possible and economically feasible. This guide addresses local governments, exploring how they can address energy efficient historic building renovation in a **comprehensive, strategic, integrated and effective approach** – considering historic buildings and districts, exploring sustainable energy and sustainable development at local community level.

There are different options that can be used in finding suitable ways to balance building protection requirements with the need for optimised energy efficiency – from design to technology and materials. Typically each building is unique and needs its own tailor-made solution, selecting form a range of existing possibilities. **Yet, what could be done to achieve change on a wider scale?** The overall approach taken by the municipality at a strategy, policy, and regulatory level can help to address many historic buildings, going beyond an ad hoc approach to a comprehensive vision for the local community, supporting the maintenance (or even reclaiming) its cultural heritage and changing energy use to more efficient and sustainable approaches.

Energy prices are rising. Climate change is a reality. Sustainable development and green growth have been identified as global priorities. It is understood that sustainable energy – energy conservation, energy efficiency and the transition to renewable energy – is at the heart of these issues. Further, considering that one can energy efficiently retrofit old buildings, that these are a core tourist attraction in many European cities, and that funding is increasingly available for local sustainable energy roll-out, this is an area where local governments can and should engage.

This document outlines how a local government in Europe, as the owner of historic buildings and monuments, as the developer of local strategy and policy, and as administrator and regulator of its geographical area, can engage.

1. Introduction

Energy efficiently retrofitting cultural heritage provides the opportunity for a wide spectrum of actions with social, cultural but also economic impact at the local community level. This makes it an **interesting area of engagement for local governments as the leaders and administrators of their local community**. They have the mandate and interest to stimulate local sustainable development, making their communities liveable and supporting good quality of life for citizens and businesses alike,(jobs, services, etc)..

The built environment and energy are at the heart of these discussions today, exploring ways to optimise energy efficiency and moving away from fossil fuels – **towards a low carbon economy**. Many European cities and towns are exploring how to achieve this, implementing technologies and stimulating behaviour, as outlined in their Sustainable Energy Action Plans (SEAPs) or Climate Plans,

Ideally, these **plans need to be closely linked to, or integrated in the Urban Master Plan, the Sustainable Development Plan and any other key policies** outlined for the local community. This will help to optimise planning, implementation and monitoring. Considering that the policies are closely inter-connected to the community´s identity (e.g. maintaining and promoting historic city centers, monuments and tourist attractions) and pro-active planning and action can have a beneficial impact on the local service industry, business and stimulating green growth**.**

Local leaders can trigger and intensify discussions, outline a clear direction and strategy for the community, and monitor implementation by the local government when dealing with these topics.

To act as a driver for such strategies **local government representatives need to make informed decisions** – based on an understanding of what is possible and not possible. This is also the case for historic buildings and monuments, as more complex building types to be addressed. Although they make out a small percentage of the total building stock in a city or town, their value go far beyond their current use as monuments, office space or residences. These buildings are the heart and should of our European cities. Visitors from around the globe flock to see and admire them. They bring an income into the local economy, purely by existing.

Decisions about energy efficient retrofit can (should) ideally be linked to the broader municipal strategy, e.g. the Urban Master Plan and the Sustainable Energy Action Plan (SEAP) or Climate Plan.

This guide offers a **brief summary of recommendations for local decision-makers** on the integration of energetic retrofit of historic buildings into municipal policy, planning and regulation.

The input comes from the **3ENCULT project** (**Efficient Energy for EU Cultural Heritage)** , a project implemented in the 7th Framework Programme (FP7) of the European Commission (EC). It bridges the gap between the conservation of historic buildings and dealing with climate protection. While this may seem like a contradiction in terms, it is clear that historic buildings have a higher chance of “survival” where energy efficiently retrofitted.

The 3ENCULT research activities are accompanied and stimulated by the involvement of eight case studies in different countries and climatic zones, from different historic eras. In each case study an **assessment of the needs** was made and then **suitable strategy or technical solutions were selected** for delivering the building energy retrofit. The aim is to ensure that the project results are relevant to the majority of the European built heritage /with

residential and social functions) in urban areas. The main focus in this guide is on the building envelope, windows, ventilation, passive and active energy efficient solutions.

2. Strategic relevance

In the EU27 14 percent of buildings were constructed before 1919 and 26 percent before 1945. Although only a certain amount of these buildings are protected (i.e. listed buildings), they have historical significance and should still be treated with care.

From past to future – it is important to consider:

- Preserving the historic building (also in this context consider the impact of climate change on buildings – more intense rainfall, flooding, droughts, heat waves, rising sea level)
- Reducing the impact on climate change (i.e. reducing ´greenhouse gas emissions)
- Keeping maintenance and energy costs reasonable (also considering that energy costs are rising).

Why do buildings have a higher chance of survival when energy efficiently retrofitted?

- Buildings are properly maintained and managed as living spaces (or used space),
- Their focus is on user comfort (or comfort of heritage collections) yet maintain historic interests,
- Structural protection is supported (relevant when considering the impacts of climate change),
- Such buildings have reduced energy needs, also lower energy bills.
- They can benefit from a change in users´ behaviour, both in the building itself and within the area where they are located

Buildings are considered as one of the main energy consumers in the urban context[1]. The energy demand of buildings in Europe is as high as 40% of the total energy demand. Creating buildings equipped with integrated sustainable energy solutions is the key to achieve more energy efficient and more environmental friendly buildings[2].

Sustainable energy is defined as: “Energy production or consumption of electricity, heating and cooling, which has no or limited impacts – compared to fossil fuels or nuclear energy – on human health, the functioning of local and global ecological systems and the environment. Sustainable energy is the combination of energy savings, energy efficiency measures and technologies, as well as the use of renewable energy sources, such as solar energy (passive and active use), e.g. solar thermal, photovoltaics, wind-, bio-energy, geothermal energy, small hydro power, wave and tidal power, as well as hybrid systems. Its objective is to provide energy security (sufficient, safe, affordable) for the present and future generations.“[3].

[1] Troi, A., Historic buildings and city centres – the potential impact of conservation compatible energy refurbishment on climate protection and living conditions, Proceedings of the International Conference Energy Management in Cultural Heritage, 6.-8.4.2011, Dubrovnik, 2011

[2] Tomás, N,, Carvalho, A., Coelho, D., Renewable Energy Integration in Buildings: A Case Study in Portugal, International Conference on Renewable Energies and Power Quality (ICREPQ’10), 23th to 25th March, Granada (Spain), 2010

[3] Source: Your LG Action Guide - to local climate and sustainable energy action - http://www.lg-action.eu/?id=8186

Role of local governments

Local governments can play a central role in this process. This could include any of the following roles:

- **own or maintain a large number of buildings,** probably also historic buildings (even listed monuments);
- **shape local strategy and policy** (e.g. sustainable development, climate protection, job creation, ..);
- **deal with urban planning and updating the urban master plan**;
- **outline and enforce building regulations** (also protection and maintenance of monuments);
- **plan the sustainable energy transition in the community** (e.g. Sustainable Energy Action Plan);
- **reducing energy demand in municipal buildings and switching to renewable energy**, e.g. green electricity; and
- **encourage the local community to engage in the sustainable energy transition** (stakeholder action).

Addressing sectorial aspects such as promoting tourism, where cultural heritage can be a substantial contributor to the local economy, also falls within the mandate of the local government.

a. Guide focus

The role of this guidelines collection is to share, with local government representatives, recommendations on integration of energy efficient retrofit of historic buildings into municipal policy, planning and regulation. Using the 3ENCULT project results, the guide aims at providing inspiration and ideas, triggering discussion and interaction between the public and private sector.

Specifically aimed at local decision-makers who are not necessarily experts on sustainable energy, urban planning and buildings, this set of recommendations will help to inform local leaders who are involved in municipal decision-making processes relevant to the built environment, urban planning, the energy sector as well as tourism and sustainable economic development.

Historic buildings are large part of the urban texture of Europe. They symbolise a link to community´s past and a manifestation of cultures, they represent social identity and a growing economic potential for the service sector. They are also an important facet constituting Europe's singularity and providing a source of strength dynamism and creativity (Horizon 20202 challenge 6.3).

The city of the future is "**smart**": reduced energy demand and emissions, better quality of life and less costs both economic and for the environment. Investing in energy efficiency has become increasingly urgent in order to respond to the steep growth curve of energy prices, and **energy security** is a main item in European agendas. European cities past can play a proactive role in their future.

Furthermore, the Kyoto Protocol on global warming proposed, among other adopted commitments, to make new and existing buildings "more sustainable", by retrofitting or upgrading, and improve their energy efficiency through the best cost / effectiveness ratio. The adjustment of the older built heritage could reduce CO2 emissions and energy costs between 42-46%. It needs to be kept in mind that retrofitting is undoubtedly more complex

than a new realization, since the necessary measures imply a differentiation and an articulation of solutions sometimes complex and integrated with each other.

In the case of buildings subject to cultural heritage protection, the situation is even more complex, but the sustainable redevelopment has several environmental advantages in addition to create in the local communities a sense of pride and awareness of its assets.

Historic buildings protection and energy efficiency are becoming a more effective combination that they have ever been, and thanks to technology and the advancements of research, bridging the gap between them becomes easier and more efficient. Energy-saving oriented renovation can help to "adapt" the irreplaceable heritage of cities to a continuously changing world, and Councils have the possibility to take the lead in the developing strategies that allow community to protect these cultural and economic assets.

The first step is through **commitment** at political level. Protecting historic building becomes part of strategic thinking **climate change mitigation and adaptation**, and heritage protection become part of the larger framework of the energy and climate strategy of the city. These interventions, discussed with the participation of all relevant stakeholders including conservationists, and planning officers, building owners and occupants, and the citizens, become an optimal opportunity for inclusion of the citizens in the public, and for **promoting** the work and the strategies implemented by the local government.

Energy efficiency retrofit of heritage could become a quite beneficial selected action to implement into a **Sustainable Energy Action Plan**, as it would help facilitating the reaching the 20-20-20 target (reduction of emission, increase of renewable by 2020) while triggering a wide **social impact**. Retrofitting of historic buildings has a beneficial ripple effect on the surrounding areas and it can be an effective drive for the reclaim of entire neighbourhoods, especially when citizens are involved in the decision process.

Giving a new energy-efficient life to historic buildings means reducing the costs of maintenance and increase the comfort of the occupants and with it its **real-estate value**. Energy efficiency retrofit allows finding new optimal uses, allowing heritage to acquire a new life and a new function.

European cities are to deal with growing **tourism and service industries**, which make of cultural heritage an important valuable attraction that needs to be preserved and that generates revenues for the local community. Historic buildings need to be from one hand protected from the impact of mass tourism, and at the same time adapted to level of energy demand that was not foreseen. Energy efficiency retrofit is a great start for living up to this new challenge.

This guidance aims to provide guidelines for the integration of historic buildings into municipal processes and outline of energy, climate strategy and master plan of the city. It addresses local political representatives and technical staff who work with urban planning, energy action plans, climate strategy, monument preservation and to stakeholders relevant to the process, including: tourism board, real estate and monument protection agencies.

b. The European Framework

In the Energy Efficiency Plan 2011[4], the European Commission states that energy efficiency is the most cost effective ways to enhance security of energy supply, and to reduce emissions of greenhouse gas and other pollutants. This is why, in 2007, the EU has set itself a target of saving 20 percent of its energy consumption by 2020.

[4] http://ec.europa.eu/energy/efficiency/action_plan/action_plan_en.htm

Buildings currently represent almost 40% of total final energy consumption and, therefore, they can make a crucial contribution to these targets, therefore a great potential lies in the built sector.

The European Commission´s strategy focuses on instruments to trigger the renovation process in public and private buildings, and on ways to improve the energy performance of the appliances used in them and to foster energy efficiency in households and the industry. Higher requirements are foreseen for public authorities purchasing goods (e.g. office appliances), services (e.g. energy) and works (e.g. refurbishment of buildings). Due to the large volume of public spending[5] (17% of GDP or roughly €2,000 bn and public buildings are about 12% of the EU build up area) the Commission considers this sector as a strong driver for higher market uptake of energy efficiency and development of the skills and knowledge required, as well as a drive for behavioural change.

The Commission is developing a common EU-wide certification scheme for the energy performance of non-residential buildings, with the aim to define a common EU methodology to express the energy performance of non-residential buildings. This will be based on a revised set of EPBD-related CEN standards, which represents a unique opportunity to harmonise the energy performance certification of buildings across Europe on a voluntary basis[6].

The minimum energy savings in buildings can make a considerable contribution to the reduction of GHG emissions, but this will be achievable only if buildings are transformed through a comprehensive, rigorous and sustainable approach, that includes historic and listed buildings into a wider climate and sustainability strategy.

The maintenance and reuse of the historic fabric, in particular of historic buildings and the historic centre contributes to the efficient handling of natural resources through reducing the need/ consumption of new materials (e.g. for construction), reducing the use of land, facilitating “urban development with short distances” (historic urban areas are usually a compact urban structure and are located in the city centre or nearby, reducing the length of transport ways/ less commuting, Attractive historic urban areas contribute to the mitigation of suburbanization trends, with an inversion of depopulation of historic centers due to lack of connection, higher prices and more care to be given to the buildings.

An attractive and lively historic urban fabric can contribute not only to the quality of life of the community, but also enhance local and regional economic competitiveness, creating a better environment for businesses and tourist sector. The facilitation towards a stronger economy would be able to create employment in the EU, alongside with inclusive social and environmental policies, which would themselves drive economic growth even further.

[5] Article 7 of Directive 2004/18/EC8 - http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32004L0018:en:HTML

[6] http://ec.europa.eu/energy/efficiency/buildings/doc/swd_2013_143_accomp_report_financing_ee_buildings.pdf

3 The process

Many cities across Europe are working on the integration of their climate and energy plans with actions that the community can benefit also from a social point of view. Often a rather challenging task, the integration of historic buildings into these larger frameworks is usually quite successful from an economic and social point of view, as historic buildings are not just dwellings but a potential identity drive for the community.

To ensure a successful integration of these actions and the best possible benefit for the community, the first step is to recognize where our process stands.

The CCP five milestones process developed for planning and development of sustainable climate actions can be adapted for this process[7]:

1. Assessment – draw your baseline!
2. Target setting – what do you want to reach?
3. Planning – how do you plan on reaching these targets?
4. Implementation – what steps to take
5. Monitoring – evaluate, optimise and start to improve again!

This circle is developed to encourage local authorities and their stakeholder to accelerate and develop action in a measurable, reportable and verifiable manner. The approach aims to increase transparency and accountability and with it, to increment participation of all relevant stakeholders to the process.

Picture 1: ICLEI´s Cities for Climate Protection (CCP) milestones

It is important to consider the close link between accountability and enhancing investments, as well the capability to foresee future actions to be taken for improving the quality of life of the community, and to increment

[7] Initiated in 1993 by ICLEI, the Cities for Climate Protection (CCP) Campaign is the first international initiative that aims to facilitate emissions reduction of local governments through a five milestone process of measurement, commitment, planning, implementing and monitoring.

The CCP Campaign assists cities to adopt policies and implement quantifiable measures to reduce local greenhouse gas emissions, improve air quality, and enhance urban livability and sustainability. The five milestones of the CCP and the methodology behind provide a simple, standardized means of calculating greenhouse gas emissions, of establishing targets to lower emissions, of reducing greenhouse gas emissions and of monitoring, measuring and reporting performance.

The five milestones provide a flexible framework that can accommodate varying levels of analysis, effort, and availability of data. This element makes the CCP both unique and innovative, by increasing its transferability amongst local governments. It is the breadth of this program that enables it to cross north/south, developed/developing, metropolis/town boundaries and that has made it successful worldwide.

long-term strategies for development both social and economic (creation of new jobs in the future). public investments in the cultural heritage as catalyst for the revitalization of the wider area, attracting local as well as external private investment and stimulating the creation of new developments.

3.1 STEP 1: Assess your baseline: understanding the building/site before carrying out works

While developing a master plan or an overarching strategy affecting a community is crucial to ensure a thorough knowledge of all the elements that may affect the planning.

This is especially true when the plan includes historic buildings and sites: these buildings have unique characteristics and needs and they can be often considered a sort of micro-environment within the larger district or center where they are built.

In the EU27 14 percent of buildings were constructed before 1919 and 26 percent before 1945. Although only a certain amount of these buildings are protected (i.e. listed buildings), they have historical significance and should still be treated with care.

They can be distinguished as historic, cultural heritage or site of cultural interest.

- For "cultural heritage" is intended the ensemble of artifacts, but also traditions, including costumes, that somehow define the specific heritage. Italy, for example, includes into this definition: archeological parks, museums, objects with cultural, historic, artistic value, monuments, cities structures but also cultural, culinary or religious traditions.

  In this definition "cultural" stands for an object with a long history which is correlated to our society and with a specific value universally recognized (being "very old" is not enough to be considered cultural heritage).

- Landscape is also considered heritage, and in Italy for example, this includes parts of the territory in which distinctive characters are derived from nature, human history or both. The safeguard of the landscape aims to protect the values and the identity that it expresses.[8]

  "Landscape protection" includes all those actions aimed to the conservation and maintenance of the key aspects that are specifc of that landscape, justifying its value as heritage, resulting from the natural configuration and/or the human interventions on it in the centuries[9].

It is important to understand clearly the distinction between these definition and it is even more important to make sure that expert from the **monument protection agency** are involved since the beginning of the process. This will allow first of all a well-rounded understanding on the exact situation of the building, to apply that specificity to the surrounding context and to have all the elements for an **appropriate planning from the beginning of the development of the strategy**.

[8] Dlgs 42/2004 -art. 131-Codice dei Beni Culturali, Italian code for protection of cultural heritage

[9] European Landscape Convention,CETS No.: 176 - adopted on 1 march 2004 and ratified in Italy on 2 January 2006 – Leg. n, 14 8GU n. 16 del 20 gennaio 2006, Suppl. ord. n. 16, http://conventions.coe.int/Treaty/Commun/QueVoulezVous.asp?CL=ENG&NT=176

Furthermore many local governments, such as the City of Bologna, extend this concept of "protection" also to buildings of historic/cultural value (even if not listed), and shape the retrofit of these building as a restoration. Only interventions allowed concern part of the building previously modified or deteriorated. For this reason it is crucial to consider not only European and national laws but also municipal regulations and the role that local governments play in both ensuring the protection of cultural heritage and making sure that these buildings can continue "living" in a more sustainable future.

The recommendation would be plan it once and plan it well including all relevant expertise: this will allow a faster development of the process, saving on extra costs (e.g.: due to delays) and to directly engage citizens.

The evaluation has to start from the building itself. Discuss with your monument protection department, with the competent national/regional or local monument protection agency and include academia and researchers with a particular interest on the field. Many cities across Europe host high-level university and are home of skilled researchers that could engage proactively.

When proposing any works to modify an historic building, it is important that it should be first properly understood. This means evaluating the status of the building, its construction and the way it performs. Furthermore, ofte local governments, as well as the monument protection agency and the owner have a template sheet with relevant information collected on the building that they are able to share before the beginning of the works.

- **Why** is it worthy of preservation **what** are its specific **features**, what the architectural elements[10]?
- What was its **historic use**? Its role in the community's life? At the same time keep in mind what role and **use** you foresee for this building **in the future**: not only by itself but also as part of the district texture and social life.
- What rules and legislation are in place on the area and concerning the building?
- Is the building listed, or does it have a historic/ cultural value recognized by urban regulations? What limits are foreseen for the retrofit?

  Where and on what elements of the building is possible to intervene, and how can you improve its energy efficiency, while respecting eventual restrictions?
- Implement appropriate **environmental indoor analysis** – including analysis on energy demand and actual level of energy consumption. Your historic building can be preserved through technologies that can improve its energy efficiency. The energy consumption can be reduced through new innovative technologies and through historic techniques, and it can utilize renewable energies!

  The analysis should include:

  - Analysis of the structure and material of the building envelope;
  - Architectural analysis (e.g.: presence of decorations, tecnica elements, materials, or decorations to be preserved);
  - Assessment of previous intevention;

[10] To learn more about methodologies on how to assess these values in urban scale as well as building scale explore the results by the 3ENCULT on comprehensive diagnosis of built heritage for sustainable intervention – www.3encult.eu

- Analysis ot the systems in the building (state-of-the-art of heating, electric, plumbing systems)
- Evaluation of energy consumption, of Energy losses and of the solar exposure of the building;
- Carrying out of a series of non-destructive investigations to explore more in detail the structure and its energetic behaviour. Also inrelation top the expected use of the building, such as: geo-radar, thermography, blower door test, statigraphic and structural investigations, verification of tension of chains and load bearing capacity of floors)

- This analysis phase should address at the same time the context where the building is located, including: environmental and landscape, infrastructural, hydro-geological, and seismeic restrictions

Historic buildings are of great value and the first concern should be related to their protection: they have a cultural, historic, social and even economic (through tourism for example) value that has to be nurtured and optimized. Explore what solutions are available and carefully choose the most appropriate for your building through consulting with experts and monument conservation specialists- keep in mind that **each historic building is unique and there are no solutions one-fits-all**! It is necessary to remember that all solutions have to be necessarily "sustainable" not only from an energetic point of view but, first of all, from a conservation and protection point of view. To this aim interventions should be **"revertible"**, so that they could potentially be undone or substituted if needed, without damaging or harming the building itself.

- Analyze the **social and economic value**: retrofitting and enhancing the historic fabric of your city can generate private investment through businesses, services and it can ensure a safer and more welcoming environment for your citizens and for the touristic sector. Evaluate your starting point:
  - What is the state-of-the art in the area where the building is located? Is the area inhabited? Are businesses finding the area appealing? Carry out a demographic analysis: it will help assess future usage of the building and foresee the economic impact of a refurbishment and help estimate the return to your investment for the community.
  - How is the building connected with other major area and site within the city? Is it/can it be part of a touristic area? Is it easily reachable by public **transport**?
  - To benefit fully of the uniqueness of your historic buildings they have to be/become active part of the urban texture: this has several benefits including a potential shift back to **repopulating** historic centers, sustainable use of the land, and reduction of the emissions through shorter distances and utilization of public transports. This could result in a reduction of possible impacts due to **anthropogenic habitat fragmentation** of the area[11].
- A change of the purpose of the building could potentially cause effects within the urban texture and mobility e.g.: cause traffic congestion. Changes in mobility may be expected and they could have an impact on public and private transport as well as on the linked activities of the business in the area.

[11] http://ec.europa.eu/agriculture/publi/landscape/ch5.htm

- Including an analysis of the public transport will help not only to improve mobility in the city and the visibility of your historic building but could also facilitate private businesses. It is crucial that all the departments in your local government are involved in the discussion, as well as relevant stakeholders, such as business associations, tourist boards conservation and planning officers, building owners and occupiers, architects and the citizens.

- Local sustainable energy action planning and climate strategy: European targets of reduction of 20% of greenhouse gas emissions, 20% increase in use of renewable by 2020 has led many cities across Europe to actively engage in planning Sustainable Energy Action Plans (SEAP) and climate strategy to ensure a better future and quality of life for their citizens. *Between 2011 and 2050, the world population is expected to increase by 2.3 billion, passing from 7.0 billion to 9.3 billion (United Nations, 2011).At the same time, the population living in urban areas is projected to gain 2.6 billion, passing from 3.6 billion in 2011 to 6.3 billion 2050.*[12]. At the same time the impact of climate change are also increasing leaving cities with the difficult task of having to introduce climate change adaptation and mitigation strategy as higher priority on their agenda.

  The mass-urbanization, combined with a growing touristic industry, and historic cities urban texture that often are not designed for the impact of climate change, are increasing the need for strategy of resilience.

  - What is the goal of your Sustainable Energy Action Plan? Is your city looking for measures to reduce emissions and energy consumption? Can you include your historic buildings into your 1st or 2nd generation SEAP?
  - What is the state-of-the art concerning adaptation and mitigation strategies in your cities? What are the risks for your local heritage? Do you have any resilience strategy to ensure its preservation?

- Last but not the least: assess your financing. What can be carried out through local public funds? What needs other investments?

  - Explore within your local government what strategies are being used by other departments, you might find in-house experts on specific funding schemes, national, European and private.
  - It is also important to build synergies with local research centers and universities, which could support local authorities to look for investment funds for new business based on valorization and development of new technologies and services.

    This should also include activities and incentives for collaboration between local business and university operating in the field of Renewable Energy, energy saving and environment.

    It is also important to underline that energy efficient retrofit can have a beneficial impact on the local economy (especially on the construction sector), thanks to the capacity of stimulating the production of innovative solutions that can be potentially exported worldwide.

How resilient is your cultural heritage? Padua includes historic district into adaptation planning for the future of the city

[12] World Urbanization Prospects - The 2011 Revision , UNDESA, March 2012 - http://esa.un.org/unup/pdf/WUP2011_Highlights.pdf

In the past years Padua has become a frontrunner on climate mitigation. The city has signed the Covenant of Mayors in 2010 and has developed its Sustainable Energy Action Plan (SEAP) aiming to a reduction of a 20% reduction of the greenhouse gas emissions equivalent to 378.432 CO_2e.

The impact of climate change on the city have been slowly increasing, and after the flood of the river Bacchiglione that has hit the neighboring city of Vicenza in 2011 and following a record heat-wave during the same year, Padua has decided to proactively plan for an adaptation strategy to build on the mitigation actions already in place.

The **Adapatation Plan**, still in the "baseline assessment" phase, aims to include all the specificity of the territory including historic buildings. The very large historic center is home of one of the oldest university in the world, and of several heritage, historic and listed buildings such as the Scrovegni Chapel (with frescos by Giotto), the Basilica di Sant´ Antonio and of an ancient Botanic Garden that was added to the UNESCO World Heritage List in 1997.

1. Basilica del Santo, copyright: syder.ross / Foter.com

In the years, excessive rainfalls have threatened the Scrovegni Chapel, whose crypt has been repeatedly flooded. Lack of integrated planning within the park in which the Chapel is located, allowed trees to be planted very closely to the building, which is now threatened by them during particularly windy days.

The city is now taking into consideration possible adaptation strategies, starting from an in-depth vulnerability study to assess how to better proceed with integrated actions. Among the foreseen actions the city is already considering: integrated approaches for green urban areas, improvement of already existing plans through the support of the civil protection office with a special focus on water and rainwater management.

A step-by-step process has lead the city to explore integrated approaches for the citizens and for the environment where they live.

For more information contact: Comune di Padova, Settore Ambiente - Ufficio Agenda 21 c/o Informambiente - www.padovanet.it

3.2 STEP 2: Set your targets: Identification of challenges and priorities

While setting your targets, there are some general indicators to be considered. These include some of the key issues that have been already addressed during the assessment of the baseline and they will most likely repeat thorough the process in most of the steps, as they are crucial requirements within the whole process.

Recommended requirements:

- Job creation and income generation
- Property values

- Heritage tourism
- Environmental measurements
- Impact on revitalization of the area

While setting your targets, the early involvement of all relevant stakeholders (building control bodies, heritage protection office, etc.) is necessary to guarantee a smoother process of implementation. The early involvement can help to ensure that the works are appropriate to the original performance of the building in question. The **access to data** and indicators also proves to be particularly useful both in this phase and in the planning phase. It is recommended that all parties seek to reach an agreement, particularly with the conservation officer and the building control body, before proceeding with the actual building work.

Historic buildings are often public and devoted to activities from which all the community benefits from, furthermore they are often part of historic districts were business and tourism are particularly active.

Especially when the historic building is public, or if the retrofit is part of a general claiming of an urban area, the first goal to reach is **political commitment**. The process of including retrofit into integrated urban planning takes time and it is a process that needs to be agreed upon by the council. Ensuring a fruitful discussion with both the majority and the opposition will ensure that the process will be receiving a joint acceptance and that it will remain in the agenda of the local authority even with a political change in the administration. Moreover, the political commitment should act as driver to include the concept of energy efficiency retrofit into the priorities of all departments within the municipality. This will ensure a common guideline in the action of the different department and will solidly anchor energy efficiency and the carbon reduction agenda to the future operations.

Once the political commitment is jointly agreed upon, a special effort has to be made in order to endure that all departments within the local authority are involved in the process when relevant.

To this aim knowledge and capacity building should be fostered within the staff, allowing exchange among fields of expertise. Many are the potential solutions for this challenge:

- Exchanges among departments, including staff exchange and roundtables
- Twinning with other cities that have worked in a similar field, as well as work-shadowing
- Trainings: attending both external relevant trainings or internal training by an external experts - this is usually recommended in order to address all the departments jointly and at the same level
- Best practices and inspiration: many information and resources are available on line and through comprehensive platforms (e.g. 3ENCULT website, Toolbox of Methodologies on Climate and Energy, Covenant capacity training Platform)

This process not only represents a good opportunity for improving interaction among departments, but it also opens the possibility of building further in-house skills.

When dealing with historic buildings it is necessary to involve the responsible monument protection agency from the very beginning. This, as mentioned before, will decrease the potential set-backs that could either result into a change in the planning or cause a delay if not a stop to the works.

When the baseline is draw, the political commitment is achieved, the staff is on board and ready to collaborate with all relevant experts, it is possible to set the final target.

The target should be ambitious in order to motivate and inspire all the stakeholders, and the method to reach the target should be transparent, as well as the decision process. Once the objective is set, the local authority should approach community and business and ensure the development of a participatory process through public consultations. This is particularly important because:

- Citizens, and especially the users and inhabitants of the building, or of the area involved, should always be considered as their comfort should always be one of ultimate goals of a retrofit
- An informed support is beneficial both politically and in order to facilitate the works
- Involving the public means raising awareness on the topics of sustainability, energy efficiency and climate change, with an high and positive impact on the community and with a potential impact on the final users' bahaviour

While setting the target you should consider among other: how do you plan on maintaining the character and significance of the building /site that you aim to retrofit, paying attention to the overall building regulations. Monument protection expert will be able to support you in assessing the aesthetic value, historic value, from the community and the inhabitants of the area you will be able to capture the communal value and the future that they foresee for that building.

Valhalsgade, Copenhagen (Denmark): The Osram building – Preserving the soul of an historic building through addressing its future

The Osram building is a shining example to both Copenhagen and the rest of the world of the energy savings that can be achieved through sustainable retrofitting. The building, previously used for the manufacturing of light bulbs, has been renovated while retaining respect for the building's unique history. Throughout the renovation environmentally sound solutions have been used to enhance the structure.

The Haraldsgade neighbourhood was built from the end of the 1800s, and slightly over half of the area's buildings are from 1920-1939, mostly composed of industrial buildings. After industry became less significant in Denmark, much of the space in the old working-class neighbourhood lost its previous function.

In the new millennium, new demands have been made on the neighbourhood alongside changes in the makeup of the 9500 residents. People of 30 different nationalities, live together in the neighborhood - largest groups are from Palestine, Turkey and Somalia. About 30% of the residents in the neighbourhood are ethnic minorities.

It was decided in the early in the planning of the Haraldsgade neighbourhood Integrated Urban Renewal Scheme[13], a five year plan funded by the City of Copenhagen and the Danish Ministry of the Interior and Social Affairs to improve the district, that the Osram building would be renovated.

The five-year **urban renewal project** is holistic, and aimed to improve the district physically, culturally and socially. The scheme would have been in accordance with the needs of the local residents, including them in the discussion: residents were engaged in the preparation of the neighbourhood plan together. Residents also play a central role as representatives in the scheme's steering committee, which decided the projects to be financed.

THE BUILDING: The Danish architect Karl Wiedemann Petersen built the Osram building as the first construction in Copenhagen to be built with blasted concrete elements. The

[13]http://www.covenant-capacity.eu/fileadmin/uploads/se/Events/osram_pr%C3%A6sentation_26062012.pdf

prefabricated elements were then assembled at the site, with the advantage that the building could be completed in a short time and regardless of the season. The blasted concrete, very durable, also made it possible for the architect to express his creativity in designing the shape of the outer walls.

The building has been renovated while still retaining respect for the building's unique history, environmentally-sound solutions for local issues and a good interaction with the city's strategy for modernising the district heating network. This renovation work brought the Valhalsgade 4 to gain a frontrunner position during the 15th Conference of the Parties to the United Nations Framework on Climate Change (COP15).

Renovations have cut more than 60% of the building's energy consumption. This has been partly achieved through connecting the building to the modern district heating network (which was also being modernised at the time), and through installing a new and environmentally friendly heat pump.

One of the major themes in the culture house is daylight. New low-energy windows, skylight windows and glass walls help to make the house brighter. The glass also ensures optimal use of daylight, which saves not only electricity consumption on lighting, but also warms the building. A green yard has been created for residents of the area to use. The lights used are not the original appliances restored but modern LED lights: the aim with the rebovation was not only to preserve the structure of the building but also its innovative soul, showing thorough the day the "pulse" of the dwelling and of its occupants.

Today the Osram Building fulfills various functions, including housing the offices of the Haraldsgade Integrated Urban Renewal Scheme. It is also a social and cultural gathering place for various activities, and an area of social importance. A gardening project takes place around the building. There, citizens originally from Copenhagen and belonging to minorities can meet, get to know each other while sharing a small garden that they cultivate together.

To learn more visit www.3encult.eu!

New ideas for retrofitting heritage school buildings: Non-invasive ventilation system tested in masterpiece of early-modern architecture

In Innsbruck, at the Neue Mittelschule Hötting - a historic building and 3ENCULT pilot project - a new minimally invasive ventilation system for school buildings is being tested. The **dual aim** of this system is to **preserve the architectural value** of the building while **guaranteeing scholars´ comfort**.

When ventilation systems are integrated into historic buildings this requires minimal invasiveness (structurally) with maximum reversibility. For this purpose the principle of "active overflow", which is already used in refurbished dwellings, is an optimal energy efficient solution that can also be applied to school buildings. The idea is simple: fresh air is vented into the corridor and stair case, with fans actively pushing the air from the corridor into the classrooms. Typically to optimize this approach, the ventilation system is linked to heat

recovery and therefore needs ducts for air inlet and - exhaust to and from the rooms. Silencers are also needed to prevent noise.

Two 3ENCULT partners, the University of Innsbruck together with the company ATREA, are testing the first prototypes of active overflow elements with vans and silencers in one class room of the Hötting school. The prototypes aim for the obvious advantage - to avoid the need for ducts in the corridor or for the installation of a vertical shaft to provide fresh air.

The heat recovery system is instead placed on the roof and the fresh air is distributed via the open staircase and corridors through vertical ducts. Driven by a fan through a silencer the air is then distributed through textile ducts. The flow rate of the central unit is controlled by CO_2-sensor in the corridor and the fans in the classrooms are switched on according to a schedule one hour before the start of lessons. Motion control sensors switch off the fans after a delay of 15 minutes.

With a special focus on cultural heritage, this minimally invasive strategy is a big advantage to combine together preservation aspects and **user comfort** at the same time.

The technologies applied and the experience of the retrofit talking place in this school is setting a best practice that will potentially be **replicated** not only in schools in Austria but potentially across Europe.

3.3 STEP 3: Planning: Exploring possible solutions

After having assessed the baseline of the interventions to be carried out, and following the selection of the overall target of the renovation a thorough planning can start.

The planning phase - as the two previous steps – has to include experts in the field of energy, conservation in addition to urban planners. This will guarantee that all objectives can jointly be achieved.

During the planning phase possible solutions for the retrofit are being identified and shortlisted the input gathered by all stakeholders.

First step is to ensure all data relevant to the building are collected and scientifically-sound. It is essential to remember that **every historic building is unique**: there are no ready-solutions which fit all. However, there are standards activities which should be done, starting with an assessment of renovation needs.

When starting to plan for an energy retrofit of your historic buildings it is crucial to **explore a series of key points**:

i. What is the purpose agreed upon for the building and who will be the final user? Always considering the building role when part of a bigger transition programme for the city or area

ii. Keep in mind what regulations need to be followed for the protection of the historic building

- Is this a listed monument? Or is it subject to any specific relevant regulations? What limitations to interventions (what and why)
- What are the optimal renovation options? approaches for potential opportunities of energy innovation

iii. It is important to make the most out of this investment – also considering the economic and social impact when planning. Is this being done?

iv. Joint discussion with the historic building expert (monument protection agency) and experts on sustainable energy solutions for buildings have to take place thorough the process in order to identify and discuss the specific situation, explore and select appropriate technologies.

An indoor environmental analysis should be carried out first with all the required tests to ensure appropriate intervention on the building –what can you do? This includes: thermography, Ground Penetrating Radar testing, Blower Door Tests, Heat flow meter measurements; Hygrothermal monitoring with the use of wireless sensors (WSN); "Spot" measurements of expressive parameters of the Hygrothermal, visual and acoustic comfort; Psychrometric and lighting maps material compatibility. Discuss with the expert and involve them thorough the process.

Explore your options for maintaining character and significance while upgrading energy efficiency, including:

- Old energy conserving features,
- Heating strategies,
- Adding insulation,
- Draught proofing,
- Permeability

Many solutions have and are being studied and (further) developed as part of a retrofit intervention of a specific building – i.e. in a 3ENCULT case study. These solutions are the results of a joint dialogue between researchers, energy experts, industry representatives and building conservationists.

It is important to keep in mind that every heritage building is unique and that not all solutions are replicable one-to-one.

Building energy solutions can be divided into two main clusters:

- Passive solutions (resulting from design and change in user behaviour)
- Active energy solutions, meaning improving energy efficiency (technologies) and generating renewable energy for electricity, space and water heating or space cooling.

It is important to keep in mind that the applicability and the results of the application of a certain solutions depend on:

- type of building,
- use of the building
- climate
- materials
- national regulations on heritage protection
- funds available

Nonetheless solutions might be adaptable to different needs and adopted in specific cases, after discussion with all relevant stakeholders and especially with experts in conservation.

The solutions can be grouped into **five areas of intervention** (building envelope, windows, ventilation, active and passive solutions), all of which are interlinked. **We recommend you read the guide on innovative solutions developed by the 3ENCULT project.**

Once decided what actions are possible on your unique building, consult experts (including your own local government relevant departments!) and find the optimal energy efficient solution:

- Energy efficiency do not always come from the newest technologies – explore with conservator if historic techniques can be reapplied to the building (e.g.: cooling , shading)
- Innovative technologies / techniques are not always the more expensive, especially when it comes to refurbish an historic building, where different materials are used.
- Even when the costs are higher, don't forget to look at the larger picture: energy saving means not only less emissions for your community but also less costs. Discuss with the experts what are the feasible options for the building: investment recovery time might surprise you, especially if you can utilize renewable energy.

Copenhagen's multidisciplinary team follows iterative approach towards the solution

Fæstningens Materialegård, the Material Court of the Fortress, in Copenhagen (Denmark), is one of the case studies explored by 3ENCULT. Restored in 1994-96, the main building, Building I, was brought back to its original shape of 1756. The building, owned by Realdania byg A/S and the Cultural Authorities, has been refurbished and turned into office space. The restoration of the court is a pilot project, offering concrete results and a best practice example both of successful implementation of energy efficiency mesaures in an historic building, and of cultural heritage converted to new usage.

The energy retrofit of the listed "Old Material Court" in Copenhagen was aimed not only at the preservation of the building itself, but also at becoming a best practice on preservation and CO_2 emission reduction for listed buildings across Denmark. Realdania byg A/S, a foundation owning a large number of historic buildings, worked closely together with the Danish Heritage Authority and experts from the different fields from the very beginning of the project.

The decision on the final solutions to be applied was developed through an iterative process: starting from a high number of potential solutions, following a series of analyses increasingly detailed, a poll more and more narrow of solutions have been shortlisted, up to reaching the optimal solutions for the building and the purpose of the retrofit – utilizing integrated Multidisciplinary Decision Process approach.

A multidisciplinary working group, including professionals with great experience in building renovation contributed to the single tasks with their specific viewpoint. The group included:

Building owner - impact on rental opportunities, operating and maintenance conditions

Heritage authority - conservation viewpoint (also general evaluation of building typology)

Architects - building history, conservation project, shape, appearance, functionality, interior design conditions

Structural engineer - impact on existing construction, risk assessment (moisture)

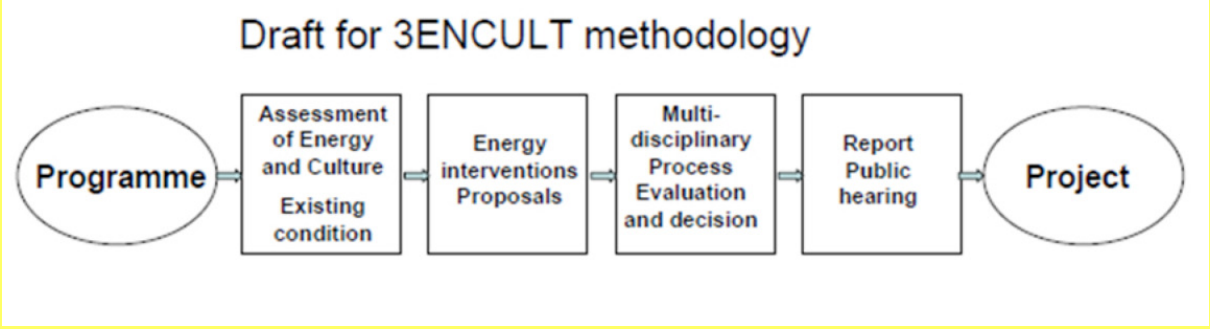
Services engineer - assessment of energy and indoor climate

Visit www.3encult.eu to learn more about this success story!

3ENCULT new methodology of Environmental Impact Assessment

The Royal Danish Academy of Fine Arts has developed a new methodology based on Environmental Impact Assessment (EIA). The methodology is being applied to the eight case studies selected by the 3ENCULT project, representing a diverse, and comprehensive, mix of European built heritage (urban and rural, cold and warm climates, humid lowlands and dry mountain areas).

The aim of the methodology is to provide **guidelines for identifying and better integrating cultural and energy indicators** within conservation works of built heritage. Through doing so, environmental, social and political decision-making is supported. This methodology has been developed as an instrument that identifies different stakeholders' perspectives as part of a process that includes energy and culture in environmental impact assessment. This process also involves public participation.



This methodology, developed on the basis of a survey conducted by 3ENCULT, wishes to identify and find a balance between the value of cultural heritage and energy efficiency.- In doing so the methodology refers to European and international cultural charters and conventions, as well as to energy standards and directives. The identified indicators will be integrated in scenarios and setups for the democratic process, public hearings and decision-making. Scenarios will include passive and active energy retrofit solutions to be evaluated in a multidisciplinary decision forum, and will take into account local and even universal environmental impact assessment.

To learn more about the methodology visit www.3encult.eu

3.4 STEP 4: Implementing

After the assessment of the possible solutions it is crucial to ensure that the funds for the implementation are in place and able to support the action.

There are several options for supporting energy efficiency retrofit of historic buildings, from European to national funds and the options of Private Public partnerships.

Each European country has its own funding schemes that might be addressed to the public sector or to the private or to both. Buildings retrofit is a crucial component in ensuring the reaching of the European 202020 and the municipality should set the good example showing citizens that refurbishment, especially of historic buildings can be not only a challenge but also an opportunity.

The European Commission's report[14] Financial support for energy efficiency in buildings [COM(2013) 225] , published in May 2013, provides with a good overview of the European funding instruments used in the past 5 years:

Funding Source	Instruments/mechanisms	Total funding available	Funding for EE
Cohesion Policy Funding	Operational Programmes incl. financial instruments (e.g. JESSICA)	€ 10.1 billion planned for sustainable energy (RES & EE)	€ 5.5 billion planned for EE, co-generation and energy management
Research Funding	FP 7 (e.g. Concerto, E2B PPP, Smart Cities)	€ 2.35 billion for Energy research	€ 290 million for energy efficiency
Enlargement Policy Funding	IFI facilities (SMEFF, MFF, EEFF)	€ 552,3 million (381,5 +117,8 +53 respectively)	About one third of total funding for projects in industry and buildings
Programme for European Energy Recovery (EEPR)	European Energy Efficiency Fund (EEE F)	€ 265 million	70% of funding to be dedicated to energy efficiency
Competitiveness and Innovation Funding (CIP)	Intelligent Energy Europe Programme (including ELENA) Information and Communication Technologies Policy Support Programme (ICT PSP)	Approximately € 730 million for each programme	About 50% of the funding was dedicated to energy efficiency in all sectors

Table 1: Funding for energy efficiency under the current Multiannual Financial Framework (2007-2013)

Although not developed specifically for historic buildings, many of these funds apply to public buildings and to energy efficiency and sustainable energy action plans.

Among the research funding, the CONCERTO initiative has co-funded since 2005 around € 180 million for projects in 58 communities, resulting in savings of around 310,000 tonnes of CO2 per year in their building sectors and the reduction of total electricity consumption by 20%. The initiative's goal was to demonstrate that integrated refurbishment and optimization of a community's building sector is more cost efficient that single retrofits.

EU financing programmes in co-operation with International Financial Institutions (IFIs) have allocated one third of the foreseen budget of € 550 million for energy efficiency related projects in the industry and building sectors.

The European Local Energy Assistance (ELENA) Facility, which provides grants to local and regional public authorities for developing, structuring and launching investments in energy efficiency and renewable energy, facility provided a total of € 31 million in project development contributions until the end of 2012.

From 2008 until the end of 2011, the European Investment Bank (EIB) mainstreamed energy efficiency into its operations, resulting in a total funding volume of € 4.8 billion in the EU, of which € 1.7 billion in the building sector.

The Commission aims to obtain a comprehensive assessment on the impact of financial measures on the energy performance of buildings and to obtain a comprehensive overview of the financial support for energy efficiency in the Member States. Within the next Multi-annual Financial Framework, the Commission has proposed to continue its support for tackling non-technological barriers through the Horizon 2020 programme, under which €6.1 billion would be allocated to research and innovation under "Secure, clean and efficient energy" in 2014-2020. A significant share of this budget would focus on non-technology

[14] Financial support for energy efficiency in buildings [COM(2013) 225]

aspects and removal of existing regulatory, financial, market and behavioural barriers, under the 'Market uptake of energy innovation' priority, continuing the positive experience with the Intelligent Energy Europe Programme.

EU has adopted a “Cohesion Policy” that is framed around targeted long term growth and efficient investments for the continent. In the context of sustainable urban development, funding is channelled through the ERDF, ESF, and CF. Part of this policy is concerned with energy efficiency within historic buildings. It is important for cities to have a well developed plan in order to fully take advantage of these funding opportunities.

The further development of the energy services market is often seen as one of the most effective ways of triggering energy efficiency measures, particularly in public buildings and industry. The business model in this market is based on the delivery of energy services (i.e. the rational use of energy rather than the delivery of energy per se), often through so-called Energy Performance Contracting (EPC). Under an EPC the service provider (i.e. an energy service company or ESCO) delivers energy efficiency improvements by financing the upfront investment costs and refinancing this through the savings achieved. Energy performance contracting can thus be seen as a financial instrument for improving energy efficiency without up-front capital cost to be invested by the client. Several stakeholders identified the need for stronger support for the ESCO/EPC market e.g. by setting up more loan guarantee systems, by establishing a more robust certification framework and by improving the trust in the EPC concept.

In the public sector, the potential for off-balance sheet financing has been identified as driver for investment in public buildings, particularly in light of obligations to renovate 3% of central government buildings per annum.

Furthermore, the Commission will develop technical guidelines on the use of innovative financial instruments during the first half of 2013 to facilitate a wider uptake, and a better coordination and implementation of such instruments. The EED creates an opportunity for Member States to introduce a step-change in the levels of investment into energy efficient buildings, as it requires the Member States to establish by April 2014 a long-term strategy for mobilising investment in the renovation of the national stock of residential and commercial buildings, and to facilitate the establishment of financing facilities for energy efficiency improvement measures to maximise the benefits of multiple streams of financing. [15]

Public/Private Partnerships: The State Parliament of Brandenburg in Potsdam

In the historic centre of Potsdam once stood the Old City Palace, however like many German structures it was severely damaged in the Second World War. The historical building was then later demolished by the East German State. Today it is being rebuilt, using even some of the original stone fragments. The construction of this building is unique, in that it’s a cultural heritage site, and is subject to a variety of authorities.

Financing is being done through a public private partnership, combining the state of Brandenburg’s prefinancing with funding from KfW IPEX-Bank. Over a 30 year period the state will rent for the building to the private partnership in order to repay the estimated 106 Million Euros lent. This approach is a prime example of combining private and public enterprise to adapt the past in the form of buildings to the present.

The state government estimates construction and operating costs of EUR 300 million over the 30-year tenancy period.

[15] http://ec.europa.eu/energy/efficiency/buildings/buildings_en.htm

The special challenge of the project: part of the construction site is heritage listed, creating the need for extensive consultation and coordination with the contractor and the diverse authorities. KfW IPEX-Bank is financing the PPP project with around EUR 106 million together with two other banks.

The Brandenburg Parliament Project in figures:

- Investment volume: approx EUR 120 million
- Project volume: EUR 300 million
- Tenancy period: 30 years

Sustainable Construction & Innovation through Procurement

The SCI-Network (Sustainable construction and innovation through procurement) is an organization that seeks to connect European Public authorities with sustainable building procurement opportunities. The Network provides five working groups that assist in the procurement process, including:

- Environmental assessment tools
- Innovative technical solutions
- How to encourage innovation in construction procurement
- Life cycle/whole life costing
- Innovative financing and contracting approaches

The Network has produced two publications which aim to assist public authorities in their construction procurement:

A Guide on Procuring Innovative and Sustainable Construction Solutions has been produced by the project and is now available for download. The Guide contains a series of recommendations for good practice developed by a series of working groups within the network.

The Guide is available in English, Dutch, Finnish, German and Italian.

A collection of best practice "Snapshots" has also been produced to accompany the Guide, which provides concrete examples from across Europe to illustrate the recommendations given in the Guide.

More information at: http://www.sci-network.eu/

3.5 STEP 5: Monitoring and Evaluation

The 5th step is monitoring and evaluation of the results. This is a crucial part of the action as monitoring allows not only to assess the effectiveness of the intervention implemented but also gives transparency and accountability to the actions undertaken.

The citizenry will be able to investigate more in depth the results obtained and to contribute actively and more confidently to next actions promoted by the local authority.

Monitoring also allows room for amelioration in the future and it is the base for setting new and more ambitious targets for the same area, for more buildings or for the overall strategy of the municipality.

The evaluation of the retrofit undertaken can not only prove in scientifically-sound data the reduction of emission and energy consumption , but should also be aimed at assessing the improvements to the comfort for the occupants of the building retrofitted. To this aim, when possible monitoring of the building should continue also during the phase of usage of the dwelling in order to ensure a thorough evaluation of the refurbishment undertaken in combination with the user behaviour.

Very often the user behaviour has a large impact on the effectiveness of the measures implemented: whether new or traditional technologies have been applied, the way that the user interacts with the building is crucial to its energy performance.

There may be changes necessary to the way in which a property is occupied, which must be clearly understood: for example, with many types of internal solid wall insulation it is vital not to pierce the waterproof membrane behind the insulation which might happen easily when putting up shelves or hanging a picture.

Air-tightness/passive ventilation can be compromised by arbitrary opening and closing of windows; utilization or lack of usage of shutters and curtains, which have traditionally played an important role in the indoor climate of historic buildings, can change the temperature and affect not only the comfort of the users but also of eventual art-works hosted in the building.

Defining a monitoring system to assess and evaluate energy efficiency actions in public buildings, especially historic ones, is a very ambitious task. Historical buildings from different periods and with various building standards are hard to compare. Detecting the existing energetic status as well as evaluating other aspects like environmental impact, cost effectiveness is very difficult and work-intensive.

Among the indicators to be monitored and evaluated, it is important to consider the social and economic impact:

- creation of new *green* jobs,
- attraction of new business,
- repopulation of the centre, as well as
- impact on the surroundings of the building when driver for an entire urban renewal scheme
-

Monitoring for users´ comfort: Palazzina della Viola becomes an international hub for the University of Bologna

A fresh start for the XV century building of Palazzina della Viola in Bologna, Italy. The Palazzina, one of 3ENCULT's case studies, has been refurbished after 16 months of work.

The building is now the headquarters of the University's Department of International Exchange – a working area for exchange and multiculturalism of about 1,300 m2. The area hosts 40 employees who interact with around 5,000 international students and more than 2,000 exchange students annually. The Palazzina symbolises the continuous joint effort and the crucial collaboration between the City and the University.

Since the end of the refurbishment works in March 2012, an extended and innovative cloud sensing network was installed in the building. The system, developed by the DEIS Dept. of University of Bologna, consists of about 40 nodes, each equipped with a number of sensors. These nodes are distributed throughout the four levels of the building. The sensors continuously record energy and structural and environmental data, which is then stored in a database. The data is accessible in real-time through a website for data visualisation and downloading, creating a valuable data bank for further studies.

Light distribution maps, air temperature and relative humidity data have been obtained through a number of “movable” WSN nodes located on the first floor. These nodes are used to perform post-intervention diagnosis and facilitate greater analysis of employee behaviour and use of the building. This in-depth evaluation will help to find ways of improving both the comfort and energy consumption of the Palazzina, a “living lab” for the University of Bologna.

New jobs from an old profession – Strickbau in Appenzell (Switzerland)

As part of the 3ENCULT project case studies, researchers and experts are working together to make Strickbau wood log buildings more energy efficient whilst restoring them in line with conservation principles, and, at the mean time, actively working for creating a sustainable future for the Strickbau building technique, typical of the Swiss Appenzell region.

The challenge is to use modern and traditional features, and preserve historic architecture, to give this buildings a new comfort standard and energy efficiency.

Developed during the 18th century, Strickbau features a highly recognisable architecture with even planking and wooden shingles on the facades. The traditional technique used conical beams able to dove-tail connections at the corners, meaning beams are fitted perfectly on top of each other. At the beginning of the 20th century, however, this technique was slowly abandoned and the knowledge was also lost.

The research of the 3ENCULT project aims to remedy this situation through an energy efficient retrofit of Strickbau without losing their historic character. The aim is to achieve airtightness in the house by adding new windows and finding solutions for moisture transport, including testing different techniques, such as vacuum-insulation- and wood-wool-panels, to identify the most suitable solution.

The efforts of retrofitting the Strickbau with modern, energy efficient, restoration methods, has triggered a recent revival and interest with some carpenters acquiring the traditional techniques used for these buildings in the past. Although it is estimated that it will take up top two generations to be able to restore fully this technique, a new “re-vamped” interest for craftsmanship is creating new skilled labor and job opportunities.

For more information visit: www.3encult.eu.

4 Implementation overview: Palazzo D´Accursio, Bologna

The Municipality of Bologna launched a public tender for the refurbishment works to be carried out in the Sala Urbana (also known as Coat of Arms Hall), located in the Municipal Arts Collection Museum of Palazzo d' Accursio. The tender follows a series of investigations, conducted in collaboration with the University of Bologna and the local 3ENCULT case study team, to assess the stability of the building and the level of indoor comfort.

This case study is particularly interesting and significant because of its museum function: the building does not only have to satisfy conservation and protection requirements for the collections contained, but also to guarantee health and comfort of the public and the personnel.

A delicate microclimatic balance has to be found for both people and objects hosted within this building. Structural safety has also to be guaranteed, as well as security, and firesafety.

Environmental comfort includes all the actions aimed at the protection of the building from external agents (e.g.: micro-climate, pollution). Among the parameters that can affect environmental comfort there are: hygrometric and thermal conditions (temperature, humidity and ventilation) and lighting conditions, including UV, also chemical pollution, amonmg others. These values have to be confronted with real condition to identify a compromise taking into consideration conservation, users 'needs and systems functions.

Structural safety includes stability of the building against natural events (snow, wind, earthquakes). To this aims it is crucial to verify the static capacity of the structure and if needed to plan an improvement. To this aim, in Italy, is foreseen, a compulsory analysis of the seismic vulnerability of all buildings declared of so called "primary interest" (such as: libraries, schools, museums) in seismic areas (1 to 3 risk index).

Safety in the usage addresses all issues related to utilization of the building as well as safety of the collections hosted. Fire alarms, smoke detectors, motion sensors, security alarm and safety shutters and glass able to stop UV rays – damaging frescos. All these interventions need to be verified in advance for compatibility with structural and aesthetic criteria, and to be potentially revertible.

An important element to assess the internal microclimate is captured by temperature and relative humidity data. To gather this information extensive monitoring is required: it is crucial in order to detect fluctuations during different periods.

It is also crucial to evaluate the illumination: both sunlight and heat can cause damages. Non- destructive investigations and monitoring can provide indispensable information for the energy efficiency retrofit.

Among the non-distructive investigations conducted: thermography, Ground Penetrating Radar testing, Blower Door Tests, Heat flow meter measurements; Hygrothermal monitoring with the use of wireless sensors (WSN); "Spot" measurements of expressive parameters of the Hygrothermal, visual and acoustic comfort; Psychrometric and lighting maps.

The monitoring and analysis of energy consumption in the selected areas were followed by a series of dynamic energy simulations, to evaluate the effectiveness of different technical solution. This aided in selecting the best performing energy and environmental solutions. Three types of intervention were selected:

- the replacement of all fixtures with a selective double-glaze;
- the replacement of the terracotta-tiled wood roof with a ventilated roof, providing a package of wood fiber insulation;
- the renovation of the limestone plasters.

The process of investigation of the building required the collaboration among several expertise including: experts on building conservation, urban planners, experts on installation of systems, specialists on retrofitting and energy efficiency, on monitoring and non-destructive investigations, on data collection and scenario simulation (both static and dynamic), experts on conservation of art collections, among others.

The process of approval of the intervention required several steps of authorization:

- approval by the local government administration
- approval of the cost by the administration
- approval of the project by the National Heritage Protection Agency
- review of the project by the office for anti-seismic safety
- and re-approval by the local government administration

The retrofit has also become a pilot case within the GovernEE project, a complementary project funded by the Central Europe program, dealing with issues regarding, in particular, the governance in energy saving projects, as an example of technical-administrative management. The project also supported the cost of replacing the windows. All other operations are funded by the city of Bologna.

This retrofit has allowed the city of Bologna to delineate multiple scenarios for the Local Action Plan for increasing energy efficiency in municipal buildings, in collaboration with several departments of the municipality. The Plan foresees activities also on selected historic buildings.

The Local Action Plan (LAP) is aimed at reaching the target fixed while elaborating the Sustainable Energy Action Plan (SEAP), developed within the context of the Covenant of Mayors ´initiative targets: 20% reduction of energy consumption for thermal uses in whole municipal stock of buildings.

The Final Scenario involving 87 buildings foresees energy savings for 13,5 GWh/year, photovoltaic production of 775,5 MWh/y, costs of 16,6 million euros and payback of 14,1 years.

For more information visit: www.3encult.eu, www.governeeproject.eu and http://www.comune.bologna.it/paes.