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# Social housing energy retrofitting: Business Model and supporting tools for public administration

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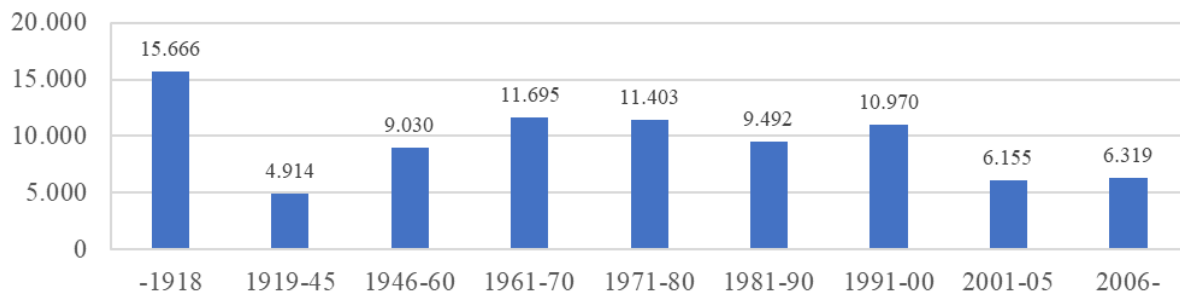
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**Abstract.** High refurbishment costs and uncertainty of the investment payback period account as the main reasons of low rate of energy retrofit of the European building stock. Moreover, assessing energy and economic benefits of energy retrofitting may result difficult e.g. due to the unpredictability of users' behaviour which may alter the effectiveness of energy refurbishment intervention. This paper deals with the question whether approaches exist, aimed at securing the profitability of energy retrofitting and at creating the market condition to incentivize the energy refurbishment on a large scale. The paper presents the operational tools, developed to support the public administrations along the entire retrofit process, and the Business Model (BM), structured to financially support the refurbishments by the energy cost savings. This tools and the BM has been developed for the South Tyrolean context, to promote the energy retrofit of the social housing building stock of the Autonomous Province of Bolzano. The results presented in this paper are part of the ongoing research project "KlimaKit", founded by operational programme European Fund for Regional Development of the Autonomous Province of Bolzano EFRD 2014-2020 – Investments in Growth and Employment.

## 1. Introduction

The European Commission [1], as well as the Intergovernmental Panel on Climate Change [2], identify the construction sector as the one with the highest potential in reducing energy consumptions and environmental pollution. According to the European Commission the CO<sub>2</sub> emissions of the residential sector should be reduced about 90% by 2050 [3]. Considering that the annual growth rates of new constructions is around 1.0–3.0% per annum [4,5], it means that existing building stock represents the main opportunity to save energy. For reducing the CO<sub>2</sub> emissions, the political measures of the 28 EU countries set to 2,5% the energy retrofit rate of existing building stock by 2020 and 5%-5.5% by 2030 [6]. Despite this, the renovation rates of residential buildings still remain relatively low, about 1% per year in most of the EU countries [5, 6]. In South Tyrol the trend is similar to Europe: more than 50% of the residential buildings were built before 1970 (Table 1) and the retrofit rate is about 1% (550 buildings per year) [7]. For this reason, at regional level, the objective for 2020 is increasing the overall amount of renovated buildings to 1,500 per year, namely equal to 2.5% of the existing housing stock. Some of the main barriers in investing in energy refurbishment are the high investment costs, the lack of information [8], the uncertainty related to payback time [9], lack of collaboration of stakeholders involved in retrofit process [10] and the wide variety of possibilities offered by the market [11]. For changing the dynamics of the market, a figure of a frontrunner is essential.





**Figure 1** - Number of residential buildings by construction period (Source: ASTAT).

Social housing associations have a key role in mobilizing the refurbishment market, becoming an inspiring example for the private sectors. Once technical solutions and business models have been developed and tested on the social housing stock, it is much easier to penetrate the private housing market [12]. For this reason several studies [13, 14, 15, 16] and European projects [17, 18, 19, 20, 21, 22] deals with energy refurbishment of social housing. A promising strategy to promote the energy refurbishment seems to be the development of standardized retrofit solutions [23, 24], especially since social housing buildings are characterized by a typological and technological homogeneity [13, 14]. The definition of integrated packages of Energy Efficiency Measures (EEMs), developed based on representative building, allows take advantage of synergies between EEMs [8, 25] and improve the collaboration among stakeholders of building and energy sector. The idea of moving from one-off project towards standardized refurbishment packages with defined energy performance underpins the Dutch program Energiesprong [12, 26, 27]. By linking up home owners, skilled builders, financing institutions, housing associations, researchers and local government, it was possible to transform more than 100'000 home into net zero energy buildings. The basic concepts are the realization of the retrofiting works within 10 days and a 40-year energy performance warranty from the builder [28]. This retrofit concepts are combined with a Business Model (BM), which allows the financing of the refurbishments by the energy cost savings. The success of the BM is a key driver for shifting the model to large scale [29, 30, 31].

The paper presents the operational tools developed to support the renovation of the building stock of the social housing association of the Autonomous Province of Bolzano (IPES - Istituto Per l'Edilizia Sociale) and the BM defined to drive the changes of energy refurbishment market in South Tyrol. IPES is rather sensible to the topic of energy refurbishment and it is already involved in some important renovation processes, such as the European Sinfonia Project [17], which aims at testing urban-scale strategies for improving the energy efficiency of social housing stock [32, 33]. However, the major part of the social housing stock has not been renovated and still presents high energy consumptions. Section 2 presents the methodology used to develop the supporting tools and the BM. Section 3 reports the results of the analysis carried out to define the main critical issues of the energy retrofiting supply chain and the existing retrofit process. The supporting tools and the proposed BM are presented in Section 4. Section 5 identifies the limitations and the opportunities of the proposed solutions. Conclusions with the main recommendations and future development of the work are reported in Section 6.

## 2. Methods

The methodology used to develop the supporting tools and the BM for energy retrofit of social housing includes two distinct steps. The first step entail the systematic analysis of the management of energy retrofit process by the local social housing department. To this aim, the Director of the technical services Division and the Director of the west technical Office of IPES attended semi-structured interviews (approximately 60 minutes based on predefined open questions). The experts interviewed contributed to define the specific characteristics of the process, the main organizational challenges emerging along the entire energy retrofit supply chain and the different actors involved in each phase. The second step consists in a series of workshop, reported in Table 2, carried out to discuss the proposed solutions. The

series of workshop was conceived as an iterative process where the experts validate progressively the results of the project, enabling the research team continuing the development and finetuning of the most promising concepts. The different stakeholders were not involved at the same time during the workshops, but they took part at the meetings where they are directly involved in the decision making process, in order to preserve high commitment into the project.

**Table 1.** Structure of the workshops

<b>Workshop</b>	<b>Objective</b>	<b>Participants</b>
<i>Concept</i>	Description of organisational structure First draft of the Business Model	Social housing department
<i>Implementation</i>	Benefit and role of actors Team requirements	Social housing department Energy service provider
<i>Simulation</i>	Market and legal scenarios Risk management plan	Social housing department Public procurement agency Tenants association
<i>Validation</i>	Supporting tools Business Model	Social housing department Energy service provider Public procurement agency Tenants association Companies

In the first workshop, a draft of the BM concept, formulated according to the information collected during the interviews, was presented to the social housing department. The BM has been compared with other national and international similar experiences. Through the second workshop, the implementation of the supporting tools has been proposed and discussed. Specific solutions and the stakeholders role were defined for each phase of the retrofit process. The third workshop provided concrete scenarios supporting the introduction of the energy retrofit model in the market. The legal aspects along the entire renovation process were also considered and discussed with the local public tender agency. During the final workshop the supporting tools and the validated BM were presented to the stakeholders involved in the energy retrofit supply chain, including different companies and suppliers. The different workshops, conducted between November 2017 and December 2018, consisted of presentation of preliminary results and open discussion moderated by research team, composed by researchers of Fraunhofer Italia and the Institute of Renewable Energy of Bolzano.

### 3. Findings of the Analysis

The systematic analysis of the existing energy retrofit process allows to identify the most critical aspects of the energy retrofit supply chain and the existing structure of an energy refurbishment project carried out by the social housing association. The main findings are reported in the following sessions.

#### 3.1. Critical aspects of the energy retrofit supply chain

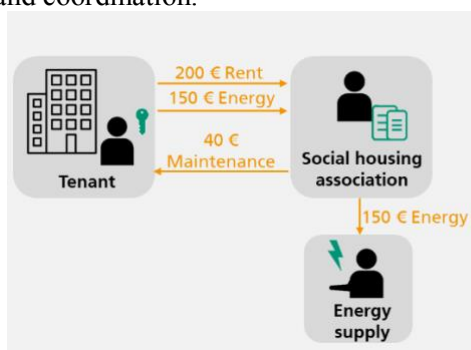
For each phase of the energy retrofit supply chain the most common problems have been identified.

- *Preliminary design.* During the preliminary design the requirements of the retrofit project are defined. In this phase, the most critical aspect is related to the choice among several option offered by the refurbishment market.
- *Designing.* The design project is entrusted to external professionals through a public tender. The choice of the reliable partners appears to be the most critical step because of the tendering process that it is not structured in a proper way.
- *Building Construction works.* In this phase it is noted a poor control over quality of building works. This aspect generates uncertainties in costs, timing and architectural quality.

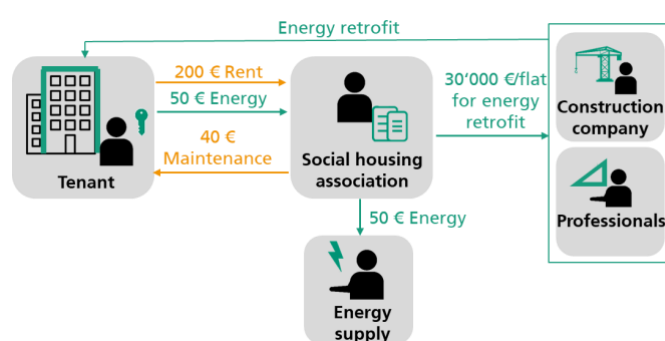
- *Operational Phase.* In the current process, energy savings assessment and planning of maintenance of the building system are not scheduled. This lack generates uncertainty on the retrofit benefits and the malfunctions of the technical system are not prevent.

### 3.2. Existing retrofit process

Besides the critical aspects of the supply chain, according to the existing retrofit process a real BM for encouraging the retrofit process on a large scale is not present and all the incurred costs are faced just by the social housing association. As shown in figure 2, before the retrofitting, the tenants pay a fix rent to the IPES, calculated based on family income. The comfort conditions, as well as the condition of the building, are not taken into account for the rent calculation. An average estimation of this cost is about to 200€. In addition, the tenants has to pay for the energy supply of the utilities. This cost changes on a monthly base and it is managed and debited to the tenant by IPES, which acts as an intermediary between the tenants itself and the energy supplier. For exemplifying purpose, a cost of 150€ for the overall energy supply has been estimated. A total expense of 350€ per month for each apartment is collected by IPES from tenants. On the other hand, the social housing association takes care of the maintenance of the building and the heating system during the operational phase (estimated about 40 € per month). In this framework, since there is not a real planning of the management and maintenance of the building, the costs tend to be higher than it should be. Once the building has to be retrofitted (Figure 3), the retrofit is not structured to take advantages of synergies between different EEMs, but it often involves just some individual measures. The design phase and the realization work are entrusted respectively to external professionals and construction companies by means of a public tender. All the construction activities are supervised by the IPES technicians, which have to guarantee the achievement of specific standard of architectural quality. Based on IPES experience, a total cost for the energy retrofit of about 30.000€/flat has been estimated. This cost is entirely financed by IPES. According to this process, the only stakeholder that benefits of the energy refurbishment is the tenant, who pays less for energy supply and enhances indoor comfort conditions. The monitoring and the assessment of energy performances after retrofit are not planned and no guarantee of performance is due. This process is characterized by a fragmented supply chain, resulting in many difficulties in communication, planning and coordination.



**Figure 2** – Costs before the retrofit.



**Figure 3** – Existing retrofit process of the social housing association IPES

## 4. Results

The series of workshop allows to define and validate the identified solutions to the critical aspects of the energy retrofit supply chain. During the workshop the BM has been developed based on the South Tyrolean context and according to the social housing association requirements and needs.

### 4.1. Supporting tools for public administration

To support the public administration and IPES during the refurbishment process, the following operational tools have been developed:

- *Building Analysis*: during the preliminary design a decision support tool can help in choosing among different EEMs, improving the awareness of decision makers. To develop this tool, the social housing stock of Merano has been analysed [34] and five reference buildings, representative of the building heritage, were selected. Based on these buildings, five standardized retrofit packages with heterogeneous levels of certified energy saving performances, have been defined. By answering a set of questions, related to an existing building belonging to the South Tyrolean housing stock, the tool identifies the most similar reference building and, according to a series of drivers, recommends one of the standardised retrofit packages. Beyond the recommendations of the technological solutions, the tool provides a reliable range of information regarding the expected energy savings, the reduction of CO<sub>2</sub> equivalent emissions, the retrofit costs for the envelope and for the technical system and an estimation of the payback time of the intervention. The process development of the tool is presented in [35].
- *Soft Criteria*: The introduction of soft criteria into a public tender is a practical input to support the public administration in choosing reliable partners during the designing phase. Soft criteria should not be compulsory, but they should award professionals and building companies that include the following aspects into their offer. The first criterion is the warranty of building energy performances. In particular, the public tender participants should specify the method used to calculate the energy savings and the time-frame within this performance should be guaranteed. The second criterion is the application of a monitoring system for checking the indoor thermal conditions and the energy consumptions post retrofit. Especially in case energy savings are lower than the expected ones, it is important to define whether the responsibility belongs to the construction company or to the user behaviour. The planning of management and maintenance of the building and the building system is the third soft criteria. Planning these aspects is particularly important to prevent malfunctions and to avoid deteriorations of the system.
- *Building Information Modelling (BIM) Methodology*: In a retrofit project the use of BIM methodology leads to several benefits. First of all, during the realization phase, by improving the management of the building site, it increases the control on the quality of the realization. BIM allows also to create a database with all the information related to the retrofit project, for example the specification of construction materials applied to the building, the characteristics of the glazing or heating system, etc. This information can be integrated in a facility management system and can improve the management and maintenance process. Moreover, coupling BIM with the data coming from the monitoring system allows to easily visualize comfort conditions within the building and to detect malfunctions of the building energy system.
- *Contracts*: The relationship between the stakeholders involved into the BM has to be defined by contracts. It is particularly important for the application of the BM to regulate the relations between the social housing association and the energy supplier, as well as the relationship with the tenants. At this purpose, the guide line, for supporting both the realization of the building retrofit project and the following phase of monitoring and management, has been defined. By means of the consultancy of the Faculty of Law of the University of Trient, the regulatory framework, the main structure of the contract and the contractual elements, that has to be integrated into the contract, such as obligations, compensation, legal protection or duration, have been specified.

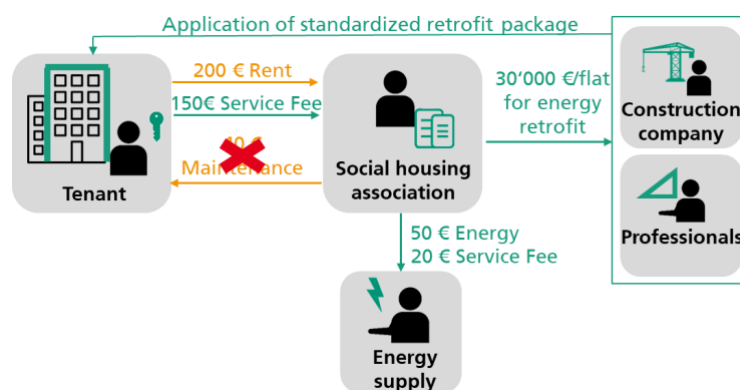
#### 4.2. Business Model (BM)

The developed supporting tools facilitate the application of the BM. The idea behind the BM is similar to the one proposed by Energiesprong [12, 25] and used as a model by Energy Service Companies (ESCOs): integrating the energy bills of the tenants into an energy plan. This allows the social housing association to recover part of the retrofit investment cost by means of energy savings. The proposed BM is summarized in the schema below (Figure 4). The social housing association applies one of the

standardized retrofit packages, able to optimize synergies among different EEMs. The investment cost related to each retrofit packages changes according to the package itself and to the level of energy performance, defined in each package. It varies from 15'000 €/flat to 40'000€/flat. Also the energy savings changes according to the package and the level of performance (from 50% until about 90%). For exemplifying purpose, an investment cost of 30'000€/flat and an energy reduction of about 80% have been considered. The soft criteria allow the selection of reliable partners for the designing and the realization phase. The entrusted professionals and construction companies apply the retrofit packages and a monitoring system, giving the warranty of energy performance and architectural quality of the realization.

After the refurbishment, the tenants continue to pay a fixed renting rate and a service fee. These costs are equal to the sum of the rent and the energy bills paid before the retrofit (350€ per month). The service fee (150€/month), paid as a fixed monthly fee, guarantees the thermal energy supply, for maintaining an indoor temperature of 20°C, domestic hot water and an electricity bundle for electric utilities. If tenants exceed that agreed amount of energy performance, they pay the additional energy consumption. In this way, since the energy costs are reduced, the energy savings allow IPES to recover some of the investment costs. The monitoring system provides information to tenants about their energy consumption and if the performances are not consistent with the estimated ones it provides the cause, whether it is behavioral or technical. On the other hand, also the social housing association pays a service fee to the energy supplier, for the management and maintenance costs for the building energy system. A regular maintenance of the system improves the system efficiency and permits costs reduction. This BM presents several benefits:

- It allows social housing association to recover part of the investment costs for retrofit that can be one more time invest in other refurbishment project, spreading the refurbishment on a large scale;
- It protects the tenants to future energy prices;
- It defines a long-term customer loyalty between energy supplier and social housing association;
- It improves the collaboration among stakeholders, that should collaborate to create integrated solutions with warranty of energy performance.



**Figure 4** – The proposed Business Model

## 5. Discussion

The success of the BM is a key driver for shifting energy retrofitting of the existing building to large scale. In this paper some operational tools for supporting the application of the BM on the South Tyrolean context have been presented. The application of this BM has to face several difficulties, first of all, the agreement with tenants that normally benefits of the retrofit interventions without being charged of any renovation costs. In fact, IPES is not allowed by provincial legislation to increase the monthly rent after the refurbishment and this could compromise the feasibility of this BM. In this framework, the communication strategies pays a crucial role to make the tenants aware of the importance



of reducing the energy consumptions and to make them understand that even if they do not have an immediate reduction of the energy costs, they can benefit of enhanced indoor comfort conditions. It is important to highlight that the identified supporting tools, combined with the BM, have been developed for the social housing association of the Autonomous Province of Bolzano, therefore, to extend the results on a national or European level, both tools and BM need some changes.

## 6. Conclusion

The paper presents some of the main outcomes of the KlimaKit project. In particular, it presents the methodology used to develop the supporting tools and the BM for supporting the social housing association of the Autonomous Province of Bolzano in promoting energy refurbishment in South Tyrol. A systematic analysis allows to identify how the process of energy refurbishment is carried out by IPES and the most critical aspects of the existing retrofit supply chain. By means of a series of workshop, the supporting tools and the BM have been discussed and validated by the main stakeholders. The idea behind the proposed BM is to integrate the energy bills of the tenants into an energy plan. This enables the social housing association to recover part of the investment costs for retrofit and to invest more in other refurbishment project. The application of an efficient BM is crucial in energy refurbishment project, because it allows to start a virtuous circle able to scale up the refurbishment on a large scale.

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