Renovating Historic Buildings Towards Zero Carbon
SHC Task 59 / EBC Annex 76

IEA SHC Workshop: Integrating Solar in Buildings – What We’ve Learned & What’s Next

Alexandra Troi, Eurac Research
IEA SHC “virtual national day”
Online meeting, 15th June 2021
There is a need

one of the greatest challenges
the continent faces is converting the
historic buildings in Europe’s centuries-
old cities for a sustainable future
European climate commissioner and EU executive vice-
president Frans Timmermans

We will set up a new
European Bauhaus – a co-
creation space where
architects, artists, students,
engineers, designers work
together to make that happen
Ursula von der Leyen, State of the Union
Adress 2020
Whom we addressed

- Architects and consultants
- Building owners
- Heritage authorities
- Developers and contractors
- Policy makers
Task structure

A. Knowledge Base

B. Multidisciplinary planning process

C. Conservation compatible retrofit solutions

D. Demonstration and dissemination
A – Knowledge Base

Task lead: e7 / Austria

www.hiberatlas.com
Some highlights – House Breuer, House Maurer, Freihof Sulz

- Original construction was carried out using old techniques wherever possible.
- The outer wooden façade has been preserved in its entirety: wooden construction with 24 cm of isofloc insulation → U-value 0.17 W/m²K
- Solar thermal and PV system are integrated in the roof

- Characterized by an integrative planning process.
- Special focus on sustainability in the sense of economical and careful use of scarce resources as well as the sensible use of ecological building materials are considered.

- The living space changed from a 4-apartment house with 370 m² for an average of 5 people to a 7-apartment house for 12 residents
- Insulation of Holzstrick from inside with 100 mm and outside behind the shingles 50 mm (U-value: 0.20 W/m²K)
Case Studies
Assessment Report
June 2021

RENOVATING HISTORIC BUILDINGS TOWARDS ZERO ENERGY

www.iea-shc.org

Task 59

4.2.5 Ventilation

4.2.1.1 Overview of ventilation solutions

Table 1: Overview of ventilation solutions

<table>
<thead>
<tr>
<th>Case study</th>
<th>Country</th>
<th>Building</th>
<th>Solution</th>
<th>Method of calculation</th>
<th>Heat gain (GWH)</th>
<th>Heat loss (GWH)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Case 1</td>
<td>Austria</td>
<td>Administration</td>
<td>Mechanical</td>
<td>Ventilation simulation</td>
<td>1.8</td>
<td>2.0</td>
</tr>
<tr>
<td>Case 2</td>
<td>Italy</td>
<td>Residential</td>
<td>Natural</td>
<td>CFD analysis</td>
<td>1.2</td>
<td>1.5</td>
</tr>
<tr>
<td>Case 3</td>
<td>Germany</td>
<td>Commercial</td>
<td>Mixed</td>
<td>HSP software</td>
<td>2.0</td>
<td>2.5</td>
</tr>
</tbody>
</table>

The table above provides an overview of the ventilation solutions for different case studies. Each case study includes the country, building type, solution type, method of calculation, heat gain, and heat loss values.

4.2.6.2 Quality assurance (review process) (Framework)

Ensuring the quality of the heat analysis deployed in the database is crucial for obtaining accurate and reliable results. This is achieved through a structured review process that involves expert assessments and peer reviews.

The review process is divided into stages, where each stage is followed by a thorough evaluation of the data. The process is iterative, allowing for continuous improvement and correction of any errors.

A summary table of the energy performance of the selected case studies is presented, highlighting the main results and achievements.

The table below shows the energy performance of the selected case studies, including key metrics such as energy demand, efficiency ratings, and cost savings for each case.

The review process and the resulting energy performance data are crucial for understanding the potential for energy savings and the effectiveness of the ventilation solutions implemented in the case studies.
C – Conservation compatible retrofit solutions

Task lead: UIBK / Austria

➔ from the HiBERatlas, but also beyond
➔ knowledge of a wide group of experts
C – Conservation compatible retrofit solutions

Task lead: UIBK / Austria

- **What is the solution?**
  (compatibility with conservation, technical function, energy improvement)

- **Why does it work?**

- **Description of the context**
  (What is special about the building and its surroundings?)

- **Pros and Cons** of the solution

- **Additional Information**
  (Publications, Links to further information)

---

2 A Replacing inner glass (includes vacuum and insulation glazing) (L1-M)
Author: Dagmar Exner

What is the solution?
This method can only be used for constructions with several window layers (one behind the other), such as tall or large windows. The historic window construction consists of a window frame and outer glazing is present and removed. The solution however is to replace the historical inner golden-silver glass pane with insulating glass or vacuum glazing. In order to fit insulating glass, the ribbon at the front frame of the inner window frame has to be extended on the outer side with a wooden leaf. This medium impact solution can be combined with 10.

Why does it work?
The inner window glass is protected from external heat and the glazing of this inner window pane is substituted by a double glazing. So that the historical frame can hold the thicker glazing pane. It is reduced at the outside by a wooden strip (see drawing). The insulating glass will find again on the outside with only (if lined all). The window frames were restored on site by replacing the paint with lined all. The outer window sash is painted with lined all of paint in order to fit to the specifications of the monument office while the inner window sashes are not painted with lined all of paint as there is a risk that the lined all could damage the build of the insulating glass. Traditional outer frames were repaired with intact historical inner glass pane. Thus, all outer windows have an exclusively historical glazing.

Figure 14. Rennovatd double-glazed window – before and after renovation

Figure 15. Rennovatd double-glazed window – view from inside after renovation

Figure 16. Rennovatd double-glazed window – details after renovation

Figure 17. Rennovatd double-glazed window – details after renovation

Figure 18. Rennovatd double-glazed window – details after renovation

---

Conservation: The retrofit solution reproduces the requirements of the heritage: preserving the historic window construction and replacing all other criteria on color and proportions. Visual changes were therefore only on the inside as on the window; the replacement of the historic single glazing in the inner window sash into the thicker double-glazing with better energy performance required the widening of the inner window frames with a wooden strip. Besides that, the first double-glazing has another option than the historic glazing. The integrated seal on the inner side of the window frame is only visible when the inner window sashes are open.

Thus, the window appearance and proportions didn’t change at all from the inside and only slightly on the outside. Billets also fit the inner glazing of the window construction after renovation is generally preserved. Through the double glazing in the inner window sash, we have higher surface temperatures on the pane and thus less condensation risk. Further temperatures in the single glazing inside the window frame are reduced and are already right in case of a single glazing. In case of the double-glazing, inner and outer glazing in the window reveal, avoids additional consideration all around the window frame. The window manufacturer used special tools and a special manufacturing of the glazing which made it possible to make even slightly window frames completely tight. Thus, the vapor pressure inside the interstitial space between the inner window layer and condensation on the inner surface of the outer glazing. Energy improvement: ventilation heat losses through heavy mullions were decreased by improving the air-tightness through a seal on the inner side of the window frame and between the two inner window sash. Transition loss tables were determined by the exchange of the inner glazing into a double-glazing (Ug = 1.0 W/m²K after Ug = 0.75 W/m²K before); the overall U-value was thus improved from 2.39 W/m²K to 1.26 W/m²K.

Description of the context:
The Rehband is a residential house located in Karlstein in South Tyrol (North Italy) on a sea level of about 1,000 m. The building is a row house which is one of the oldest buildings in the village. It was built as tenant family houses with a central horn and status. After its renovation, the house was unoccupied for 40 years. The heritage preservation efforts have formulated clear requirements for the building, which is under monument protection, which were taken into account during the retrofit. Conservation
C – Conservation compatible retrofit solutions

Task lead: UIBK / Austria

Around 40 solutions
- Internal insulation, frame infill insulation, cavity insulation, reversible systems and innovative solutions

Around 16 solutions
- Classified according to the type of window (single window, box-type window, etc.)
- Further distinction according to the historical impact

Around 40 Solutions
- Plants attached to the roof, roof integrated, attached to the wall, façade integrated
- Free-standing solar plants and solutions for the integration into the landscape

18 Solutions for ventilation
- 25 Solutions for heating which are divided in heating production and heating distribution

Walls

Windows

Solar

Ventilation

Heating

www.hiberatlas.com
C – Conservation compatible retrofit solutions

Task lead: UIBK / Austria

→ in a report, but also in a guidance tool with decision tree

HiBERtool - (Historic Building Energy Retrofit Tool)

With the Hibertool a possibility is given to explore and find different solutions for the energy-efficient retrofit of historical buildings. The tool documents solutions for windows, walls.
C – Conservation compatible retrofit solutions

Task lead: UIBK / Austria

Compatibility assessment following EN 16883 → Link to SubTask B

<table>
<thead>
<tr>
<th>Assessment category</th>
<th>ROOF ATTACHED BAPV-BAST</th>
<th>ROOF INTEGRATED BIPV-BIST</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Strengths</td>
<td>Weakness</td>
</tr>
<tr>
<td>Hydrothermal risk</td>
<td>(2)</td>
<td></td>
</tr>
<tr>
<td>Structural risk</td>
<td>(2)</td>
<td></td>
</tr>
<tr>
<td>Reduction efficiency risk</td>
<td>(2)</td>
<td>Water proof (2)</td>
</tr>
<tr>
<td>Fire safety</td>
<td>(2)</td>
<td></td>
</tr>
<tr>
<td>Design and installation</td>
<td>(2)</td>
<td>Design and installation (12)</td>
</tr>
<tr>
<td>Connections</td>
<td>(2)</td>
<td>Connections (12)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heritage significance</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Risks of visual impact</td>
<td>(2)</td>
<td></td>
</tr>
<tr>
<td>Risk of spatial impact</td>
<td>(2)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Economic viability</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operating costs</td>
<td>(1)</td>
<td></td>
</tr>
<tr>
<td>Economical return</td>
<td>(1)</td>
<td>Economical return (5)</td>
</tr>
<tr>
<td>Capital costs</td>
<td>(2)</td>
<td></td>
</tr>
<tr>
<td>Economic savings</td>
<td>(2)</td>
<td>Economic savings (6)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Energy</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Energy performance</td>
<td>(2)</td>
<td></td>
</tr>
<tr>
<td>Life cycle energy demand</td>
<td>(1)</td>
<td>Life cycle energy demand (2)</td>
</tr>
<tr>
<td>IE quality</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IE conditions suitable</td>
<td>(2)</td>
<td>IE conditions suitable (10)</td>
</tr>
<tr>
<td>Impact on the outdoor environment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Greenhouse gas emission</td>
<td>(1)</td>
<td>Natural resources (2)</td>
</tr>
<tr>
<td>Research and development</td>
<td>(2)</td>
<td></td>
</tr>
<tr>
<td>Aspects of use</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Effects of RES on users</td>
<td>(2)</td>
<td></td>
</tr>
<tr>
<td>Effects of change of use</td>
<td>(2)</td>
<td>Effects of change of use (10)</td>
</tr>
<tr>
<td>Easy to manage and operate</td>
<td>(2)</td>
<td>Easy to manage and operate (4)</td>
</tr>
</tbody>
</table>
B – Multidisciplinary planning process

Task lead: Uppsala University / Sweden

EN 16883 → is a procedural standard

→ Factsheets
→ Feedback for future improvement
→ Handbook – „a guide for the guide“ complement the standard with examples and tools written with two examples, a small building and a big one through the whole process
D – Demonstration and dissemination

Task lead: Historic Environment Scotland / United Kingdom
D – Demonstration and dissemination

- Non-destructive techniques and tools for the thermal characterisation of historic buildings
  April 2021 – S. Álvarez-Díaz - CARTIF Technology Centre

- Webtool to help owners and design professionals to characterize the qualities and needs of historical residential buildings with heritage value
  March 2021 – D. Sternon, S. Altomonte - Université Catholique de Louvain

- Brightly colored solar modules for building facades: State of development of MorphoColor® technology
  February 2021 – T. Kroyer, A. Dinkel - Fraunhofer ISE

- BIPV in dialogue with history
  January 2021 – C. S. Polo Lopez, P. Corti, P. Bonomo - SUPSI

- Thermal performance of historical masonry structures: experimental data and numerical modeling
  December 2020 – A. Lo Faro, V. Constanzo, G. Eiola, F. Nocera - Università di Catania

- Embedding thermal comfort into retrofitting design
  November 2020 – A. Petsou - University College London

- SBE21 Heritage Conference, the final event of Task59
  October 2020 – D. Herrera, A. Troi - Eurac Research

- Old buildings can’t be energy efficient, right?
European Congress on the Use, Management and Conservation of Buildings of Historical Value

The following videos were recorded October 16,17, 2019 at the Hofburg in Vienna (Austria) during the above event:

OVERVIEW
Book the Touring Exhibition for your event!

The Touring Exhibition shows some exemplary case studies of energy retrofits in historic buildings developed as part of the HIBER ATLAS best practice database. The ultimate goal is to inspire owners of properties to maintain and improve our built heritage.

The exhibition is made up of 12 individual banners, one introductory panel and 11 examples of retrofitted buildings across Europe. Take a closer look at them here.

The exhibition is travelling around the world, with some dates already fixed. For more information on where and when to see the exhibition in action, and how to book it for your own event, please visit the Touring Exhibition calendar.
Task News View All

05 MAY
SBE21 conference spotlights historic NZEBs
The SBE21 Heritage conference in mid-April involved a deep exchange of ideas between researchers, architects and practitioners about how to reduce the...
read more

13 APR
On-Site Registration available for SBE21
From the 14th to the 16th of April 2021, it will be possible to register "on-site". The "on-site" day-by-day registration...
read more

19 JUN
SBE Heritage conference calls for papers
The SBE conference's 2021 edition will be held under the title SBE Heritage in Bolzano, Italy, between 14 and 16 April 2021.
read more

19 MAY
Call for Proposals: SBE21 Heritage
The conference will be dedicated to the sustainable improvement of the built heritage, a research area that has grown significantly over the last 10 years...
read more

Recent Publications View All
… and finally the word to the Netherlands