GENERAL PROGRAMME

WEDNESDAY JULY 24TH

TIME TABLE	PROGRAMME			LOCATION
8:30 - 9:00	REGISTRATION			ENERGY CENTER
9:00 - 9:30	OPENING CEREMONY			
9:30 - 10:15	PLENARY SESSION			
10:30 - 11:00	COFFEE BREAK			ROOMS P AREA
	Parallel Sessions			
	ROOM 1P	ROOM 4P	ROOM 3P	
11:00 - 12:20	Built Environment I	Cities and Communities I	Cleaner Energy Supply I	
12:30 - 14:00	LUNCH			
14:00 - 15:40	Built Environment II	Cities and Communities II	Cleaner Energy Supply II	
15:40 - 16:00	COFFEE BREAK			
16:00 - 17:40	Markets and Policies I	Sustainability Assessment and Resiliancy to Climate Change I	Taking Energy Policies Further	
18:15	WELCOME DRINK			ENERGY CENTER Garden/Hall

THURSDAY JULY 25TH

TIME TABLE	PROGRAMME			LOCATION
	Parallel Sessions			
	ROOM 1P	ROOM 4P	ROOM 3P	
8:30 - 10:00	Markets and Policies II	Cleaner Energy Supply III	Built Environment III	
10:00 - 10:30	COFFEE BREAK			
	Parallel Workshops			
10:30 - 11:30	WS1 BuildHeat	WS2 Energy Transition		
11:30 - 12:30	WS3 Energy Center Lab	WS4 Energy and Economy		
12:30 - 14:00	LUNCH			
14:00 - 15:40	Cities and Communities III	Cleaner Energy Supply IV	Markets and Policies III	
15:40 - 16:00	COFFEE BREAK			
16:00 - 17:20	Cities and Communities IV	Sustainability Assessment and Resiliancy to Climate Change II		
19:45	CONFERENCE DINNER			CASTELLO DEL VALENTINO Sala Colonne

FRIDAY JULY 26TH

TIME TABLE	PROGRAMME			LOCATION
	Parallel Sessions			
	ROOM 1P	ROOM 4P	ROOM 3P	
8:30 - 10:10	People and Systems I	Markets and Policies IV		
10:10 - 10:40	COFFEE BREAK			
10:40 - 12:20	People and Systems II	The Smart Readiness Indicator of Buildings		
12:30	LUNCH			

ENERGY CENTER HALL
24th July | 8:30 – 9:00
REGISTRATION

ENERGY CENTER AUDITORIUM
24th July | 9:00 – 9:30
OPEN CERIMONY

ENERGY CENTER AUDITORIUM
24th July | 9:30 – 10:15
PLENARY SESSION - Speaker: *Kathryn Janda*

ROOMS P AREA
24th July | 10:30 – 11:00
COFFEE BREAK

24th July | 11:00 – 12:20 | Room 1P
SESSION: **BUILT ENVIRONMENT**
Chairman: *Luísa Dias*

ID	
114	**GENERATION OF A REFERENCE DATASET WITH TWENTY LOWINCOME SINGLE-FAMILY HOUSES IN FORTALEZA, BRAZIL, AND THERMAL DISCOMFORT ASSESSMENT** *Jean M. Parente, Eugénio Rodrigues, Marco S. Fernandes, Bárbara Rangel, João P. Martins*
130	**DEVELOPMENTS OF A BIM ADD-ON TOOL FOR DEEP RENOVATION OF BUILDINGS** *Eugénio Rodrigues, Marco S. Fernandes, Adélio Gaspar, Álvaro C. Gomes, João F. Oliveira, Luís Cotrim Mateus, Victor Mota Ferreira*
104	**A COMPOSITE DECISION SUPPORT SYSTEM FOR ASSESSING TRANSFORMATION SCENARIOS AT THE DISTRICT LEVEL** *Cristina Becchio, Marta Bottero, Stefano Paolo Corgnati, Federico Dell'Anna, Giulia Pederiva, Giulia Vergerio*
102	**AN ENERGY-FINANCIAL DECISION-MAKING TOOL FOR PLANNING BUILDING RETROFIT BASED ON BASIC INPUT DATA** *Giulia Vergerio, Sara Viazzo, Cristina Becchio, Stefano Paolo Corgnati*

25th July | 8:30 – 10:00 | Room 3P SESSION: **BUILT ENVIRONMENT** **Chairman: *Eugénio Rodrigues***	
ID	
92	**INDIVIDUALIZED SUSTAINABLE AND COST OPTIMAL ENERGY RETROFITTING SOLUTIONS FOR THE EXISTING OFFICE BUILDING STOCK** *Marta Gangolells, Miquel Casals, Ariadna Puig, Jaume Ferré, Kàtia Gaspar*
73	**FINANCING MODELS FOR DEEP RETROFIT ACTIONS WITHIN THE BUILDHEAT PROJECT: A CASE STUDY** *Sergio Olivero, Paolo Lazzeroni, Federico Stirano, Roberto Fedrizzi*
133	**THERMAL BEHAVIOUR OF A MODULAR GREEN ROOF SYSTEM - EXPERIMENTAL CHARACTERIZATION** *Catarina Serra, Nuno Simões, Katya Coelho, Julieta António*
35	**THE HELLO PROJECT: RISK ANALYSIS AND MITIGATION STRATEGIES** *Luisa Dias Pereira*

ROOMS P AREA
25th July | 10:00 – 10:30
COFFEE BREAK

25th July | Rooms P **WORKSHOPS**	
ROOM	10:30 – 11:30
1P	**WS1 – *Energy-driven urban regeneration***
4P	**WS2 – *Science based support for energy transition***
	11:30 – 12:30
1P	**WS3 – *Evaluation tools for decision-making process in energy investment projects***
4P	**WS4 – *New paradigms for the energy transition at the consumer scale***

ROOMS P AREA
25th July | 12:30 – 14:00
LUNCH

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Designing a Sustainable Future
Turin, 24-26 July 2019

THE HeLLo PROJECT: RISK ANALYSIS AND MITIGATION STRATEGIES

L. Dias Pereira[1]

1: Architettura>Energia Research Centre, Department of Architecture,
University of Ferrara
44121 Ferrara
e-mail: dsplmr@unife.it web: http://www.unife.it/centro/architetturaenergia

Keywords: Historic buildings, Cultural Heritage, Energy refurbishment, Experimental test, On-site training, Living lab

Abstract

Built heritage represents a significant part of tangible Cultural Heritage (CH). One important way of preserving this CH for the future is to keep it into use, and more importantly in a sustainable use. The MSCA-IF project entitled HeLLo – Heritage energy Living Lab onsite *is grounded in the field of energy refurbishment of heritage buildings.*

In order to respond to the challenges/criticalities of intervening in historic buildings, an analysis of the guidelines, norms and procedures of CH protection was considered, including Italian Regulation (mostly due to the in-situ profile of the HeLLo *project – to measure the building actual thermal-hygrometric behaviour and further thermal insulation materials performance). This paper presents the risks analysis and mitigation strategies of this project.*

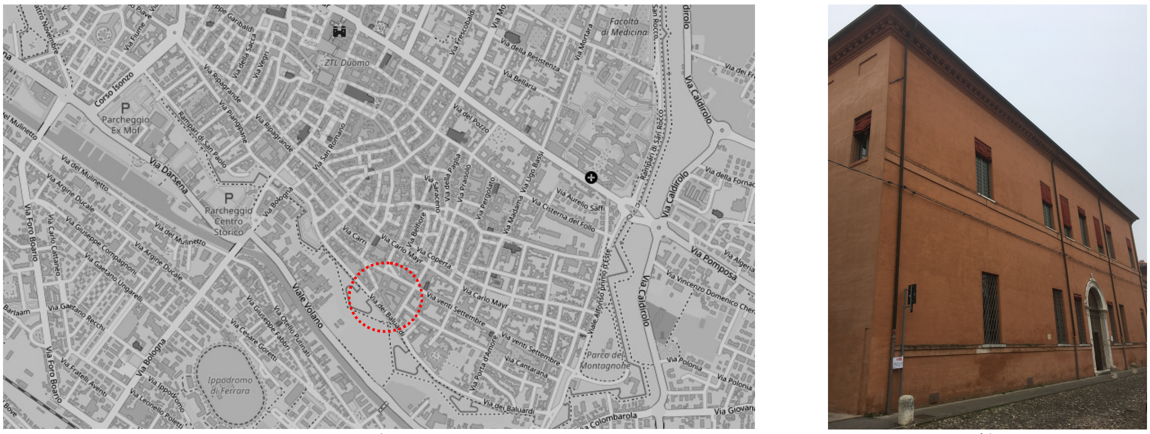
Firstly, HeLLo *is presented and framed in the guidelines and procedures for Cultural Heritage (CH) protection, including UNESCO/ICOMOS documentation. Then, a series of potential risks related to CH interventions are identified and HeLLo specific mitigation strategies are signalled. Finally,* HeLLo *initial steps and ongoing research are unveiled.*

1. INTRODUCTION

Built heritage represents a significant part of tangible Cultural Heritage (CH). One important way of preserving this CH for the future is to keep it into a sustainable use. Furthermore, tackling energy efficiency of historic buildings has been a particular point of interest of the EU research priorities [1]. The MSCA-IF project entitled *HeLLo – Heritage energy Living Lab onsite* [2] is grounded in the field of energy refurbishment of heritage buildings.
One of the strategies for the energy retrofit of historical buildings is to improve the building envelope through the insertion of insulating layers on the inner face, normally considering the greatest difficulty in placing it on the outer one. Using the standard technologies in historic buildings can give rise to fundamental risks**:** putting the energy improvement and the cost/benefit ratio of the adopted solution into a crisis, but also risking the CH safeguarding. Such subject requires specific skills and field survey of the specific energy situation.
In order to respond to the challenges/criticalities of intervening in historic buildings, an analysis of the guidelines, norms and procedures of CH protection was considered, including Italian Regulation (mostly due to the *in-situ* profile of the *HeLLo* project – to measure the building actual thermal-hygrometric behaviour and further thermal insulation materials performance).
HeLLo risk management approach, summarizing this investigation, is presented at the end of section 4, and, finally, *HeLLo* initial steps and ongoing research are unveiled.

2. HeLLo PROJECT PRESENTATION

The HeLLo project [2] aims at spreading the awareness of professionals (architects, public administrations, superintendents, end-users) and the knowledge of the real potential of some retrofit solutions in the case of intervention on historic buildings. Today's construction market offers many varied technologies designed specifically for new buildings. However, it is not always possible to make generalizations due to potential incompatibilities or criticalities that are difficult to foresee during the design phase. In a perspective of a model of 'itinerant network laboratory', the first onsite case study of HeLLo is Palazzo Tassoni Estense in Ferrara, a renaissance building rich of historical and artistic values to be protected (Figure 1).



a) b)

Figure 1 – a) Site plan of the Palazzo Tassoni Estense [© OpenStreetMap contributors (2019)]; b) Façade of the Palazzo Tassoni Estense [Photo by M. Calzolari], *in* [3].

Herein, the following potentiality (P) and criticality (C) are addressed: P – it is a monumental building, therefore a significant and representative example of the characteristics of historic buildings (e.g. thermal inertia, surface mass, bricks). It is to be restructured, therefore, there are less criticalities to deal with; C – there are difficulties of integrating new technologies (e.g. compatibility with worth structures).

3. RISK ANALYSIS METHODOLOGY

3.1. Guidelines, norms and procedures for CH protection

Though there have been *'Cultural Heritage Policy Documents'* published in the 19th c. (namely *The SPAB Manifesto*, 1877), for many, the bottom line document concerning heritage protection is the *Athens Charter* (1931), the first international recommendation on conservation [4]. In Italy, this was followed by *Carta italiana di restauro. Norme per il restauro dei monumenti* (1932) [5], the first official directive of the Italian State in this field. Since 1985, Italy has its own *'Law of Historical Heritage'* and several other regulations at national and regional level, which are updated from time to time. These include the Legislative Decree No 42 of 22 January 2004, *Codice dei beni culturali e del paesaggio ai sensi dell'articolo 10 della legge 6 luglio 2002, n. 137*. (Code of Cultural Heritage and Landscape).

In 2003, UNESCO[1] launched the *UNESCO Database of National Cultural Heritage Laws* [6], a free online tool which allows access to CH *'heritage laws currently in force as well as a rapid consultation of other relevant national cultural rules and regulations'*. After Faro convention (2005), was created HEREIN [7] – another information network which provides a database on CH policy and legislation. This entity was established by the Council of Europe at the request of the Member States to take stock of the changes in legislation and practices in the participating countries and provide a forum for pooling and sharing information on CH, bringing together European public administrations in charge of national CH policies and strategies [8] (p.34). In 2011, ICOMOS[2] launched *Guidance on Heritage Impact Assessments for Cultural World Heritage Properties* [9], a publication *'to offer guidance on the process of commissioning* HERITAGE IMPACT ASSESSMENTS (HIAs) *for World Heritage (WH) properties in order to evaluate effectively the impact of potential development on the Outstanding Universal Value (OUV) of properties'*. One year later, another important publication came to light: *Guidelines on Cultural Heritage Technical Tools for Heritage conservation and management* [10], produced within the framework of the Joint Project "EU/CoE Support to the Promotion of Cultural Diversity in Kosovo", implemented by the Council of Europe (CoE). This guidance for the process of commissioning HIAs was complemented in 2017 with the *Operational Guidelines for the Implementation of the World Heritage Convention* [11], Committee 41 COM 11.

3.2. CH RISK ANALYSIS COMMON BACKGROUNG

When generally talking about CH interventions, several risks emerge: (i) destruction and/or loss; (ii) disappearance or deterioration of cultural assets; (iii) asset decay or dispersion, which may cause any devaluation. When talking about architectural assets in particular, some other risks arise. Table 1 presents the main typical damage risks in Historic Buildings according to [12] *cited in* [13]. Nonetheless, other risks can be pointed out, namely: (i)

[1] United Nations Educational, Scientific and Cultural Organization

[2] International Council on Monuments and Sites, created in 1965 after *The Venice Charter*

structure failure (not all apparent cracks mean an indication of structure risk); (ii) damage in non-structural elements, e.g., cladding or internal partitions; (iii) **hygrothermal risks** (e.g. mold growth or condensation).
Recalling the European project *HeritageCare*[3] [14]: *'the* **condition survey** *is the first step to undertake in order to plan appropriate and effective preventive conservation measures on built cultural heritage, thereby minimizing future damage and deterioration processes'* [15].

Table 1. Typical damage risks in historic buildings structural walls [13]

General	**External walls**	**Other**
Infestation of timber components (fungus, mould, rot)	Efflorescence, salt deposits	Sooting up of chimneys
Removal of hazardous substances, materials	Exposed reinforcement	
Water damage due to defect waste-water pipes, drains, roof drain, roof covering, water installation	Erosion of masonry joints	
Moisture damage from ground water due to missing sealing, horizontal barrier	Spalling of external material layers (masonry, plastering)	
	Surface mould growth due to bad insulation standard, high moisture loads	

4. SPECIFIC RISKS OF HeLLo PROJECT

4.1. HeLLo and CH protection

The HeLLo project [2] intends to implement and test *in-situ* the insertion of insulating layers on the inner face of historical buildings for energy retrofit, which necessarily gives rise to some risks. One of these, is the **risk of condensation**, which will be monitored: when applying a new internal insulation layer to an existing wall, a new 'barrier' is generated between the original wall and the indoor climate. Because of this, *'the structures' dew point (the temperature in which the water vapour condensates) shifts inside'* [16]. From the evidence of risk for frost damage, mould and condensation [16][4] (p.341), for T > 0 ºC, RH should be kept below 80%.
Within an important historic building, the aesthetic-morphological quality and its effect on CH is also significant. Therefore, a compromise is established between the conservation of the historic fabric and character and the upgrade for energy efficiency in no damaging and possibly, in a compatible, minimally invasive and above all reversible manner[5].

4.2. HeLLo project – The Risk Management table

Whatever the field of a research project, the exposure to a given risk can be estimated using a risk matrix. Herein, the *EMBRIC* project Risk Matrix [17] was used as reference. According to this [17] (p.9), HeLLo risks were synthetized in Table 2.

Table 2. Synthesis table of the specific risks of HeLLo project

<table>
<tr><td colspan="3">Foreseen risks | List of the risks identified in the HeLLo project proposal – forecasted before the beginning of the project</td></tr>
<tr><td>Risk No.</td><td>Description of Risk</td><td>Proposal risk-mitigation measures</td></tr>
</table>

[3] *Monitoring and Preventive Conservation of Historic and Cultural Heritage*
[4] *Appendix D: GUIDELINES – Procedure for the calculation hygrothermal performance with an assessment example.*
[5] To address this strategy, a technical worktable with Heritage Authorities - which regulate works on this type of buildings to protect the historic character of the building - will be planned to discuss technical limits within aesthetic and conservation restrictions.

R1	Companies might not provide the material to be studied (little collaboration/ insufficient material obtained)	Expansion of the research pool of companies
R2	Longer technical execution times caused by differences of opinion or because the investigated solutions are not compatible, so they need to be replaced.	The solution will be revising the action plan to look for new materials and/or find new technicians;
R3	Technical problems in the monitoring phase, such as: i) instrument breaks; ii) insufficient estimated time; iii) problems with the season (anomalous climate trends)	One solution can be using the intermediate seasons for monitoring campaigns and to repeat tests which might have not succeeded.
Unforeseen / non-specified risks | Risks arisen since the beginning of the project (mostly related to CH protection)		
Risk No.	**Description of Risk**	**Proposal risk-mitigation measures**
R4	*Case-study* Not suitable for the planned experimental activity because of technological or architectural features.	Identification of another case study
R5	*Monitoring system* From literature review & data collection on key technologies, the necessity of using wired monitoring systems/sensors has emerged. As such, passaging cables through an historic wall became a risk.	The technology should be compatible and preferably non-invasive, therefore it should: i) use pre-existing cracks and holes for the passage of cables. ii) use extended cables if necessary
R6	*Historic material deterioration* From literature review and data collection on *in-situ* tests, the necessity of promoting a significant ΔT (between I/O faces of the wall) has emerged. This might lead to the overheating of the historic wall components and risk of damaging it.	Identification/ selection of a wall with minor architectural features, old but not original materials (e.g. plasters).
R7	*Risks related to the experimentation: alteration of the hygrothermal properties of the wall* From literature review and data collection om *in-situ* tests, the necessity of promoting a significant ΔT (between I/O faces of the wall) has emerged, which might lead to the overheating of the historic wall components. Moreover, the addition of new materials/layers for the energy retrofit of the wall under test, might introduce changes to the original performance of the wall.	Identification/ selection of compatible, minimally invasive and reversible technologies. If necessary, the new installed layers might be removed to restore the original performance of the wall. Moreover, the continuous monitoring of the hygrothermal parameters in between the new added layers, will allow preventing condensation.
State of the Play for Risk Mitigation *(mitigating measures that have been taken since the beginning of the project)*		
Risk No.	**Did you apply risk mitigation measures? [Yes / No]**	**Comments**
R1	[Yes]	To mitigate **R1** | ***absence of sponsored material provided from companies to be tested***, the contact with thermal isolation production companies was anticipated and established from the early beginning of the project: attending SAIE, Bologna 2018 and *Klimahouse,* Bolzano 2019 - two construction and built environment fairs
R3	[Yes]	To mitigate the risk of ***Technical problems in the monitoring phase, e.g. insufficient estimated time,*** the selection of suitable spaces inside the case study was anticipated

5. DISCUSSION, ONGOING AND FORTHCOMING WORK

Assuming that CH protection is of the public interest and a dynamic process, the existing standards and good practices on conservation and restauration should be respected. As such, starting from the challenge of monitoring heritage buildings, namely respecting the *compatibility* and *reversibility* of any applied system, a low-cost remote sensing technology serving the conservation constraints is being developed with EURAC research team [3]. Moreover, having been determined the 1st experimental room in the not refurbished area of Palazzo Tassoni, an inhabited and not air-conditioned space of circa 700 m^3, it has been decided to build an in-situ "hot-box" (≈ $20m^3$), aiming at enhancing the experiment sustainability: i) minimizing the surface of impact [(only a part of the walls of the room will be heated (see R6 and R7, Table 2)]; ii) minimizing the amount of required energy to promote the required temperature difference (between the inner and outer face of the historic wall). The installation of the first insulation material being tested is expected in the next months.

ACKNOWLEDGMENTS

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