Deep renovation of historic buildings

The IEA-SHC Task 59 path towards the lowest possible energy demand and CO_2 emissions

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Abstract

Purpose – Improving the energy performance of historic buildings has the potential to reduce carbon emissions while protecting built heritage through its continued use. However, implementing energy retrofits in these buildings faces social, economic, and technical barriers. The purpose of this conceptual paper is to present the approach of IEA-SHC Task 59 to address some of these barriers.

Design/methodology/approach – Task 59 aims to achieve the lowest possible energy demand for historic buildings. This paper proposes a definition for this concept and identifies three key socio-technical barriers to achieving this goal: the decision-makers' lack of engagement in the renovation of historic buildings, a lack of support during the design process and limited access to proven retrofit solutions. Two methods – dissemination of best-practice and guidelines – are discussed in this paper as critical approaches for addressing the first two barriers.

Findings – An assessment of existing databases indicates a lack of best-practice examples focused specifically on historic buildings and the need for tailored information describing these case studies. Similarly, an initial evaluation of guidelines highlighted the need for process-oriented guidance and its evaluation in practice.

Originality/value – This paper provides a novel definition of lowest possible energy demand for historic buildings that is broadly applicable in both practice and research. Both best-practices and guidelines are intended to be widely disseminated throughout the field.

Keywords Historic buildings, Energy retrofit, Best practice, Guideline, Low energy
Paper type Conceptual paper

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Introduction

Global greenhouse gas emissions have increased continuously since 1960 and CO_2 concentrations have risen above the threshold established to "preserve a planet similar to that on which civilization developed" (Hansen *et al.*, 2008, p. 217). Retrofitting existing buildings has the potential to greatly reduce carbon emissions. For example, just the retrofit of European dwellings built before 1945 could save annually up to 180 Mt of CO_2, equivalent to 3.6 per cent of the total EU-27 CO_2 emissions in 1990 (Troi and Bastian, 2015).

Although the composition of the existing building stock changes across countries, historic buildings constitute a considerable share of the building stock in many countries around the world. More than 14 per cent of the existing buildings in Europe were built before 1919 and 12 per cent were built between 1919 and 1945 (Troi and Bastian, 2015). In the USA, almost 40 per cent of commercial and residential buildings were built before the development of building energy conservation codes in the 1970s (Webb, 2017). Improving the energy performance of historic buildings will not only lead to carbon savings, but will also improve the occupants' thermal comfort conditions, reduce energy demand, and subsequently reduce the risk of fuel poverty. Providing occupants with current standards of comfort is crucial to ensure the continued use of historic buildings over time and, consequently, their conservation (Aigwi *et al.*, 2018).

Despite the many benefits, the renovation rate of the existing building stock is still very low (Artola *et al.*, 2016), and the renovation rate for historic buildings is likely to be even lower. In countries like the UK (Itard and Meijer, 2008) and Italy (Lucchi and Pracchi, 2013) the built heritage has been exempted from energy retrofit programme until recently. However, since the first Energy Performance of Buildings Directive (EPBD 2010/31/EU Art. 4), in which historic buildings were given a waiver from the obligatory nature of the directive, there has been a significant change in the perception of energy retrofits of historic buildings. Several interdisciplinary research projects (e.g. 3encult, EFFESUS, RiBuild, or Spara och Bevara), series of international conferences (e.g. EEHB) and the establishment of international committees (e.g. ICOMOS ISCES+CC, Heritage & Regeneration committee of ECTP) demonstrate a growing interest in the topic from both technical and conservation perspectives. The rising interest in the topic is also reflected by an increasing number of scientific papers in the last decade (Martínez-Molina *et al.*, 2016), although the reflection on the heritage significance is, in most cases, still limited (Lidelöw *et al.*, 2019).

The International Energy Agency (IEA) has recently made the preservation of built heritage the focus of a new collaborative research project. Within the Solar Heating and Cooling programme (SHC), 25 organisations (including public and private research institutions, heritage authorities, public administration and industry) from 13 countries have joined forces in IEA-SHC Task 59 – deep renovation of historic buildings towards lowest possible energy demand and CO_2 emission (NZEB) (http://task59.iea-shc.org/). The Task 59 was developed to support historic building decision makers (i.e. those that are able to pursue the renovation of historic buildings; this includes owners, managers, practitioners and public sector) by sharing the existing research work, knowledge and new findings from all involved partners in a highly interdisciplinary collaboration. The purpose of this conceptual paper is to present the approach of Task 59 to addressing some of the socio-technical barriers that are preventing the implementation of solutions already available. Additionally, this paper discusses the need for a new definition of what the lowest possible energy demand should mean for historic buildings.

Barriers to energy retrofits in historic buildings

Previous research in the field provided valuable insights into the motivations and limitations for the energy retrofit of historic buildings. Most of this research, however, is focussed on privately owned residential buildings and limited to the European context. In a recent study, Kaveh *et al.* (2018) proposed three main categories of limitations to the implementation of retrofit measures: social, economic and technical viability.

Social viability is probably the most complex of the three groups defined by Kaveh *et al.* (2018). Within this category, previous studies have highlighted that owners' personal circumstances play a crucial role in the final decision. Householders' perception of the benefits of improving the building must exceed the disruption caused, regardless of the costs (Vadodaria *et al.*, 2010). Mallaband *et al.* (2012) identified some common barriers among owners of historic properties related to their values and preferences, concerns about professionals' availability and expertise (Glew *et al.*, 2017), and compatibility with the historic features of their homes. Up to 70 per cent of those households abandoned the idea of improving their homes because of "their personal set of values" (p. 7). That is, the information and solutions available to the homeowners when making that decision were not enough to persuade them to include energy-efficient measures in the renovation of their home. Ownership and interest of the local community also play an important role in the case of public historic buildings (Yazdani Mehr and Wilkinson, 2018).

Other studies pointed out that the major drivers for renovation are comfort, utility bills or aesthetics rather than energy efficiency (Simpson *et al.*, 2016). The attitude towards carbon emissions then becomes a burden in an already complex decision-making process (Kaveh *et al.*, 2018). The interviews carried out by Sunikka-Blank and Galvin (2016) with historic building owners revealed the difficulties that "retrofitters" (p. 98) faced when trying to balance the buildings' efficiency and the aesthetic conservation of their properties. In fact, aesthetics was as important as the economic criteria in most of the cases. Although most owners see interventions such as wall insulation or window replacement as invasive and inappropriate (Anderson and Robinson, 2011), homeowners do not share a common vision of aesthetics or heritage and instead need to be understood individually. Sunikka-Blank and Galvin's study revealed that homeowners wanted to safeguard their properties despite not being formally listed ("heritage by designation", p. 97) since they perceived them as having an aesthetic value ("heritage by appropriation" p. 97). It has also been noted by Femenías *et al.* (2018) that historic buildings bring added value to their occupants (both homeowners and tenants) regardless of their level of protection. Preserving the value of historic buildings (including aesthetic, cultural and social aspects) is of major importance. However, if decisions are made by experts unaware of the occupants' appreciation of heritage (Fouseki and Cassar, 2014), there is a risk of losing the "existential value" (Coeterier, 2002, p. 121) that historic buildings offer to people and eventually endangering the relationship between heritage authorities and private owners (de Groot *et al.*, 2008).

The economic viability of interventions has a prominent place in literature (Almeida and Ferreira, 2018; Ascione *et al.*, 2017; Liu *et al.*, 2018). However, the many competing objectives related to energy decisions in historic buildings, as well as the importance of (contested) cultural heritage values, make actual decision making far off the cost-benefit calculations presupposed in much theoretical work about energy efficiency in buildings (Leijonhufvud, 2016).

Within the technical viability of interventions, one of the main barriers for any decision maker, but especially for private owners of historic buildings, is deciding "what to do, where to start, and which measures to implement in which order" (Fabbri *et al.*, 2016, p. 4). Ástmarsson *et al.* (2013) concluded that informational barriers are more limiting than any actual lack of technical solutions. In the specific field of listed building renovation, Friedman and Cooke (2012) suggested that a lack of consistency in the planning policies of local authorities might be acting as a barrier for the adoption of energy-efficient measures. This has proven to be particularly important in the case of integration of renewable energy sources (Scognamiglio *et al.*, 2012). Additionally, energy modelling has also been identified as a technical barrier for the implementation of energy-efficient measures (Berg *et al.*, 2017). Building accurate energy models of existing buildings is a complex, resource-intensive process suited only to expert users.

The IEA-SHC Task 59 approach: towards lowest possible energy demand

The scope and approach of Task 59 is the combined result of three different efforts. First, the results achieved in previous research projects (e.g. 3encult, EFFESSUS, Spara och Bevara) are the foundation stone of Task 59 and this paper. In addition, several members involved in these projects participated in the two Task definition meetings that took part before the launch of the project (Brussels 2016 and Vienna 2017 with the participation of 24 experts) to narrow down its scope. Last, the analysis of previous research presented in this paper informed the specific objectives of Task 59, in response to the barriers identified in the implementation of deep retrofits in historic buildings.

The approach proposed by Kaveh *et al.* (2018) to structure barriers around three categories helped the Task 59 team understand the nature of such limitations. Beyond the purely technological (development of conservation compatible solutions) and economic (funding schemes) limitations, most of the barriers are due to social factors. However, this category, as defined by Kaveh *et al.* (2018), is too broad as it tries to gather very different causes under the same term. Also, some limitations identified in the studies presented above are neither purely social nor technical, but rather the combined result of socio-technical issues. Based on the analysis of the existing literature, the main barriers that are preventing decision makers from the actual implementation of such deep retrofits can be reformulated into: the decision makers' lack of engagement in the renovation of historic buildings; lack of support and guidance in a complex design process; and limited access to tested retrofit solutions that can ensure heritage compatibility and long-term performance.

This paper presents and discusses the multidisciplinary methodologies developed within the Task 59 to address the first two issues. The limited access to solutions is partly tackled with the development of a best-practice database for historic building renovations explained below and is also the focus of a separate activity currently under development within the same project.

The definition of lowest possible energy demand in the context of historic buildings

The European directive 2010/31/EU (The European Parliament and The Council of the European Union, 2010) defines NZEB as "a building that has a very high energy performance. The nearly zero or very low amount of energy required should be covered to a very significant extent by energy from renewable sources, including energy from renewable sources produced on-site or nearby" (p. 153/18). It is left to the Member States to specify how this benchmark is met and define low amount of energy, and on-site or nearby. While there is no equivalent definition in the USA, low energy demand is considered a fundamental quality of zero energy buildings; renewable energy should only be implemented when energy efficiency strategies are no longer cost-effective (Pless and Torcellini, 2010). In both cases, the discussion is almost exclusively centred on the cost-optimal analysis of different scenarios when it comes to the identification of an energy demand target. Technology availability is no longer a limitation in the achievement of high-performing buildings, both new and retrofitted.

A key question, not only for this paper, but for energy policy regarding existing buildings in general, is how lowest possible energy demand in historic buildings should be defined. In this paper, historic building does not necessarily refer to a formally listed or protected building, but rather to any building that is worth preserving because of its cultural value (in line with the scope of EN 16883; CEN, 2017). This way of defining historic buildings deviates from the conventional approach that underpins most contemporary planning, in which a distinct line is drawn between heritage and non-heritage buildings. To open up for a more flexible definition also implies a wider space of negotiation when it comes to what kind of energy retrofits can be considered appropriate. This means that conservation aspects should be taken into account when choosing the energy retrofit measures, even when the building is not formally listed, but also that no measure should be ruled out beforehand, regardless of the level of protection.

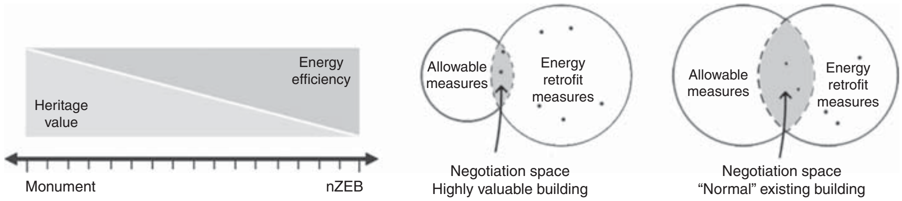
Previous attempts to define an energy benchmark have presented the performance of historic buildings as a linear continuum between their conservation requirements and the achievable efficiency (Figure 1, left). With this approach, a building's highest energy efficiency is assumed to be defined by its level of formal protection (Uranga *et al.*, 2018), class of cultural value (Tønnesen, 1997) or how much (quantitatively) the building can be altered (Dulski, 2011). Although the ultimate goal is to improve the efficiency of buildings, this approach presupposes that the more valuable the building is, the less efficient it will be. As a consequence, some measures are discarded *a priori*, based exclusively on the building's category. In addition to that, most of these methodologies rely almost exclusively on a formal distinction between heritage and non-heritage (heritage by designation) and neglect how heritage is perceived by those who live in or occupy the buildings (heritage by appropriation), as well as the time-dependent change in that perception. This rigid classification could potentially lead to the loss of valuable heritage, especially in the case of not formally listed buildings.

The new approach proposed here focusses on the idea of a changing negotiation space (Figure 1 right). The negotiation space would include any retrofit measure that is compatible with the building. It would therefore depend on the assessment of the single building and result from the dialogue among the different stakeholders involved in the decision making. The implementation of all compatible measures included in the negotiation space would achieve the lowest possible energy demand for that building. In many cases, however, other factors would have to be considered (e.g. cost, occupants' acceptance, or market accessibility) and may well result in a different intervention. The ultimate goal of the methodologies presented below and the Task 59 as a project is to promote the energy retrofit of historic buildings and facilitate implementation towards their lowest possible energy demand.

Lidelöw *et al.* (2019) pointed out in their review the still scarce but growing number of articles with a wider life cycle perspective. The existing literature already shows that embodied energy cannot be disregarded and that the idea of "avoided environmental impact" (p. 236) can support conserving and retrofitting vs demolition and new construction. The negotiation space, as a concept, can be broadened to include other aspects of the life cycle assessment. However, this goes beyond the scope of this paper, which keeps in line with the European directive and only considers the energy used in the operational phase.

Addressing barriers in decision makers' engagement through best practices

The barriers identified in the literature indicate the need for tools that change attitudes towards energy efficiency in historic buildings. The dissemination of exemplary case studies has positively impacted the transition towards sustainable development in the construction



Note: Traditional approach of heritage conservation vs energy efficiency (left, based on Tønnesen, 1997 and Uranga *et al.*, 2018) and proposed definition of lowest possible energy demand as a negotiation space (right)

Figure 1. Graphical representation of energy efficiency targets in historic buildings

sector (Femenías, 2004). As part of a development process that includes basic practice, best practice, demonstration projects and experimental projects, "Good examples" are described as a powerful tool that has been successfully used to show what can be achieved (e.g. in terms of energy efficiency) as a way to influence mainstream building practices.

If "basic" practice is seen as "business as usual", "best-practice" has been defined as "the best that can be achieved with present technology and methods" (Femenías, 2004, p. 250). Best-practice examples could therefore be a valuable resource for decision makers and practitioners to learn from, especially if the renovation project is presented together with an explanation of the building's heritage value and cultural significance. Explicitly articulated heritage values support a more informed selection process (Lidelöw *et al.* 2019). As Adams *et al.* (2014) pointed out, "by increasing awareness of the historic features of these buildings, specifically as they relate to energy use, it might be possible to engender attitudes that promote more effective use of the infrastructural legacies of the past" (p. 179).

Additionally, a collection of best-practice examples with detailed documentation of the decision-making process could play a key role in the negotiation with the local authorities during the planning application. However, the usefulness of a resource like this would depend heavily on how well the information is fitted to the targeted audience and the technical robustness of the examples shown.

The main pitfalls for the success of best practices and demonstration projects, as identified by Femenías (2004) in her literature review, were mostly linked to the nature of the information provided (poor definition of the target audience, lack of access to appropriate examples and the incomplete documentation and evaluation of results). Ultimately, the development of a curated database of best-practice examples should provide decision makers with comprehensive information on the different aspects of the intervention and present these projects as aspirational models. Such a database would promote exemplary retrofits so "that tomorrow's 'best' practice and demonstration practice will become mainstream" (Femenías, 2004, p. 250).

Review of existing databases

An overview of existing online accessible databases is presented in Table I. Although this list does not claim to be complete, it presents the state of the art and reveals the weaknesses of such repositories for our specific purpose. None of the identified databases has a focus on energy-efficient renovation of historic buildings, with the exception of the Responsible Retrofit Knowledge Centre. However, this database has only included two examples since its creation in 2012. Other databases also incorporate buildings of particular cultural value, either generally under renovations or as a special category (e.g. dena). The most comprehensive surveys of energy-efficient renovations, as in Construction21 or the US Green Building Council's database of LEED certified buildings, do not consider the specific requirements of historic buildings. Furthermore, none of these databases reflects the construction systems of historic architecture. Ultimately, a best-practice database must leave enough room to explain why certain products and solutions have proven to work in a particular historic building. Product databases (e.g. EffiBUILDING database; www.effibuilding.eu/db/) miss the depiction of the connection between the building and the solution, something indispensable in the case of historic buildings. The balance between local and global context, or between focussed and generic data, is a delicate issue that might have an important effect on the final usability of the database, the size of the sample and its persistency.

A best-practice database for historic buildings

The assessment of energy interventions in historic buildings requires a level of detail, and a targeted query strategy, that none of the existing databases can offer. The scope and

Database name	Considered region Europe (EU)/World Wide (WW)	Projects included New Construction(N)/Renovation (R)/Hist. Buildings(HB)	Recorded items Districts (D)/Buildings (B)/Components (C)/Products (P)	Size of the data collection Number of recorded items: only renovations (R)/ only historic building renovations (HB)	Level of interaction Filter function for building types (FB) and Solutions (FS)/ Integrated Decision Support (D)/ Constant Quality Assessment (Q)/Growing Database (+)	Features considered	General Building Information (A)/	Cultural Values (V)	Construction of the thermal envelope (C)	Energy Performance (E)	Building Services (B)	Renewable Energy Systems (R)	Planing Process + Business modells (P)	User comfort (U)	Economic aspects (X)	Environmental Assessment and Sustainability (S)	Monitoring data (M)	Comments enrolment process, reliability of data, quality assessment, level of detail, etc.
Construction21[a]	WW	N, R	D, B, C, P	468 91 (R)	FB, FS, Q +		■		■	■	■	■			■	■		Case studies are declared by the architect in a datasheet, basic data are mandatory, data reliability is stated by the customer; the case studies are generated, among others, from the applications for the Green Solutions Award
Responsible Retrofit Knowledge Centre, STBA[b]	UK	HB	B	2 (HB)	D, Q, +		■	■	■		■			■				General information on building construction and energy efficiency measures, no construction detail; The evaluation of the case studies should lead to a decision process within the project development
IEA SHC Task 37: Advanced Housing Renovation[c]	WW	R, HB	B	60 (R)			■	■	■	■	■	■						Report on lessons learned from a collective look at the case studies, involved countries: AT, BE, CA, CH, DE, DK, I, NL, NO and SE
IEA SHC Task 47: Solar Renovation of Non-Residential Buildings[d]	WW	R, HB	B	20 (R)			■	■	■	■	■	■	■			■		Non-residential buildings in three categories: educational buildings, office buildings and historic and protected buildings; report on lessons learned
dena (Deutsche Energieagentur)[e]	DE	N, R, HB	B	ca. 1,300 (60% (R), 5% (HB))	FB		■		■	■	■	■						Registered buildings have to meet an “Effizienzhaus” standard. Registration of examples by architects with the consent of the owner
ExcEED[f]	EU	R, N	D, B	Work in progres	FB, FS, D, +		■		■	■	■	■		■		■	■	Continuous transmission of monitoring data. Database conceived for last generation of buildings but applicable to any building typology. The database integrates an IEQ survey and geocluster visualization tool
NZEC Zero Energy Residential Case Study Database[g]	US, CA	N, R	B	80	R, +		■		■	■	■	■	■					The most comprehensive source of North American zero energy residential case studies.
US Green Building Council's project directory[h]	US, WW	N, R	B	111,146 11,242(R) 46 (HB)	FB, +		■		■	■	■	■		■	■	■	■	Database of projects certified by LEED (Leadership in Energy and Environmental Design), the most widely used green building rating system in the world
Passive House Database[i]	WW	N, R	B, C	4270 ca. 210 (R)	FB, Q, +		■		■	■	■	■		■				Passive House Buildings that have already been completed or are under construction (also EnerPHit certification). All information is based on data entered by the project registrant (planner or building owner)
Sanierungsgalerie[j]	DE		B		FB, Q, +		■		■	■	■	■				■		Elaborated in Interreg GreenSan for the state of Baden-Württemberg. Will be continued later by the regional energy institute. The registration and quality control takes place via this central office
Bruxelles Environment[k]	BE	N, R	B (S)	ca. 250	(FB)		■		■			■						Part of the Brussels Environment GIS Portal, Exemplary buildings within the Brussels city area
Historic Building Atlas	WW	HB	B, (S)	Work in progress	FS, FB, A		■	■	■	■	■	■	■	■	■	■	■	Elaborated in the IEA-SHC Task 59 and Interreg Alpine Space project ATLAS (here specifically for Alpine region) as an online database specifically for historic buildings

Sources: [a]https://www.construction21.org/; [b]http://responsible-retrofit.org/search-results/; [c]http://task37.iea-shc.org/publications; [d]http://task47.iea-shc.org/publications; [e]https://www.dena.de/themen-projekte/energieeffizienz/gebaeude/bauen-und-sanieren/effizienzhaus-datenbank/; [f]http://www.exceedproject.eu; [g]http://netzeroenergycoalition.com/case-studies/; [h]http://www.usgbc.org/projects/; [i]http://www.passivhausprojekte.de/; [j]https://www.sanierungsgalerie.de/; [k]http://geoportal.ibgebim.be/webgis/batiments_exemplaires.phtml

Table I.
Summary of existing databases appraisal

content of such a database has been discussed with the interdisciplinary panel of experts that forms the Task 59. The aim is to make existing best-practice experiences available to decision makers. However, this is not a homogeneous target group as it includes different stakeholders with different understanding of the complexity of the renovation process (e.g. building owners, real estate developers and managers, public sector, and architects, engineers and planners). It is crucial to identify the characteristics that define a best practice as well as the requirements for the data provided so that the information made available to the users meets their needs.

Establishing a single quantitative criterion or threshold to measure the degree of success of an intervention exclusively as a function of the energy saving (i.e. kWh/m^2), would not be compatible with the definition of lowest possible energy demand presented before as it goes against the principle that every building must be considered individually. Instead, this database will consider as best practice any example that fulfils the following requirements:

- Renovation of the whole building. The database aims to present examples that have sought an improvement in the building's overall energy performance, rather than remain limited to the improvement of a single aspect of the building. Also, in the case of retrofitted historic buildings, the whole is often greater than the sum of its parts and the integrated application of solutions is key for the success of the intervention (Troi and Bastian, 2015).
- The project has been implemented. Most of the limitations in the renovations of historic buildings appear when it comes to the compatibility with the existing construction and use. It is therefore important that the database shows renovation projects that have already been implemented.
- The intervention followed the results of a thorough heritage value assessment. Energy improvement in historic buildings cannot be achieved at the expense of their heritage value. This database should therefore illustrate the relationship between the building's heritage significance and the solutions adopted.
- A significant energy demand reduction was achieved. Although the result achieved will depend largely on the heritage value assessment, all projects included in the database should have pursued an ambitious renovation in terms of efficiency.
- A detailed documentation of the decision process, technical solutions and evaluation results must be made available. Access to targeted and robust information is crucial to the successful dissemination of best practices (The Swedish Environmental Protection Agency, 2003).

The lack of targeted information has been considered a common deficiency in previous attempts to disseminate best-practice collections (Femenías, 2004). Thus, the database will be driven by the user needs and will therefore focus heavily on the browsing experience. The use of visual information (photographs, icons, charts and construction drawings) and short texts make the experience accessible to the user. The information displayed in the database is structured in four categories (Figure 2): a first section of general information; a section focussed on the renovation process with the overall aim of describing the context and the rationale behind all the solutions adopted; the different retrofit solutions implemented are presented in the third section; and, lastly, the evaluation of the intervention in terms of energy efficiency, internal climate control, financial assessment and environmental impact.

The database addresses users with different needs and levels of understanding. The information displayed at the start is tailored to private building owners approaching the database looking for inspiration and ideas for what can be done. All the information can then be expanded and a second layer of detailed data and information is made available to the user desiring more detail (note the arrow in Figure 2 indicating the button for additional information).

Ensuring the quality of the best practices displayed in the database is crucial to help eradicating any concern about professionals' expertise. The database will be only useful if all the solutions presented are robust from both conservation and technical points of view. Initially, the main providers of best-practice cases will be researchers involved in the Task 59 and the collaborating Interreg AlpineSpace project ATLAS, and (early adopter) architects. However, the

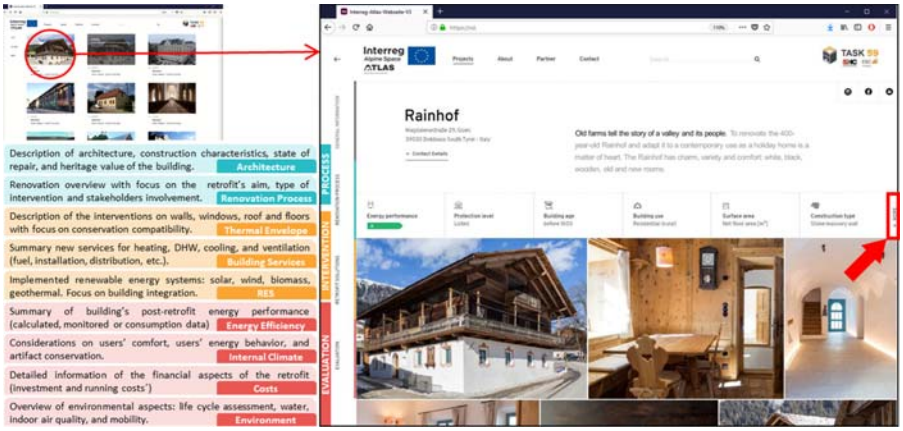


Figure 2.
Best practice database interface (developed by teamblau GmbH InternetManufaktur) and categories' description

database is designed to last beyond the end of these projects and to be open to anyone with a well-documented example. Thus, the implementation of a review process that can assess the validity of the projects and, most importantly, the way they are documented becomes necessary.

The ultimate goal of the review process is not to reject proposed examples, but to ensure their robustness and to improve the way they are presented. The review model takes inspiration from the academic peer-review process (Figure 3). Every best practice gathered during the project will be assessed by the experts participating in the Task 59 following this methodology to test the feasibility of such review process. At the end of the Task 59 project, the lessons learned will be used to adapt and improve the reviewing model.

After checking the completeness of the information provided, the best practice is assigned to at least two members with different expertise: heritage or technical. If a case study is rejected by one of the reviewers, this is submitted to an alternative reviewer for

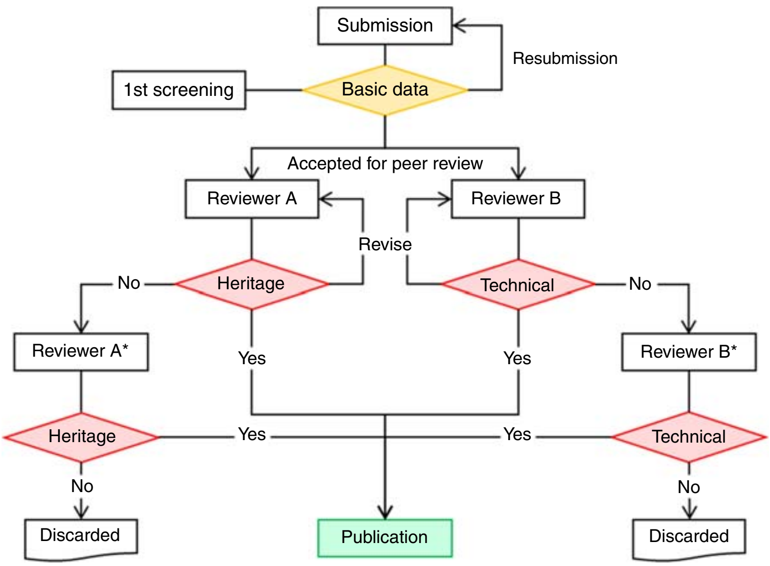


Figure 3.
Flowchart of the peer review process applied to best-practice evaluation

a second opinion. A second rejection will mean that the project should not be included in the database.

The contributions from partners of Task 59 and the Interreg AlpineSpace project ATLAS are expected to add up to 100 case studies. Such a repository is expected to attract the interest of decision makers and additionally create the momentum needed to attract new examples from architects, owners or new research projects.

Addressing barriers in the planning process through guidelines

The discourse on energy retrofit of historic buildings has shifted towards a less rigid take on what historic buildings can be and the measures that can be considered appropriate. Instead of exempting historic buildings from energy performance targets in legislation, standards provide an alternative "soft law" better suited to contemporary modes of governance (Brunsson and Jacobsson, 2000). Traditional policy does not facilitate the iterative and interdisciplinary design processes that are needed to achieve customised solutions. Voluntary standards focussing on the decision-making process have emerged as a promising but thus far untested alternative.

The European standard EN 16883 "Guidelines for improving the energy performance of historic buildings" incorporates a flexible approach by not requiring compliance with a specific end result. Instead, it provides a decision-making road-map for the planning phase. The underlying idea is that the appropriate solutions will be specific and must be found on a case-by-case basis. The recent Italian guidelines (MIBAC, 2015), as well as the new ASHRAE (2019) guideline, are also recent examples that outline a systematic decision process for the planning phase. Despite the amount of resources and efforts spent on standardisation in recent years within the cultural heritage field, little attention has been paid to if and how standards actually are used in practice (Leijonhufvud and Broström, 2018). It is therefore the intention of Task 59 to evaluate recent innovative standards in the field, in order to overcome the barriers identified in the introduction regarding a lack of support and guidance in a complex design process.

Process-oriented guidelines

EN 16883 was accepted in 2017. The guidelines are meant to be used by building owners, practitioners and public sector to select appropriate measures in the planning stage. The guidelines are applicable "to a wide range of buildings where special considerations are needed in order to find a sustainable balance between the use of the building, its energy performance and its conservation".

Rather than specifying general solutions beforehand, EN 16883 provides a procedure to facilitate the best decision for each individual building. The main steps in this procedure are: building survey and assessment; specifying the objectives; deciding if improvement of energy performance is needed; assessment and selection of measures for improving energy performance; and implementation, documentation and evaluation of improvement measures.

In 2012, ASHRAE began developing Guideline 34, Energy Guideline for Historic Buildings. The purpose of the guideline is to provide advice on the practices and processes that should be followed in energy retrofits of historic buildings. The guideline is intended to be applied to listed buildings, as well as buildings which are "eligible to be so listed". The guideline has undergone several public review periods and has been finally published in 2019.

This guideline contains the following major sections: definitions, background, planning phase, building envelopes, environmental control and energy systems, HVAC system selection, lighting. It also contains five informative appendices: project flow overview, recommended reading, collected case studies, building diagnostics and energy modelling for historic buildings. It includes methodological guides, providing information on how diagnostic tests (e.g. blower door tests) and whole-building energy modelling should be applied to historic buildings. Two sections in the guideline are more process-oriented: the planning section, and the project flow overview. The Planning section provides project teams with a step-by-step approach to planning an energy efficiency project in an historic building, and the project flow overview provides a corresponding flowchart. While both sections are process-oriented, they still provide much more explanatory detail on the various steps in the process than EN 16883. Compared to EN 16883, which is structured as a procedure, ASHRAE Guideline 34 is structured more like a handbook, similar to the Italian guidelines described next.

The Italian guidelines for the energy improvement of built heritage were published in 2015 by the Italian Ministry of Cultural Heritage (MIBAC). The aim is to provide practical advice to help practitioners during the planning phase and public authorities in the assessment of projects. The guidelines are divided in three sections: context knowledge, energy efficiency assessment and energy efficiency improvement.

The first section offers a theoretical background formed by a collection of restoration and technical concepts to support professionals in performing energy diagnosis and environmental quality assessment. In the second section, the suggested planning and assessment procedure is divided into six steps. The first step is the building survey and energy assessment. The user is supposed to define the energy audit's level of detail, depending on the availability of resources and time, resulting in a differentiated output. As a second step, retrofit measures are selected and the four following steps are focussed on the assessment of measures. The criterion to decide among different packages of measures is based on the level of energy performance improvement of the whole building.

The third and last section of the standard includes a description of retrofit interventions, a section about maintenance costs and a collection of best practices. The aim is to show a range of innovative measures, focussing on new materials and explaining pros and cons of each retrofit technique.

A multi case study approach

To understand how recent energy efficiency standards are used in practice, a multiple case study approach is used within the Task 59. The usefulness of the standards is evaluated in real case studies in different countries in Europe. The final aim is to investigate how existing standards can be improved and what kind of complementary resources are needed to make them work in practice. The IEA project will primarily focus on the EN 16683 standard, but also compare it to other standards and guidelines. The rationale for focussing on EN 16883 is that it best exemplifies the new approach described above, where the scope of the standard is the decision process and not the outcome. There are other standards that partly display the same shift of scope, such as the two other standards described above. These standards also outline a systematic decision process for the planning phase, but EN 16883 has explicitly abandoned the conventional outcome-oriented approach.

The evaluation is based on qualitative data collected with surveys and interviews with decision makers and other stakeholders involved in the energy retrofit processes. The project partners actively search for projects where the standard is being used. The evaluation takes place during and immediately after the planning phase of the project is ended.

The evaluation is a work in progress and will be finalised in 2020. So far, there are eight ongoing case studies in four different countries. Initial findings suggest that the EN 16883 has not been widely adopted yet. It has generally been difficult to find case studies where decision makers are interested in using the standard. A preliminary analysis points to a number of hypotheses about why the uptake of the standard so far has been low. First, compliance with the standard is not yet demanded by customers or forced by public authorities. Second, the scope of the standard is new and it is therefore not a matter of replacing an existing standard with a new one. Third, users have struggled with determining how to carry out the generic decision-making steps suggested by the standard. It is up to the forthcoming analysis to confirm these preliminary hypotheses and discuss ways in which the standard can be complemented in order to increase its use and effectiveness. The results of the study have the potential to make a critical contribution to future standardisation, not least for the next revision of the European standard.

Conclusions

Non-technological barriers are hampering the energy performance improvement of historic buildings. In order to increase the speed at which historic buildings are being retrofitted and the depth of these renovations, new tools are needed. This paper presents the approach developed within IEA-SHC Task 59 to overcome the decision makers' lack of engagement in the renovation of historic buildings and to support them in a complex design process.

The overarching purpose of this project is to promote the energy retrofits of historic buildings towards their lowest possible energy demand. The definition of quantitative performance targets has been beneficial in the development of a low-carbon construction industry. However, an analogous approach is unsuitable for buildings of historical value. This paper presents a new approach based on the definition of a negotiation space that allows pursuing low-carbon standards while taking into account the conservation requirements of the building, regardless of the level of formal protection. This new approach highlights one of the main findings of this paper: the need for co-operation between the different agents involved in the decision-making process. In order to achieve low energy historic buildings, research should not only focus on technical and economic aspects, but also pay attention to how the decision makers can be motivated, guided and ultimately helped to implement energy-efficient measures in historic buildings.

In this paper, two different activities developed within Task 59 are presented. Both tools described here – dissemination of best-practice and process-oriented guidelines – are not new in the area of low-carbon construction but represent a novel approach in the specific field of historic building renovation.

These tools alone will not suffice to solve every problem. The barriers identified in this work can only be overcome if future research focusses on a multidisciplinary dialogue aimed at helping decision makers. The Task 59 is also exploiting the co-operation between different expert fields (technical, conservation or social) and stakeholders (industry, academia and public sector) to tackle the limited access to proven retrofit solutions.

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