Energy efficiency strategies for the historic city

Aitziber Egusquiza
Historical Heritage, Tecnalia Research & Innovation
e–mail: aitziber.egusquiza@tecnalia.com

ABSTRACT

In order to ensure the maintenance of our urban historic heritage, urban policies should aim at improving quality of life in historic centres, facilitating the sustainable development and integrating citizens' participation into planning processes, focusing on protecting not only the physical fabric but also the social context. Consistent with this ideal, this work points at recommending energy efficiency strategies for the historic city. E2CH ("Energy Efficiency for the Historic Town") project arises from the concept that historical cities could be handled as a reference model for contemporary urban development. One of its main goals is to improve knowledge of energy performances within the historic centre as a system, studying the efficiency and adaptability of traditional buildings to the environment. The project has developed a comprehensive methodology and different tools for the diagnosis, the decision making, the implementation of solutions and the subsequent management of energy at urban-scale. The case study of this project is Santiago de Compostela. For the past 17 years the Consortium of Santiago has been a pioneer in the design and development of programs for the rehabilitation of the historic city and the improvement of its liveability, respecting its assets represented by their historic dwellings.

INTRODUCTION

Heritage conservation policies should comprises not only cultural issues, but questions intensely linked with housing policy, infrastructure renewal and, specially, habitability improvements aspects. The improvement of the quality of the habitability of the historic cities should mean the construction of a sustainable conservation, increasing comfort and reducing maintenance costs, energy consumption and CO2 emissions involving the citizens in the decision making process.

Then, a critical factor for the improvement of this liveability is energy efficiency. Historic cities have been designed taking into account specific climate, built largely from renewable materials obtained locally, then they have a bioclimatic potential to exploit.

E2CH project is intended to define the criteria, the methodological approach and the tools that are necessary to face this issue by the energetic rehabilitation of the historic cities. The project aims at developing the framework for a "second generation" rehabilitation of his historic urban context, which connects the improvements of the energetic performance with the preservation of its authenticity.

The projects main goals were:

- To generate a deeper knowledge about the energy performance of the historical centre as an "environmental system" [1], studying the efficiency and adaptability of traditional buildings to the environment.

- To develop coherent and technologically compatible solutions with the built heritage and pre-industrial building techniques by means of understanding historic buildings in terms not only of their special cultural interest but also of how the building works as technical and constructional system.
- To preserve and reuse the unique bioclimatic solutions characteristic of the built heritage of the historic centre.
- To define the criteria, the methodological approach and the tools that are necessary to face the energetic rehabilitation of the historic cities through an integrated approach for the evaluation, decision-making and the management of energy at urban-scale level.
- To improve users' energy saving behaviour by involving citizens in an active way and by learning from historical energy management strategies.
- To provide the stakeholders with the management tools necessary to establish a program of actions in relation to improving the livability and energy efficiency.

ENERGY EFFICIENCY AND THE HISTORIC ENVIRONMENT

Energy efficiency is a key factor to talk about sustainability in the historic city. A proper management of energy saving is an effective way to improve the quality of the habitability of the historic cities whilst constructing a sustainable conservation, because the historic city, far from being a problem, could be a model and a reference of urban efficiency and sustainability.

To address this continue and unfinished sustainable conservation process a holistic methodology has been defined, facing both urban and building scale (strategic and executive scales). The methodology is structured in three subprocesses:

1. Generation of knowledge
2. Design of the strategy
3. Management, which integrates:
    a. Implementation
    b. Monitoring

The structure of the proposed methodology can be seen in the following scheme:

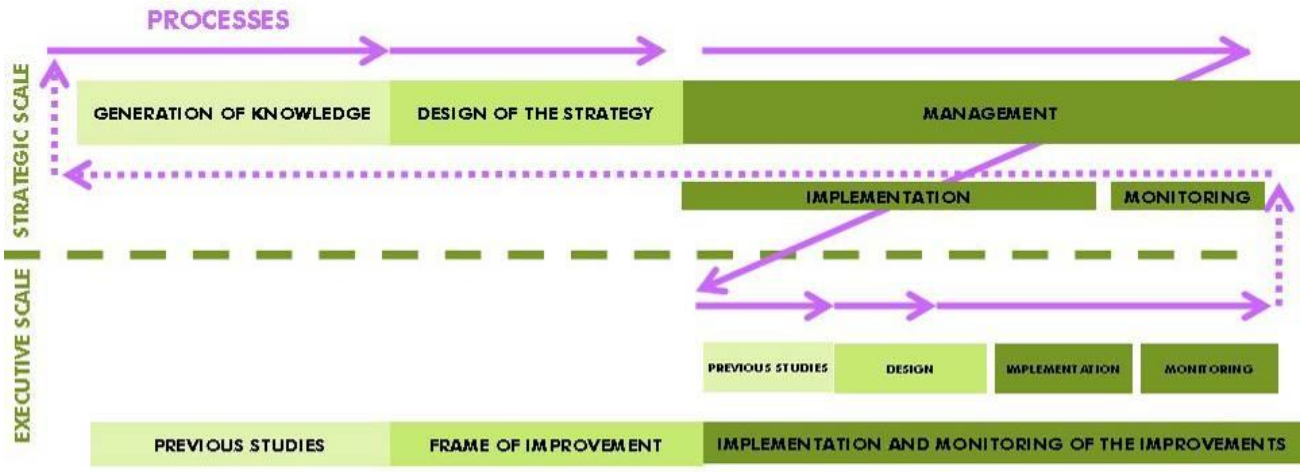

Figure 1. Methodological scheme

GENERATION OF KNOWLEDGE

The traditional architecture constituting the urban fabric of the historic cities was developed to operate in a time when energy was really expensive; consequently it was designed taking into account the climatic environment and using local resources and materials. But over time, the interaction between buildings and environment changed, due to the use of new buildings materials with different thermal properties then, from a thermal point of view, there is an important change from the traditional architecture to the industrialized one[2]. Therefore in order to work in historic environments a specific energetic approach is necessary for the following reasons:

- Heterogeneity of the envelope due to the stratification of different stages of construction and re-built generates a very complex building context where different materials and construction systems coexist, so a strict diagnosis phase is necessary.

- Pre-industrial building techniques and local materials have to ensure material and technical compatibility of the interventions, by means of understanding historic buildings in terms not only of their special cultural interest but also of how the building works as technical and constructional system: how it accommodates structural movement, how they relate to patterns of air and moisture movement, and how easy it is to damage these balances by carrying out standards 'improvements' [1].

- Historic buildings are a reservoir of embodied environmental and energy capital that makes repair a better strategic choice than replace, moreover compared to the relatively small amount of their operational energy [3].

- Lack of deeper knowledge in the energetic performance of the traditional buildings as an "environmental system". The hygrothermal behaviour of its porous and permeable materials responds to air and moisture in very different ways instead of waterproof materials used in most modern buildings and work with greater thermal inertia. Traditional buildings need more ventilation than newer ones, in order to accommodate evaporation of moisture from the building fabric.

- Presence of unique bioclimatic solutions characteristic of the built heritage of the historic centre, which must be preserved and reused.

- Limitations on the admissibility of certain solutions because of the needs of conservation and protection of cultural values and the urban landscape

Therefore it is necessary to improve the knowledge of energy performances of the historic centre, studying the efficiency and adaptability of traditional buildings to the environment and facing the various energy scales of the city in searching energy efficiency and energy conservation: urban scale, building scale and element scale. In order to achieve this goal the project has developed a comprehensive methodology to generate the necessary knowledge.

This approach has been oriented to rehabilitation processes and the development of specific products by a monitoring approach at urban scale. Therefore a Living Lab

approach has been defined by TECNALIA and the Consortium of Santiago of Compostela:

- To generate a deeper knowledge in order to understand the cultural, technical and constructional values of the historic city promoting the preservation and reusing of the unique bioclimatic solutions which characterize its built heritage.

- The living lab should be oriented to the evaluation of solutions, methods and tools to support rehabilitation processes and the development of specific products.

- To improve users' energy saving behaviour by learning from historical energy management strategies and by involving citizens in an active way.

DECISION MAKING PROCESS

The urban renewal strategies must be based on a continuous decision making focused on identifying what is important to protect and what allows a controlled evolution of the historic environment. In order to achieve this goal, the relationship between heritage preservation and habitability in the historic cities must be deepened.

In this sense, the historical heritage of the city, as well as its material form, can be understood as a process, where the authenticity is also given for the survival of its management model. Then, it is necessary to understand the historical processes of adaptation and evolution of the historic city to design strategies and actions to facilitate the reconciliation of conservation with the improvement of the quality of life of its inhabitants allowing a sustainable management of the change.

Within the holistic approach, criteria for decision making are central. When addressing the update of the historic city to current requirements, as seen in the state of the art, a classical approach is the confrontation of the habitability criteria with the respect to heritage, with the addition of economic viability and environmental sustainability criteria.

Within the project a new approach is defined, that energy conservation and building conservation are complementary [4]. Based on the idea of improving energy efficiency in historic cities should not be faced as a conflict between sustainability and preservation, the following three main criteria have been identified for the decision making process:

- Compatibility with the system
- Energy Efficiency
- Feasibility

Which are divided into the following subcriteria:

- Compatibility with the system
    - The continuity of cultural diversity
    - Minimum intervention
    - Resource management

- Energy Efficiency subcriteria
  - Optimization of energy consumption
  - Improved livability

- Feasibility subcriteria
  - Technical feasibility
  - Economic viability
  - Compliance with the legislation

Then, in addition to the documentation of specific solutions, the project has established the decision tree to assess possible future solutions that technology offers.

Compatibility with the system

The continuity of the technical knowledge and building skills of traditional architecture is a key aspect of cultural and socio-economic development of the city, but is also, is a criterion that ensures compatibility of the chosen solutions to the energy system that involves the traditional building. Within this sub-criterion should be evaluated:

- Respect for the authenticity
- Respect for the integrity
- Respect for the original typology
- Compatibility with traditional construction techniques of the historical city
- Readability of modern inputs
- Adaptation to the life style of the inhabitants
- Use of historical conditioning strategies
- Use of traditional materials.

The minimal intervention is a criterion shared by both the science of conservation of heritage and the field of environmental sustainability. Within this sub-criterion should be evaluated:

- The preference for the adaptation or repair before the substitution
- Building maintenance solutions
- Reversibility of the adopted solutions
- Preference for non-invasive solutions

The classic "3 Rs" (Reduce, reuse and recycle) of waste management and renewable resources, is also a classical approach to the evolution of the historic city. Within this sub-criterion should be evaluated:

- The embedded energy of chose solutions
- The use of local materials
- Durability and reliability of the materials and systems used
- The minimization of waste and pollutants generated
- Minimal impact on the historic urban environment

Energy Efficiency subcriteria

The improvement of habitability could be seen as the continuation of the traditional housing function but with actual standards. In this context energy efficiency could

mean the improving of the livability with minimal energy expenditure. This subcriteria is structured as followed:

- Sub-criterion of energy consumption optimization
  - Performance of the systems
  - U-value of the materials used
  - Improvement of the energy performance
  - Use of renewable energy systems

- Sub-criterion of improved livability: IEQ (Indoor Environmental Quality) is a key concept in health and welfare of the occupants [5]. The concepts include:
  - Humidity
  - Noise
  - Thermal comfort
  - Air quality (and ventilation)
  - Lighting
  - Security

Feasibility subcriteria

It is necessary to ensure that the solutions and measures proposed are viable from economic, technical and legislation point of view:

- Economic viability
  - Initial cost of the investment
  - Return of the investment
  - Maintenance Cost
  - Cost-benefit analysis

- Technical feasibility
  - Compatibility with the energy performance of traditional buildings
  - Easy installation
  - Minimal discomfort for the user

- Feasibility standards
  - Compliance with heritage legislation
  - Compliance with energy legislation

THE CASE STUDY

To test the feasibility of the proposal it was necessary to analyse its applicability in a concrete historical city. The case of study chosen was Santiago de Compostela and the project was developed by working with the technicians of the Consortium as potential end users. The Consortium of Santiago is an institution which proposes and promotes, financial and technically, innovative projects for the city of Santiago de Compostela.

Therefore, for the past 17 years the Consortium of Santiago has been a pioneer in the design and development of programs to rehabilitate the historic city and to improve its livability, respecting its assets represented by their historic dwellings.

During the year 2010 the Consortium encourages, as part of its multi-annual programming, an urban infrastructure master plan that will address a plan of renovation of the infrastructures and urban services in the historic city of Santiago. This plan to modernize infrastructure and urban services could not be understood without facing the issue of the various energy scales of the city in the search for energy efficiency and energy conservation.

Then the city of Santiago de Compostela could be one of the best-case scenario for the implementation of an Energy Rehabilitation Program and the Consortium of Santiago, for his extensive experience in management intervention programs in the city, appears as one of the most appropriate agencies to test the applicability of this proposal in a real case.

Figure 2. E2Ch case study (Santiago de Compostela)

CONCLUSIONS

E2CH project aims to develop urban renewal strategies for the historic cities based on the belief that heritage preservation is compatible with livability criteria. This project intend to deal with a key issue for this livability, the energy efficiency, by means of develop intervention strategies for the rehabilitation, conservation and valorisation of the historic city, based on a specific approach.

The project has established the key issues for an own energy-heritage approach of the historic city: this is the relationship between conservation and sustainability criteria and the energetic issue as a new heritage value. This has made possible to define the requirements for a comprehensive methodological framework that articulates the processes needed to improve the livability of the historic city as a step in the process of updating its historical role as a technological system for housing. The applicability of the methodology has been assessed for the case of the historical city of Santiago de Compostela

REFERENCES

1. English Heritage, Building Regulations and Historic Buildings: Balancing the needs for energy conservation with those of building conservation: an Interim Guidance Note on the application of Part L, English Heritage, 2002.
2. Cantin, J. Burgholzer, G. Guarracino, B. Moujalled, S. Tamelikecht, B.G. Royet Field assessment of thermal behaviour of historical dwellings in France Building and Environment, Vol. 45, No.2, pp 473-484, 2010.
3. May Cassar Sustainability and the historic environment Centre for Sustainable Heritage 2006.

4. Rodwell D.,Conservation and Sustainability in Historic Cities, Wiley-Blackwell, May 2007.
5. Jaggs M., Palmar J., Energy performance indoor environmental quality retrofit—a European diagnosis and decision making method for building refurnishment, Energy and Buildings, Vol. 31, No. 2, pp.97–101, 2000.