Interdisciplinary research: FP7 project "3ENCULT – Efficient Energy for EU Cultural Heritage"

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ABSTRACT

The FP7-project 3ENCULT bridges the gap between conservation and climate protection, which is not a contradiction at all: historic buildings will only survive if maintained as living space – and energy-efficient retrofit can improve structural protection and "comfort", both for users and heritage collections. Reducing the energy demand by Factor 4 to 10 is feasible, if a multidisciplinary approach guarantees high-quality energy-efficiency-solutions, targeted and adapted to the specific case. Twenty-two partners, including conservation, technical and urban development experts, industry partners and stakeholder associations, work on (i) criteria for the assessment of energy-efficiency-measures regarding their conservation-compatibility, (ii) diagnosis, monitoring and control instruments, (iii) passive and active energy-retrofit-solutions, (iv) implementation in urban context and (v) regulation framework. Eight case studies will demonstrate and verify the solutions.

KEYWORDS

Energy efficiency, multidisciplinary approach, diagnosis, passive & active retrofit solution, monitoring, conservation, building physics, case studies

INTRODUCTION

Historic buildings are the trademark of many European cities, towns and villages. From World Cultural Heritage sites as the old town of Regensburg to an ensemble in any village on the continent, historic quarters are what make our cities unique, a living symbol of Europe's rich cultural heritage, and a reminder of times past, which made our cities what they are today.

However, it is clear that these buildings are in general not energy efficient and are substantial contributors to greenhouse gas (GHG) emissions and rising energy bills. At a time when climate change poses a real and urgent threat to humanity and its infrastructure, it is vital to initiate an improved approach to the refurbishment of historic buildings, which in many cases are in danger themselves.

OBJECTIVE

The FP7-project 3ENCULT bridges the gap between conservation and climate protection, which is not a contradiction at all: historic buildings will only survive if maintained as living space – and energy-efficient retrofit can improve structural protection and "comfort", both for users and heritage collections.

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The project will demonstrate, that reducing the energy demand by Factor 4 to Factor 10 is feasible, if a multidisciplinary approach guarantees high-quality energy-efficiency-solutions, targeted and adapted to the specific case.

AREAS OF INTERVENTION

A – Active and passive energy retrofit solutions

The project develops passive and active solutions, as result of open and constructive dialogue among stakeholders and experts. The fields tackled cover all relevant aspects for historic building retrofit (see Figure 1). Starting with materials and products already available on the market and from solution already applied for new buildings, the project aims to ensure the widest possible dissemination of the achieved results all around Europe.

B – Diagnosis and monitoring instruments

Diagnosis and monitoring instruments are defined in order to (i) study historic buildings and find out the best technological and constructive energy retrofit solutions, (ii) support their commissioning, (iii) assess the actual performances of buildings once retrofitted and (iv) monitor such performance.

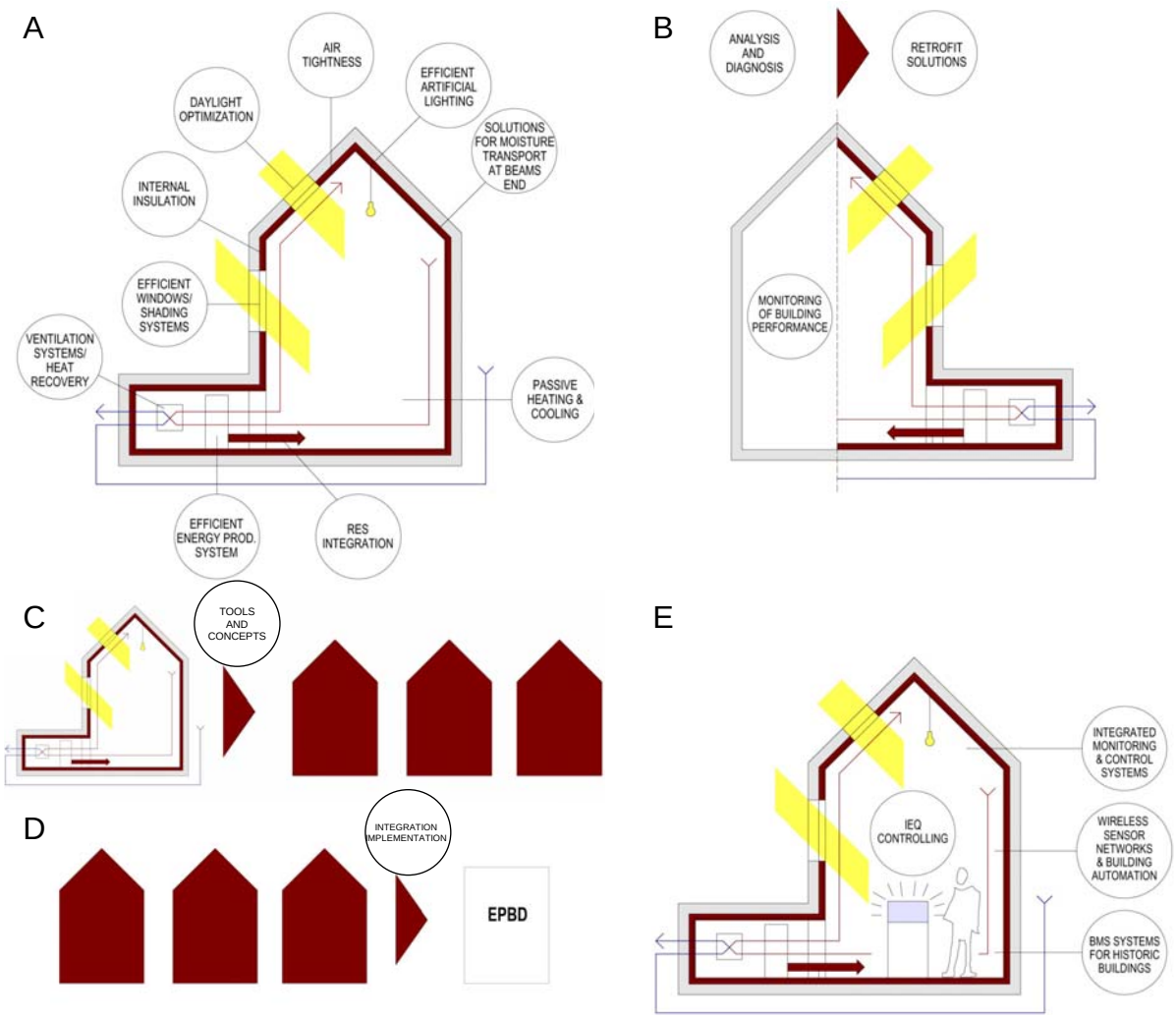

Figure 1. Five areas of intervention are addressed by 3ENCULT

C – Tools and concepts – the urban context

In order to support the implementation in different urban context and to ensure the effective transferability to historic buildings located in different locations, the calculation software used in the project is provided for wider use, solutions inventories are elaborated, a dedicated internet portal is realised, monitoring systems are recommended and assessment approaches tested and proposed.

D – Integration of the present regulation framework

Position papers suggesting possible integrations and/or implementations of the present regulation framework for improving energy efficiency of historic building in urban areas are issued - in particular (i) on the relation of EPBD (Energy Performance of Buildings Directive) and historic buildings, (ii) the development of a pertinent standard with CEN TC 346 on cultural property and (iii) EIA as well as the SEA Directives and SUIT guidelines.

E – Indoor environmental Quality (IEQ) controlling

Define a methodological approach in order to use the developed monitoring system also for IEQ controlling in historic buildings where cultural heritage collections are located (comfort for users and “comfort” for heritage collections).

WORK PLAN

3ENCULT supports the sustainable refurbishment of Europe’s built heritage through the development and demonstration of new systems and technologies both for “hard facts” energy efficient building concept and “soft systems”, such as the intelligent monitoring & control system.

This approach is also reflected in the WP structure: After WP1, which gathers all activities management of the project consortium, WP2 is aimed at analysis and diagnosis of the built heritage at different levels with the aim to identify replicable factors that can be highlighted for general or particular contexts. Multidisciplinary elaboration of the challenge to be solved (demand) will also bring to strong integration of the “local case study teams”, especially the involved representatives of local authorities and conservation offices.

Considering the emerging demands from WP2, WP3 and WP4 will investigate the above mentioned “hard fact” and “soft systems” towards the development of (a) technical solutions for the energy enhancement of historic buildings, integrating passive and active solutions (WP3) as well as (b) low-cost passive and active monitoring and control systems for diagnosis, management and assessment of the building-plant system optimising the energy demand and user comfort (WP4).

WP5 will allow a demonstration of the developed solutions, while WP6, starting from the very beginning of the project will allow stimulus for the solution development and successively feedback on monitoring & control systems. The solutions used in the case studies (WP6) will be generalised both theoretical and experimentally in WP3 and WP4.

WP7 is aimed at providing the stakeholders with reliable design tools and specific material information that are developed in the above described WPs, in order to guarantee a smooth and consistent design process in a widespread application of the

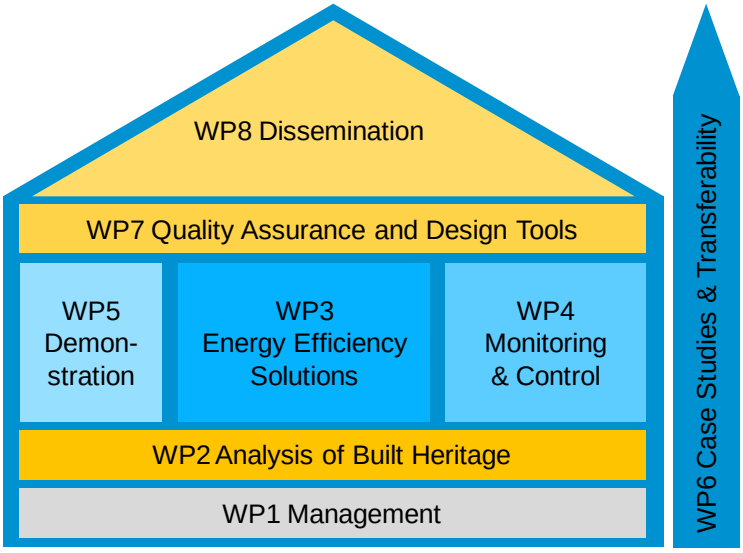

Figure 2. The PERT chart indicating the relation of WPs.

energy refurbishment measures on historic buildings. A second – and not less important – aim is to develop an international certification scheme and assure the quality of the interventions, in order to prevent low quality interventions and promote transparency on the market. The demonstrated best practice, available design tools and quality assurance methods will finally contribute to the integration of historic building issues in normative and guidance.

Finally WP8 is focused on the dissemination of results to all relevant stakeholders including policy-makers, the media, industry (with special focus on SME), professional representatives, educational institutions and society. It will contribute to European social and technological progress by disseminating its results to a carefully defined target audience in appropriate formats. The dissemination and exploitation of results will be carried out throughout the project's duration and is based on a strong cooperation between all partners.

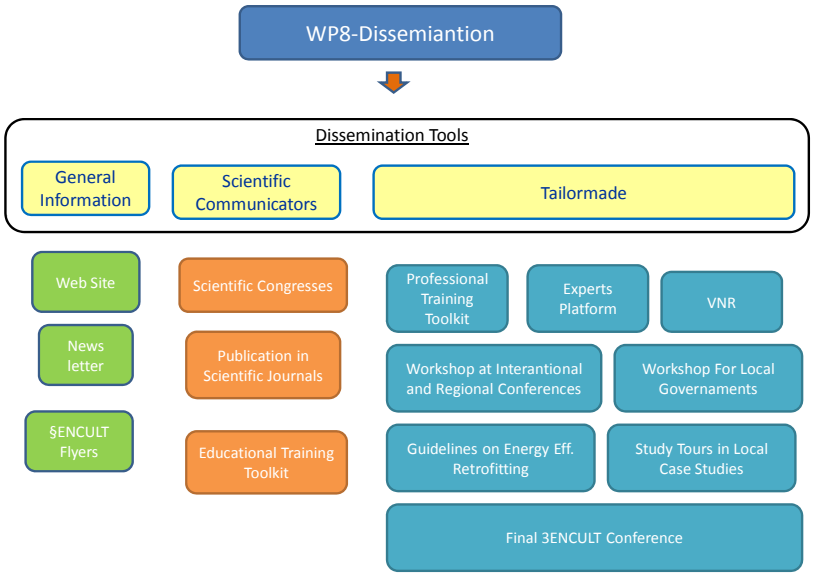

Figure 3. Dissemination Activities and target groups

MULTIDISCIPLINARY PROJECT CONSORTIUM

The joint task of conservation and energy efficient retrofit is highly interdisciplinary. The 3NCULT project partners cover a wide range of expertise and sectors, including conservation experts, technical experts, urban development experts, industry partners, implementation experts and stakeholder associations.

Table 1. Overview of partners and their role within the project

		Country		Case study	Role			
					"Technical solutions"	"Urban context"	"Conservation"	"Dissemination"
1	EURAC research	IT	Coordinator, WP1 & WP8 lead	x	x			
2	The Royal Danish Academy of Fine Arts	DK	WP2 lead	x		x		
3	IDK - Institut für Diagnostik und Konservierung an Denkmalen	DE	WP2 co-lead				x	
4	Universität Innsbruck	AT	WP3 lead	x	x			
5	ARUP	UK	WP3 co-lead		x			
6	Universität Darmstadt	DE	WP4 lead	x	x			
7	Cartif	ES	WP4 co-lead	x	x			
8	Bartenbach Lichtlabor	AT	WP5 lead		x			
9	TU Dresden	DE	WP6 lead	x	x		x	
10	Comune di Bologna	IT	WP6 co-lead	x		x		
11	Passivhaus Institut	DE	WP7 lead		x			
12	TNO	NL	WP7 co-lead					x
13	Alma Mater Studiorum Università di Bologna	IT	diagnosis & monitoring	x			x	
14	Artemis	IT	diagnosis & monitoring				x	
15	Elettronica Gelbison	IT	lighting solutions		x			
16	Grupo Unisolar	ES	solar solutions		x			
17	Menuseries Andre	FR	window solutions		x			
18	Remmers	DE	insulation solutions		x			
19	ATREA s.r.o.	CZ	ventilation solutions		x			
20	youris.com	BE	dissemination					x
21	ICELI - Local Governments for Sustainability	EU	dissemination			x		x
22	REHVA	BE	dissemination					x

Furthermore, **Local Case Study Teams** bring together those individuals with hands on experience: building owners, local offices for the protection of monuments, city councils, and the architects and engineers in charge of the retrofit activities.

CASE STUDIES

The research activities are accompanied and stimulated by different case studies. At the same time, these will allow the assessment of the developed solutions. From here an analysis will be conducted to generalize proposed solutions, identify replicable factors and the context where replication is possible.

3ENCULT will contribute to the diagnosis, support the design and planning phase and give feedback with its monitoring. The project cannot, however, contribute financially to the intervention itself. It was thus important to select case studies, where the owners are committed to implement dedicated solutions and where the planned intervention's time schedule matches the project's time schedule.

Different kinds of utilisation

Case studies reflect typical utilisations in urban areas and range from residential use over commercial and office use to educational use for schools and universities. Furthermore, in order to cover also the special case of the preservation of cultural heritage collections in historic buildings, museum use is also covered.

Different kinds of building structure and epoch

The buildings date from different epochs – ranging from middle age (13th century) to the 20th century. As regards the buildings structure, the most common types ranging from stone, over masonry and clinker to wooden structures are covered.

Different kinds of climate

The sites chosen cover all major European climates (see Figure 4).

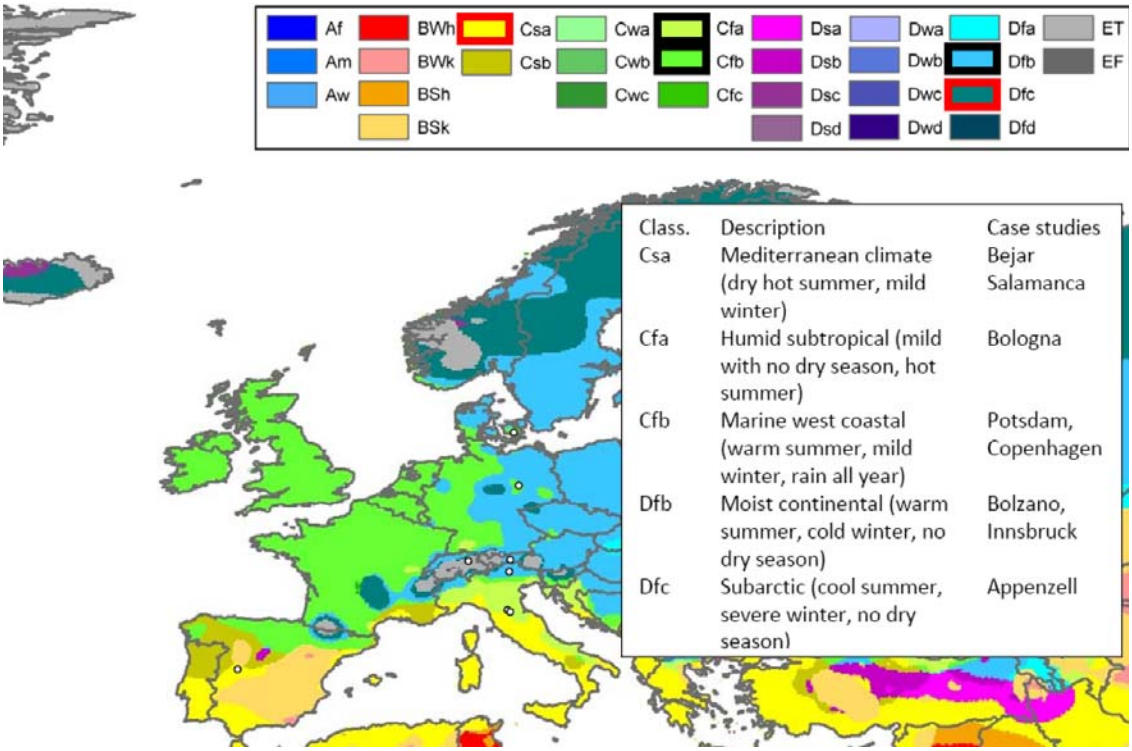

Figure 4. Case studies on the map of Europe in Köppen-Geiger classification.

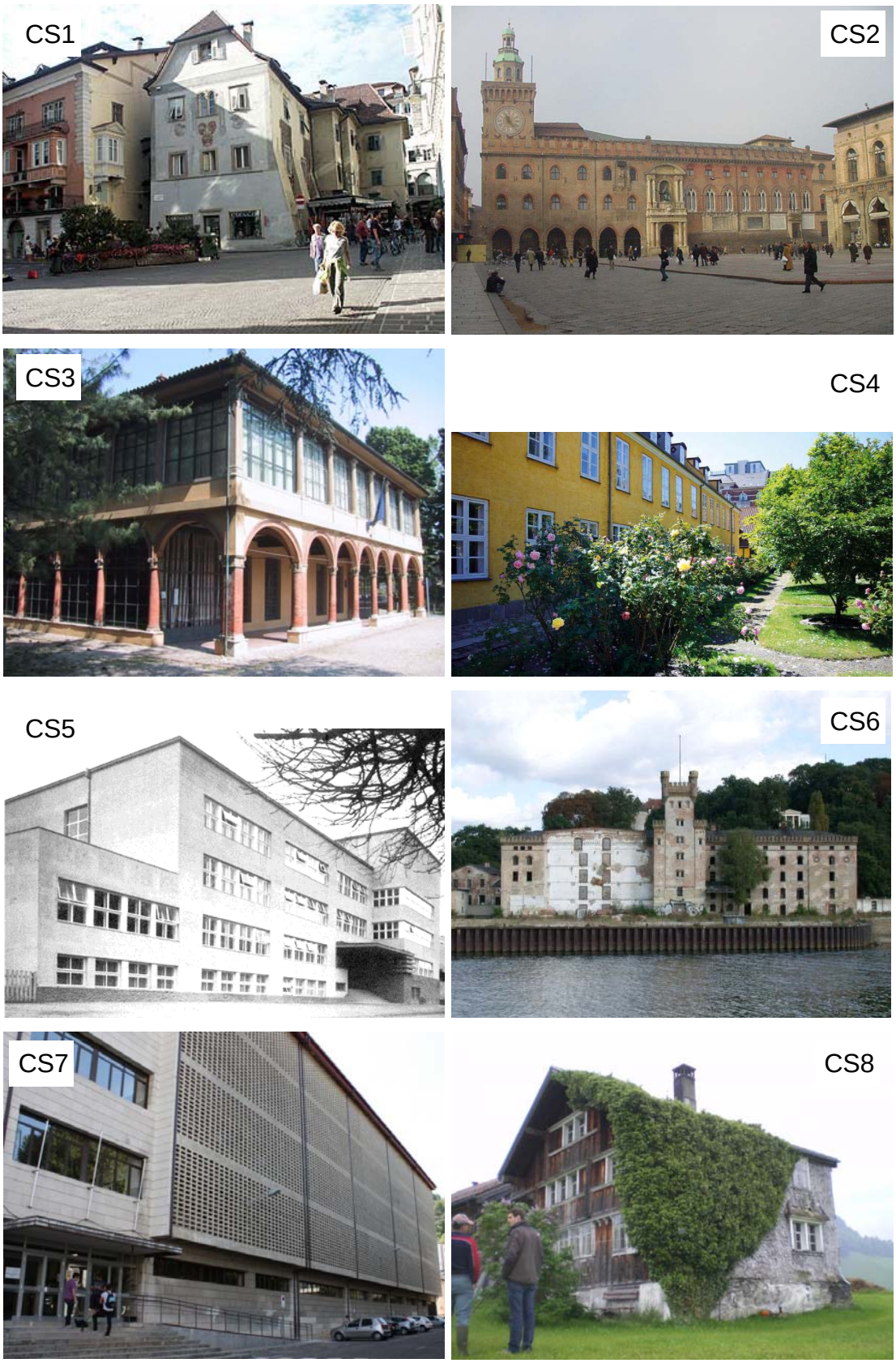

Figure 5. 8 case studies – representing buildings from north-south-east and western Europe, and different eras of construction - will assess the solutions developed in the project and analyse whether these solutions can be replicated in other cases

CS1 – Public Weigh House, Bolzano (IT)

Object: Romanesque origins (13th century). Rehabilitation intervention necessary. Use: commerce, residential, (exhibition). Owner: Stiftung Südtiroler Sparkasse
Proposed activities: diagnosis & support for architecture competition, support during planning phase (insulation, windows, energy system), transfer to urban scale.

CS2 – Palazzo d'Accursio, Bologna (IT)

Object: 13th century nucleus, developed over centuries. Use: museum, public administration. Owner: Comune di Bologna
Proposed activities: diagnosis & NDT, support during planning phase (insulation, windows, HVAC, lighting), transfer to concept on urban scale

CS3 – Palazzina della Viola, Bologna (IT)

Object: 15th century, lightened by double open gallery, enriched with frescoes and painted wooden ceilings. Intervention and functional requalification planned. Use: university. Owner: University of Bologna
Proposed activities: diagnosis & NDT, modeling, - verification of intervention results

CS4 – Fæstningens Materialegård, Copenhagen (DK)

Object: Built mid of 18th century, part of the fortress next to Frederiksholm Canal. Use: public administration. Owner: Realea (Foundation)
Proposed activities: diagnosis & NDT, monitoring, transfer to concept on urban scale

CS5 – Höttinger School, Innsbruck (AT)

Object: Building from 1929-31, Architect Franz Baumann, Early building in . High Energy consumption, overheating, low air quality and problems with humidity. Use: school. Owner: Innsbrucker Immobilien GmbH&Co KG
Proposed activities: high efficiency passive house windows with integrated shading, insulation of walls and roof, ventilation system with heat recovery

CS6 – Warehouse City, Potsdam (DE)

Object: Schinkelspeicher (19th century), refurbishment already completed, monitoring data available to 3ENCULT. Persiusspeicher (17th century), refurbishment planned. Use: Residential, offices, exhibition. Owner: Speicherstadt Potsdam
Proposed activities: diagnosis of historical constructions, development of energy efficiency solutions (insulation, windows, energy system)

CS7 – University Building, Bejar/Salamanca (ES)

Object: Salamanca University Building (19th century). Project in advanced state, (photovoltaic galleries, semi-transparent atriums, analyze air tightness …)
Proposed activities: diagnosis of historical constructions, support in design phase

CS8 – Strickbau building, Appenzell (CH)

Object: Typical wooden construction, dating back to 17th century. The Owner has the permission to dismantle the old building with the constraint to make it available to research for one year. This allows for outstanding activities!
*Proposed activities:*to analyze behaviour of wooden constructions after extreme interventions, to use destructive analysis techniques usually not applicable on historic wooden buildings, to realise different thermal and moisture conditions.

EXPECTED IMPACT

3ENCULT triggers significant energy saving in historic buildings

The project builds upon experience and solutions based on already market available products further developing them for the use in historic buildings. The demand side is fostered with ICLEI, involving a network of engaged municipalities, the supply side is prepared addressing REHVA's associated enterprises and construction sector.

3ENCULT leads to substantial CO_2 reduction

In the European Union 14 percent of buildings were constructed before 1919, 26 percent before 1945. Although only a certain amount of these buildings are protected (listed), they have historical significance and should still be treated with care. By reducing the buildings' energy demand (~1'400 TWh) by Factor 4 (i.e. 75%), more than 200 Mt of CO_2 could be saved (4.5 percent of EU-27 emissions in 1990).

3ENCULT improves living conditions within historic urban areas

Energy savings achieved with retrofit measures to improve indoor comfort for the occupants (perceived temperature, avoided air draught, daylight ...) and reduce energy bills

3ENCULT leads to improved quality management of historic cities

ICLEI works with committed local governments (Cities for Climate Protection – CCP campaign) on replicable factors to be fed back to the Leipzig charter process. Furthermore the project helps implement the EU Environmental Impact Assessment Directives when applied to historic buildings, introducing energy issues and more detailed standard references and thresholds in a well framed methodological approach (SUIT).

3ENCULT fosters sustainable renovation and long term conservation of our built heritage

As the FACH vision highlights, real protection of Cultural Heritage can be achieved by its integration in everyday life. Similar to that within the EU project SUIT the concept of "active conservation" was introduced, which has an enlarged and more complex view of urban built heritage conservation problems. Comprehensive diagnosis guarantees sustainable conservation and the selection of compatible (or even beneficial) measures. SUIT –

3ENCULT contributes to Europe's Economic Recovery

The project triggers "smart investment" as formulated in the European Recovery Plan in relation by both supporting the implementation of "energy efficient systems and material in [...] renovated buildings to reduce radically their energy consumption and CO_2 emissions (Action 9)" and setting demanding targets (Action 6)". On the one hand side, demonstration and guidelines, how to use existing products and materials will address a large number of construction enterprises across Europe. On the other hand side with a number of innovative European enterprises very specific solutions are developed.

3ENCULT preserves the basis for cultural tourism, a significant economic factor in Europe

By providing solutions for the conservation-compatible retrofit of historic buildings, 3ENCULT supports the preservation of the diverse urban landscape in Europe, our typical 'old towns', historic grown structures and public spaces.

3ENCULT contributes to European Energy Policy

Specifically it supports (i) the EU climate action and renewable energy package with the 2020 goals, (ii) the EPBD with the proposal for a more differentiated approach with the aim to integrate historic buildings, (iii) CEN with the contribution to the development of 2nd generation standards related to EPBD and a work item proposal of TC 346 on cultural property, as well as (iv) RES integration.

3ENCULT supports the Strategic Research Agenda of the European Construction Technology Platform (ECTP) and its Focus Area in Cultural heritage (FACH)

The project objectives are well in line with a number of priorities of the ECTP SRA with regard to (i) healthy and safe indoor environment, (ii) efficient and clean buildings, (iii) avoidance of demolition and improved LCA, (iv) assessment, diagnosis and monitoring, use of RES and sustainable management of cultural heritage, (v) creation of a global map of different refurbishment and renovation options and (vi) assessment of technologies of "energy optimised buildings". Finally it contributes to three key targets of FACH vision for 2030: (i) promotion of energy efficiency in historic buildings, (ii) reduction in dependence on fossil fuel and (iii) contribution in reduction of CO_2.

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