

Attractive, Acceptable and Affordable deep Renovation by a consumers orientated and performance evidence based approach

Contract No.: 784972

Report: D4.2 System functional specification document

Work Package: WP4 – Task 4.2 Analysis and design of the business module

Deliverable: D. 4.2

Status: public



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05/11/2018

THIS PROJECT HAS RECEIVED FUNDING FROM THE EUROPEAN UNION'S H2020 FRAMEWORK PROGRAMME FOR RESEARCH AND INNOVATION UNDER GRANT AGREEMENT NO 784972.

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Revision and history chart:

VERSION	DATE	EDITORS	COMMENT
Version 0.1	2018-10-16	BRAMO	First version provided
Version 0.2	2018-11-3	UNIBO	First version revised
Version 1.0	2018-11-5	HIA	First version submitted

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1 Introduction

This document was produced starting from the activities carried out in the WP4 in the first six months of activity.

Given the structure of the team dedicated to the development of the platform, we propose the adoption of agile work methodologies -i.e. i. small, poly-functional and self-organized development teams; ii. iterative and incremental development; iii. adaptive planning; iv. direct and continue involvement of the consortium's members in the development process-.

As a consequence, this document has to be regarded as a starting point that will be progressively updated and reviewed to take into account the indications and suggestions that will be implemented in the following phases of the TripleA-reno project (a 'living' document). It is the authors' considered opinion that an iterative process like this, disregarding the analysis of the expected requirements as in the classic "cascade model" of the software development, will be able to fulfil the innovative, interactive, and user-orientated approach of the project.

In addition, we will use a terminology similar to the UML (Unified Modelling Language) without adopting the relative formalisms; this is to give the possibility to access the document even to those who do not have a thorough knowledge of the specific modelling language; the decision to formally adopt the UML will be considered and selected in the following phases of the project.

2 The TripleA-reno (Attractive, Acceptable and Affordable deep Renovation) platform

The idea at the bases of the development of the TripleA-reno project comes from the consideration that the prevailing perception is that buildings consume energy; for example, we are led to think the buildings as the subject of energy consumption by the recurring statement that "Buildings in the EU use almost 40% of final energy". With the TripleA-reno project we will try to overcome this concept, assuming that it is actually people, and not buildings, that consume energy for their comfort.

This basic idea, accompanied by the requirement that the rate of energy renewal should increase from the current level of 1.2% per year to at least 2-3%, leads to focus on the understanding of the dwellers' behaviour and their effective involvement along with on the best practices to be adopted for the energy redevelopment of buildings.

This means that it is necessary to identify the end users' behaviour, actions and habits in relation to the use of energy and their way to make decisions regarding energy retrofit interventions; this should be done considering also the economic savings and the costs, health and wellbeing of people as important drivers in the decision-making process. To do so, in the next section, we will try to outline the main barriers encountered by users in the deep renovation.

2.1 Main barriers encountered in deep renovation

Deep Renovation¹ (DR) refers to energy renovation processes involving the full energy efficiency potential of improvements by combining several necessary measures in one strategy instead of focusing on single standard actions (i.e. windows replacement, wall insulation, new generator with greater performances, etc.). In the recent years, numerous EU projects have tackled the technical aspects of deep-renovation through the search for innovative technological solutions to overcome the obstacles present in the market of energy requalification.

The main barriers that have been found in the deep renovation processes are the following:

- **Economic and financial barriers;**
- **Technical barriers;**
- **Legislative barriers;**
- **Social barriers.**

As for **the economic and financial barriers**, they are essentially given by):

- i. High up-front costs and owners reluctant to borrow funds for energy renovation purposes;
- ii. Long pay-back times of retrofitting interventions;
- iii. Lack of confidence of the potential investors;
- iv. Insufficient and instable available funding;
- v. Lack of attractive financing for homeowners with low to medium incomes who are usually not eligible for regular bank loans;
- vi. The fact that existing financial tools are insufficient and unattractive.

As for the **technical barriers**, they include:

- i. Lack of consistent and standardized solutions or integrated solutions to comply to new and different building standards requirements on energy saving;
- ii. Lack of skilled workers to carry out the work;
- iii. Shortcomings in technical solutions and long process discouraging owners;
- iv. Safety/seismic risk connected with the deep renovation processes (damages can be done to the homes while retrofitting or unsure perception of the current safeness in the existing buildings);
- v. End users' and owners' lack of technical expertise and trust in effective energy renovation savings.

As far as the **legislative barriers** are concerned:

- i. The fact that fiscal policies offer insufficient incentives such as tax credits;
- ii. The time-consuming and complex procedures in bureaucracy;
- iii. Some national programs that do not offer conditions in favour deep renovation measures.

¹ This part is built on top of the lessons learnt from the ABRACADABRA project, Deliverable 2.5, Final users constrains, preliminary report.

Finally the main **social barriers** include:

- i. Decision-making processes that are long and complex, especially in case of multi-owner houses (condominiums);
- ii. The lack of consensus, understanding and support from the inhabitants that often hinders the effective approval of the interventions;
- iii. The problem of disturbance during site works and/or relocation (in case owners/users need to leave their homes during the process);
- iv. Low awareness about energy efficiency and non-energy benefits of renovation; v) - Lack of dialogue between the different stakeholders.

As a consequence, there is a strong need to create a demand both from the market and the final users to strengthen the investor's confidence and accelerate the market of deep renovation.

2.2 Technical challenges and possible solutions

The technical feasibility of deep renovation measures is of great importance for end users and property owners. Yet, the purpose of this chapter is not to assess what is feasible or technical suitable in specific cases. Rather it is important to understand what is relevant when it comes to technological aspects for end users and property owners, how property owners perceive technological changes and how they assess their benefit and potential disadvantages. Identifying the key barriers that influence public attitudes is the first step towards the design of the TripleA-reno platform.

Lack of confidence in Construction professionals. Latent mistrust toward professionals, the lack of energy efficiency professionals – in particular in local areas - or, on the contrary, the overwhelming number of offers can weigh heavily in the balance when it comes to the final decision to renovate or not renovate. Individual homeowners and users do not know where and how to find reliable experts and professionals and ask for advice and assistance. Taking such an important decision as a deep renovation is for many, the second most important investment – after buying their home – they will undertake in their life. As a consequence, they demand some guarantees that the work will be done appropriately, that the given advice is neutral and does not favour particular technologies or services. They are looking for long-lasting solutions that will be both economically and practically viable.

The TripleA-reno platform should therefore consider **delivering lists of trusted professionals** provided by neutral parties such as public authorities, property owners' or consumers associations or "one-stop-shop" structures. The lists should have a non-exhaustive character, but with sufficient choices and a rather wide price range for the services offered would be advised. This would constitute a relatively low-cost measure to cope with the lack of transparency in the market. They could be directly involved in providing a comprehensive service package with information on the most efficient technologies, available funding instruments, fiscal measures, lists of certified building professionals, etc. to property owners at the local level.

Consumer acceptance towards new technologies and innovative renovation solutions. Users and owners often feel mistrust towards new technologies. This phenomenon that can also be referred as 'consumer

acceptance' has been widely documented². It corresponds to behavioural aspects towards available technological solutions and the possibility of purchase and use of new products. It is mainly due to a lack of knowledge about issue and technologies, the perception and feelings and interpretation of the information and finally, the fear, i.e. worry, risk and inconvenience that people may feel regarding new energy technologies. **Training and awareness-raising activities** are key elements for the acceptance of innovation; they are the first crucial step to provide knowledge on the importance of improving buildings' energy efficiency through the application of the respective innovative technologies.

Lack of knowledge of available solutions and customisability. The lack of knowledge about available solutions is a major obstacle. This is particularly relevant for energy efficiency solutions.

Disruption factor. The disruption factor is also fundamental and needs to be assessed especially in the case of deep renovations. It refers to all the troubles linked to refurbishment work for the occupant, which might impact on the decision to renovate. This aspect is confirmed by extensive literature and research that pointed out that one of the main barriers to retrofitting is the disruption caused to users³.

Favouring '**Plug-and-play type of solutions**' that limit the intervention on site should help to overcome occupants' reluctance to face renovation work. Major dissatisfaction can be avoided if the owners (occupant and landlord) have been sufficiently informed of the renovation plan and the possible disruption.

Decision-making in condominiums. A significant part of the existing building stock in many Member States is composed of multi-apartment buildings, often with multiple owners, decision-making rules on necessary majorities can be complex. Making a decision for energy retrofits in condominiums requires a majority higher than 50% in some countries, while in others the consensus of owners should exceed 75% according to the national condominium laws and can even require unanimity. Another aspect influencing consensus building is a potential uneven distribution of benefits and costs of an energy retrofit to the individual apartments⁴. Making easily understandable information from the start of renovation process could facilitate the complex decision-making process and consensus building in condominiums. The provided information should focus on the benefits in terms of energy efficiency, housing quality, indoor conditions, but should also specifically address condominium concerns relating to individual owners' rights.

² Tsokaa, S. et. al: Rethinking user based innovation: Assessing public and professional perceptions of energy efficient building facades in Greece, Italy and Spain. Energy Research & Social Science, Vol. 38 (2018), p. 167; Assefa, G. and B. Frostell: Social sustainability and social acceptance in technology assessment: a case study of energy technologies, Technol. Soc., Vol. 29(1) (2007), p. 63-78.

³ As reported in DELIVERABLE 2.5 - FINAL USERS CONSTRAINTS – PRELIMINARY REPORT, ABRACACABRA Project, Disruption can be of different nature. Disruption of utilities: occurs when retrofit works affect the continuity of utility supplies and the provision of gas, water or electricity is interrupted; Disruption of traffic: when retrofit works constrain the flow of occupant is disturbed (e.g. access to the building is blocked or limited); - Disruption of physical space: occurs when retrofit works restrict space for working or living because spaces are being shared between workers and occupants and physical comfort is affected; - Disruption of internal environment: occurs when retrofit works affect the internal environment by generating different levels of pollution.

⁴ The significance of the collective agreement hurdle has equally been elaborated on in a number of publications relevant to this topic, most notably in the 2017 Report on "Overcoming the split incentive barrier in the building sector" of the European Commission's Joint Research Centre. See also: Castellazzi, L. et. al.: European Commission's Joint Research Centre Technical Report: Overcoming the split incentive barrier in the building sector (2017) (Castellazzi et. al (2017)), p.61; and: Federal Institute for Research on Building, Urban Affairs and Spatial Development of Germany: The investment processes of condominium owners' associations with particular emphasis on energy-efficiency and age-appropriate renovations (2014) (BBR (2014));

2.3 Economic and financial challenges

Financial aspect is one of the highest barriers for owners and co-owners when it comes to renovation. Payback time and up-front costs are crucial in this context.

The time taken for the initial outlay to be recouped is a major barrier. Users and owners are not likely to consider investments that do not pay for themselves within 3-7 years. Therefore the profitability of renovation in terms of building life cycle costs and long-term maintenance costs that can be avoided, thanks to energy efficiency deep retrofitting, should be easily displayed.

The initial investment costs can be high and this is seen as an obstacle to consumer investment decisions. The most ambitious retrofits will undoubtedly require considerable upfront funding.

Lack of funding opportunities and/or inability to secure finance on acceptable terms is generally one of the most cited barriers to investing in energy efficiency measures. This applies at all the levels of ownership (from the level of the individual householder to the small landlords, to the case of fragmented ownership in condominiums and, finally in the renting market –tenants).

With the reduction of public spending, those funding opportunities became scarce and the uncertainty and volatility of the schemes proposed increased. Policy-makers at the European level are increasingly encouraging the reduction of grants and instead promote revolving financial support that combine public and private resources including the procedure of the Public Private Partnership (PPP) for large redevelopment. Yet, grants remain a significant argument to incentivise users and owners to renovate⁵.

This is why the TripleA-Reno platform should consider the opportunity to provide information and refine the calculations considering the **existing financial incentives**.

2.4 The TripleA-reno approach to overcome the barriers

In order to convince the end-users to undertake a process of deep renovation, it is necessary to acquire an in-depth knowledge of the current building conditions, of the users' habits, requirements and satisfaction before and after the renovation phases; therefore, analytical protocols for the acquisition of data relating to the consistency and qualification of real estate assets in terms of "real-estate value" in the pre and post retrofit conditions must be designed, developed and implemented.

As observed, one of the main barriers in the process of energy renovation is the **absence of the adequate involvement of end users**, which often leads them to see the process as an unclear black box. Therefore, in order to increase the end user's involvement, one of the objectives of the project is to **make the process interactive during all its component phases**: the economic feasibility, the technical design, the implementation, the use and monitoring of results.

⁵ In surveys conducted within the framework of Energy Days in several countries during the European Sustainable Energy Week in 2011, it clearly appeared that, for the majority of owners interviewed (e.g. 75% in Belgium), financial incentives can convince them to renovate. Adequately informing owners about funding opportunities and providing advices, notably through "one-stop-shop" mechanisms, can considerably improve the uptake of energy efficiency renovation work.

To give the opportunity to implement this interactivity, it is necessary to systemize the materials, the technical solutions and the building and plant components and make them usable in the form of standard packages, so as to make it directly clear to the users, as a ready package to control the renovation process in terms of quality, technical efficiency, economic and environmental value. If this mechanism of quantization of the components is inevitably less flexible for the possible choice of solutions, on the other hand it produces a mechanism of simplification able to translate the same options in immediately understandable possibilities also for non-professionals, thus encouraging the participation of users and increasing the interactivity of the process.

Finally, to further increase the interactivity of the process and keep the motivations of the end-user high, the project will adopt elements from the techniques of the gaming world (gamification).

In brief, the goal is to define a **DSS (Decision Support System)** that takes into account the economic performance aspects of the interventions that can be translated into an on-line platform participated by users (consumers, producers, investors) aimed at the representation of the scenarios resulting from the energy retrofit interventions.

The standardization of the possible packages and components must necessarily comply with the current standards in the building market and in the HVAC system practices and products. To achieve this one of the most important tool is certainly the BIM (Building Information Model), which describes in a complete and portable the technical, economic, environmental and graphic aspects of the individual components.

Thus it is necessary to develop a representation of the objects that can be used both as BIM elements within the cycle of activities during the process (design, construction, installation), and in the interactive platform available to users (or user groups). In other words, the models that describe the basic packages, which can be grouped together, will have

1. a BIM component to be integrated into the process within the building design and implementation;
2. a functional component for their use in the platform;
3. a gaming component in order to be integrated into the game engine.

The objective of the project is the identification of the techniques and the tools for achieving an "increased knowledge" on the technical and economic feasibility of possible energy renovations, considering different building types and different kind of users.

The increased knowledge of the solutions preferred by users, intended as consumers and producers ("prosumers"), will constitute an opportunity for the formation of a solid background for the development of technical, economic and financial tools necessary to activate and make attractive the participation of the different players in the TripleA-reno online platform.

3 System overview

TripleA-reno will be based on these aspects, trying to make the entire process of energy renovation available and usable by consumers and end users through understandable, interactive and attractive ways.

The idea is to activate the "**engine of energy requalification**" focusing on the end user through a platform that facilitates the understanding of the achievable benefits, enhancing:

- trust: to provide transparency, traceability and recognition of all the actors involved in the process;
- compatibility: building and making available to the user solutions that are immediately usable by the technicians and the companies involved in the process, through the adoption of standardized tools and components;
- participation: encouraging the involvement of end users in supporting decision making, facilitating the creation of virtual spaces that connect users, user groups, stakeholders, technicians, construction companies, installation companies to accelerate the ongoing renovation processes and to increase the number of potential retrofit interventions;
- - connection: directly with the products and technologies available on the market;
- attractiveness: of the energy renovation process, using tools and techniques from the gaming world (gamification).

The platform that can be used by all the players involved in the energy requalification processes (end users, stakeholders, professionals, installers, construction companies, etc.) that integrates within it:

- a financial model that includes innovative tools, mechanisms and solutions for the economic evaluation of interventions;
- - a network of operators who work in the field of energy renovation certified and who are able to demonstrate their skills, so as not to constitute a barrier for the activation of the process;
- the increased interactivity for the end users in order to make them actively involved in the process;
- the use of gamification mechanisms that trigger the renovation process in an attractive way for the users.

In the **web gamified platform**, the main features are given by:

- using the results from the morphological design tool as a starting point;
- the energy analysis of buildings and user behaviour, calculation of primary energy required for HVAC, lighting and other energy building requirements;
- the analysis of user behaviour
- the economic evaluation showing the return time of the intervention and economic, environmental and social benefits (including climate, health, comfort and security developed on the OGP platform);
- a comparison of deep renovation projects and construction of a ranking list based on different indicators of the attractiveness of the interventions, thereby stimulating the competitiveness of the end users among themselves towards potential investors;

- the deep renovation projects' publication on a board accessible to potential investors to arise their interest for the more relevant projects;
- the opportunity given to investors to directly bid for the deep renovation realization of the most interesting/attractive projects;
- the possibility for users to modify their project in accordance with the offer of investors, to meet the investors' demand and/or decide to financially contribute to the investment, thus making the project more attractive/competitive, able to "climb" the list of showcased projects and to engage more investors.

Existing financial instruments developed in other EU projects (see H2020 - ABRACADABRA project) will be adopted; the innovation lays in the use of such instruments and tools, since they will adopt in the TripleA-reno gamification mechanism. This will attract the interest of un-experienced users in a procedure that otherwise would have been dull and subject to data input errors.

We will analyse the dynamics governing relations between the various actors involved in the process of the building renovation highlighting, in particular, the different stages of the renovation process and which are the mutual interests in order to:

- consolidate the links between the actors of the process who have common interests, encourage their aggregation and provide them with an instrument that facilitates such sharing;
- build a mechanism that can support competitive dynamics with clear, fair and shared rules, so as to facilitate the achievement of objectives that may be the right balance between the needs of the different participants;
- encourage the participation of end-users in projects of deep renovation, making them as active as possible;
- make available to investors more information than normally available with their own means, so that they have a greater choice of renovation projects in which they would be willing to be involved;
- provide the certified professionals the opportunity to promote their skills and activities towards potential investors and end-users.
- provide a tool for the end user to let them get in touch directly with investors and certified professionals;
- provide investors with an effective instrument to access information entered by end users so as to expand their database of potential deep renovation candidate buildings; from that database they can choose renovation projects with higher levels of profitability;
- provide certified professionals a tool that enables them to fit within the energy renovation process and to play a mediating role between the interests of end users and investors' interests.

The main features of the TripleA-reno platform are:

1. the **energy analysis of buildings**, the calculation of the primary energy required for heating and cooling, lighting and other energy demand required from the users within the building;
2. the **economic evaluation of interventions**, displaying the return time of the intervention and the economic, environmental and social benefits (including climate, health, comfort and security developed on the OGP platform);
3. the **comparison between the various renovation projects** and the construction of a ranking based on different indicators describing the “attractiveness” of the interventions, thereby stimulating the competitiveness of the users between themselves and towards potential investors;
4. the **exhibition of the energy retrofit solutions** on a public board, accessible to potential investors, in order to create and rise their interest in the deep renovation projects;
5. an opportunity for investors to send a **demonstration of interest to the most attractive deep renovation projects**; this demonstration of interest can also be equipped with an economic proposal (bid for the contract) for the implementation phase –construction phase-;
6. the **possibility for users to modify their project in order to encounter and fit the investors’ demands**, also as a consequence of the above mentioned access and actions from potential investors; in this way the users can re-adapt their project with more competitive solutions for investors, thus rising their position in the ranking list of the 'showcased' projects and thus potentially attracting more/other investors;
7. the possible development of **incentive mechanisms for projects that apply for monitoring campaign before and/or after the renovation process**, so as to stimulate the implementation, installation and promotion of tracking/monitoring systems. The incentive mechanism will not be based on public resources but will seek to involve private sponsors promoting their monitoring systems. Here again, a gamification system can be used: the interventions that will be at the top of the list will access the incentives provided.

4 Functional description

In the functional description we will give a description of the types of users who will use the system, i.e. define the actors involved in the deep renovation process and their role.

Then we will describe the workspaces, intended as a dashboard in which one or more types of actors can perform different actions. These are modules for which the types of users that access them have to be defined, as well as the input data, the output data, and the actions that can be performed.

4.1 Notes on the dynamics of the participating actors

The process of energy renovation is a complex process in which the types of individual actors have an interest that can also be strongly competitive between them economically, while from a technical point of view there is a more synergic common vision.

For example, if a user group decides to start a renovation project without the financial resources to implement it, they must compromise with the investors so that they can find a “compromise point” and achieve a win-win solution for all.

The development of the business model must take into account this competition and provide homogeneous yet consistent aggregation spaces in order to manage within these spaces the aggregation of actors with the same interests and subsequently make available their own requests to the members of the community they are willing to interact with.

User-driven dynamics are multiple. Users who are linked to one-to-one building (such as a condominium) are pursuing a common interest: improving the viability of their building in terms of welfare and reduced spending. Two or more users' aggregations, gathered for the upgrading of their buildings, are in competition with each other: their proposal has to be the most appealing to the potential investors. Also the investors could aggregate each other in groups, but in general they compete with each other to gain the access to the best buildings in terms of profitability of the investment.

In parallel, certified professionals are generally in competition with each other; yet they may form a group that, in the case of complex interventions, could provide improved and more competitive services than the ones they could guarantee individually.

Therefore, the TripleA-reno platform will:

- **encourage the aggregation of actors** sharing the same interests and provide them with an instrument to facilitate such sharing;
- **build a mechanism that can support competitive dynamics** with clear, fair and shared rules, so as to facilitate the achievement of objectives that may be the right balance between the needs of the different participants.

4.2 Actors

4.2.1 End user

By **end user** we mean a person who intends to renovate his/her house/apartment. Let us assume that, at the beginning, the end user looks at the virtual space of the realized projects; this virtual space should activate its curiosity, make him wondering: *"How could my life improve in economic terms and comfort if the building in which I live was retrofitted?"* or *"Compared to similar buildings, how much I spend for gas, electricity, water?"*

In the next step, being the TripleA-reno platform appropriately attractive, the user should be encouraged to initiate and activate the project of renovation of his/her own house/apartment, verifying whether his/her building is already undergoing a restructuring project; at this point the user should be able to insert the first fundamental data, like the location of the building (country, city, address), and to verify if the building is already present in the platform as the object of a renovation project previously activated, for example, by another dweller in the same building. In the case of a building already undergoing a renovation project, the user asks its "administrator" to invite him/her to the development of the project, so that a bottom-up process of building renovation can be activated and implemented. Else, a retrofit project is created based on the data being provided and the data that the user directly enters, becoming himself/herself the "administrator" of the renovation project.

It is important to underline that here for administrator we do not intend the administrator of the condominium but the "administrator" of the project; in the TripleA-reno platform he/she is one of the building's dwellers willing to evaluate a possible renovation project for the building/the apartment he/she lives in.

Once the renovation project is activated, the user goes through the planning phase of the intervention and then accesses the relative workspace, which is associated only with the project in progress and is visible to him/her as well as to all the members of the group.

The fundamental objective of this module developed is to overcome the bottlenecks and the typical obstacles present in the initial phase of each deep renovation process, where the user is forced to go through an intermediary entity or figure to trigger the process. I.e., the end user is usually forced to pass through a request to the administrator of the condominium. Thereafter, the administrator must consult a technician whose findings must be ratified by the assembly of owners. This generally results in an elongation of times for the activation of the deep renovation process and thus causes the effect of cooling interest in intervention

4.2.2 Investor

The investor has access to the virtual space of the deep renovation best practises that are already realized and to the virtual space of the showcase of the deep renovation projects that the end users propose to realize. In case the investor is interested in a particular intervention, he/her will send the "proposal of interest" in which he/she can specify his/her economic and financial proposal along with the services and the support provided for the implementation and construction phase. The investor also has his/her own space

from which all the proposals can easily be handled and where it is also possible to join other possible investors to create a group in the cases where additional resources are needed to carry out the deep renovation.

The bottom-up activation of the energy requalification process is beneficial for the investors because they can easily and directly handle a database of candidate projects, with no use of internal resources for the research and the creation of feasibility projects to identify potential business cases.

Furthermore, the individual investors, especially the minor ones, have the possibility to join together to implement more significant interventions and thus improve their own chances of accessing the deep renovation market.

4.2.3 Certified operators and professionals

The certified operator can be a construction company, HVAC and RES operators, ESCO, etc. or a professional who can support the end user for the development of their project or for the issue of any authorizations from the Public bodies. The end user can consult a list of qualified professionals (result of the WP3 activity).

The certified professional can also propose his/her services and competences to the investors for the implementation of selected interventions; also in this case he/she can create a group of professionals who join together to participate in a specific deep renovation intervention.

4.2.4 Notes

In addition to the users described above, the system also includes the following types (ii): i) the system administrator and ii) the expert user, who has the task of managing the characteristic data of single countries or areas of expertise.

4.3 Workspaces

The modules will be structured in six different workspaces, representing different scenarios of deep renovations for the users:

1. consultation of already completed deep renovations;
2. creation of new deep renovation projects;
3. new projects' management;
4. showcase of deep renovation projects;
5. investor dashboard, to track the evolution of their offers;
6. certified consultants and professionals' dashboard.

4.3.1 Consultation of projects already completed

This is a space in which the interventions already carried out with the relevant parameters are advertised: the current consumption, the post-intervention consumption, the costs before and after renovation, the evaluation on improved quality, information on the monitoring of interventions, references to those who have realized the deep renovation, etc. This space is accessible to everyone and is designed to promote and disseminate the outcome and the results of the TripleA-reno community.

4.3.2 Wizard to create and design a new project

It is a space in which a user can create his/her own renovation project. Within this space the user can acquire all pieces of information available and integrate them with the specific data of the building through an assisted procedure. The result of this procedure is the creation of the current state of the building to be renovated, including the 3D geometrical model, the thermo-physical and economic data. The result of this procedure will be the visualization of the current state of the building and will be called scenario 0.

In this phase gamification will come into play, i.e. the possibility of overcoming the fact that data entry is a generally boring procedure and a source of errors. The goal is to assist the user in entering data, minimizing the possibility of error and making this operation attractive, quick, easy.

In this phase we will provide a first set of indications on the possible interventions that can be implemented on the specific building, suggesting a standard package of measures deriving from questions on the economic availability, on the required building quality, on the level of consumption to be achieved, on desired levels of comfort, giving an initial economic evaluation. The result of this activity is the creation of a first alternative scenario, which will be called scenario 1.

From the users' point of view, the aim at this stage is to answer the questions: does my building consume too much energy, how much energy could I save, how much should I spend now, how much will I spend after renovation, how much it will cost me without the intervention 'Intervention of funding agencies, as I will save in the future with the intervention of funding agencies (banks, ESCO, ...), etc.

4.3.3 Project management

In this workspace the user can scenarios alternative to scenarios 1 and 2, in response to questions that the system poses, such as:

- how much my building currently consumes?
- how much it will consume after the deep renovation?
- how much I should spend at the present moment?
- how much will I spend in the future?
- how much it will cost me the intervention with or without the public incentives?
- how much will I save in the future with/without the intervention of funding bodies (banks, ESCO, ...)?

The administrator user can give the opportunity to participate in inviting other users to project development.

In this workspace, the user 'administrator' of the intervention is assisted in the development by other 'connected' users (e.g. condominiums, 'expert' acquaintances, etc.). The goal of this phase is to compare the various solutions, to choose the best solution from the economic point of view and to 'publish it', that is to get it into a list of redevelopment projects that includes other projects. This solution will automatically be assigned a score, using a ranking algorithm, and then compiled against other projects. The comparison will focus on the profitability of the investment from the point of view of an investor.

At this stage, the user can ask for the help of a retraining professional, if available, for assistance in entering data. In this workspace the database of products will be made available to the end users; the list of available

products will be categorized according to the type of user and intervention (example: indoor renovation or renovation on the whole building). Among the available solutions will also be the possibility of carrying out DIY intervention and the system will talk with OGP for visualization.

In this space the knowledge acquired in WP 2 and WP3 will be of crucial importance. In particular, the knowledge acquired by WP 2 will be used to understand the motivations and habits of users and to propose ways to interact with other users.

The knowledge acquired in WP3 will be used to construct ways of interacting with users based on 2 techniques:

1. co-creation, which should facilitate the decision-making process and the acceptance of the energy requalification intervention;
2. the implementation of a catalogue of packaged and certified interventions, in order to simplify the selection process.

In addition, the graphic interface will be managed, in an attractive and easy way to make the whole process similar to a real game. The interface with other platforms (P2Endure) shall be provided, either directly or through an interface that has the function of an adapter between the TripleA-reno data format and the data format of the other platforms.

4.3.4 Showcase renovation projects

This workspace contains the list of projects resulting from the design phase operated by users and ready to be accessed and possibly financed. This list is made visible to investors and classified according to the profitability of the intervention. In other words, each project publishes the optimal solution from the users' point of view; to this solution will be automatically assigned a score, through a ranking algorithm, and thence compared with other projects. This comparison will be based on the profitability from an investor's point of view.

The showcase renovation project workspace is shared by:

- the registered users that are linked to a project,
- the investors and the certified operators and professionals.

The usefulness of this workspace lies in the fact that:

- the end users can get an idea of the market trends; this can build and increase their capacity, and train them in designing more attractive deals;
- the end users can compare their project with the other projects in order to take useful ideas for a possible change, for example in the case in which their project remains in the window for too long;
- the investors can focus on projects that looks more interesting, by contacting the end users directly and possibly proposing their changes so as to arrive at a shared win-win solution;

- the certified professionals, in their third-party position between users and investors, can suggest solutions to guarantee the appropriate quality of the interventions and facilitate the activation of the process.

4.3.5 Management of tenders: investor's dashboard

This workspace is available to individual investors to keep track of offers and participate in the renovation projects submitted along with the related workflow; in this space notifications of changes in the conditions will be activated. It is intended as a private space, reserved for investors, accessed through authentication.

4.3.6 Management of on-going projects: certified consultants and professionals' dashboard.

This workspace is accessible to users connected to the renovation project and to the investors that financially support the project. It shows the progress of the various stages of the renovation project and may include graphics, photos, videos, and so on, which illustrate the various phases of the project, thus enabling the monitoring of the renovation phases by the involved users, investors and professionals.

5 Business model

5.1 Cost assessment model

In this section we will show the proposal of the financial model that must be used to calculate the profitability of the deep renovation process.

The model provides the calculation of the profitability of the energy renovation process based on various aspects, since this process involves the participation of various actors, often with conflicting interests. For this reason it is necessary to consider the calculation according to the different points of view and to provide a search mechanism for the optimized solution, taking into account the balancing of the profits of the single types of participants, and implementing a mechanism considering the variations proposed by individual actors to meet the counterpart's requests.

5.1.1 Cost assessment approach

Based on feasibility studies and cost-analysis assessment implemented on the TripleA-reno case studies, a detailed economic and financial assessment will have to be carried out based on a financial analysis developed by using Net Present Value (NPV) and other economic indicators like ROI, income statements, debt service ratio, and so on. Therefore there will develop a cost assessment tool in order to analyse different scenarios involving various hypothetical investors and financial schemes to assess benefits/barriers/constraints in each case study with the aim of providing (ii): i) a large spectrum of possible scenarios; ii) a scheme for the standardisation of the financial process.

The renovation hypotheses will be contemplated within scenarios, which will be compared to each other to arrive at the optimal solution. We will try, as far as possible, to standardize this process to make it usable in a simplified way to the end user.

5.1.2 Cost assessment tool

The cost assessment tool allows end users to carry out an estimation of the potential savings, payback period required for the different energy efficiency measures that they consider, as well as the new value of the building after the deep renovation process.

This tool will allow the comparison of different scenarios/renovation that have been made available. The end user can select several options of interest and therefore build his/her own 'scenario' (collection of options).

The tool will provide an updated calculated payback period for the chosen scenario, as well as for the improved real estate value of the building.

The variables listed in the following table (Table 1) have been considered to be used in the cost assessment tool and will have a scope depending on whether they will be extracted from the common database or if specific to the project:

Table 1: variables

name	description	scope
specific building value	the original real estate value of the building, expressed as a value per square meter of the building before the renovation; in first approximation it may be associated with the country/region, but most likely it will be one of the parameters that will vary in the customized scenarios	country/region
specific energy price	the cost of energy per unit of measurement, including taxes and other expenses, which will be used in conjunction with the energy performance calculation tool to estimate the total energy costs per year; these costs must be specified depending on the energy source (gas, electricity, etc.)	country/region
energy variation	change in the cost of energy, which will take into account the oscillation of energy costs over the years	country/region
energy price	The energy prices (the energy savings considered for the payback calculation are adjusted according to the inflation rate and maintenance costs);	project
specific renovation cost	the cost of the works chosen for the retrofitting of the existing building;	country/region
loan interest rate	the interest rate of the loan; we consider an average value for the country	country/region
loan duration, starting year, capital	the financial information related to the loan (if required): duration, starting year and capital	project
inflation	the value of the inflation	country/region
project duration	it is the period that is taken into consideration to verify the convenience of the intervention	project
opportunity rate	value of the opportunity rate in relation to the individual countries: represents the value of the remuneration of the money in the event it was invested	country/region
total investment	Total investment for the renovation	project
energy savings	The expected energy savings (in %) for each of the variables considered	project
specific value of the renovated building	The average real estate value per m ² of the renovated building	country/region
building maintenance cost	annual building maintenance costs in the current state (estimate per sq.m. and parameterized according to the age of the building)	country/region
renovated building maintenance cost	annual maintenance costs of the renovated building (estimate per square meter and parameterized according to age)	country/region
specific renovation cost	The cost of the works chosen for the retrofitting of the existing building, estimated per measuring unit	country/region

THIS PROJECT HAS RECEIVED FUNDING FROM THE EUROPEAN UNION'S H2020 FRAMEWORK PROGRAMME FOR RESEARCH AND INNOVATION UNDER GRANT AGREEMENT NO 784972.

The sole responsibility for the content of this report lies with the authors. It does not necessarily reflect the opinion of the European Communities. The European Commission is not responsible for any use that may be made of the information contained therein.

For all the financial costs, values and energy cost are adjusted based on inflation, on the average yearly evolution of the energy prices, etc. generating positive and negative cash flows for every year; then, based on accumulated cash flows (regarding savings, costs and earnings), the Net Present Value of the building is calculated.

The main output for each scenario are:

- energy saved (kWh/year)
- money saved (€/year)
- new value of the building (€/m²)
- payback time (year)

An estimation of the unforeseen changes in the values of the parameters chosen for the creation of the scenarios will also be provided, considering two confidence thresholds that we may call pessimistic and optimistic, as illustrated in the following table (Table 2).

Table 2: sensitivity analysis

Variable	Pessimistic	Neutral (base)	Optimistic
building value	80%	100%	120%
inflation rate	120%	100%	80%
interest rate of loan	120%	100%	80%
renovated building specific value	80%	100%	120%

In the TripleA-reno platform the end user can request support from a certified professional to complete the entry of the data required by the system. All the renovation components shall be associated with data that refers to the maintenance costs. This data can be provided referring to an annual quota; the yearly cost of replacement refers to the costs associated to the accumulation of funds required to replace those elements of the retrofit once they reach the end of their useful lifespan. As some of the lifespans are quite lengthy, the values are adjusted to the applicable inflation rate (based on the available averages per country), therefore this annual quota is calculated as NPV of the sum of the substitution interventions taking into account the value of the annual inflation.

We will propose to adopt another method, that considers the actual number of years of duration of the component and calculates the NPV of these substitution interventions taking into account the value of the annual inflation. It is also necessary to clarify that these costs are different from maintenance costs, and must not be confused, therefore these costs should be separated.

Actually if investment in maintenance is reduced two negative effects may take place:

- the reduction in the expected efficiency of the retrofit elements;
- the reduction in the useful lifespan of the retrofit elements.

In the case that an overall quote is provided and not a detailed one, the calculation of replacement cost will have to be carried out on the basis of averages of their useful life-span.

5.1.3 Calculation procedure

Here the main steps for the calculation procedure are illustrated:

- data entry (common to all scenarios);
- entering the geometric data of the building with a simplified but guided procedure in order to minimize user errors;
- based on the location of the building, extract the climatic data (automatically);
- on the basis of some simple questions and the year of construction of the building, extract the thermo-physical data;
- definition of the observation period (e.g. 30 years).

For the building as it is (scenario 0) the calculation procedure will be as follow:

- estimated consumption calculation;
- based on the location of the building, simple questions about the plant, the geometric and thermo-physical data, calculation of the annual energy consumption (kWh / (sqm x year));
- calculation of the current value of the building;
- calculation of the discounted value of consumption in the next n years;
- calculation of the cash flow for energy consumption, considering the changes in the cost of energy;
- calculation of the NPV of energy consumption, considering for the calculation the opportunity rate net of the inflation rate;

For the energy renovated building (scenario 1):

- based on the geometric and thermo-physical data entered, calculation of the annual energy consumption -kWh / (sqm x year)-, considering the new parameters of the components used for energy renovation;
- calculation of the annual cost for energy consumption after renovation;
- calculation of the cash flow for energy consumption, considering the annual variation in the cost of energy;
- calculation of the NPV of energy consumption, considering for the calculation the opportunity rate net of the inflation rate;
- calculation of the value of the redeveloped building;
- calculation of the cost of redevelopment.

Following the main formulas (cash flow formula and Net Present Value) used in the cost-assessment tools are reported.

Cash flow formula:

$$p_t = p_o * (1 + r_i)^t$$

where:

- p_t : value at year “t” (with $0 < t < 50$)
- r_i : inflation rate.

Net Present Value formula:

$$w = \sum_{t=0}^n \frac{p_t}{(1 + c)^t}$$

where:

- w = Net Present value
- p_t = value at year “t” (with $0 < t < 50$)
- c =“opportunity rate”*

* *The opportunity rate consents to evaluate the convenience of an investment compared to an alternative situation. For convenience it is compared with a scenario where the user does not invest the money for the renovation so the opportunity rate in this case would be the inflation rate.*

6 Conclusions

This report has presented the first proposal for the overall structure of the platform, to be shared and discussed in the next phases of the TripleA-reno project. As the activities of the project are reflected in the platform, the design of the platform itself will result in a continuous process and not in a one-time effort at the beginning of the project; instead, the platform design will be continuously updated until the end of the design phase.