Integrating Existing Knowledge to Accelerate Buildings Renovation Rates in Europe

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Abstract. Nowadays, boosting the implementation of energy efficiency measures in buildings and subsequently, mainstreaming energy efficiency financing is of paramount importance for the European Union towards achieving its goal of carbon-neutrality by 2050. Unfortunately, statistics have shown that a lot of effort is needed to achieve the Europe's targets, since energy efficiency is not yet considered as an attractive investment by the financial sector. The lack of expertise and knowledge, as well as the different perspective of project developers and financing institutions are some indicative challenges that have to be overcome. Specific to energy efficiency in buildings this is reflected by the current insufficient trends observed in the renovation rates of buildings, which reveal the urgent need for action since this is the largest consumer of energy in Europe. Furthermore, a combination of public and private funding through innovative financing instruments is required to overcome current barriers that prevent mobilization of necessary investments. The aim of this paper is to set up a role-based methodological approach for the deployment of an integrated matchmaking mechanism on an ICT platform to boost energy efficiency investments in an easy-access and trust-worthy way. The methodology envisages to follow a multidisciplinary perspective which takes into account the interactions between various key factors, such as stakeholders and barriers, so as to facilitate the complex set of decision-making actions for building renovation. The core of concept centres around the definition of the roles of the potential users of a big data for buildings platform, their interdependency and requirements with the ultimate purpose of accelerating renovation rates.

Keywords: Decision Support · Energy Efficiency · Sustainable Finance · Private Finance · Big Data Platform · Building Sector

1 Introduction

A better performing and smarter building stock is considered the foundation stone of the European Union's (EU) energy strategy towards decarbonisation. Indeed, energy

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Efficiency investments in buildings have a direct effect on reducing energy consumption towards achieving the EU energy and climate objectives for 2030 and 2050, while also driving economic growth [1].

In order to achieve efficient energy use, updates in industry processes, building stock and other sectors are needed, and, thus, capital should be oriented to energy efficiency investments. With regards to the building sector, it uses 23% of the global primary energy and approximately 30% of global electricity [2]. Most of those existing buildings are not energy efficient. Many rely on fossil fuels for heating and cooling and use old technologies and wasteful appliances. Energy poverty remains a major challenge for millions of Europeans. More specifically, in Europe, the percentage of energy consumption by the building sector is 40%, while buildings are responsible for 36% of its greenhouse gas emissions from energy [3].

The Covid-19 crisis has also brought into sharper focus our buildings, their importance for our lives and their fragilities. As Europe seeks to overcome the Covid-19 crisis, renovation offers a unique opportunity to rethink, redesign and modernise our buildings to make them fit for a greener and digital society and sustain economic recovery [4]. Since today's renovation rate of around 1% of buildings per year, a timely transition of the EU building sector towards climate-neutral levels by 2050 cannot be ensured [3].

The building sector is expected to undergo a substantial transformation over the next few decades to meet the goals set out by the European Union in relation to the transition towards a clean energy economy [5]. It is estimated that the majority of buildings in which EU citizens currently live, work and use for recreational, educational or other purposes are in need of an energy efficiency upgrade. Energy renovations —which entail various intervention measures on the envelope of a building and its technical systems resulting into significant energy efficiency improvements— are an important pillar for achieving the EU energy efficiency target for 2030 and the transition towards climate-neutral Europe by 2050 [6]. Despite this, actual energy renovations taking place today neither meet the rate, scale nor the depth aligned with their energy efficiency potential [7].

In this respect, nowadays, more than ever, boosting the implementation of energy efficiency measures in buildings and subsequently, mainstreaming energy efficiency financing is of paramount importance [8, 9]. Unfortunately, statistics have shown that a lot of effort is needed to achieve the European Union targets. Investments should be realized, and energy efficiency measures are considered necessary to update building stock and manufacturing processes. New elements should include the reinforcement of existing financial instruments, establishment of new financial models or supporting mechanisms and a more active participation of financial institutions [10].

Energy Efficiency is not yet considered as an attractive investment by the financial sector [11]. The lack of expertise and knowledge, as well as the different perspective of project developers and financing institutions are some indicative challenges that have to be overcome, already from the first stages of investments generation and conceptualisation [12]. There is a significant lack of information which include also gaps created by asymmetric information that are not well monitored or documented. The energy efficiency in general is difficult to be observed commonly, given also its multi-disciplinary nature, thus requires standardisation approaches. Consequently, this further intensifies

the lack of information. Stakeholders advocates energy efficiency in a different way (i.e., project developers concern more about initial investment cost while engineers look for annual savings) [13].

In order to fill this gap, stakeholder engagement is considered important to get an alternative perspective, and perhaps shift the focus from related activities to intended results. The purpose of this paper is two-fold: (i) to analyse and understand the market needs towards the increase of the energy efficiency investments and (ii) to leverage this analysis and translate into a user-friendly ICT-enabled marketplace for the key players of these investments. To this end, the multidisciplinary problem of understanding and bringing together the key players of the energy efficiency investments will be taken into account and key barriers and bottlenecks could be faced or eliminated in the most optimised way. The core of concept centres around the definition of the roles, their relationships and requirements of the potential users of a big data for buildings platform offering aggregated energy efficiency projects and packaged solutions with the ultimate purpose of accelerating renovation rates.

2 Effective Engagement of Key Actors

The first principal when think to develop a holistic methodological approach to build packaged energy efficiency solutions is to effectively engage key actors. According to literature, to identify the current situation and main barriers for the building sector's energy efficiency increase and promotion of related investments, relevant targeted stakeholders should be engaged [14]. Experts' and energy efficiency stakeholders' opinion becomes crucial for addressing the issues and finding the best practices in the energy efficiency sector. Stakeholder engagement is considered important, since involvement of key stakeholders is very useful to get an alternative perspective, and perhaps shift the focus from related activities to intended results at an early stage [15]. Stakeholders have experience, advice, information and valuable insights to be considered. Addressing their concerns early in the process can lead to obstacles avoidance and same valuable time and money.

In this approach is envisaged that the required knowledge for the development of an ICT platform is provided by several stakeholder groups that are active along the entire energy efficiency investment value chain (Fig. 1). It is vital for the whole process to effectively engage key actors; thus, a participatory approach should take place with the utilisation of various actions, from training workshops and events to bilateral consultations and dedicated surveys [16].

To ensure the effectiveness of energy financing in the building sector, it is important not only to identify all the relevant target groups, but also to understand what type of effort and messages should be used for reaching each one of them [17]. In that regard, on the one hand key actors should be identified, while on the other well-defined consultation activities should be proposed, including specific and concrete actions, in order to ensure the active participation of the identified stakeholders [18]. The scope is to identify all the relevant groups, organisations and experts of the building sector's energy efficiency financing value chain and compile a list in view of a balanced professional, institutional and geographic representation of stakeholders (Fig. 1).

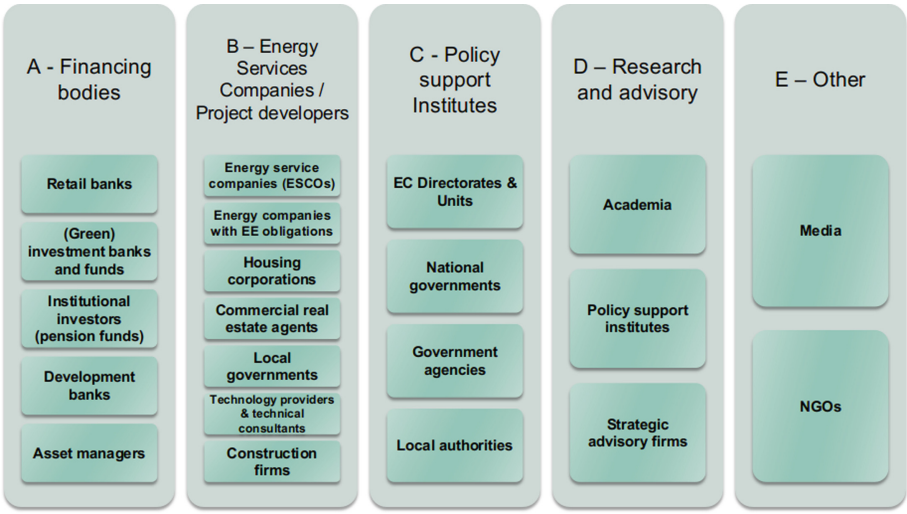

Fig. 1. Stakeholder Groups in Energy Efficiency Financing

The involvement of key stakeholders is very useful to get an alternative perspective, which often stimulates a shift of the focus from an activity to intended outcomes in the early stage and to clearly communicate main ideas about the project in terms of objectives, milestones and outputs. However, the involvement of stakeholders with different, and sometimes opposite, views, backgrounds, aims and expectations might increase confusion. Furthermore, dealing with a large number of stakeholders might be an overwhelming exercise and an extra challenge.

Smart energy services are gradually developing beyond the margins of energy savings, and they are growingly aiming at taking advantage of additional revenue streams and satisfying a range of different consumer needs (e.g., indoor quality, security, etc.). However, high upfront costs of project evaluation and risk assessment lowers the ability of institutional investors and private ones to invest in energy efficiency projects. Projects, therefore, must be developed in a manner, which allows them to be aggregated, traded in bundles and create a platform where projects can easily be bundled, assessed and where a matchmaking process is provided to accelerate deal flow.

Of course, not all stakeholder groups are equal, and some are more important when focusing on solving the problem of promoting energy efficiency financing in building sector than others. Financing bodies and companies/project developers are the major recipient of all actions and can therefore be marked as key beneficiaries. Additional target groups which enable the development, implementation, testing and exploitation of the ICT platform are policy makers and policy support institutes, researchers, and academics in business and techno economic fields, and other groups.

From a different angle this very purpose may be considered as an effort of bringing together energy services and sustainable finance within an efficient ICT-enabled marketplace.

To this end, a role-based methodology should be followed in order to ensure transparency, independency and clarity about each role scope and potential. The dynamic nature of a role also provides flexibility in the very unstable field of energy efficiency investments while ensuring autonomy and easy access to information and data to each role to act independently and achieve its purpose.

3 Methodology

3.1 Role-Based Methodology

More particularly, this study focuses on building up a role-based methodology for designing an ICT-enabled platform that aggregates energy efficiency projects to packaged solutions, it is important to define the roles of the potential users of this big data for buildings platform (Fig. 2). Relationships and requirements of potential users should also be defined. The methodology identifies as the "commodity" to be traded in this big data platform are the energy savings cash flows stemming from the energy efficiency projects, while the following key categories of market actors are identified:

- Supply side: Actors interested to develop energy efficiency projects for which they seek (additional) funds, hence "supplying" energy savings i.e., the "commodity". The supply side should be able to supply energy savings by developing project pipelines that appear attractive for the financing partners to invest. These can be public or private parties with different projects and different financing access and credibility profiles (public authorities, private asset managers, private owners, social housing administrators, communities/cooperatives, etc.).
- Demand side: Actors interested to invest in sustainable projects for which they offer funds, hence "demanding" cash flows derived from energy savings i.e., the "commodity". The demand side adopts a standardized approach on how potential projects are assessed in terms of their expected return and associated risks. They may comprise energy companies with EEOs, financing partners and even public or private funds.
- The intermediaries/service providers – comprise several other actors including e.g., the aggregator, the technical consultant/validator, the ESCO, the data services provider (big data platform provider).

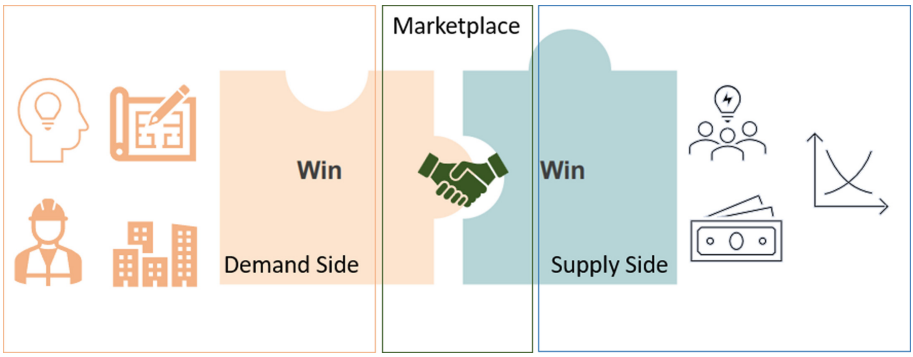

Fig. 2. Role-based Methodology to Unlock the Potential of Big Data in Buildings and Energy Efficiency Projects under an ICT Platform

In order to facilitate the deployment and implementation of an ICT solution to act as a facilitator, key stakeholders of both "demand" and "supply" side actors should play important role (Fig. 2). In fact, the ICT-platform in order to work as a marketplace and act as the facilitator of these two sides, it has to be built up in such a way for the "commodity" which is the energy efficiency project to be traded in the market by the "demand" and "supply" side actors, the project managers and financiers respectively.

Co-creation of the platform should be based on and mirror with the needs and demands evaluation of "demand" and "supply" side in order all discrete options and diversity to be present in the marketplace for an efficient and trust-worthy aggregation and match-making process.

3.2 Integrated Solution for Matchmaking of the Interested Parties

An integrated solution for matchmaking of the interested parties is proposed to be deployed on an ICT Platform to boost energy efficient investments in an easy-access and trust-worthy way. In particular, the matchmaking mechanism acting as a facilitator on making the energy efficiency in buildings a marketplace, considers the market needs and key actors' requirements, creating an environment that market actors can interact by closing deals in a comfortable, predictable, and risk-free environment. The proposed methodology is based on three (3) major platform stages Fetch-Process-Deliver (Fig. 3).

On the Fetch stage, all important information on building renovation projects will be gathered in a structured way, while the Process stage as the core of the marketplace, will proceed with the matchmaking and aggregation process. In other words, all the packaging of building renovations for appropriate financing is taking place here, taking also into account opportunities for capturing revenue streams beyond energy savings. Finally, the Deliver stage enhances the flow of real, project-based monitored information on energy efficiency projects and energy savings results. This information is used to deliver appropriate feedback that act as an input information in the Fetch stage.

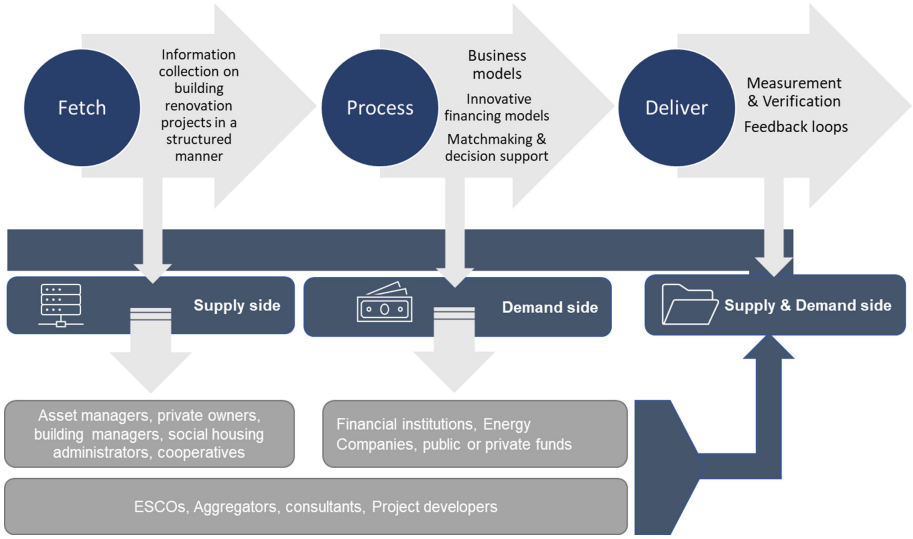

Fig. 3. Flow Chart for Matchmaking and Aggregating Energy Efficiency Projects

As already mentioned, stakeholder engagement is considered important to get an alternative perspective. All key stakeholders in the building sector that participate in the entire energy efficiency investments' value chain, are the ones that provide the required knowledge, information and key insights for the development and validation of the ICT platform. They also expect to receive specific contribution for the energy efficiency marketplace established (Table 1).

Table 1. Platform's Input and Output to Each Stakeholder Group

Stakeholder	Side	Input	Output
Financing bodies	Demand	✓ Building renovation projects analysis ✓ Market regulations ✓ Financing schemes ✓ Standardisation procedures ✓ Energy efficiency policy impact ✓ Market indicators	✓ Standardisation procedures on energy efficiency investments ✓ Trustworthy energy efficiency portfolios ✓ Reduction of implementation risks ✓ Credibility profiles

(*continued*)

Table 1. (*continued*)

Stakeholder	Side	Input	Output
ESCOs	Supply/Demand	✓ Monitoring and M&V procedures ✓ Contracting and management indicators ✓ Marker indicators ✓ Aggregation mechanisms ✓ IoT-enabled energy services information ✓ Energy services solutions ✓ Energy efficiency measured impact	✓ Appealing energy efficiency projects portfolio preparation ✓ Increased the probability of financing energy efficiency projects ✓ M&V data access ✓ Energy services validation ✓ Credibility profiles ✓ Standardisation procedures on energy efficiency investments ✓ Trustworthy energy efficiency portfolios ✓ Reduction of implementation risks
Project developers	Supply/Demand	✓ KPIs establishment and assessment ✓ Benchmarking of assets ✓ Techno-economic assessment ✓ Market indicators ✓ Energy efficiency measured impact	✓ Appealing energy efficiency projects portfolio preparation ✓ Increased the probability of financing energy efficiency projects ✓ M&V data access ✓ Energy services validation ✓ Credibility profiles ✓ Standardisation procedures on energy efficiency investments ✓ Trustworthy energy efficiency portfolios ✓ Reduction of implementation risks
Building Owners/Users	Supply	✓ Building monitoring data ✓ Energy savings monitoring ✓ Market needs assessment	✓ Appealing energy efficiency projects portfolios ✓ M&V data access ✓ Increased the probability of financing energy efficiency projects ✓ Trustworthy energy efficiency portfolios ✓ Energy services validation ✓ Credibility profiles ✓ Energy demand reduction

The two sides of stakeholders' position in the methodology are showcased in Fig. 3 and they have been strategically selected for a practice-proven support and active engagement for the validation of trustworthy opportunities ready for uptake. Their active participation includes relevant indicators and cost-optimal aggregates that are derived in the

form of optimised large, standardised, financeable project packages of energy efficiency measures. In that way, further customisation and readjustment of prototype inputs and outputs are enabled.

3.3 User Requirements of the ICT-Enabled Platform

In order to depict the full canvas of the market needs and to provide the necessary framework for key actors this section provides the user requirements per stage of the ICT-enabled platform (Fig. 4).

At the 1st stage Fetch the aim is to collect information on building renovation projects in a structured manner ensuring that key information related to the technical, commercial and risk-related aspects are properly declared by each project at the state of entering into the platform. There are various building uses by various types of ownership and administration models, so through a standardised online form buildings projects are classified by their typology and other similarities or energy and environmental KPIs (Key Performance Indicators). Building typologies classify buildings into distinct categories in accordance to their physical characteristics, functional use and historical context and are based on several criteria such as a) ownership and use information (occupancy, location, functional use etc.), b) technical data (floor area, energy consuming equipment, benchmarks, level of automation, construction method, year of construction/renovation), c) renovation measures (envelop, equipment, automation).

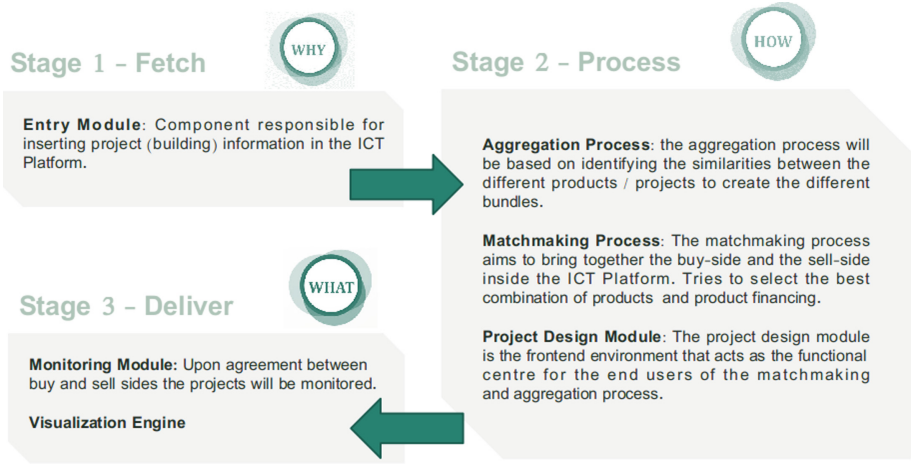

Fig. 4. User Requirements and Key Modules of the ICT-enabled Platform

On the Process stage, the focus is on packaging of building renovations for appropriate financing taking also into account opportunities for capturing revenue streams beyond energy savings. Data collected through the previous Fetch stage are fed into analytics services (Machine Learning, Artificial Intelligence, digital twins, etc.) for the aggregation process and use visualisation tools for the purposes of proposing optimal solution

packages that serve both demand and supply side needs and preferences (matchmaking process).

Finally, the Deliver stage enhances the flow of "real" information on energy efficiency and energy services results and use it for delivering appropriate feedback. The more the databases are populated by data deriving from real-life renovation projects, the more its analytical functions become more robust and fine-tuned. Information requirements here are energy, productivity and financial data deriving from the implemented projects.

Therefore, and after analysing the key players needs for an energy efficiency projects marketplace, the user requirements that is being taken into account for the development of and effective and reliable ICT-enabled platform are as follows:

- Comprehensive access to information: the marketplace should provide access to detailed information about energy efficiency projects, including technical specifications, costs, and estimated energy savings.
- Matchmaking capabilities: the marketplace should have a matching algorithm that connects supply and demand side effectively, i.e. the right energy efficiency projects to the most appropriate and sustainable financing instruments and bodies based on their needs and preferences and other investment criteria.
- Ease of use: the marketplace should be user friendly and easy to navigate, with clear interactive interface.
- Transparency: the marketplace should be transparent about critical information, such as costs, funding instruments etc. using trustworthy ranking techniques and other relevant information in order to enable informative decision support.
- Trustworthiness: the marketplace should be trustworthy and credible to ensure quality and minimize risks.
- Feedback mechanism: the marketplace should have a feedback mechanism to allow users monitor, review and rate the implementation of the proposed solutions so as to benefit other users from their experience and to provide a continuous integration of data flow back in the methodology which eventually increases the marketplace's reliability.
- Integration with other platforms: the marketplace should be able to integrate with other energy efficiency platforms (energy management systems, energy auditing systems etc.) to provide functionalities for a more integrated experience.
- Security: the marketplace should ensure robust security to protect data (buildings and financial once) from fraud and other ethical issues.

It should be highlighted that the proposed work is part of the European project ENERGATE funded by the LIFE – Programme for Environment and Climate Action (GA No. 101076349) with full title is "Energy Efficiency Aggregation Platform for Sustainable Investments" initiated in January 2023 and scheduled for completion in June 2025. ENERGATE aims to present a robust decision-making process leading to the creation of an effective energy efficiency marketplace, bringing together energy services and sustainable finance techniques to accelerate the renovation rate of buildings by increasing the chances for projects to be financed. Thus, it is envisaged that the methodology introduced in this study is co-created, materialised, tested and validated through pilot applications and participatory approach of stakeholders within the frame

of the particular European project aiming not only to the marketplace launch but the publication of key insights and best practices as well.

4 Conclusions

Nowadays, energy efficiency is considered one of the most important instruments towards achieving Europe's environmental targets, while preserving the business as usual in most economic sectors.

Energy efficiency projects represent an attractive investment opportunity; however, many technical obstacles and controversial perspectives and needs should be overcome.

The present study proposes a methodology to increase transparency and efficiency of decision-making processing towards the promotion of energy efficiency investments in buildings and thus increase the renovation rates. With the ultimate purpose to be the acceleration of building renovation rates by effective financing, the energy efficiency ICT-enabled platform proposed brings together energy services and sustainable finance, increasing the chances for energy efficiency projects for buildings to be financed, since it supports the development, implementation, monitoring and enforcement for increased energy efficiency. ICT-enabled solution relies greatly on its target groups and brings to the table the co-creation of a marketplace which leads to a win-win situation for the key players of energy efficiency investments in buildings. The presented role-based methodology analyses the market needs, the user requirements and the solution potential for each key stakeholder customizing the contribution in a view of the target groups' needs. The user requirements of the energy efficiency marketplace are based on the market needs and key stakeholders' preferences and include user friendly access, comprehensive project information, effective matchmaking algorithms, trustworthiness and security and feedback and monitoring mechanisms.

To this end, the single-entry ICT solution that is proposed may contribute to the specific needs of each target group as follows:

Companies and project developers:

- Increase the probability of financing their EE projects.
- Assist them in the process design, by the replicability of project ideas and the information contained in the building typology.

Banks and Financing Institutes:

- Reach ready-made, de-risked projects and build portfolios.
- Structuring and financial closure of demonstrated financeable packages.

Policy makers and local authorities

- Synthetic set of targeted recommendations on policy framework, market architecture and risk mitigation strategies in the country context.

Research and advisory

- Create energy efficiency building renovation financing typologies, case studies and pilots, supporting the research and literature in energy efficiency in buildings.

Other

- Create awareness, communication and marketing to create and support the demand for energy efficiency investments.

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