3encult
EFFICIENT ENERGY FOR EU CULTURAL HERITAGE

D 8.8 Proceedings of conference sessions & workshops

Task 8.8 Dedicated sessions or parallel workshops at conferences

EUROPEAN COMMISSION

DG Research and Innovation

Seventh Framework Programme

Theme [EeB.ENV.2010.3.2.4-1]

[Compatible solutions for improving the energy efficiency of historic buildings in urban areas]

Collaborative Project – GRANT AGREEMENT No. 260162

SEVENTH FRAMEWORK PROGRAMME

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Technical References

Project Acronym	3ENCULT
Project Title	Efficient ENergy for EU Cultural Heritage
Project Coordinator	Alexandra Troi EURAC research, Viale Druso 1, 39100 Bolzano/Italy Alexandra.troi@eurac.edu
Project Duration	1 October 2010 – 31 March 2014 (42 Months)

Deliverable No.	D8.8
Dissemination Level	PU
Work Package	WP 8 “Dissemination & Training”
Lead beneficiary	EURAC
Contributing beneficiary(ies)	PHI, ICLEI, REHVA, PHI, UIBK
Author(s)	Alexandra Troi
Co-author(s)	
Date	31st March 2014
File Name	WP8_D8.8_20140331_P01_Proceedings of Conference sessions-workshops

Table of Content

0 Abstract

In order to use synergies and save resources for the organisation, but also with the aim to optimise participation and therefore dissemination outreach, 3ENCULT organised a number of sessions and workshops within conferences addressing different target groups:

- ICLEI workshops targeting Local authorities, policy representatives and decision makers
- EWCHP addressing the Cultural Heritage research community
- International Passive House Conferences addressing architects but also enterprises experienced with very low energy buildings
- CLIMA 2013 addressing HVAC professionals and enterprises;
- ENERGY FORUM addressing an interational audience with focus on building envelopes);
- Better Buildings' session chaired by ICOMOS adressing conservation architects and conservation professionals

1 Overview

In order to use synergies and save resources for the organisation, but also with the aim to optimise participation and therefore dissemination outreach, 3ENCULT organised a number of sessions and workshops within conferences addressing different target groups.

what	where	when	who
Session at ICLEI European Convention 2011	Brussels BE	13.9.2011	Focus on local authorities, policy and decision makers 60 participants from all over Europe
Session at ICLEI Local Renewables 2011	Freiburg DE	27.-28.10.20911	Focus on local authorities, policy and decision makers 15 participants from all over Europe
Workshop at EWCHP 2013	Oslo NO	24.-26.9.2912	Focus on Cultural Heritage research community and professionals 25 participants from all over Europe at the workshop, 100 at the conference
Session at International Passive House Conference	Frankfurt DE	19.-20.4.2013	Focus on architects 1000 participants at conference, ~250 at the session (4 parallel)
Workshop at CLIMA 2013	Prague CZ	17.-19.6.2013	Focus on HVAC professionals and enterprised 15 participants in the workshop
Three workshops at EWCHP 2013	Bolzano IT	16.-18.9.2013	Focus on Cultural Heritage research community and professionals 25 participants from all over Europe at the workshop, 100 at the conference
Session at ENERGY FORUM 2013	Bressanone IT	5.-6.11.2013	Interational audience with focus on building envelopes 100 participants from all over Europe at the workshop, 100 at the conference
ICOMOS chaired session at Bette Buildings Conference	Dublin IR	9.4.2014	Focus on architects and building professionals, session target conservation architects ~500 participants in conference, ~100 participants in session
Session at International Passive House Conference	Aachen DE	25.-26.4.2014	Focus on architects 1000 participants at conference, ~250 at the session (4 parallel)

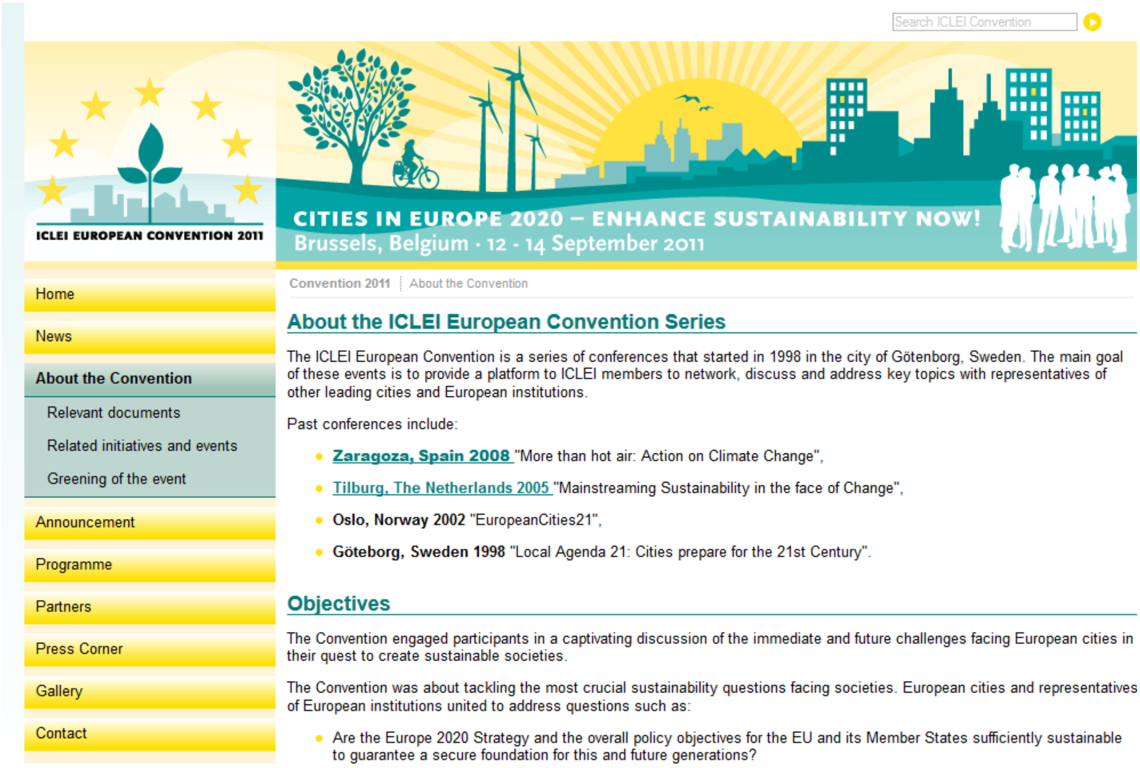
2 Dissemination Activity Reports

Dissemination Activities Report

Kind of activity	workshop
Lead Beneficiary	Choose an item. ICLEI
Contributing beneficiaries	ICLEI
Title	Organization of sessions on buildings at ICLEI European Convention 2011 -Cities in Europe 2020 - Enhance Sustainability Now!
Date	13.09.2011
Place	Brussels, Belgium
Type of audience	☐ End-users & their associations ☐ Consumer organisations ☑ EU, national & local authorities ☑ NGOs in CH Preservation ☑ Technological enterprises ☑ NGOs in energy Efficiency ☑ Scientific Community Other:
Size of audience	60 participants (in the dedicated sessions), 300 overall
Countries addressed	Europe

Description

ICLEI Europe organized two specific sessions on "building design and construction", facilitated by Maryke van Stane (ICLEI) and with contribution by Rainer Pfluger (UIBK) who presented 3ENCULT case studies Inssbruck and Bozen as examples of local governments' experiences and practical challenges they had to deal with and how these were resolved, and UIBK was also invited as a speaker to represent 3ENCULT.


Search ICLEI Convention

ICLEI EUROPEAN CONVENTION 2011

CITIES IN EUROPE 2020 – ENHANCE SUSTAINABILITY NOW!
Brussels, Belgium · 12 - 14 September 2011

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Convention 2011 | About the Convention

About the ICLEI European Convention Series

The ICLEI European Convention is a series of conferences that started in 1998 in the city of Götenborg, Sweden. The main goal of these events is to provide a platform to ICLEI members to network, discuss and address key topics with representatives of other leading cities and European institutions.

Past conferences include:

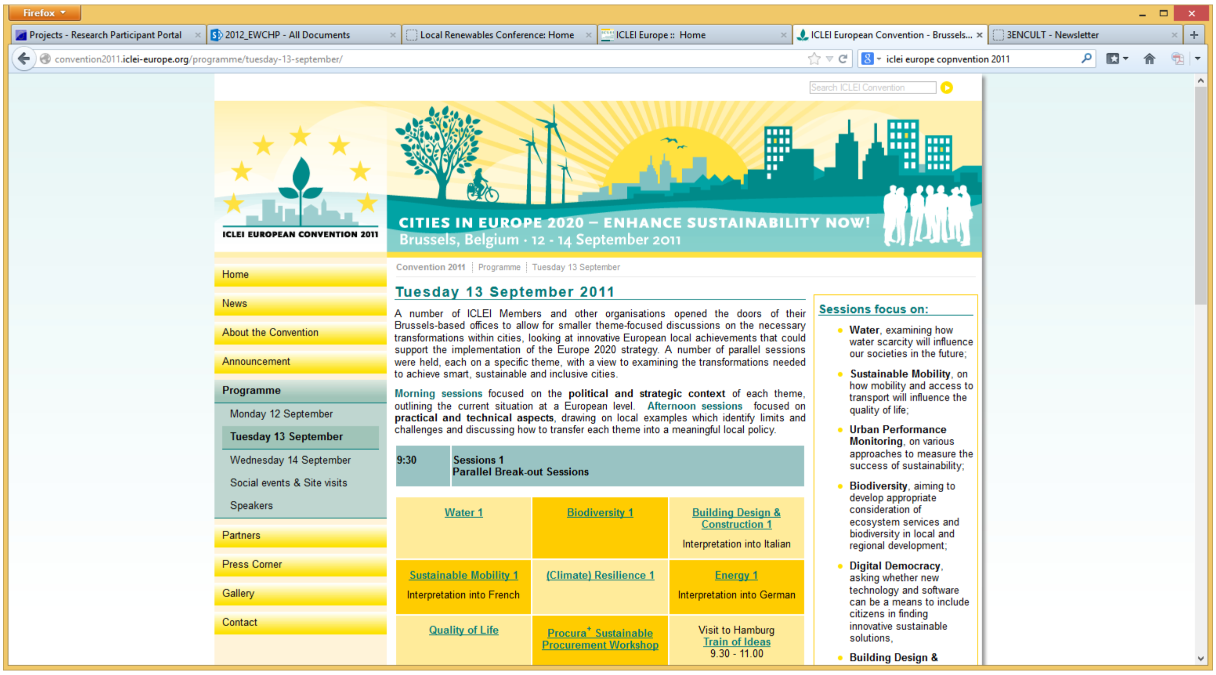
- **Zaragoza, Spain 2008** "More than hot air: Action on Climate Change",
- Tilburg, The Netherlands 2005 "Mainstreaming Sustainability in the face of Change",
- **Oslo, Norway 2002** "EuropeanCities21",
- **Göteborg, Sweden 1998** "Local Agenda 21: Cities prepare for the 21st Century".

Objectives

The Convention engaged participants in a captivating discussion of the immediate and future challenges facing European cities in their quest to create sustainable societies.

The Convention was about tackling the most crucial sustainability questions facing societies. European cities and representatives of European institutions united to address questions such as:

- Are the Europe 2020 Strategy and the overall policy objectives for the EU and its Member States sufficiently sustainable to guarantee a secure foundation for this and future generations?


convention2011.iclei-europe.org/programme/tuesday-13-september/

ICLEI EUROPEAN CONVENTION 2011

CITIES IN EUROPE 2020 – ENHANCE SUSTAINABILITY NOW!
Brussels, Belgium · 12 - 14 September 2011

- Home
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Convention 2011 | Programme | Tuesday 13 September

Tuesday 13 September 2011

A number of ICLEI Members and other organisations opened the doors of their Brussels-based offices to allow for smaller theme-focused discussions on the necessary transformations within cities, looking at innovative European local achievements that could support the implementation of the Europe 2020 strategy. A number of parallel sessions were held, each on a specific theme, with a view to examining the transformations needed to achieve smart, sustainable and inclusive cities.

Morning sessions focused on the **political and strategic context** of each theme, outlining the current situation at a European level. Afternoon sessions focused on **practical and technical aspects**, drawing on local examples which identify limits and challenges and discussing how to transfer each theme into a meaningful local policy.

9:30	**Sessions 1** **Parallel Break-out Sessions**

Water 1	Biodiversity 1	Building Design & Construction 1 Interpretation into Italian
Sustainable Mobility 1 Interpretation into French	(Climate) Resilience 1	Energy 1 Interpretation into German
Quality of Life	Procura^{+} Sustainable Procurement Workshop	Visit to Hamburg Train of Ideas 9.30 - 11.00

Sessions focus on:

- **Water**, examining how water scarcity will influence our societies in the future;
- **Sustainable Mobility**, on how mobility and access to transport will influence the quality of life;
- **Urban Performance Monitoring**, on various approaches to measure the success of sustainability;
- **Biodiversity**, aiming to develop appropriate consideration of ecosystem services and biodiversity in local and regional development;
- **Digital Democracy**, asking whether new technology and software can be a means to include citizens in finding innovative sustainable solutions,
- **Building Design &**

Dissemination Activities Report

Kind of activity	presentation at conference
Lead Beneficiary	ICLEI
Contributing beneficiaries	ICLEI, EURAC
Title	Dedicated session at Local Renewables 2011
Date	27-28.10.2011
Place	Freiburg, Germany
Type of audience	☐ End-users & their associations ☐ Consumer organisations ☑ EU, national & local authorities ☑ NGOs in CH Preservation ☑ Technological enterprises ☑ NGOs in energy Efficiency ☑ Scientific Community Other:
Size of audience	150 participants
Countries addressed	Europe

Description

The theme of Local Renewables Freiburg 2011 is building.

ICLE therefore organised a session dedicated to “Renovating historical buildings: where to invest

Historical buildings can consume a significant amount of energy and in many cases are particularly difficult to improve energy efficiency, due to restrictions applying to monuments and the sensitive building structure. European historic building centers are the hallmark of the continent, drawing many tourists, yet also have enormous retrofit needs. In this session, experts from various European retrofitting projects discussed the challenge of retrofitting historical buildings and how to do so efficiently while complying (or creating new) with rules and regulations for the conservation of ancient structures.

Facilitator: Maryke van Staden, Project Coordinator, Climate and Air Team, **ICLEI Europe**

Speakers:

- **Architectural heritage and energy efficiency**
  Dr Christian Hanus, Head, Center for Architectural Heritage & Infrastructure, Donau University, Krems, Austria [Abstract] [Presentation]
- **AC/DC project - to Adapt and Conserve / Develop and Create**
  Jan Falconer, Manager, Projects, Partnerships and Funding, Aberdeen City Council, Scotland, United Kingdom [Abstract] [Presentation]
- **Energy efficiency in historic buildings - the 3ENCULT project in focus**
  Dr. Alexandra Troi, Vice Head of the Institute for Renewable Energy, European Academy of Bozen/Bolzano [Abstract] [Presentation]

Dissemination Activities Report

Kind of activity	workshop
Lead Beneficiary	P01 EURAC
Contributing beneficiaries	UIBK, TUD, USTUTT, UNIBO, KA
Title	3ENCULT training at the 2nd European Workshop on Cultural Heritage Preservation EWCHP
Date	26.9.2012
Place	Oslo, Norway
Type of audience	☑ End-users & their associations ☐ Consumer organisations ☐ EU, national & local authorities ☑ NGOs in CH Preservation ☑ Technological enterprises ☐ NGOs in energy Efficiency ☑ Scientific Community Other: architects and conservato
Size of audience	More than 100 in the conference, about 25 in the training.
Countries addressed	Europe

Description:

Half day training on 3ENCULT themes:

Energy Efficiency in Cultural Heritage Buildings. How can diagnosis, monitoring & simulation play together to reach high quality energy retrofits of Cultural Heritage Buildings? Different tools and their application - explained and demonstrated on practical examples.

Apart the presentations in the Annex the training included

- Practical presentation of measurement devices (as e.g. heat flux plates)
- Practical experimation with the Roombook
- Video on 3ENCULT case studies with focus on diagnosis
- Video on internal insulation simulation
- Extensive discussion with participants on practical experience and need for tools

Dissemination Activities Report

Kind of activity	presentation at conference
Lead Beneficiary	P11 PHI
Contributing beneficiaries	EURAC, UIBK
Title	3ENCULT session at the 17th International Passive House Conference
Date	19.-20.4.2013
Place	Frankfurt, Germany
Type of audience	☑ End-users & their associations ☑ Consumer organisations ☑ EU, national & local authorities ☑ NGOs in CH Preservation ☑ Technological enterprises ☑ NGOs in energy Efficiency ☑ Scientific Community Other: architects
Size of audience	More than 1000.
Countries addressed	Worldwide

Description:

17th International Passive House Conference. Conference session III dedicated to 3ENCULT with two presentations from project partners

- Alexandra Troi: *Solutions & tools for the conservation compatible energy retrofit of historic buildings*
- Rainer Pfluger: *Active overflow ventilation for refurbishment of school buildings*

as well as two paper presentation and one poster presentation from other contributors

3ENCULT was also present with an own booth in the exhibition area of this conference

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Dissemination Activities Report

Kind of activity	workshop
Lead Beneficiary	P01 EURAC
Contributing beneficiaries	REHVA
Title	3ENCULT workshop at CLIMA 2013 World Congress
Date	17 June 2013
Place	Prague, Cz
Type of audience	☑ End-users & their associations ☐ Consumer organisations ☑ EU, national & local authorities ☐ NGOs in CH Preservation ☑ Technological enterprises ☑ NGOs in energy Efficiency ☑ Scientific Community Other: HVAC practicioners
Size of audience	15
Countries addressed	EU

Description

3ENCULT project consortium organised a workshop that presented special HVAC solutions for the refurbishment of historic buildings having beed developed during the project. Project coordinator Alexandra Troi (EURAC) gave an overview about the main aims, challenges and outcomes of the project pointing out the importance of the multicidsiplinary approach and the involvment of different stakeholders in the planning and implementation of refurbishment of listed buildings. Rainer Pflugler (University of Innsbruck) presented the case study of the listed Höttinger school building in Innsbruck, where the HVAC system was refurbished and special tailor made solutions compliyig the local regulations on listed buildings were developed by a multidisciplinary team. Enrico Zara closed the session with a presentation on the Multidisciplinary design for integrated solution in historical buildings. After the presentations attendees discussed the different aspect and challenges of the refurbishment of historical buildings and gave some useful views for the next period of the project.

SEVENTH FRAMEWORK PROGRAMME
3ENCULT – Grant Agreement No. 260162
EUREOPEAN COMMISSION – DG ENVIRONMENT

Dissemination Activities Report

Kind of activity	workshop
Lead Beneficiary	P01 EURAC
Contributing beneficiaries	UIBK, TUD, USTUTT, UNIBO, KA
Title	Three 3ENCULT related trainings at the 3rd European Workshop on Cultural Heritage Preservation EWCHP
Date	18.9.2013
Place	Bozen/Bolzano, Italy
Type of audience	☑ End-users & their associations ☐ Consumer organisations ☐ EU, national & local authorities ☑ NGOs in CH Preservation ☑ Technological enterprises ☐ NGOs in energy Efficiency ☑ Scientific Community Other: architects and conservato
Size of audience	More than 100 in the conference, about 25 in each training.
Countries addressed	Europe

Description:

WS2: Assessment of the potential for energy improvements in historic buildings: Practice, standards, case studies (3ENCULT, EFFESUS, Spara och bevara, CEN)

Coordinators: Tor Broström, Alexandra Troi

Description: Starting from the experiences in 3ENCULT, EFFESUS and Spara och Bevara and together with representatives from European standardization groups on “Energy Efficiency of Historic Buildings” (CEN TC346 WG8) and “Energy Performance of Buildings (EPBD)” (CEN TC89) , the participants discuss approaches how to best assess the potential for energy retrofit in historic building and how to best guide the development of conservation compatible solution for the specific building

Target audiences: architects, engineers, conservators, Local Authorities, owners of historic building

WS3: Comprehensive diagnosis and multidisciplinary approach for conservation compatible energy retrofit (3ENCULT)

Coordinators: Francesca Roberti, Dagmar Exner

Description: During a visit of the Public Weigh House, a listed medieval building in the historic centre of Bozen/Bolzano and case study of 3ENCULT project, the comprehensive diagnosis performed there within the project – including both heritage and energy related aspects and ranging from the building historians study over IR-thermography and Blower Door Test and Thermal Fluxes to material and construction detail analyses – is explained and practically shown. Moreover, the support of this multidisciplinary diagnosis and following design phase by a further developed Raumbuch is presented.

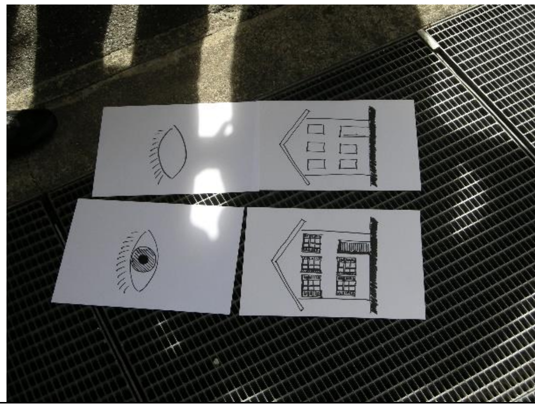
Target audiences: architects, engineers, conservators

WS4: Energy efficiency of the windows in the historic context (3ENCULT)

Coordinators: Mathilde Andre, Dagmar Exner and Franz Freundorfer

Description: The workshop presents a correct procedure for conserving the cultural heritage values and upgrading the energy performance of a historic building – with a focus on windows. First, a visit in the historic center of Bolzano/Bozen permits to show and to compare the esthetical value of old and new windows, glasses and frames. Second, in the beautiful building of the Public Weigh House (case study of the 3ENCULT Project) the solutions developed for conservation compatible highly energy efficient windows – for cases where the original window or has to be) replaced – are presented and discussed. Finally, the participants investigate how the presented solution details can also be used for repairing and enhancing existing windows and how the concepts can be applied in different regional window construction traditions.

Target audiences: architects, engineers, conservators



Dissemination Activities Report

Kind of activity	workshop
Lead Beneficiary	P01 EURAC
Contributing beneficiaries	TUD, BLL, G1S
Title	...
Date	5.11.2013
Place	Bressanone/Brixen, Italy
Type of audience	☑ End-users & their associations ☐ Consumer organisations ☐ EU, national & local authorities ☐ NGOs in CH Preservation ☑ Technological enterprises ☐ NGOs in energy Efficiency ☑ Scientific Community Other: architects
Size of audience	~100
Countries addressed	...

Description

Dedicated session at the ENERGY FORUM 2013 in Brixen, chaired by 3ENCULT coordinator Alexandra Troi, with contributions from Franziska Haas (TUD), Robert Weitlaner (BLL) and Oscar Monatero (G1S) and two more invited presentations

Programme:

3encult EFFICIENT ENERGY FOR EU CULTURAL HERITAGE

INTRODUCTION
Chair – Alexandra Troi

SUN HAS ALWAYS BEEN A RESOURCE - TRADITIONAL WAYS OF USING SOLAR ENERGY
Sonja Jurosevic, NTNU, Norway

- The sun as resource in northern climates
- How we built with the sun in the south
- What we can learn from and how we can re-activate traditional systems

SOLAR ENERGY IN HISTORIC BUILDINGS – SUSTAINABLE CONCEPTS
Franziska Haas, TU Dresden, Germany

- Historic buildings and quarters
- Guiding principles for solar integration in historic buildings
- Practice examples

TECHNOLOGICAL SOLUTIONS FOR PV IN THE HISTORIC CONTEXT
Oscar Montero, SOLIKER, Spain

- BIPV based on semi-transparent amorphous silicon (a-Si)
- Flexibility in transparency, pattern, form and colour
- Practice examples

SOLAR LIGHTING SOLUTIONS IN HISTORIC BUILDINGS
Robert Weitlaner, Bartenbach Lichtlabor, Austria

- Assess the situation and develop solutions
- Integrable daylight (re-direction) systems
- Practice examples

SOLAR ENERGY INTEGRATION – CHALLENGE AND CHANCE FOR CONSERVATION ARCHITECTS
Cristina S. Polo López, SUPSI, Switzerland

- Understand & respect the existing
- Develop high quality architectural solutions
- Practice examples

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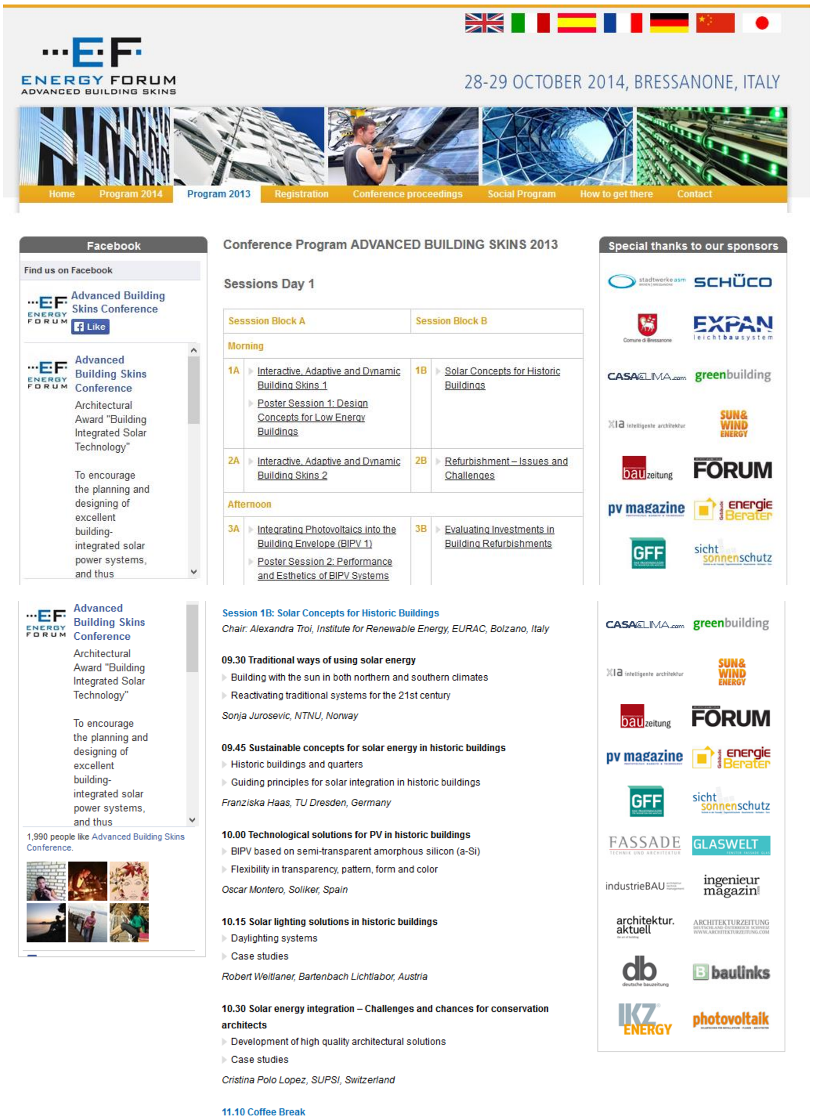


Dissemination Activities Report

Kind of activity	presentation at conference
Lead Beneficiary	P01 EURAC
Contributing beneficiaries	
Title	Conception with a presentation on 3ENCULT within the session chaired by ICOMOS at the Better Buildings Conference 2014
Date	9.4.2014
Place	Dublin, Ireland
Type of audience	☑ End-users & their associations ☐ Consumer organisations ☑ EU, national & local authorities ☐ NGOs in CH Preservation ☑ Technological enterprises ☑ NGOs in energy Efficiency ☐ Scientific Community Other: architects
Size of audience	> 1000 at the conference
Countries addressed	Ireland, UK, Europe

Description

First parallel session at the Better Buildings Conference:

> 10:05 - 11:15 | Sustaining Heritage | Canal Suite
>
> Retrofits are not always straightforward and historic buildings or buildings of high cultural value such as early modernist structures need a different approach. Expert speakers set out how ambitious energy targets can be achieved while retaining the cultural value of existing buildings.

Session chaired by Peter Cox for the ICOMOS scientific Committee on Energy and Sustainability who gave an introduction on the importance of pro-actively contributing to conservation compatible energy retrofit of historic buildings

Invited contributions by

Alexandra Troi has been Vice Head of the Institute for Renewable Energy of the European Academy of Bozen/Bolzano Italy since 2005. Previously she was a researcher at the European Academy of Bozen/Bolzano - Italy (Institute for Alpine Environment). She has a PhD from the University of Munich and a degree in electrical engineering. Her interests include indoor climate in heavy buildings, measurement and assessment, numerical simulation of energy and air flow in built environments and solar heating and cooling: system analysis, monitoring and simulation. She is the project coordinator for 3ENCULT FP7 project and WP4 leaCarsten Hermann, Historic Scotland

Carsten Hermann is a conservation architect working as Senior Technical Officer at Historic Scotland, which safeguards and promotes the Scotland's historic environment. Carsten advises on sustainable building conservation, including the management of research and refurbishment projects. He specialises in energy efficiency of historic buildings and in conservation of 20th century built heritage. He is Historic Scotland's lead on the EFFESUS research project, investigating energy efficiency of European historic urban districts. Carsten is a chartered architect accredited in building conservation, he has worked for several years for conservation architects in Edinburgh, before joining Historic Scotland in 2009.d for several years for conservation architects in Edinburgh, before joining Historic Scotland in 2009.

Fergal McGirl is a Dublin-based architect whose practice, Fergal McGirl Architects, has developed a specialised focus on energy conservation in historic buildings. Fergal is part of a multi-disciplinary team including Building Life Consultancy and IHER that are in the process of finalising the latest "Built to Last" Dublin City Council/Heritage Council research project. The project seeks by means of case studies and physical measurement to address the absence of a rigorous evidence base of data on the performance of pre-1945 Dublin housing in the area of energy efficiency and thermal comfort while respecting the architectural and cultural integrity of individual houses and historic streetscapes and places.

Dissemination Activities Report

Kind of activity	presentation at conference
Lead Beneficiary	P11 PHI
Contributing beneficiaries	UIBK, EURAC
Title	Conception of and contribution to several sessions at the 18th Passive House Conference
Date	25.-26.4.2014
Place	Aachen, Germany
Type of audience	☑ End-users & their associations ☐ Consumer organisations ☑ EU, national & local authorities ☐ NGOs in CH Preservation ☑ Technological enterprises ☑ NGOs in energy Efficiency ☑ Scientific Community Other: architects
Size of audience	> 1000 at the conference
Countries addressed	Almost 50 countries, conference languages German, English, French & Polish plus Chinese at dedicated sesssions

Description

At the 18th Passive House Conference from 25th to 26th of April 2014 (shortly after official project closure) 3ENCULT contributed to the following dedicated sessions

- Major contribution to session XVI “Passive House Retrofit” with 3 (out of 5) presentations
- Contribution to session III, “Retrofit” with one presentation
- Contribution to session VI, “PH design tools” with one presentation

Moreover the developed window was exhibited at the booth of ProPassivhausfenster.

Flyers were distributed both the above booth and at the booths of PHI and UIBK, as well as at the sessions with 3ENCULT contributions.

3 Annexes

Session Description

Building Design & Construction 1

Date: Tuesday, 13 September 2011
Time: 09:30 – 12:30
Location: BIP: Bruxelles Info Place

Session languages: English, Italian
Contact person: maryke.van.staden@iclei.org

Objectives

Although proven to be effective, with enhanced user comfort and reduced energy costs, the 'passive house' and similar standard low energy building concepts are not yet the norm in European cities and towns. Neither is the use of sustainable building materials.

Considering that buildings require high financial investments and are constructed to last for several lifetimes (perhaps even centuries), the approach to design and construction needs to be changed and should contribute to reducing the vast amounts of construction waste. How can and should we move forward to create zero and low carbon districts and communities? This session is linked to Resource Efficient Europe and the 2nd Session on Building Design and Construction.

Methodology

- Addressing important developments impacting on building design and construction, with a focus on policy and strategic issues - linked to an afternoon 'building' session that addresses other practical elements and examples.
- Following the session introduction, a keynote technical expert will kick off the session (*25 min*) followed by examples of local governments' experiences and practical challenges they had to deal with and how these were resolved with *15 minute presentations* and *5 minutes for questions*.
- A panel will follow, with representatives from different organisations that typically influence developments in the local energy / building context, sharing their viewpoints through brief *6 minute statements or presentations*.
- After this a discussion with participants will follow to explore solutions and identify key elements that impact on the EU2020 policy.
- Conclusions will be captured in a paper feeding into the ICLEI Europe strategy on energy / buildings.

Contributors

Facilitator — Maryke van Staden, Coordinator Climate & Air Team, ICLEI Europe

09:30 — Welcome to the BIP
Minister Evelyne Huytebroeck, Brussels Capital Region, Belgium

09:35 — **KEYNOTE: Evolution from passive solar architecture to Passivehaus to net-zero houses – impacts of technology on architecture**
Prof emerit. Robert Hastings, AEU GmbH, Switzerland

10:05 — **Brussels – built environment challenges in a large, densely populated city, the political point of view**
Minister Evelyne Huytebroeck, Brussels Capital Region, Belgium

10:15	**Renovation of historic building stock – what is possible? Examples of Innsbruck and Bolzano** Dr. Rainer Pfluger, Faculty of Civil Engineering, Unit Energy Efficient Buildings University of Innsbruck – 3ENCULT project partner
10:35	Break
11:05	**Interactive panel addressing key developments that impact on the built environment** *(6 mins presentation per speaker, then discussions)*
	Brussels – built environment challenges in a large, densely populated city, the technical point of view Sebastian Moreno Vacca, Architect, Brussels Capital Region, Belgium
	City of the Future: Passive Houses und the Zero-Emission-District Heidelberg/Bahnstadt Hans-Wolf Zirkwitz, Director, Office of Environmental Protection, Trade Supervision and Energy, Heidelberg, Germany
	Scaling up passive housing and similar standards – what is needed? Prof emerit. Robert Hastings, AEU GmbH, Switzerland
	The Building process – Involving all stakeholders as active participants Dan Troest Birkemose, Construction Architect, Building Department, Copenhagen, Denmark
	Large scale Green Public Procurement – integrated energy services for public sector buildings Lidia Capparelli, Building and Construction expert, Consip Spa (Italian Public Procurement Agency)
11:50	***Discussion with participants and panelists*** Rapporteur: Giorgia Rambelli, Project Assistant, ICLEI Europe
12:30	**Session conclusions**
13:00	Lunch

Tuesday 13 September 2011

A number of ICLEI Members and other organisations opened the doors of their Brussels-based offices to allow for smaller theme-focused discussions on the necessary transformations within cities, looking at innovative European local achievements that could support the implementation of the Europe 2020 strategy. A number of parallel sessions were held, each on a specific theme, with a view to examining the transformations needed to achieve smart, sustainable and inclusive cities.

Morning sessions focused on the **political and strategic context** of each theme, outlining the current situation at a European level. **Afternoon sessions** focused on **practical and technical aspects**, drawing on local examples which identify limits and challenges and discussing how to transfer each theme into a meaningful local policy.

9:30	Sessions 1 Parallel Break-out Sessions

Water 1	Biodiversity 1	Building Design & Construction 1 Interpretation into Italian
Sustainable Mobility 1 Interpretation into French	(Climate) Resilience 1	Energy 1 Interpretation into German
Quality of Life	Procura+ Sustainable Procurement Workshop	Visit to Hamburg Train of Ideas 9.30 - 11.00
	Effective solutions for green urban transport - CIVITAS external workshop 1	

12:30 Lunch at the various venues

14:00	Sessions 2 Parallel Break-out Sessions

Water 2	Biodiversity 2	Building Design & Construction 2
Sustainable Mobility 2 Interpretation into French	(Climate) Resilience 2	Energy 2 Interpretation into German
Urban Performance Monitoring	Digital Democracy	Visit to Hamburg Train of Ideas 14.00 - 15.30
Mayors Session	Effective solutions for green urban transport - CIVITAS external workshop 2	

17:00 End sessions

Sessions focus on:

- **Water**, examining how water scarcity will influence our societies in the future;
- **Sustainable Mobility**, on how mobility and access to transport will influence the quality of life;
- **Urban Performance Monitoring**, on various approaches to measure the success of sustainability;
- **Biodiversity**, aiming to develop appropriate consideration of ecosystem services and biodiversity in local and regional development;
- **Digital Democracy**, asking whether new technology and software can be a means to include citizens in finding innovative sustainable solutions,
- **Building Design & Construction**, tackling the question how we can move forward to create zero and low carbon districts and communities;
- **Quality of Life** asking "do we need to redefine quality of life?" Or "how do we go about measuring this concept?";
- **Resilience** the session will firstly address the 'approach to climate resilience' and, secondly address the framework conditions needed by local governments to successfully perform;
- **Energy** discussing the energy transition phase with urban areas or a visit to the Hamburg European Green Capital's "Train of Ideas".

18:00 European Energy Service Awards Ceremony

The European Energy Service Award honours outstanding efforts and achievements for the development of energy services in Europe. The prestigious award has been awarded since 2005 within the scope of European Energy Service Initiative.

It is a means to increase awareness on energy services as proper way to more energy efficiency by showing its successes and motivating others to follow. Furthermore, the European Energy Service Media Award honours journalists dealing with this complex subject in a generally understandable way, hence contributing to its stronger dissemination.

The award-winners were selected by an international jury of experts, including **Marie Donnelly** (European Commission), **Paolo Bertoldi** (European Commission), **Fiona Hall** (European Parliament), **Jean-Louis Joseph** (FEDARENE), **Peter HobsonDr** (EBRD) and **Klaus Müschen** (German Federal Environmental Agency).

Organiser of the EESA was the European Energy Service Initiative - EESI. More information on the event and online registration:
www.european-energy-service-initiative.net/eu/eesa.html

20:00 Dinner

As a conclusion to the day, participants of the ICLEI European Convention 2011 gathered for a formal dinner, hosted by the city of Hamburg.

Participants were welcomed by **Holger Lange**, State Secretary, Ministry for Urban Development and Environment, Free and Hanseatic City of Hamburg, Germany

Renovation of historic building stock – what is possible? Examples of Innsbruck and Bolzano

Rainer Pfluger, UIBK, Alexandra Troi, EURAC

3encult

EFFICIENT ENERGY FOR EU CULTURAL HERITAGE

Efficient Energy for EU Cultural Heritage

Historic buildings

- are the trademark of numerous European cities
- are a living symbol of Europe's rich cultural heritage & diversity
- reflect the society's identity and need to be protected

- show a high level of energy inefficiency
- contribute with considerable CO_2 emissions to climate change
- do not always offer "comfort" – to people as well as to artworks

Historic buildings

Talking in numbers:

- 150 towns & urban fragments are World Cultural Heritage sites
- 55 million dwellings, home to 120 million Europeans, were built before 1945
- they need 1400 TWh of energy and emit 300 Mt of CO_2 (estimated)
- contribute to the income from tourism – which stands for 5.5% of EU GDP and employs 6% of EU workforce

- **Factor 4 to 10 of energy need reduction is achievable**, also in historic buildings, respecting their heritage value, if a multidisciplinary approach guarantees the implementation of high quality interventions, specifically targeted and tailored to particular case.

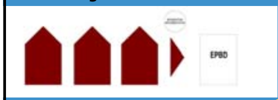
Project Consortium

3encult

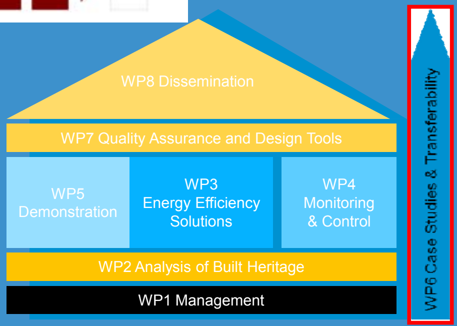
EFFICIENT ENERGY FOR EU CULTURAL HERITAGE

- 22 partners from 10 countries
  (IT, DE, AT, DK, UK, ES, BE, NL, FR, CZ)
- Technical solutions (development & exploitation)
  R&D: Eurac, Uni IBK, TU Dresden, Passivhaus Institut, ARUP, Bartenbach Lichtlabor, Cartif, TU Darmstadt, Uni Bologna
  Industry/SMEs: on insulation, windows, HVAC, light and solar systems
- Urban context
  Danish Academy of Fine Arts, TU Dresden, ICLEI
- Conservation
  TU Dresden, Uni Bologna, Artemis, IDK, Danish Academy of Fine Arts
- Dissemination
  TNO, ICLEI, youris, REHVA
- Local Case Study Teams

Project structure



Issue position papers suggesting possible **integrations and/or implementations of the present regulation framework**



Case studies Overview

8 CASE STUDIES

- Different kinds of use
- Different kinds of building structure and epoch
- Different kinds of climate

1. Waaghaus, Bozen/Italy
2. Palazzo d'Accurso, Bologna/Italy
3. Palazzina della Viola, Bologna/Italy
4. Arsenal, Kopenhagen/Denmark
5. Höttinger School, Innsbruck/ Austria
6. Speicherstadt, Potsdam/Germany
7. University building, Bejar-Salamanca/Spain
8. Strickbau, Appenzell/Switzerland

Case studies Short information

CS1: Public weigh house, Bolzano (IT)

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

Case studies Short information

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,
  - modelling
  - 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

Case studies
Short information

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)

Case studies
Short information

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, Appenzell (CH)

- **Object**
  Old Strickbau-building in Appenzell/Switzerland (17th century). Permission to dismantle the old wooden building with the constraint to make it available to research for one year.
- … this allows for **outstanding 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

Keep updated!

- Website (www.3encult.eu)
  - Information on project
  - Description of Case Studies
  - All public deliverables
- Newsletter
- FAQ platform
- Workshops for local governments
- Study tours to case studies
- Handbook
- Conferences, Publications, University & Professional training, Trade fairs, Final Workshop, etc.

Contact the coordinator for further information:
Alexandra Troi (alexandra.troi@eurac.edu), EURAC research, Italy

CS5 – Hauptschule Hötting, Innsbruck/Austria

Pfluger Rainer UIBK, rainer.pfluger@uibk.ac.at
Kai Längle, kai.laengle@uibk.ac.at

Case Study 5
School building, Innsbruck (Austria)

Franz Baumann,
pioneer of modern architecture

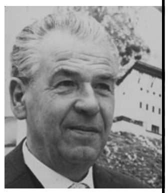
Fürstenweg 13 / A-6020 Innsbruck

Arch. Franz Baumann

Hauptschule Hötting

(Neue Mittelschule)

Year of construction 1929/31



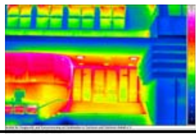
Local case study team INNSBRUCK (A)

- UIBK (scientific guidance)
- Innsbrucker Immobilien GMBH&CO KG (IIG),
- Bundesdenkmalamt, Landeskonservatorat für Tirol (preservation of monuments),
- Arch. G. Gaigg, (architectural team)

Local case study team INNSBRUCK (A)

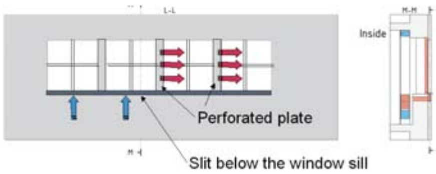
Transmission losses Thermal bridges, insulation

- Diagnosis by IR-Thermography
  (by Christoph Franzen 02/11)
- Thermal Bridge calculation
- PHPP-calculation
- Measured heating consumption **(2005-2010) 187 kWh/m²a TFA**
- Measured electric consumption **(2005-2010) 23,2 kWh/m²a TFA**

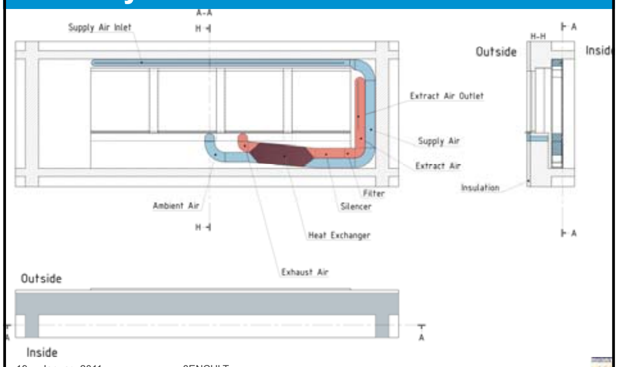


Ventilation with heat recovery

- Wall ingration
- Architectural design
- Heat recovery
- Air quality and comfort measurements



Ventilation with heat recovery



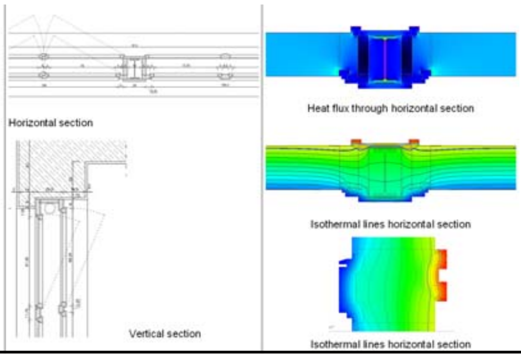
Ventilation with heat recovery

Reduction of Ventilation losses:

Window ventilation | Ventilation with heat recovery 80%

-80 %

Cross section and thermal bridge calculations of window and lintel detail



Cross section and thermal bridge calculations of window and lintel detail

Enhancement of historic windows:

Original Windows

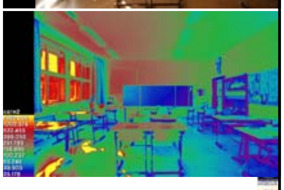
U_w= 2,0 W/(m²K)

Enhanced window

U_w= 0,69 W/(m²K)

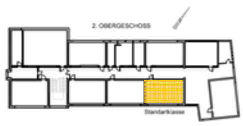
Lighting measurements, evaluation and optimisation

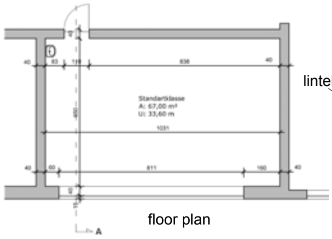
- Energy consumption
- Artificial lighting
- Daylight: redirection, shading
- Glare

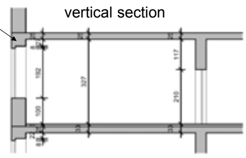


Dimensions of Class Room

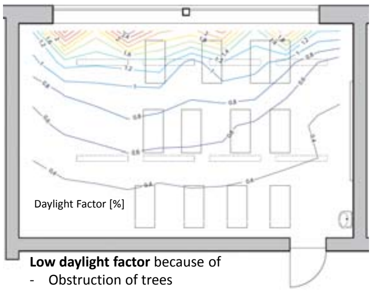
Dimension of a
Standard Class Room 6.5 x 10.3 m







Daylight Factor < 0.5%
Current State (Ground Floor)

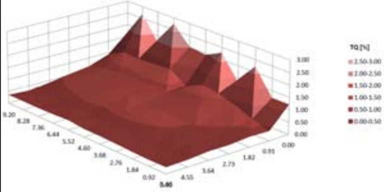


Natural Obstruction

Low daylight factor because of
- Obstruction of trees
- Deep reveal
- High frame area

Reveal and Frames

Daylight Factor < 0.5%
Current State (Ground Floor)



Natural Obstruction

Low daylight factor because of
- Obstruction of trees
- Deep reveal
- High frame area

Reveal and Frames

Daylighting – solutions

Daylight redirection

shading

bright coloures

Artificial lighting

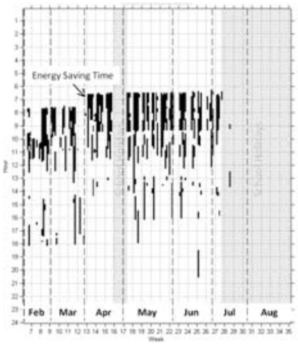
Illuminace measurement (artificial light)
min val. acc. standard 300 lx

min measured 250 lx

Blackboard according EN 12464-1
min 500 lx not achieved !

Measurement Light on/off Room 011

Measurement Light on/off
with light sensors 10.02.11 – 29.08.11



Occupation Plan

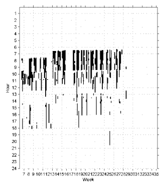
	St	Mo	Di	Mi	Do	Fr		
Klasse 1a - 011	1						07:45	08:35
	2						08:40	09:30
	3						09:35	10:25
	4						10:40	11:30
	5						11:35	12:25
	6						12:30	13:20
	7						14:30	15:20
	8						15:20	16:10
	9						16:20	17:10
	10						17:10	18:00

29

Light Measurement - Switch On/Off

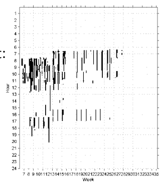
Room 011

Total Runtime Light:
298h

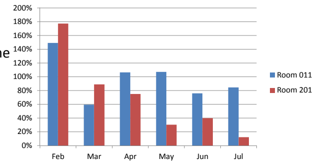


Room 201

Total Runtime Light:
188h
(less obstruction)



Percentage of runtime of the light related occupation hour

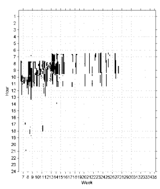


30

Light Measurement - Switch On/Off

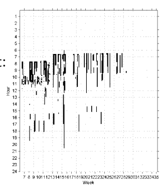
Room 213

Total Runtime Light:
164h

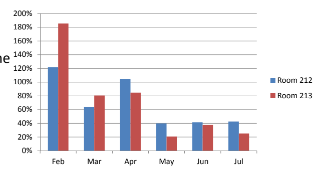


Room 212

Total Runtime Light:
204h

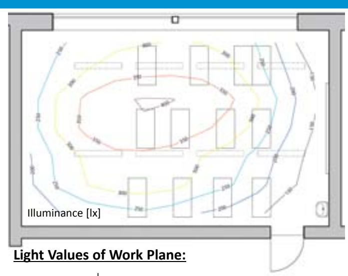


Percentage of runtime of the light related occupation hour



31

Artificial Light [lx] Current State



Light Values of Work Plane:

	Current State	Requirement	
E_{mean} [lx]	265	300	X
Uniformity g1	0.66	0.70	X

Luminaires:

Lamps:
8 x F58W/33 + 15%
Powerloss of ballast

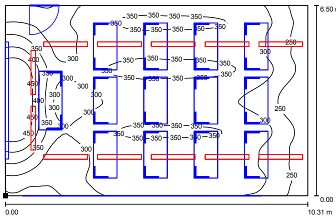
-> 533.6 W
-> 7.96 W/m²

electricity consumption lighting class rooms estimated by measured runtime hours

2822 kWh/year

18.06.2014 Light Evaluation & Refurbishment of Höttinger School 32

Refurbishment with High Efficient Luminairs



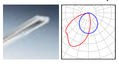
Light Values of Work Plane:

	With new Luminaires	Requirement	
E_{mean} [lx]	317	300	√
Uniformity g1	0.78	0.70	√

Change the Luminaire to
10 x TRILUX 5041RPX-(35W) EDD

-> 5.79 W/m²

Additionally at Black-Board
Ev = 500lx is required:
2 x TRILUX 5041RAV- (80W) EDD



-> 8.28 W/m²

Reduction ratio because of dirt & aging: 0.67

Visualisation (RELUX)

Enhancement of artificial light

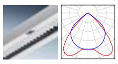
Change the Luminaires & Lamps high efficient reflector grid and fluorescent lamp

8 x F58W/33

-> 7.96 W/m²

-28 %

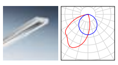
10 x TRILUX 5041RPX-(35W) EDD



-> 5.79 W/m²

+ wall washer

Black-Board Lighting
2 x TRILUX 5041RAV- (80W) EDD



-> 8.28 W/m²

Enhancement of artificial light

Is LED-Technology already an realistic alternative ?

At the moment about the same efficiency but longer live time
Reduction of maintenance costs!

First example in Innsbruck (Bundesrealgymnasium in der Au)

Summary

Energy efficient solutions and saving potentials CS5 (Innsbruck)

- Thermal insulation (depending on type, location and area)
- Enhanced windows (U_w-values down to 0,7 W/m²K)
- Building integrated ventilation with heat recovery (HR 80%)
- Enhancement of daylighting (redirection, coloures)
- Refurbishment of artificial light and control (30 % saving)
- Enhancement of heating system, distribution and control

CS1 – Public Weigh House Bolzano/Italy

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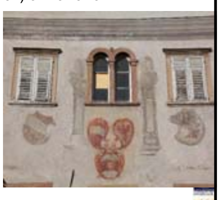
roberto.lollini@eurac.edu
dagmar.exner@eurac.edu

CS 1: Public Weigh House_Bolzano (Italy)

Location/climate
- Bolzano, Italy
- Altitude: 269 m
- Heating days: 183
- Heating Degree Days: 2791 HDD
- Surrounded area: mountainous

Urban context
- Historic city centre of Bolzano
- Building is part of the "portici" of Bolzano
- East and south façade look toward a little square, while the north façade is directed to the tight historic shopping street ("portici") of Bolzano





History use

Original objective
- Seat of the public weigh-house (Waaghaus) up until 1780

Expected use in the future
- Ground floor remains for shops
- Upper floors for cultural purpose

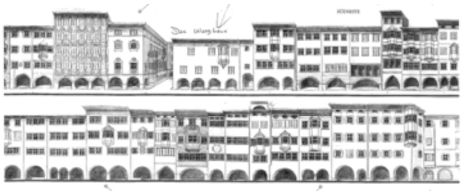
Present use
- Ground floor: shops
- 1st and 2nd floor: apartments
- 1st and 2nd basement: storage

First ideas: museum of photography, regional cultural associations, apartments for artists




Architecture/ Construction

- Massive construction in natural stone (vaults)
- Wooden roof construction
- **Characteristics “Portici” of Bolzano:**
  - Ground floor: Walkway for the mercantile life, behind it vaults for the storage of goods, often several floors below ground level
  - On the upper floors: apartments often placed around an atrium



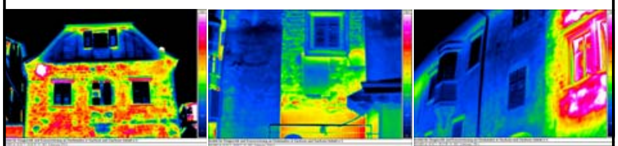
History construction

Local case study team

- **EURAC** as focal point and for scientific support and IDP
- **Building Owner**: Stiftung Südtiroler Sparkasse
  - Silvia Amonn
- **Office for Preservation of Monuments**
  - Dr. Waltraud Kofler Engl (director)
- **Conservator** (optional)
  - Adriano Salvoni
- **Architect**
  - After tender in summer 2011
- **City of Bolzano**

State of diagnosis preintervention

- **Calculations/Simulations**
  - PHPP and Energy plus: As-is-state
- **Measurements:**
  - Thermography (unheated building) by Christoph Franzen 02/11
- **Monitoring system:**
  - Installation 04/11 by TUDA



Monitoring system

Monitoring As-is-state:
Selected rooms will be temperate and dependent on the results on historical surfaces (indoors) they will be also conditioned regarding the relative humidity
- Acquisition of energy consumption -

Interventions:
Selected rooms/surfaces: Interventions like:
- Installation of windows prototype
- Installation of interior insulation

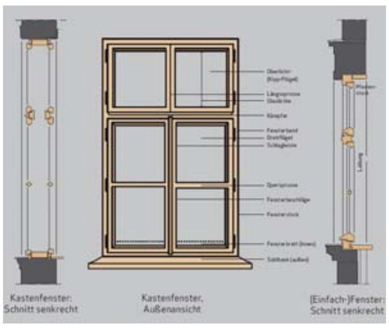
Monitoring after interventions

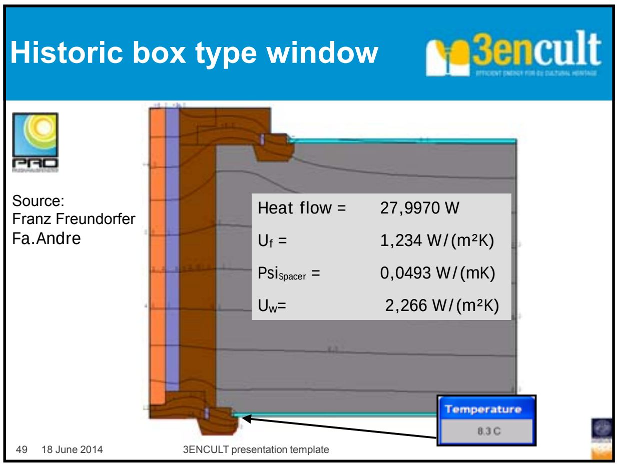
Monitoring layout: Second floor

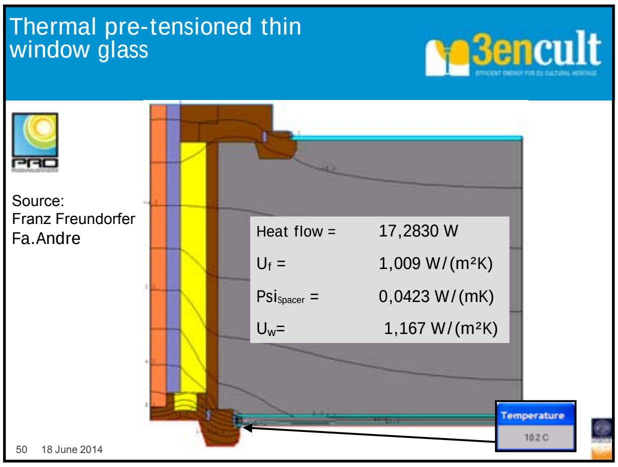
Planned steps: Diagnosis/Interventions

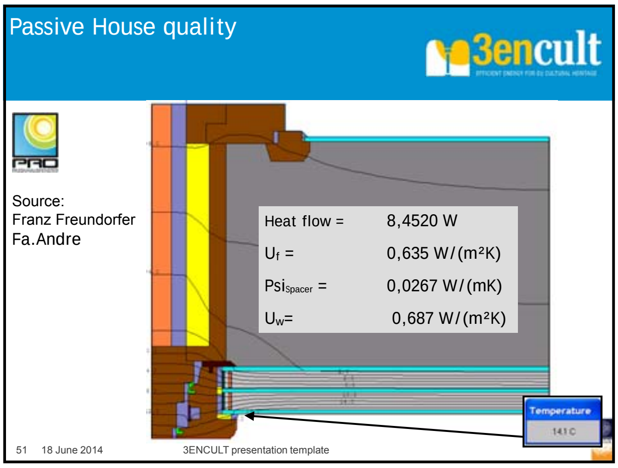
- **Measurements:**
  - Thermography next winter (in parts heated building)
  - Blower Door Test
- **Documents:**
  - Collection of energy bills from inhabited situation
- **Window prototype**
  - On-site inspection 03/11
  - Development prototype 04/11 – 11/11
  - Installation prototype winter 2011/12
- **Other interventions**
  - Optionally interior insulation
- **Simulation:**
  - Evaluate best passive refurbishment solution
  - Accompany Integrated Design Process during refurbishment planning

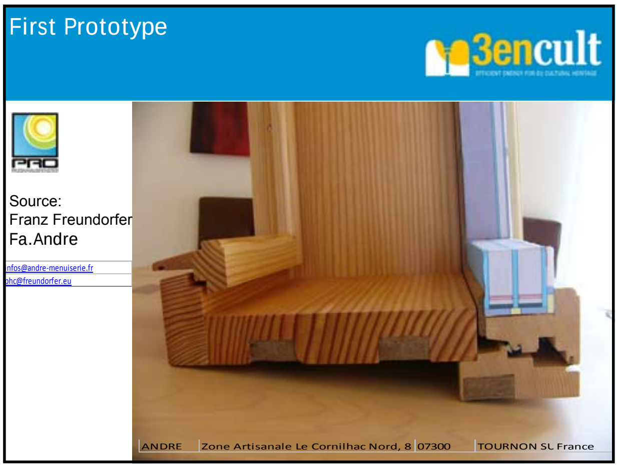
Historic box type window




Historic box type window
3encult
Source:
Franz Freundorfer
Fa.Andre
Heat flow = 27,9970 W
U_f = 1,234 W/(m²K)
Psi_{spacer} = 0,0493 W/(mK)
U_w= 2,266 W/(m²K)
Temperature
49 18 June 2014 3ENCULT presentation template


Thermal pre-tensioned thin window glass
3encult
Source:
Franz Freundorfer
Fa.Andre
Heat flow = 17,2830 W
U_f = 1,009 W/(m²K)
Psi_{spacer} = 0,0423 W/(mK)
U_w= 1,167 W/(m²K)
Temperature
50 18 June 2014


Passive House quality
3encult
Source:
Franz Freundorfer
Fa.Andre
Heat flow = 8,4520 W
U_f = 0,635 W/(m²K)
Psi_{spacer} = 0,0267 W/(mK)
U_w= 0,687 W/(m²K)
Temperature
51 18 June 2014 3ENCULT presentation template


First Prototype
3encult
Source:
Franz Freundorfer
Fa.Andre
ANDRE Zone Artisanale Le Cornilhac Nord, 8 07300 TOURNON SL France

Examples for reduction in energy demand

→ Factor 4 for
reduction in energy demand
assumed as feasible value

Conclusion

- energy saving – factor 4
  - 640 TWh/a (Europe)
  - 11'500 kWh/a (dwelling)
- CO_2 emission reduction
  → reduction of 180 Mt/a (Factor4 applied also here),
  i.e. 3.6% of EU-27 1990 emissions
  depends very much on energy source, can also be higher!
- comfort
  → higher surrounding temperatures and less draughts
- societal aspects
  → lower energy costs, more attractive historic city centres

Thank You!

Dr.-Ing. Rainer Pfluger

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LOCAL RENEWABLES FREIBURG 2011

Green Buildings and Renewable Energy: The Way Forward in Urban Development

Freiburg im Breisgau, Germany, 27-28 October 2011

Final Programme

www.local-renewables-conference.org/freiburg2011

Local Renewables – An ICLEI Initiative

Freiburg im Breisgau

ICLEI Local Governments for Sustainability

Programme of the conference - themes and overview

Discussions will revolve around:

- The framework for sustainable construction and urban planning: policy and regulations
- Financing models and mechanisms
- Cool design, hot technologies – sustainable energy for buildings and districts
- Cost-effective renovation solutions for existing building stock
- Possible today: examples of zero emission districts across Europe
- Can it be done? Smart grids, sustainable district heating and cooling
- Challenges in the value chain of energy efficient building

An exciting line-up of expert speakers will pull efforts towards a holistic approach, addressing all aspects of building design and construction with the ultimate aim of improving quality of life.

Special collaboration with SCI-Network

The Network for Sustainable Construction and Innovation through Procurement (SCI-Network) is a growing network of European public authorities working together to find new, sustainable construction solutions and encourage innovation in construction procurement.

The Network has established five working groups to investigate good practice in different areas:
• Environmental assessment tools • Innovative technical solutions • How to encourage innovation in construction procurement • Life cycle/ whole life costing • Innovative financing and contracting approaches •

Innovation in sustainble construction frequently involves and encourages energy efficiency and renewbale energy. In the Plenary Workshop B1, you will get the opportunity to discuss recommendations developed by the working groups with other public authorithies and stakeholders.

To find out more about the network, come to the SCI-Network stand or visit www.sci-network.eu.

Programme overview

TIME	Thursday 27 October 2011	Friday 28 October 2011
	Registration	
09:00	**Plenary 1: Conference opening** – Energy and buildings: potential for changing policies in support of energy efficient building	**Plenary 3:** Intelligent financing mechanisms and models for new and existing building stock
11:00	**Plenary 2:** Technical solutions, clever design – Energy efficient solutions for new and existing buildings	**Session A3:** Zero emissions districts / **Session B3:** Cutting-edge implementation in buildings and building systems
13:00	*Lunch*	*Lunch*
	Plenary Workshop B1: Driving energy efficiency innovation at all stages of the public construction process	**Plenary 4:** Future perspectives on energy efficient buildings – challenges in the value chain
15:00		**Plenary 5:** Summary and outlook
	Session A2: Renovating historical buildings: where to invest? / **Session B2:** District heating & cooling: technical solutions	**Study visits**: Vauban • Rieselfeld • Buggingerstraße
17:00		
19:00	**Reception** Hosted by the City of Freiburg at Rathaus,Historischer Ratssaal	

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Thursday, 27 October 2011

08:30

REGISTRATION OPENS

09:30 – 10:30

PLENARY 1: CONFERENCE OPENING – ENERGY AND BUILDINGS: POTENTIAL FOR CHANGING POLICIES IN SUPPORT OF ENERGY EFFICIENT BUILDING

Buildings contribute to around 36 percent of the EU's CO2 emissions, accounting for 40 percent of total primary energy consumption. Improving the energy performance of buildings is key to contributing to the EU's climate and energy objectives, namely a 20 percent reduction in greenhouse gas emissions by 2020, a 20 percent increase in energy savings by 2020, and using 20 percent renewable energy by 2020. The opening plenary will examine the political framework for these elements in buildings from a European, national and sub-national perspective – with speakers reviewing the current situation, identifying the options, and solutions and policies needed to accelerate the process, both for new buildings and existing European building stock.

Facilitator: Gino Van Begin, Regional Director, ICLEI European Secretariat

Welcome by host city – Dr. Dieter Wörner, Head, Environment Department, City of Freiburg, Germany

A discussion on the current context, challenges and opportunities related to accelerating the translation of the European Energy Performance of Buildings Directive (EBDR) into national legislation, to help bring about local improvements at the local level.

- **Local perspective** – Dr. Dieter Wörner, Head, Environment Department, City of Freiburg, Germany
- **State level perspective** – Helmfried Meinel, Secretary General to the Minister of Environment Baden-Württemberg, Germany

MuSIC

10:30 – 11:00

Coffee break

11:00 – 12:30

PLENARY 2: TECHNICAL SOLUTIONS, CLEVER DESIGN – ENERGY EFFICIENT SOLUTIONS FOR NEW AND EXISTING BUILDINGS

Existing standards and regulations and the latest state-of-the-art of technology in the building sector will be placed under the microscope in this plenary. Bringing together experts from different fields – such as science, planning and business – speakers and participants will explore key technical developments, standards and solutions for clever building design. A number of questions will be addressed, such as, which of these cutting edge technologies can most easily be rolled-out and why are passive house and similar efficiency standards not yet widely applied. How can we engage the interest of local decision-makers in choosing the optimal solutions with regard to energy efficiency?

Facilitator: Rian van Staden, Principal Consultant, Intelligent Renewable Energy

- **Energy savings in buildings and urban microclimate improvement: The role of materials** – Theoni Karlessi, Physicist- Research Associate, National & Kapodistrian University of Athens, Greece
- **Cutting edge technologies for today and tomorrow** – Sebastian Herkel, Engineer, Fraunhofer Institute for Solar Energy Systems (ISE), Germany
- **Adaptation of real estate to smart grids** – Rolf C. Buschmann, Prof. Aux UCLV, EnED, Solar Info Center GmbH, Germany
- **Smart Buildings – Key player in a sustainable environment** – Christoph Conrad, Head Strategy and Marketing, Siemens Building Automation

MuSIC

12:30 – 14:00

Lunch in the exhibition area in the foyer


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14:00 – 15:30

PLENARY WORKSHOP

PLENARY WORKSHOP B1: DRIVING ENERGY EFFICIENCY INNOVATION AT ALL STAGES OF THE PUBLIC CONSTRUCTION PROCESS

Every public construction project – whether a renovation project or a new building – involves a multitude of different public and private actors, with various and complex procurement procedures. The leap from wanting to reach a sustainable outcome to actually achieving one is equally complex. The SCI-Network has been exploring different methods for encouraging innovative, sustainable outcomes within the typical procurement process for construction projects. This session will explore some recommendations. Issues include, how to engage with the private sector before tendering for construction services, how to set up procedures to maximise expert involvement, and how to assess the life-cycle costs of construction in the decision-making process.

Facilitator: Simon Clement, Project Coordinator, ICLEI European Secretariat

- **GLA group sustainable construction – best practice examples** – Matthew Galvin, Responsible Procurement Manager, Greater London Authority (GLA), United Kingdom
- **How to procure energy efficient public construction – recommendations for local governments** – Isa-Maria Bergman, Expert Consultant, Motiva Oy, Finland
- **Promoting sustainability in the urbanisation of the El Boscarró Nord business and industrial estate** – Joan Estrada i Aliberas, Environment, Landscape and Energy Unit Director, INCASÒL (Catalan Land Institute), Spain
- **New face of Koprivnica** – Helena Hecimovic, Councilor, City of Koprivnica, Croatia

MuSIC

15:30 – 16:00

Coffee break

16:00 – 17:30

PARALLEL WORKSHOPS

A2: RENOVATING HISTORICAL BUILDINGS: WHERE TO INVEST?

Historical buildings can consume a significant amount of energy and in many cases, it is particularly difficult to improve their energy efficiency, due to restrictions protecting monuments and the sensitive building structure. European historic building centers are the hallmark of the continent, drawing countless tourists, yet also have enormous needs in terms of retrofitting. In this session, experts from various European retrofitting projects will discuss the challenge of retrofitting historical buildings and how to do so efficiently while complying with (or creating new) rules and regulations for the conservation of ancient structures.

Facilitator: Maryke van Staden, Project Coordinator, Climate and Air Team, ICLEI European Secretariat

- **Architectural heritage and energy efficiency** – Dr. Christian Hanus, Head, Center for Architectural Heritage & Infrastructure, Krems, Austria
- **Energy efficiency in historic buildings – the 3ENCULT project in focus** – Dr. Alexandra Troi, Vice Head of the Institute for Renewable Energy, European Academy of Bozen/Bolzano, Italy
- **AC/DC project - to Adapt and Conserve / Develop and Create** – Jan Falconer, Manager, Projects, Partnerships and Funding, Aberdeen City Council, Scotland, United Kingdom

ClasSIC

B2: DISTRICT HEATING & COOLING: TECHNICAL SOLUTIONS

District heating and cooling by means of efficient systems using renewable energy can play a significant role in the supply of low-carbon energy in Europe. Whether optimising systems by using waste heat and heat recovery or linking to geothermal energy or hydro-power, there are many different solutions to make heating / cooling more efficient. This session will address how to improve the effectiveness of sustainable energy district systems for roll-out, as well as the policies needed to support this and replace non-optimised individual heating concepts.

Facilitator: Sabine Froning, Managing Director, Euroheat & Power (EHP)

- **District Heating 2.0 (En route towards DH 3.0?)** – Peter Odermatt, CEO, , Stadsverwarming Purmerend B.V., Netherlands
- **Successful planning and realisation of district heating systems** – Klaus Preiser, Managing Director, Badenova-Tochter WärmePLUS, Germany
- **Biofueled district heating and cooling** – Johan Saltin, Project Manager Heat and Power, Växjö Energie AB, Sweden

MuSIC

19:00

RECEPTION HOSTED BY THE CITY OF FREIBURG – NEUES RATHAUS, HISTORISCHER RATSSAAL

The City of Freiburg has the pleasure to invite all participants to a cocktail reception in the beautiful Historischen Ratssaal of the Rathaus (City hall). Welcome by Prof. Dr. Haag, Deputy Mayor for Buildings and Urban Planning, City of Freiburg.

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EFFICIENT ENERGY FOR EU CULTURAL HERITAGE

Energy efficiency in historic buildings – the 3ENCULT project in focus

Alexandra Troi, EURAC research

The research leading to these results has received funding from the European Community's Seventh Framework Programme (FP7/2007-2013) under grant agreement n° 260162

Key question

Is it reasonable to invest – thoughts and money – in the energy refurbishment of historic buildings?

What is the potential impact in terms of
→ energy saving
→ CO_2 emission reduction
→ comfort
→ societal aspects

Definition

- Buildings dating before 1919

  Certainly the **big part of this building stock** makes part of the **cultural heritage** of European countries und gives **identity** to European cities, villages and public spaces.
- Buildings built 1919 - 1945

  Even if much less buildings from this latter epoch than from the building stock before 1919 are listed, they **form a part of the city-centre and cityscape** and retrofit interventions should take account of the **specific demands in terms of aspect preservation.**

→ Denmark
→ Bologna

Denmark

- 9,000 buildings in Denmark are listed (as the best or most characteristic of their type and period)
- 300,000 buildings have been assessed to be worthy of preservation.

→ SAVE project: documentation of buildings built before 1940

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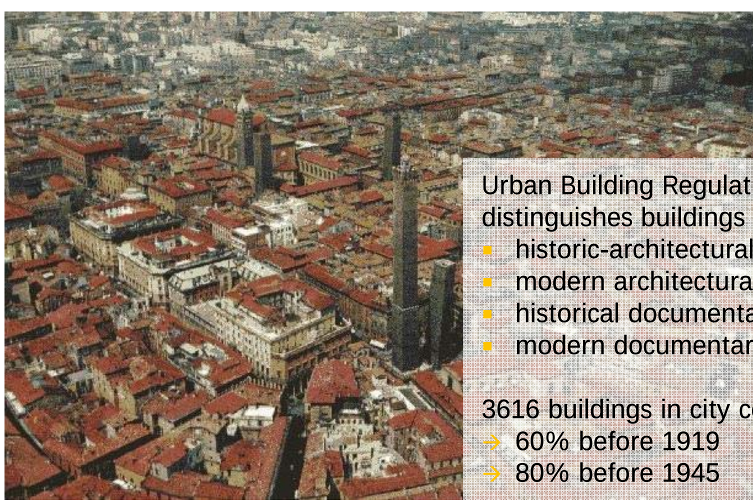
Bologna



Urban Building Regulation distinguishes buildings of
- historic-architectural value
- modern architectural value
- historical documentary value
- modern documentary value

3616 buildings in city centre
→ 60% before 1919
→ 80% before 1945

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Statistics

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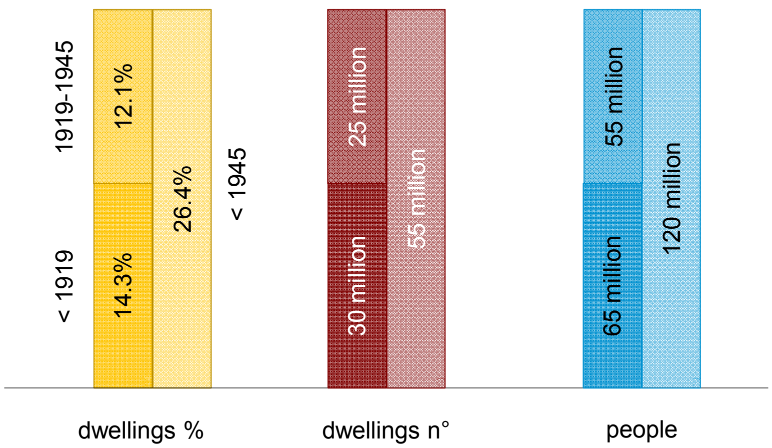

Energy demand & CO_2 emissions

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specific energy demand	170 kWh/m²a	European average [Balaras & al. 2007], [Uihlein & Eder 2010]
X	X	
dwellings' size	90 m²/dwelling	based on 50% of stock [UNECE 2004 consistent with [Balaras & al. 2007]
X	X	
n° of dwellings	55.9 million dwellings	
=	=	
energy demand	**855 TWh/a**	
energy demand	855 TWh/a	
X	X	
specific emissions	0.28 kg/kWh	For EU-27 in 2000 [Uihlein & Eder 2010]
=	=	
CO_2 emissions	**240 Mt/a**	**~5% EU-27 emissions in 1990**

It is an issue!

- energy saving
  → factor 4: **640 TWh/a** (Europe) & 11'500 kWh/a (dwelling)
- CO_2 emission reduction
  → reduction of **180 Mt/a,** i.e. 3.6% of EU-27 1990 emissions
  depends very much on energy source, can also be higher!
- comfort
  → higher surrounding temperatures and less draughts
- societal aspects
  → lower energy costs, more attractive historic city centres

Further information on www.3encult.eu
Troi A., "Historic buildings and city centres – the potential impact of conservation compatible energy refurbishment on climate protection and living conditions", Int. Conference Energy Management in Cultural Heritage, Dubrovnik, April 2011

… are the **trademark** of numerous European cities
… are a living symbol of Europe's *rich cultural heritage & diversity*
… reflect the society's identity and need **to be protected**

… show a high level of **energy inefficiency**
… contribute with considerable **CO_2 emissions** to climate change
… do not always offer "**comfort**" – to people as well as to artworks

Factor 4 to 10 of reduction in energy demand is achievable, also in historic buildings, respecting their heritage value, if a multi-disciplinary approach guarantees the implementation of high quality interventions, specifically targeted and adapted to the specific case.

Project Consortium

The direct project partners cover:
- Conservation experts
- Technical experts
- Urban development experts
- Industry partners
- Implementation experts and stakeholder associations

Furthermore **Local Case Study Teams**, with one project partner as focal point and scientific partner, gather building owner, representatives from the offices for the protection of historic monuments, representatives from other local bodies concerned (e.g. city council) as well as the architects and engineers in charge of the retrofit works

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**Report on
demand analysis and
historic building classification**

EURAC research

Preservation criteria

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- Shape and Design
  the Art History Value

Preservation criteria

- Shape and Design
  the Art History Value
- Use, Function, Tradition
  the Historical Value

Preservation criteria

- Shape and Design
  the Art History Value
- Use, Function, Tradition
  the Historical Value
- Techniques
  Heritage as Scientific Source

Preservation criteria

- Shape and Desi
  the Art History V
- Use, Function, T
  the Historical Va
- Techniques
  Heritage as Scie
- Location and Setting
  Urbanistic Value

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	Substance	Image	Reversibility
Shape and Design the Art History Value	++	++	++
Use, Function, Tradition the Historical Value	+	++	+
Techniques Heritage as Scientific Source	++	+	++
Location and Setting Urbanistic Value	+	++	+

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Experience Copenhagen: Building description

5.3 **Bygning 4 - Kontorbygningen mod Byghusgade**

Bygningens historie
Bygningen er opført i 1768, tilbygget i 1819 og 1889, og derudover ombygget markant af flere omgange, første gang allerede i 1771.

Bygningen er atten fag lang og to etager høj. Taget har halvvalmet gavl mod syd, stående gavl mod nord og en høj rejsning, hvorpå fire skorstenspiber og en brandkam markerer sig. På tagfladen er der tretten kviste mod gården, elleve kviste mod gaden, og derudover en række tagvinduer, som giver lys til en udnyttet tagetage. Bygningens sokkel er meget beskeden, og man træder således næsten direkte ind i bygningen.

...

for each of the 4 buildings

- building and construction history
- existing conditions
- historic and architectural value

...

De bærende fredningsværdier er:
- Længdeskillevæggen
- Forskelle mellem bygningens nordlige og sydlige del
- Rumstrukturelle helheder
- Snedkerdetaljer

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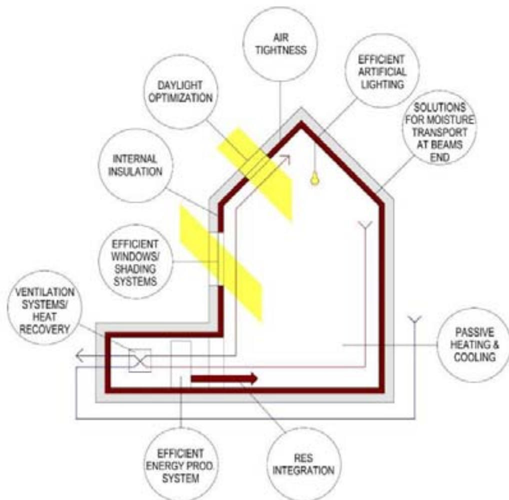
Technical solutions
State of the art

Technical solutions - state of the arte & development



Further information on www.3encult.eu

D3.1 Discussion basis for multidisciplinary workshop - Report on energy efficiency solutions in historic buildings
→ online!

D3.4 Virtual library with developments of 3ENCULT (sketchbooks, drawings, design guidelines)
→ from M24 i.e. autumn 2012

D3.6 Summary results e-guide for local goverments
→ M28 i.e. spring 2013

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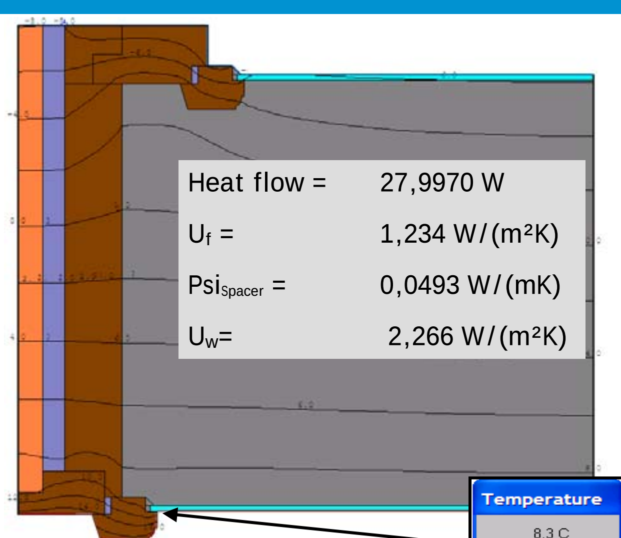
Historic box type window

Source:
Franz Freundorfer
Fa.Andre

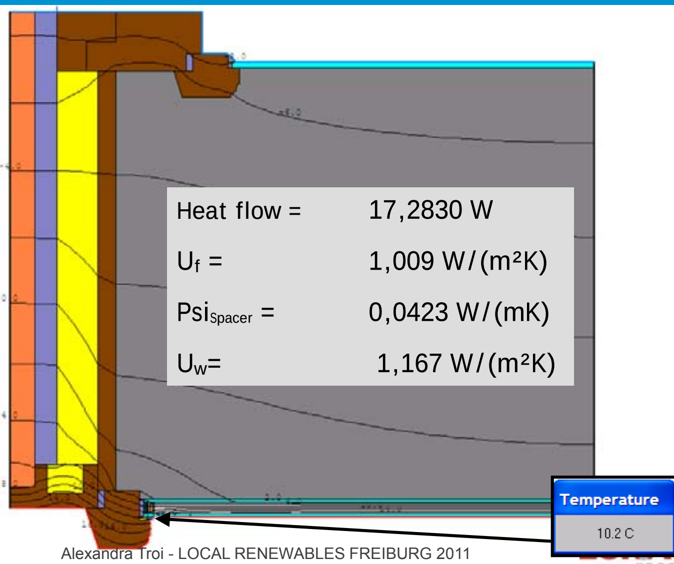


Heat flow =	27,9970 W
U_f =	1,234 W/(m²K)
Psi_{Spacer} =	0,0493 W/(mK)
U_w=	2,266 W/(m²K)

22 08 May 2014 / October 2011 3ENCULT Presentation template / Alexandra Troi - LOCAL RENEWABLES FREIBURG 2011 EURAC research

Thermal pre-tensioned thin window glass

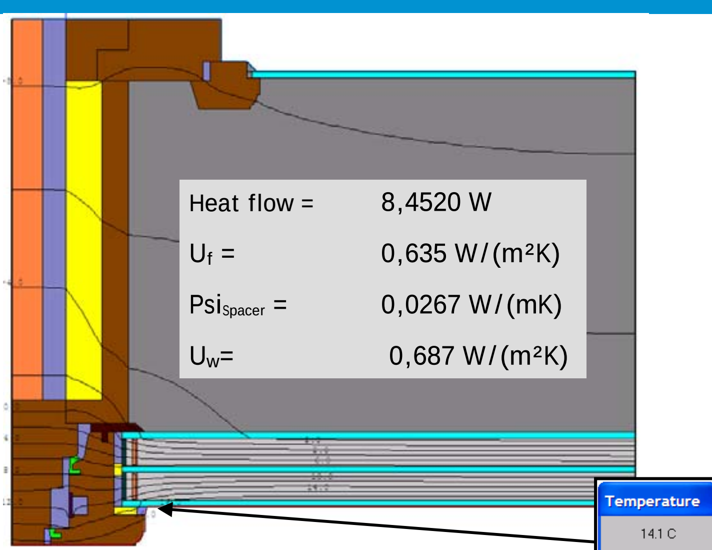
Source:
Franz Freundorfer
Fa.Andre



Heat flow =	17,2830 W
U_f =	1,009 W/(m²K)
Psi_{Spacer} =	0,0423 W/(mK)
U_w=	1,167 W/(m²K)

Passive House quality

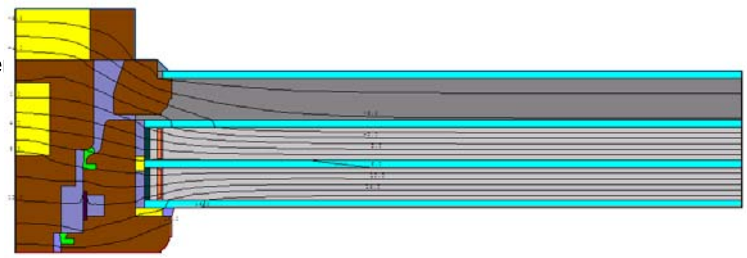
Source:
Franz Freundorfer
Fa.Andre



Heat flow =	8,4520 W
U_f =	0,635 W/(m²K)
Psi_{Spacer} =	0,0267 W/(mK)
U_w=	0,687 W/(m²K)

Passive House quality Compound window

Source:
Franz Freundorfer
Fa.Andre



First Prototype

Source:
Franz Freundorfer
Fa.Andre

infos@andre-menuiserie.fr
phc@freundorfer.eu

ANDRE	Zone Artisanale Le Cornilhac Nord, 8	07300	TOURNON SUR France

Examples for reduction in energy demand

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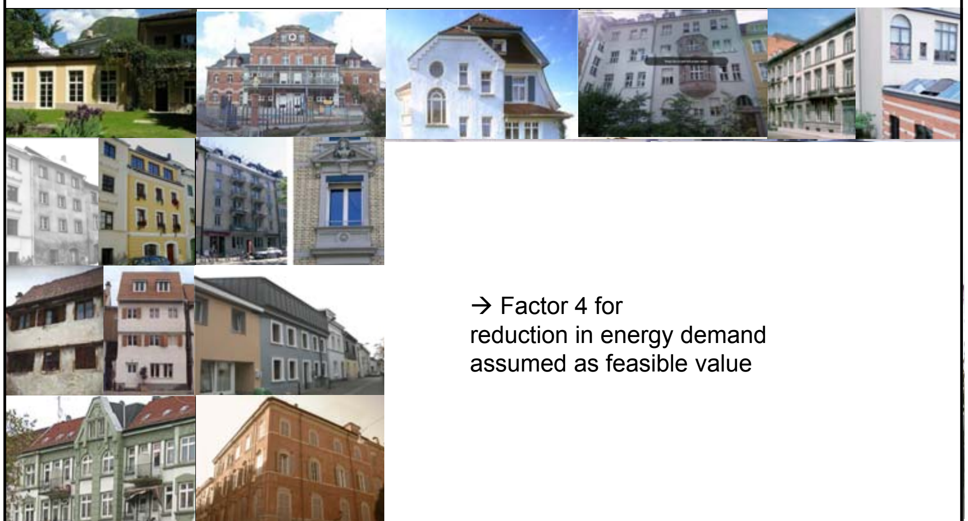

→ Factor 4 for
reduction in energy demand
assumed as feasible value

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Assessment criteria
… or start to
Talk and develop together

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EURAC research

Experience Saxony: Visualisation – saving potential and conservation compatibility

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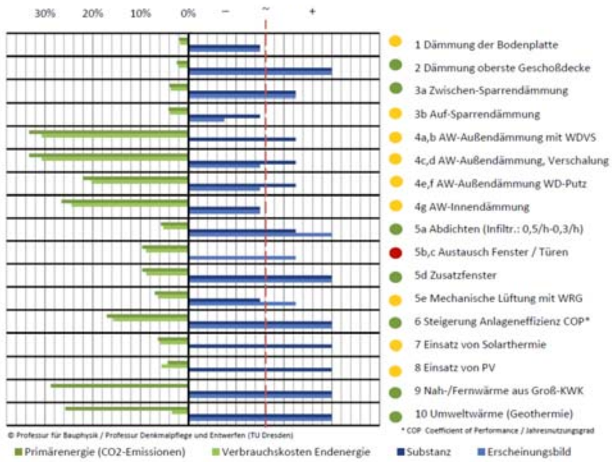
Energy saving potential   Conservation compatibility



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Experience Saxony: Assessment Criteria

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- CO_2 balance over whole life-cycle
- Resource consumption
- Primary energy saving potential
- Final energy cost reduction
- Enhancement indoor comfort
- Recoverability ("Werthaltigkeit")
- Damage risk
- Utilisation value ("Gebrauchswert")
- Loss of substance ("Substanzverlust")
- Change to appearance
- Reversibility

Detailed calculation and assessment → Primary energy saving potential, Final energy cost reduction, Enhancement indoor comfort

Assessment in Workshop → Damage risk, Utilisation value ("Gebrauchswert")

Assessment in Workshop → Loss of substance ("Substanzverlust"), Change to appearance, Reversibility

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Experience Copenhagen: Gross list & assessment

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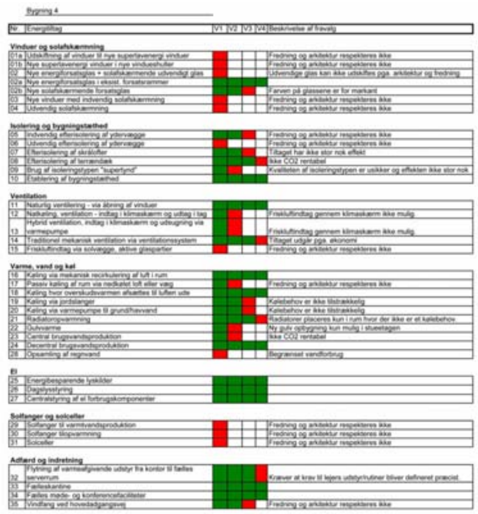

Bygning 4

Nr.	Energitiltag	V1	V2	V3	V4	Beskrivelse af fravalg
Vinduer og solafskærmning						
01a	Udskiftning af vinduer til nye superlavenergi vinduer					Fredning og arkitektur respekteres ikke
01b	Nye superlavenergi vinduer i nye vindueshuller					Fredning og arkitektur respekteres ikke
02	Nye energiforsatsglas + solafskærmende udvendigt glas					Udvendige glas kan ikke udskiftes pga. arkitektur og fredning
02a	Nye energiforsatsglas i eksist. forsatsrammer					
02b	Nye solafskærmende forsatsglas					Farven på glassene er for markant
03	Nye vinduer med indvendig solafskærmning					Fredning og arkitektur respekteres ikke
04	Udvendig solafskærmning					Fredning og arkitektur respekteres ikke
Isolering og bygningstæthed						
05	Indvendig efterisolering af ydervægge					Fredning og arkitektur respekteres ikke
06	Udvendig efterisolering af ydervægge					Fredning og arkitektur respekteres ikke
07	Efterisolering af skrålofter					Tiltaget har ikke stor nok effekt
08	Efterisolering af terrændæk					Ikke CO2 rentabel
09	Brug af isoleringstypen "supertynd"					Kvaliteten af isoleringstypen er usikker og effekten ikke stor nok
10	Etablering af bygningstæthed					
Ventilation						
11	Naturlig ventilering - via åbning af vinduer					
12	Natkøling, ventilation - indtag i klimaskærm og udtag i tag					Friskluftindtag gennem klimaskærm ikke mulig
13	Hybrid ventilation, indtag i klimaskærm og udsugning via varmepumpe					Friskluftindtag gennem klimaskærm ikke mulig
14	Traditionel mekanisk ventilation via ventilationssystem					Tiltaget udgår pga. økonomi
15	Friskluftindtag via solvægge, aktive glaspartier					Fredning og arkitektur respekteres ikke
Varme, vand og køl						
16	Køling via mekanisk recirkulering af luft i rum					
17	Passiv køling af rum via nedkølet loft eller væg					Fredning og arkitektur respekteres ikke
18	Køling hvor overskudsvarmen afsættes til luften ude					
19	Køling via jordslanger					Kølebehov er ikke tilstrækkelig
20	Køling via varmepumpe til grund/havvand					Kølebehov er ikke tilstrækkelig
21	Radiatoropvarmning					Radiatorer placeres kun i rum hvor der ikke er et kølebehov
22	Gulvvarme					Ny gulv opbygning kun mulig i stueetagen
23	Central brugsvandsproduktion					Ikke CO2 rentabel
24	Decentral brugsvandsproduktion					
28	Opsamling af regnvand					Begrænset vandforbrug
El						
25	Energibesparende lyskilder					
26	Dagslysstyring					
27	Centralstyring af el forbrugskomponenter					
Solfanger og solceller						
29	Solfanger til varmtvandsproduktion					Fredning og arkitektur respekteres ikke
30	Solfanger tilopvarmning					Fredning og arkitektur respekteres ikke
31	Solceller					Fredning og arkitektur respekteres ikke
Adfærd og indretning						
32	Flytning af varmeafgivende udstyr fra kontor til fælles serverrum					Kræver at krav til lejers udstyr/rutiner bliver defineret præcist
33	Fælleskantine					
34	Fælles møde- og konferencefaciliteter					
35	Vindfang ved hovedadgangsvej					Fredning og arkitektur respekteres ikke

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Case studies Overview

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- 8 case studies
  - Waaghaus, Bozen/Italy
  - Palazzo d'Accurso, Bologna/Italy
  - Palazzina della Viola, Bologna/Italy
  - Arsenal, Kopenhagen/Denmark
  - Höttinger School, Innsbruck/ Austria
  - Speicherstadt, Potsdam/Germany
  - University building, Bejar-Salamanca/Spai
  - Strickbau, Appenzell/Switzerland

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Keep updated!

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EFFICIENT ENERGY FOR EU CULTURAL HERITAGE

- Website (www.3encult.eu)
  - Information on project
  - Description of Case Studies
  - All public deliverables
- Newsletter (subscription at www.3encult.eu)
- FAQ platform
- Workshops for local governments
- Study tours to case studies
- Handbook
- Conferences, Publications, University & Professional training, Trade fairs, Final Workshop, etc.

Contact the coordinator for further information:
Alexandra Troi (alexandra.troi@eurac.edu), EURAC research, Italy

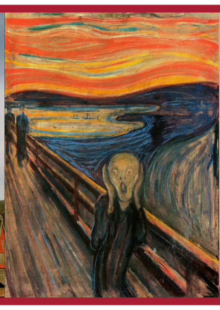
Thank you for your attention!

alexandra.troi@eurac.edu

EWCHP–2012

EWCHP–2012
2nd European Workshop
on Cultural Heritage Preservation
Oslo, Norway, September 24 to 26, 2012

http://ewchp-2012.nilu.no



The 2nd European Workshop on Cultural Heritage Preservation (EWCHP) is an European Cluster Workshop on research and development activities in the field of cultural heritage and its preservation for future generations. The workshop will take place on September 24–25, 2012 and an additional training day will be held on September 26th 2012. The 2nd EWCHP will take place at Kjeller, just 25 km outside of Oslo, Norway and will be hosted by NILU – Norwegian Institute for Air Research. The Organizing Committee is delighted to invite you to the 2nd EWCHP and looks forward to welcoming you.

Scope

The objective of the 2nd EWCHP workshop is to provide a forum for scientists, conservators, owners of cultural heritage structures and other experts and stakeholders who are involved in cultural heritage preservation. The focus will be in the field of museum objects and historic structures and their conservation and preservation. The workshop integrates European activities and initiatives capturing the current state-of-the-art in research and development. It will show latest results from national funded project and EU funded projects like MEMORI, Climate for Culture, NANOMATCH, 3ENCULT, TEACH and SMooHS.
In addition other projects related to the topics presented below will be presented.

Topics

- Assessment of the impact of indoor environments on movable cultural heritage objects (damage effects, prediction models, preventive measures and mitigation strategies).
- Determination and assessment of the impact of climate change on cultural heritage objects (climate evolution scenarios, prediction models, preventive measures and mitigation strategies).
- Monitoring methods and technologies including non-destructive and minimal-invasive test methods for the evaluation and assessment of movable heritage objects and historic structures.
- Simulation and modeling tools for indoor movable heritage objects and historic buildings and building materials (models for deterioration processes, environmental impact and assessed tolerable doses).
- Tools and strategies for enhanced management, conservation, preservation and maintenance of cultural heritage structures.
- Case studies on preservation and conservation methods and techniques applied to historic buildings.
- Energy efficiency in cultural heritage buildings, adaptation and mitigation strategies.

Working Language

The working language of the workshop and training day is English. Please note that no simultaneous translation will be provided.

Call for Abstracts

Abstracts of maximum 300 words (pdf or doc format). Please use the abstract template. The abstract should be submitted to the following email: ewchp@nilu.no before 1 April, 2012. You will be notified if your abstract will be chosen for a paper.

Papers

Papers will be peer-reviewed. All accepted papers will be published.
Please download the paper template including the information about the paper format. Papers should be submitted to ewchp@nilu.no before June 1, 2012.
Best papers will be selected for oral presentation.

Posters

During the workshop a poster session will be arranged. Papers not accepted for oral presentation can be presented as posters.

Training day

In a special training day on 26th September the participants will have the possibility to participate in one of the following workshops (duration 3-4 hours):

- ♦ ***Climate change and cultural heritage***
  (more specific topic to be decided upon)
  Organized by the "Climate for Culture" consortium
- ♦ ***Management of indoor air quality by use of the MEMORI technology***
  Practical workshop on measurements, mitigation and preventive conservation strategy.
  Organized by the MEMORI consortium
- ♦ ***Energy efficiency in cultural heritage buildings***
  Organized by the 3ENCULT consortium
- ♦ ***Constructing cultural heritage: defining, selecting and understanding***
  How is cultural heritage understood in society and does this affect our research perspectives?
  Organized by the Norwegian Institute for Cultural Heritage Research (NIKU)
- ♦ ***Research need markets – markets need research: How to take your reasearch products successfully to the market.***
  Organized by Karin Drda-Kühn/Joachim Rix (Association Culture & Work, Berlin/Bad Mergentheim – Germany).

Key dates

Submission of abstracts	*April 1, 2012*
Notification of acceptance of abstracts	*May 1, 2012*
Submission of papers for review	*June 1, 2012*
Notification of acceptance of papers	*July 1, 2012*
Submission of revised papers	*July 31, 2012*
Notification of selected papers for oral presentation	*July 1, 2012*
Workshop	*September 24-25, 2012*
Training day	*September 26, 2012*
Early bird Registration	*Before June 30, 2012*
Final registration date	*August 15, 2012*

Registration and Fees

To register, please fill in the registration form presented at the EWCHP web page.
The registration fee includes refreshments and lunch in addition to conference documents.

- ♦ Early–bird registration (until June 30): *€ 220,-*
- ♦ Workshop registration after June 30: *€ 270,-*
- ♦ Training day fee: *€ 60,-*
- ♦ Workshop dinner (September 24): *€ 65,-*

Organization Committee

- ♦ ***Elin Dahlin***, Chair, NILU – Norwegian Institute for Air Research
- ♦ ***Markus Krüger***, Co-chair, MPA University Stuttgart
- ♦ ***Terje Grøntoft***, Senior Scientist, NILU
- ♦ ***Susana Lopez-Aparicio***, Senior Scientist, NILU
- ♦ ***Bjørg Karlsen***, Responcible for local organization, NILU

Please contact the Organization Committee by using the following e-mail: ewchp@nilu.no

Scientific Committee

- ♦ ***Francesca Becherini*** (Institute of Atmospheric Sciences and Climate, National Research Council, Italy)
- ♦ ***Alessandra Bonazza*** (Institute of Atmospheric Sciences and Climate, National Research Council, Italy)
- ♦ ***Maria Perla Colombini*** (University of Pisa, Italy)
- ♦ ***Elin Dahlin*** (NILU– Norwegian Institute for Air Research, Norway)
- ♦ ***Terje Grøntoft*** (NILU – Norwegian Institute for Air Research, Norway)
- ♦ ***Markus Krüger*** (MPA University Stuttgart, Germany)
- ♦ ***René Larsen*** (Royal Danish Academy of Fine Arts, School of Architecture, Design and Conservation, Denmark)
- ♦ ***Johanna Leissner*** (Fraunhofer Brussels, Belgium)
- ♦ ***Susana Lopez-Aparicio*** (NILU – Norwegian Institute for Air Research, Norway)
- ♦ David Thickett (English Heritage, UK)
- ♦ ***Alexandra Troi*** (Institute for Renewable Energy, Bolzano, Italy)
- ♦ ***Merete Winness*** (Norwegian Institute for Cultural Heritage Research, Norway)

Venue

The 2nd EWCHP workshop will be held at the conference centre called ***Kunnskapsbyen Konferansesenter AS***, at Kjeller, about 25 km outside of Oslo, Norway.

Conference Web Page

http://ewchp-2012.nilu.no

Supporting Organizations

NILU
Norwegian Institute for Air Research

NIKU
Norwegian Institute for Cultural Heritage

NORSK KULTURRÅD
Arts Council Norway

MPA
MPA STUTTGART
Otto-Graf-Institut
Materialprüfungsanstalt Universität Stuttgart

SEVENTH FRAMEWORK PROGRAMME

EFFICIENT ENERGY FOR EU CULTURAL HERITAGE

Energy Efficiency in Cultural Heritage Buildings

How can diagnosis, monitoring & simulation play together to reach high quality energy retrofits of Cultural Heritage Buildings? Different tools and their application - explained and demonstrated on practical examples.

9.00	Introduction into 3ENCULT's postulates
	• Multidisciplinary: Include all stakeholders in the process of the energy retrofit • Holistic: Comprehensive diagnosis - design considering all aspects of the building - integrated monitoring & control • A substantial reduction of energy demand to one fourth or even lower is possible also in historic buildings, if solutions are developed and adapted to the specific building
	Raumbuch integrated with energy issues A tool coming from preservation practice integrated with energy aspects to support the discussion and exchange through disciplines
	Diagnosis of structure & structural health IR thermography. Radar measurements. Surveys. Material analysis.
	Diagnosis & monitoring of energy demand related aspects Measurement of thermal flux through wall. IR thermography. Material analysis. Use of Blower Door Test to and analyse critical areas.
11.00	COFFEE BREAK
	Höttinger School, Innsbruck (Austria) Early modern architecture, one of the first example of concrete buildings in Austria
	Evaluation of different scenarios to increase comfort and save energy with PHPP Analysis of structural health at potentially critical points Integrated solution including wall & window enhancement, ventilation & lighting
	Warehouse City Potsdam & other (Germany) Masonry buildings 17th to 19th century
	Development of optimal internal insulation system for the specific conditions and analysis of critical points. Verification of success with monitoring
	Appenzell, Appenzell (Switzerland) Strickbau-Building (wooden construction)
	Development and demonstration of specific solutions for interior insulation in wooden buildings. Diagnosis, simulation & monitoring.
13.00	CLOSURE

Several measurement devices will be available to be experienced at the workshop and live access to 3ENCULT case studies' monitoring will be provided.

SEVENTH FRAMEWORK PROGRAMME

EUROPEAN COMMISSION DG RESEARCH

Seventh Framework Programme - Theme [EeB.ENV.2010.3.2.4-1]
Collaborative Project – GRANT AGREEMENT No. 260162

Bridging the gap between preservation of European cities' cultural heritage and energy efficiency

Project coordinator EURAC
Alexandra Troi, alexandra.troi@eurac.edu

The research leading to these results has received funding from the European Community's Seventh Framework Programme (FP7/2007-2013) under grant agreement n° 260162

Historic buildings

- are the **trademark** of numerous European cities
- are a living symbol of Europe's **rich cultural heritage & diversity**
- reflect the society's identity and need **to be protected**

- show a high level of **energy inefficiency**
- contribute with considerable **CO_2 emissions** to climate change
- do not always offer "**comfort**" – to people as well as to artworks

Factor 4 to 10 of reduction in energy demand is achievable, also in historic buildings, respecting their heritage value, if a multi-disciplinary approach guarantees the implementation of high quality interventions, specifically targeted and adapted to the specific case.

Bologna

Urban Building Regulation distinguishes buildings of
- historic-architectural value
- modern architectural value
- historical documentary value
- modern documentary value

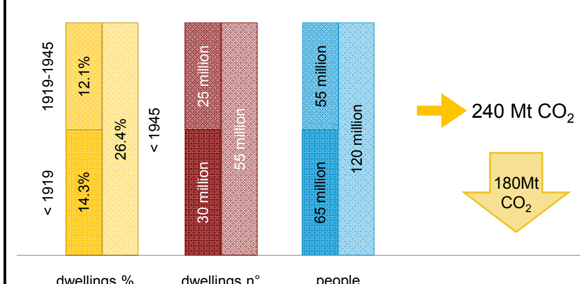
3616 buildings in city centre
- 60% before 1919
- 80% before 1945

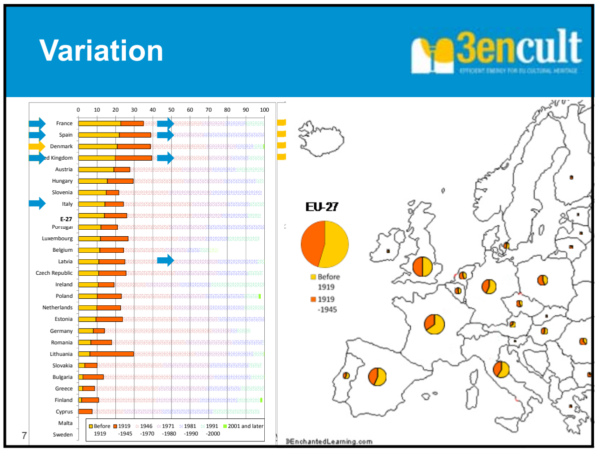
Denmark

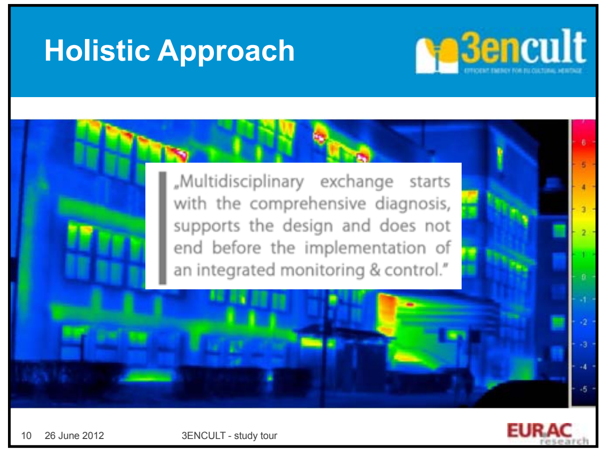
- 9,000 buildings in Denmark are listed (as the best or most characteristic of their type and period)
- 300,000 buildings have been assessed to be worthy of preservation.

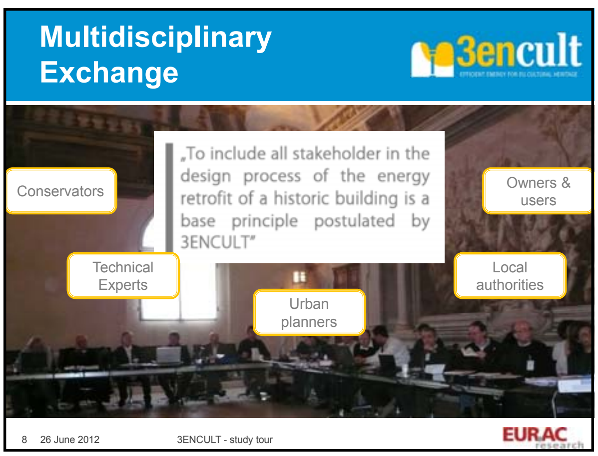
→ SAVE project: documentation of buildings built before 1940

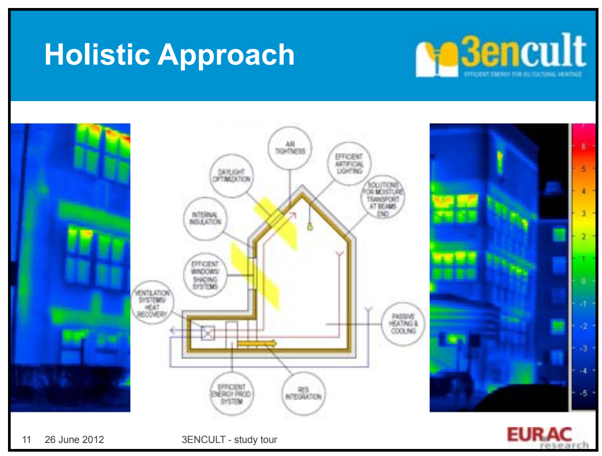
Impact

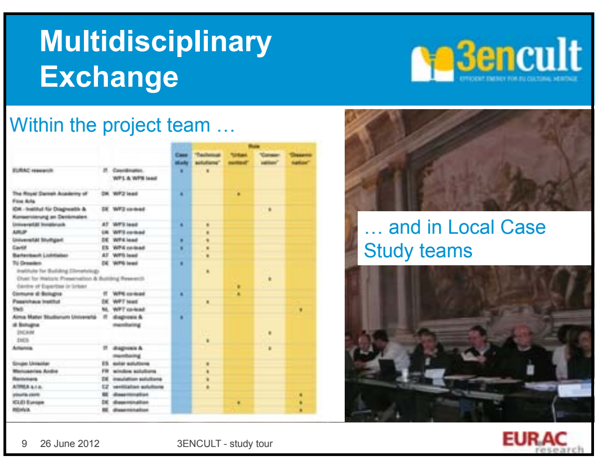



Variation
3encult
EU-27
Before 1919
1919 -1945
7
EnchantedLearning.com


Holistic Approach
3encult
„Multidisciplinary exchange starts with the comprehensive diagnosis, supports the design and does not end before the implementation of an integrated monitoring & control."
10 26 June 2012 3ENCULT - study tour
EURAC research


Multidisciplinary Exchange
3encult
„To include all stakeholder in the design process of the energy retrofit of a historic building is a base principle postulated by 3ENCULT"
Conservators
Owners & users
Technical Experts
Local authorities
Urban planners
8 26 June 2012 3ENCULT - study tour
EURAC research


Holistic Approach
3encult
11 26 June 2012 3ENCULT - study tour
EURAC research

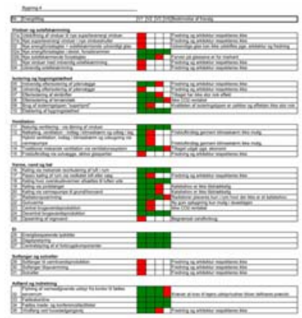

Multidisciplinary Exchange
3encult
Within the project team …
… and in Local Case Study teams
9 26 June 2012 3ENCULT - study tour
EURAC research


Research & development
3encult
„3ENCULT aims at developing necessary solutions, both adapting existing solutions to the specific issues of historic buildings and developing new solutions and products."
12 26 June 2012 3ENCULT - study tour
EURAC research

Case studies Overview

- 8 case studies
  - Waaghaus, Bozen/Italy
  - Palazzo d'Accurso, Bologna/Italy
  - Palazzina della Viola, Bologna/Italy
  - Arsenal, Kopenhagen/Denmark
  - Höttinger School, Innsbruck/ Austria
  - Speicherstadt, Potsdam/Germany
  - University building, Bejar-Salamanca/Spain
  - Strickbau, Appenzell/Switzerland

Experience Copenhagen: Gross list & assessment



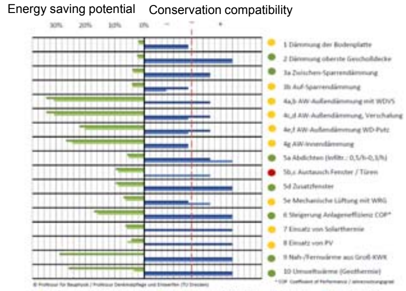
Dialogue and develop together

"Raumbuch" integrated with energy issues

- Monuments are unique → any change has to be prepared by a **comprehensive analysis**
  - information to the **historic** materials and constructions,
  - potential existing **damages** as well as
  - strong and weak points from **energy** perspective
- Collect and **visualize** in a structured way any information needed for the diagnosis (descriptions, plans, photographs, drawings of details, results of non or minor destructive testing, monitoring data as well as calculations and models).
- Architects, conservators and engineers
  → **"move" through** the building on different levels of detail
  → information for constructive discussion **at their hands**.

Experience Saxony: Visualisation – saving potential and conservation compatibility

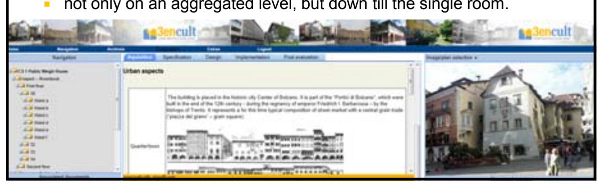
Energy saving potential Conservation compatibility



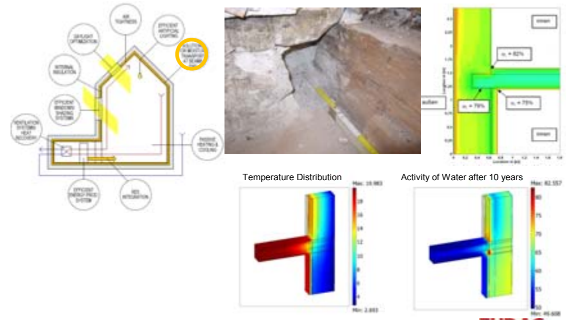
"Raumbuch" integrated with energy issues

Usefulness goes beyond diagnosis!
- development of solutions,
- comparison of different options
- selection of the best one for the specific building

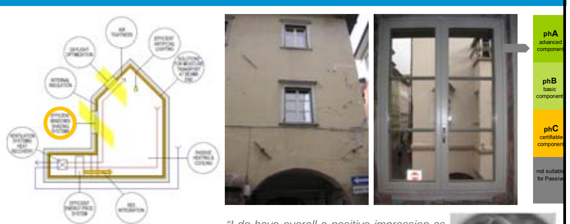
will profit from the
- structured presentation and
- simultaneous look at both conservation and energy aspects
- not only on an aggregated level, but down till the single room.



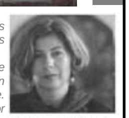
Research & development
… just a "taste"



22 26 June 2012 3ENCULT - study tour

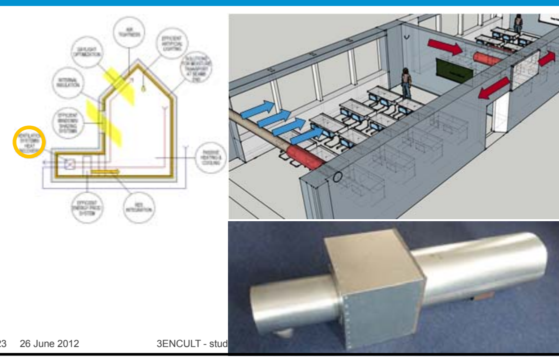


"I do have overall a positive impression as regards frame & sash bar dimension as well as subdivision & proportions. The optic of the outer glasing seems to me exagerated, both the too irregular reflection from outside, and distortion from inside. And I ask whether a 3-pane glasing for Bolzano climate is really needed.

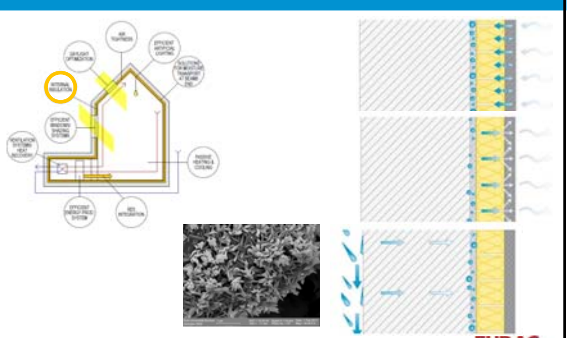


Frau Dr. Waltraud Kofler Engl

20 26 June 2012 3ENCULT - study tour



23 26 June 2012 3ENCULT - study tour



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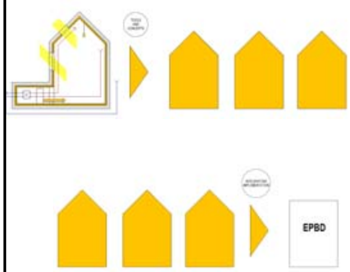
From the specific case to planning scale

… from the specific case to …



ICLEI “translates” findings into an e-guide for local governments

ICLEI supports integration in urban planning and climate action plans

TNO addresses issues related to EPBD and related CEN standards

EURAC keeps links with CEN TC Cultural Heritage

25 26 June 2012 3ENCULT - study tour

Keep updated!

- Website (www.3encult.eu)
  - Information on project
  - Description of Case Studies
  - All public deliverables
- Newsletter (subscription at www.3encult.eu)
- FAQ platform
- Workshops for local governments
- Study tours to case studies
- Handbook
- Conferences, Publications, University & Professional training, Trade fairs, Final Workshop, etc.

Contact the coordinator for further information:
Alexandra Troi (alexandra.troi@eurac.edu), EURAC research, Italy

26 26 June 2012 3ENCULT - study tour

Thank you for your attention!

alexandra.troi@eurac.edu

- Development of optimal interior insulation system
- Warehouse City Potsdam & other Masonry buildings 17th to 19th century
- Hydrothermal analysis of construction details
- Verification of success with monitoring

Rudolf Plagge

Institute of Building Climatology
University of Technology Dresden, Germany

Analysed interior insulation systems


perlite board


loam cork kieselguhr


iQ-Therm


calcium silicate board

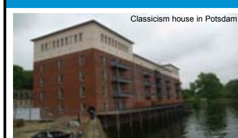
Development of interior insulation systems

During the last 20 years ...

- 1990 ➡ Idea and Research approach
- 1995 ➡ Measurement program and Test buildings
- 2000 ➡ Research projects material optimation
- since 2002 ➡ Application at listed historic buildings

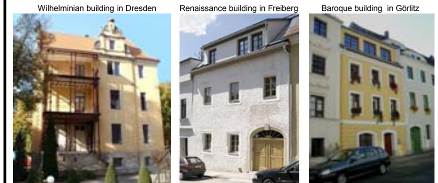

Rijksmuseum Amsterdam
loam, insulation plaster, Perlite board, iQ-Therm System, On-Spray Cellulose plaster ...

TUD Test houses


Classicism house in Potsdam

Warehouse City Potsdam & other masonry buildings 17th to 19th century

Analysis and comparison of different interior insulation systems, evaluation of historical buildings


Wilhelminian building in Dresden — Renaissance building in Freiberg — Baroque building in Görlitz

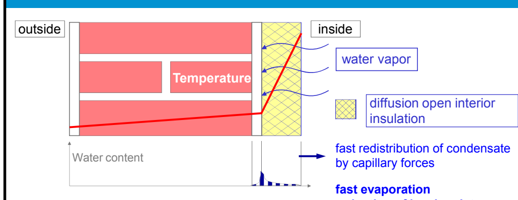
1- Classicism warehouse building in City Potsdam (1835)

2- Wilhelminian building in Dresden (1890)

3- Middle Ages, Renaissance building, in Freiberg (1518)

4-.Baroque building in Görlitz, (1726)

Diffusion open interior insulation with capillary redistribution

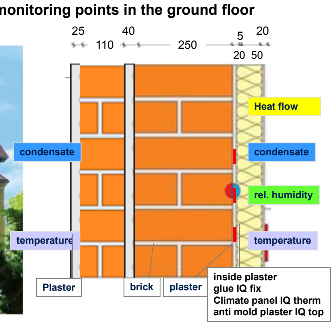


condensation zone is located at the cold side of insulation

multi functional material properties
+ good insulation
+ proper moisture buffer, room climate control
+ large drying potential
 reduction of freezing damages
+ resistance against mould
+ fire protection, noise transmission reduction, ..

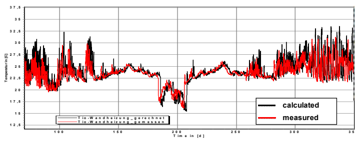
Wilhelminian style building in Dresden

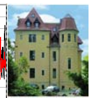
Wall profile and position of monitoring points in the ground floor



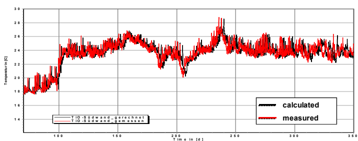
Example of monitoring and calculation results

comparison of measurement and calculation





temperature warm side of insulation (10.03.011-15.12.011)

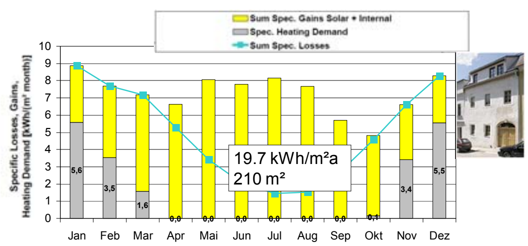


temperature cold side of insulation (10.03.011-15.12.011)

Loam cork insulation

Energy efficiency of case study bulding: PHPP results

Renaissance building in Freiberg: Heating energy consumption (PHPP)

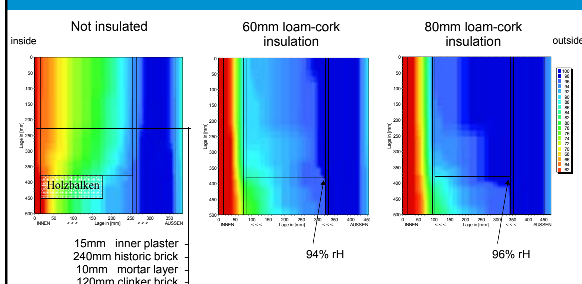


- annual heating energy consumption of 4140 kWh / year (19.7 kWh/m² a)
- hot water demand of 2226 kWh/a (warming of 8 ° C to 50 ° C, 25l/Person/day, 5 persons
- total heat consumption: 6366 kWh/a

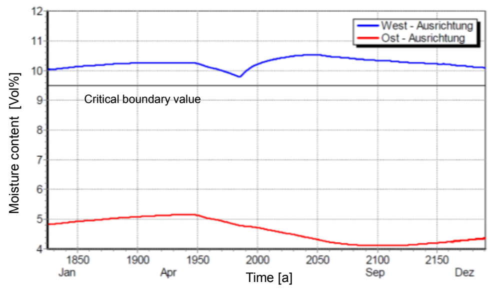
Application of loam cork insulation at the construction

“Schinkel” ware house

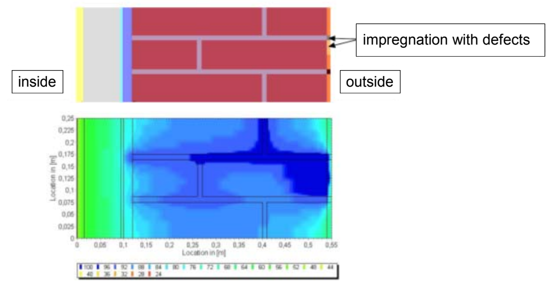
Comparisson of loam cork insulation of different thickness



Moisture content of wodden beam west oriented, east oriented

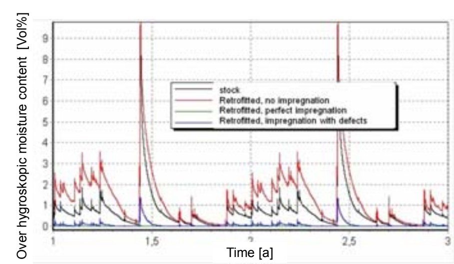


Impregnation with surface defects

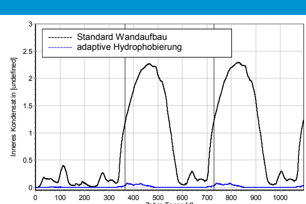


Driving rain problem due to open mortar joints

Impregnation with surface defects

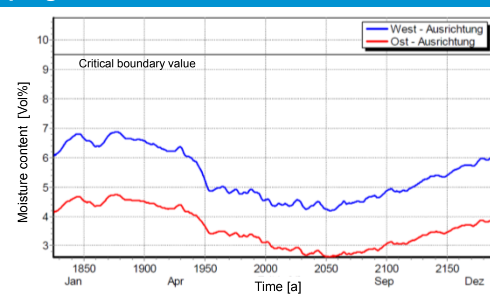


Driving rain protection

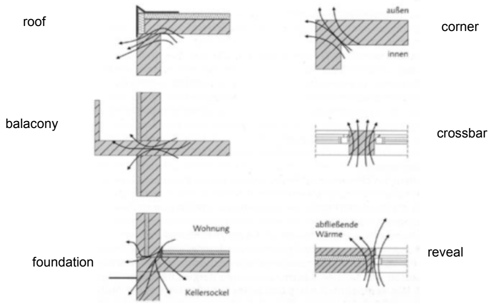


Adaptive hydrophobic Impregnation
- functionality and durability of driving rain protection,
- homogeneous penetration up to 15mm depth,
- applicable on moist undergrounds → emulsions cream
- keeping drying potential
- unchanged optical impression after application

Moisture content of wodden beam west oriented, east oriented after impregnation

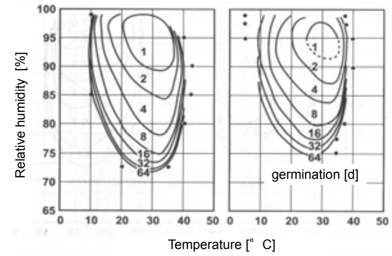


Typical thermal bridges



Mold growth isoplet system

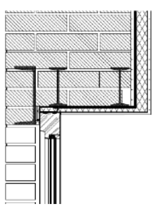
Aspergillus restrictus (left) und A. versicolor (rigth) (Smith)



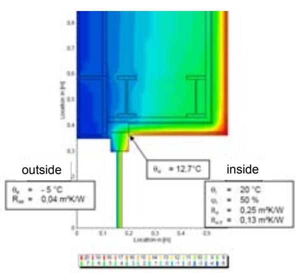
Points indicate, where after 95 days no germination could be found.

Window detail

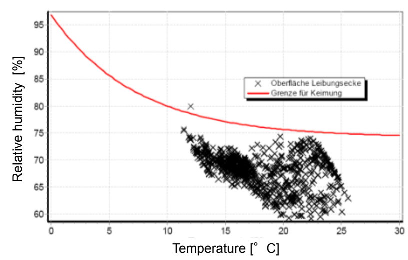
Detail sketch



Thermal calculation



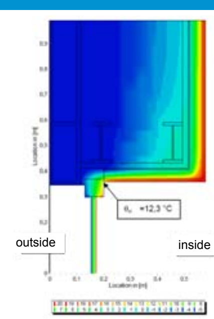
Window detail

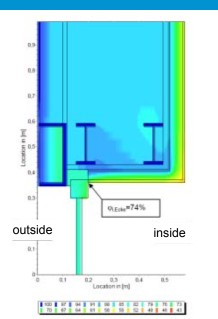


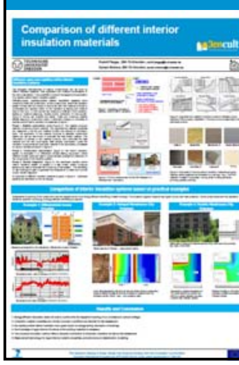
Yearly cycle of temperature and relative humidity at the window corner, isopleth for germination of mold

Window detail

hygrothermal simulation







- Development of optimal interior insulation system
- Warehouse City Potsdam & other Masonry buildings 17th to 19th century
- Hydrothermal analysis of construction details
- Verification of success with monitoring

Rudolf Plagge

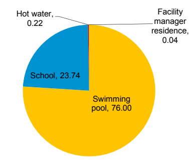
Institute of Building Climatology
University of Technology Dresden, Germany

Case Study 5: School Building in Hötting Innsbruck, Austria

The research leading to these results has received funding from the European Community's Seventh Framework Programme (FP7/2007-2013) under grant agreement n° 260162

Innsbruck 24/09/2012

Measurements results: Heating Demand



Average yearly consumption between 2006 and 2010

	Yearly consumption [MWh]	Proportion [%]
School - heating	458.07	23.74
School – hot water	4.32	0.22
Facility management	0.76	0.04
School - total	463.14	24.00
Swimming-pool	1491.08	76.00
TOTAL	1954.22	100

- Over 75 % of the heat produced in the school is consumed by the swimming pool !!
- approx. 25 % loss in the boiler and in the main duct between the top floor and the basement.

Innsbruck 24/09/2012 3ENCULT CS5, Höttinger School

The School in Hötting

• Planed and built in the end of 1920 by the architects Franz Baumann and Theodor Prachensky
• One of the most important examples of early modern architecture in Tyrol
• High heating energy demand (more than 200 kWh/(m²a))

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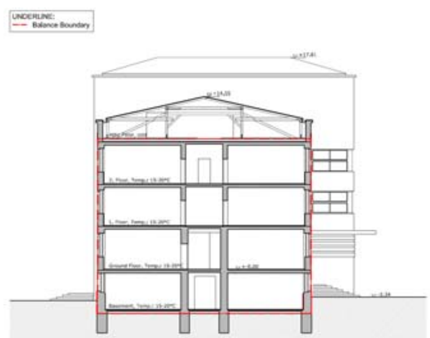
Warm Zone



Aim of the Project

ENERGY EFFICIENCY
- Determination of the heat consumption
- Calculation of the heat demand by PHPP
- Energy consumption for the electric lighting

USER COMFORT
- Thermal comfort
- Indoor air quality
- Daylight
- Lighting

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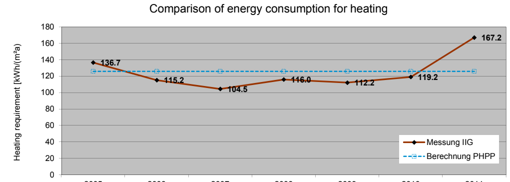
PHPP Calculation Versus Measurements



Deviation (mean Value): 1.3%
-> 1.3% from **126,0 kWh/(m²a)** are1,6 kWh/(m²a)
measured data 2005-2011

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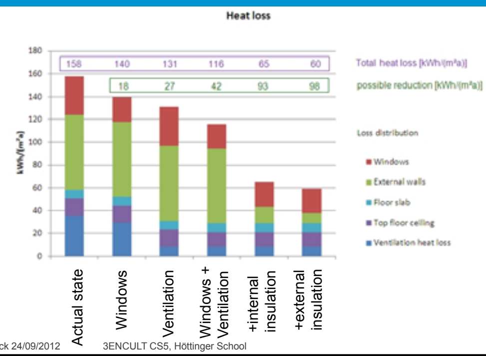
Saving Potential



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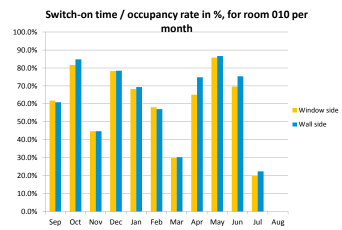
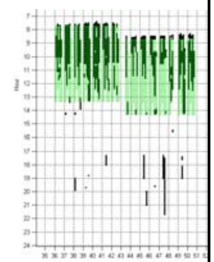
Switch-on Time



Daily switch-on time (black) to occupancy times (green).



- Pupils switch on before the class
- Cleaning times or miscellaneous evening occupancy are not considered.

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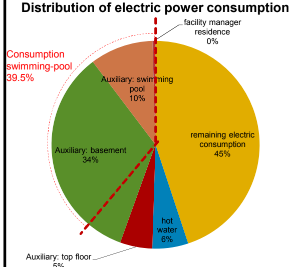
Electric Power Consumption

Distribution of electric power consumption



Average yearly consumption (2005-2011):
102130 kWh/a -> 23.76 kWh/(m²a)
Swimming pool:
39.5 % -> 40280 kWh/a

Remaining electric consumption

- Lighting
- Auxiliary power in the kitchen
- Small boiler for toilet blocks
- Computer room (PC´s, screens)
- Hardware in teachers room (copier, printer, PC´s, screens)

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Daylight

Determination of the daylight factor

- Illuminace measurement
- Luminace measurement (digital camera)

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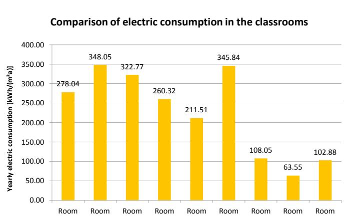
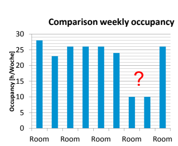
Electric Power Consumption



Electric power for lighting in each room: 533.6 Watt



Influence factors

- Position inside the building (daylight input)
- Orientation (south-east or north-west)
- Occupancy (ambiguity for rooms 212, 213)

Comfort Measurements

Air quality

CO_2 concentration (1m above floor level)

Thermal Comfort

- Combined humidity and temperature sensor
- Globe thermometer for radiative temperature
- Thermo-anemometer for indoor air velocity
- 1 NTC – sensor for temperature 10 cm above floor level

Sensors logged by the Almemo logger 2590-4S

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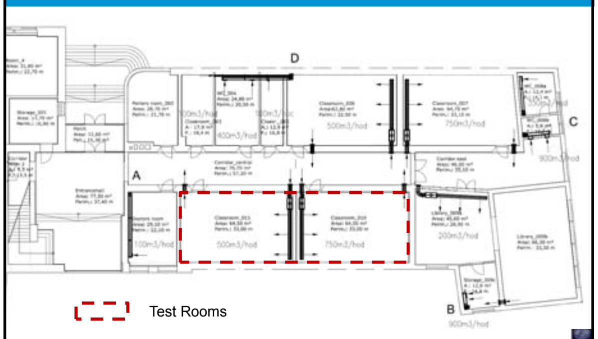
Test Classrooms



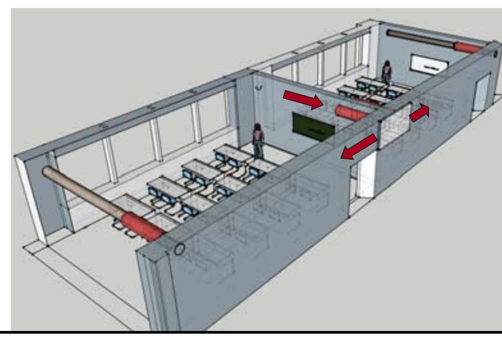
Ventilation:Active Overflow Concept by UIBK

Refurbishment scheme

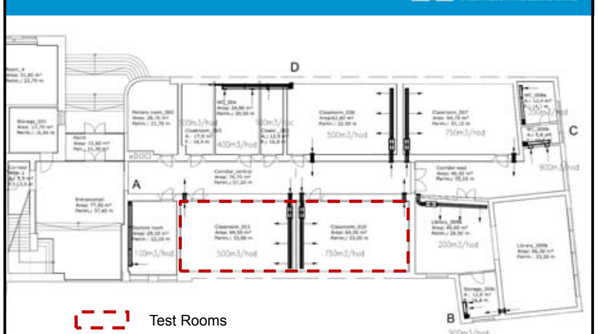
Test Classrooms

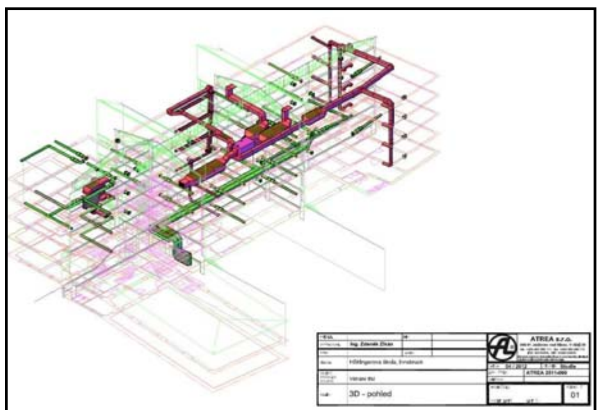
- Internal isolation (temperature and moisture monitoring)
- Refurbishment of windows and replacement of the internal panes
- Lighting concept (research project from Zumtobel) with daylight redirection system
- Improvement of room acoustics with sound absorbers in the ceiling
- Ventilation: Active overflow elements

Ventilation System

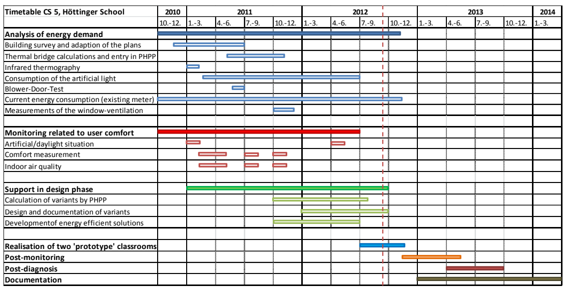


Test Classrooms





Project status and global case study process



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Thank you for your attention!

Rainer Pfluger
Kai Längle
Michele Bianchi Janetti

Innsbruck 24/09/2012 3ENCULT CS5, Höttinger School

CS 8 "Strickbau" Appenzell

University of Stuttgart
Germany

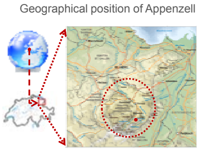
The research leading to these results has received funding from the European Community's Seventh Framework Programme (FP7/2007-2013) under grant agreement n° 260162

Content

Environment features and architectural aspects

Handcraftet log homes have been built for centuries in the canton Appenzell by laying both round and hwen logs horizontally overtop of each other and over-lapping the logs at the corner.

Geographical position of Appenzell



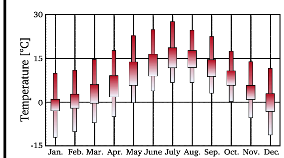
Study object

Corner joint: full-scribe fit

In order to get strong structures, different methods of corner timbering were used, e. g. full-scribe fit, saddle notch, interlocking saddle notch, Butt-and-pass, vertical corner post, etc.

Historical features and motivation

- Build in the middle of the 17th century
- Renovated in 1873 and 20th century
- High exposure by the weather
- Building sturcture partially damaged
- Leaky windows and construction
- Energy demand ~ 400 kWh / (m²a)
- External insulation not possible



Energy demand pre-intervention: **447 kWh/m²a**

Internal insulation
Opimized windows

Energy demand after intervention: **158 kWh/m²a**

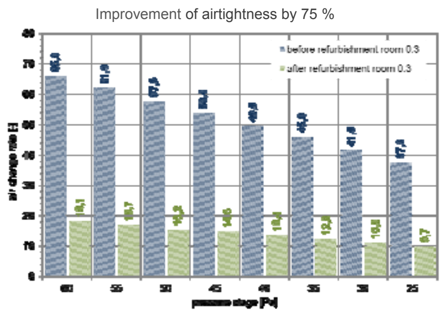
Interventions
Intenal wood fiber insulation with a thermal conductivity of 0.040 W/(m²/K)

- Three rooms are fully internal insulated and one room only partially
- Electrical radiators and humidifiers for the room climate
- Climate conditions are controlled in real time by monitoring

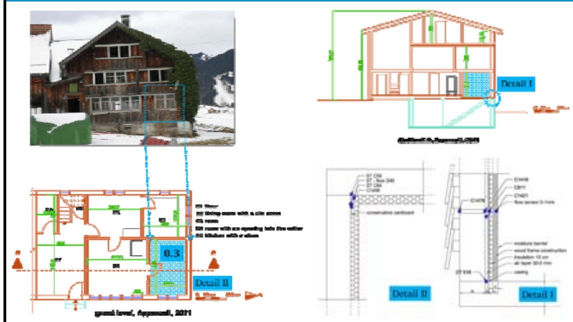
Interventions
Wooden dowel and windows

- Preventing convection into the insulation layer by use of wooden dowels
- Simulation of optimum windows with acryl glass were placed to room side

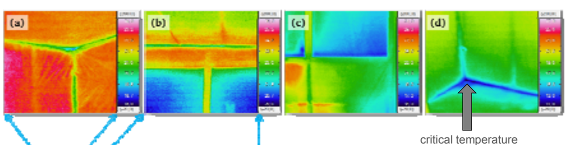
Investigations
Blower-door-test before and after intervention

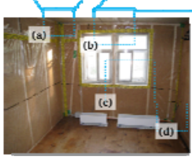


Monitoring
hygrical impact, room climate, near field climate and surface temperature



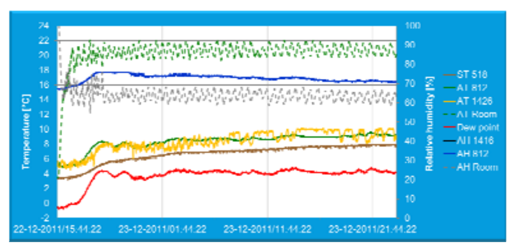
Investigations
Infrared thermography after intervention





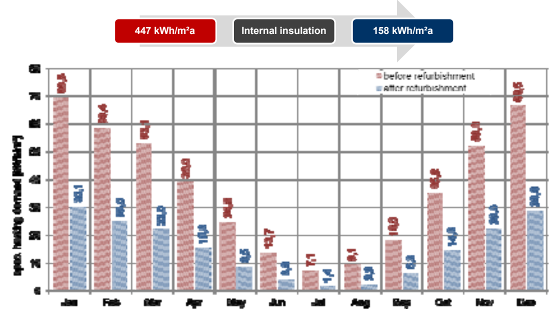
By using a infrared thermography camera thermograms can show the amount of emitted radiation of a building where the colours form red to blue indicate a loss of temperature inside the considered room.

Monitoring
After intervention in room 0.3 (Detail I)



The warming of the construction is visible after the heating installation, the temperature is rising from about zero to over ten degrees and no condensate can be founded in the construction.

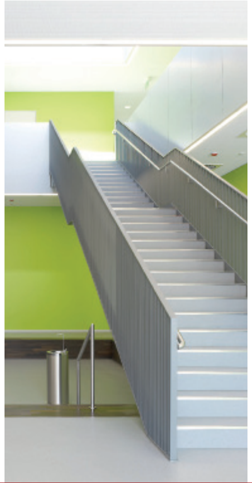
Energy efficiency - PHPP
Spec. heating demand before and after intervention



Thank You!

FRIDAY PROGRAMME | 19 APRIL 2013

17[TH] INTERNATIONAL PASSIVE HOUSE CONFERENCE 2013


Programme of the Passive House Conference 2013

and Exhibition
Congress Frankfurt | Frankfurt am Main

Passive House Basics Course
Wednesday, 17 April 2013

Passive House Components Workshop
Thursday, 18 April 2013

Conference and Exhibition
Friday and Saturday, 19 and 20 April 2013

Excursions
Sunday, 21 April 2013

STADT FRANKFURT AM MAIN

HESSEN
Hessisches Ministerium für Umwelt, Energie, Landwirtschaft und Verbraucherschutz

Passive House Institute

PLENARY SESSION | Harmony Hall

9:15 Opening remarks: Mark Weinmeister, State Secretary of the Environment, Energy, Agriculture, and Consumer Protection for the State of Hesse | Olaf Cunitz, Mayor of the City of Frankfurt | Horst Westerfeld, State Secretary of Finance for the State of Hesse | Barbara Ettinger-Brinckmann, President of the Chamber of Architects and Urban Planners Hessen | Dr. Christof Riess, Chamber of Trades Frankfurt-Rhein-Main

10:00 Frank Junker | Experience from more than 1,600 Passive House apartments

10:45 Wolfgang Feist | Passive House efficiency makes the energy revolution affordable

11:15 Tour of exhibition | Hall 5

12:00 LUNCH

	Harmonie Hall | level C2	Illusion Hall | level C3	Fantasy Hall | level C3	Spektrum Hall | level C2
	Session I: Passive House Capital Frankfurt* (PassREg)	Session II: Global cooperation*	Session III: 3ENCULT (held in English)	Session IV: Results and Analysis (held in English)
13:00	Werner Neumann | Frankfurt am Main, Passive House Capital – how can the success story continue?	Thilo Cunz, Jean-Denis Mège | Building Together (BuildTog) - Europe-wide adaptation of an apartment building design	Alexandra Troi | Solutions & tools for the conservation compatible energy retrofit of historic buildings	Anda Kursisa | Passive House method for industrial buildings
13:30	Harald Mathes, Wolfgang Hasper | Passive House for the Hesse State administration	Michael Tribus, Christoph Holzner | A cost comparision of three built Passive House apartment building designs	Rainer Pfluger | Active overflow ventilation for refurbishment of school buildings	Mark Siddall, John Trinick | Bridging the Energy Performance Gap
14:00	Wiebke Fiebig, Peter Hufer | Energy retrofit of a Wilhelminian building with Passive House components	Michael Klinski | The Norwegian Passive House experience	Ann-Marie Fallon, Joseph Little | Retrofitting Ireland's first EnerPHit building - Issues, challenges and solutions	Jelle Langmans | Quantitative study on the hygric response of timber frame walls with exterior air barriers
14:30	Winfried Naß | Passive House hospitals – a challenge Frankfurt is pleased to tackle	Rena Vallentin | International cooperation between Korea and Germany continues	Frances Bradshaw | Detailing for Passivhaus retrofit in London; terrace houses, solid walls, timber floors and internal insulation	Elisabeth Sibille | Optimization of dwelling floor-plan configuration for cascade ventilation
POSTER CONTRIBUTION 15:00	1) Buth: Heppenheim administrative centre. Germany's first Passive House administrative building born of the PPP process	1) Engelmann: Energy concepts for floating buildings 2) Amirisamkouei: Application of a particular wind catcher to reduce cooling energy requirement of residential buildings	1) Vanaga: Reaching the EnerPHit standard using a holistic approach	1) Mader: Life Cycle Assessment results of PH buildings with different construction methods 2) Ochs: Energetic and Economic Optimization of the Renewable Energy Yield of Multi-Storey PHs
15:10	COFFEE BREAK			
	Session V: future-proof renovation*	Session VI: Energy-efficient building services*	Session VII: Passive House Regions (held in English) (PassREg)	Session VIII: Passive House around the world (held in English)
15:45	Florian Kagerer | Renovating a high-rise to fulfill the Passive House Standard – a year of operational experience	Kristin Bräunlich | Ventilation in commercial kitchens	Marianne Fujara | PassREg – Supporting Politicians to create model structures for Passive House with Renewable Energies	Paola Leardini | Building Passive Houses in subtropical climates? A lesson learnt from New Zealand
16:15	Florian Lichtblau | Multi-story residential complex 1958, timbered model renovation	Oliver Kah | Energy efficiency in cafeterias and commercial kitchens	Dragomir Tzanev | Passive House Regions: A guide to success	Georg W. Reinberg, Tõnu Mauring | First certified Passive House in Estonia
16:45	Marc Großklos | Results from the retrofit of seven multi-family units to the Passive House Standard	Tjado Voß, Karsten Voss | The effect of façade-integrated fresh air elements on energy demand and indoor temperatures in the summer	Carmelo Sapienza | Smart NZEB in the Passive House Standard in Sicily	László Szekér | Passive Houses in Hungary
17:15	Barbara Wörndle, Oscar Stuffer | Taylor-made solutions for a historical residential building in the center of Bolzano (I)	Jan Riha | Highly diffusive overhead lights – heat loss versus energy conservation	Anne-Laure Maerckx | Aeropolis II & Elia: passive buildings showing the (r)evolution of eco-construction in Brussels	João Marcelino | The Passive House in Portugal: how to spread it in South West Europe
17:45	Kristin Bräunlich | Measuring moisture buildup in timbered beam ends for renovation with interior insulation	Matthias Werner | Influence of retrofitting on daylighting	Lorenzo Pagliano | nZEB coupled with an Earth to Air Heat Exchanger	Ling Guo | Current Development of Passive Houses in China
POSTER CONTRIBUTION 18:15	1) Böhme: Life in a renovated PH watermill 2) Rongen: The Heinsberg Protestant church – renovation, conversion, and expansion to the EnerPHit Standard (with interior insulation) 3) Bastian: Factors that influence the energy balance and affordability of non-residential EnerPHit projects	1) Großklos: Testing new air quality controls with VOC sensors for residential ventilation systems 2) Struckmeier: PH heating with waste heat from computers („server heater") 3) Riis Dietz: LED Light in Passive Houses	1) Anne Gerin: Successful Passive House skyscrapers 2) O'Donnell: A very Irish Solution – adapting local techniques for Passivhaus	1) Redon: Lean PH: the key to affordable performance 2) Kim: A study on building energy consumption of the first Passive House in Korea
20:00	Evening Event (reservation must be made in advance)			

* Session held in German with translation into English

SATURDAY PROGRAMME | 20 APRIL 2013

Organisers of the 17th International Passive House Conference: Passive House Institute; Stadt Frankfurt am Main

Patronage:

Lucia Puttrich
Minister of the Environment, Energy, Agriculture, and Consumer Protection for the State of Hesse

Hessen – Hessisches Ministerium für Umwelt, Energie, Landwirtschaft und Verbraucherschutz

» Registration by post:

Passive House Institute | Rheinstraße 44/46
64283 Darmstadt | Germany

» Online registration:

www.passivehouseconference.org

» 2013 Conference schedule

17 April 2013	Passive House Basics Course | University of Applied Sciences Frankfurt
18 April 2013	Passive House Components Workshop | Congress Frankfurt
19-20 April 2013	17th International Passive House Conference and Exhibition | Congress Frankfurt
21 April 2013	Passive House Excursions

» Conference languages: German and English

Simultaneous translation into English will be provided at all German language sessions.

Supported by:

PLENARY SESSION | Harmony Hall

8:45 Gordon Sutherland, Intelligent Energy Europe (IEE) Senior Project Officer for Energy efficiency in buildings, industry, equipment and transport | Towards nearly zero-energy buildings: the European path till 2020
9:15 James Scott Brew | Reinventing Fire: Passivhaus role in bold solutions to get one nation off coal and oil by 2050
9.45 Helmut Krapmeier | Austrian State Prize for Architecture and Sustainability

	Harmonie Hall | level C2	Illusion Hall | level C3	Fantasy Hall | level C3	Spektrum Hall | level C2
	Session IX: Planning and implementation*	Session X: Sustainable solutions for multistory apartment complexes*	Session XI: Hot and Humid Climates (held in English)	Session XII: Residential and non-residential Passive House buildings (held in English)
10:30	Ralf Bermich | Urban development with the Passive House Standard – Heidelberg's new Bahnstadt district grows dynamically	Margrit Schaede | Multi-family Passive House units with energy gains	Jessica Grove-Smith | PHPP calculations in hot and humid climates	Tomás O'Leary | Target to deliver 100,000m² Passive House Projects in New York City by 2017
11:00	Robert Persch | Quality management system for Heidelberg's Bahnstadt Passive House district	Ludwig Rongen, Werner Welfers | The Geilenkirchen-Waurichen, Walderych 27 Passive House residential complex	Susanne Theumer | Mexico study: Passive Houses in tropical climates	Adam J. Cohen | Design & Construction of the Malcolm Rosenberg Center for Jewish Life
11:30	Burkhard Schulze Darup | DomRömer Frankfurt – a historical monument as a new build	Stefanie und Hans-Dieter Rook | Joint building ventures – getting more done together	Andreas Gruner | Towards sustainable housing in Mexico	Sebastian Moreno-Vacca | Passivhaus + Breeam and green lease at no extra cost. A myth?
12:00	Norbert Stärz | Mainzeile apartment building: planning in a challenging field – quality, costs, Passive House	Klaus Zeller | Multi-storey apartment complexes with single-shell brick walls – 17 units in Cologne	Clare Parry | Multi-use Passive House buildings in humid & hot climates: Jakarta	Hannes Mahlknecht | User habits – impact on energy consumption in Passive Houses
POSTER CONTRIBUTION 12:30	1) Krause: Combining a balance-based approach for Passive House planning with simple dynamic building simulation 2) Steiger: PHPP 8 - worldwide applicability, added functions, improved user-friendliness and compatibility 3) Edwards: "designPH" plugin for Trimble Sketchup: A visual tool to export building geometry to PHPP and provide instant feedback on performance at pre-planning stage	1) Tribus: Different approaches in basement isolation in a Passivhaus condominium in relations to its overall energy efficiency 2) Vallentin: Training towards the Certified Passive House Designer qualification in a Passive House design office	1) White: A Method for Peak Cooling Load Calculation for Low-Load Houses in Humid Climates 2) Gilliland: Passive House Design produces First Certified Net Zero Energy Home in California 3) Reddy: Performance evaluation of solar insulation materials in UAE conditions	1) Rossi: Zero energy cooperative building in North Italy 2) Langenkamp: Challenging the possibilities
12:45	LUNCH			
	Session XIII: success in non-residential construction*	Session XIV: Sustainability*	Session XV: Retrofit: Validation of the Potential (held in English)	Session XVI: Implementing Passive House Standard (held in English)
14:15	Harald Krause | Passive House schools in the City of Offenbach	Gernot Vallentin | Holistically sustainable building concepts – a plus for the Passive House	Lars Ørtoft | A Large Energy Efficient Renovation to Passive House	Virginie Leclercq, Pierre Willem | Exemplary Buildings, a step towards nZEB in the energy policy of the Brussels Region
14:45	Bärbel Steinmann | Day care centres – building services in timbered and solid construction	Benjamin Krick | Nearly Zero Energy Building? The Passive House provides an answer	Mike Duclos | EnerPHit in Boston: Refurbishment of a timber frame two-family house	Markku Hienonen | What public authority can do to increase energy efficiency in new buildings
15:15	Søren Peper | Monitoring the Lünen Passive House indoor pool	Rainer Vallentin | Energy transition and energy sustainability: what the Passive House concept can do up to 2060	Agris Kamenders | Post-occupancy evaluation of dormitory building with aim of EnerPHit renovation	Tadeja Kovačič | The effects of Eco Fund's grants for energy efficiency in buildings: Slovenian experience
15:45	Michael Hörner | The IWU building: modernization with Passive House components – concept, costs, and operational experience	Martin Bauer | Using Passive Houses to store non-electric energy in smart grids	Tobias Loga | TABULA – Residential Building Typologies in European Countries	Art McCormack | Groundbreaking Training for Passive House Tradespersons
POSTER CONTRIBUTION 16:15	1) Gollwitzer: A comparison of insulation apron solutions 2) Freundorfer: Windows of efficiency class phA+: an important step towards zero-heating-energy homes?	1) Sørnes: Energy efficient timber framed external walls: Energy and environmental assessment over the life cycle 2) Miščevič: Passive House and ECO-SANDWICH EU Eco-innovation Project for Facade Panels	1) Little: Managing moisture – the key to healthy internal wall insulation retrofits of solid walls	1) Zbasnik-Senegacnik: Seismic safety of Passive Houses founded on thermal insulation 2) Nikolov: Three approaches to the ground insulation in seismically hazardous regions 3) Silkworth: A Multi-Zone Manager for the PHPP
16:30	COFFEE BREAK			

Subject to alterations

PLENARY SESSION | Harmony Hall

17:00 Wolfgang Feist | Energy concepts – the Passive House in comparison. Conferal of the Passive House Pioneer Award
18:00 End of conference

* Session held in German with translation into English

Solutions & tools for the conservation compatible energy retrofit of historic buildings

Alexandra Troi, EURAC research, Drususallee 1, 39100 Bozen (Italien)

1 Introduction

Historic buildings are the trademark of many European cities, towns and villages and are a living symbol of Europe's rich cultural heritage. However, they are also substantial contributors to CO_2 emissions [Troi 2011 a] and rising energy bills, and often do not offer the comfort needed – comfort for users and "comfort" for heritage collections. Can these buildings be made more energy efficient while conserving their heritage value – or rather: in order to guarantee their long term structural health and preservation?

2 Method

The joint task of conservation and energy efficient retrofit is highly interdisciplinary – and research project 3ENCULT (Efficient Energy for EU Cultural Heritage, funded within FP7) gathers in its therefore scientists and stakeholders, from architecture, conservation, building physics and specific technologies. This team develops passive and active solutions, including available products as well as new developments by involved SMEs, it defines diagnosis and monitoring instruments, and works on planning and evaluation tools as well as concepts supporting the implementation and control of success of the energy retrofit measures. Eight case studies demonstrate and verify solutions that are applicable to the majority of European built heritage in urban areas [Troi 2011 b].

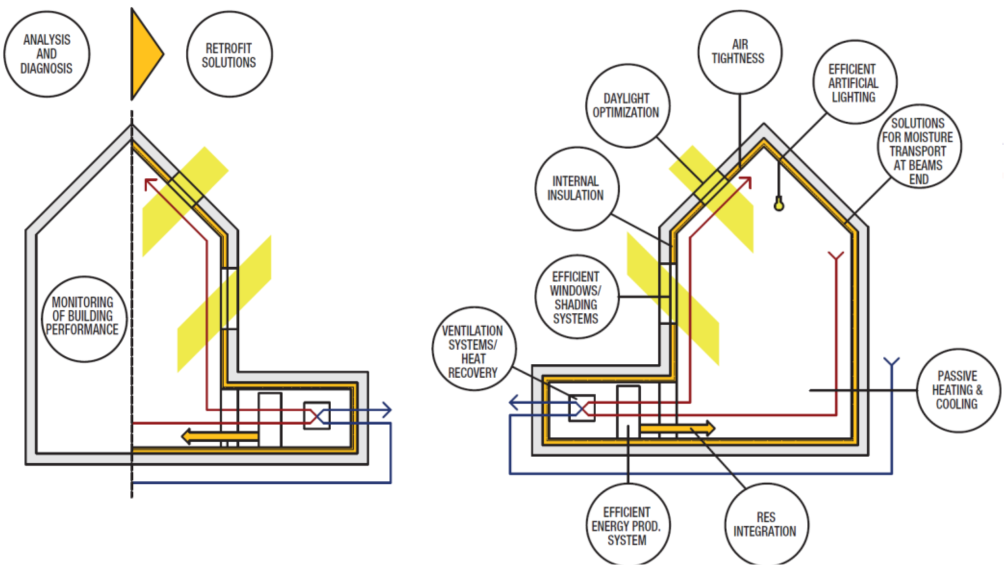


Figure 1 **Diagnosis of both conservation and energy related aspects and looking at the object in a holistic way, allows to develop retrofit solutions fitting the specific building.**

3 Results

Half a year after mid-term of the project several prototypes are ready – from the conservation compatible phA window over enhanced internal insulation to low impact ventilation – as well as application and solution guidelines, diagnosis and planning tools. But what besides the pool of technical solutions is significant, is the experience that it actually is possible to communicate across disciplines.

In the following sections, an overview over selected developments is given:

Conservation compatible window

Starting from historic drawings and the discussions at the multidisciplinary workshop (including a guided tour with the conservator) in Bolzano, 3ENCULT project partner Menuiserie André together with Freundorfer [2012] developed an A-class passive standard window which meets the aesthetics demands of a historic building. Typical application cases will be buildings, where the original windows have anyway been lost – and the new windows might even improve the perception of the historic context.

In order to avoid “bowing” of the glazing due to the pressure between the single glasses in modern insulation glasses, Andre and Freundorfer opted for a countersash window with a single glass in the outer window [Engelhardt 2012]. The inner window is has triple glazing, which thanks to hardened 2 mm glasses has the less weight and similar thickness than a standard double glazing – keeping the overall construction very light.

Figure 2 **At the “smartwin historic” prototype, installed at the Public Weigh House in Bolzano, the two functions “energy efficiency” and “aesthetics” are realised in separate layers**

Internal insulation

In historic buildings interior insulation is often the only option, if energy loss through the wall should be reduced and comfort increased. In terms of hygrothermal behaviour this is however less error-prone than exterior insulation. 3ENCULT project partner REMMERS with their IQ-Therm scores on combining low conductive base material with holes filled with a capillary active mortar, which takes condensed moisture backed to the room. Within the project both mortar formulation and base material are varied and optimised. The product is tested both in the lab of TU Dresden and under every day conditions case study 5, the Höttinger School in Innsbruck.

Besides this specific development, 3ENCULT partner TU Dresden is providing guidance on the right selection and dimensioning of interior insulation: How to take into consideration different boundary conditions (regional climate and moisture load) as well as construction details and thermal bridges. What has to be done in the lab, and which tools can be used in design practice. And the document monitored best practice cases [Bishara 2012].

Most commercial HAM calculation tools are however 2-dimensional – which means that they cannot accurately map the processes in a 3-dimensional structure as e.g. a wooden beam entering the stone wall. Janetti [2011, 2012] analyses the capability of 3D tools and the sensibility. At the same time at the Passive House Institutes test are being done on different methods to provide an airtight contact between beam and insulation – first condition to avoid convection of humid air to the beam end and condensation there,

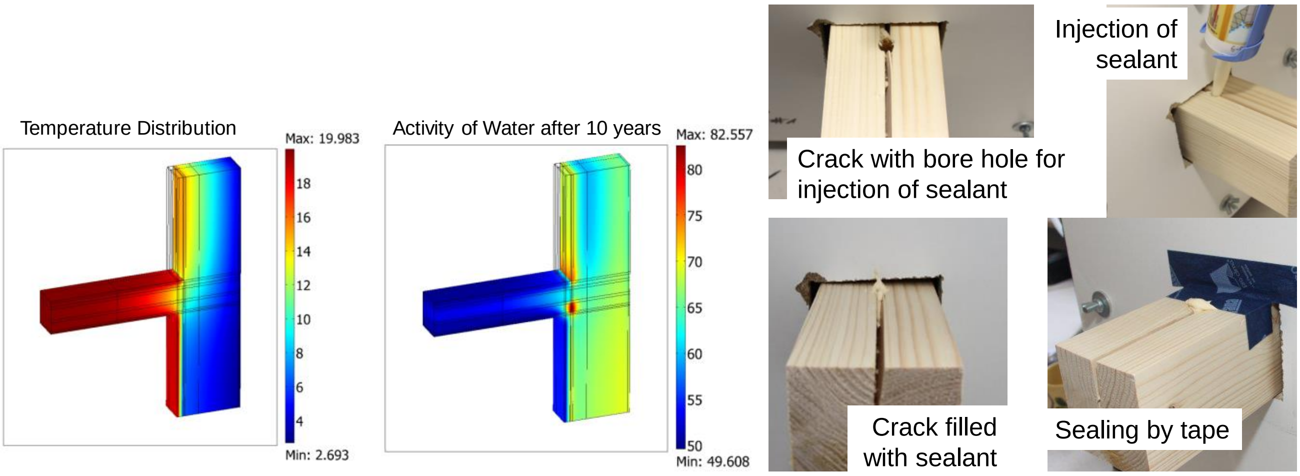


Figure 3 **3D-simulation of the typical beam end situation with COMSOL by 3ENCULT partner University of Innsbruck and air-tightness test at 3ENCULT partner PHI .**

Low impact ventilation

In order to minimise impact (and maximum reversibility) for the architecture and structure of historic buildings, 3ENCULT partner University of Innsbruck has designed and tested a new ventilation systems the already above mentioned Höttinger school [Pfluger 2013]. In order to minimize the ductwork within the building, an active overflow system takes the air from the large corridors, which serve as fresh air reservoirs, to the class room and vents the extract air back to it. A central heat recovery system ventilates the staircase and the corridors with preheated fresh air.

Pfluger [2013] gives also guidance on low impact ventilation systems in general, presenting e.g. a wall integrated ventilation systems – there with an amazing special development to be integrated in the historic windows aesthetics (see Figure 5).

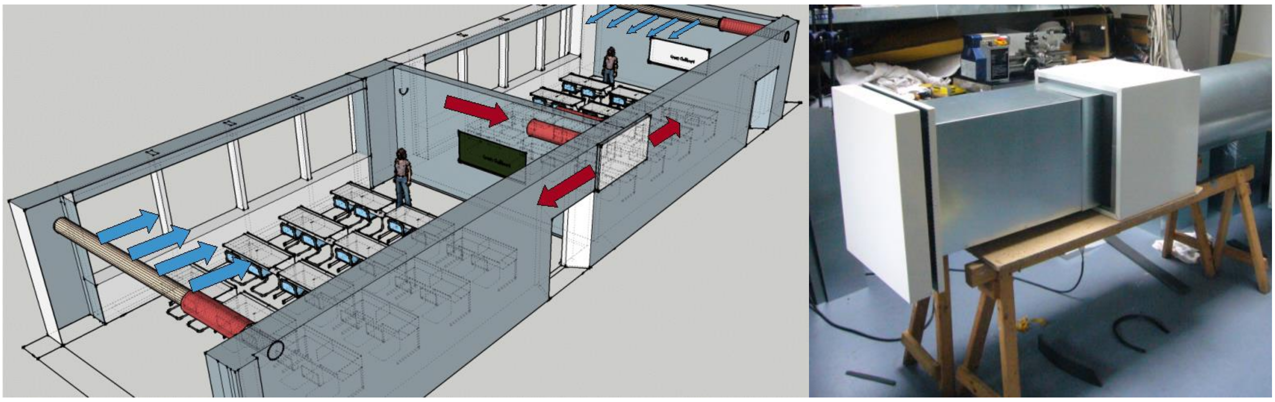


Figure 4 **Ventilation system in the two test classes at the Höttinger school and prototype developed and manufactured by 3ENCULT partner ATREA (CZ).**

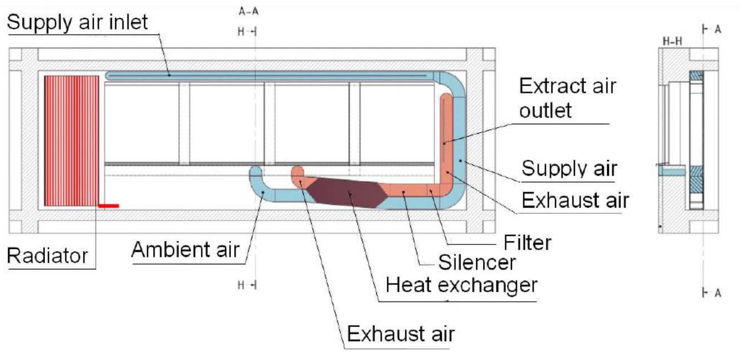


Figure 5 **View from inside: counterflow heat exchanger mounted on the parapet, supply air inlet above window, extract air outlet besides the window.**

Raumbuch concept – integrated with energy aspects

How important a comprhenesive diagnosis both of conservation values and energy aspects is, has been shown for the 3ENCULT case study in Kopenhagen, The Fæstenings Materialsgård already by Strunge [2009]. In order to support the constructive discussion across disciplines, 3ENCULT has integrated the – in conservation well established – “Raumbuch” (room book) with energy issues.

In [Exner 2012] the authors describe, which specific issues the conservation and energy experts look at in the survey and documentation phase and how the joint and structured documentation, not only on an aggregated level, but down till the single room supports also the development of solutions, comparison of different options and finally selection of the best one for the specific building.

To close the circle and come back to the comprehensive diagnosis, which was pointed out at the beginning to be the basis for any deliberated decision on interventions in heritage buildings, exemplary IR thermography as tool for both the diagnosis of structure – and structural anomalies – as well as energy aspects and thermal bridges [Franzen 2011] as well as the on-site (wireless) monitoring as instruments to well identify indoor climate, conservation aspects and energy demand both before an intervention to well understand the building and during operation to control and optimise the system [Paci 2012, Alexandrakis 2012] shall be mentioned here.

Figure 6 **Screenshot of the database for joint documentation of conservation and energy issues developed by ProDenkmal within 3ENCULT.**

4 Conclusions

3ENCULT can demonstrate that a consistent reduction of energy demand is feasible also in historic buildings and respecting their heritage value – if a multidisciplinary approach guarantees the implementation of high quality energy efficiency solutions, specifically targeted and adapted to the specific case. 3ENCULT does not result in any "standard solutions" but rather in a pool of possible measures and tools, and guidelines how to find those fitting the single building.

The role of the architect gets even more important is the case of energy retrofit of historic buildings - reading the history of the building, supporting the dialogue, developing solutions and balancing the different needs.

5 Acknowledgements

"3ENCULT - Efficient Energy for EU Cultural Heritage" is receiving co-funding from the EC's Seventh Framework Programme (FP7/2007-2013) under grant agreement n° 260162.

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Active overflow ventilation for refurbishing of school buildings

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1 The active overflow principle (AOP)

The AOP was developed and tested for the application in residential buildings by “Hochbaudepartement, Amt für Hochbauten, Stadt Zürich” (see [Sprecher 2011]). The occupied spaces take the air from the corridor via a fan installed in the door. The return flow of the air into the passage can be realized via the crack in the door or via an overflow valve (passive or active) back to the corridor, which works as distribution and mixing zone. It is vented by a heat recovery system.

As the AOP works successfully in refurbishing of residential buildings, the author decided to investigate, if the principle is also applicable for school buildings. The major difference compared to residential buildings is the higher flow rate, which is more difficult to distribute without draft risk and low sound emission. Airborne sound transmission from the class room to the corridor and vice versa can be minimized as described in the next section.

2 Active overflow prototype for a listed school building

Within the FP7 project “3ENCULT – Efficient Energy for EU Cultural Heritage”, the school building “Höttinger Hauptschule” in Innsbruck (Austria) is one of the 8 case studies for demonstration and verification of energy efficient solutions (see [Troi 2011]). Besides the reduction of thermal losses, a special focus will be on adaptation and optimization of the ventilation system. The active overflow principle as described above was transferred to school buildings. In this case, the high flow rate (about 700 m³/h) calls for a dedicated air distribution system to avoid complains due to draft risk and airborne noise. This was realized by textile hoses for supply air distribution as shown in the next figure. The air passes (driven by fan) from the corridor via silencers into that hoses, which are perforated by laser for uniform flow distribution. To minimize the sound transmission between the class rooms and corridor, also the overflow openings are equipped with silencers (see Fig. 2). The building under investigation is a listed four-story school building (year of construction 1929/30). Fig. 1 shows the ground floor plan with four class rooms, a library as well as the toilets and cloakrooms etc. There is a hydraulic heating system with radiators. The cooling in summer is realized by night ventilation via the windows, no mechanical cooling is necessary.

Fig. 2: Silencer and fan-box prototype manufactured by ATREA

The staircase is directly linked to the open space of the corridors, the fire doors will only be closed in case of emergency. A central heat recovery system ventilates the staircase and the corridors with preheated fresh air. The active overflow system (one for each class room) takes the air from the corridor to the class room and vents the extract air back to it. Finally the air is sucked to the toilets and cloakrooms and from there, via vertical ducts, back to the central heat recovery system located at the attic.

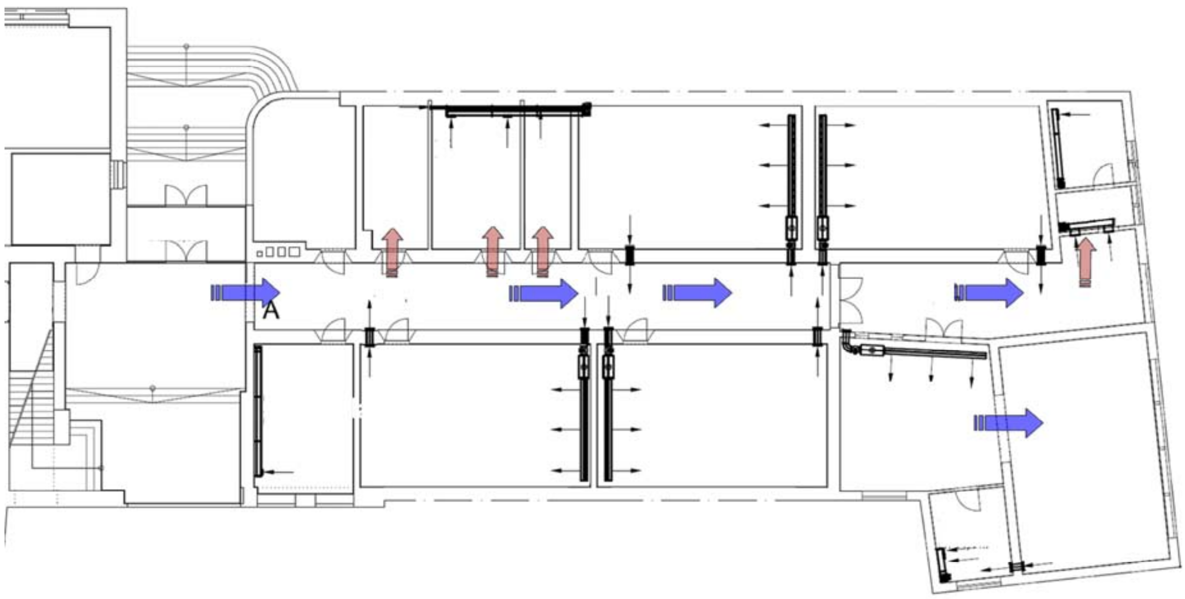

Fig. 3: Ground floor (NMS Hötting, Innsbruck, Austria), ventilation designed by ATREA

3 Control strategies for central and active overflow fans

The most simple control strategy is to control the fans (both, the active overflow as well as the central fans) depending on a fix time schedule. The advantage is the low installation costs, because no sensor is necessary. The disadvantage is that this system is not flexible in terms of changes related to the real occupation and the time schedules.

If the CO_2-concentration is measured in the corridors or in the staircase, the central fans can be controlled via a Proportional-Integral (PI) controller to a set point of e.g. 600 ppm in order to keep high air quality in the staircase and corridor zone for ventilation of the class rooms. The concentration in the corridors will vary according to the occupation of the adjacent class rooms. Hence at least one CO_2-sensor per corridor should be installed; the maximum value measured by all of the sensors compared to the set point (error signal) is used as input signal for the PI-controller.

In general, the start time for operation of the fans should be at least one hour before pupils enter the school. This guarantees a good indoor air quality already at the beginning of the occupation time. Otherwise the accumulation of contaminants throughout the nighttime would result in low air quality within the first hour of occupation in the morning.

Keeping this in mind, a switch-on signal for all of the fans (both, active overflow and central fans) for one hour (e.g. from 6:45 to 7:45 a.m. at each working day) by time schedule is necessary in any case. As the air quality rating from emissions which are independent of occupation cannot be detected by CO_2-measurements, the flow rate of the central fans should be controlled additionally by TVOC-concentration measurement or simply by time schedule. As the TVOC-measurement is expensive and calls for maintenance, the latter option is preferred.

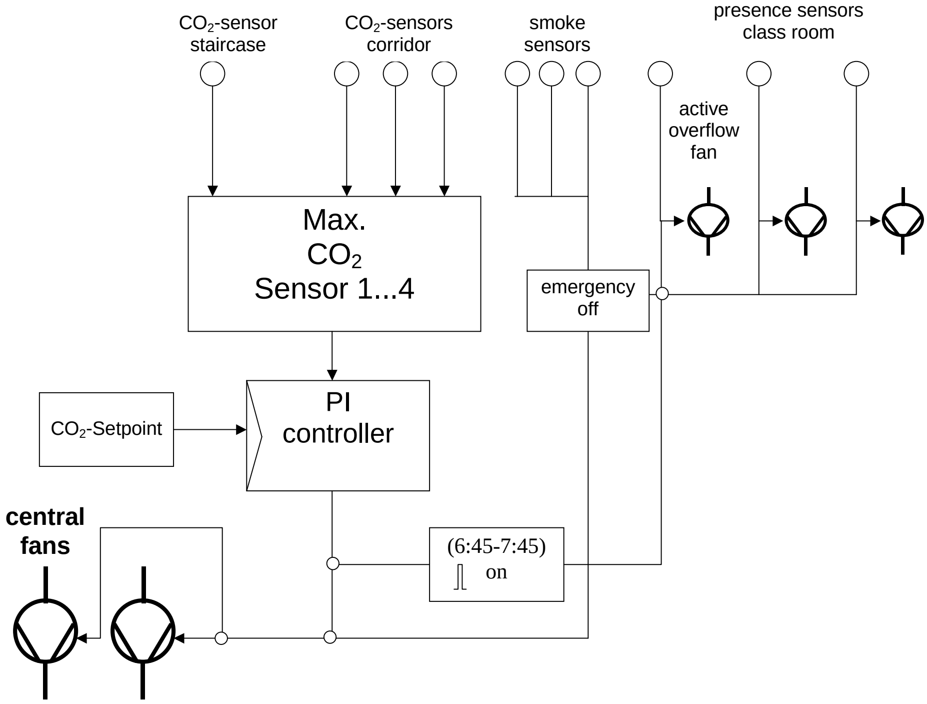

Fig. 4: Control scheme for Central Fans and Active Overflow Fans

In order to control more flexible in respect to changing occupation, the on/off signal for the active overflow fans could come from presence-control sensors in each room, which is considered a rather robust and low cost solution. However, even for this control strategy the pre-ventilation before occupation has to be controlled by time schedule.

To prevent bad odor within the time after the occupation, a time delay of one hour after the switch-off signal for the active overflow fan helps to bring down the contamination concentration.

In case of fire, any signal from a sensor for smoke or fire will switch off all fans, the central fan as well as all of the active overflow fans in order to avoid any active smoke distribution.

The control scheme as summarized in this section is displayed in Fig. 4

4 Dynamic simulation of indoor air quality

In order to simulate the CO_2-concentration as well as the indoor air humidity within the classrooms, corridors, staircase, cloakroom and toilets etc., a 52-zone model was set up with the simulation software CONTAM 3.0 (NIST [Walton 2011]). 48 zones are considered as well mixed and four zones (i.e. three corridor zones and the stair case zone) are modelled as 1-D-convection-diffusion zone. The latter was necessary because of the large extent of the corridors in longitudinal direction (length of the corridor 39.5 m in the ground floor, 45.3 m in the first and second floor and height of the staircase 13.1 m).

The time schedules of occupation for all occupied zones are implemented in the model. The occupation of the classrooms is mostly five hours a day, starting from 7:45 a.m. A number of 20 pupils per class at the age of 10 to 14 years (CO_2-source of 12 L/h and H_2O-source of 90 g/h per pupil) were assumed for the simulations.

The simulation results for these boundary conditions (CO_2-concentration of ambient air 400 ppm, set point for the CO_2-concentration in the corridor 600 ppm, active overflow flow rate 700 m³/h) show that the CO_2-concentration in the class rooms is limited to peak values of around 1000 ppm. The mean value during occupation time is around 900 ppm.

5 Measurement results

Electricity consumption, pressure drop and flow rate

The electric efficiency of the active overflow fan and the flow rate (by tracer gas) was measured as shown in Fig. 5. The curve shows a minimum at 220 m³/h, the electricity consumption at 600 m³/h is lower than 60 W (electric efficiency 0.1 Wh/m³. As the electric efficiency of the central ventilation system is much better in case of an active overflow systeme due to the short supply air duct system, the total electricity consumption (active overflow fans plus central fans) is lower than an equivalent standard ventilation system, if the control strategies according to section 3 are applied.

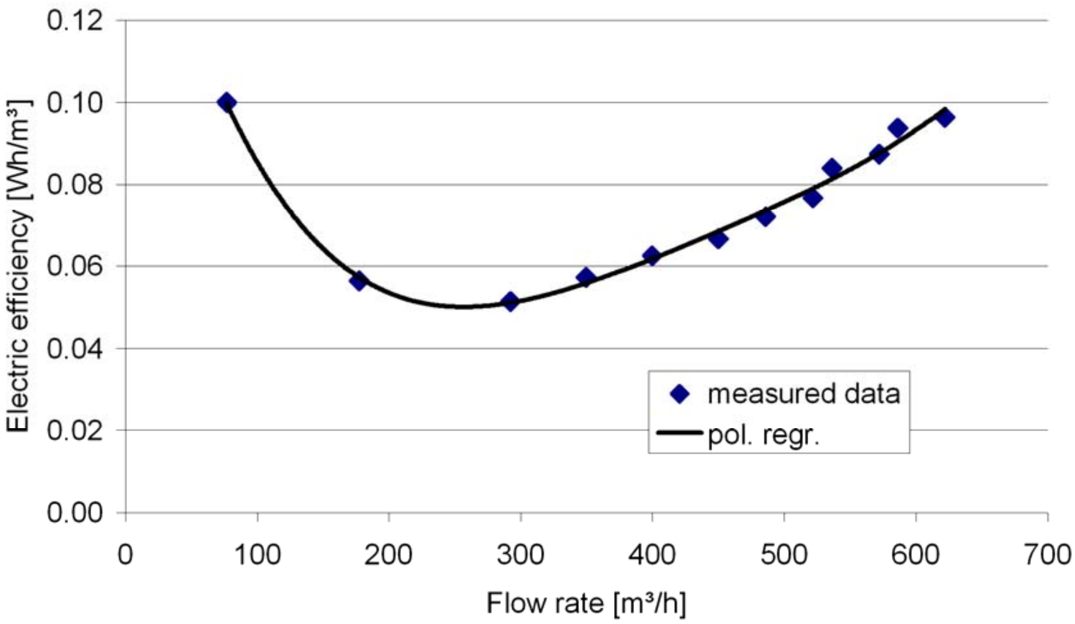

Fig. 5: Electric efficiency of the effective overflow fan prototype (manufactured by ATREA, CZ)

Airborne sound transmission and sound emission

The Austrian legislation concerning the sound protection in school buildings is written in [OISS 2007]. According to [Önorm 2002], table 6, the minimum airborne sound reduction between two classrooms without door in between is 55 dB, whereas with door in between, the limit is 38 dB. This value has to be reached also in case of the active overflow system installed. The measured values are 30 dB for class room 1 and 28 dB for class room 2, which is due to the low sound reduction of the door with large air gaps. With airtight doors the values 42 dB and 41 dB were measured respectively.

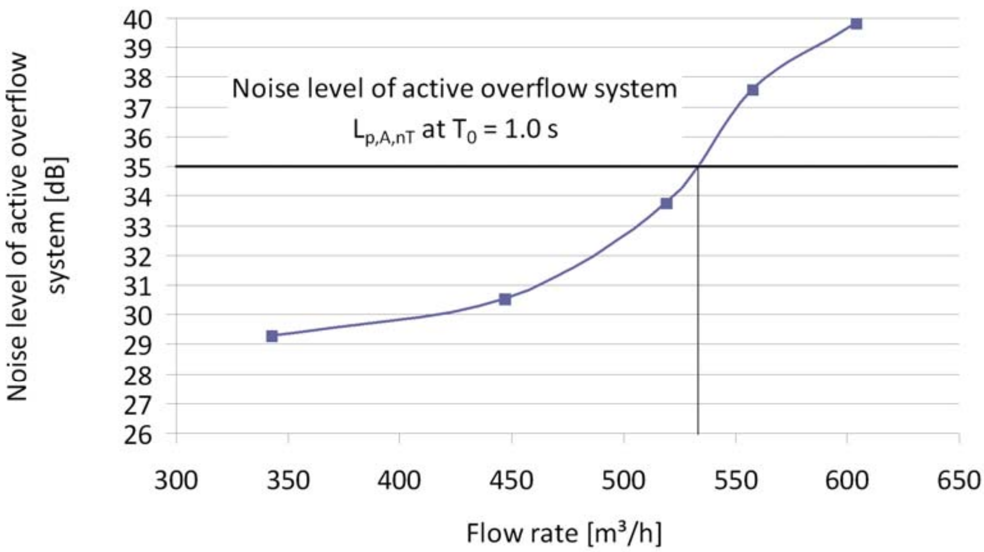

Fig. 6: Measured sound emission of the effective overflow fan prototype as a function of the flow rate

The ventilation system is to be built according to [Önorm 2007]. The max noise level of the ventilation system $L_{p,A,nT}$ for the class rooms is limited to 35 dB, for the corridor and the gymnasium to 40 dB and for the office rooms to 35 dB. The noise level (sound emission of the effective overflow fan) as function of the flow rate is shown in Fig. 6. The maximum sound level is exceeded for flow rates greater than 540 m³/h. If higher flow rates are necessary, the control strategy should restrict the higher flow rate to time-slots without occupation (break-times).

6 Summary and conclusion

A new type of ventilation systems for historic school buildings, based on the active overflow principle is analyzed via measurements on prototypes installed in two class rooms as well as by dynamic simulation. The ventilation efficiency of an active overflow system compared to a cascade ventilation is lower, because of the mixing of supply and extract air in the corridor. The electric efficiency however is higher and the control strategy for the central fans as well as the active overflow fans is rather simple and effective. From the architectural and/or preservation point of view, the active overflow system is preferable, because the ductwork is reduced to a minimum.

7 Acknowledgement

Investigations were granted by EU-project 3ENCULT: Efficient ENergy for EU Cultural Heritage Contract No. 26016.

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WS 6: Special HVAC Solutions for the Refurbishment of Historic Buildings

Monday, June 17, 15.00-16.30, Meeting room 4

Workshop organiser	*Additional information, links*
3ENCULT project consortium	www.3encult.eu

Presenter

Chair:	Alexandra Troi	EURAC research
Co-chair:	Rainer Pfluger	University of Innsbruck
Co-chair:	Enrico Zara	ARUP

Scope

Where space is limited and invasive interventions have to be avoided – be it historic buildings in particular or refurbishment projects in general – particular awareness and special solutions for HVAC systems are needed. Within FP7 project 3ENCULT a number of such solutions have been developed and tested at case studies. These and the design approach will be presented for discussion.

Attendees

Both HVAC industry and building companies as well as professionals working in the refurbishment sector are invited to join the discussion, feed it with their experience and contribute thus to the guideline being developed.

Expected results

The outcome of the workshop will be used to improve the impact of the 3ENCULT project and to be implemented in continuous professional development.

Tentative Programme

15:00 – 15:15	Introduction | values and potentials	*(Alexandra Troi)*
15:15 – 15:30	A variety of solutions to choose from | How HVAC can improve building existing buildings	*(Rainer Pfluger)*
15:30 – 15:45	Multidisciplinary design for integrated solution in historic buildings	*(Enrico Zara)*
15:45 – 16:30	Discussion	

Discussion topic

Experiences & opinions from participants with regard the following 3ENCULT hypotheses are collected and discussed:

- Different building types require different approaches (thermal mass, natural ventilation and HVAC solutions)
- It is possible to achieve better results by working together across disciplines (e.g. windows, envelope, HVAC systems)
- Energy models are a suitable tool to forecast which is the best the strategy

And very important: How can these approaches be implement this in daily retrofit practice?

WS 6 Special HVAC Solutions for the Refurbishment of Historic Buildings

WS organizer: 3ENCULT project consortium

Chair: Alexandra Troi, EURAC research, alexandra.troi@eurac.edu

Co-Chairs: Rainer Pfluger, University of Innsbruck, rainer.pfluger@uibk.ac.at

Enrico Zara, ARUP, enrico.zara@arup.com

Presentations at the workshop:

1. *Introduction – values and potential in historic buildings*
   (Alexandra Troi, EURAC research, alexandra.troi@eurac.edu)
2. *A variety of solutions to choose from – how HVAC can improve building existing buildings*
   (Rainer Pfluger, University of Innsbruck, rainer.pfluger@uibk.ac.at)
3. *Multidisciplinary design for integrated solution in historic buildings*
   (Enrico Zara, ARUP, enrico.zara@arup.com)

Introduction & background

Where space is limited and invasive interventions have to be avoided – be it historic buildings in particular or refurbishment projects in general – particular awareness and special solutions for HVAC systems are needed. Within FP7 project 3ENCULT a number of such solutions have been developed and tested at case studies. These and the design approach were presented for discussion at the workshop.

Both HVAC industry and building companies as well as professionals working in the refurbishment sector were invited to join the discussion, feed it with their experience and so contribute to the guideline being developed. The outcome of the workshop should be used to improve the impact of the 3ENCULT project and to be implemented in continuous professional development.

Summary of the presentations

Values and potential in historic buildings – introduction to 3ENCULT project

Historic buildings are the trademark of numerous European cities, they are a living symbol of Europe's rich cultural heritage & diversity and reflect the society's identity and need to be protected. They do, however, also show a high level of energy inefficiency and thus contribute with considerable CO_2 emissions to climate change. And they do not always offer "comfort" – to people as well as to artworks contained in them. 3ENCULT aims at demonstrating that a considerable reduction in energy demand – by a factor of 4 to 10 – is achievable in historic buildings, whilst respecting their heritage value.

Taking as an indicator for the number of historic buildings – which are not necessarily listed but anyway “worthy of preservation” – the number of dwellings built before 1919 or 1945, it can be estimated that 14% resp. 26% is the share of European building stock targeted by 3ENCULT – with 180 Mt of CO_2 possibly being saved every year if this is retrofitted with factor 4.

Preservation in these buildings has many drivers and constraints ranging from historical aesthetics and urban planning to provide scientific archaeological sources. Depending on the kind of value and the specific building it might be more important to keep the substance (in terms of original material) or the appearance and limit a visual impact. The fundamental principle in conservation however being the reversibility of any intervention.

To include all stakeholders in the energy retrofit of a historic building is therefore a base principle postulated by 3ENCULT – and that this multidisciplinary exchange, starting with a comprehensive diagnosis, supports the design and includes monitoring and control. There is no “one-fits-all”-solution – each historic building is unique. This project will rather propose a “pool” of solutions and guidance how to find the right one for the specific building.

A variety of solutions to choose from – how HVAC can improve building existing buildings

In his presentation “**A variety of solutions to choose from**”, Rainer Pfluger showed examples, how HVAC can improve existing buildings. The following main topics were taken into account, with special focus not only on historic listed buildings but also refurbishment of other existing buildings.

- **Decentral/central mechanical ventilation**
  Decentralised systems can help to avoid ductwork (horizontal and vertical distribution ducts). The drawback is the number of holes to be drilled for outdoor and exhaust air ducts (see **Figure 11**). Vertical ducts with horizontal distribution in the attic might be a good compromise for historic buildings. Suspended ceilings should be avoided as far as possible.
- **Special ductwork for renovation**
  Flat ducts and prefabricated ductwork helps to integrate ventilation systems in existing buildings where space for installations is limited. It was shown, that the pressure drop of flat ducts can be equivalent to round ducts with slightly higher cross section area. New products especially for the refurbishment market are available (see **Figure 12**).
- Principle of **cascade ventilation**
  The principle of cascade ventilation is to guide the air from the sleeping room via ‘overflow’ openings to the living rooms and the corridor to the extract air rooms (such as the toilet, bathroom and kitchen). This principle helps to avoid ductwork and to build energy and cost efficient ventilation systems.

- Principle of **active overflow ventilation – adapted to school buildings**
  This principle is frequently used for residential buildings, within the 3ENCULT project; it was transferred to the use in school buildings. A fan is used to duct the air from the corridor to the class rooms and back again (see **Figure 13**). A central heat recovery unit takes the air from the toilets and cloakrooms for preheating the outdoor air, which is ducted to the staircase. This way, vertical and horizontal ducts can be avoided, because the staircase and corridors are used as a duct.

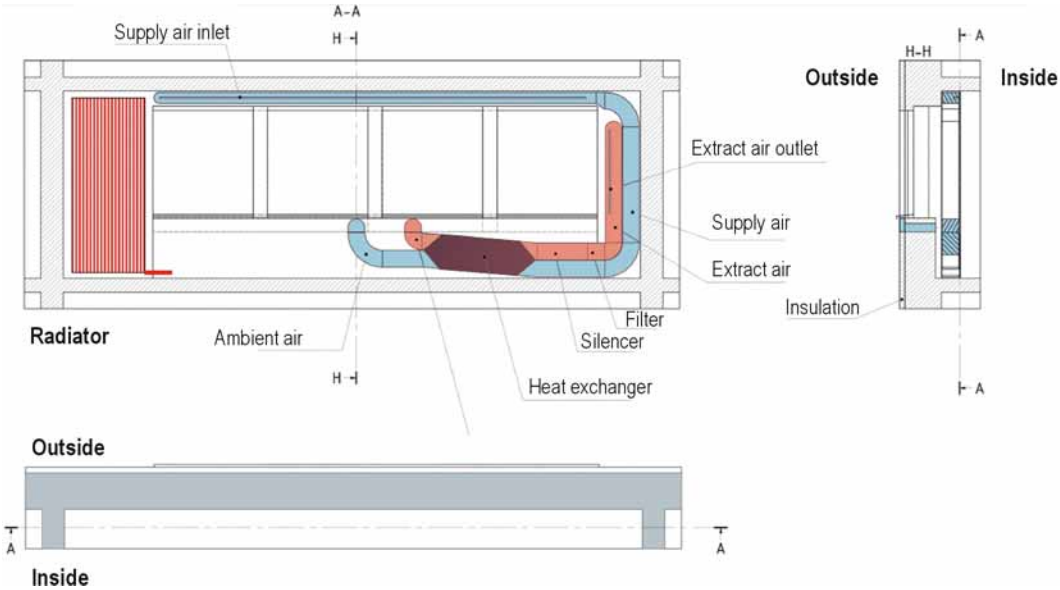

Figure 11. *Decentralised Ventilation system for school buildings.*

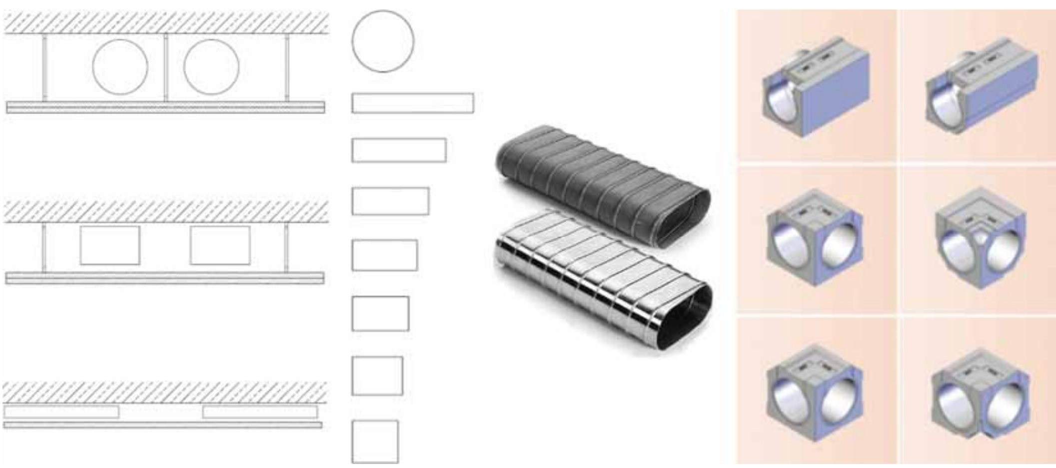

Figure 12. *Special ductwork for integration in existing buildings.*

- **Coaxial duct system** for ambient/exhaust air
  Coaxial duct systems, developed by University of Innsbruck can help to minimize the number of holes through the external walls (see **Figure 14**). The outdoor air is ducted through the annular gap whereas the exhaust air flows through the central duct. As shown by tracer gas measurement, there is no danger of short circuit flow from exhaust air outlet to outdoor air inlet.
- Combined **fan and heat recovery**
  New types of space saving heat recovery systems will help to integrate high efficient ventilation systems in existing buildings. The innovative development of a combination of fan and heat exchanger (see **Figure 15**) by University of Innsbruck is an example of that type of unit which can be integrated in the external wall. This will help to save space, energy and money.

Figure 13. *Active overflow ventilation in prototype class room in Innsbruck (A), textile diffuser and fan.*

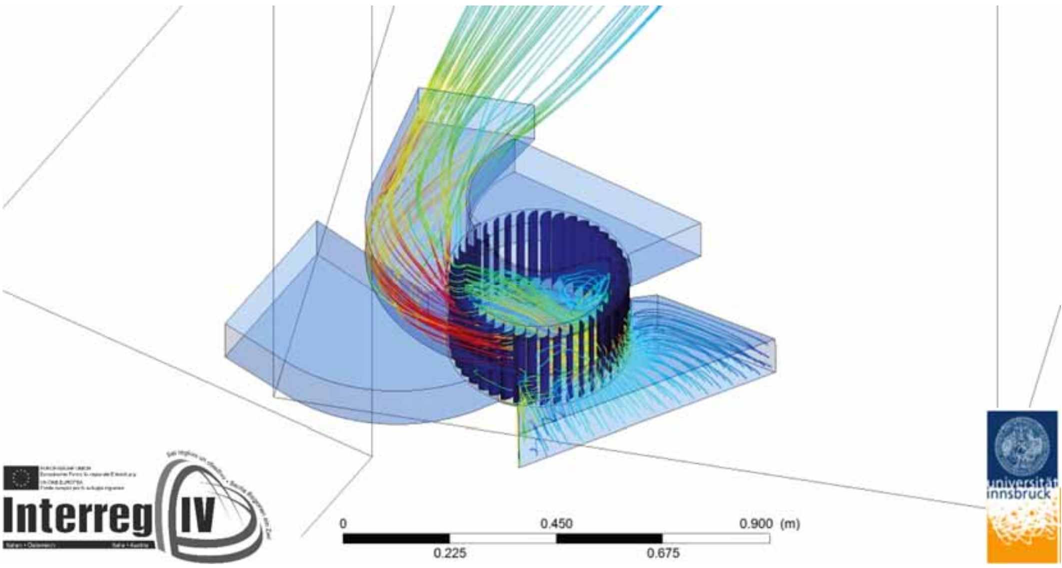

Figure 14. *Coaxial duct for outdoor air intake and exhaust air outlet developed by University of Innsbruck within the research project 'low_vent.com' - prototype built by POLOPLAST*

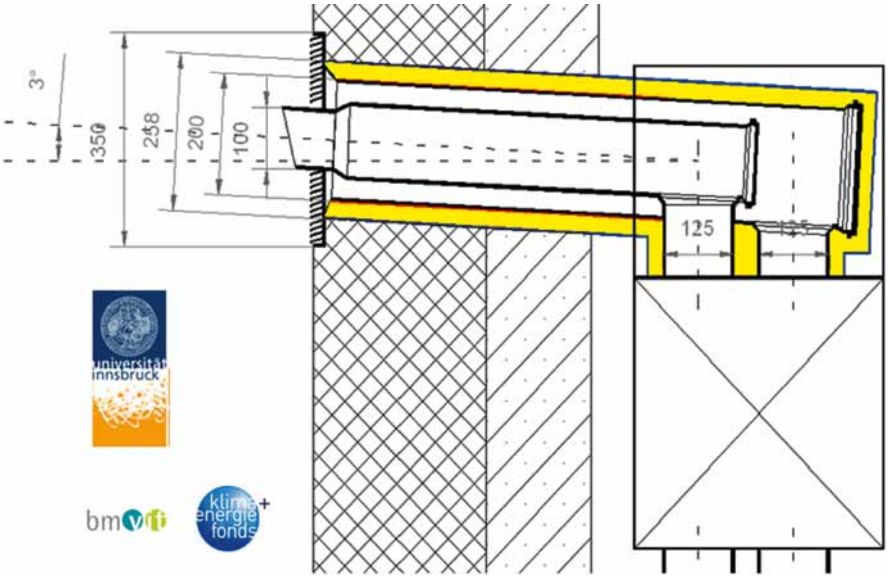

Figure 15. *Heat recovery fan developed by University of Innsbruck within the research project Vent4Reno (INTERREG).*

Multidisciplinary design for integrated solution in historic buildings

Existing buildings are part of a city's or town's heritage, skyline and distinct character. Although seen by many as a valuable asset and fundamental to successful operation, they also consume significant energy, resources and investment. Maintenance, new technologies and occupancy changes also need to be considered.

A multidisciplinary approach provides the best result in terms of performance improvement.

In this process a key element is to predict the building behaviour under different design scenarios.

An energy model is a calculation tool that is usually applied in order to assess: relative performance of options, energy measurement prioritization, existing building modelling for improvement, fault detection, operations optimization and compliance with standards.

Depending on the design stage, the accuracy of the model can change drastically. For a concept design it could be possible to estimate the loads, when the design is advanced it could be used to have a better idea of the final energy consumption of the building.

An energy model is based on assumptions; in fact to calculate the annual energy use it is necessary to considers typical schedules for all the parameters like:

- Lighting;
- Plugs loads;
- Internal loads;
- Infiltration
- Etc...

When all this information is provided the software is able to estimate the performance of the modelled building (heating, cooling and electrical loads etc..). However it is important to bear in mind that an energy model cannot predict human behaviour, that of course af radically affects the final consumption of the building.

Common issues related to an energy model can be: data organization, phasing/timing, excess of detail and false expectation.

An energy model is a very effective tool for multidisciplinary design. Moreover many engineering disciplines are involved: building physics, facades, HVAC system and architecture. It is becoming an essential tool for modern design, and since the final result is usually very simple and straightforward, it is also very important for communication purposes.

Discussion and main results

The discussion was initiated and guided by the following questions:

1. Experiences & opinions from participants with regard to their practical experience with HVAC in historic buildings and refurbishment projects:

- What is different in HVAC for new buildings / refurbishing?
- Is there any further demand for research and products for integration of ventilation in historic buildings / refurbishing?

2. Experiences & opinions from participants with regard the following 3ENCULT hypotheses:

- Different building types require different approaches (thermal mass, natural ventilation and HVAC solutions)
- It is possible to achieve better results by working together across disciplines (e.g. windows, envelope, HVAC systems)
- Energy models are a suitable tool to forecast which is the best the strategy

Acknowledgement

This work was financially supported by the EU FP7 program (GA n. 260162). The authors wish to express their gratitude for the financial support.

References

www.3encult.eu

www.buildup.eu/communities/culturalheritage

EWCHP-2013

EWCHP–2013
3rd European Workshop
on Cultural Heritage Preservation
Bozen / Bolzano, Italy, September 16 to 18, 2013

www.3encult.eu/en/ewchp

1st day – Workshop

Monday, 16th September 2013

8.30 REGISTRATION

9.30 Welcome and opening

9.40 KEYNOTE

SESSION I ASSESSMENT OF INDOOR AIR & CLIMATE CHANGE IMPACT ON CULTURAL HERITAGE OBJECTS

10.00 **The "Memori System"; measurements, effect assessment and mitigation of pollutant impact on movable cultural assets. Innovative research for market transfer**
T. Grøntoft, E. Dahlin, S. Håland, H. Vika Røen, T. Heltne, D. Thicket, P. Lankester, A. Schieweck

10.20 **The impact of organic acids on varnishes in museum environments**
I. Bonaduce, M.P. Colombini, F. Di Girolamo, Sibilla Orsini, M. Odlyha, S.Rutkowska, M.Scharff, T. Grøntoft

10.40 COFFEE BREAK

11.00 **Adaptation of energy storage systems to Cultural Heritage: the application of Phase Change Materials technology to historical buildings and objects**
A. Bernardi, F. Becherini, M.D. Romero-Sanchez, Ángel M. López-Buendía, A. Vivarelli, P. Moretti, G. Baldisseri, C. Ghiretti, L. Pockelé

11.20 Introduction into Climate for Culture

11.30 **The climate for culture method for assessing future risks resulting from the indoor climate in historic buildings**
R. Kilian, T. Broström, J. Ashley-Smith, H.L. Schellen, M. Martens, F. Antretter, M. Winkler, C. Bertolin, D. Camuffo, J. Leissner

11.50 **Experimental methods on monitoring of materials surfaces in climate change conditions**
V. Tornari, E. Bernikola, J. Leissner, C. Bertolini, D. Camuffo

Surface Analysis of varnishes and collagen-based materials (parchment and leather): physicochemical characterisation and effect of nanoparticle-based conservation treatment
M.Odlyha, L.Bozec, S.Hackney, M. P. Colombini, I.Bonaduce, F. Di Girolamo, R.Larsen, K. Mühlen Axelsson, D.Vestergaard Poulsen, M. Scharff, T.Grønthoft, E.Dahlin , D.Chelazzi and P.Baglioni

The use of spectrophotocolorimetry techniques in modern art
S. Omarini

12.05 DISCUSSION

12.25 POSTER VIEWING & EXHIBITION AREA

13.00 LUNCH

SESSION II CHURCHES AND OTHER LARGE OCCASIONALLY USED SPACES – SPECIAL ISSUES

14.00 **Adaptive ventilation for occasionally used churches**
P. Klenz Larsen, M. Wessberg, T. Broström

14.20 **Relative humidity control in historical buildings allowing the safe natural indoor-climate fluctuations**
T. Vyhlídal, P. Zítek, D. Camuffo, G. Simeunovic, O. Sládek, M. Wessberg

14.40 **Fan pressurization method for measuring air leakage in churches. Wind and stack induced uncertainties**
M. Mattsson, M. Sandberg, L. Claesson, S. Lindström, A. Hayati

15.00 **Evaluation of two air infiltration models on a church**
A. Hayati, M. Mattsson, M. Sandberg, E. Linden

Plaster finishes in historical buildings. Measurements of surface structure, roughness parameters and air flow characteristics
M. Sandberg, A. Sattari, M. Mattsson

Efficiency of an organ heater and its potential impact on the organ in a church
C. Bertolin, D. Camuffo, A. della Valle

Church heating a balancing act between comfort cost and conservation
A. Troi

15.20 DISCUSSION

15.40 POSTER VIEWING
and COFFEE BREAK

SESSION III INNOVATIVE MATERIALS, TREATMENTS AND TOOLS IN CONSERVATIONS

16.00 **Investigations on former stone conservations at the Kapellenturm, Rottweil**
F. Grüner

16.20 **Alkaline earth alkoxides for conservation treatment of stone and wood in built heritage**
M. Favaro, M. Chiurato, P. Tomasin, F. Ossola, N. El Habra, N. Brianese, I. Svensson, E. Beckers, V.J. Forrat Pérez, M.D. Romero Sánchez, G. Orial, E. Bourguignon, A. Bernardi

16.40 **Nanomaterials for the conservation and preservation of historical monuments**
M.L. Ion, R.C. Fierascu, M. Leahu, R.M. Ion, D. Turcanu-Carutiu

17.00 **Preliminary assessment of atmospheric plasma torches for cleaning of architectural surfaces**
C. Aibéo, T. Cavallin, E. Egel, M. Favaro, V. Kamenova, L. Nodari, A. Patelli, A. Pavlov, I. Pavlova, O. Schalm, P. Scopece, S. Simon, P. Storme, E. Verga Falzacappa, S. Voltolina

17.20 **Assessment of salt crystallization through numerical modelling**
G. Castellazzi, S. de Miranda, L. Grementieri, L. Molari, F. Ubertini

17.40 DISCUSSION

18.00 END OF 2ND DAY'S PRESENTATIONS

Cultural programme & gala dinner

18.00	transport by reserved bus from the front courtyard of EURAC Research to the castle
18.20	arrival to the castle parking lot > there is a 10 minutes unpaved trail (50m total altitude gap) from the street to the castle (please wear comfortable shoes)
18.30	cocktail on castle court
18.45	free guided tour of the castle (in English, 2 or 3 groups)
19.30	gala dinner under castle arcades (depending on weather conditions, but please bring something warm)
22.30-23.00	transport by reserved bus from castle parking lot back to EURAC Research

2nd day – Workshop

Tuesday, 17th September 2013

SESSION IV ENERGY EFFICIENCY IN HISTORIC BUILDINGS AND DISTRICTS – 3ENCULT CASE STUDIES

8.30 Introduction into 3ENCULT project
Alexandra Troi

8.40 **Development and demonstration of new systems and technologies for sustainable refurbishment of Europe's built heritage**
A. Bishara, R. Plagge, J. L. Hernández, S. Reeb, G. Paci, H. Garrecht, D. García, E. Gabrielli, C. Colla, B. Krick

9.00 **Energetic retrofit of a historic log house on the example of a "Strickbau"**
H. Garrecht, S. Reeb

9.20 CS1 – Public Weigh House, Bozen / Bolzano, Italy
CS2 – Palazzo d'Accursio, Bologna, Italy
CS3 – Palazzina della Viola, Bologna, Italy
CS4 – Materials Court, Copenhagen, Denmark
CS5 – Höttinger School, Innsbruck, Austria
CS6 – Schinkelspeicher at Warehouse city Potsdam and others, Germany
CS7 – Industrial Engineering School, Bejar, Spain

9.55 DISCUSSION

10.10 POSTER VIEWING
and COFFEE BREAK

SESSION V
ENERGY EFFICIENCY IN HISTORIC BUILDINGS AND DISTRICTS – HERITAGE VALUE AND PLANNING APPROACHES

10.40 **Energy efficiency and preservation. System thinking in a multiple case study**
H. Norrström

11.00 **Identifying cultural building values. Methodology review for energy efficiency alterations**
T. Örn, K.L. Nilsson

11.20 **A method for categorization of European historic districts and a multiscale data model for the assessment of energy interventions**
T. Brostrom, A. Bernardi, A. Egusquiza, J. Frick, M. Kahn

11.40 **Analysis of built heritage. Energy and culture**
O. Wedebrunn, C. Colla, T. Dahl, C. Franzen

12.00 **Integrated strategies for sustainable renovation of early post-war housing: the case of Torpa, a housing area and National Heritage asset in Sweden**
P. Femenías, L. Thuvander, A. Danielsson

12.20 **Energy efficiency and restoration in the historic centre of Ferrara, a view between conservation and performance**
K. Ambrogio, M. Zuppiroli

12.25 DISCUSSION

12.45 PRESENTATION IN EXHIBITION AREA

13.15 LUNCH

SESSION VI ENERGY EFFICIENCY IN HISTORIC BUILDINGS AND DISTRICTS – SOLUTIONS AND CASE STUDIES

14.10 **High- and low-impact strategies for the internal insulation retrofit of traditional masonry walls**
C. Hermann

14.30 **Numerical simulation of thermal performance of window retrofit options for historic buildings**
C. Misiopecki, A. Gustavsen

14.50 **Simulation of energy consumption for dehumidification with cooling in National Museum in Kraków**
J. Radon, F. Antretter, A. Sadlowska, M. Łukomski, L. Bratasz

15.10 **Sustainable natural ventilation and cooling of museums**
J. Käferhaus

Protecting historical buildings doesn't mean only to respect their appearance
V. Pracchi, E. Rosina

Energy modelling of historic buildings: applicability, problems and compared results
R.S. Adhikari, E. Lucchi, V. Pracchi

Conservation compatible insulation on a baroque building
C. Franzen, M. Zötzl, T. Löther

„upgrade - stories about people and buildings"
Carlo Azzolini, Klaus Ausserhofer, Peter Erlacher, Margot Wittig, Rudi Zancan

Large scale measurement campaign to assess the thermal behaviour of an 18th Century historic building in Athens
I. Atsonios, I. Mandilaras, D. Kolaitis, E. Tsakanika-Theohari, E. Alexandrou, M. Founti

Technical Guideline for Energetic Redevelopment of Existing Buildings
Ilaria M. Brauer

Development of a highly energy efficient and conservation compatible window
Mathilde Andre, Franz Freundorfer, Dagmar Exner

15.50 DISCUSSION

16.10 POSTER VIEWING
and COFFEE BREAK

SESSION VII SMART MONITORING & CONTROL

16.30 **A novel monitoring and control system for historical buildings**
J.L. Hernández, S. Reeb, G. Paci, H. Garrecht, D. García

16.50 **Monitoring and improvement of indoor environments in cultural heritage**
J. Frick, M. Reichert, G. Baumbach, S. Song, A. Neuwirth, M. Krüger, K. Schmitt, J. Huber, M. Ebermann, L. Pockelé, A. Khanlou, A. Ekonomakou, J. Balau, G.M. Revel, M. Arnesano, F. Pietroni

17.10 **On the advance of impedance measurements for monitoring moisture in sandstone**
F. Lehmann, M.I. Martínez Garrido, M. Krüger

17.30 DISCUSSION

17.50 CLOSURE

18.00 END OF 2ND DAY

3rd day – Training

Wednesday, 18th September 2013

MORNING SESSION 9:00 – 12:00

WS1: Innovative Technology for Mitigation of Pollutant Impact for Museums, Archives and Libraries

Coordinators: Elin Marie Dahlin, Terje Grontoft and Karin Drda-Kuehn

Description: The workshop is a practical training session on measurements, mitigation and preventive conservation strategy. It will demonstrate the MEMORI dosimeter technology developed in the EU project MEMORI. The MEMORI technology is an instrument for preventive conservation with the aim of reducing costs to provide long term benefits for cultural heritage collections. The participants will get the opportunity to apply the air quality evaluation methodology developed in MEMORI.

Target audiences: conservators in museums, archives and libraries

WS2: Assessment of the potential for energy improvements in historic buildings: Practice, standards, case studies (3ENCULT, EFFESUS, Spara och bevara, CEN)

Coordinators: Tor Broström, Alexandra Troi

Description: Starting from the experiences in 3ENCULT, EFFESUS and Spara och Bevara and together with representatives from European standardization groups on "Energy Efficiency of Historic Buildings" (CEN TC346 WG8) and "Energy Performance of Buildings (EPBD)" (CEN TC89) , the participants discuss approaches how to best assess the potential for energy retrofit in historic building and how to best guide the development of conservation compatible solution for the specific building

Target audiences: architects, engineers, conservators, Local Authorities, owners of historic building

WS3: Comprehensive diagnosis and multidisciplinary approach for conservation compatible energy retrofit (3ENCULT)

Coordinators: Francesca Roberti, Dagmar Exner

Description: During a visit of the Public Weigh House, a listed medieval building in the historic centre of Bozen/Bolzano and case study of 3ENCULT project, the comprehensive diagnosis performed there within the project – including both heritage and energy related aspects and ranging from the building historians study over IR-thermography and Blower Door Test and Thermal Fluxes to material and construction detail analyses – is explained and practically shown. Moreover, the support of this multidisciplinary diagnosis and following design phase by a further developed Raumbuch is presented.

Target audiences: architects, engineers, conservators

(for more information see the specific programmes)

AFTERNOON SESSION 13:00 to 16:00

WS4: Energy efficiency of the windows in the historic context (3ENCULT)

Coordinators: Mathilde Andre, Dagmar Exner and Franz Freundorfer

Description: The workshop presents a correct procedure for conserving the cultural heritage values and upgrading the energy performance of a historic building – with a focus on windows. First, a visit in the historic center of Bolzano/Bozen permits to show and to compare the esthetical value of old and new windows, glasses and frames. Second, in the beautiful building of the Public Weigh House (case study of the 3ENCULT Project) the solutions developed for conservation compatible highly energy efficient windows – for cases where the original window or has to be) replaced – are presented and discussed. Finally, the participants investigate how the presented solution details can also be used for repairing and enhancing existing windows and how the concepts can be applied in different regional window construction traditions.

Target audiences: architects, engineers, conservators

WS5: Indoor air quality monitoring (CETIEB)

Coordinator: Jürgen Frick

Description: The workshop presents results of the EU-FP7 project CETIEB "Cost-Effective Tools for Better Indoor Environment in Retrofitted Energy Efficient Buildings" (www.cetieb.eu), which aims to develop innovative solutions for better monitoring indoor environment quality and to investigate active and passive systems for improving it. The focus lies on results which are relevant for the use in cultural heritage buildings.

Target audiences: conservation scientists, architects, engineers, conservators

AFTERNOON SESSION 13:00 to 17:00

WS6: NanoMaterials for cultural heritage (NanomeCH cluster)

Coordinator: Adriana Bernardi

Relators: Francesca Becherini, Matteo Chiurato, Monica Favaro, Martin Labouré, Alessandro Patelli, Luc Pockelé, Stefano Voltolina

Description: The organization, focus and activities of the "NanomaCH CLUSTER" will be presented through research developed within two projects of the cluster, namely "NANOMATCH" and "PANNA" currently in progress. In the workshop the application of innovative metal alkoxides products for the conservation treatment of different kind of stones and wood, and of an innovative plasma-torch devoted to the removal of dirt on stone, metal and wall painting substrates will be discussed. The application methodologies, the laboratory tests, the preliminary results, the studies on the impact on human health and environment and the first concepts of application guidelines will be discussed. Finally, the advantages and drawbacks of different commercially available plasma devices and the new plasma-torch during the removal of polymers, graffiti, organic and inorganic dirt will be covered. The market impact and opportunities for the involved SMEs will also be addressed.

Target audiences: scientists in CH, restorers, end users, policy makers in CH , sellers of products for CH, material science/scientists, chemist/chemistry, physic/physics

(for more information see the specific programmes)

3ENCULT is co-funded by the European Union Seventh Framework Programme (FP7/2007-2013) under grant agreement n° 260162.

EWCHP-2013

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MORNING SESSION 9:00 to 12:00

Assessment of the potential for energy improvements in historic buildings: Practice, standards, case studies

Participating projects: 3ENCULT, EFFESUS, Spara och bevara, CEN TC 346

Coordinators: Tor Broström, Alexandra Troi

Target audiences

Architects, Engineers, Conservators, Local Authorities, Owners of historic building

Background

As the economic and political pressure for improved energy performance is increasing we must carefully consider how to balance energy conservation and building conservation in historic buildings. There is a need for a systematic approach where techno- economic and environmental considerations can be weighed against the impact on heritage values. A number of European projects are developing procedures for decision making on energy retrofits of historic buildings and districts. In parallel, CEN TC 346 has initiated a work group aiming to present European guidelines for energy efficiency in historic buildings.

Given that many European projects are represented at EWCHP 2013 and that the CEN work group has a meeting in connection to the conference, this would be a good opportunity to present the latest developments and discuss a common ground for a standard.

Objective

The objective of the workshop is to present and discuss different approaches and methods for a systematic and integrated decision making on energy retrofits in historic buildings. This will strengthen the efforts in the project and provide input to the proposed European guidelines.

Programme

The program will introduce into the theme with a number of short presentations, which are then followed by a discussion.

The objectives and progress of CEN TC 346 WG 8 Guidelines for improving energy performance of architecturally, culturally or historically valuable buildings (15 min)

Marte Boro, Norway

Potential and policies for energy efficiency in Swedish historic buildings (15 min)

Tor Broström, Sweden

The 3ENCULT approach: a multidisciplinary team to find the right solution for the specific historic building (15 min)

Alexandra Troi, Italy

Relation between historic buildings, the Energy Performance of Buildings Directive (EPBD) and the most important EPBD CEN standards (15 min)

Marleen Spiekman, Netherlands

Heritage significance and building retrofit: developing an impact indicator matrix for the EFFESUS project (15 min)

Carsten Hermann, Scotland

Guided Discussion with all participants (75 min)

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EWCHP - 2013

The objectives and progress of

CEN/TC 346/WG 8

Guidelines for improving energy performance of architecturally, culturally or historically valuable buildings

Marte Boro, Senior adviser Directorate of Cultural Heritage, Norway

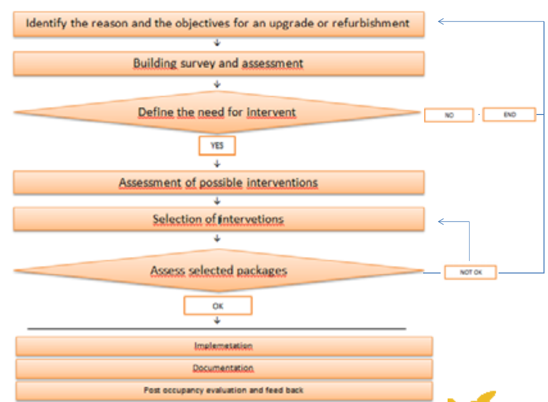
Scope

This European standard provides guidelines for improving the energy performance of architecturally, culturally or historically valuable buildings while preserving their inherent cultural heritage values; its use is not limited to buildings with statutory protection. It covers a range of buildings from the vernacular to monumental.

This standard presents a normative working procedure for planning and selection of measures based on an in depth examination and documentation of the building. It outlines procedures to assess the impact of those measures in relation to preserving the authenticity and the architectural, cultural and historic values of the building, this includes taking into account risks and consequences of refurbishment measures.

Qualifications requirements of personnel

Principles of building conservation and sustainable building management



Assessment of possible interventions in relation to a specific building

Risk-benefit analysis to identify the best solutions and eliminate the in appropriate ones

Risk	Low	Acceptable	Unacceptable
Benefit	High	Medium	Insignificant

Which categories to consider?
Energy saving
Reduction of CO² emissions
Renewable energy
Economic return
Savings cost
Impact on architectural, cultural or historical values
Resource use
Indoor climate
Damage risk
Durability
Aspects of use
Other?

Selection of measures for the specific building

Put together packages of solutions
Evaluate them with respect to the targets

The effect of individual measures cannot be added and therefore the effect shall be calculated as one package

If the result is not in agreement with the targets, revise the package or consider revising the targets.

A method to assess the effect of energy saving interventions in the Swedish stock of historic buildings

Uppsala University
Linköping University
Swedish Technical Research Institute

EWCHP 2013 Training session

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www.sparaochbevara.se

Objectives

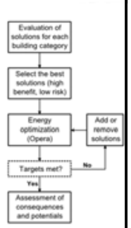
- Investigate the relations between energy saving potentials and the impact on cultural significance (cultural heritage values) in vernacular buildings.
- To define the needs of policies, information and solutions in order to meet the challenges of a sustainable management for the built heritage.

Objectives

- Investigate the relations between energy saving potentials and the impact on cultural significance (cultural heritage values) in vernacular buildings.
- To define the needs of policies, information and solutions in order to meet the challenges of a sustainable management for the built heritage.
- The idea is not to find one right answer but to allow for a comparative analysis of many scenarios
- The end users would be national and regional authorities

Method (2010)

1. Definition of targets for energy performance as well as for preservation of heritage values.
2. A categorization of the building stock based on available data
3. An assessment of risks and benefits based on a repository of interventions for energy efficiency.
4. Life cycle cost (LCC) energy systems analysis aiming to find the optimal combination of solutions
5. The proposed solution is compared to the targets. If the outcome is not satisfactory, iterations will follow.



Defining targets

- Preservation
- Energy reduction
- CO_2 reduction
- Cost reduction
- Political targets: 20%, 50%
- Etc

Building stock modelling

Building stock modelling
↓
Select typical buildings
↓
Building modelling and analysis
↓
Results for typical buildings
↓
Extrapolation to district level

Building stock modelling

- The BETSI project (The Swedish National Board of Housing, Building and Planning)
- Aiming to describe the technical characteristics and condition in Swedish Building stock
- Approximately 1800 building were statistically selected to represent the entire Swedish building stock.
- We will use the buildings built before 1945

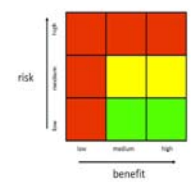
Assessment of interventions
(For each type of building)

Long list of Interventions ⟷ Assessment → Short list of Interventions

Assessment of interventions

Assessment criteria:

- Energy savings
- Economic return
- Green house gas emissions
- Heritage values/Significance
- Reversibility
- Durability
- Moisture
- Indoor environment
- User aspects



Optimization

Short list of Interventions

Supply side →  → Demand side

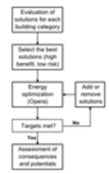
Optimization

Short list of Interventions
⇩
Optimization
⇩
Optimal package of solutions

Optimization

- Building, ventilation and heating system measures are dealt with simultaneously
- Finds combination with the lowest life cycle cost (LCC)
- The LCC includes the total building costs, maintenance costs and the operating costs for the building.

Analysis



- Targets met?
- Acceptable consequences?
- Iteration
  - Add or remove solutions
  - Revise targets

Analysis

- Targets met?
- Acceptable consequences?
- Iteration
  - Add or remove solutions
  - Revise targets

An example

- A one and a half storey house from the 1920s.
- Plank frame, with vertical wood panelling
- Double-glazed windows
- District heating, radiators
- Natural ventilation
- Located in Stockholm

Targets

- 20% (EPBD)
- 50% (National target)
- New building regulations: 90 kWh/m2 (70%)

Results

Target	Measures
20%	Ground source heat pump Improved air tightness Insulation of attic 6 cm

Results

Target	Measures
20%	Ground source heat pump Improved air tightness Insulation of attic 6 cm
50%	Wood pellet furnace Improved air tightness Insulation of attic 38 cm Insulation of floors 36 cm

Results

Target	Measures
20%	Ground source heat pump Improved air tightness Insulation of attic 6 cm
50%	Wood pellet furnace Improved air tightness Insulation of attic 38 cm Insulation of floors 36 cm
90 kWh/m2 70%	Wood pellet furnace Improved air tightness Insulation of attic 38 cm Insulation of floors 36 cm External insulation of facade 16 cm

Discussion

- We can not, and should not, try to agree on good or bad solutions in general
- Can we agree on a **procedure** to find appropriate solutions for a building in a given context?
- What are the general requirements and generic components of such a procedure?
- Guidelines: WHY, WHAT, HOW and for WHOM?

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3encult

WS2: Assessment of the potential for energy improvements in historic buildings: Practice, standards, case studies

The 3ENCULT approach:

a multidisciplinary team to find the right solution for the specific historic building

Alexandra Troi
3ENCULT coordinator

EURAC research

FINAL CONFERENCE:
3ENCULT is co-funded by the European Union Seventh Framework Programme (FP7/2007-2013) under GA n° 260162

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Multidisciplinary exchange starts with the comprehensive diagnosis, supports the design and does not end before the implementation of an integrated monitoring & control.

To include all stakeholder in the design process of the energy retrofit of a historic building is a base principle postulated by 3ENCULT

Experience Saxony: Assessment Criteria

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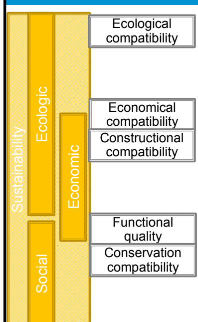

- CO_2 balance over whole life-cycle
- Resource consumption
- Primary energy saving potential
- Final energy cost reduction
- Enhancement indoor comfort
- Recoverability (“Werthaltigkeit”)
- Damage risk
- Utilisation value (“Gebrauchswert”)
- Loss of substance (“Substanzverlust”)
- Disturbance of appearance
- Reversibility

Experience Saxony: Assessment Criteria

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- CO_2 balance over whole life-cycle
- Resource consumption
- Primary energy saving potential
- Final energy cost reduction
- Enhancement indoor comfort
- Recoverability (“Werthaltigkeit”)
- Damage risk
- Utilisation value (“Gebrauchswert”)
- Loss of substance (“Substanzverlust”)
- Change to appearance
- Reversibility

Detailed calculation and assessment → Primary energy saving potential, Final energy cost reduction, Enhancement indoor comfort

Assessment in Workshop → Damage risk, Utilisation value (“Gebrauchswert”)

Assessment in Workshop → Loss of substance (“Substanzverlust”), Change to appearance, Reversibility

---

Experience Saxony: Integrated and comparative final assessment

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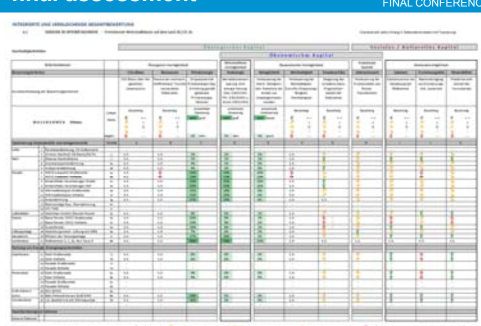

Experience Saxony: Visualisation – saving potential and conservation compatibility

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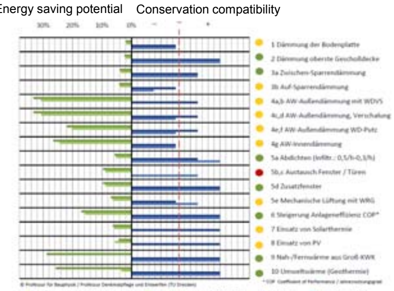

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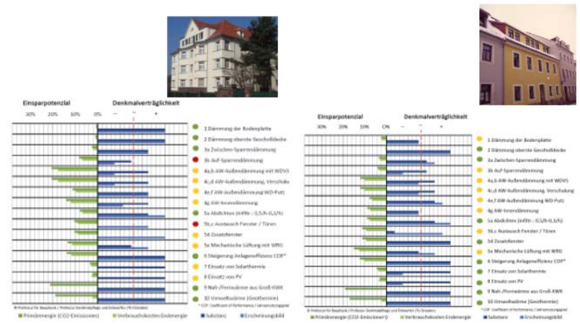

Experience Copenhagen

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- Starting position

Old Material Court to be renovated and used for office purposes.

- Objective
  1. Reduce CO_2 **emissions** and guarantee high **indoor comfort** with office use, in compliance with conservation and architecture
  2. Provide **guideline** for the more than 1000 protected buildings in Denmark used for office purposes
- Approach – within multidisciplinary working group
  1. Building analysis and description
  2. Broad gross list of possible interventions
  3. Dynamic simulation of single interventions and evaluation of CO_2 emissions and indoor climate
  4. Stepwise reduction of options and selection of the solution to be implemented

Experience Copenhagen: Interdisciplinary Working Group

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Professionals with great experience in building renovation, with the task to contribute with their specific viewpoint each

- Building owner
  → impact on rental opportunities, operating and maintenance conditions
- Heritage authority
  → conservation viewpoint (also general evaluation of building typology)
- Architects
  → shape, appearance, functionality, interior design conditions
- Structural engineer
  → impact on existing construction, risk assessment (moisture)
- Services engineer
  → assessment of energy and indoor climate

Experience Copenhagen: Building description

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…

for each of the 4 buildings
- building and construction history
- existing conditions
- historic and architectural value

…

Experience Copenhagen: Energy analysis of status quo

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- Consumption from energy bills
- Thermographs
- Blower door test

- Calculation of demand according Danish certification scheme

4.3 **Builddesk Energimærkningen - anvendelsen**

I projektet er beregningsmodellen udelukkede brugt til at klassificere bygningerne i forhold til myndighedskrav og som sammenligningsgrundlag for den eksisterende danske bygningsmasse.

	Myndighedskrav BR08, for nybyggeri	Eksist. forhold.	Nye forhold.
Forvalterboligen	99 kWh/m2	213kWh/m2 Energiklasse E	173kWh/m2 Energiklasse D
Kontorbygn. v/Bryghusg.	97 kWh/m2	229 kWh/m2 Energiklasse F	182 kWh/m2 Energiklasse E
Halvtagshusene	98 kWh/m2	221 kWh/m2 Energiklasse F	184kWh/m2 Energiklasse E
Bindingsværksbygningen	98 kWh/m2	222 kWh/m2 Energiklasse F	170kWh/m2 Energiklasse D

Experience Copenhagen: Workflows

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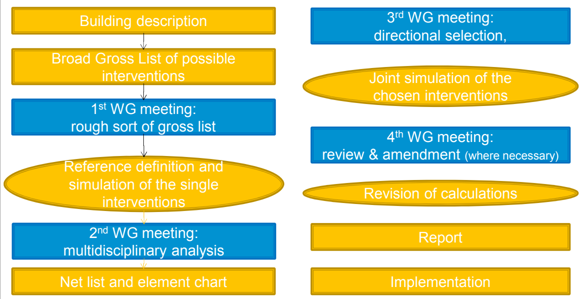

Experience Copenhagen: Gross list & assessment

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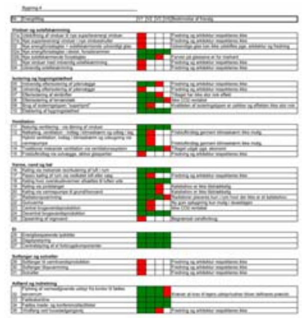

Experience Copenhagen: Element chart

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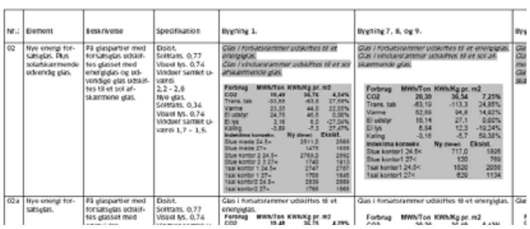

Experience Copenhagen: Final solutions chosen

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Assessment depends on circumstances

example window replacement (or enhancement)

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FINAL CONFERENCE

ENERGY

Proposed measure

Retrofitting a window to a U-value of 1.3 W/m²K

A) Existing window: single glas, U-value ~ 5 W/m²K

→ reduction of heating demand by nearly factor 4

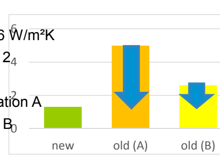
= to 25% of demand

B) Existing window: Coupled window, U-value ~2.6 W/m²K

→ reduction of heating demand by factor 2

= to 50% of demand

With the same end performance starting from situation A three times more energy is saved than in situation B



Assessment depends on circumstances

example window replacement (or enhancement)

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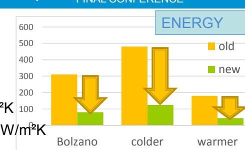
ENERGY



Proposed measure

Retrofitting a window to a U-value of 1.3 W/m²K

A1) Existing window: single glas, U-value ~ 5 W/m²K

in Bolzano with 2600 HDD

→ reduction of heating demand from 310 to 80 kWh/m² (window)

= 230 kWh/m² (window) saved

A2) in colder climate with 4000 HDD

→ reduction of heating demand from 480 to 125 kWh/m² (window)

= 355 kWh/m² (window) saved

A3) in warmer climate with 1500 HDD

→ reduction of heating demand from 180 to 45 kWh/m² (window)

= 135 kWh/m² (window) saved

Assessment depends on circumstances
example window replacement (or enhancement)

EWCHP-2013
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ENERGY

Proposed measure
Retrofitting a window to a U-value of 1.3 W/m²K
A1') Existing window: single glas, U-value ~ 5 W/m²K in Bolzano
small stone building with 10% windows' area
→ total heating demand from 587 kWh/m² (floor)
thereof 107 kWh/m² (floor) through windows reduced to 27 kWh/m² (floor)
= 80 kWh/m² (floor) saved → -13%
A1'') larger brick building with 30% windows' area
→ total heating demand from 295 kWh/m²
thereof 175 kWh/m² through windows
reduced to 45 kWh/m²
= 130 kWh/m² (floor) saved → -44%

	STONE	BRICK
10%	13%	
30%		44%

Assessment depends on circumstances
example window replacement (or enhancement)

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ENERGY

Proposed measure
Retrofitting a window to a U-value of 1.3 W/m²K → Embodied Energy = 720 MJ/m² = 200 kWh/m² (window)
A1) Existing window: single glas, U-value ~ 5 W/m²K
in Bolzano with 2600 HDD, 230 kWh/m² (window) saved per year
→ energy payback 0.9 years
A2) in colder climate with 4000 HDD, 355 kWh/m² (window) saved
→ energy payback 0.6 years
A3) in warmer climate with 1500 HDD, 135 kWh/m² (window) saved
→ energy payback 1.5 years
B1) Existing window: compound window, ~2.6 W/m²K
in Bolzano with 2600 HDD, 80 kWh/m² (window) saved
→ energy payback 2.5 years

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Relation between:

- **Historic buildings**
- **The Energy Performance of Buildings Directive (EPBD)**
- **The most important EPBD CEN standards**

Marleen Spiekman

2 types of CEN groups

Focus on cultural heritage → with highlight on energy

- CEN TC 346: Conservation of cultural heritage
- WG8 energy efficiency of historic buildings

Focus on EBPD: buildings and energy in general → NO specific link with cultural heritage

- CEN EPBD: all CEN TC's working under mandate M/480:
  - CEN TC 371: Project Committee - Energy Performance of Building project group
  - CEN/TC 89 - Thermal performance of buildings and building components
  - CEN/TC 156 - Ventilation for buildings
  - CEN/TC 169 - Light and lighting
  - CEN/TC 228 - Heating systems in buildings
  - CEN/TC 247 - Building automation, controls and building management

Framework vs Standards

- **Energy legislative frameworks:**
  - **EPBD: Energy Performance of Buildings Directive**
  - 3ENCULT: What requirements are there/could be set for historic buildings
- **Standardisation/calculation procedure**
  - **CEN: European Standards CEN (EPBD CEN)**
  - 3ENCULT: How can we make the methodology work for historic buildings

Why energy legislation for historic buildings?

- Legislation → driving force → impact on large scale
- Integration historic buildings in EU legislation (EPBD) → > impact on energy saving in historic buildings

3ENCULT:

- Do we want to integrate historic buildings in the EPBD?
- How can we achieve this in a optimal way knowing what historic buildings need and don't need

EPBD: global content

EU:

- EPBD: framework
- Scope of:
  - Requirements
  - Tools/instruments

National/regional:

- Implementation: details
- Actual level of requirements
- Concrete specifications

EPBD: implementation for historic buildings

Mandatory for historic buildings:

- Large heating and air-conditioning systems:
  - regular inspection
- Major renovation:
  - Minimum system requirements for new, replaced or upgraded technical building systems (heating, cooling, ventilation, domestic hot water)

Exemption for historic buildings:

- Major renovation:
  - Minimum requirement for building envelope
- Energy performance certificate

- buildings officially protected as part of a designated environment or because of their special architectural or historical merit, in so far as compliance with certain minimum energy performance requirements would unacceptably alter their character or appearance;
- buildings used as places of worship and for religious activities;

Possible requirements for historic buildings

- Not necessarily certain minimum energy requirements
- The obligation to do inspections on certain aspects of the building 
- The obligation to make/display a certificate with an energy label 
- The obligation to consider the technical, environmental and economic feasibility of certain measures via e.g. an analysis 
  - Combined with impact analysis on cultural heritage value?

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Aims of energy legislation

- To guarantee a minimum quality level, within reasonable boundaries
- To guarantee all (reasonable) energy saving potential is capitalized
  - Not only the frontrunners
  - But also the masses
  - And the back markers
- To encourage innovation
- …

(not exhaustive)

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Tool: Energy rating

- Assessing the Energy Performance (EP)
  - Standards (CEN EPBD/National standards)
- Judging the outcome
  - EPBD/national or regional legislation

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Assessing the EP

Are the EP assessment standards valid for historic buildings?

- Typical construction differences
- Non-standard use and functionality
- Lack of information on current performance
  - E.g. method needed to calculate U-value of 'air space windows'

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Tool: Energy rating

- Assessing the Energy Performance (EP)
  - Standards (CEN EPBD/National standards)
- Judging the outcome
  - EPBD/national or regional legislation

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Judging the outcome

- It's not necessarily about reaching a certain ABSOLUTE minimum energy requirement (e.g. in MJ/m^2 or CO_2-emission/m^2)
- Should we judge/rate a historic building on an ABSOLUTE energy performance level?
- Is it possible instead to focus on: what energy performance level do we reach given the possibilities?
- So:
  - Not a focus on maximizing energy savings
  - But a focus on optimizing energy savings

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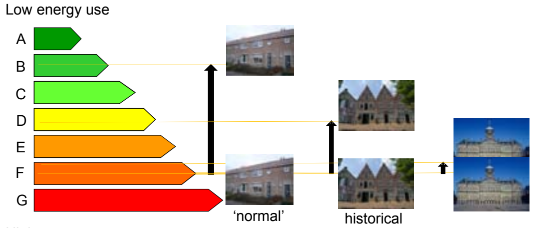
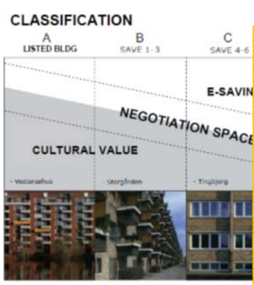
Outcome of an energy rating



Danish study

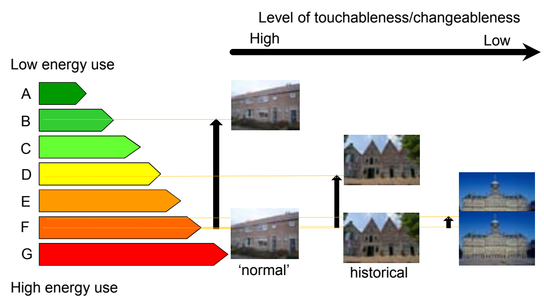
Energibesparelse i procent ift. reference.	Fredede bygninger og bygninger med høj bevaringsværdi	Bevaringsværdige bygninger	Bygninger med enkeltstående arkitektoniske kvaliteter	Anonyme bygninger
Vinduer og solafskærmning				
Forsatsrammer med energiglas, U = 1,7	-	5 %	-	-
Lavenergi vinduer, U = 1,4	-	-	11 %	-
Superlavenergi vinduer, U = 1	-	-	-	14 %
Isolering og tæthed				
Hulmursisolering - gavle, 75 mm	4 %	4 %	-	-
Delvis udvendig efterisolering af ydervægge, gavle, 200 mm + hulmursisolering 75 mm	-	-	8 %	-
Nye højisolerede kviste, 200 mm i vægge og 250 mm i tag	-	-	2 %	-
Total udvendig efterisolering af ydervægge + hulmursisolering, 75 mm + 200 mm	-	-	-	26 %
Tagetage efterisoleres u. ombygning: 200 mm på loft, 100 mm i skunke, 75 mm i skråvægge	16 %	16 %	16 %	-
Tagetage efterisoleres inkl. ombygning: 400 mm på loft, 250 mm i skunke, 200 mm i skråvægge - inkl. nye kviste	-	-	-	22 %
Tæthed, 0,4 h-1	-	3 %	-	-
Tæthed, 0,3 h-1	-	-	6 %	-
Tæthed, 0,1 h-1	-	-	-	11 %
Ventilation				
Kontroludsugning	-2 %	-2 %	-	-
Central ventilation	-	-	7 %	-
Decentral ventilation	-	-	-	8 %
Varme- og vandinstallationer				
Ny varmecentral, inkl. efterisolering af rør i kanaler	13 %	13 %	13 %	13 %
Energibesparelse				
Samlet energibesparelse ift. reference ved udførelse af de markerede tiltag	29 %	37 %	51 %	73 %

E-saving vs Cultural value



- Main advantages:
  - making an **informed discussion** possible among experts with **different backgrounds**
  - gaining **negotiation space for non-listed buildings**
- Main disadvantages:
  - **global rating** on building level can't judge what are possible measures on **detail level**
  - Will such a rating be used eventually in legal contexts?
  - Energy savings does not contradict with historic buildings contradict

Energy rating



Aims of energy legislation

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- To guarantee all (reasonable) energy saving potential is capitalized
  - Not only the frontrunners
  - But also the masses
  - And the back markers
- To encourage innovation
- …

(not exhaustive)

Thank You!

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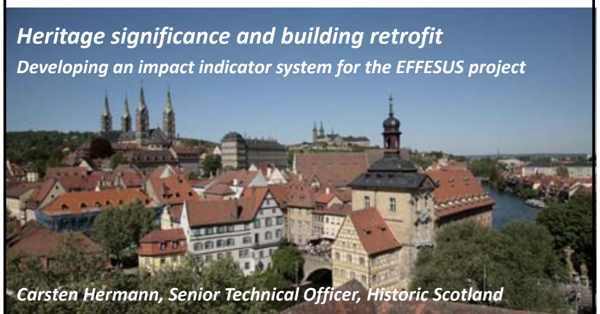

Heritage significance and building retrofit

Developing an impact indicator system for the EFFESUS project

Carsten Hermann, Senior Technical Officer, Historic Scotland

18 Sep. 2013, EWCHP & CEN workshop, Bolzano / Bozen

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SME - Targeted Collaborative Project

HERITAGE SIGNIFICANCE AND BUILDING RETROFIT

Contents

- EFFESUS project and its Decision Support System
- Balancing heritage significance and retrofit measures
- Proposal for a structured system to assess heritage significance
- How the system might work in practice?
- Conclusions

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HERITAGE SIGNIFICANCE AND BUILDING RETROFIT

EFFESUS project

- Europan research project under FP7
- Researching energy efficiency for European historic urban districts
- 23 partners from 13 countries
- Project period: 2012 – 2016
- Budget: approx. 6 mio. €
- 7 case studies in historic districts of European cities

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EFFESUS project is concerned with

- Urban district
- Grouping of old buildings
- Built before 1945
- Representative of their period
- Not necessarily protected by heritage legislation

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EFFESUS project will deliver

- Decision Support System
- New and adapted technologies and systems to retrofit historic urban district
  - Aerogel insulation
  - Secondary window solutions
  - Thermal insulating mortars
  - Radiant reflective coatings
  - Intellegent energy management systems
  - Systems for energy generation from renewable sources
- Support to overcome technial and non-technical barriers preventing implementation
- Outreach and education

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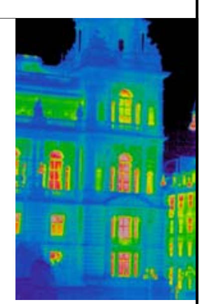
EFFESUS Decision Support System

- is a software tool to help make informed decisions about improvement measures suitable for historic urban districts
- includes
  - Multi-scale data modell
    - Building stock and its energy use and heritage significance
    - Local climatic conditions
  - Repository of energy efficiency retrofit solutions
    - Economic, life-cycle and techical assessments of improvement measures



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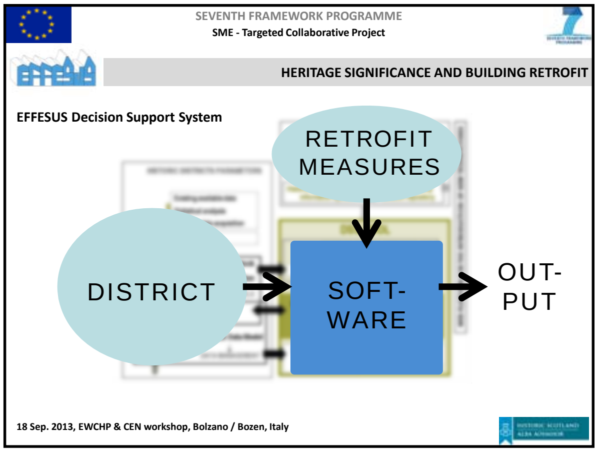
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EFFESUS Decision Support System
RETROFIT MEASURES
DISTRICT
SOFT-WARE
OUT-PUT
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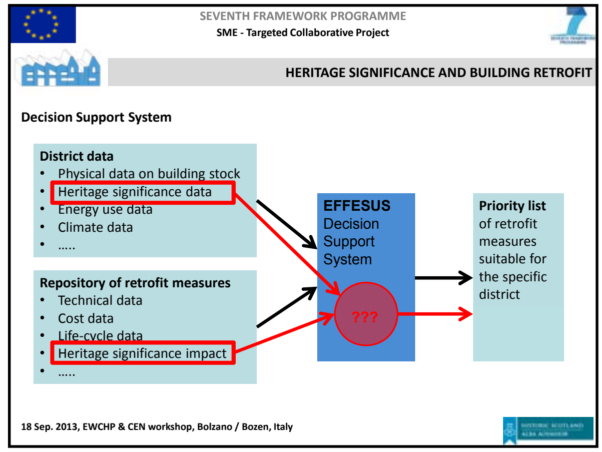
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HERITAGE SIGNIFICANCE AND BUILDING RETROFIT
Decision Support System
District data
• Physical data on building stock
• Heritage significance data
• Energy use data
• Climate data
• .....
Repository of retrofit measures
• Technical data
• Cost data
• Life-cycle data
• Heritage significance impact
• .....
EFFESUS Decision Support System
???
Priority list of retrofit measures suitable for the specific district
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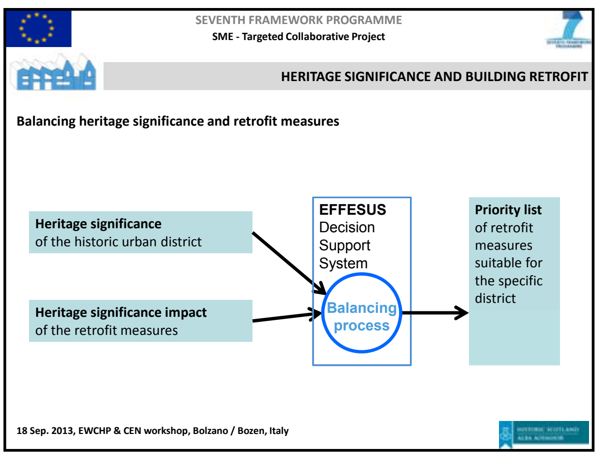
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Balancing heritage significance and retrofit measures
Heritage significance of the historic urban district
Heritage significance impact of the retrofit measures
EFFESUS Decision Support System
Balancing process
Priority list of retrofit measures suitable for the specific district
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HERITAGE SIGNIFICANCE AND BUILDING RETROFIT
Heritage significance
• Walls
• Windows
• Doors
• Roof
• Roof features
• Wall features
• Ceilings
• Floors
• Wall finishes
• Fixed interiors
• Urban patters?
• features?
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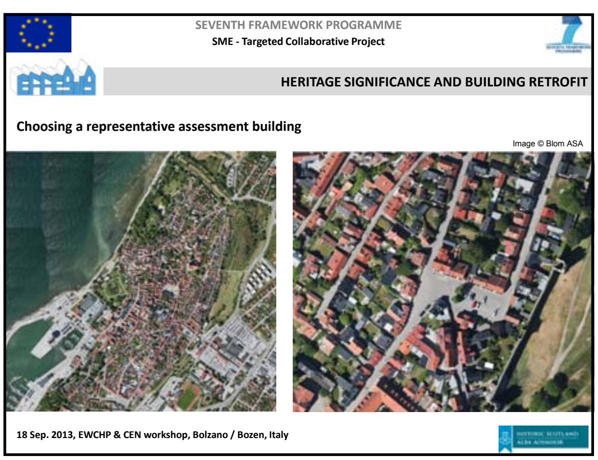
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HERITAGE SIGNIFICANCE AND BUILDING RETROFIT
Choosing a representative assessment building
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Choosing a representative assessment building
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Choosing a representative assessment building

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HERITAGE SIGNIFICANCE AND BUILDING RETROFIT

Heritage significance structured by building components

Urban	Gardens and parks
	Ground archaeology
	Public spaces
	Roof-scapes
	Street-scapes
	Vistas
Building exterior	Doors
	Roofs
	Roofs, features
	Windows
	Walls
	Wall finishes
Building interior	Ceilings
	Ceilings, finishes
	Fixed interiors
	Floors
	Walls
	Walls, finishes

Building exterior	Walls	Primary
		Secondary
		Tertiary
	Walls, finishes	Primary
		Secondary
		Tertiary
	Windows	Primary
		Secondary
		Tertiary
Building Interior	Ceilings	Primary
		Secondary
		Tertiary

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HERITAGE SIGNIFICANCE AND BUILDING RETROFIT

Visual, physical and spatial assessments

Building exterior	Walls	Visually
		Physically
		Spatially
	Walls, finishes	Visually
		Physically
		Spatially
	Windows	Visually
		Physically
		Spatially
Building Interior	Ceilings	Visually
		Physically
		Spatially

- Visually: aesthetics, appearance
  Is the appearance of the materials important?
- Physically: authenticity, materiality
  Are the materials themselves important?
- Spatially: space, floor plan
  Is the spatial configuration important?

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HERITAGE SIGNIFICANCE AND BUILDING RETROFIT

Assigning values for heritage significance

0	Negative or neutral importance / not applicable	for a gypsum-plasterboard ceiling which replaced traditional ceiling plasterwork
1	Minor importance	for traditional ceiling plasterwork
2	Major importance	for traditional, ornate ceiling plasterwork
3	Outstanding importance	for traditional, ornate, 16^{th} century ceiling plasterwork
4	Exceptionally outstanding importance	for rare and well surviving traditional, ornate, 16^{th} century ceiling plasterwork

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SME - Targeted Collaborative Project

HERITAGE SIGNIFICANCE AND BUILDING RETROFIT

Assigning values for heritage significance

Building exterior	Walls	Visually	4
		Physically	3
		Spatially	1
	Walls, finishes	Visually	0
		Physically	0
		Spatially	0
	Windows	Visually	4
		Physically	2
		Spatially	1
Building Interior	Ceilings	Visually	5
		Physically	2
		Spatially	3

18 Sep. 2013, EWCHP & CEN workshop, Bolzano / Bozen, Italy

SEVENTH FRAMEWORK PROGRAMME
SME - Targeted Collaborative Project

HERITAGE SIGNIFICANCE AND BUILDING RETROFIT

Two data sets are required for comparison

Heritage significance
of the historic urban district

Heritage significance impact
of the retrofit measures

Balancing process

Priority list

i.e. catalogue of retrofit measures

18 Sep. 2013, EWCHP & CEN workshop, Bolzano / Bozen, Italy

Repository of retrofit measures

- ....
- External insulation
  - Conventional insulating systems (e.g. mineral wool insulation with render finish)
  - High-performance, slim-profile insulating systems (e.g. aerogel insulation with render finish)
  - Low-performance, slim-profile insulating systems (e.g. insulating lime render)
  - Insulating coatings (e.g. Insulating paint)
- Solar photovoltaics for pitched roofs
  - Panels mounted above roof coverings
  - Panels replacing roof coverings
  - Panels in form of the roof covering (e.g. 'solar tiles' or 'solar slates')
- ....

Defining heritage-significance impacts

Urban	Ground archaeology	Visual
		Physical
		Spatial
	Roof-scape	Visual
		Physical
		Spatial
	Street-scape	Visual
		Physical
		Spatial
Building exterior	Roof finish	Visual
		Physical
		Spatial
	Wall	Visual
		Physical
		Spatial
	Wall finish	Visual
		Physical
		Spatial

0	No impact / not applicable
1	Minimal impact
2	Minor impact
3	Major impact
4	Severe impact

Defining heritage-significance impacts

Urban	Ground archaeology	Visual
		Physical
		Spatial
	Roof-scape	Visual
		Physical
		Spatial
	Street-scape	Visual
		Physical
		Spatial
Building exterior	Roof finish	Visual
		Physical
		Spatial
	Wall	Visual
		Physical
		Spatial
	Wall finish	Visual
		Physical
		Spatial

Defining heritage-significance impacts

			Solar roof photovoltaic		
			Panel mounted on top of roof covering	In-line Panel replacing original roof covering	Slates or tiles replacing original covering
Building exterior	Roof finish	Visual	4	4	1
		Physical	1	4	4
		Spatial	2	0	0


Image © Red Mile Energy (left and middle photo) and Lizabeth Croft (right photo)

Assigning values for heritage significance

Heritage significance of the historic urban district

Heritage significance impact of the retrofit measures

Balancing process

Priority list

Assigning values for heritage significance

Heritage significance level	Impact level of retrofit measure (0 = no impact to 4 = severe impact)	Balancing result *Use of retrofit measure …*
0 neutral or negative	0, 1, 2, 3 or 4	… acceptable
1 minor	0	… acceptable
	1 or 2	… likely to be acceptable
	3	… potentially acceptable
	4	… not acceptable
2 major	0	… acceptable
	1	… likely to be acceptable
	2 or 3	… potentially acceptable
	4	… not acceptable
3 outstanding	0	… acceptable
	1	… likely to be acceptable
	2, 3 or 4	… not acceptable
4 exceptionally outstanding	0	… likely to be acceptable
	1, 2, 3 or 4	… not acceptable

Thank you

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www.effesus.eu
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MORNING SESSION 09:00 to 12:00

Comprehensive diagnosis and multidisciplinary approach for conservation compatible energy retrofit (3ENCULT)
Coordinator: Francesca Roberti, Dagmar Exner

Welcome to the Weigh House (10 min)
Stiftung Sparkasse, owner of the building [tbc]

Presentation of the building Weigh House, a listed medieval building in the historic centre of Bozen/Bolzano (30 min)
Klaus Ausserhofer
Klaus Ausserhofer, collaborator of the conservation office of South Tyrol, explains the history and the original use of the medieval building of the Weigh House, one of the eight case studies of the project 3ENCULT, and of the surrounding historic building complex of the "Portici". At first, he highlights the architectural, historic and cultural values of the buildings, visiting them from the outside. Then, entering in the Weigh House, he explains the peculiarities of the case study and the most important architectural elements that have to be preserved during the refurbishment.

Monitoring system (T and RH monitoring) (20 min)
Francesca Roberti, Dagmar Exner
A monitoring system that records every minute the interior air temperature and relative humidity of some rooms and walls is installed in the Weigh House. The collected interior climate data are necessary to understand the thermal behaviour of the building in order to propose the best interventions for the energy retrofit. Visiting the inside of the building, the aim of the monitoring system, the location of the sensors and the most significant results will be presented.

IR thermography measurements (40 min)
Christoph Franzen
The IR thermography measures the thermal emissivity and indirectly the surface temperature. This information is important both for conservatory and energetic aspects. From a conservatory point of view, the thermography helps in the definition of the history of a surface made of different materials. From an energetic point of view, the IR thermography shows where the thermal bridges are concentrated. At first, Christoph Franzen, collaborator at the Institute for diagnosis and conservation on monuments in Saxony and Saxony-Anhalt (IDK), explains the theory of the IR thermography, concentrating on how to avoid the most common errors. Then, he practically do a thermography survey in the Weigh House.

Heat flux meter measurement (20 min)
Francesca Roberti, Dagmar Exner
One of the most important parameter influencing the thermal behaviour of a building is the U-value of exterior walls. In the Weigh House it has been measured several times in different periods with a heat flux meter. At first, the results of these measurements are presented, highlighting the difficulties and the limits of this technique applied to a historic building. Then, a practical measure is shown to the participants.

Blower Door Test (30 min)
Francesca Roberti, Dagmar Exner
The airtightness of the exterior envelope is another important parameter influencing the thermal behaviour of a building . In the Weigh House it has been measured for the whole building and for some single rooms. At first, the results of the measurements are presented, highlighting the difficulties in building with very poor airtight envelope. Then, a practical measure is shown to the participants.

Discussion with all participants (30 min)

3ENCULT is co-funded by the European Union Seventh Framework Programme (FP7/2007-2013) under grant agreement n° 260162.

AFTERNOON SESSION 13:00 to 16:00

Energy efficiency of windows in historic context (3ENCULT)

Coordinator: Dagmar Exner

Visit of typical examples of historic and refurbished windows in the historic city center of Bolzano

Klaus Ausserhofer (60 min.)

On a guided walk through the historic city center of Bolzano, Klaus Ausserhofer, collaborator of the conservation office of South Tyrol, shows typical historic windows of different construction eras. Among the examples, he explains also specific traditional window constructions that are responsive to the climatic requirements. Participants will see furthermore some examples of refurbished windows and discuss relevant aspects with regards energy efficiency and preservation of the historic value, such as proportions of window frames and sashes, different appearance of historic glazing and new glazing, air- and weather tightness, condition of the weatherboard and coating options. To understand the different energy performance and the risk of condensation or moisture damage of different window typologies, in parallel window details with heat-transfer analysis will be shown and analyzed (on posters).

A procedure for conserving the cultural heritage values and upgrading the energy performance of a historic building with focus on windows

Franz Freundorfer (60 min.)

The second part of the workshop takes place in the Public Weigh House in the center of Bolzano, one of the eight case studies of the project 3ENCULT. Based on different historic window typologies and the individual preservation demands of historic buildings, Franz Freundorfer explains challenges and opportunities when it comes to the development of solutions for the improvement of energy performance of historic windows. He presents appearance and problems of industrial (not individual) manufactured refurbishment solutions for historic windows. In this context, he shows the history and development of the industrial produced double glazed windows, used during the last decades.

The participants will see the development of a new high-energy efficient window prototype for the Public Weigh House, a case where the original window could or has to be replaced. Both window prototypes were developed within the project 3ENCULT on the base of a multidisciplinary approach that implemented a strong collaboration and exchange between technical experts and conservators. The participants investigate how the presented procedure can be transferred to other buildings, for repairing and enhancing existing windows and how the concepts can be applied in different regional window construction traditions. Energy calculations show the energy saving potential of different single solutions in different climate zones with different installation variants into the existing wall.

Presentation of conservation compatible highly energy efficient windows on-site, developed within the project 3ENCULT

Franz Freundorfer, Matilde André (30 min.)

Finally, the two window prototypes installed in two test room of the Public Weigh House and the box-type window developed for the Aufschnaiter School of Bolzano will be presented. Participants will examine the approach that led to this individual solution, how it was possible to integrate both energy efficiency aspects and conservation demands.

Additionally the participants will have the opportunity to have a look at examples of different types of glazing and recent developments in the field of high-energy performance glazing and its thickness.

Discussion

All participants (30 min.)

3ENCULT is co-funded by the European Union Seventh Framework Programme (FP7/2007-2013) under grant agreement n° 260162.

EFFICIENT ENERGY FOR EU CULTURAL HERITAGE

Title:

INTEGRATE SOLAR CONCEPTS IN HISTORIC BUILDINGS

Description:

Historic buildings are the trademark of numerous European cities, towns and villages: historic quarters give uniqueness to our cities, they are a living symbol of Europe's rich cultural heritage and reflect society's identity. However, it is clear that these buildings are also substantial contributors to greenhouse gas (GHG) emissions and rising energy bills.

To exploit – actively & passively, for heating & lighting – the sun, natural resource available at the site since the building was constructed and in many cases already an issue in the original energy concept of the building, would be an obvious step.

Combining advanced technologies, respectful integration, ambitious architectural approaches and holistic concepts allows developing successful solar concepts even in the special case of a historic context.

Presentations in this session shall range from presentation of technology and its application potential to demanding case studies as well as holistic assessment methods and multidisciplinary design approaches.

Chair:

Dr. Ing. Alexandra Troi,
Coordinator of FP7 project 3ENCULT, www.3encult.eu
Vice-Head of the Institute for Renewable Energy, EURAC research
+39 0471 055600, alexandra.troi@eurac.edu, Drususallee 1, 39100 Bozen, Italy

Programme:

INTRODUCTION
Chair – Alexandra Troi

SUN HAS ALWAYS BEEN A RESOURCE - TRADITIONAL WAYS OF USING SOLAR ENERGY
Sonja Jurosevic, NTNU, Norway

- The sun as resource in northern climates
- How we built with the sun in the south
- What we can learn from and how we can re-activate traditional systems

SOLAR ENERGY IN HISTORIC BUILDINGS – SUSTAINABLE CONCEPTS
Franziska Haas, TU Dresden, Germany

- Historic buildings and quarters
- Guiding principles for solar integration in historic buildings
- Practice examples

TECHNOLOGICAL SOLUTIONS FOR PV IN THE HISTORIC CONTEXT
Oscar Montero, SOLIKER, Spain

- BIPV based on semi-transparent amorphous silicon (a-Si)
- Flexibility in transparency, pattern, form and colour
- Practice examples

SOLAR LIGHTING SOLUTIONS IN HISTORIC BUILDINGS
Robert Weitlaner, Bartenbach Lichtlabor, Austria

- Assess the situation and develop solutions
- Integrable daylight (re-direction) systems
- Practice examples

SOLAR ENERGY INTEGRATION – CHALLENGE AND CHANCE FOR CONSERVATION ARCHITECTS
Cristina S. Polo López, SUPSI, Switzerland

- Understand & respect the existing
- Develop high quality architectural solutions
- Practice examples

Traditional architecture: designing with the Sun

Sonja Jurošević

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Abstract

Traditional buildings are more often than not built in accordance with climate conditions, being built before dependency on off-site energy resources and mechanical systems. A range of passive strategies of solar control was utilized to provide for comfortable indoor conditions. Based on the analysis for a given climate, recommendations for passive solar strategies are drawn, and then compared to the features of the traditional architecture of the region. The results demonstrate that traditional buildings were built to respond to the local climatic conditions and how they utilized the passive strategies of solar control.

Keywords: traditional architecture, solar radiation, passive strategies, climate zones

1. Introduction

Traditional buildings were built before dependency on off-site energy resources and mechanical systems. In order to provide for comfortable indoor conditions, buildings have been built to respond to outdoor conditions in such a manner that would secure an optimal environment for living. Every region has vernacular building types that are, to a great extent, based on adaption to the local climate [1]. Through centuries, with migrations towards urban areas these types changed to respond to the new conditions. Before the mass use of mechanical systems and various technologies for heating and cooling, the buildings and their surroundings had to maintain the role of achieving thermal comfort, even in extreme weather conditions [2].

Depending on the local climatic conditions, a range of passive strategies of solar control was utilized in order to reduce the energy demand [3]. The goal of passive solar heating is to deliver the heat at the time when it is needed, and to prevent unnecessary overheating of interior of the building by using the building elements (walls, apertures, roof and floors) for collecting, storing and distributing solar energy [4]. The intensity of sunlight entering the building is determined by the season, but also the latitude – in the northern hemisphere the radiation is weaker in the winter, but the angle of solar incidence is smaller, therefore the solar radiation penetrates deeper into the interior; in the summer it is opposite [5]. The position, size, shape and type of apertures, but also the shading devices, influence the effects of the solar gain in the interior, determining what is the best possible use of the winter sun, and also minimizing of summer sun's heat, in a given building. Colours of the interior, materials of the structure, types of glazing, are some of the factors that influence the solar radiation control. Adjustable shading plays an important part in lowering the summer temperatures inside the house [6]. In traditional buildings, we find different kinds of shading devices. In some cases, the shape of the building envelope and the roof are used as shading devices, while in some cases they can be in a form of a fixed decorative screen made from various materials. Vegetation can be a very useful shading device. Deciduous trees are green during summer, thus providing the shade, while, in the winter, when there is a need for sunlight; these trees are leafless, allowing for direct sunlight to enter the building [7].

This paper presents a part of the research done within the Effesus project (Energy Efficiency for EU Historic Districts Sustainability, funded from European Union's Seventh Framework Programme under Grant Agreement No. 314678.

2. Method

According to Köppen-Geiger classification Europe can be divided into several climate zones [8]. This classification system is, with minor modifications added over this time, currently being used. There are three main climate types in Europe: cold, temperate and polar, and around 15 subtypes [9].

In this paper, traditional architecture from cold and temperate climates is analysed with numerical analysis performed through the CPZ methodology, developed by Szokolay inside the Givoni diagram [10]. The method is used to identify which passive strategies are recommended for use in a given climatic region, based on the Olgylay's bioclimatic approach [11]. The psychrometric chart combines the comfort zone with the micro-climate conditions. The climate data is obtained through the EnergyPlus Energy Simulation Software Weather Data Files [12], from the nearest weather station to the reference city, and then calculated in the Climate Consultant software.

In addition to identifying most effective passive strategies related to solar radiation, this method provides indications on the most suitable kind of building system for the climatic region in question (light construction, or heavy construction with high thermal mass). The systems highlighted by this methodology were then compared to the ones commonly used by vernacular architectures [13].

3. Analysis

3.1 Warm Mediterranean Climate zone

3.1.1 Climate analysis

Warm Mediterranean Climate zone ranges is located around the Mediterranean Sea, the coasts of Iberian, Apennine and Balkan Peninsula. Main characteristics of this climate zone are warm and dry summers (with average temperatures around 26°C), and cold and humid, rainy winters (with average temperatures around 10°C). Solar radiation is intensive, especially during summer. During the warm seasons, there is a problem of overheating, therefore cooling plays an important role in maintaining the comfortable conditions, while in the winter, due to high precipitation and strong winds, solar radiation is being used for heating.

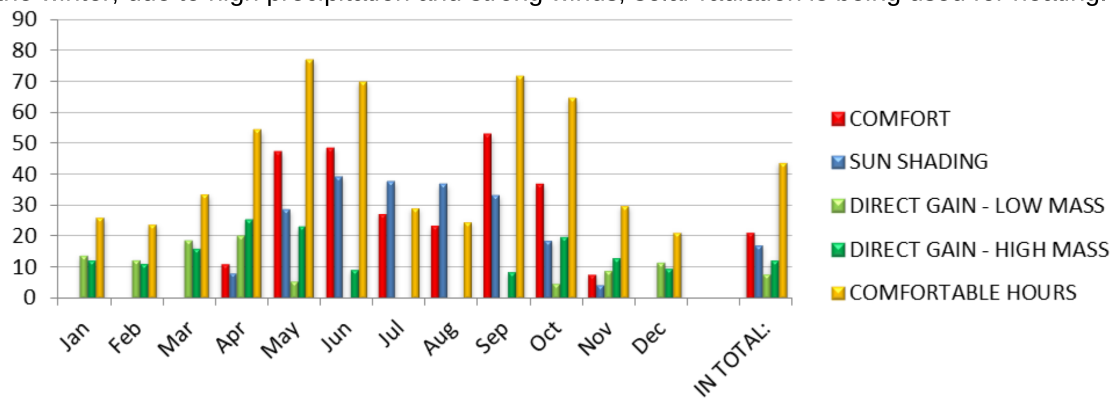

Figure 1: Passive strategies chart for Warm Mediterranean climate zone – reference city: Athens

Based on the climate analysis, Warm Mediterranean climate is a comfortable climate. Shading should be provided during warmer seasons to prevent overheating – this can be accomplished by building orientation, plot plan, shading with shutters, vegetation and roof overhangs. Passive solar gain should be provided in the winter. In both seasons, high thermal mass plays an important role for providing for thermal comfort.

3.1.2 Examples

As typical representatives of Mediterranean traditional architecture, Andalucían Morisco houses were built in the XVI century by the people Morisco in Spain. The urban type of dwellings was developed around a central patio, with vegetation and a small pool in the centre, making a shaded, private inner courtyard, with cooling vegetation and water surfaces. Buildings usually had 2 storeys, sometimes with a third one on the northern side (to protect from the cold northern wind). Towards the street, the windows were small, and located usually only on the upper floor both for privacy, as well as protection against the strong summer sun. The main rooms were located on the north and the south sides of the patio. Sometimes, the east and the west side would only be galleries, without the living quarters. It is important to note the use of the upper and lower floors depending on the season. The main summer living area was the patio, due to the comfortable temperatures and the shade, while in the winter the upper floor was mostly in use. Materials for construction were rammed earth and lime, sometimes reinforced with brick pillars, and having high thermal mass properties they added to heating during winter months [14].

A very specific type of dwellings is located at the island of Santorini in Greece, based on the use of local volcanic materials and the slope of the terrain. Besides the issues of protection against conquerors (labyrinth-type street pattern), they paid special attention to the climate and thermal comfort. Dwellings are excavated on a slope, into the face of a cliff, with small courtyards and terraces in the front, protected from the sun by a masonry wall. The space inside the cliff consisted often of several rooms, in the shape of cylindrical vaulted caves. The outside walls were usually the base for the neighbour's house or veranda, and the roof or courtyard of one house was often used as a route to another house. Small openings, solid volumes, whitewashed plaster didn't allow the strong summer sunlight to enter, and the heat capacity of thick masonry walls reduced the diurnal and annual fluctuations, making the best use of sun radiation [15].

3.2 Temperate Mediterranean Climate zone

3.2.1 Climate analysis

This climate zones is located on the north-west part of Iberian Peninsula, and differs from the Warm Mediterranean mostly because of the strong influence from the Atlantic, bringing mainly high precipitation rates and cold winds. The main characteristics of this climate zone are warm and dry summers (average temperatures 17°C), cold, humid winters (rainy and sometimes snowy, with average temperatures around 8°C), with occasionally strong seasonal winds. High precipitation levels are caused by the proximity of the Atlantic Ocean and the Gulf Stream.

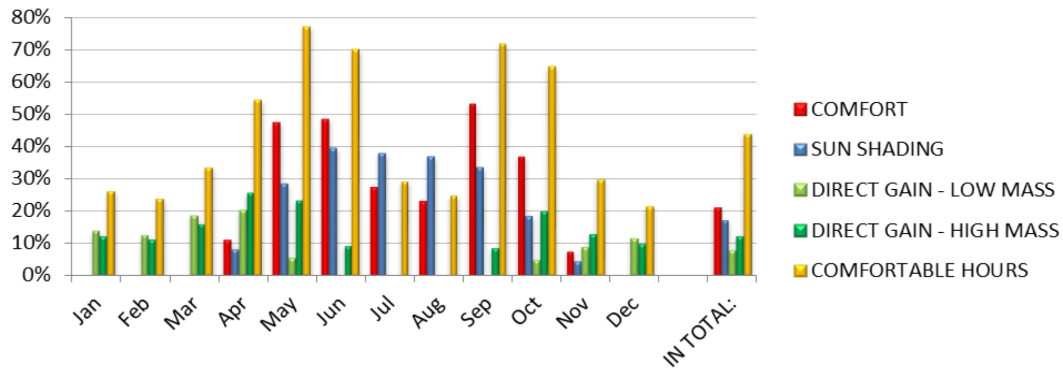

Figure 4: Passive strategies chart for Temperate Mediterranean climate zone – reference city: Santiago

Design recommendations for this climate zone would be to build with heavy construction materials, providing for high thermal mass. Large window areas should be facing south, and shaded with overhangs rather than with fixed sunshades, or, sunshades can be operable, allowing for winter sun to penetrate the interior. Sun should be able to enter the building through small well-insulated skylights. Compact building form is a recommendation, in order to prevent the heat loss during colder seasons.

3.2.2 Example

In medieval plots inside the old city wall of Santiago de Compostela in Spain, solar access to buildings is difficult, due to the high density and narrow streets. Buildings are long in depth and narrow in width, compact, built one next to another, making heat loss lower, but this organization makes natural ventilation and solar radiation lower as well. Suppression of overhangs helps increase sunlight over the streets and facades, and large windows and skylights introduce the sunlight into the interior of buildings [16].
Typical house consists of two thick masonry walls of granite. The front porch, containing the commercial space, presents a buffer zone towards living spaces, but also shade and protection from rain to the entrance. Flush windows are positioned on the outer side of the façade, because of the rainy weather. These windows have no frame, allowing for continuous ventilation, but additional windows on the inner side were introduced in the XX century, for thermal regulation. Shutters are usually on the inside, and can be integrated into the window sash or separated, in that manner creating an air chamber that regulates the heat balance. There is

a piece of profiled stone on the outer side of the window with the structural role to help obtaining higher windows. Higher windows bring more light, which is especially important due to great depth of the typical building.

Gallery is a typical Galician element in urban buildings. Besides being glass protection from different weathering conditions, it is a crucial element for solar capture. It is a glasshouse, basically, working by the greenhouse effect. Solar radiation passes through glass surface into the gallery. The stone wall behind the gallery receives sunlight and emits a higher energy wavelength, and since in this shape it is harder for energy to pass through the glass, it stays inside, stored in the thermal mass, to be released later during the night. In the interior wall, there are flush windows with shutters that allow the user to regulate the thermal conditions during the day/night time. The sash windows of the gallery open completely, thus allowing transformation into a completely open balcony [17].

3.3 Humid Continental Climate zone

3.3.1 Climate analysis

This climate zone spreads throughout central and east Europe, from Balkan Peninsula to Scandinavian Peninsula, including the coast of Baltic Sea. Depending on the subtype, summers can be warm or temperate, while winters can be cold, snowy and windy. Precipitation is high throughout the year and even more so during the transitional seasons. In Copenhagen, as the reference city for the analysis, summer average temperatures are around 15°C, and winter average is around 1°C. Due to the proximity to the sea, the weather is more changeable during the day than further from the coast.

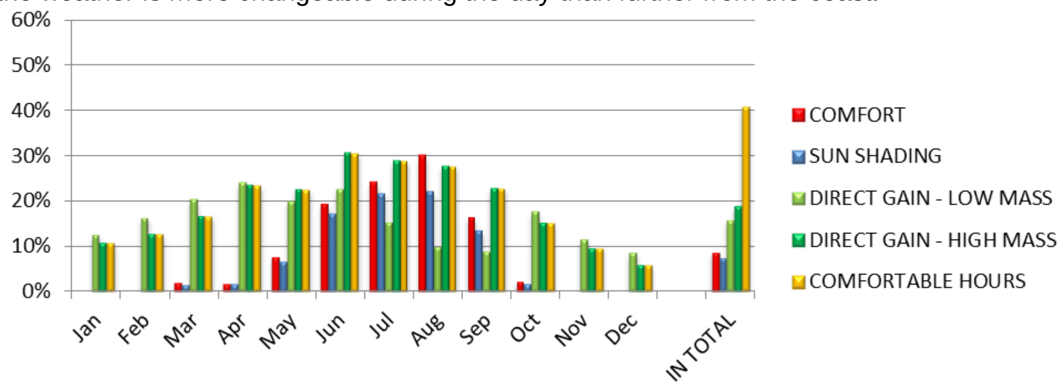

Figure 6: Passive strategies chart for Humid Continental climate zone – reference city: Copenhagen

Due to the rather smaller solar radiation intensity than in the previous two climate zones, insulation plays a very important role for prevention of heat loss. High-pitched roof and overhangs are recommended in order to divert rain and wind, but also to provide for sufficient insulation. Living quarters should be orientated towards south, and vegetation used for wind protection, particularly to allow for wind-protected spaces as day-time living areas. Thermal mass should be used for storing daytime solar gain, including stoned fireplace, walls and floors.

3.3.2 Example

The archetype of Danish traditional architecture is the “wing-house”, the farm house consisting of several wings surrounding the courtyard. In the urban context, one façade is on the street, forming row-houses together with the neighbours’ houses fronts. Courtyards (one or more) are formed by adapted wings in the back. They were used for agriculture and farming, while the living area was in the wing closest to the street. The construction technique has changed over the years from timber frame into more solid brick construction.

Courtyards were used for climate control – allowing for inner walls to be orientated independent from the street pattern, sheltered from the wind. In some towns, houses are orientated east-west to provide maximum sun exposure and minimum wind exposure. No matter how the streets are orientated, living quarters are turned towards the south. Landscaping plays an important role in diverting the winds, through the use of trees, hills and dunes for screening, reducing the need for heating. During the cold months, houses were traditionally heated with open fireplace (or oven), which was keeping the indoor temperature comfortable. Living rooms were usually orientated towards the south, while service rooms and kitchen were used as buffer spaces, orientated towards north. There was a room with the particular purpose to create a buffer zone for the exchange of cool and warm air between the entrance and living rooms, called ‘Vindfang’ [18].

4. Conclusions

Based on the completed climate analysis I conclude that these buildings responded to the climatic needs to a great extent. It is my belief that this kind of analysis can be used as a basis for defining a big number of possible strategies for improving the environmental behaviour of any building in a specific region or climatic context. This knowledge of traditional architecture and design with the solar energy is important to be identified as the first step of planning energy efficiency measures on historic buildings.

5. Acknowledgements

The author wishes to thank Luca Finocchiaro (Associate professor at NTNU, Trondheim) for assistance in developing the method for analysis, Eir Ragna Grytli (Professor at NTNU, Trondheim) and Marianne Knapskog (PhD student at NTNU, Trondheim) for valuable comments. In addition, special thank you to Alexandra Troi (Vice Head of the Institute for Renewable Energy of the European Academy of Bolzano).

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Solar Energy and Conservation of Monuments - A Contradiction?

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Abstract

Cultural heritage is an integral part of our environment, the conservation of and care for monuments is therefore on important social concern. But what is actually a monument and what are the principles of heritage preservation? These two questions should be answered shortly as an introduction to continue with aspects of energy retrofit of historic buildings with special emphasis on solar energy. First of all, it must be clarified which requirements must be fulfilled to guarantee the effectiveness of local solar systems in the context of historic buildings and city centres. Certain urban instruments can avoid problematic interventions without compromising the use of renewable energy. Smaller systems for the own-requirement are possible also for historic buildings, provided that they do not contradict to existing laws and regulations. For the installation must be paid full attention to the design quality as well as to the preservation of historical values.

Keywords: cultural heritage, city centres, passive and active solar energy, guidelines.

1. Introduction

The Venice Charter is the still valid and contemporary international Charter for the conservation and restoration of monuments and sites. The first article provides a definition of historic monuments which "embraces not only the single architectural work but also the urban or rural setting in which is found the evidence of a particular civilization, a significant development or a historic event. This applies not only to great works of art but also to more modest works of the past which have acquired cultural significance with the passing of time." [1] The monument registers of European countries contain therefore not only castles, churches and medieval town centres, but also farmhouses, industrial buildings, settlements of the 20th century and even structures like the remnants of the Berlin Wall. The monument registers differ not only in content but also in type and intensity of the documentation. However, it must be clearly emphasised: if we consider the issue of using solar thermal energy in historic buildings we should face the whole historic building stock. There is a need for strategies and solutions not only for the registered buildings. But in the Monument sector not only the ethical questions have a regulating effect but also special directives and policies. Even if the laws in terms of protection of monuments in Europe are very heterogeneous, some strategies in the dealing with monuments can be generalized. These again set the Charter of Venice:

> Article 3: The intention in conserving and restoring monuments is to safeguard them no less as works of art than as historical evidence.
>
> Article 4: It is essential to the conservation of monuments that they be maintained on a permanent basis.
>
> Article 5: The conservation of monuments is always facilitated by making use of them for some socially useful purpose. Such use is therefore desirable but it must not change the lay-out or decoration of the building. It is within these limits only that modifications demanded by a change of function should be envisaged and may be permitted.
>
> Article 6: The conservation of a monument implies preserving a setting which is not out of scale. Wherever the traditional setting exists, it must be kept. No new construction, demolition or modification which would alter the relations of mass and color must be allowed.[2]

Central aims of conservation works are the preservation of monument-related fabric, as well as the maintenance of the full richness of their appearance. The basis for responsible work is therefore the knowledge about the interactions among the heritage object and its environment, and their variations over time. Beside the exact knowledge of the building the heritage related use is one of the basic requirements for preservation. In particular with changes in use or with the increased comfort, interventions at the monument are necessary. If they affect the heritage-related fabric and/or the appearance, there should be put emphasis on the reversibility of the measure. Experiences show, however, that any intervention leaves its positive or negative impact, thus the different experts have to set high standards in the planning and to aspire an interdisciplinary approach from an early planning stage.

When it comes to the issue of solar use at historical buildings, the various actors often draw different worst-case scenario: On the one hand representatives of the solar energy already predict the pretty old monument the final decay, since any type of energy efficiency is avoided and thus the unprofitable building is hardly usable in the future. On the other hand conservationists see the appearance of the monument irreversibly destroyed by the shiny smooth panels. (Figure 1) However, numerous preserved monuments with integrated energy efficient measures show that with an early interdisciplinary planning appropriate solutions may are found. In addition, climate protection and conservation of monuments pursue the same objective: the maintenance of our environment. In the definition of feasible methods, however, there are often conflicts. But how the two sides can converge and which experience has been gained in the past? Any generally applicable regulations are hardly to define, all the more for the European context. This is not only attributable to different climatic conditions and national legal requirements, but also to the fact that every monument is unique and therefore needs individual treatment.

2. Passive use of Solar Energy

Solar energy can be used both actively and passively. The passive use bears in our context generally less potential for conflict, since the principle has been known for a long time. The use of solar energy always went beyond the mere installation of windows. Already in the 1st century BC Vitruvius, the Roman author, architect, and engineer wrote: "In the north, buildings should be arched, enclosed as much as possible, and not exposed, and it seems proper that they should face the warmer aspects. Those under the sun's course in southern countries where the heat is oppressive, should be exposed and turned towards the north and east. Thus the injury which nature would effect, is evaded by means of art. So, in other parts, due allowance is to be made, having regard to their position, in respect of the heavens."[3] Even historic residential buildings are often zoned intelligently, so that the living zone is oriented (at least in temperate climates) to the warm south and the cooler rooms in the north are preferably used for storage. Also the installation of winter gardens and pergolas were supposed to regulate the solar incidence depending on the season. The traditional architecture is often best adapted to the existing climatic conditions. Massive constructions of the building, a

Figure 1: Gerolzhofen, Bavaria/Germany, barn within the city ensemble, in the background the Tower “Weißer Turm” (Hans-Christof Haas, BLfD). With the modified roof surface the relationship between tower and building changes.

Figure 2: Untereisenheim, Bavaria/Germany (Hans-Christof Haas, BLfD)

Figure 3: Bamberg, Bavaria/Germany. The historic roof structures are part of the significance of the World Heritage City.

bright colour and large shaded areas should prevent overheating in the hot regions, while larger windows in northern areas let light and heat in the house. If these structures will be reactivated and/or technically improved, there is usually no conflict with the conservation of a monument.

3. Active use of Solar Energy

The active use of solar energy usually means the integration of completely new elements into the historic building or ensemble. Solar panels correspond neither in their material nor in their surface design to the historic building stock. For the fitting urgently the roof surfaces are used. The sloping roof surfaces in Europe are covered traditionally with brick, slate, flagstone, wood shingles and thatched roofs with their small-scale elements (tiles, slabs). Large-format panels with a strict geometric form are just difficult to integrate harmoniously. If the inhomogeneous roof is replaced by smooth homogeneous surfaces, it is a significant intervention in the appearance. In addition, the creative balance of facade and roof, which is characteristic for historical buildings, could be destroyed. In the end whole roofscapes are permanently changed. But these roofscapes are distinctive for historical towns like the example of Bamberg shows. (Figure 2,3) The same applies to exposed standing buildings and groups of buildings, such as castles and farmsteads. If individual roof sections (which are oriented to the south) are fully equipped with flat PV installations grouping of related roofs are no longer perceived visually matched by its materiality. (Figure 4) Regional characteristics are extinguished by the supra-regional uniform plates. But the regional identity is important not only for the well-being of residents and tourism but also provides an important location factor for the future.

Figure 4: Castle Brauneck, Baden-Württemberg/Germany (Hans-Christof Haas, BLfD). The homogeneity of the roof is lost by installation of the PV system. Furthermore the castle has with its exposed position a high long-distance effect.

4. Solutions in urban context

The historic building stock is not adapted to install large-scale solar thermal systems and thus to serve as a power company over the own requirements. Of course, there are also examples which should not be condemned wholesale. Good solutions exist for example with the integration of PV panels in shed roofs of industrial buildings, also protected as historical monuments. In the years 1999/2000 the Deutsche Bundesstiftung Umwelt funded a research project supporting PV systems on church roofs with partly good results.[4] But in certain assessments the environmental and conservational facts partially played off against one another, as the environment was cited as a basic requirement for preservation of monuments.

However, to show the active engagement of a community for the use of renewable energies, new well designed buildings are far more suitable, in which the innovative techniques are integrated into the design and technical planning. In addition, the total area rate of roofs on historic buildings or in direct connection with them is very low. The share of listed buildings in Germany in the total housing stock is estimated at just 2.8%. An electricity generation that goes beyond the own needs of each building is therefore not economically necessary and unacceptable with view on the heritage preservation. Generation via PV is furthermore not locally bound, thus a compromise would be larger systems on less sensitive buildings or less sensitive locations, such as factory halls or malls out of the visual field of monuments. Another solution offer regions and cities, like Nuremberg/Germany, with the establishment of a solar roof exchange. Potential solar investors lacking the suitable roof area are scheduled to meet roof owners without the necessary investment capital for a solar system.

The majority of our monuments are located in densely populated city centres. Gerhard Hausladen turns out in a study of the city Iphofen in Bavaria/Germany that the use of active solar energy depends on the intended power supply for the entire district.[5] Should this be done centrally, the expansion of individual solar thermal systems contradicts the efficiency of the network. However, a decentralized solution is desired, the installation of local solar thermal systems comes in consideration. To avoid the negative impact on the

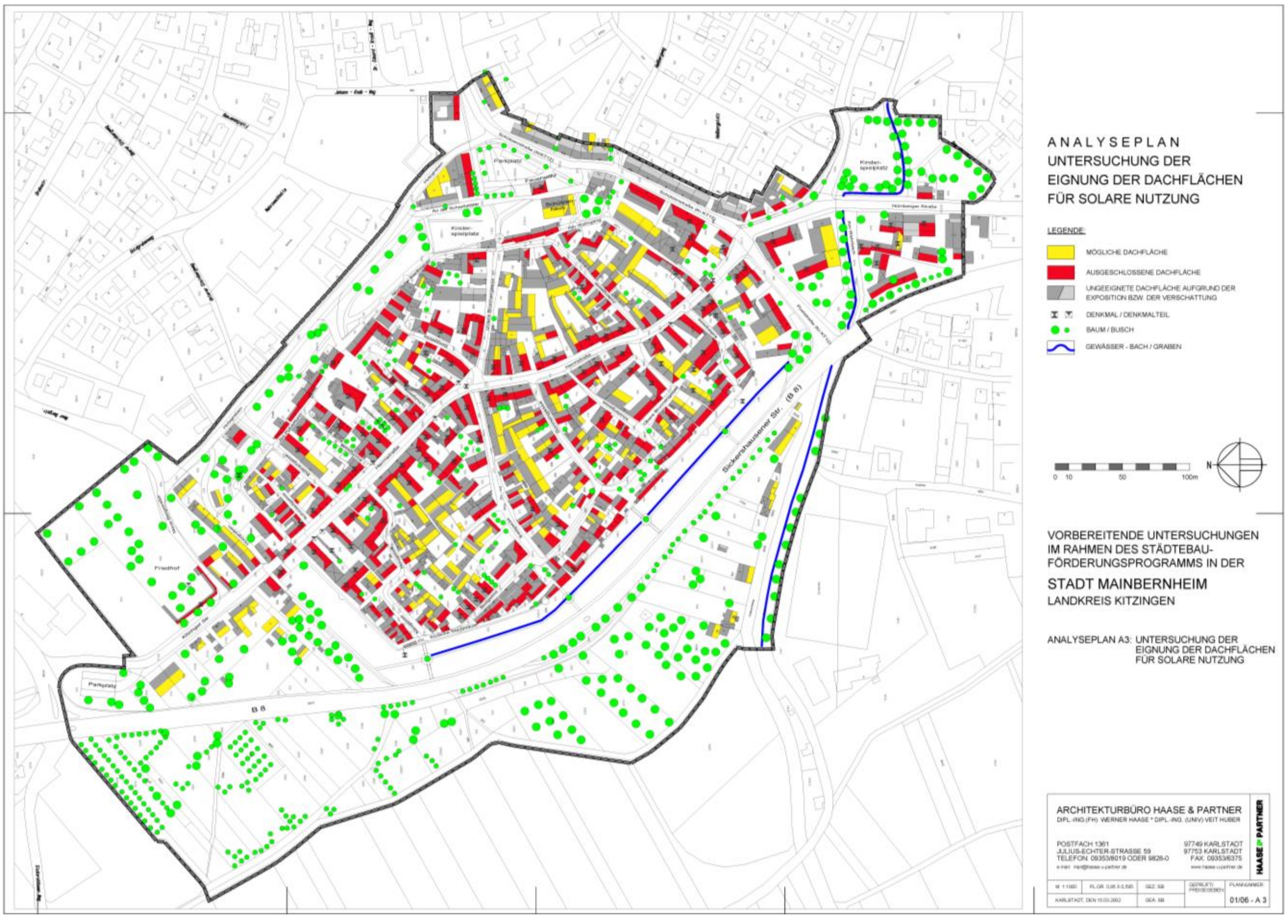

Figure 5: Mainbernheim, Bavaria/Germany. Analysing Map with registration of roof surfaces, which are suitable for solar use (Architekturbüro Haase&Partner, Karlstadt)

Figure 6: Kleinlangheim, Bavaria/Germany (Hans-Christof Haas, BLfD), The solar panels is almost not visible from the street. It was not installed at the main building but on an annex.

appearance it is supposed to install the equipment only in non-visible areas, as several municipalities have already written into their statutes. Thereby not only the visibility from the public space of the city as streets and squares are considered, but also – in particular for cities in the valley - the long-range effect of the surrounding hills. In order to facilitate early planning, some cities have created a so-called energy master plan which covers the suitable roofs. The first municipal solar statute in Europe was adopted in 2000 in Barcelona, but did not refer to the conservation aspect yet. The energy master plan of the city Mainbernheim in Bavaria/Germany for instance, takes this issue into consideration and thus shows the roof surfaces which fit on both: the orientation and the impact on building fabric and appearance.[6] (Figure 4) Considering additionally the small scaled roof surfaces in historic city neighbourhoods the profitability for the possible area of PV systems is further reduced. Therefor cities, like the World Heritage city of Bamberg in Bavaria/Germany provide owners and users of buildings in the historic centre the preferable participation in community solar installations. In Bamberg are several large-scale installations operated by the municipal utility, inter alia on a newly built swimming pool.

5. Regulations/guidelines

If there is a lack of local or regional regulations, there is often a veritable “proliferation” of solar and PV systems, which barely meets aesthetic and architectural design principles. If such systems, however, be attached directly to a listed building or one within a registered ensembles, the legal requirements as for any upcoming measure at the monument must be respected. The energy retrofit introduces new challenges for the conservators since several years. Various manuals and guidelines have therefore been developed as a guide for planners and decision makers. Particularly worth mentioning are the Saxon study and the guidelines of the BDA Austria, which also cover solar thermal systems.[7] The umbrella organization of conservators as well as the authorities of the Federal States in Germany published several guidelines which differ slightly.[8]**Error! Reference source not found.** Helpful for planning are the clear definition and description of historic buildings as well as the specification of the protection zones by the conservation authorities. As any decision is an individual case the planner has always to get in contact with the authorities in an early planning stage!

6. Integration of individual systems

If the participation in a common PV facility is not possible and other legal principles does not argue against the attachment of small solar systems an installation for the own energy and/or heat consumption can be considered. Thus usage restrictions of historic buildings can bypass and, as a result, the preservation of the monument can be encouraged. However, in order not to disturb the historic structure and appearance, sites should first be checked for adjoining or new buildings (eg carports). (Figure 6) Good examples are also available as balcony shelters or canopies. Sometimes even not observable garden space is suitable for

Figure 7: Thüngersheim, Bavaria/Germany (Hans-Christof Haas, BLfD) The small facility for the own requirement is not visible from the public area.

installation. Also, the reduction of facilities to a (non-visible) part of the roof area sometimes provides an alternative. (Figure 7) Always, however, architecturally and aesthetically demanding solutions should be found. Roof-top installations are therefore less suitable as integrated solutions, since the silhouettes and valuation of surfaces are changed. Good design solutions are available with individual plates or tiles, which can also record the structure of the roof surface. If the historic roof covering remained, instead, an exchange is of course not possible.

When installing the equipment it is important to put special emphasis on avoiding damage. This regards notably the damage of historic building fabric by the additional load, the lack of ventilation and the penetration with the fixing systems of the panels. With the use of solar systems there is a risk of leaks, which can lead to damage at roof trusses and ceilings of historic importance. Systems to ensure the accessibility in the case of fire must be guaranteed. Any necessary accompanying measures must also be coordinated with the legal conservation authorities.

7. Conclusion

The difficult situation in the integration of solar systems in historic buildings and ensembles requires a high degree of planning accuracy and individual adjustments. Besides the avoidance of local solar systems by urban instruments, there are also many opportunities for the integration into historic buildings. But since each monument is a particular case and must therefore be planned individually, standard solutions are not applicable. So the monument sector offers a field of activity for regional providers. And if the social support and legal basis in general promotes the building culture, this statement can expand from the listed building stock to historic buildings in a broader sense.

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BIPV solutions based on the amorphous silicon thin-film technology for singular buildings

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Abstract

The aim of this paper is to show the main characteristics, feasibility and performance profile of the main developments made by Soliker and their application as BIPV solutions for singular buildings, being among them those included in the historical context. These novel BIPV solutions are based on the amorphous silicon (a-Si) thin-film photovoltaic technology. The overall performance of this technology within the building environment together with the tuneable capabilities of the PV glass in terms of patterns, transparencies, colours and shapes enable the substitution of current passive building materials by active constructive elements using this technology and adding solar control, thermal and acoustic isolation and aesthetical properties. Some solutions developed for these purposes and for different building applications will be shown in this paper with especial focus on its suitability for the historical context with analyzed examples.

Keywords: BIPV, singular and historical buildings, amorphous silicon, thin-film technology, solar control.

1. Introduction

The European Council in different Directives and Communications emphasize the need to improve energy efficiency in the Union. The objective of reducing by 20 % the Union's energy consumption, improving by 20% the energy efficiency, contribution the renewable energy by 20% and reducing of overall green house gas emission by at least 20% below at 1990 level has to be achieved by 2020. EC calls for a thorough and rapid implementation of the priorities, specifically to [1-2]. Those actions identified the significant potential for cost-effective energy savings in the building sector. As a consequence, the introduction of renewable energy technologies, and in particular solar energy in the built environment, can be really useful and shall contribute significantly to comply with the EU policy.

In a general view, the conception of buildings as an energy consumer has changed into a unit system with a very high energy performance, with roofed construction and having active and passive walls, for which energy is used to condition the indoor climate. This conception leads to the nearly zero-energy building, which is the aim of the European energy efficiency legislation.

Given the long renovation cycle for existing buildings and their impact on long-term energy consumption, the ones subjected to major renovation should therefore meet minimum energy performance requirements adapted to the local climate. In the case of historical buildings, the renovation has to be careful enough to conservate the distinctive building elements, details and original aesthetic appearance, and to integrate harmoniously the new improved elements with low visual impact at the same time.

In Soliker we have worked within the 3ENCULT project to develop multifunctional solutions based on the a-Si thin-film technology to be integrated in the historical buildings in a friendly way, opening a new horizon in renovation of historical buildings, reducing the energy demand and ensuring a minimum compliance with modern sustainability and energy efficiency parameters.

2. Features of PV Glass based a-Si thin-film technology

BIPV stands for Building Integrated Photovoltaics, combining in a single element features such as electricity generation, thermal insulation, solar control and architectural design. As glass is the preferred material for manufacturing a PV device, so it is for a BIPV solution. The devices are manufactured by means of a Plasma Enhanced Chemical Vapour Deposition (PECVD) system. Silicon remains deposited in amorphous state (a-Si) over a glass substrate and then the back contact is deposited by using a Sputtering Magnetron system, resulting in a 1 μm-thick PV system. The interconnecting cuts done by laser ablation determine the voltage drop among the narrow and elongated cells and the cell area determines the current intensity.

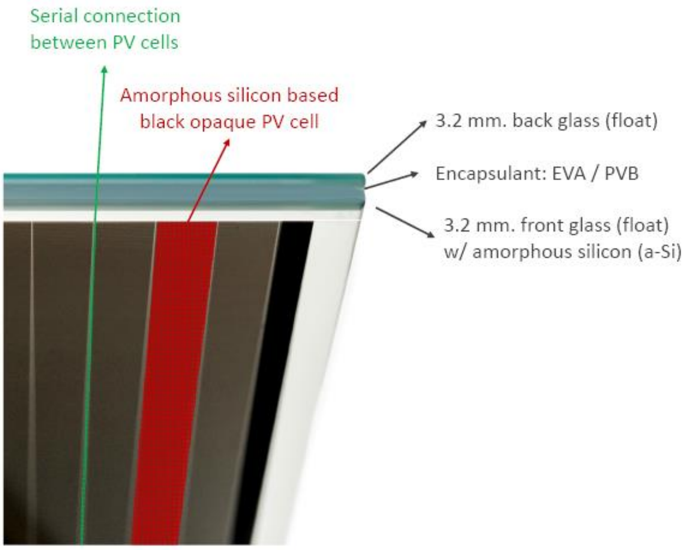


Figure 1: Standard module configuration.

The device is then glass-glass laminated with ethyl vinyl acetate (EVA) or polyvinyl butyral (PVB) in order to obtain encapsulation and durability (Figure 1). By laminating, also configuration for security and up to 5 m^2 big shape devices can be achieved. As silicon is an abundant and non-toxic material, it is much more environmentally attractive and can be used more extensively than other thin-film technologies, provided the especial and sensitive needs of the buildings in general and the historical buildings in particular.

In urban integration, other buildings or trees can shade partly one or more of these devices. The elongated design of the cells reduces this possibility compared to other PV silicon technologies. This means that this technology is very suitable where the obstacles are not avoidable [3]. Besides, the low intensity current (eight times less than crystalline silicon cells) of a-Si thin film technology avoid the “hot spot” effect when a whole (or a part of a) cell is shaded, so a-Si based BIPV devices cannot be damaged by this harmful effect.

The new processes developed at Soliker enable playing with a great number of possibilities. Different sizes, shapes, colours and even laser-patterned transparencies can be added to the PV generating character. Our glass technology workshop can provide glasses with special features for applications where thermal isolation is required or to comply with security requirements. As a whole, solar control characteristics can be achieved with our PV glass solutions for BIPV applications. These tailor-made solutions are suitable to be used either in its opaque version in ventilated façades, semitransparent for solar control in double skins and curtain walls and even with different cell pattern enhancing the inhabitant comfort.

2.1 Electricity generation

Regarding the electric energy production, the a-Si thin-film PV glasses have several advantages compared to other technologies when using them in the building environment, where orientation, shadows and ventilation of the glasses are not the optimal. For example, due to the higher energy gap, the spectral response is higher for blue wavelengths and lower for red wavelengths compared to other technologies. So, a-Si thin-film technology matches better the spectral distribution of the outside illumination, with higher contribution of the blue ambience illumination during midday and spring to fall seasons, when the highest intensities of the irradiation are also reached.

When thinking of a PV glass as the building envelope, the next thing which comes to the mind is the high temperature it can reach, especially in opaque ventilated façades. It is known that the overall performance of PV devices is reduced as the temperature is increased. But whereas for crystalline silicon the reduction of power is -0.4 % / K, the power factor for amorphous silicon is just -0,1 % / K at the typical operational outdoor envelope temperature of 60 ºC [4]. Even positive power factor of 0.13 % / K has been reported at low irradiances [5]. Moreover, the energy needed for producing a-Si PV glass is lower than in other technologies.

This different behaviour in temperature, better behaviour against deep shadows and the feasibility in solar control lead to a better performance in comparison to other technologies with higher powers. The final annual energy count is proven to overcome the tough outdoors applications of the building environment by extracting more energy and having a higher rate of energy per peak power than for crystalline silicon [6].

2.2 PV Glass: Cell patterning.

The a-Si thin-film technology enables the manufacture of PV devices with semitransparencies by using the selective laser ablation of the active material. Mostly inspired in the adjustable area selection (10, 20, 30, 40%) for obtaining uniform transparencies described by Ricaud et al in 1991 [7], different, modern and architecturally attractive patterns have been designed at Soliker (Figure 2). Cell patterns have to be properly balanced in order to avoid current mismatches among cells and the glasses are laminated with PVB and tested in order to ensure mechanical resistance against thermal gradients.

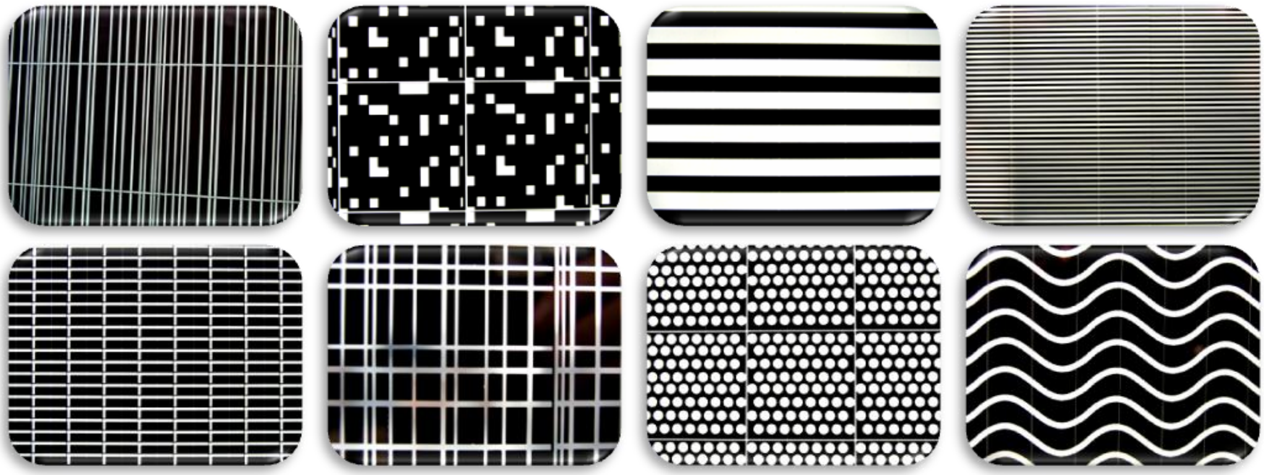


Figure 2: Example of cell patterning (the elongated PV cells are visible only at very close distances).

Obviously, the efficiency of the PV device is linearly reduced as the transparent area increases, but at the same time other functionalities appear, such as solar control and aesthetics, while still generating energy.

The solar factor has been measured at Tecnalia and behaves linearly with the patterned transparency, ranging from 22% for 0% transparency (opaque) to 46% for 40% transparency area. The power dependence with the voltage for different irradiances can be seen in Figure 3 for a patterned glass in real building conditions, far from STC. The high temperature effect can be noted in the reduction of the voltage at the maximum irradiance.

I (W/m_2)	1000
FF	0.682
Rsh (Ω)	6.973
Rs (Ω)	777
Voc (V)	61.31
Isc (A)	0.959
Wpmp (W)	40.119

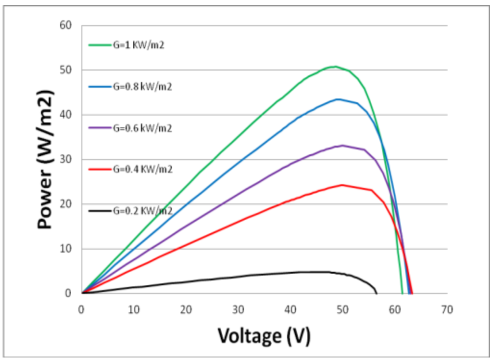


Figure 3: semitransparent PV glass, main technical characteristics, with P-V chart for different irradiances..

In applications where the solar control is important, such as curtain wall, double skins (Figure 4), skylights and atria, the possibility of patterning a desired cell is an advantage with a low-cost process of laser scribing. This process enables not only to play with the aesthetic appearance but also the effect created inside the building spaces. The transparency degree can be different depending on the shadows projected over the building by other surrounding buildings, depending on the orientation of the façade and even the location of the building. An in-site study has to be accomplished to tailor the adequate transparency degree with the purpose of enhancing the inhabitant comfort and also depending on the usage of the building (i.e. offices with before noon usage, dwellings, schools…). Moreover, where glasses must comply with safety regulations, an extra security lamination is applied.

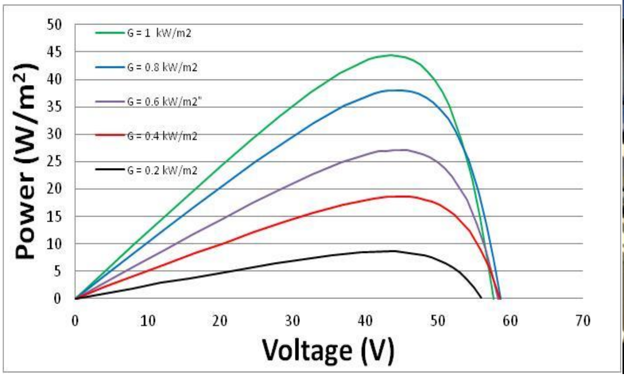
Figure 4: Left and center: Double skin with semitransparent PV glasses with security profile. Right: Atrium.

In Figure 4 left the Centre for Genomics and Oncological research (GENyO) in Granada is shown. The view through the skin is perfectly clear and recognizable while avoiding glare problems (Figure 4 centre). The installed power of the 20% semitransparent PV glasses is 15 825 W_p covering 527 m^2 and producing about 31 800 kWh/year. In Figure 4 right, the XVI-th century town hall in Alzira (Alicante), a listed building in Spain with number RI-51-0000355 also became active as the main yard was covered by 115 m^2 of 10% semitransparent PV glass, with an installed power of about 5 kW_p and producing about 6 000 kWh/year, so saving more than 5 Tm of CO_2.

2.3 PV Glass: Colours and shapes.

As commented previously, shapes, colours and sizes can be customized in order to comply with the requirements as a constructive element. Novel shapes with architectural interest can be done by cutting the glass and therefore adapting to the constructive element to be substituted. Sizes can be achieved by electrically connecting and laminating together several standard PV sizes up to 5 m^2. Coloured PV glasses can be obtained by following two routes. The first one implies using the patterns to obtain a certain semitransparency degree. Then the colour is given at the lamination process by using a coloured PVB (Figure 5) which at the same time improves mechanical resistance at the cost of a slightly higher temperature effect due to a bit higher opacity compared to patterned PV glass with same transparency degree but keeping the same dependence with voltage and irradiance (Figure 6 left).

Figure 5: Colours and shapes for 20% semitransparent PV devices.



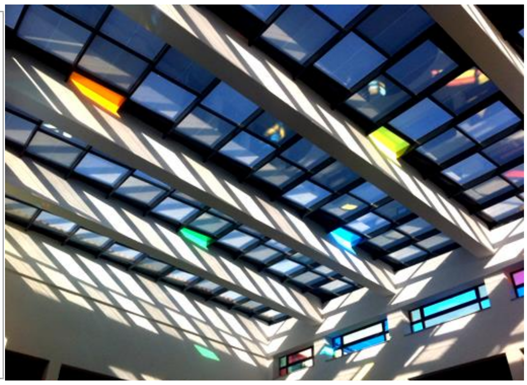


Figura 6: Left: P-V chart for different irradiances. Right: Historical market in Béjar, Spain.

The second way of getting coloured PV glasses is by controlling the thickness of the a-Si deposit in the PECVD process. By decreasing the thickness of the active material, the opaque PV deposit starts to be translucent, enabling absorption of certain wavelengths of the light and letting other wavelengths to pass. This process enables colours ranging from black (opaque), red, orange and yellow as the thickness decreases.

Atria are the most common use of PV glass with transparency degree. In Figure 6 right, an historical market in Béjar changed the rooftop for an active PV cover with transparency degrees ranging from 10% to 30%, some of them with colour, covering a total surface of 270 m^2. The installed power is 6.75 kW$_p$ and it produces about 8 700 kWh/year, saving about 6 Tm of CO_2.

2.4 Double-glazed semitransparent PV glass.

Single laminated units or glass-glass lamination, as the ones shown until now, can be improved in order to create a constructive element with thermal isolation properties by creating an air chamber between the semitransparent PV device and a back glass (Figure 7). The back glass, the thickness of the chamber and the gas contained can be changed and tailored according to the the U values required while additional solar control features can be incorporated by using different back glasses i.e. with filters for certain wavelengths, tinted glass, low emissive, etc. The U-value can be as low as 1.2 W/(m^2 K) and a solar factor as low as 10%. The double-glazed PV glass shown in Figure 7 comprises a 3 mm 20% transparent PV glass laminated with another 3 mm glass, 12 mm air chamber and a 4 mm low emissive back glass. The solar factor is 18% and the U-value is 1.6 W/(m^2 K)

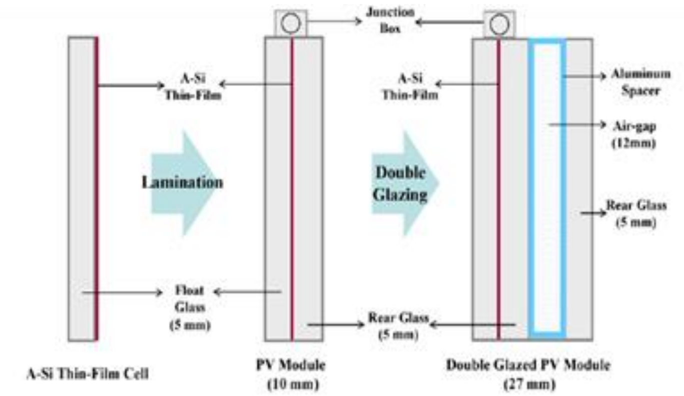


Figure 7: Double-glazed semitransparent PV glass. Left: schematic. Right: commercial device.

As it was previously stated, the effect of the temperature in the power factor for a-Si is the lowest of all technologies, showing a small reduction of power (Figure 8 left) and enabling double-glazed PV solutions have thermal isolation and energy generation capabilities at the same time.

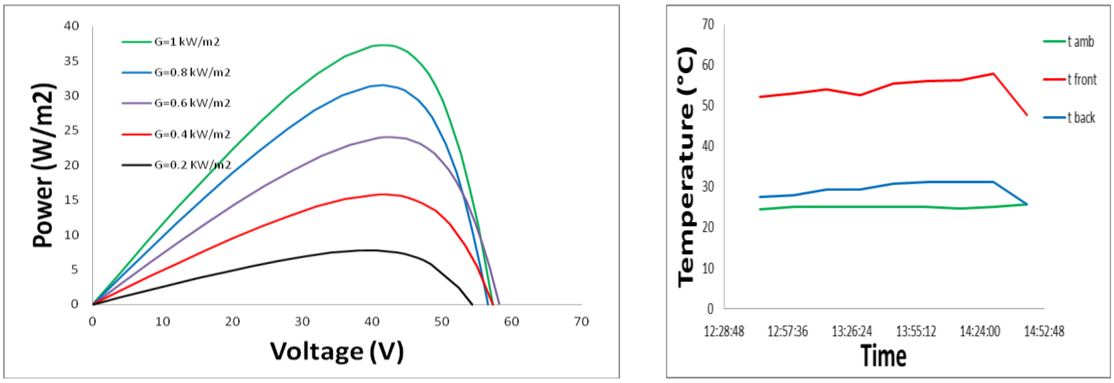


Figura 8. P-V chart (left). Temperatures of front and back glasses (right).

Also suitable for atria, double-glazed PV glass must be used for windows and curtain-walls also to reduce temperature of the inner glass (Figure 8 right), avoiding hazard and to create a friendly and comfortable interior environment. Double-glazed units equipped with the proper back glass can achieve also acoustic isolation and inhabitants can be prevented from glare at the same time (Figure 9). In this example for the Polos office building in Calatayud (Zaragoza), the installed power is 6.5 kW_p with 10% transparency, facing south and covering 95 m^2. They produce about 6 700 kWh/year, saving about 4.5 Tm of CO_2.

Figure 9: Double-glazed PV glass with filter properties for solar control and acoustic isolation.

3. Conclusions

Different PV solutions based on the a-Si thin film technology for singular buildings combining in a single element features such as electricity generation, thermal insulation, solar control, acoustic isolation and architectural design have been developed at Soliker.

The variety of possibilities that can be achieved with this technology enable a better integration in singular buildings, such as the historical ones, due to its architectural attractive, leaving a technological footprint in the buildings, in line with the refurbishment trends for historical buildings, as well as reducing the energy demand in line with the EU policy. Moreover, these novel properties can enhance the user perception in the spaces inside the building.

Due to the extreme and tough outdoor conditions of the building environment such as high temperatures and deep shadows the most suitable PV technology to be used is the amorphous silicon thin-film technology, with a lower temperature factor for power compared to other technologies. The final energy count is proven to be better than other technologies.

Attractive patterns enabled by the transparency process while at the same time generating energy have been done by laser ablation, obtaining semitransparencies ranging from 10% to 40%. The increase in semitransparency degree implies a reduction of efficiency, while obtaining other features such as solar control, user comfort and architectural acceptance.

Colours and shapes with architectural interest can be added in order to cover flat or warped surfaces. Atria, double skins, canopies, pergolas, ventilated façades can be benefited by using semitransparent PV glass, which can comply with the security requirements of the façades by the proper lamination. Two atria in two historical markets (Béjar and Alzira) were shown with interesting figures on energy generation and confirming the integration possibilities of this technology in the especial environment of the historical building. A double skin in a singular building (GENyO) proves the architectural attractive of the semitransparencies and the solar control features while all façades generate energy.

Double-glazed PV glasses with semitransparency add the thermal and acoustic isolation required to be used as curtain-walls and windows as in the example shown, while reducing the energy demand of the building. The usual problems of overheating, glare and heat loads can be overcome. The part of the energy absorbed for producing electric energy is not transferred to the interior and the air chamber breaks thermal bridges. The U-value can be as low as 1.2 W/(m2 K) and a solar factor as low as 10%.

Acknowledgements

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SOLAR LIGHTING SOLUTIONS IN HISTORIC BUILDINGS

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Abstract

Any historic building will be kept for future generations only if adequate and comfortable utilization is provided. Otherwise they will turn abandoned and will wait their break down. The starting point of any daylight intervention is the measurement of the current situation. The diversity in daylight exploitation potential is vast in historic buildings. On the one hand, buildings with mediaeval walls and small windows represent the lowest potential of exploitation. On the other hand, glass & metal architecture in some regions of Europe is representing the contrary extreme of the exploitable potential. Concluding, there are listed buildings with a severe lack of daylight while others suffer from overheating in summer and accelerated surface deterioration caused by the immense daylight/solar energy input.

The foreseen usage of the building defines requirements for daylighting solutions. Assessed daylighting devices help to define the needed improvements in new developments. Finally, an intelligent daylighting solution solves the inconsistent requirements: providing a scenery of maximum - task related - visual comfort, reducing the demand of artificial lighting, slowing down deterioration and controlling solar gains in winter and summer times.

This report explains measurement and assessment methods and shows some specific solutions to improve daylighting.

Keywords: daylight, solar gains, assessment, conservation, deterioration, visual comfort

1. Introduction

Daylight is changing throughout the day and year in its intensity, its spectral power distribution and its direction dependent on time, location and climate (e.g. strong parallel beam with clear sky, scattered skylight without sun from cloudy sky). Architects of all centuries already used this variety for staging the building and its interior. Recent worldwide efforts to decrease the energy consumption of buildings (key word: nearly zero energy buildings) put daylight back into main focus. Beyond the energetic issues, the psychological, physiological and biological benefits for the occupants are of the same importance [4]. The complex and variable behaviour of daylight is essential for its visual and biological impact on humans and its physical/chemical impact on materials.

The most important psychological effect is the connection to the outside, which is needed to be informed about the daytime and the weather. Other effects are improved motivation and mood, higher driving force, lower fatigue, reduced eyestrain etc. [5]. Physiological and biological effects are important to maintain health and well-being.

Next to the physiological and psychological effect, daylight is responsible for deterioration of materials and surfaces.

2. Measurement

The current illumination concept of the building is evaluated by qualitative and quantitative means. An overall - written - description of the room by an expert is recommended. The quantitative data is acquired by technical devices as luminance-, lux meter and a luminance camera. If the future utilization of the building is known the measurement might focus on key aspects for this utilization. Otherwise the measurement must cover all possible and necessary data. In this case the representative rooms (dimensions, occupant number, window area, luminaire position, etc.) are investigated and documented (geometry, roughness, flatness, surface, orientation). Natural and artificial light sources (lamp, type, controller, etc.), characteristics of internal surfaces (e.g. flatness in figure 1, reflectance in figure 2), frequency of maintenance and photos of the interesting room are collected in the measurement log.

Figure 1: Documentation of room envelope, her: walls are not completely flat (view to the ceiling)

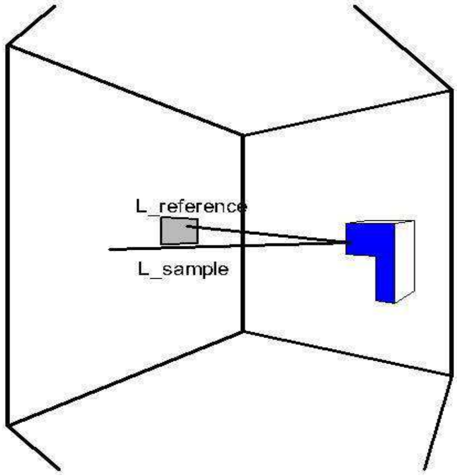
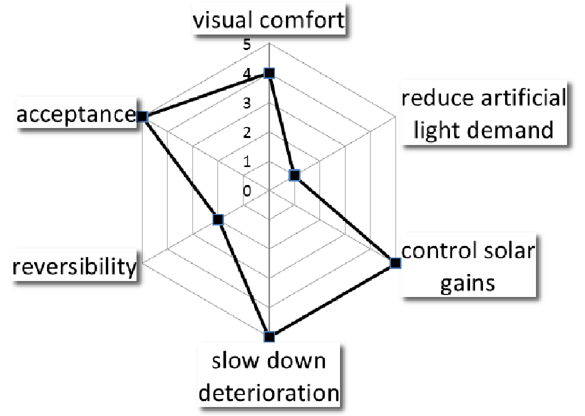


Figure 2: Acquisition of reflectance of surfaces by a reference material with well-known reflectance.

Then a measurement grid is defined for determining punctual illuminance levels (e.g. daylight factor as ratio between internal illuminance and outside unobstructed horizontal illuminance.) samples with a lux meter, while simultaneously logging the outside unobstructed horizontal illuminance. Daylight factors give a hint of the available daylight supply in the room, but as they are measured in a grid there is an inherent lack of information generated. This insufficiency is solved by taking luminance pictures and estimating - with known reflectance - illuminance distributions (for diffuse materials: $E = L \cdot \pi \div \rho$). Additionally, thermal data for the building is collected or continuously monitored for a certain period to gather information about the energy flows into and out of the building. The surrounding scenery (buildings/landscape) is captured via fish-eye pictures or obstruction diagrams.
All data are interpreted together with the building owner (and monument conservator), then multidisciplinary requirements are defined.

3. System Requirements and assessment

As already mentioned an intelligent daylighting solution in historic buildings solves inconsistent requirements: (i) provide task related visual comfort, (ii) reduce the demand of artificial lighting, (iii) control solar gains in winter and summer times, (iv) slow down deterioration (v) be reversible and (vi) be accepted by conservational authorities.



importance		rate
3	visual comfort	4
2	reduce demand art. Light	1
1	control solar gains	5
5	slow down deterioration	5
5	reversibility	2
5	acceptance is in doubt	5
Total	$\sum_{k=1}^{6} \text{importance}_i \cdot \text{rate}_i$	**79**

Figure 3: Result of an assessment procedure with weighing factors for different requirements. The total number is needed for quantitatively comparing different existing solutions.

The prioritization of all the categories in figure 3 must be discussed with all contributing experts:

The conservational authorities decide if a solution is acceptable or not. Therefor the weighing factor (i.e. importance) of the acceptance is generally at maximum level, except the level of restriction is not very high. Reversibility is in some cases of highest importance, even if this means that any intervention is therefore impossible and the planned utilization is not feasible. This blocking situation must be solved by resuming discussions and probably creating an alternative concept of utilization.
Deterioration is caused by electromagnetic radiation (figure 4) and is generally modelled according to [2] and figure 5. The model assumes that higher photon energy causes more damage and a material – exposed to an illumination solution – undergoes a distinguishable change in colour after a specific time. This time is then characteristic for the lighting solution. Depending on the used materials and their age the weighing factor of this category might be low or high.

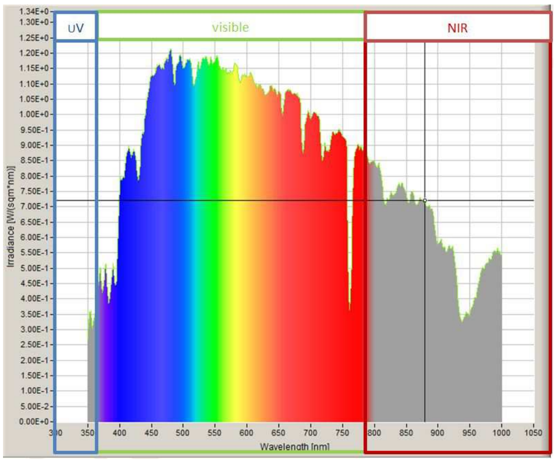


Figure 4: An exemplary daylight spectrum (ultraviolet, visible and infrared)

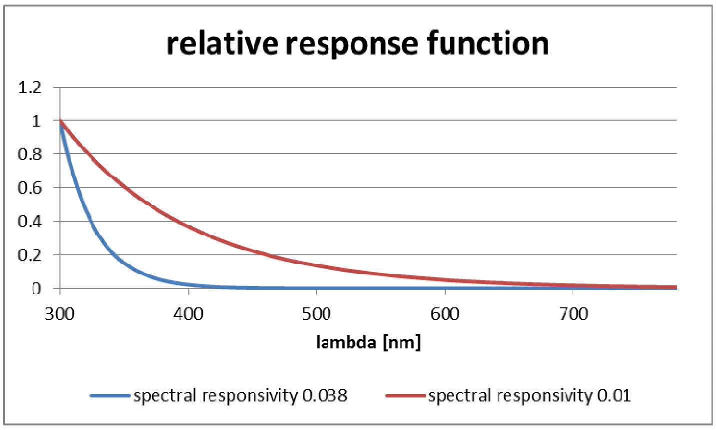


Figure 5: Models of damage potential as function of wavelength in [2]. Sensitivity of different materials (e.g. Canvas and newspaper).

The transparent partitions of the façade define the energetic behaviour of the building (e.g. cooling or heating dominated). An intelligent daylight solution is able to shift the energy loads (no/little cooling resp. no/little heating). Both, the local climate and the type of construction define the level of importance, which is given to this category.
The demand of electricity is reduced if the daylight system is able to redirect daylight into the building/room even in sun shading or glare-protection operation. The use of the building and the potential of daylight exploitation define if the daylighting solution must be capable of daylight redirection (i.e. if this category's importance is maximum or moderate).
Visual comfort is achieved for example, if the illumination scene provides an adequate luminance distribution for any task environment, as e.g. writing, typing, reading in a 'working environment', viewing videos/paintings in an 'exhibition environment' or relaxation/comforting in a 'residential environment' [1]. Spectral modulations of daylight when penetrating the daylighting solution is affecting visual comfort (e.g. colour rendering). Lighting experts in the design team will stress the importance of this category depending on the planned utilization.

4. Hands-on examples

Following the assessment (figure 3) of existing solutions their deficits trigger new developments or adapted applications.
In an Austrian school that was built in 1930s daylight utilization, reversibility and visual comfort were given highest importance. The installed box type windows were not replaced but their frames were reinforced and new glazings were installed. The geometry of the cavity (figure 6, out of [6]) recommended including a daylighting device by

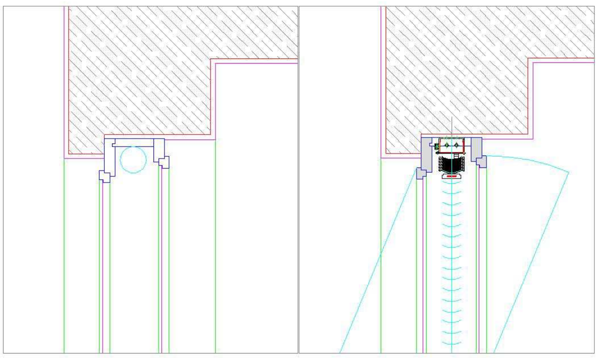


Figure 6: The boxtype window in a listed Austrian building presented the chance to include the package of a daylight redirecting lamella system by milling a casement into the top board.

milling the top wooden board. Different lamella systems were analysed regarding their integrability (figure 6) and their daylighting performance. The best performing highly specular system was recommended to the building owner and was accepted by the conservational authority, although the specular lamellas alter the appearance of the building – viewed from outside - when in sun shading position. The multidisciplinary design approach resulted in an integral lighting control system that combines day- and artificial light energy efficiently [7,8].

In case that deterioration is considered to be of singular highest importance the application of UV protecting films is analysed. Filters stop the transmission of unnecessary wavelengths, but do consequently reduce daylight availability within the building. This trade-off between deterioration protection and daylighting has to be discussed in the multidisciplinary group of all experts, building users and owners. Many UV filters can be modelled as step-functions with an edge around 350 – 380nm. There is one advertised filter which edge is defined at a wavelength of 400nm (figure 7). At this wavelength the response function of the human visual system is very close to zero. So the energy between 370 – 400nm does generally cause fading but does not contribute to visual perception a lot (except phosphorized or fluorescent pigments are used). The durability of applied films is often in doubt but solutions within laminated glazing promise indeed long lifetime.

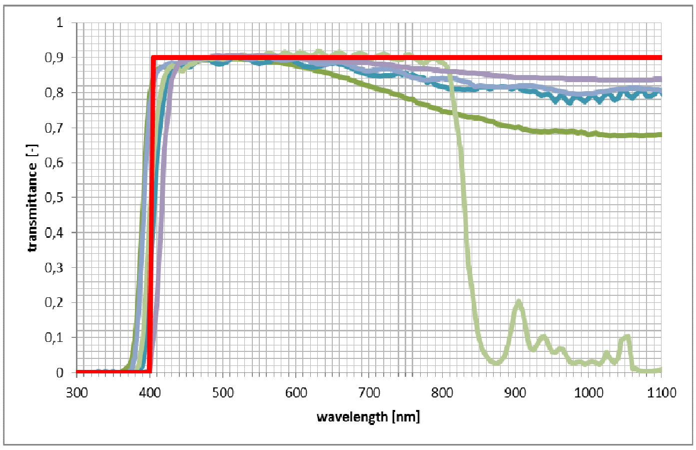


Figure 7: Different filters and a fictive step-filter(400nm).

In central-south Europe many listed building us shutters as shown in figure 8 outside of the building. As encountered in a medieval Italian building solar control, reversibility and acceptance are of highest weight. In this case the request to use daylight triggered the idea to partially use some of the boards (shutter in figure 8), reshape and use them to redirect daylight [3]. Additionally unused chimneys give the visionary chance to bring daylight - captured at the roof - into the building (figure 9, out of [3]).


Figure 8: shutter system in many southern European buildings.

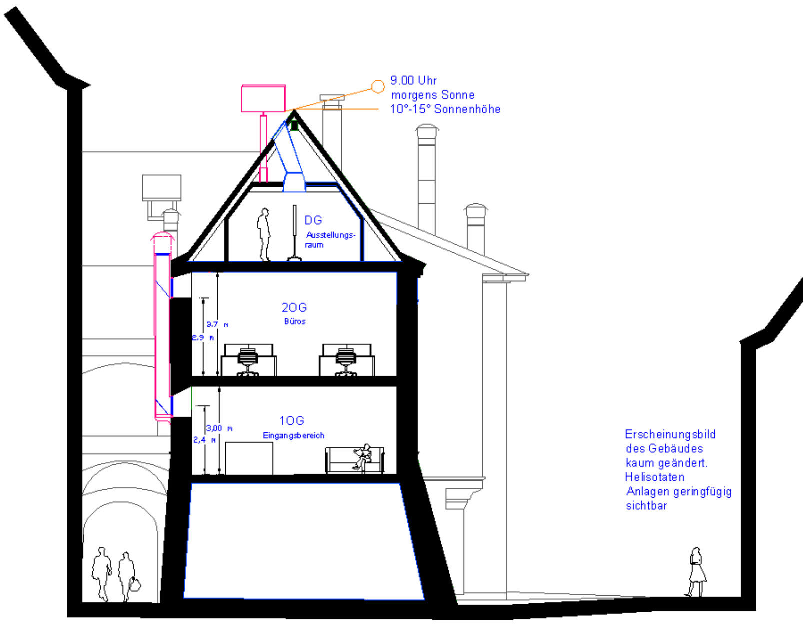


Figure 9: Heliostat system used in historic buildings.

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SEVENTH FRAMEWORK PROGRAMME

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Solar Energy Integration – Challenge and Chance for Conservation Architects

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Keywords: Historical buildings, Energy performance, Solar energy integration, Renewal energy supply

Abstract

Governments are committed for decreasing greenhouse gases emissions to accomplish with the global world set targets and towards NZEB, Net Zero Energy Buildings. Since new construction in Europe amounts only a small percentage of the total building stock, emissions from existing buildings cannot be ignored and it need to be reduced. Historic buildings, located in inner cities can also have room for some energy improvements, even across compliance with some modern standards and new construction techniques without damaging their main valuable architectural features. However, to meet these energy requirements it is necessary to promote the use of solar energy also on existing buildings, with or without particular historical values. This matter should thus become a top priority for mid-term future but today it is still not being properly exploited because of psycho-social barriers and lack of information.

This paper presents some experience and the lesson learnt from different research projects carried out in Switzerland by the Institute for Applied Sustainability to the Built Environment (ISAAC) to promote energy efficiency and regulate the use of solar energy system, such as PV, solar thermal and solar passive systems, on historical buildings. These research projects have enabled ISAAC to establish specific measures to integrate properly these solar systems with the collaboration and special contribution of different and same time divergent field experts.

1 Understand & Respect the existing

Replacing an existing building with new ones requires a considerable investment of 'embodied' energy in materials, transport and construction. The balance of advantage strongly favours the renovation of existing building stock, particularly when the energy consumption of the building can be drastically reduced. Particular cases are the protected heritage buildings.

Cultural heritage items are fragile and can be compromised easily and irreparably unless they have been studied meticulously and fully understood prior to any internal/external changes altering the stratifications and balances that have been established over the course of time. With the aim to preserve and protect this kind of buildings as pointed in Article 4 of the new Recast of the Energy Performance of Buildings Directive [1], when setting of minimum energy performance requirements, Governments can opt to omit the following categories: *"buildings and monuments officially protected as part of a designated environment or because of their special architectural or historic merit, but only where* compliance *with the requirements would unacceptably alter their character or appearance"*

But at the same time, different European and national [2, 3] projects demonstrate and already proposed innovative approaches to raise energy efficiency through the refurbishment of the building stock. These energy improvements are desirable but cannot always be implemented in such a way as to reach the highest standards. Alterations are often impossible without unacceptable damage to the historic fabric or cultural record, or the creation of new uncertain construction risks but opportunities for energy saving should be achieved. The quality of a conservation and renovation project for a historical building depends on the capacity to reach a compromise between the many, and often divergent, requirements of current legislation on static safety, accessibility, levels of environmental hygiene and energy savings, set against the architectural and material features of buildings designed and constructed in accordance with other criteria.

1.1 Intended use of historical buildings: analysis of the requirements and needs

A good renovation project must also ensure an acceptable level of comfort for people and artworks. The environmental qualities of historical architecture, the bio-climatic aspects and benefit from solar passive strategies and the climatic qualities of the site can be an important starting point for an energy refurbishment project aimed at facilitating energy savings in a building. These buildings are usually characterized by a high energy demand and major thermal dispersion but furthermore, are more thermally stable due to its higher thermal inertia. In the case of historical buildings we must try to understand how to ensure a sufficient level of environmental quality, transferring some environmental regulation functions to the building itself with the possibility of achieving passive control over the microclimatic parameters. Passive energy solutions contribute significantly to improve the energy efficiency of the building without invasive and intrusive intervention. These solutions represents an opportunity for reconsidering "tradition", by adopting an analytic and critical outlook of the capacity expressed by the historical building in solving the microclimatic problems.

In effect, the objective of a historical building energy adaptation project is to improve the levels of comfort and to reduce the energy consumption required for heating, lighting and other purposes. Another important aspect when considering energy savings, it will also be advisable to evaluate the contribution of renewable energy sources. Integrating these resources into existing structures is a challenge that cannot be ignore nowadays.

1.2 The widespread contribution of renewable energies in historical context

When renovation works affects structural safety, fire safeties, and access for disabled people, are normally accepted by everybody because these measures improve the human comfort. Furthermore, technologies that are highly visible today, such as aerials, lightning rods and other technological equipment, which have been integrated into building coverings because they are considered as "necessary", have now become generally accepted due to their importance.

Nowadays solar technologies available on the market have been specifically designed and adapted for this type of integration, while also reducing the impact on the buildings. Such devices include for example photovoltaic roof tiles, thermal collectors for hot water production, lighting elements, transparent and coloured elements. In any case, materials are being developed and in the future there might be new forms and elements that can be integrated appropriately, and with reduced visual impact, even into buildings of architectural value. It is also very important that the designer understands the diverse qualities and the unique features of each photovoltaic element, in terms of both performance and aesthetics, in order to increase the number of potential choices and solutions. Even though the situation may become slightly problematic when the thermal solar collectors and / or photovoltaic panels must to be installed, integrating renewable technologies into an urban context, or into existing buildings, can improve the architectural and technical quality of the building, in terms of economic and environmental sustainability. Good examples to be replicated are a big chance for the promotion of solar energy resources [4].

2 Develop high quality architectural solutions

Swiss federal energy policies emphasise the importance of incrementing the supply of energy from renewable resources, while also reducing the energy demand in consumption sectors, with specific focus on the construction sector. These objectives have become much more relevant since the 2011 Fukushima nuclear station accident, after which principles were defined for a new "2050 energy strategy". The Institute for Applied Sustainability to the Built Environment (ISAAC), part of SUPSI, the University of applied sciences and arts of Southern Switzerland, received several mandates both from the federal office of Energy (BFE) and from the Association for the Heritage Building, to carry out different researches in order to promote and regulate the use of solar energy system, on historical buildings and in particular landscapes.

The experience matured at the Swiss Centre of Competence for BIPV starts from understanding if solar systems have a direct impact upon the performance, design, form and shape of a building.

The final result, both in terms of cultural heritage preservation and energy efficiency, was due to the willingness to compromise and to the technical know-how demonstrated by all the players involved in the different research projects. An early dialogue between the building control and the conservation officers in the local planning authority is needed and all the actors involved in a renovation project (architects, renovation experts, owners, technicians, protection officers) must therefore carefully consider the new technological developments, and understand how they can be introduced and integrated into existing buildings. Targeted aspects must to be considered when redeveloping existing historical buildings:

Urban Scale	↔	**Building Scale**	↔	**Building Energy System**
Urban planning	↔	**Aesthetic and Technical issues**	↔	**Global Energy methodology**

Usually most of the historical buildings that were built between the 19th and the beginning of the 20th centuries lie in old city centres, characterized by dense and compact **urban scale** settlements that compromise the proper solar access. In this situation, **urban planning** significantly determines the possibility to relish solar irradiation in buildings. Solar energy exploitation on existing buildings (in particular historical buildings) could be compromised during urban transformation. To maximize exploitation of the solar energy resources in urban zones it is necessary to ensure its acceptance on an upper level assuring both building and urban context needs. To prevent an arbitrary use of solar energy technology, it is necessary to assess the solar potential (solar photovoltaics, thermal collectors and direct and indirect passive solar systems) and availability for a building in relation with its immediate environment and with its constructive and typological features.

In densely built-up areas it is important to consider factors such as the buildings' geometry and height, the materials and colours, as well as the size and morphology of the streets, as these factors affect the absorption and reflection of solar radiation. In the same way urban shape also depends on the specific conditions of the local place and the climate. In the research project *UiSOL, Urban Integrated PhotoVoltaics* [5], in collaboration with HES-SO (Friburg, CH) and Accademia di Architettura di Mendrisio the solar potential in urban environment has been studied by calculating the solar and daylight availability in an urban area, composed of several multi-storey residential building near Lugano. This strategy has proven to be a useful tool for architects and renovation experts to locate active or passive solar systems, to guide choices and investments in the energy and urban planning fields allowing the elaboration of a repeatable procedure of analyses.

To shift the detail at a **building scale**, but always linked to the urban environment, with the aim of identify various solar systems integrative possibilities in sensitive environments, it is necessary to examine the existing architectonical situation, by analysing the distinctive elements of the surroundings, the building and the solar technology to be considered. Generate an inventory of the buildings typology it will be useful to highlight the main factors for overcoming the hurdles that often limit solar integration. The existing housing stock is a repertory of very heterogeneous constructions which not only have to fulfil different needs but can also be identified according to building techniques, the year of construction, the materials used, and the representative status and, by the architecture. Within the SURHIB research project - Sustainable Renovation of Historical Buildings [6], with the aim of develop, test and promote solutions for the sustainable renovation of non-protected historical buildings, guidelines have been draw up for the proper integration of solar installations in historical town centres in Ticino. The procedure was then applied to a particular case study, the historical core of Bellinzona –TI-CH.

In this instance it was verified that **aesthetic and technical issues** are important for improve solar systems acceptance by the inhabitants, tourists, architects, planners and representatives of monument protection authorities. As an example, to enhance the architectural quality of solar systems -solar thermal (ST) collectors and/or the photovoltaic (PV) modules- by defining, first of all, the formal constraints that negatively affect the installation in order to identify appropriate solutions, six objective criteria, focusing on shape and emplacement of the solar panels, were define in SURHIB project: 1) *Co-planarity,* with the building surface*;* 2) *Respect of the lines;* 3) *Shape,* compliance with the proportions to avoid random solar installation*;* 4) *Grouping,* for better integration*;* 5) *Accuracy* of connecting elements; 6) *Visibility,* from other building or from the streets. In addition, five recommendations deal with more subjective aspects such as the visual characteristics of the installations were been suggested: a) *Cover the construction surface*; b) *Multi-functionality*; c) *Application*; d) *Aesthetics*; e) *Sizing*. These recommendations were consequently conceived as a set of suggestions which can be helpful, but are not mandatory, when approaching the design and the installation of a solar plant. This research serves to elaborate guidelines for the public institutions of Canton Ticino: "Solar panels in historic centres. *"Installation criteria and landscape evaluation".*

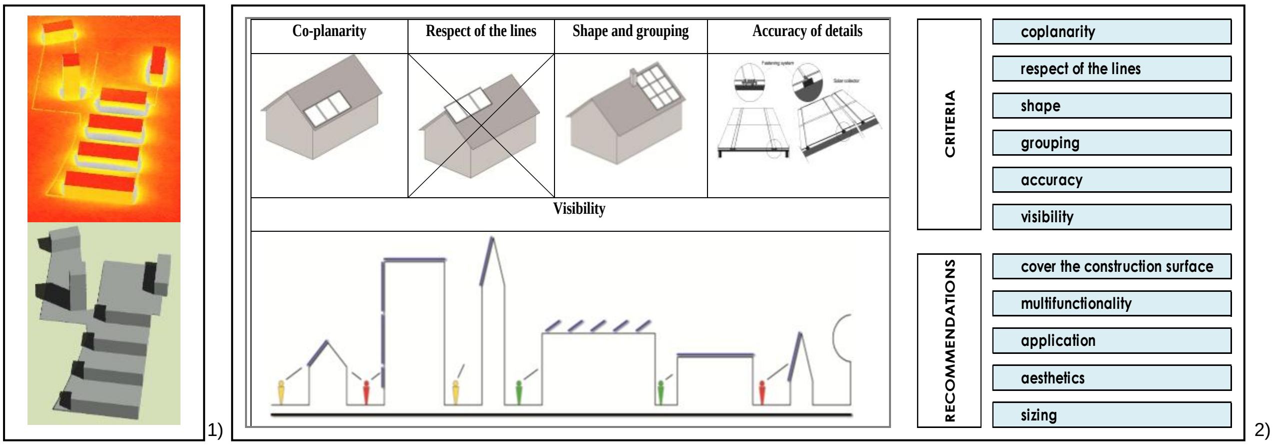

Figure 1: 1) iPPF tool developed at the University of Applied Sciences of Western Switzerland used in UiSOL research project allows to assess the potential for different solar techniques; 2) Criteria and recommendations set out in the research project SURIHB.

Moreover, when considering the energetically and environmental upgrading of a protected heritage building all **building energy system (i.e. HVAC system)** must also be considered. The technical equipment in a historical building are almost always part of the architectural heritage them self. These systems provide unique evidence of historical developments and of the construction techniques then in use and that can often still be used, although with some appropriate supplementary elements or adjustments. Unfortunately often in a building renovation process the final expectations in terms of aesthetics and regarding the expected levels of comfort, and maximum energy savings will not be achieved. Reducing the energy consumption of historic buildings using fossil fuels is a hard work and often it is not economically justifiable; for this reason a possibility would be integrating new solar technologies in the building itself to contribute to the energy production.

During EnBau, Energie und Baudenkmal research project [7], focused on energy conservation practices on Heritage Buildings, three tangible cases studies settled in Switzerland have been analysed, in order to define a series of solutions aimed mainly at improving the energy features of the buildings and the level of comfort inside. All the energy efficiency improvement measures by renovation/restoration or rehabilitation of these particular buildings that have been studied are focuses at maintaining and protecting the original architectural features reinforcing the historic character and increasing property values while avoiding degradation. Such this difficult task entails the involvement of an inter-disciplinary work group and the methodological approach developed to evaluate each improvement solution with specific objectives and requirements had been considered and set up in a logical manner:

➢ *In the first stage, it is necessary to set off the requirements and acquire all necessary information about the property to assess the current status condition*: 1) objectives to reach; 2) needs of the client and of all the stakeholders; 3) main features of the historical building (external envelope, internal structure, surrounding environment, current energy assessment, final use); 4) analysis of the critical aspects, restrictions and regulations.

➢ *The second stage foresees the energy measures proposal based on previous information in order to define different energy retrofitting solutions and tools to enhance and improve the present situation;*

➢ *A third stage consists in the evaluation of the proposals and of the results achieved: assessment of retrofit measures, management, planning and maintenance.*

To establish a common procedure, main indicators were defined to assess energetically refurbishment measures in relation to the characteristics of each historical artifact. The main key parameters for energy efficiency assess measures are: *Feasibility; Reversibility; Reliability; Comfort Improvement; Potential savings; Environment effects; Maintenance and management.* Finally a scoring system gives the evaluation of these key parameters that can be used in the evaluation of further interventions.

This methodological approach allows studying different heritage buildings and to quantify the effectiveness of each retrofitting measure that depends on so many factors: type of building (residential, museum...), intervention limits, the intended use, constructive features; status condition, existing technical equipment, etc. how it is used, the in the building and other factors. This methodology determines the criteria to establishing priorities of the work to be done on each case studio, as example of the standard that should be adopted by architects and state and local officials for the review of historic preservation projects aiming at energy efficiency improvements.

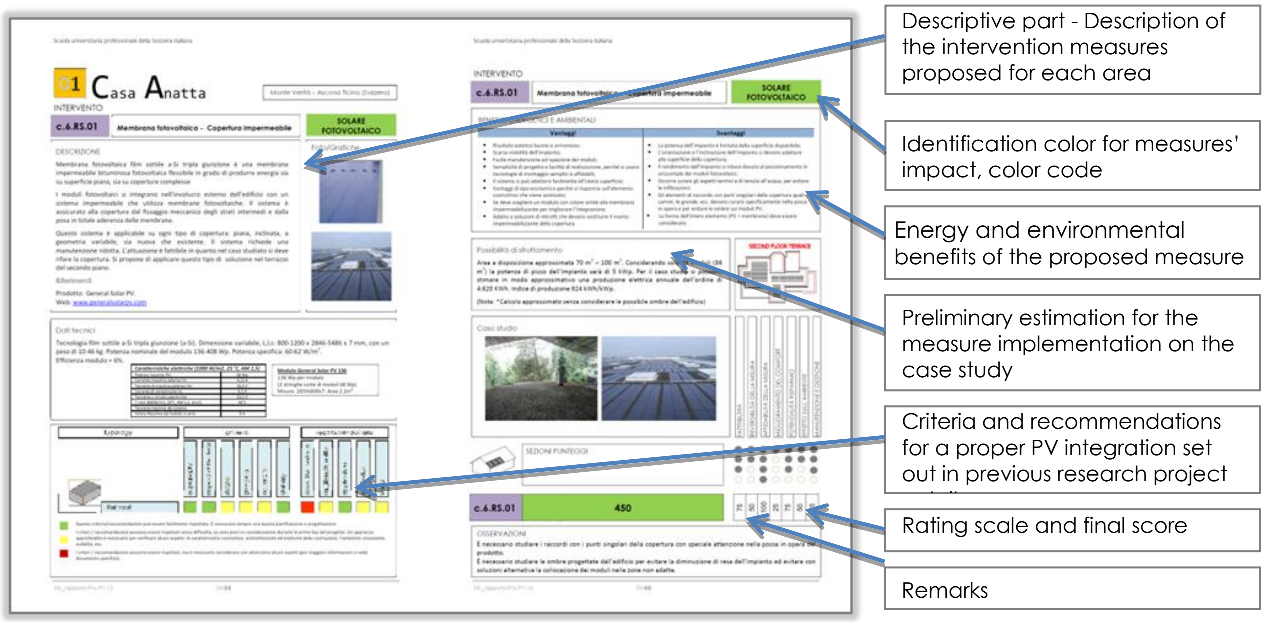

*Figure 2: Example of chart developed at ENBAU research pro*ject. *This chart shows the possible solar energy integration for the specific case studio and application of the evaluation criteria.*

In conclusion, different aspects must be considered when solar energy resources must be integrated in historic buildings. Potential solutions should be measured by knowing all the aspects involved, from the macro scale of the urban structure as well as, the micro scale of the building itself. Priorities should be streamlined and ranked, to clarify the potential advantages and disadvantages of the different technical solutions with regard to the features of the intervention proposed by applying a methodological approach.

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Programme

Programme sponsored by Philip Lee Solicitors

08:00 – 08:55 | Registration

09:00 – 10:00 | Plenary Session | Main Hall

Kevin Hydes, President and CEO of Integral Group - Revolutionary Engineering

James Drinkwater, Policy Adviser of World Green Building Council

Donal O'Riain, Founder and Managing Director of Ecocem

10:05 - 11:15 | Sustaining Heritage | Canal Suite

Retrofits are not always straightforward and historic buildings or buildings of high cultural value such as early modernist structures need a different approach. Expert speakers set out how ambitious energy targets can be achieved while retaining the cultural value of existing buildings.

Speakers: **Alexandra Troi**, 3ENCULT, **Carsten Hermann**, Historic Scotland and **Fergal McGirl**, Fergal McGirl Architects

10:05 - 11:15 | The EU Green Building Market Opportunity | Ard Chomhairle

This session looks at the trends in Europe for green products, materials and services, and what you need to know. This session is hosted by Enterprise Ireland.

Speakers: **James Drinkwater**, World Green Building Council, **Conor**

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Point 32 is a real estate development company & project manager. Developed Bullitt Centre, Chris Rogers speaking about it now. #bbconf
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Castle Rock Chamber 15 Jun

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O'Riain, Ecocem and **Dr Paul Butler**, Enterprise Ireland, **Rory McNeill**, Senior Market Advisor, Enterprise Ireland

10:05 - 11:15 | **It's the End of the World as We Know It... or New Opportunities for the Professions?** | Main Hall

The Building Control (Amendment) Regulations 2013 are finally here. How should practitioners cope with the increased responsibility? What do they need to do? What will be the impact on contractors? What are the opportunities? What is the quality of documents lodged so far under the new system?

Speakers: **Orla Fitzgerald**, Fitzgerald and Associates Architects, **Hubert Fitzpatrick**, CIF, **Aidan O'Connor**, Dept Environment, Community and Local Government and **William Purcell**, South Dublin County Council

11:15 – 11:35 | **Coffee Break**

Coffee break sponsored by Survey Instrument Services

11:40 - 13:00 | **A Residential Rating System for Ireland** | Main Hall

As Ireland starts building houses again, a rating system could improve the quality of our new and existing houses by looking at much more than energy consumption. Can we do for sustainability and quality what the BER certificates have done for energy awareness? What could such a system look like? We look at three systems from around Europe.

Speakers: **Dominic Church**, DGNB (German Sustainable Building Council), **Amanda Gallagher**, BRE Code for Sustainable Homes - UK and **Corinne Block-Raguin**, Cerway HQE Residential - France

11:40 - 13:00 | **A Strategy Towards Low Carbon Construction and Infrastructure** | Ard Chomhairle

Resource consumption and embodied carbon are increasingly coming to the fore as we increase the operational efficiency of new buildings. This session looks at the latest research on the balance between energy / carbon invested and the resulting savings. It looks at the Dutch model for innovative procurement and practices to reduce impacts of materials specified and an industry initiative to green the supply chain.

Speakers: **Ronald Rover**, Zuyd University and **Evert Schut**, MVO

Nederland

11:40 - 13:00 | **The Truth about Renewables |** Canal Suite

Are you confused about the different solutions for on-site renewables? Two experts give an independent evaluation of the different technologies that can be used for larger commercial building and smaller domestic scale building.

Speakers: **John Burgess**, Arup and **Xavier Dubuisson**, XD Sustainable Energy Consulting

13:00 – 14:00 | **Lunch**

Lunch reception sponsored by Senior Architectural Systems

14:00 – 15:15 | **Stimulating Investment in Retrofit |** Ard Chomhairle

What are the steps to developing investment ready projects? How do you get from an initial intention to a successful retrofit? What role do standards play in guaranteeing success and ensuring payback is as modelled? How can the new Energy Efficiency Fund facilitate retrofits and how will it work?

Speakers: **David Hourihane,** SDCL Ireland Energy Efficiency PLC, **Rufus Logan,** BRE Scotland, **Liam Woods**, HSE, and **Philip Lee**, Philip Lee Solicitors

14:00 – 15:15 | **Deeper Green with The Living Building Challenge |** Main Hall

This session looks at a case study of The Bullitt Centre in Seattle and how it realised the The Living Building Challenge, the world's most rigorous construction standard. The session also explores willow wastewater treatment systems for net zero water. Furthermore, it explores the lessons that have been learnt from practice of the standard and asks the question: "Is it practical for Ireland?" including a look at eco building performance indicators from Cloughjordan ecovillage.

Speakers: **Chris Rogers**, Point 32, **Brian O'Brien**, Solearth Architecture, **Feidhlim Harty**, FH Wetland Systems and **Davie Philip**, Cultivate

14:00 – 15:15 | **Skills and Education for Quality/Better Building**

Canal Suite

A key challenge for Ireland meeting the demands of a low energy built environment, will be the rapid up-skilling of professionals and trades. Construction workers have yet to understand the changed paradigm of quality needed and the response of "This is the way I have always done it" will now guarantee dismissal from site. It has yet to dawn on professionals that they need to go back to school to cope with the massive complexity of designing and certifying zero energy buildings. This looks at a number of initiatives to upskill both.

Speakers: **Mark Keyes,** ITB and **Cormac Allen**, DIT

15:15 – 15:35 | **Coffee Break**

Coffee break sponsored by Survey Instrument Services

15:40 – 17:00 | **The Big Better Building Debate**

This plenary session is hosted by RTE's **John Bowman** and features **Dr Melrona Kerrane**, **Stjohn O'Connor**, and others.

This allows participation from attendees on the outcomes from the conference.

17:00 – 18:00 | **Network Reception**

Reception sponsored by Munster Joinery

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3encult
EFFICIENT ENERGY FOR EU CULTURAL HERITAGE

How 3ENCULT is busy bridging the gap between preservation of European cities' cultural heritage and energy efficiency

Project coordinator EURAC
Alexandra Troi, alexandra.troi@eurac.edu

The research leading to these results has received funding from the European Community's Seventh Framework Programme (FP7/2007-2013) under grant agreement n° 260162

Historic buildings

- are the **trademark** of numerous European cities
- are a living symbol of Europe's **rich cultural heritage & diversity**
- reflect the society's identity and need **to be protected**

- show a high level of **energy inefficiency**
- contribute with considerable **CO_2 emissions** to climate change
- do not always offer "**comfort**" – to people as well as to artworks

Factor 4 to 10 of reduction in energy demand is achievable, also in historic buildings, respecting their heritage value, if a multi-disciplinary approach guarantees the implementation of high quality interventions, specifically targeted and adapted to the specific case.

Bologna

Urban Building Regulation distinguishes buildings of
- historic-architectural value
- modern architectural value
- **historical documentary value**
- modern documentary value

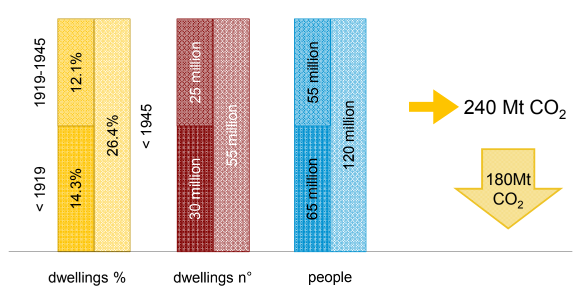
3616 buildings in city centre
- 60% before 1919
- 80% before 1945

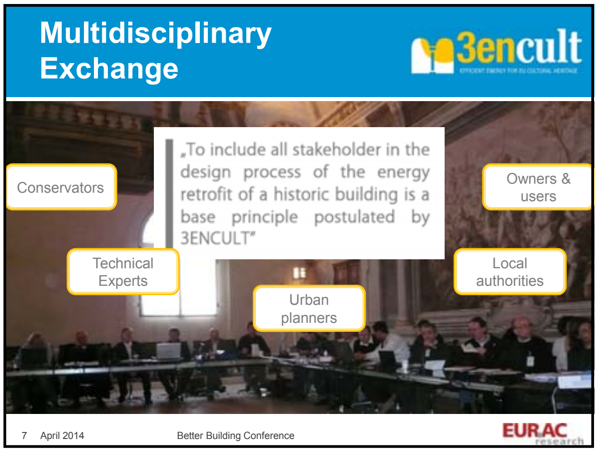
Denmark

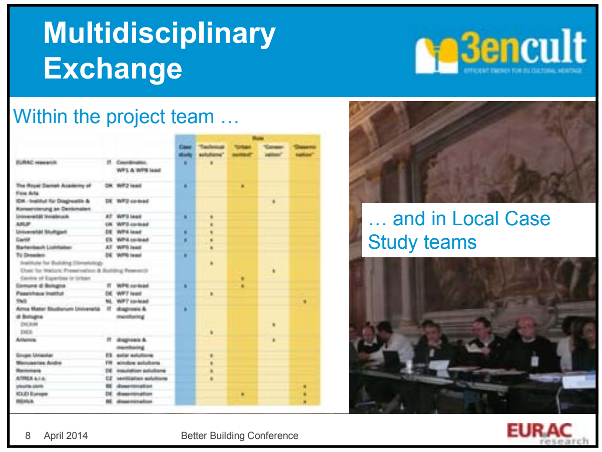
- 9,000 buildings in Denmark are listed (as the best or most characteristic of their type and period)
- 300,000 buildings have been assessed to be worthy of preservation.

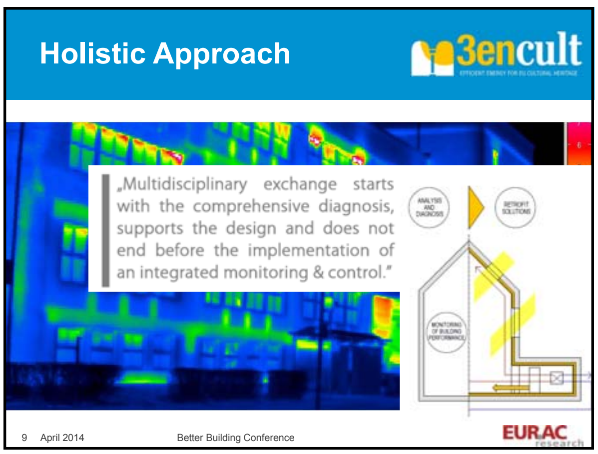
→ SAVE project: documentation of buildings built before 1940

Impact

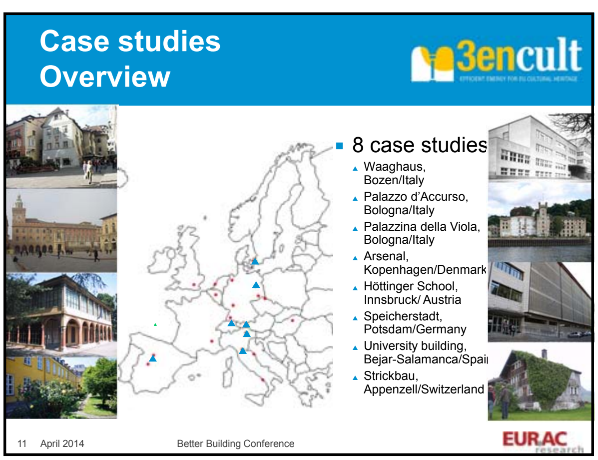


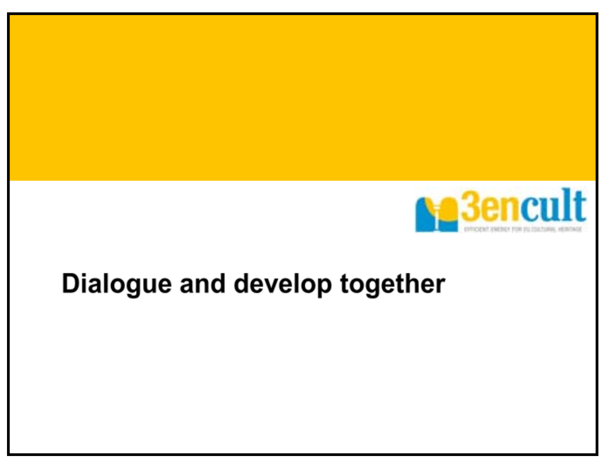

Multidisciplinary Exchange
3encult
Conservators
„To include all stakeholder in the design process of the energy retrofit of a historic building is a base principle postulated by 3ENCULT"
Owners & users
Technical Experts
Urban planners
Local authorities
7 April 2014
Better Building Conference
EURAC research


Multidisciplinary Exchange
3encult
Within the project team …
… and in Local Case Study teams
8 April 2014
Better Building Conference
EURAC research


Holistic Approach
3encult
„Multidisciplinary exchange starts with the comprehensive diagnosis, supports the design and does not end before the implementation of an integrated monitoring & control."
9 April 2014
Better Building Conference
EURAC research


Research & development
3encult
„3ENCULT aims at developing necessary solutions, both adapting existing solutions to the specific issues of historic buildings and developing new solutions and products."
10 April 2014
Better Building Conference
EURAC research


Case studies Overview
3encult
8 case studies
Waaghaus, Bozen/Italy
Palazzo d'Accurso, Bologna/Italy
Palazzina della Viola, Bologna/Italy
Arsenal, Kopenhagen/Denmark
Höttinger School, Innsbruck/ Austria
Speicherstadt, Potsdam/Germany
University building, Bejar-Salamanca/Spai
Strickbau, Appenzell/Switzerland
11 April 2014
Better Building Conference
EURAC research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Dialogue and develop together

Experience Saxony: Visualisation – saving potential and conservation compatibility

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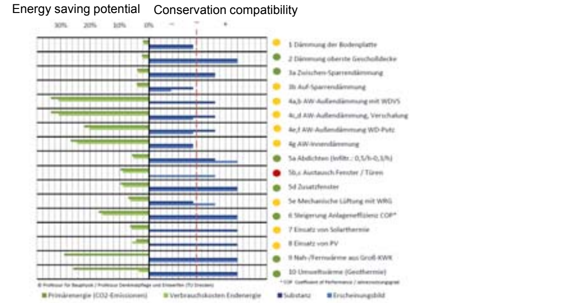
Energy saving potential   Conservation compatibility



Copenhagen experience: shared choices of the retrofitting solutions

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"Roombook" integrated with energy issues

3encult

- Architects, conservators and engineers
  → **"move" through** the building on different levels of detail
  → information for constructive discussion **at their hands**.
- Collect and **visualize** in a structured way any information needed for the diagnosis (descriptions, plans, photographs, drawings of details, results of non or minor destructive testing, monitoring data as well as calculations and models).

Dialogue example

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Conservation compatible window

Windows in the building stock …

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… are usually

- not thermally insulating
  e.g. CS1 Waaghaus / Bozen:
  → 33 kWh/m²
  = 11% of total transmission losses
- not airtight
  e.g. CS1 Waaghaus / Bozen:
  → ~40 kWh/m²

What to do?

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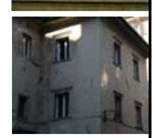
- original windows with heritage value
  → restoration of the existing window
- if original windows have already been replaced – as e.g. in 3ENCULT CS1
  → new energy efficient and aesthetically fitting window



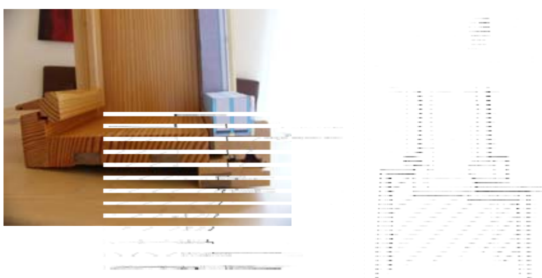
This was the challenge for …

3ENCULT Partner
Menuiserier Andre with their development expert Franz Freundorfer

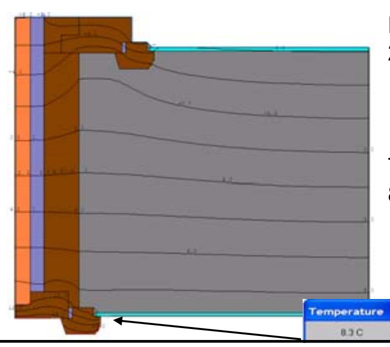
… in close collaboration with the consortium!

1st meeting & Workshop in Bozen

Workshop in Bozen



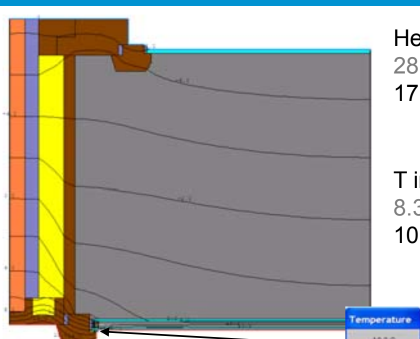
… start of simulation with the profile of a historic casement window



Heat flow:
28 W

T in edge:
8.3°C

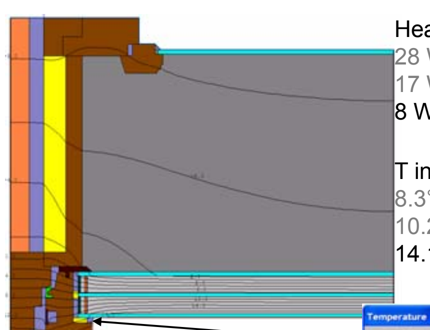
… first variant with thermal pre-tensioned thin window glass



Heat flow:
28 W
17 W

T in edge:
8.3°C
10.2°C

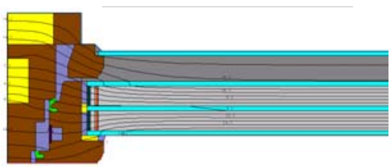
… second variant with Passive House Quality



Heat flow:
28 W
17 W
8 W

T in edge:
8.3°C
10.2°C
14.1°C

… simulation of compound window

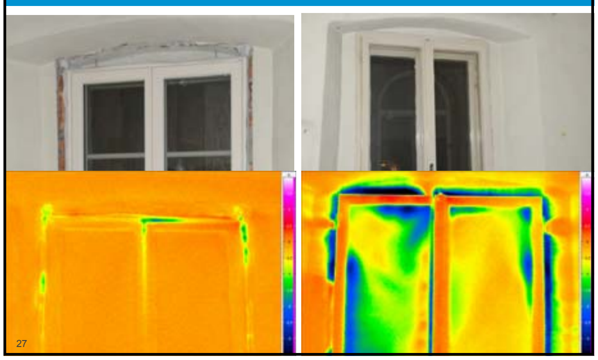


Heat flow:
28 W
17 W
8 W

T in edge:
8.3°C
10.2°C
14.1°C

1st prototype for CS1, the Weigh House

Efficiency of the 1st prototype



Feedback from conservator

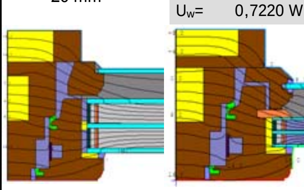
"I do have ***overall a positive impression*** *as regards frame & sash bar* ***dimension*** *as well as subdivision &* ***proportions****.*
The optic of the outer glasing seems to me exagerated, both the too irregular reflection from outside, and distortion from inside. And I ask whether a 3-pane glasing for Bolzano climate is really needed.

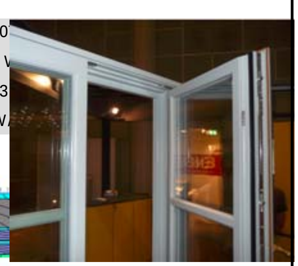
2nd prototype

Using thin glass→ 2mm!

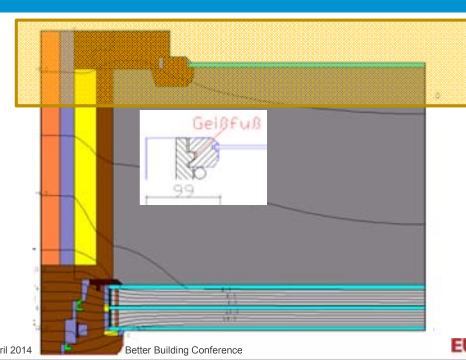
- 2+8+2+8+2 = 22 mm
- 4+12+4 = 20 mm

Heat flow = 9,130
U_f = 1,00 V
Psi_{Spacer} = 0,023
U_w= 0,7220 W/





Flexibility of the concept



Flexibility of the concept

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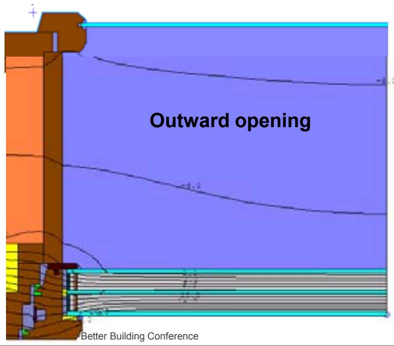

Flexibility of the concept

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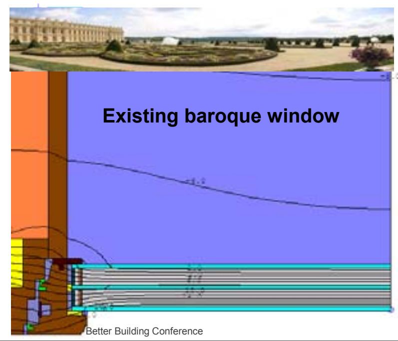

3rd prototype

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3rd prototype

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Smartwin
European network of window fitters

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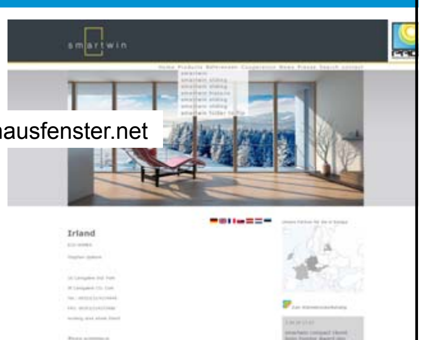

www.propassivhausfenster.net

Energy balance As-is-state/Window exchange

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Planned Solutions/Interventions

Proposal of passive solutions
- **Insulation of roof**
- **Insulation of baseplate**
- **Insulation of ceiling portici**
- **Higher airtightness** (10,05 -> 1,5 h-1)
- **Substitution of windows** (2,5-2,9 ->1,2-1,4 double glazing)
- **Controlled ventilation with heat recovery** (85%)
- Solar collector under roof tiles (in comb. with heat pump)

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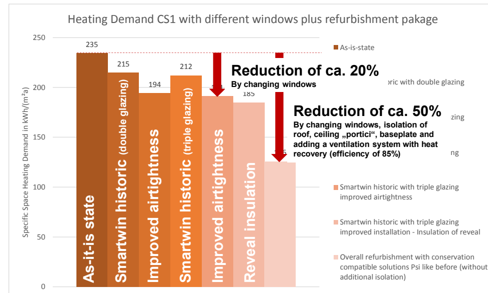
Energy balance As-is-state/Window exchange



38 September 2013 EWCHP 2013 presentation template

Dialogue example
Low impact ventilation

Höttinger School Innsbruck / Austria

1929-29131, Franz Baumann & Theodor Prachensky
Typical for a school of early modernism

In 3ENCULT:
Universität Innsbruck,
Architekt Gerald Gaigg

40

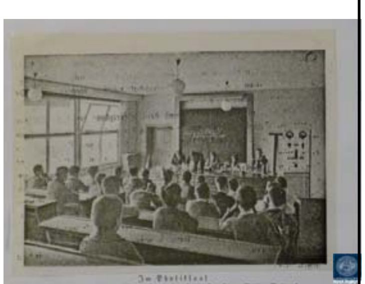
Fresh air demand …

… can not be guaranteed with window ventilation between one lesson and the other

→ Windows are opened also during lessons

☹ heating demand

☹ comfort



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… but which system?

- Central?
  → standard with heat exchanger in cellar
  ☹ horizontal & vertical ducting
  ☹ holes in ceiling
  → vertical ducting
  ☺ no horizontal ducting in the corridor
  ☹ more holes in the ceilings
- Decentralised?
  → one ventilation system per class room
  ☺ less ducts
  ☹ two holes in the facade per room …

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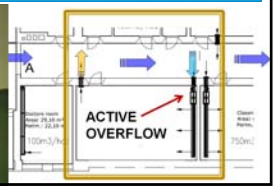
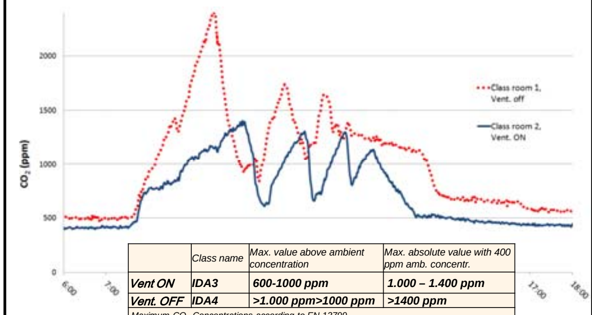
What „offers“ the buildng?

- central stair case
- large corridors with access to class rooms

→ Use this potential of the building!
- **Fresh air reservoir** in the corridors

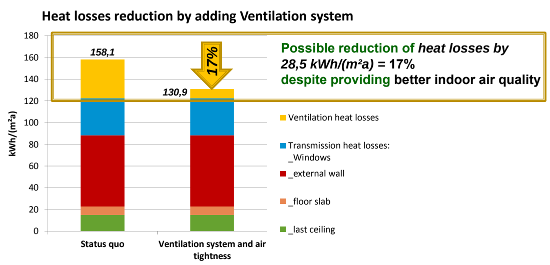


Impact of the ventilation?

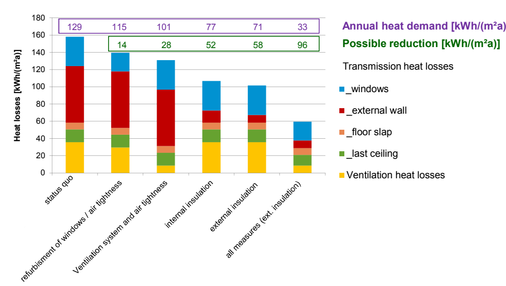


	Class name	Max. value above ambient concentration	Max. absolute value with 400 ppm amb. concentr.
Vent ON	***IDA3***	***600-1000 ppm***	***1.000 – 1.400 ppm***
Vent. OFF	***IDA4***	***>1.000 ppm>1000 ppm***	***>1400 ppm***
Maximum CO_2-Concentrations according to EN 13799			

ANALYSIS of energy demand Before / After intervention



ANALYSIS of energy demand Before / After intervention



Interior insulation

… overview & which results to find where

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EURAC research

Thank you for your attention!

Acknowledgement
This work was financially supported by the EU FP7 program (GA n. 260162).
The authors wish to express their gratitude for the financial support

alexandra.troi@eurac.edu

Negotiation space

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EFFICIENT ENERGY FOR EU CULTURAL HERITAGE

EURAC research

18TH INTERNATIONAL PASSIVE HOUSE CONFERENCE 2014

Passive House Conference 2014

and Exhibition

Eurogress Aachen | Germany

25 and 26 April 2014

Framework programme 23 – 27 April 2014

Programme

Passive House Institute

EnergieAgentur.NRW

stadt aachen

FRIDAY PROGRAMME | 25 APRIL 2014

PLENARY SESSION | Europa Hall

9:00 Opening remarks: Gisela Nacken, Head of Planning and Environment of the City of Aachen | Lothar Schneider, Director of the EnergyAgency.NRW

9:15 Heinrich Bottermann, General Secretary of the DBU foundation | The Passive House – an established construction standard on the way to energy revolution

9:30 Diana Ürge-Vorsatz, Director of the Center for Climate Change and Sustainable Energy Policy (3 CSEP), Central European University | Energy efficient buildings – an important opportunity to mitigate climate change

10:15 Wolfgang Feist | Passive House is more…

10:45 **2014 Passive House Award Ceremony**
Greeting | Dr. Heidrich, Department Head, German Federal Ministry for Economic Affairs and Energy

11:15 Johannes Remmel, Minister for Climate Protection, Environment, Agriculture, Nature Conservation and Consumer Protection of North Rhine-Westphalia

Tour of exhibition | lunch

	Europa Hall (PassREg)	Brüssel Hall	Berlin 1 Hall (EuroPHit)	Berlin 2 Hall
	Session I: PH on the regional level*	Session II: Ventilation*	Session III: Retrofit	Session IV: Day-care centres / schools*
13:00	Ulrike Leidinger, Eckhard Wendel | The City of Aachen – on the way to Passive House	Rolf-Peter Strauss | Ventilation – simple and elegant!	Witta Ebel, Berthold Kaufmann | Economy and financing of efficiency: new buildings and renovations	Kai Künzel | ›KlimaKita‹ in three weeks An affordable retrofit for a Passive House day care centre
13:25	Hartmut Murschall | Energy efficiency in North Rhine-Westphalia: political commitment and support	Bernhard Martin | A new ventilation concept for small dwelling units	Peter Keig | Analysis of the operational energy performance of a retrofitted solid wall terraced house versus designed performance	Robert Heinicke | The "House by the lake"
13:50	Matthias Linder | The City of Frankfurt: 10 years of experience with public Passive House buildings	G. Rojas-Kopeinig | Cascade ventilation – air exchange efficiency in living rooms without separate supply air inlets and exhaust air outlets	Herwin Sap | A concept for quick and clean Passive House renovation for mass housing in the Netherlands	Patrick Ostrop | Passive House school and educational center "Tor zur Welt" in Hamburg
14:15	Michael Stephan | Tradesperson and designer network in the Aachen region	Rainer Pfluger | Heatpipes for frost protection in PH ventilation systems	Alexandra Troi | Energy efficiency of windows in historic buildings	Helmut Heuer | Certification and architectural quality – a contradiction?
14:40	I. Klawitter, J. Probst | Energy concept and sustainable design in Belgium's German community	Rainer Lautner | Highly efficient ventilation systems with rotation heat exchanger für Passive House buildings	Harry Paticas | Monitoring building fabric moisture in a historic house retrofitted with internal insulation	Joachim Göttsche | Science College Overbach: Passive House school in Jülich-Barmen
15:05	Markus Lehmenkühler, Peter Fischer | E-View – an online monitoring system not only for public administrative bodies	1) Schmidt | The new generation of enthalpy exchangers – performance and energy efficiency 2) Brandmeier | Outdoor installation and special characteristics of ventilation systems 3) Sibille | Development of a coaxial-duct as outdoor air inlet and exhaust air outlet for ventilation units 4) Woollett | Rotary heat exchanger: practical experience	1) O'Leary | Ten Trans-European EuroPHit projects lead the next wave of Passive House promotion 2) Pedersen | Online platform for systematic Passive House certification	Martin Endhardt | Passive House day-care centre with class rooms in prefabricated concrete construction
15:30	COFFEE BREAK			
	Session V: Components: building envelope*	Session VI: PH design tools*	Session VII: Climatic challenges	Session VIII: EnerPHit refurbishment*
16:00	Benjamin Krick | PHI window certification: cold and arctic climates	Gernot Vallentin | Design principles for Passive House buildings: illustration of completed day-care centres	Fabio Ferrario | The first certified Passivhaus hotel in Italy	Ludwig Rongen | Heinsberg Protestant Christ Church – EnerPHit refurbishment, conversion and extension
16:25	Günter Pazen | Passive House windows are cost-effective!	Zeno Bastian | Variant calculations and economic assessment with PHPP 9	Rena Vallentin | Seminar and youth guest-house – a flagship project in Korea	Stefan Oehler | Conversion of a trading post into a multy-family building with lofts
16:50	Patrick Ziegler-Herboldt | Presentation of certified curtain wall substructure components & experiences	Pia Regner | Simulation and construction of cost-effective Passive House schools with minimised mechanical systmes	Thomas Greindl | An ecological, sustainable Passive House 300 km south of the Arctic Circle	Georg Reinberg | Passive House refurbishment with extension and redensification under challenging conditions
17:15	Klaus Zeller | Two residential building projects with monolithic masonry walls in Cologne	Alexandre Schütze | Sensitivity analysis with PHPP	1) Mauring | Winter performance of Certified Passive House building in Northern European cold climate 2) Krauklis | Design, optimisation, construction and operation of a large single-family Passive House in Riga	Eva Anlauft | Cultural heritage preservation award for an energy retrofit – prevention of structural damage, cost-effectiveness and regulatory compliance
17:40	1) Muskatewitz | Challenging connection details and their impact on the heating demand 2) Kethorn | Durable airtightness of joints between windows and walls 3) Gollwitzer | Optimisation of roller shutters and exterior blinds 4) Park | Comparative evaluation of EIFS using VIPs for better performance 5) Andreau | Electronically tintable glass: greater design freedom without compromise	1) Nordhoff | ecolearn – Passive House experts at your fingertips 2) Hasper | Advance! Education!	3) Szalavicz | Can Passivhaus Standards be adapted to high-rise residential buildings in South Africa? 4) Marcelino | The performance of the first Passive Houses in Portugal: the path to sustainability 5) Rosemeier | Is mechanical ventilation dispensable in temperate climates? 6) Vicente/Rodrigues | Passivhaus economic feasibility for Portuguese climate	Oliver Ottinger | Comparison of four interiour insulation systems – measurements and hygrothermal simulations 1) Reinke | From a traditional Hamburg detached house to a low-energy house with a Passive House extension 2) Graf | EnerPHit – an early pilot project 3) Rongen | Passive House refurbishment of Baesweiler's secondary school – monitoring and user survey
18:15	End of event | 20:00 Evening event **(reservation must be made in advance)**			

Organisers of the 18th International Passive House Conference: Passive House Institute, EnergieAgentur.NRW, stadt aachen

Under the patronage of:

Johannes Remmel
Ministry for Climate Protection, Environment, Agriculture, Nature Conservation and Consumer Protection of the German State of North Rhine-Westphalia

Ministerium für Klimaschutz, Umwelt, Landwirtschaft, Natur- und Verbraucherschutz des Landes Nordrhein-Westfalen

» Registration by post:
Passive House Institute | Rheinstraße 44/46
64283 Darmstadt | Germany
» Online registration: www.passivehouseconference.org

» 2014 Conference schedule

23 April 2014	Passive House Basics Course
23 April 2014	Passive House Windows Workshop
24 April 2014	Passive House Components Workshop
25-26 April 2014	18th International Passive House Conference and Exhibition, Eurogress Aachen
27 April 2014	Passive House Excursions

» Conference languages: German and English
Simultaneous translation into English will be provided at all German language sessions.

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SATURDAY PROGRAMME | 26 APRIL 2014

PLENARY SESSION | Europa Hall

9:00 Vincent Berrutto | Head of Unit for Energy Efficiency, European Commission - Executive Agency for Competitiveness & Innovation (EACI) (tbc)
9:15 Pat Cox | ‚German know how - Irish can do': A sustainable enterprise and innovation cluster
9:45 Grégoire Clerfayt | 2015 – Brussels goes passive – from stimulation to regulation

	Europa Hall	Brüssel Hall	Berlin 1 Hall	Berlin 2 Hall
	Session IX: Swimming pools, hospitals, super markets*	Session X: PH and renewables = NZEB*	Session XI: North America	Session XII: Passive House regions
10:30	Jörn Kaluza | Improving the electricity efficiency of indoor swimming pools	Manfred Huber | Field report: Nearly-zero energy multy-family building with load management	Adam Cohen | Built comparison of a Passive House and a standard American dormitory – a twin study	U. Scherer, M. Wohlfahrt | Promoting efficient building: The PassREg principle in the Hanover Region
10:55	Jessica Grove-Smith | Energy efficiency in Passive House swimming pools: demand and consumption of the "Lippe" bath	Christoph Deimel | Contemporary design in Berlin: From Passive House to Plus energy buildings	Timothy McDonald | Strategies for affordable, modular and multifamily PH housing in the USA	Paola Leardini | How do Passive Houses perform in New Zealand? From simulation to facts
11:20	Oliver Kah | Baseline study – implementing the Passive House concept in hospitals	Ralph Wortmann | Passive and zero-emission refurbishments	Adam Cohen | Design & construction of the LDS Dental Clinic	Mark Siddall | Occupant satisfaction in UK Passivhaus dwellings
11:45	Kristin Bräunlich | Aspects of efficient ventilation in hospitals	Edith Varga | Evaluation of a Passive House settlement according to DGNB criteria	Jörg Rügemer | Maximizing the Passive House at market rate – Utah's most energy-efficient and cost-effective house	Ruut Peuhkuri | Indoor environment in 126 Danish Passive House apartments heated by ventilation air
12:10	L. Lepp, J. Schnieders | Passive House super markets on the rise: requirements, examples and results	Christian von Ballmoos | Palazzo Positivo – refurbishment of a multy-family building in Chiasso to plus energy level with BIPV	Malcom Isaacs | Passive House economics: A simplified North American approach	Ljubomir Miščević | The first twenty Passive Houses in Croatia
12:35	Steafan Oehler | Laboratory building of Mainz University's anthropology department	1) Struckmeier | Passive House: Computer data centres with a PUE below 1? 2) Wamsler | A construction group builds passive and „positive" 3) Garg | Design of a cost effective net Zero Home for Ahmedabad. India 4) Yeats | Lancaster Cohousing. 41 Passive Houses with on-site renewable energy distribution	Matthew O'Malia | Design/ Build/ Refine/ Repeat: A systems approach for Passive House construction in North America	Clarence Rose, Dragomir Tzanev | Set of Solutions & lessons from the new Passive House regions 1) Pietrobon | Mediterranean Passive House solutions towards nearly zero energy buildings in italian regions
13:00	LUNCH			
	Session XIII: Living: examples and mechanical systems*	Session XIV: Experiences: integrated design and use*	Session XV: Tools and applications	Session XVI: EnerPHit: Passive House Retrofit
14:30	Martin Treberspurg | Passive House residential complex in Vienna's Kaisermühlenstraße	Astrid Müller | Energy concept Aachen Richtericher Dell	H. Malzer, D. Edwards | designPH – 3D Passive House design tool	Zeno Bastian | International EnerPHit-certification criteria
14:55	Michael Müller | Passive House dormitory	Peter Lückerath | Interface management in Passive House buildings	Georgios Dermentzis | Heat pumps in Passive Houses – PHPP application	1) Butcher, Herring | EnerPHit barn conversion: achieving high thermal performance & structural stability 2) Sevela | Energy refurbishment of heritage buildings with PHPP´s and real measurements´ feedback 3) Janetti | Internal insulation applied to a listed school building: in situ measurements and numerical analysis 4) Hrynyszyn | Passive House – an option for a modern rorbu? 5) Jacobs | High performance insulation: technology innovation and tailoring for replication 6) Egea Barbosa | Passivhaus Refurbishment in Mexico City
15:20	Peter Tappler | Indoor air quality in energy efficient residential new builds	Ingo Höffle | Integrated design and cost-effectiveness of Passive House office buildings	Maria del Carmen Rivero | Adapting the PHPP to Mexican social housing: the challenges of creating the DEEVi tool	
15:45	Jürgen Schnieders | Experience with a drain water heat recovery	Bernhard Frohn | Balanced Office Building – BOB.Aachen: 10 years of building use	Nick Grant | Internal heat gains	
16:10	Erwin Nolde | Grey water recycling and heat recovery – a steppingstone from Passive House to zero-energy buildings?	1) Teizer | Cost and pay-off comparison: Passive House office building and German legal requirements 2) Psyk | Use of geothermal energy in a renovated office building 3) Jünnemann | Resident consulting – involving residents in the refurbishment process	1) Arnăutu | PHPP interface certification 2) Vide Lutman | Seismic Foundation Pillow 3) Dinis Alves | Building with Passivhaus requirements: thermal bridge modelling and thermal influence	
16:35	1) Kraus | Compact heat pump systems and drinking water regulations			
16:45	COFFEE BREAK			

PLENARY SESSION | Europa Hall

17:15 Wolfgang Feist | Passive House – the next decade
18:00 End of conference

Subject to alterations

* Session held in German with translation into English

Energy efficiency of windows in historic buildings

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1 Introduction

Windows are inseparable components of the building envelope. They shape the building from architecture point of view – and in a historic building, this aesthetical value is complemented by the value of perhaps still preserved original material. They provide daylight, fresh air and view to the outside, but are energetically speaking also the weak part of the thermal envelope: The thermal transmittance of windows was in the past and remains till today lower than for walls. But windows also let in solar radiation which lightens and heats up the room. Therefore, by optimizing gains and minimizing losses, windows have a huge potential to save energy.

Building efficiency legislation actually has triggered replacement of traditional windows recently, but inappropriate window replacements or upgrades can ruin the historical value of the building and, in addition, cause problems of building physics nature, like condensation, and thermal bridges. In the recent history two main mistakes occurred: the raising of airtightness without raising the air exchange/ventilation at the same time and exchanging of windows without enhance the thermal insulation of the opaque part of the envelope at the same time. This led to a high risk of mould growth because of higher condensation risk (water activity) in combination with less ventilation.

The paper presents a method for improving the energy efficiency of the windows in a historic building, through a progressive approach and targeted intervention that respects the documentary value. After explaining the heritage value of historic windows, glasses and frame and the development of a holistic façade concept, the replacing of an existing window with a high efficient system is discussed. Basis are the experiences from one case study: the Public Weigh House of Bolzano/Italy[1].

[1] Case study of FP7 project 3ENCULT "*Efficient Energy for EU Cultural Heritage*".

2 The heritage value of historic windows and development of a holistic façade concept

By tradition, windows offer lightening, ventilation and protection from outside climate, cold or heat, rain, snow and wind. As a component of the façade, they highly contribute to the architectural expression by giving a vertical and horizontal rhythm to the building. Their design, materials used and technical solutions represent the historical style of the building. The lifetime of the windows is shorter than the one of the building. We can frequently find original windows in buildings from the 19th century, sometimes from the 18th century, but rarely from the 17th century or earlier periods. From conservation's point of view, it is important to preserve as much as possible all the elements, especially for windows dating from the origin of the building. Nevertheless, if the windows do not fulfil their function any more, if anyhow an intervention is needed, the task should be to offer more comfort for the users of the building, save energy and still maintain the original aspect of the windows and thus, of the building.

Historic windows need a retrofit project that takes into account the historic, aesthetic and material values, the state of conservation and the need of comfort for the users. Conservation aspects must be considered at the same level as thermal performance.

Before starting with the enhancement of existing windows, a holistic façade concept for the whole building has to be elaborated in tight collaboration with the conservator. This overall window concept is based on a detailed acquisition and evaluation of every single window during an (interdisciplinary) on-site inspection, describing window typology, state of conservation, construction, materials, installation, surrounding framing (profiled stone frame etc.), type of window sash, glazing, wood joints, fittings and additional equipment such as window shutters etc. From the façade concept emerges which (part of) windows and additional equipment must be retained and which parts can be replaced, as well as the position of the original/new window or respectively the position of an additional new second window layer and how to treat the surrounding framing (reveals, profiled stone frame).

When developing the façade concept, it is crucial to consider not only the thermal performance of the window itself, but also the connection window-wall and the energy balance of the whole building – in order to optimize the heat losses and, most importantly, to assure sufficient internal surface temperatures to avoid condensation and mould growth.

3 Case Study:

The Public Weigh House, a building of Romanesque origins in the historic city centre of Bolzano in Italy, is one of eight case studies that accompanied FP7 project 3ENCULT. At the end of the 16th century, there was a large reconstruction of the building, unifying e.g. the dimensions of window apertures and extending the building on the east side. The window size is therefore typical for baroque era. The major part of the original windows was however replaced by box-type windows in the 1950s/60s – which are not of historic value from conservator's point of view and should be replaced, reproducing the appearance of a historic window. For the development of such a new window the aim was to (i) build a highly energy efficient window with Passive House quality and (ii) a window that answers to the heritage demands of the building.

A first workshop with window developer and producer, building physicist, architect and conservator, helped to understand the aesthetic, visual, formal and functional needs of the new window, before starting with the development of a first concept. It was important to know typical characteristics of local historic windows and relevant recurrent problems in connection with energy refurbishment of protected windows (see figures 1-6). From conservator´s point of view, two aspects of the original appearance of (local) historic windows should be adopted to the new window: (i) the original proportion between glass area and sash bars and window frame and (ii) the optic appearance of original historic glazing.

Figure 1-6: Originally, the wooden frames, impost and sash bars were very fragile and thin, possibly moulded (fig.1-3), while the optic of the typical replacements is much broader (simple application of the IV68 standard, fig.4-6).
Exchanging historic single glazing with double-glazing changes the look to the façade because of different reflection and mirroring, caused by (i) convex or concave deformation of the glass pane through expansion and contraction of gas between the two glass layers, (ii) different surface finish of flat modern float glazing compared with traditional mouth-blown historic glazing and (iii) more regular reflection if subdivisions are not any more glass-dividing (and thus not causing different glass inclination)

In an expert workshop the overall window concept for the whole building was developed: for some rare original windows from the late baroque era, it was decided to possibly enhance them from energetic point of view with an additional second window layer, while the windows from the 1950s should be replaced with new windows, which fit better the historic context.

As there were no drawings from the original historic window available, the new window was based on a "classic" (coupled) window in terms of function, division and proportion, two sashes with two sash bars each. The developed concept separates the demands and functions into two layers: one outer layer for the reproduction of the original historic window and an inner layer for high energy efficiency. In this way, it is possible to obtain the same appearance like the original historic window from outside in terms of frame dimensions, sash bars and mirroring by taking a single glazing, without any negative effect on the energy efficiency. This outer layer takes over the weather tightness. The passive house window with triple glazing is integrated in a second additional inner layer, taking over the airtightness. By rotating the frame cross section 90 degrees and by moving the centre of rotation of the fitting, a smaller frame than the conventional solution was achieved (see figures 7-8). It is positioned in a way that its frame is not visible from the outside. Following to this approach, both box-type and a coupled window are executable (see figures 8-9). Additionally, it allows also preserving the original old window and just adding the second energy efficient layer (on the inside or also on the outside).

On the installed prototype of the coupled window version the conservator evaluated if heritage demands have been fulfilled: the appearance of the outer single glazing and the optic of the inner triple glazing, the proportions, subdivision and frame thickness and the evaluation of the concept of “division of functions” as well as colour and profiling. Based on this feedback the prototype was developed further. Since in the meanwhile a building historian had discovered traces of cut out imposts (in some rare cases where the outer sashes the of box-type window from the 1950s/60s where installed in an original baroque frame), the new prototype was also built with a horizontal impost and four window sashes (2 above, 2 below). As model served the still existing window with impost in the jutty. The use of the very thin triple glazing (2/8/2/8/2), with the thickness of a double glazing, made it possible that the frame proportion became even more fragile and the optic from inside becomes very similar to a double glazing (see figure 11).

The application of the concept and the execution of the window prototype profited from the flexibility, experience and know-how of the small traditional window producer, which is able to tailor his facilities to the production of this individual adapted windows.

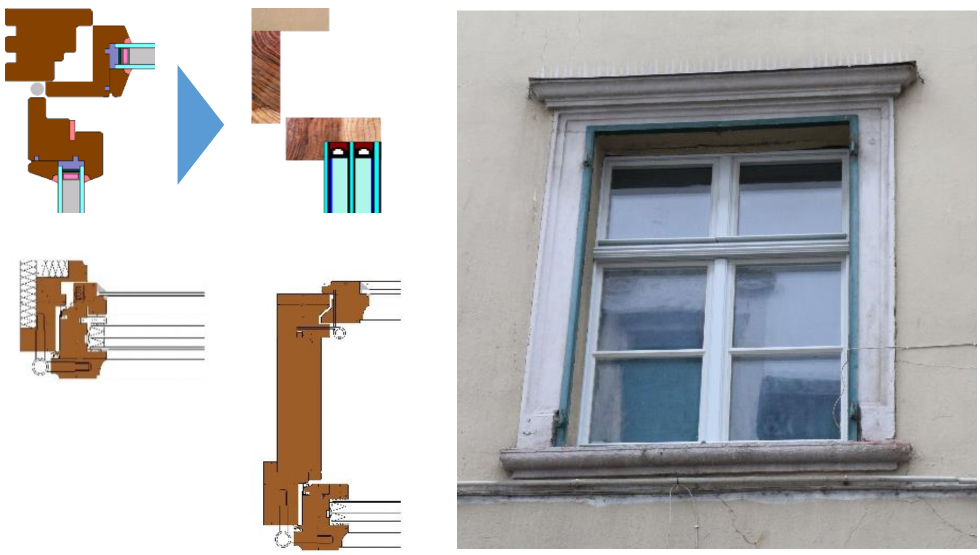

Figure 7-11: rotation of the frame cross section by 90 degrees (fig. 7-8) to achieve a smaller frame; separation of functions into two layers: “historic” window outside, integration of passive house window inside (fig. 9-10), last prototype installed in the Weigh House (fig. 11).

With regard to the window-wall connection, since in the major part of the case study, no application of internal insulation is possible, the junction was optimised by studying the existing reveal on-site and inserting all around the window an insulation layer of 4-6 cm. This helped two improve the psi-values and thereby to rise the surface temperatures in the critical points to required values (see figures 12-13).

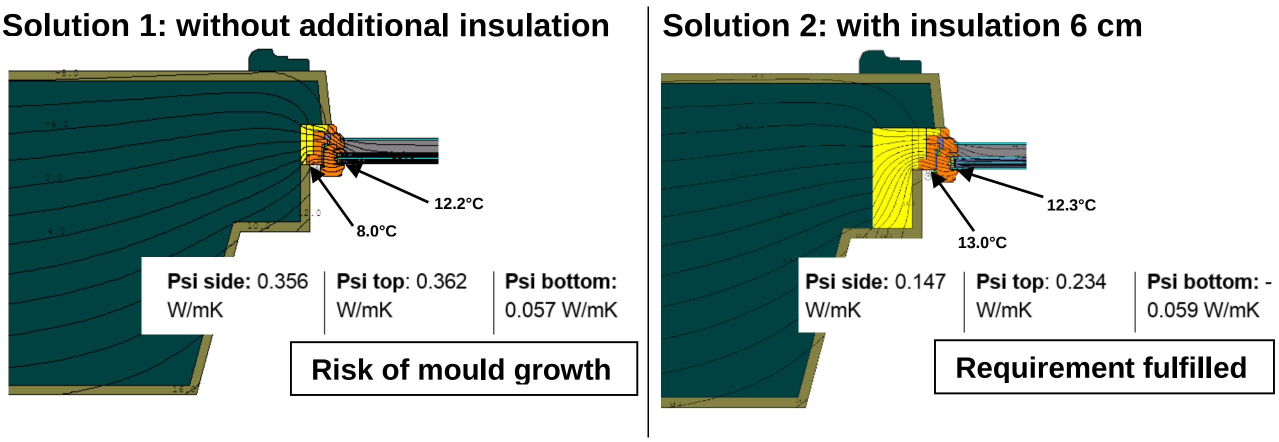

Figure 12-13: comparison of two window connections – with and without additional insulation

The entire transmission heat losses caused by the original windows are 31.100 kWh/a. With the installation of the developed window (with triple glazing) a reduction of 21.000 kWh/a can be achieved. Taking into account the window energy balance (losses minus gains) the net losses can be reduced by 70% (double glazing vs. original window) or respectively 80% (triple glazing). Looking at the total energy balance of the whole building with 14% of window area and walls in natural stones, the exchange of windows can reduce the demand by up to 20%: 10% due to thermal performance increase, 10% due to airtightness improvement (need for indoor air quality considered, without heat recovery).

4 Flexibility of the developed smartwin window concept

The flexibility of the developed window system allows the integration of an original historic window. In case of the three baroque windows in the bay, it is important to maintain the interior view; the additional layer should be added therefore on the outside. For these windows the following solution was developed: removing the existing wooden frame outside, which served for the fixing of the window shutters. Instead of those, provide a second window layer, which takes over the energy efficient function (concept of the composite window prototype “the other way round”). The outer wing can be opened to the outside; it can be executed without the horizontal impost (only one sash). For the other remaining three original windows, instead it was decided to apply the second layer on the inside.

5 Compatible energy retrofit of historic buildings

An adequate enhancement of windows in historic building requires a tight collaboration between architect, window developer and producer and conservator from a very early planning stage on. The multidisciplinary team should follow the following approach:

Step	Measure	Content/scope
1.	**On-site inspection (with conservator)**	Documentation of every single existing window, evaluation of the heritage value of the window and its components, definition of an overall façade/window concept

2.	**Multidisciplinary workshop**	Definition of aesthetic, visual, formal and functional needs of the enhanced window. Definition of window details such as proportions, material, profiling and finish with the help of detail drawings.
3.	**Calculation of window connection**	Study and optimization of window/wall joint, both for minimization of heat losses at the connection and assurance of minimum internal surface temperatures and a minimum air exchange to avoid condensation and mould growth
4.	**Calculation of building energy balance**	Building energy balance: evaluation of different window technologies (e.g. different glazing solutions), taking into account reachable airtightness level and installation variants (window/wall joint) on building level.
5.	**On-site inspection (with conservator)/ multidisciplinary workshop**	Building and installing of first prototype – evaluation of conservator, possibly improvement, further adaptation

6 Conclusions

A significant energetic enhancement of historic windows is possible, while maintaining the historic value of the building and the window, thanks to the developed smartwin window concept. The flexible system is adaptable to the single individual case: Be it in case of improvement of an existing window by inserting of a new window layer or be it in case of the exchange of an existing window. Prerequisites are however: (i) the tight collaboration of planer, window developer and conservator from an early planning stage on; that (ii) with a sensitive approach adapt the developed window concept to the individual case and take (iii) into account not only the window performance, but also the impact of the installation to the whole building. Furthermore, there is the need to find window manufactures that have the necessary handicraft skills and facilities to produce smartwin historic windows.

Acknowledgements

This work has been funded by the European Union, through the research projects “3ENCULT: *Efficient Energy for EU Cultural Heritage*” (Seventh Framework Programme, grant agreement n° 260162).

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International EnerPHit Certification Criteria for Energy Retrofit with Passive House Components

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1 Introduction

When old buildings are renovated, it is often difficult to achieve Passive House standard. Typical reasons for this are unavoidable thermal bridges as well as a general building design, which was originally not optimized for compactness and solar gains. For such buildings, Passive House Institute (PHI) has introduced the EnerPHit standard. The basic principle is to modernize all relevant parts of the building with Passive House components. This way almost all advantages of the Passive House standard can be realized in retrofits, even if the heating demand is not reduced all the way down to 15 kWh/(m²a).

Figure 1: EnerPHit seal

In the past the requirements for Passive House components such as windows and ventilations systems were only defined for cool temperate climates as prevails in Germany and Central Europe. As the EnerPHit criteria are based on the requirements for Certified Passive House Components, the first version of the EnerPHit criteria published in 2010 was also applicable to buildings located in cool temperate climates only. However, this also already included locations outside of Central Europe with similar climatic conditions, such as New York. Additionally EnerPHit renovations in other climate zones have been certified as pilot projects, such as a family home in the colder climate of Minneapolis, USA.

In the recent past PHI has carried out intensive research with the aim of defining truly international component requirements. An international certification scheme for Passive House windows is running with 6 windows for colder climate zones already certified. International requirements for other components have been defined, with corresponding certification schemes to be set up in the near future.

The development of international Passive House component requirements has now progressed far enough to serve as a reliable basis for international EnerPHit criteria. In November 2013 a project team at the PHI (led by the author) has completed a beta version of the international EnerPHit criteria. This paper describes the requirements as well as how they have been derived. It is important to keep in mind that these are preliminary requirements that may still be subject to change until the official release of the certification scheme.

General derivation of the international EnerPHit component requirements

The requirements for individual building components continue to be the core of the international EnerPHit criteria. Switching to a reference building procedure has been considered during the development process. However, this idea has been dropped again, amongst others due to the resulting double effort of calculating the reference building as well as the real building with the PHPP.

As stated above, the international EnerPHit component requirements are based on the requirements for Passive House components. These requirements have been derived by means of an economic optimization process. The process has been carried out for each location in a grid of climatic data sets covering the whole globe, with the aim of finding the set of component qualities with the lowest life cycle costs for an example building. 200 combinations of different ventilation, window and shading qualities were additionally combined with different insulation levels of the opaque building envelope (for a more detailed description of the method see [Feist 2011]). The combination with the lowest sum of investment and energy costs could thus be determined using the net present value method (see [AKKP42]). Some building components were considered for the study that are not or not widely available at the moment. These may currently be expensive due to low production numbers. For the study estimated investment costs for these products under mass production conditions have been used.

The cost-optimal component set for the new end-of-terrace example house used at first in the studies, resulted in a functional Passive House[1] in almost all locations. At the same time minimum requirements for thermal comfort and prevention of moisture accumulation were “automatically” met. In order to test the suitability of the these component qualities for refurbishments the method was also applied to several variants of another example building which was a typical 3-storey Wilhelmenian-style residential building in a historic city quarter. For this building a full refurbishment with Passive House components (with remaining thermal bridges) as well as refurbishment with interior insulation was analyzed. In additional variants only one component was refurbished as could be the case in step-by-step renovations or if other measures are not possible because of restrictions by cultural heritage authorities. The resulting cost-optimal component qualities were often even better than for the new example building. This can be explained by the longer heating period in less efficient buildings. Thus an individual improved building component can save energy for a greater number of months every year than in a Passive House, making it even more economic to invest in better quality. As the effect was not highly significant and as it also

[1] A functional Passive House can be conditioned by heating or cooling the amount of fresh air, which is necessary anyways for hygienic reasons.

depends on the situation in an individual building this is not taken into account for the international EnerPHit component requirements.

As different component requirements for each location in the world would not be practical for use in general certification requirements a further step of simplification was required. Locations with similar sets of optimal component qualities were grouped resulting in 7 climate zones, with one set of component requirements for each zone (see figure 2).

2 Some component requirements in detail

2.1 Insulation of the opaque envelope against ambient air

The requirements for thermal insulation are naturally highest in the arctic climate zone with a maximum U-value of 0.09 W/(m²K). They are much less severe in warm and hot climate (≤ 0.50 W/(m²K)) and tighten again in very hot climate (≤ 0.25 W/(m²K)) where heat transmission through the opaque envelope adds to the cooling load. The requirements for interior insulation are always lower as applying interior insulation reduces the floor space, making it less rewarding from an economic perspective.

2.2 Floor slab and basement ceiling insulation

The temperature in the ground below a building or in an unconditioned basement largely depends on factors such as the geometry of the building, the characteristics of the soil and the air exchange (in basements). The temperature can be very close to the ambient air but also very close to the temperature inside the building. However, the heat loss of a building and thus the economic viability of insulation measure depend on the temperature difference between inside and outside. Thus a single U-value requirement for the basement ceiling / floor slab for all buildings would not make sense.

In the current EnerPHit criteria the U-value requirement can be divided by the reduction factor from the PHPP “Ground” worksheet in order to take the conditions in individual buildings into account. However this approach does not work for mixed climates with heating and cooling demand. Thermal insulation that helps reduce heat losses to the ground in winter also reduces heat transfer to the ground in summer, when the ground could be used as a heat sink reducing the cooling demand in moderately warm climates.

The optimal insulation level for a specific building can only be determined in the PHPP. Thus a method for calculating the insulation requirements based on project specific heating and cooling degree days against ground will be implemented in the next PHPP version. The EnerPHit certification criteria will make reference to this algorithm.

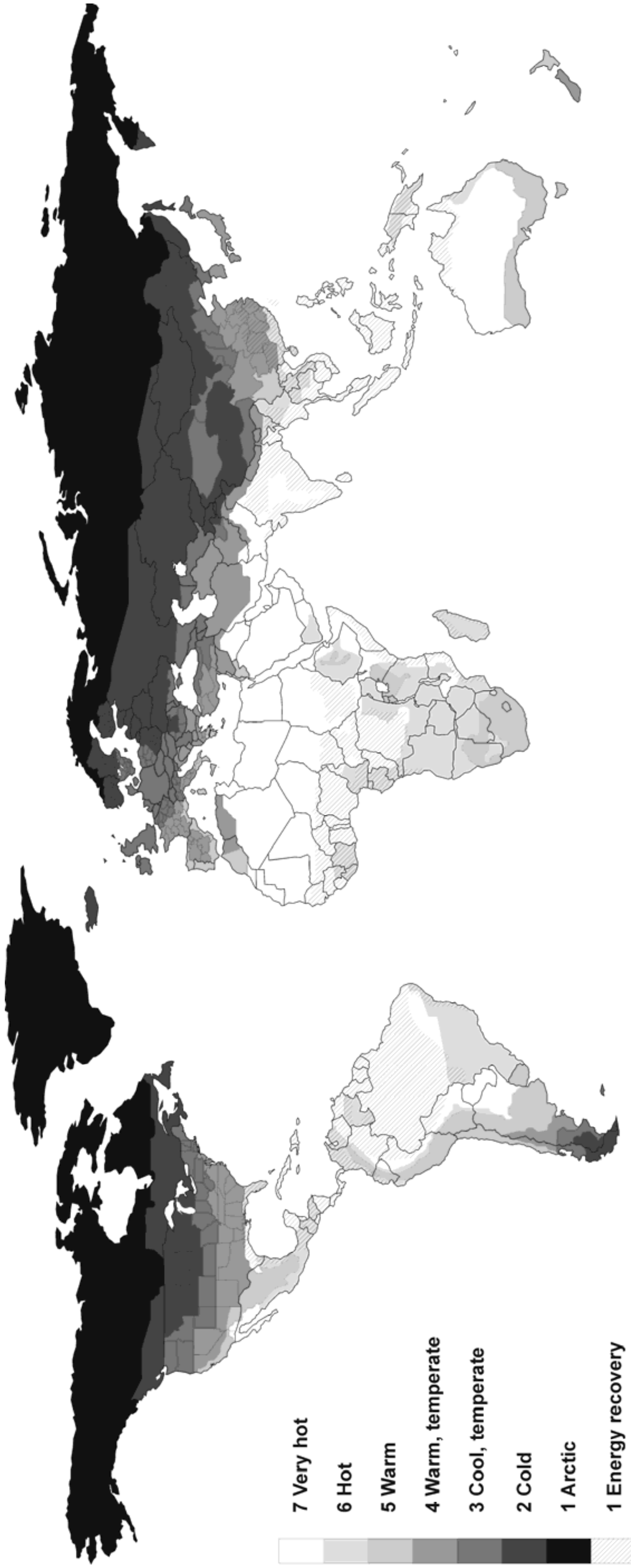

Figure 1: World climate zone map for Passive House component and EnerPHit requirements

2.3 Windows and solar loads

The international requirements for Passive House windows are already in use [Krick 2012] and can easily be adapted for the EnerPHit criteria. However the reduction of solar loads in cooling

climates is not fully covered by the Passive House component criteria, as they do not include measures such as shading overhangs or blinds. For refurbishment of a whole building these measures of course do have to be considered, though, in order to keep the cooling demand at an acceptable level. The solution for the certification criteria was to set a maximum level of solar loads entering per square meter of window during the cooling season. If these solar loads are above 100 kWh/(m^2_{window}a) additional measures have to be taken to get below this value again. This could include installation of overhangs or temporary shading devices as well as anti-sun glass in hot and very hot climates. An analysis had shown that above a solar load of 100 kWh/(m^2_{window}a) the installation of shading devices generally becomes economically viable.

The measures are only required if the building has an active cooling system. An active cooling system can be omitted if the frequency of overheating (>25 °C) does not exceed 10 % of annual hours.

For the hot and very hot climate zones additionally cool colors are required if the exterior surface is painted. These are colors which have a low absorption coefficient in the infrared part of the solar spectrum.

2.4 Ventilation

In the cool temperate climate the heat recovery requirement stays at ≥ 75 %. In cold and arctic climate it rises to 80 % as HRV is even more important in locations with cold and long winters. Additionally humidity recovery is required in these climates, in order to avoid very low relative indoor air humidity in winter. Alternative measures to this aim are also accepted.

In warm climates, which have neither a high heating demand nor a high cooling demand, there is not a lot of energy to be saved by heat recovery ventilation. Thus a simple extract air system without heat recovery will be sufficient. Going to hot and very hot climate heat recovery is required again, as it helps reduce the cooling demand. In hot and very hot climates that are very humid at the same time (see the hatched area in figure 2), an additional humidity recovery is required, in order to reduce the energy required for dehumidification of the supply air.

2.5 Airtightness

An airtightness of n_{50} ≤ 1.0 1/h will be required in all climate zones.

3 Alternative certification method based on space heating and space cooling demand

In the current EnerPHit criteria for cool, temperate climate the component requirements can be omitted, if a heating demand of 25 kWh/(m²a) is not exceeded. This principle will be kept in the international EnerPHit criteria with the requirement rising to 30 and 35 kWh/(m²a) in cold and arctic climate and going down to 20 and 15 kWh/(m²a) in warm, temperate and warm climate. In contrast to the existing EnerPHit criteria there will also be an alternative requirement for the cooling demand, which will be exactly the same as for new-built Passive Houses. An analysis had shown that in general refurbished old buildings do not need to have a significantly higher cooling demand than new-built Passive Houses if there are no exceptional difficulties.

4 Outlook and Acknowledgements

PHI plans to put the international EnerPHit criteria into effect simultaneously with the publication of the upcoming PHPP version 9. However a draft version is planned to be published on the PHI website www.passivehouse.com before this year's International Passive House conference. Certification of some pilot projects by PHI will already be possible based on this draft version.

The part of the development of the certification criteria, that was needed for certification of retrofits of historic buildings in the different European climates was supported by the European commission within the European FP7 project 3encult (Efficient Energy for EU Cultural Heritage").

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Variant calculations and economic assessment with PHPP 9

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1 Introduction

The Passive House Planning Package (PHPP) has a long track record as an accurate and easy-to-use tool for planning Passive House buildings and EnerPHit retrofits. It is also accepted as proof of compliance for certification purposes and subsidy programs. The Passive House Institute regularly refines, improves, and adds more functions to this tool.

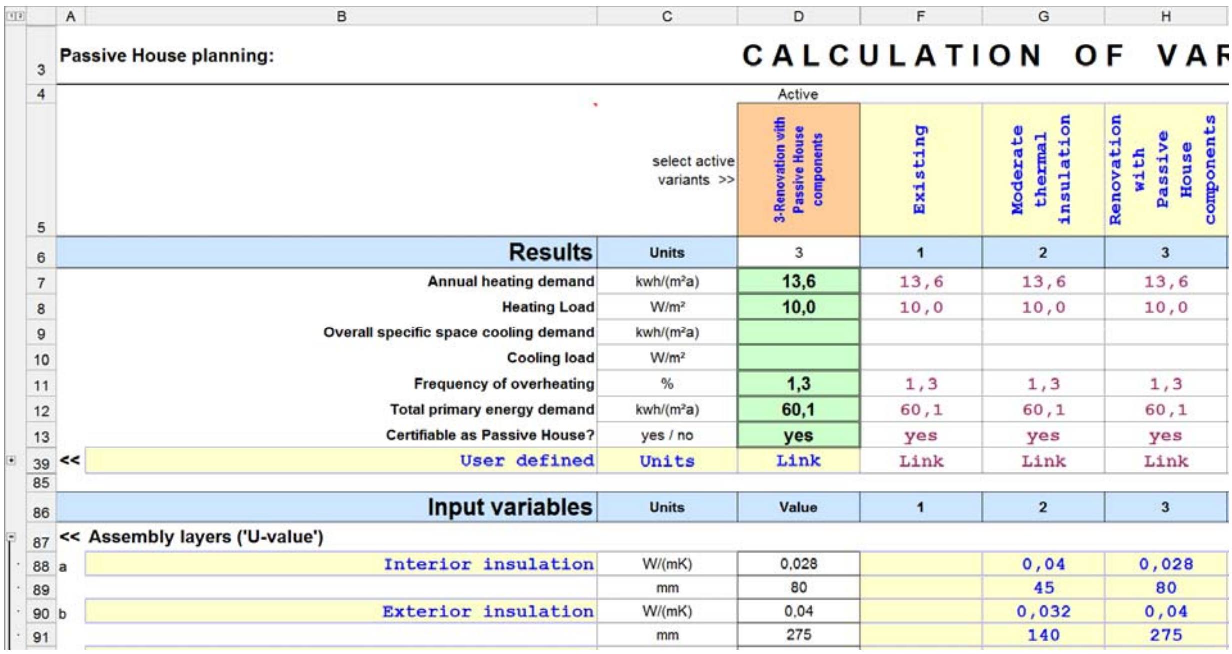
PHPP 8, the latest version when this presentation was drawn up, allows users to input a single building with its geometry and the heat insulation properties of its building components etc. and calculates an energy balance for them. But a frequent PHPP user may be asked repeatedly to calculate various design options for the same building. This may arise with modernization projects if users need to calculate an unrenovated and renovated version, and possibly any intermediate steps, too. Comparing different designs may also help to come up with the most cost-effective combination of measures to achieve Passive House Standard for new builds as well. Up until now, users had to overwrite each cell entry with different values, for instance for insulation thickness. Looking at different designs in parallel was only possible by copying the PHPP project file once it had been filled out, unless users had advanced Excel programming skills. This process quickly became impractical, confusing, and prone to errors where several variants existed.

PHPP version 9, which is slated for release towards the middle or end of 2014, will feature two additional worksheets entitled Variants and Comparison along with other innovations. The Variants sheet gives users the option of inputting different designs and displaying the results in parallel. The Compare sheet allows two of these variants to be selected to compare their energy demand and affordability in depth.

Another tool, the PHeco external calculation tool (not integrated into the PHPP) has been developed by the working group for cost-efficient Passive Houses [AKKP42, 2012]. This worksheet uses the PHPP's findings to calculate affordability. It does so by comparing different building designs' heating energy demand and the costs of their respective energy-saving measures. The PHI can provide this tool on request.

2 New PHPP Variants worksheet

Figure 1 shows a screenshot from the Variants worksheet. The user can enter names for the different designs to be considered at the top in row 8. The sheet has enough columns set up for up to 99 designs (not shown). The active design is selected in the same row in column D. This design's parameters are then displayed in each PHPP worksheet's cells and used for subsequent stages of the calculation.



	A	B	C	D	F	G	H
3		Passive House planning:		CALCULATION	OF	VAR	
4				Active			
5			select active variants >>	3-Renovation with Passive House components	Existing	Moderate thermal insulation	Renovation with Passive House components
6		Results	Units	3	1	2	3
7		Annual heating demand	kwh/(m²a)	13,6	13,6	13,6	13,6
8		Heating Load	W/m²	10,0	10,0	10,0	10,0
9		Overall specific space cooling demand	kwh/(m²a)				
10		Cooling load	W/m²				
11		Frequency of overheating	%	1,3	1,3	1,3	1,3
12		Total primary energy demand	kwh/(m²a)	60,1	60,1	60,1	60,1
13		Certifiable as Passive House?	yes / no	yes	yes	yes	yes
39	<<	User defined	Units	Link	Link	Link	Link
85							
86		Input variables	Units	Value	1	2	3
87	<<	Assembly layers ('U-value')					
88	a	Interior insulation	W/(mK)	0,028		0,04	0,028
89			mm	80		45	80
90	b	Exterior insulation	W/(mK)	0,04		0,032	0,04
91			mm	275		140	275

Figure 1: A screenshot of the Variants worksheet in PHPP 9 (beta version).

The user enters input variables for calculating the different designs in the lower section of the sheet. Figure 1 shows where users input heat conductivity and the thickness of sublayers. Different values can be entered for each design. Column D again shows values for the active variant.

One of the previously defined sublayers can now be selected from a dropdown menu in column E of the U-Value worksheet's Variant section (Figure 2). If necessary, this information can be displayed on the left side of the worksheet. Once selected, the heat conductivity and thickness parameters are shown to the right of the selection. At the same time, a macro writes a link to these parameters in the yellow cells for each sublayer. This step allows the parameters for each active variant to be fed into the PHPP calculation. Any values previously entered into the yellow cells manually are cached and restored to the original place if the variant calculation is deactivated for a sublayer.

Other areas in the Variant sheet have been set up for other frequently used input parameters. Values can be transferred from this sheet to the corresponding worksheets in a similar manner (Figure 3). Manual links can transfer other values to the respective PHPP cells from a user-defined area.

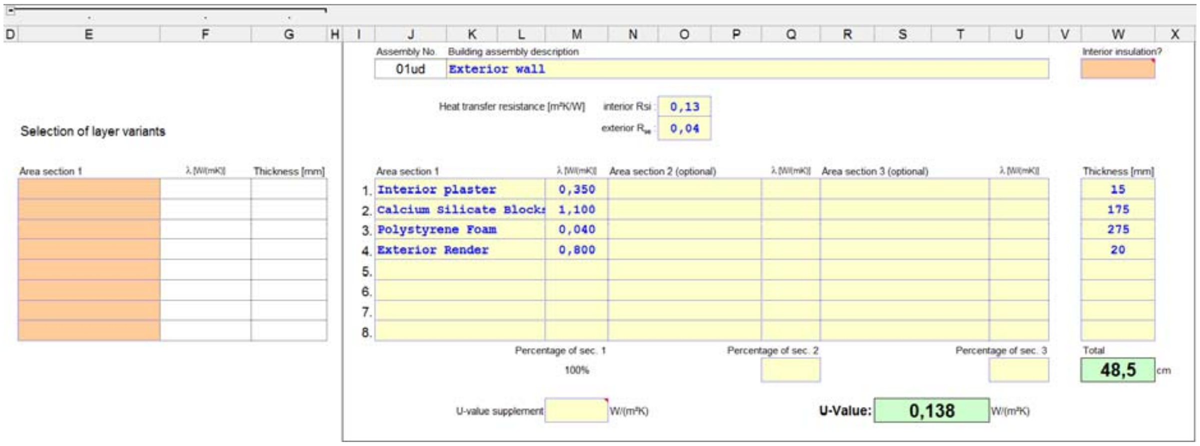


Figure 2: A screenshot of the U-values worksheet in PHPP 9 (beta version). The variant area is shown on the left side.

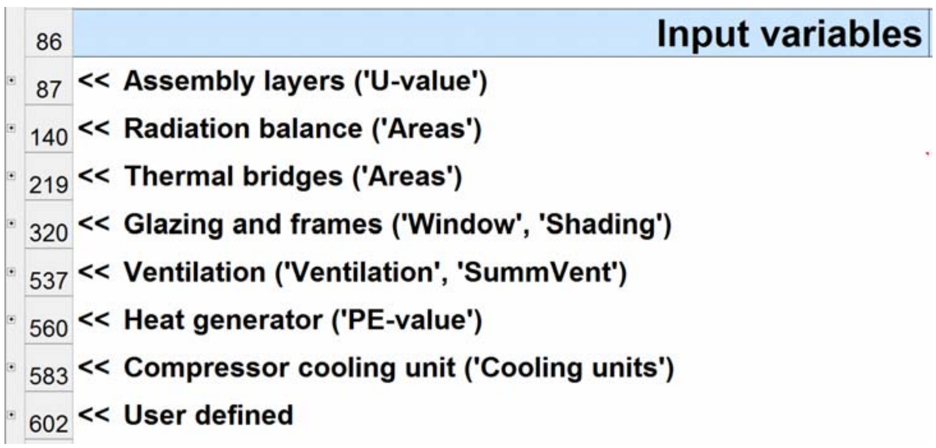


Figure 3: A screenshot of the Variants worksheet in PHPP 9 (beta version) with an overview of proposed input parameters. Each cell can be displayed by clicking on the plus sign on the left margin.

Once the input variables have been entered and activated in the appropriate PHPP sheets, key findings for each design are shown side-by-side at the top of the Variants sheet (Figure 1). These findings include the heating demand and heating load, cooling demand and cooling load, frequency of overheating events, primary energy demand, and compliance with certification criteria. Other findings can be added using user-defined links. This offers a quick, clear comparison of the different designs.

The findings for all designs are updated in real time, and every time that a change is made at any place in the PHPP. Excel calculates a complete PHPP for each variant in the background, even though worksheets only show the active version. Calculation speed may be significantly slower when entering a very large number of variants and using computers with older versions of Excel and less powerful processors. It may make sense to temporarily deactivate the automatic calculation of data tables in Excel settings if this happens.

3 The new Comparison PHPP worksheet

The Comparison sheet can compare the energy demand and affordability of two designs chosen from the Variants worksheet. Users can calculate the impact of designing individual components differently, such as varying insulation thickness, window quality, or ventilation systems. Two complete building designs with all building components may also be compared.

Users select one option with higher efficiency and one with lower efficiency. Two complete PHPPs are calculated in the background if only individual components are to be compared. These PHPPs differ solely by virtue of the different properties of the selected building component. All other building components are assumed to be the same as in the "higher efficiency" option. This approach allows the calculation to focus on the impact of the selected building component. This may avoid the exact same building component showing higher heat losses in a building lower over-all efficiency because of longer heating periods. What's more, saving and affordability calculations also tend to be conservative in most cases, as they tend to rate the poorer quality building component better.

The final energy demand for the entire building is determined for each of the two designs by adding the energy demand for heating, cooling, and mechanical ventilation. This figure is also used to calculate CO_2 output and primary energy demand. The difference between both values is shown on the right side and used to derive the savings made by the option with higher efficiency.

The worksheet also calculates economic feasibility using the dynamic annuity method. Savings in final energy demand are multiplied by the costs of the chosen energy sources to arrive at the annual energy cost saving. Annual capital costs for the additional investment in the higher efficiency option are subtracted from this figure, resulting in total annual savings for the higher efficiency option. Investment costs per kilowatt-hour saved are also shown as another finding. The maximum investment at which the higher efficiency option would be more affordable than the lower efficiency option is at least shown if information about investment costs is not available.

Passive House planning: **COMPARISON BETWEEN TWO VA**

Selection of comparison configuration

Description	1-Exterior wall
Component type	Building assemblies ('U-Value')
Component	01ud exterior wall

Calculation of selected configuration

	Lower efficiency		Higher efficiency		Difference / Savings / Profit		
Design according to variant	1-Existing		3-Renovation Passiv				
U-Value	2,519		0,138				W/(m²K)
Minimal interior surface temperature	5,2		19,0				°C
	Mould!	Uncomfortable!					
	Investment						
	Per m² of component	Whole component	Per m² of component	Whole component	Per m² of component	Whole component	
Area of component	1,00	184	1,00	184	1,00	184	m²
Investment costs less sum of financial support	39,94	7360	98,98	18240	59,04	10880	€
Annuity (capital costs)	1,41	259	3,49	643	**2,08**	**384**	€/a
	Energy (Space heating + cooling + mech. ventilation)						
	Per m² of TFA	Entire building	Per m² of TFA	Entire building	Per m² of component	Whole component	
Area	1	156	1	156	1	184	m²
Annual heating demand	241,39	37657	13,65	2129	**192,80**	**35528**	kWh/a
Cooling + dehumidification demand							kWh/a
Final energy demand	504,49	78700	33,99	5302	398,30	73398	kWh/a
CO_2-Emissions	142,33	22203	9,82	1532	112,18	20672	kg/a
Primary energy demand	558,51	87128	38,39	5989	440,31	81139	kWh/a
Total cost space conditioning	46,03	7181	3,23	505	**36,23**	**6676**	€/a
	Economic viability						
Total annual costs	47,69	7440	7,36	1148	**34,15**	**6292**	€/a
Maximal economically viable additional investment costs					**1027,52**	**189346**	€
Cost per kWh of saved final energy					**0,5**		Cent/kWh

Figure 4: A screenshot from the Comparison spreadsheet in PHPP 9 (beta version).

4 Examples

Modernizing old buildings is clearly the typical application for calculating different designs. Each interim step in a step-by-step modernization project can be entered as variants together with the renovated and unrenovated building. This enables energy demand to be determined for each step and compared with measured consumption, for instance.

The new worksheets are also a good way of calculating different designs for new and old buildings. For instance, a variety of windows from different suppliers can be compared to look at their impact on energy demand after a call for tenders. Users can also check whether energy savings throughout the window's lifetime make up for the extra cost of a product with better energy credentials.

Where several identical buildings differ only in a few points, such as orientation or shading, only one building has to be entered, with the other buildings added as variants. Deviating parameters need only be entered into the Variant sheet in this scenario. This might also be the case if terraced houses in a line are to be calculated individually in the PHPP.

The integrated economic feasibility tool can be used to apply for exemptions from EnerPHit certifications when a few required measures are unfeasible due to the nature of old buildings.

5 Outlook and acknowledgements

A beta version of PHPP 9 with variant and economic feasibility calculations was available at the time when this presentation was drawn up (January 2014). Project partners are gradually testing this version for use in a gradual modernization project as part of the EU EuroPHit initiative.
Both new functions were first integrated into PHPP 2007 as part of the European 3ENCULT project (Efficient Energy for EU Cultural Heritage; www.3encult.eu), but were not included in the PHPP version for distribution at that time. The EU EuroPHit project ("Improving the energy performance of step-by-step refurbishment and integration of renewable energies"; www.europhit.eu) is developing both functions and integrating them into the version of PHPP 9 for distribution.
Beyond the functions described in this presentation, the following innovations are also in the pipeline for PHPP 9:

- More accurate calculations of demand for energy for hot water
- Convenient generation of the entry for the Passive House project database (www.passivehaus-projekte.de) straight from the PHPP.
- A new Control worksheet: An overview of error and warning messages and suggestions about the reasons why calculation results are missing.
- A worksheet for the new Passive House sustainability rating and new classes of Passive House buildings.
- An amended Verification sheet to reflect new or altered certification criteria

References

[AKKP42 2012] Ökonomische Bewertung von Energieeffizienzmaßnahmen; Protokollband des Arbeitskreises kostengünstige Passivhäuser Phase V; Passivhaus Institut; Darmstadt 2013.

Internal Insulation Applied to a Listed School Building: in Situ Measurements and Numerical Analysis

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1 Scope

The European Project 3ENCULT aims to develop energy efficient solutions for EU cultural heritage [Troi, 2013]. In this framework a school building in Innsbruck is going to be retrofitted. The type of insulation is still under discussion; most probable is the application of internal insulation, since the façade has to be preserved.

In November 2012 two classrooms have been provided with different internal insulation systems for testing. The employed insulation materials are PU-foam in combination with capillary active channels and clay glue for the first system (IQ-Therm system, Figure 1, left) and blow-in cellulose for the second one (Figure 1, right). Capacitive sensors have been installed for monitoring of temperature and relative humidity at different positions (between insulation and masonry, at the internal and external surfaces and in the surrounding ambient). The analysis of the measured data aims to select the most appropriate solution to be employed for the retrofitting of the whole building, with respect to the moisture damage risk.

2 Results

In Figure 2 the temporal evolutions of measured relative humidity behind insulation for both the test-rooms are reported and compared with simulation results. The simulations have been performed with a finite-volumes based program [“Delphin Software,” 2011], employing 2D models. Figure 2 reports also the internal and external relative humidity values. The numerical results show satisfactory agreement with the measured values, demonstrating that the assumptions on the material data and boundary conditions used for the simulation are adequate. From the temporal evolution of relative humidity, it can be observed that both constructions are drying. However the first test-room (Figure 2, left) presents values of relative humidity under the insulation starting from 100%. This can be explained, considering that the fixing-clay used for the insulation boards has to be applied wet. The very slow drying process of the construction can represent a drawback of this system, since the favourable conditions for germination of mould are present behind the insulation over a long period of time (relative humidity over 75% all over the monitored period). Hence, air voids behind insulation, inside which germination could start, have to be carefully avoided.

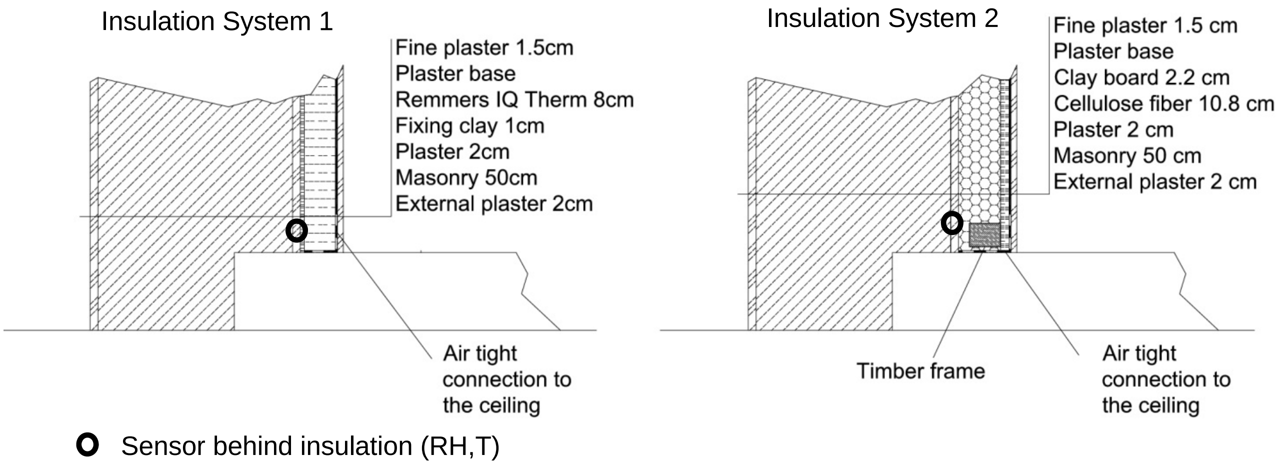

Figure 1: vertical sections of the wall-ceiling junction. Insulation system 1: PU-foam insulation in combination with capillary active clay (left). Insulation system 2: Cellulose fibre and clay boards (right)

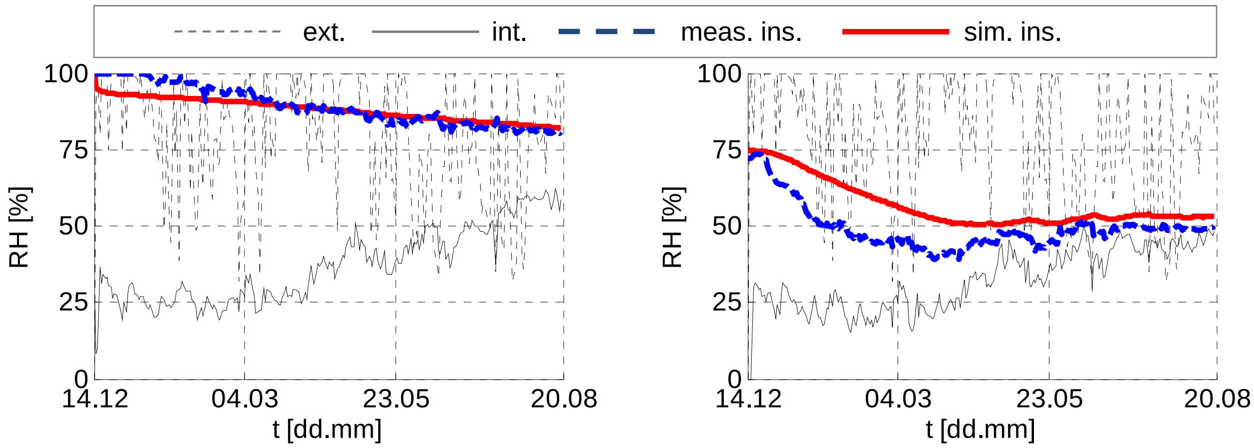

Figure 2: evolution of the relative humidity (left: system 1, right: system 2) over the monitored time period (Dec.2012-Aug.2013). External (ext.) and internal (int.) values as well as measured (meas.) and simulated (sim.) values behind insulation (ins.).

The cellulose-based system (Figure 2, right) presents non-critical values of relative humidity, therefore it can be considered appropriate for this application. However, it has to be noticed that the internal relative humidity remains very low during the whole winter period (around 25%) due to the moderate humidity sources and active ventilation in the classrooms. Numerical simulation has shown that higher internal moisture sources or limited air exchange rate can lead to modified conditions under the insulation [Janetti et al., 2013], hence mechanical ventilation is recommended.

References

Delphin Software. (2011). http://www.bauklimatik-dresden.de/delphin/.

Janetti, M. B., Pfluger, R., & Ochs, F. (2013). Comparing solutions for retrofitting of a listed school building with internal insulation. *2. Internationaler Innendämmkongress*.

Troi, A. (2013). Solution & tools for the conservation compatible energy retrofit of historic buildings. *Tagungsband Internationale Passivhaustagung, Frankfurt am Main*, 135–140.

Energy refurbishment of heritage buildings with PHPP´s and real measurements´ feedback

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Scope

“Historic buildings are the origin of uniqueness of European cities; they are a living symbol of Europe’s rich cultural heritage and reflect society’s identity. In the same time the heritage buildings are area of the high level of energy inefficiency.
The European project 3ENCULT bridges the gap between conservation of historic buildings and climate protection “[1]. Structural solutions and even non-invasive interventions were applied to a various groups of Case Studies located around Europe. This paper intends to demonstrate the application of PHPP (Passive House Planning Package) calculation tool and real data measurements and their combination in a way of approaching individual adapted energy efficient refurbishment interventions on listed buildings.

Procedure

In the first step, the PHPP was used for calculation of the energy balance of the status quo and the results were compared (as far as possible and available) with the energy consumption of the building before the intervention. The verified models were used as a basis for decisions on further variants for interventions in terms of energy efficiency. For this step was developed an additional “Parameter” sheet for PHPP (available included in PHPP9) by Passivhaus Institut. This tool was used for documentation of various energy-savings interventions and their mutual comparison within 3ENCULT, seen in Fig. 2 (right).
Then, if available, energy consumptions measured after the intervention was used for verification of the chosen variant, previously calculated with PHPP[2].

Results

In **Error! Reference source not found.**, the data concerning the 5 chosen case studies are reported. In case of school building in Hötting - Innsbruck (AT) a good agreement between measured and simulated data was obtained, see Fig.2 (left). The PHPP model was adapted to the real energy consumption. Expected reduction of total final energy demand reached 60 % despite the increase in electricity demand caused by addition of ventilation system. That caused increase of electrical energy use by 2,5 kWh/(m²a) but the overall final heating demand dropped by 21,3 kWh/(m²a) and better indoor air quality was provided.
The deviation between measured and simulated values for the other case studies, see Fig 1, can be explained considering lack of knowledge about the installed building systems. Study of the problem showed that the use of the building before refurbishment was not always studied properly, thus instead of actual inputs the standard values were applied.

CS	BEFORE INTERVENTIONS PHPP	Measured	AFTER INTERVENTIONS PHPP	Measured	Energy reduction PHPP	Match of datas PHPP/Measured	Kind of used energy
1) Innsbruck (Austria)	*14,9*	*15,1*	*16,1*	-	-8,1%	98,7%	*Electricity [kWh/(m² a)]*
	127,5	*124,4*	*39,8*	-	68,8%	102,5%	*Gas [kWh/(m² a)]*
	142,4	*139,5*	*55,9*	-	60,7%	102,1%	*Total [kWh/(m² a)]*
2) Copenhagen (Denmark)	*13,3*	*62,0*	*16,3*	-	-22,7%	21,4%	*Electricity [kWh/(m² a)]*
	154,9	*83,6*	*133,2*	*133,4*	14,1%	142,5%	*Heat [kWh/(m² a)]*
	168,2	*145,6*	*149,5*	-	11,2%	115,5%	*Total [kWh/(m² a)]*
3) Salamanca (Spain)	*20,9*	*21,9*	*18,5*	-	11,3%	95,4%	*Lighting [kWh/(m² a)]*
	51,0	-	*51,0*	-	-	-	*Gas [kWh/(m² a)]*
	-	-	-	-	-	-	*Total [kWh/(m² a)]*
4) Bologna (Italy)	*52,1*	*51,0*	*50,7*	-	2,6%	102,0%	*Electricity [kWh/(m² a)]*
	300,3	*123,9*	*281,6*	-	6,2%	242,4%	*Gas [kWh/(m² a)]*
	352,4	*174,9*	*332,3*	-	5,7%	201,4%	*Total [kWh/(m² a)]*

Figure 1: Comparison of PHPP and measured final energy consumed before and after interventions

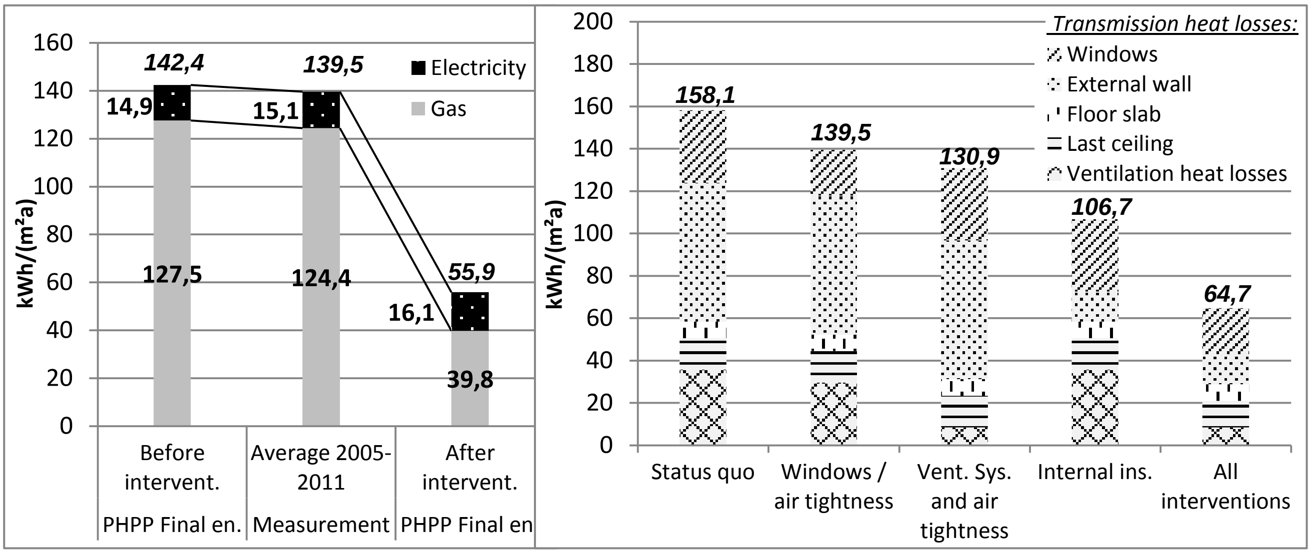

Figure 2: Comparison of PHPP and measured final energy use in case study CS5 (school building Hötting , Innsbruck, Austria (left), Heat loses for considered variants of interventions (right)

From the measurements it was often not possible to distinguish the results relevant to the adequate part of the building being reconstructed. The PHPP was found as a dissent calculation tool even for reconstructions of historical buildings but with emphasis that the input values should be based on conditions corresponding with conditions occurred during the energy measurement.

Some examples supports the message of 3encult project, that even in historical buildings the reductions of energy demand by "Factor 4" is possible.

This study is part of the European project 3ENCULT within the 7th Framework Program.

References

[1] A. Troi, "Publishable summary – 3ENCULT", pp. 1-2, 2011

[2] P. Sevela, R. Pfluger, 3ENCULT, Deliverable 7.5: Evaluation of the monitoring and PHPP