From the energy performance certificate to the building renovation passport

Graziano Salvalai*, Marta Maria Sesana, Manuela Grecchi, Mathieu Rivaillant

Highlights
The EU Member States have implemented national EPC schemes that varies significantly across Member States in terms of scope and information available, with limited acceptance by the users due mainly to low reliability. The revision of the EPBD introduced the concept of the Building Renovation Passport in legislation as a tool to increase the renovation rate across Europe. A Building Renovation Passport is a document outlining a long-term step-by-step renovation roadmap to achieve deep renovation (60% reduction) for a specific building. In this contest the ALDREN project aims to motivate the owners to undertake deep renovation in their properties.

Abstract
The energy performance certificate is currently one of the main tools for mapping the energy performance of buildings. However, the recent analyses conducted on the impact of EPC on the EU construction market level have highlighted a lack of confidence in the tool, considered by most as a mere regulatory obligation with low impact on the real quality of the built environment. The objective of the document is to frame and define a new tool called building passport for the energy redevelopment of buildings, offering an overview of current European initiatives highlighting the principles, potential impacts on the market and the main obstacles.

Keywords
Energy performance certificate, Building renovation passport, Building renovation roadmap, Energy efficiency

1. INTRODUCTION
The following document presents the results and activities carried out within the ALDREN (ALliance for Deep RENovation in buildings Implementing the European Common Voluntary Certification Scheme, as backbone along the whole deep renovation process) project [1], funded under the work programme H2020 EE-11-2016, which aims to encourage deep renovation towards the nZEB standard of existing buildings. The construction sector absorbs at European level about 40% of the total final energy and it is characterized by a retraining rate of only 1.2% per year, less than half of the trend set by the European Union in the roadmap towards 2050. It is therefore of primary importance to develop tools, procedures and technologies capable
of directing and facilitating the renovation of existing buildings. In this context, the ALDREN project, presented in this paper, aims to contribute to the resolution of the problem by creating a robust and shared solid methodology at European level to encourage an increase in the quality and number of renovation interventions. In 2015 the European Commission funded a study to analyse the potential benefits of using a European Voulnuntary Certification Scheme (EVCS) [2] on a European scale for non-residential buildings in order to increase transparency and standardise its content, in accordance with Article 11(9) of the EPBD recast of 2018 [3]. The ALDREN project starts from the need to homogenise existing certification schemes by proposing a voluntary instrument shared at European level and containing information about the current state of the building and possible improvements with a long-term vision. The project also aimed to demonstrate the effectiveness of the proposed approach (PoC - Proof of Concept) for existing non-residential buildings with a surface area of at least 10,000 m² and an annual primary energy demand of over 200 kWh/m². The project consortium is made up of 8 European partners with different profiles: public institutions linked to building authorities, research institutes and universities, certification bodies, private building professionals and sector associations.

2. STATE OF THE ART

The energy performance certificate was introduced at European level by the European Parliament Directive on the energy performance of buildings 2002/91/EC (Energy Performance Building Directive - EPBD) [4] as an important tool for improving the energy efficiency of buildings with the aim of informing owners, occupants and property developers of the state of the building and the related operating costs. The certificate includes the overall energy performance and other parameters that allow comparison with similar buildings in type and use. In 2010 with the recast of Directive 2010/31/EU [5], the certification system for existing buildings was strengthened with the inclusion of a mandatory report of recommendations, listing the improvement measures and their priorities. However, despite different regulatory additions, the impact on the existing building has not achieved the expected results. It is clear that increasing the rate of energy-related renovations is not an easy task, given the many obstacles typical of the construction process and which typically include financial, technical, procedural, regulatory and awareness-raising issues (Figure 1).

Since its introduction in 2002, the European Directive on the Energy Performance of Buildings has supported the deployment of low-energy (nZEB)
buildings and it has promoted the use of Energy Performance Certificate (EPC) as a tool that: (i) reflects as closely as possible the real energy needs and (ii) guides the conversion of energy-intensive buildings to the nZEB standard. Currently, the situation is still very fragmented, each member state has transposed the Directive in a different way and with different timing, showing significant differences in the method of calculation, the calculated parameters and the energy classification itself. The recent revision of Directive 2018/844/EU [3] introduced, in Article 19 bis [6], the concept of Building Renovation Passport (BRP) as an evolution of the current EPCs. This tool should contain, on the one hand, a description of the current state of the building and, on the other, a path with a long-term vision compacted by single actions, clearly defined in terms of costs/benefits, planning in order to reduce by at least 60% of the energy needs global compared to the pre-qualification phase. Currently there is still a no clear definition and structure fo the BRP as stated by Sesana and Salvalai [7], but there are various ongoing initiatives dealing with this topic. ALDREN is one of this focusing on BRP for Non-Residential buildings, another H2020 project iBRoad [8] is focusing on Residential ones and at the beginning of 2019 a European initiative leaded by BPIE is started on the EPBD Feasability study on Art. 19 focused on BRP [9].

3. THE ALDREN PROJECT

The main aim of the ALDREN project is to consolidate, promote and implement an extended harmonised procedure in order to promote deep restructuring actions addressing all aspects of the recovery process: from the technological study of possible energy recovery actions, to the organization of interventions, up to the economic and financial study of the whole process. The project focuses on Non-residential buildings (in particular offices and

Figure 1. Key barrier to building renovation in EU.
Given the context and obstacles identified in section 2 of this paper, the ALDREN project aims to achieve the following specific objectives:

- bring together the main market players and stakeholders in the existing building stock into a single alliance (ALDREN Alliance), to create a place - both physical and virtual - where they can work together to identify their respective needs and organize themselves in order to be able to adopt a common language on the market to overcome the obstacles that usually limit or block “deep renovations”;
- make the comparison of the energy performance of buildings feasible and coherent with a common scheme on a European scale;
- define a methodological approach (ALDREN methodology) that, starting from the principle of cost-optimality and taking into account the diversity of national/regional and climatic contexts, leads to the estimation and verification of the certification of the energy performance of existing buildings in a way that is unambiguous and acceptable to all member states.

4. METHODOLOGY

The methodology applied to the project consists in bringing together in a single common procedure different methods of analysis and synthetic indicators. Specifically, the approach is based on the evaluation of three indicators considered fundamental: the thermal comfort and indoor air quality, the potential increase in value of the building and the energy requirements for management.

The last topic is very important to support the credibility of the whole procedure, but also for the comparison between the real and the estimated energy needs.

The solidity of the concept underlying the project is based on three

![Image of the ALDREN project]

Figure 2. Pillars on which is based the ALDREN project.
components represented in Figure 2: 1) the quality of the individual parts; 2) the commitment of the different stakeholders and 3) a clear roadmap on which to build the holistic procedure of the project and which well reflects the very structure of the WPs in which it is organized.

In detail, the project is structured on three main topics:

- **WP1 - Coordination and exchange with stakeholders.** This first phase foresees the creation of an alliance between the actors of the construction market. The development and dissemination of deep renovation actions depend mainly on the possibility of having linear relationships and transparent and understandable communication between all actors involved in the building renovation process (investor-designer-builder-owner). For this reason, ALDREN has proposed to combine different methods and approaches, both traditional and innovative, to: help operators in the sector to expose, clarify and discuss their needs with each other; overcome any obstacles and constraints and finally identify solutions and tools to encourage replicability. The project strategy was in fact to create a collaborative understanding process in a common place where all the stakeholders can share, discuss and refine all the possible solutions for renovations.

- **WP2 - Technical phase in which the different components work in parallel and at the end they will structure the overall framework integrating all the building assessment procedure into the ALDREN BRP.** A fundamental methodological step within this phase is the definition of a common language (standardisation) to allow a fluent exchange of data in which: express needs, set benchmarks and targets, share recovery solutions (in terms of energy performance, comfort, and costs) and verify the achievement of performance. To avoid the creation of a new language, the methodology proposed by the ALDREN project will be based mainly on the principles of the voluntary certification system (EVCS) and the relevant CEN and ISO standards.

- **WP3 - Communication and adoption of results in the European context.** Communication, dissemination and training of the methodological approach proposed by the project are the main activities of this phase 3 through targeted training courses for the different operators of the sector. The methodology will be proposed either as a modular structure and applicable to existing certification schemes (e.g. BREEAM, HQE, DGNB, LEED etc.) or as an autonomous procedure. The objective of this phase is not to compete with the existing certification schemes, but rather to activate a close collaboration and possible integration with them.

---

**4. METODOLOGIA**

La metodologia applicata al progetto consiste nel riunire in un’unica procedura comune metodi di analisi ed indicatori sintetici differenti. Nello specifico l’approccio si basa sulla valorizzazione di tre indicatori ritenuti fondamentali: il comfort termico e la qualità dell’aria indoor, il potenziale incremento di valore dell’edificio nonché il fabbisogno di energia per la gestione. Per quest’ultimo aspetto è data molta importanza, anche per sostenere la credibilità dell’intera procedura, alla comparazione tra i fabbisogni energetici reali e quelli stimati. La solidità del concetto che sta alla base del progetto, si basa su tre componenti rappresentati in Figura 2: 1) la qualità delle singole parti; 2) l’impegno dei diversi stakeholders e 3) una tabella di marcia chiara su cui costruire la procedura olistica del progetto e che ben rifletta la struttura stessa dei WPs in cui è organizzato. Nel dettaglio il progetto è strutturato su tre principali argomenti:

- **WP1 - Coordinamento e allo scambio con gli stakeholder.** Questa prima fase prevede la creazione di un’alleanza tra gli attori del mercato delle costruzioni. Lo sviluppo e la diffusione di azioni di “deep renovation” dipendono principalmente dalla possibilità di avere relazioni lineari e comunicazione trasparente e comprensibile tra tutti gli attori coinvolti nel processo di recupero edilizio (investitore-progettista-costruttore-proprietario). Per questo motivo ALDREN ha proposto di combinare diversi metodi ed approcci, sia tradizionali che innovativi, per: aiutare gli operatori di settore ad esporre, precisare e discutere
The WP2, core part of the project, is moreover structured in distinct tasks that testify to the attention paid to the different topics which composed the ALDREN methodology, as shown in Fig. 3.

In particular, the definition of a common language and the identification of a series of innovative technological solutions for the efficient recovery of buildings are the goals of T2.1. The following tasks from T2.2 to T2.5 will focus on a specific topic, respectively: identification of a method for estimating the energy consumption of an existing building (T2.2), creation of a simplified procedure for measuring the real consumption of the building (T2.3) to be compared with the values estimated in the previous task, definition of ad hoc indicators for the comfort and well-being in office and hotel buildings (T2.4) and finally identification of economic and financial indicators for estimating the value of the building before and after the renovation (T2.5). The results of those tasks will become fundamental inputs for the T2.6 which has the goal to systematize them within a single database for the definition of a BRp for Non-residential buildings and the respective renovation roadmap with timeline, economic and technological recommendations for the efficient implementation of building renovation. Within T2.6, the possible integration of the emerging BIM standard into the ALDREN procedure will also be investigated.

5. RESULTS

As introduced in the previous sections, the main objective of the ALDREN project is to directly support EU energy efficiency initiatives and directives (EED, EPBD) by consolidating, extending and implementing the voluntary certification scheme (EPBD art. 11). The procedure identified will be...
transformed into a tool able to manage, facilitate and guide the redevelopment of existing buildings aiming to increase (over 3%) the annual renovation rate [10]. The expected results of the project can be summarized as follows:

• development of a harmonised methodology for energy performance assessment based on the common European voluntary certification scheme;
• introduction of an energy classification verified by comparing estimated and measured performance in order to increase confidence in the calculation standards and in the tool itself (CEN/ISO standards);
• introduction of the concept of thermal comfort and healthy indoor environments through appropriate indicators. The connection between thermal comfort and energy is intended as a driver to increase the number of energy upgrades;
• development of a method for the definition of roadmap for the energy building renovation with a long-term vision to 20-30 years;
• identification of indicators capable of triggering a spontaneous process of renovation in the building sector with the quantification of the building added value applying the suggested renovation strategies;
• identification and development of innovative financing instruments, integrating loans with different interest rates and business cases to motivate private investments.

Figure 4. ALDREN Building Renovation Passport elements: 1) ALDREN BuildLog and 2) ALDREN RenoMap.
The concepts presented will be integrated in a single document called ALDREN Building renovation Passport (BRP) structured in a modular way composed essentially of two main elements:

- the Logbook (ALDREN BuildLog);
- the Roadmap (ALDREN RenoMap).

The ALDREN BuildLog contains the picture of the building in its current state, while the ALDREN RenoMap presents the renovation roadmaps with all the suggested elementary renovation actions to apply to reach the NZEB target (Figure 4).

Each element is divided into modules for different themes corresponding to the topics covered within the whole project. The ALDREN BuildLog is structured in 6 modules, while the ALDREN Renomap is structured in 2 modules.

Figure 5. ALDREN BuildLog modules.

Figure 6. ALDREN RenoMap modules.
Following a brief description of each ALDREN BuildLog modules (Fig. 5):

1. Building Picture = overall indicators that permit to outline the current state of the building in term of geometry data, location, documentation, certification, technical components, general information of ownership;
2. Energy rating and targets = overall indicators related to energy consumptions, system plant and energy rating
3. Energy verification = overall indicators related to the measured energy consumptions;
4. Comfort and well-being = overall indicators that permit to outline the state of the building in term of comfort, indoor air quality and lighting;
5. Cost value and risk = overall indicators related to financial aspects, market trend and building value;
6. Documentation and BIM = overall indicators related to the existing materials for different issues to check the availability and format of all the information.

The ALDREN RenoMap is composed of two main elements (Fig. 6): the evaluation table of Elementary Renovation Actions and the final step-by-step roadmap. They have to be filled in during the process and they are parts of the ALDREN BRP.

The RenoMap is also the enforcement of other ALDREN developments. It is based on energy rating methodology covered in T2.2, which is based on hourly timested energy simulation of the studied building in standard conditions. Outcomes of T2.4 concerning internal environmental quality (IEQ) will be evaluated for the primary renovation actions in order to provide multicriteria e le direttive in termini di efficienza energetica promosse dall’UE (EED, EPBD) consolidando, estendendo ed implementando lo schema certificativo volontario (EPBD art. 11). La procedura individuata sarà trasformata in uno strumento in grado di gestire, facilitare e guidare la riqualificazione degli edifici esistenti mirando a incrementare (oltre il 3%) il tasso di riqualificazione annuo. I risultati attesi di progetto possono essere così sintetizzati:

- sviluppo di una metodologia armonizzata per la valutazione delle prestazioni energetiche basata sul sistema europeo comune di certificazione volontaria;
- introduzione di una classificazione energetica verificata attraverso il confronto tra performance stimate e misurate al fine di aumentare la confidenza nelle normative di calcolo e nello strumento stesso (norme CEN/ISO);
- introduzione del concetto di comfort termico e di salubrità degli ambienti interni attraverso appositi indicatori.

La connessione tra comfort termico ed energia è inteso come driver per incrementare il numero di riqualificazioni in chiave energetica;
- sviluppo di un metodo per la definizione delle azioni prioritarie “roadmap” per la riqualificazione energetica degli edifici nel lungo periodo con visione a 20-30 anni;
- individuazione di indicatori in grado di innescare un processo spontaneo di riqualificazione nel mercato edilizio con la quantificazione del valore aggiunto che tali edifici possono raggiungere e in quanto tempo;

Figure 7. Data granularity scheme of the ALDREN Data Model of the whole indicators database.
feedbacks. Indicators related to cost and financial valuation are developed in T2.5 and will also support the decision process of the renovation roadmap. Each module of the ALDREN BuilLog has a dedicated data model structured in four levels of granularity: from level 0 to level 3 with a gradually selection of data to arrive with around 10 core indicators at level 3 (Fig. 7). This approach supports the data transfer from one hand, and above all the data comprehension from the other according to the needs and skills of the requesting user (end user, energy manager, etc.).

6. CONCLUSIONS

Started in November 2017, after the first public event organized in June 2018 a free online webinar to present the project contents by each task leader available on Youtube channel of the project and to capture the interests of the different actors involved, ALDREN reached in April 2019 the definition of the first version of the ALDREN Protocol including the respective calculation methodologies and definition of the single topics of which WP2 is composed. This protocol is currently being applied to 15 demonstration buildings in 5 European countries: France, Italy, Spain, Slovakia and the United Kingdom. Considering the expected outputs, the expected potential energy saving is equal to 1000 GWh/a, a value considered as cumulative in the 5 years following the closure of the project. The results of the application and dissemination of the building renovation procedure developed in the context of the ALDREN project will use all existing channels in order to make as much as possible replicable and feasible the ALDREN procedure and to reach the main players of the construction sector.

7. ACKNOWLEDGEMENT

The work presented in this paper is part of the results obtained within the ALDREN project (www.aldren.eu) funded by the European Union - H2020 Work Programme - EE-11-2016-2017. Grant agreement No. 754159.

8. REFERENCES

[1] ALDREN EU project, information available on website at: http://www.aldren.eu/
e la diffusione della procedura di riqualificazione degli edifici sviluppata nel contesto del progetto ALDREN utilizzerà tutti i canali esistenti al fine di raggiungere nel modo più efficace possibile i principali attori del mercato delle costruzioni.

7. RINGRAZIAMENTI