TRIPLE-A

Enhancing at an Early Stage the Investment Value Chain of Energy Efficiency Projects

Deliverable 3.1: Draft Report on Risks of Energy Efficiency Financing and Mitigation Strategies Typology

February 2020

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Preface

Triple-A has a very practical result-oriented approach, seeking to answer three questions:

- How to ***assess*** the financing instruments and risks an early stage?
- How to ***agree*** on the Triple-A investments, based on selected key performance indicators?
- How to ***assign*** the identified investment ideas with possible financing schemes?

The Triple-A scheme comprises three critical steps:

- ***Step 1 - Assess:*** Based on Member States (MS) risk profiles and mitigation polices, including a Web based database, enabling national and sectoral comparability, market maturity identification, good practices experiences exchange, reducing thus uncertainty for investors.
- ***Step 2 - Agree:*** Based on standardised Triple-A tools, efficient benchmarks, and guidelines, translated in consortium partners' languages, accelerating and scaling up investments.
- ***Step 3 - Assign:*** Based on in-country demonstrations, replicability and overall exploitation, including recommendations on realistic and feasible investments in the national and sectoral context, as well as on short and medium term financing.

Who We Are

	Participant Name	Short Name	Country Code	Logo
1	National Technical University of Athens	NTUA	GR	
2	ABN AMRO Bank N.V.	ABN AMRO	NL	
3	Institute for European Energy and Climate Policy Stichting	IEECP	NL	
4	JRC Capital Management Consultancy & Research GmbH	JRC	DE	
5	GFT Italy srl	GFT Italy	IT	
6	CREARA Consulting SL	CREARA	ES	
7	Adelphi Research Gemeinnützige GMBH	adelphi	DE	
8	Piraeus Bank SA	PB	GR	
9	University of Piraeus Research Center	UPRC	GR	
10	SEVEn, The Energy Efficiency Center	SEVEn	CZ	
11	Public Investment Development Agency	VIPA	LT	
12	National Trust Ecofund	NTEF	BG	

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Executive Summary

An Energy Efficiency (EE) target of at least 32.5%, according to projections made in 2007 for the energy consumption in 2030, has been set in the European Union (EU) by 2030. Therefore, the EU member states have to adopt EE measures (EEMs) to reduce their annual energy consumption about 4.4% until 2030. So as to achieve these targets, significant investments in EE projects have to be implemented. In particular, €1 trillion is planned to be mobilized for implementing sustainable energy investments during the current decade via the EU budget and related instruments.

However, the heterogeneity and the immaturity of the EE market are significant barriers for financial institutions to enter the market, even though EE projects are profitable. In fact, there are plenty of project developers that are seeking funding for green development, however, these projects tend to never get financed for various reasons. On the one hand, project developers do not have the expertise or resources to make a convincing financing case for investors. On the other hand, private investors suffer from absence of knowledge on the way project developers implement their projects. Overcoming such challenges in order to obtain viable financing for EE is a topic that interests private financial institutions, industry representatives and sector experts. Towards this direction, this report focuses on the identification of the potential risks from the financial bodies' perspective, mainly in the development phase of EE investments, where plenty of EE project ideas exist and there is available capital to realize these projects.

The proposed Triple-A scheme could assist in making EE investments transparent, predictable and attractive for investors and financiers by reducing uncertainty through the assessment of the relevant risks that could possibly emerge at an early stage of a project preselection/pre-evaluation. This report aims to support the identification of 'investment grade' projects and prepare input for the rating system for EE investment projects to be developed as part of the Triple-A assessment tool.

Within the framework of this report, a systematic review was conducted both in EU legislation publications and relevant EU projects' previous experience on sustainable financing, as well as in scientific papers and working documents of financing sector key players such as World Bank, Deloitte, ADBI, etc., in order to collect and categorize risk and uncertainty factors that might reduce profitability of investments. Financial, behavioural, energy market and regulatory, economic and technological, planning and operational risk factors resulted from the categorization of the identified risks. A questionnaire was also developed in order to validate the current results and help the population of the risk matrix with risk values via a structured stakeholder consultation process. At last, this report also outlines the appropriate risk mitigation strategies with respect to the identified risks.

1 Introduction

1.1 Background

Energy Efficiency (EE) is one of the most cost-effective ways to deal with climate change and reduce its multi-level impacts [1]. Nowadays, EE has become a topic of interest as a result of the progressive reduction of the planet's natural resources and the severe climate change. Governments around the world should deal with these issues and sustain the global economy [2].

In this context, G20 countries recognized EE as one of the most critical factors to stimulate sustainable economic growth in an increasingly resource confined planet [3]. However, towards the improvement of EE and the implementation of EE Measures (EEMs), the financing of EE project ideas and initiatives is considered vital.

To that end, the International Energy Agency (IEA) suggests that, by 2035, investments in EE need to approximate a half of all the global energy investments so that the target "under the two-degree limit" to be reached [4]. In the same context, EE financing is an integral part of the International Finance Corporation's (IFC) focus on environmental sustainability and climate change [5].

Moreover, innovative financing mechanisms need to be put in place for unlocking the significant EE potential and overcoming the existing market failures [4]. Such innovative mechanisms include energy performance contracting schemes (EPCs) offered by the Energy Service Companies (ESCO), green bonds, etc.

1.2 EE Status in the EU

EE is one of the key elements of the EU energy policy. This is reflected in the EU's existing legislation and in its targets to be reached by 2020 and 2030 [4]. Specifically, the EU has set the clear commitment to become the first carbon neutral continent and remain the leader in the clean energy transition at a world-wide level as stated by the European Green Deal [6]. Within the 'Clean energy for all Europeans package', ambitious EU energy and climate targets have been established for 2030 and beyond, being also in line with the climate goals arising from the Paris Agreement for limiting global warming to well below 2^{o}C or even below to 1.5^{o}C [7].

In particular, the Revised EE Directive sets an EE target of at least 32.5% by 2030, according to projections made in 2007 for the energy consumption in 2030, based on which the EU member states have to adopt EE measures to reduce their annual energy consumption about 4.4% until 2030 [8][9]. To achieve these targets, significant investments in EE projects have to be implemented. In particular, €1 trillion is planned to be mobilized for implementing sustainable energy investments during the current decade via the EU budget and related instruments [10]. Within the framework of the sustainable economic development and finance, referred as "green finance", environmental, social and governance aspects have to be taken into consideration during the investment decision making process [10].

The Action Plan on Financing Sustainable Growth, adopted by the European Commission in March 2018, aims to redirect capital flows towards sustainable investment in order to achieve sustainable and inclusive growth; manage the financial risks arising from climate change, environmental degradation and social issues and promote transparency and long-term financial and economic activity [11]. Following this action plan, the European Commission established a Technical Expert

Group (TEG) on sustainable finance in July 2018, and in June 2019, a Technical report on EU taxonomy has been published by the TEG. This report incorporated the technical screening criteria for activities exerting significant contribution to climate change mitigation, a methodology and related examples for the evaluation of the contribution to climate change adaptation and guidance and case studies to support investors to apply the taxonomy [12]. In addition, another technical report on EU Green Bond Standard has been published by the TEG in order to increase transparency, comparability and credibility of the green bond market and the capital flow to issue and invest in EU green bonds [13].

Nevertheless, the **heterogeneity and the immaturity of the EE financing market are barriers for financial institutions to enter the market, even though EE projects may be profitable and secure investments**. Overcoming such challenges in order to obtain viable financing for EE is a topic that interests private financial institutions, industry representatives and sector experts.

1.3 Previous Experience from Horizon 2020 EE Financing Projects

A review of the outcomes (i.e. reports) of other Horizon 2020 EE financing projects has been conducted. Moreover, relevant EU projects on sustainable finance proposed from Executive Agency for SMEs (EASME) have been examined. The main goal of this review is to better understand Triple-A's contribution in the field of EE financing in comparison with the other relevant H2020 EE financing projects. As a result, a table (see **Appendix A**) consisting of the most relevant projects was developed, giving an overview of other projects' outcomes related to the investigated perspective (i.e. who could invest in EE projects), the identified risks and barriers, the researched project categories and beneficiaries of implemented EEMs, as well as the proposed risk mitigation strategies.

The total number of Horizon 2020 EE financing projects that were found, amounted to sixty-five (65). Out of these projects, only twelve (12) projects contained reports with identification of risks and/or barriers in EE financing. The main risks reported are credit risk, market risk, technology risk, repayment risk, operation and maintenance risk and regulatory risk. The main barriers reported are financial, market, regulatory, technical, economic, administrative and social. The majority of these projects refer to the residential sector, both public and private buildings, and to a lower degree, to other public and private sectors such as public and private services (tertiary), industry and transport. Only two (2) projects have focused on identifying EE project categories and these are mainly building envelope, as well as HVAC&R and lighting appliances' retrofits. Risk mitigation strategies such as guarantees in the payment mechanism and energy savings insurances are proposed by one (1) project.

It is worth mentioning that a few of these projects have developed reports with identification of risks and/or barriers in EE financing but hardly any targeted at preselection/pre-evaluation stage. As regards the perspective of the projects, four (4) of them are examining the risks from a bank's or financial institution's perspective, while the rest of them refer to SME's, municipalities and cities, facilitators of EE services (e.g. ESCOs), government bodies, landlords, consumers and energy experts. To this end, the main aim of this report is to cover the aforementioned gaps and propose an approach of assessing the risks in EE investments.

1.4 Triple-A Concept

Triple-A scheme aims to identify and mainstream EE investments focusing on the pre-screening process, where **no standardisation exists**, supporting the identification of attractive project ideas, as well as creating standardised tools and benchmarks. In general, as "Triple-A projects" are considered those investments that have a relative strong capacity to meet their financial commitments by attaining the expected sustainable performance targets.

The **'gap'** that Triple-A scheme tries to cover lays on the **development phase** of EE investments, where plenty of EE project ideas exist and there is available capital to realize EE projects as well. However, these projects tend to never get financed for various reasons. In this regard, it enables the transformation of EE project ideas to transparent, predictable and attractive investments for investors and financiers by facilitating the identification of "Triple-A investments", i.e. investments which are considered profitable and of low risk.

According to sustainable banking analysts, many profitable business cases for EE investments in companies are not being pursued because **resource allocation** (mostly time and money) are being **focused on the primary processes** of a company and **not on non-core activities like EE**. In addition, the **absence of a stable and predictable tax/energy price mechanism** leads the 90% of potential projects **not to be financeable**, thus, they claim that it does not really make sense to focus, solely, on the remaining 10% via the project risks. In this context, a **clear long-term government tax policy on energy** would be an **effective risk mitigating action**. It is also critical to examine the way EE projects are analyzed, either perceived as simply real estate investments (i.e. depending on the value of the underlying property and/or lease contracts etc.) or are analyzed separately (i.e. their own merits/business case).

On the one hand, **project developers** do not have the expertise or resources to make a convincing financing case for investors. They consume a great amount of working time on auditing one EE project's potential energy savings, but in most cases, never actually implement this project. The reason is that they cannot convince investors to leverage the investment capital needed.

On the other hand, **private investors** suffer from knowledge gap on the way project developers implement their projects, especially, at the early stage of project identification. At the same time, most of the **banking sector does not adopt EE-based criteria** for financing the most attractive projects, since the sole criterion remains the credit worthiness of the borrower, despite the fact that EE measures come along with multi-level advantages. Some of these benefits are linked with positive macro-economic impacts (higher gross value added, employment), increased industrial productivity, improved health and well-being, reduction of local air pollution, rise of property values etc. In the meanwhile, according to representatives of the banking sector, EE projects up to approximately €1 million are not financially attractive for bankers and there are hardly any people involved in the financing procedure, meaning that an automatic lending process takes place without taking into account the abovementioned EE benefits. What is more, the minimum €25-50 million threshold that banks have set for the attractive project ideas **does not live up to mainstream EE financing**.

In addition, it is considered essential to mention that the phenomenon of "**greenwashing**" and the financing of buildings' renovation or upgrade, which, in essence, do not constitute "pure" EE investments, hamper further the real mainstreaming of EE investments and realization of sustainable energy development. Banks and rating agencies are currently "free" to define which project constitutes a "sustainable investment". However, the establishment of the EU taxonomy constitutes a decisive action from the EU aiming to establish a standardization system for sustainable energy investments

and put a halt to “greenwashing”, since a project will not be considered “green” unless it meets all the concrete criteria of the new classification.

With the aim to fill in the above-mentioned gap, **Triple-A methodology and tools** offer:

- ✓ Identification of **attractive EE project ideas** for bankers, funds and other financing institutions.
- ✓ Benchmarking of the EE projects and selection of the “**Triple-A” EE investments** which merit attention by the funding organizations.
- ✓ Proposal of **funding strategies** (warehouse lending, green Bonds, EE auctions) that better match with the examined investments and respective beneficiaries.

In addition, the Triple-A scheme could facilitate the reduction of uncertainty of both project developers and financiers through the evaluation and analysis of the risks affecting EE investments, the assessment of the impact of those risks on the economic viability of these investments and the mitigation of the risks that could possibly emerge at an early stage. The role of the stakeholders’ consultation process is considered of paramount importance in order to assess the validity of the proposed methodology and extracted results.

1.5 Aim and Structure of the Report

The aim of this report is to support the identification of Triple-A projects and prepare input for the rating system for EE investment projects to be developed as part of the Triple-A scheme, which will lead to a **pre-screening of investment ideas** at EU level.

Particularly, within the “**Assess**” step, project ideas will be collected and evaluated according to their perceived risk profile and factors and based on the risk matrices composed within the initial phase of the Triple-A scheme based on the outcomes of the initial and final version of this report. Data regarding the candidate EE project will be collected from project developers (i.e. country, sector, project category, EE savings), in order to extract a comprehensive risk assessment for the examined project. In addition, a “Go-No Go” process is followed and the projects that meet the specified thresholds continue to the next step (“Agree”). It is foreseen that a pipeline of at least **100 EE financially attractive projects** will emerge through this step.

To support the pre-screening of investment ideas, an extended literature review was conducted in order to collect and categorize risk and uncertainty factors that might reduce profitability of investments and in particular endanger debt repayment. The range of risks considered covers the general and practically relevant factors common to such projects across all sectors identified in the literature (e.g. residential, tertiary and industrial) and are country independent.

The key questions to be answered through the initial and final version of this report are the following:

- Which are the key risks affecting EE investments financing from the financing bodies (banks, investment funds, etc.) perspective?
- Which are the main risk mitigation strategies for EE investments? How they are currently implemented, and which gaps emerge?
- Which are the key sectors where EE investments will deliver the most impact?
- How EE projects can be mainstreamed via innovative financing schemes (e.g. green bonds, EE auctions, warehouse lending)?

The structure of this report is the following:

- **Section 2** summarizes the EU Taxonomy.
- **Section 3** describes the literature review of the risk factors in EE investments.
- **Section 4** reports the proposed methodology and the results regarding the identification of the main risk categories, risk factors project categories and beneficiaries in EE investments.
- **Section 5** reports the risk mitigation strategies typology.
- **Section 6** presents the material to be used in the stakeholder consultation process.
- **Section 7** provides concluding remarks and future perspectives.

2 EU Taxonomy Summary

The EU Taxonomy is a structured attempt by the EU to classify viable economic activities, since currently market-based practices do not follow the EU sustainable policy objectives and the lack of classification systems promotes 'greenwashing' practices. Member States of the EU and market participants are considered as mandatory users of the Taxonomy when they invest in and propose respectively, sustainable financial products. Furthermore, investments in private equity, real estate funds and private-securitised loans should follow Taxonomy obligations, whether they are marketed as 'green'.

The amount of assets connected to sustainability performance is continuously growing, since sustainable market participants are increasingly interested in investing to such financial products. According to this fact, green activities are expected to have cheaper and better access to capital. Moreover, investors prefer long-term investment horizons rather than short-term ones, which is encouraging for the viability of sustainable investments. However, they need to understand when an economic activity is Taxonomy-eligible. For this reason, a five-step approach is proposed:

- Identify eligible activities.
- Meet the relevant screening criteria.
- Verify that do no significant harm (DNSH) criteria are being met by the issuer.
- Conduct due diligence to avoid social minimum safeguards violations.
- Calculate alignment of investments with the Taxonomy and prepare disclosures at the investment product level.

By conducting the five-step approach, investors can find the proportion of assets that fulfil the above criteria. Portfolio asset value invested in eligible activities determines the overall percentage of alignment, which is equal to the weighted sum of the percentage of revenues or expenditures generated by eligible activities. Taxonomy does not establish a standard; therefore, there are no minimum thresholds for the proportion of eligible activities in a portfolio.

Role of banks under the Taxonomy Regulation

In this direction, banks will play a bilateral role, being both investors by lending loans to finance sustainable activities of borrowers and issuers of green bonds to raise capital for funding. Positive effects such as higher access to capital for sustainable activities through loans, faster achievement of sustainability targets and lower greenwashing risks are expected from the adoption of the Taxonomy regulation by banks.

Main beneficiaries of this adoption are SMEs, as access to capital is a major barrier for them when compared to large companies, especially in the EE market, which is crowded by SMEs. Banks need to adapt their processes to the Taxonomy regulations by collecting and managing their customers' information (e.g. activities classifications, criteria, metrics and thresholds). Banks have to take into account that only the eligible part of the lending is considered as 'green'.

Taxonomy proposals for companies and issuers

On the one hand, companies with a turnover between twenty and fifty percent (20%-50%) in environmental-related activities contribute to environmental objectives. Regarding eligible activities, companies are also encouraged to disclose: i) revenues' and turnover's percentage, ii) CAPEX and/or OPEX. On the other hand, the issuers of bonds and loans can have access to better borrowing conditions if such financing schemes can lead to more 'green' investors' portfolios.

Taxonomy and EE

Taxonomy recognizes expenditures in EEMs in the eligible sectors, if these close the gap between the current efficiency levels and the levels defined by the thresholds set. EE thresholds refer to quantitative criteria, such as the U-values of EEMs (e.g. high efficiency windows with a U-value better than 0.7 W/m^{2}K) and thermal conductivity of materials (e.g. insulation products with lambda factors lower or equal to 0.045 W/mK), but there are also qualitative criteria, such as classes (e.g. high efficiency lighting appliances rated in the highest EE class that is populated in the EE label according to EU energy labelling regulations) and standards (e.g. energy-efficient building automation and control systems for commercial buildings as defined according to the EN 15232 standard).

One of the main economic activities reported in the Taxonomy is the renovation of existing buildings, where relative improvements (**at least 30% against baselines**) and comprehensive interventions (including costs unrelated to EEMs) on buildings are eligible. Specifically, regarding the individual building renovation measures, they should comply with the energy performance standards set for individual components and systems in the applicable building regulations transposing the Energy Performance Building Directive (EPBD).

3 Review for the Collection of Risk Factors in EE Investments

3.1 Literature Review Methodology

In this section, the approach for the collection of risks that occur in EE investments is described. The approach used in this section is a systematic literature review. A systematic method can ensure quality of a review since the process is both replicable and transparent [14]. This includes applying defined search terms and search strings to reduce reviewer bias [14]. Moreover, it includes classification and evaluation of the literature, which are conducted at the next stages of this study.

The prerequisite for conducting the next methodological stages of this review is the preliminary phase of the aggregation of all of the available sources that identify risk factors in EE investments, provided that they serve the set conditions of this phase. To ensure scientific rigorousness of a systematic review, one additional criterion is to describe the literature search in detail [15], which is one of the main goals of this section.

There is a wide variety of sources which analyse the risk factors in EE investments. The aim of the aggregation phase is to encapsulate all of them, so as to subsequently filter them according to the contextual conditions of the next review phases. The goal of the review is the formulation of a matrix which includes the types of risk and risk categories, the projects' categories and the beneficiaries in EE investments. The flowchart of the approach followed is depicted in **Figure 1**.

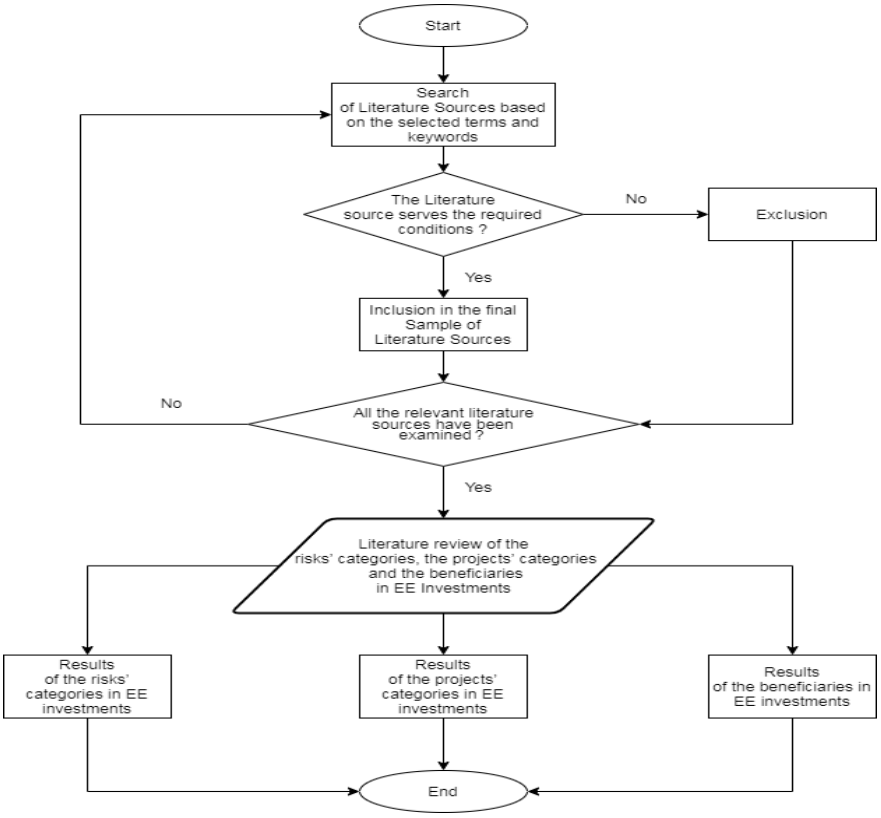

Figure 1: Flowchart of the Literature Review

Due to the nature of the examined field, it is evident that there is a wide variety of risk factors (risks and barriers) that can be identified in EE investments, which can be classified into many categories, according to the used approach. Moreover, each category can be linked with many risk factors. This indicates certain dispersion in how the terms are used in literature. Additionally, there is a wide range of vocabulary for the characterization of risk factors and for this reason, the appropriate selection of keywords for the search of literature sources is crucial. **Table 1** presents indicative search terms used for the gathering of the literature sources.

Table 1: Indicative search terms for the aggregation of the literature sources

Search terms
Energy Efficiency financing
Energy Efficiency funding
Energy Efficiency Projects
Energy Efficiency Investments
Risks of Energy Efficiency Investments
Risks of Energy Efficiency projects
Barriers to Energy Efficiency Investments
Barriers to Energy Efficiency Projects
Risk factors of Energy Efficiency Investments
Risk factors of Energy Efficiency Projects
Risk Evaluation of Energy Efficiency Investments
Risk Evaluation of Energy Efficiency Projects
Risk Management of Energy Efficiency Investments
Risk Management of Energy Efficiency Projects

The systematic search was made using mainly the Scopus database. The aim of the literature review methodology is to capture as much information as possible from the available literature regarding the risk factors in EE investments.

3.2 Collection of Risks

Overlaps were identified among the included literature sources regarding the risk categories, the risk factors, the projects' categories and the beneficiaries during the literature review. The current sample of the systematic literature review comprises sixty-eight (68) articles, conferences papers, book chapters and business studies. These literature sources are presented on the table of **Appendix B**.

The outcome of the literature review was the development of a database, which contains all the risk categories along with the risk factors associated with them, the beneficiaries and the projects categories in EE investments, for each literature source of the final sample.

The literature sources contain one hundred and six (106) reported risk categories. The most frequently stated are the Economic, Market, Behavioural, Regulatory and Organizational and in a lower frequency of reference the Financial, Technology, Imperfect Information/Information and Policy. The detailed results of Risk Categories are reported in **Figure 2** along with the frequency that each risk category is mentioned either distinctively or in combination with other risk categories by the literature. The results contain the risk categories mentioned more than five (5) times and could be considered as generic categories.

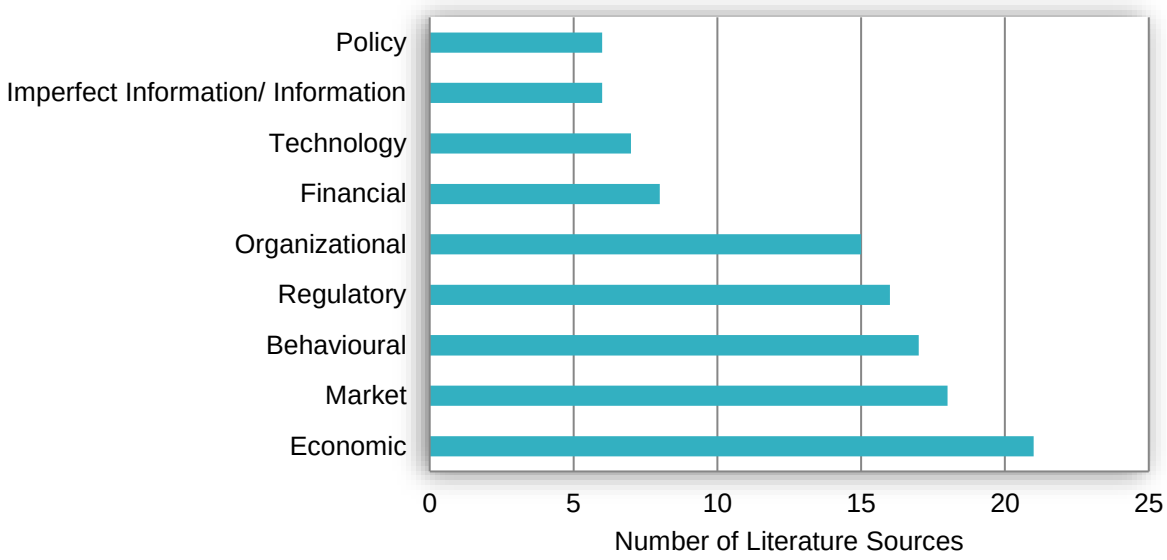

Figure 2: Results from the review of the Risk Categories in EE Investments

As far as the risk factors are concerned, a total of six hundred and twenty-two (622) risks factors have been determined. Among them, eighty-two (82) overlaps have been spotted, for risk factors being mentioned identically in literature, limiting their sample to five hundred forty (540) unique risk factors.

It should be noted that some risk factors (e.g. bounded rationality), have a dual reference in literature. Some articles indicate them as risk factors, while other as independent risk categories. The high number of reported risk factors proves the wide variety of risks and barriers that can be identified in EE investments. Additionally, in literature, strict terminology is not always used to describe the same risk factors. In many cases the same risk factor can be listed under a variety of similar terms. Therefore, many risk factors of the final results, in spite of their different reference, are semantically similar with other risk factors, and for this reason; they could be combined with other risk factors. Such instances are grouped under one designation, as it is described in **Section 4**.

The outcomes of the review regarding the beneficiaries in EE investments are depicted in **Figure 3** along with the percentage of studies that mention each one. It should be mentioned that many studies are not constrained to a specific beneficiary, but rather refer generally to all beneficiaries' categories that can be observed in EE investments.

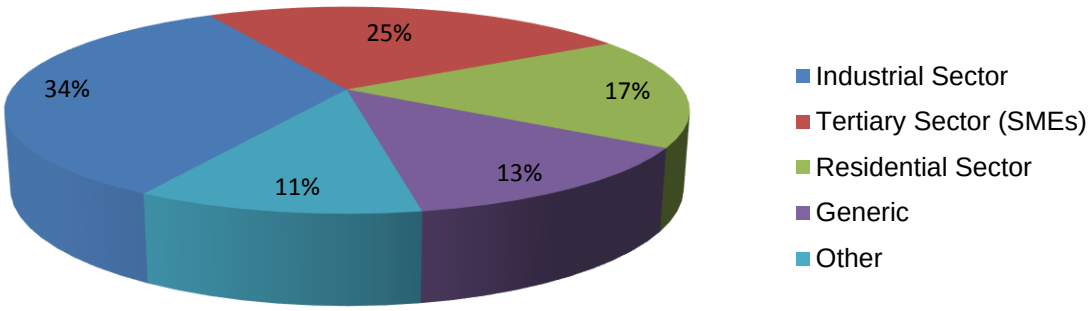

Figure 3: Results from the review of the Beneficiaries in EE Investments

The majority of sources focus on EE in the industrial sector, which proves the importance of this sector in EE investments' literature. This fact is derived from the potential of this sector in adopting EEMs. Literature review indicates many sub-sectors of the industrial sector, like chemical companies, metals companies, food companies, paper companies etc. In addition, the tertiary sector mainly comprises the SMEs. The high number of sources that study this sector validates the importance of this sector in EE investments' literature. Researchers emphasize less on the residential sector, which can partially be explained by the high potential of both the industrial and tertiary sectors in adopting EEMs compared to residential sector. The literature sources of the "Generic" category are not constrained to a specific beneficiary but rather refer generally to all beneficiaries' categories that can be observed in EE investments. In the "Other" category, there are sources that refer to public, agricultural or transport beneficiaries, but their percentage is too low to be considered as distinct categories.

In respect of EE project categories' typology, although most of the literature sources don't associate their studies with specific EE project category, main project categories can be summarized into four groups, according to case studies and surveys conducted in the examined sources:

a. Building envelope retrofits,
b. HVAC&R retrofits
c. Lighting appliances' retrofits
d. Industrial-specific retrofits

It should be noted that each aforementioned project category is composed by different EEMs.

The results presented above about the risk categories, the risk factors, the project categories and the beneficiaries in EE investments, are the outcomes of the literature review. These results are going to be validated and enriched by the stakeholder's consultation process, further analyzed in **Section 6**. Therefore, the risk matrix will be presented in the final version of this report.

3.3 Key Barriers to Mainstreaming EE Investments

'Access to capital' has been the most frequently reported barrier in literature [16], [17]. It is related to the ability of the investor to leverage the required capital for the EE investment either from external funding or from internal capital budget. Based on studies, the access to capital constitutes, from the policy maker's perspective, a risk factor to the extended implementation of EE investments. Policy measures, such as financial incentives and tax credits for EE investments are suggested in order to reduce the limitations in access to capital [18].

In addition, split incentives are a common barrier towards the extensive conduction of EE projects in buildings. Split incentives are identified when two parties have different incentives for a specific action [19]. A common example of this kind is the landlord – tenant problem, when the landlords do not have any interest in investing in an EE project if they cannot convey the cost of the investment to the tenant. Respectively, tenants may not invest in EE if they plan to move out before the payback period of the investment.

Another example of split incentives within a company is that of a manager remaining in his position in the short-term. In these situations, the manager may have limited or even no incentives to initiate an EE investment with a payback period longer than the time period that he remains in his position [20], [21]. To deal with split incentives, regulatory measures and financial mechanisms like minimum performance standards, energy labelling, individual utility meters in multi-occupancy buildings and financial and fiscal incentives can be put forward [18], [22].

Apart from the project-related risks of EE investments that may be mitigated via the adoption of appropriate actions by the project developers, there are several structural risks that are associated and impact the mainstreaming of EE investments. In general, a critical barrier and structural risk is that the existing databases lack detailed techno-economic data on EE projects, including, among others, capital leverage structure, size and stage of project, beneficiaries etc. Moreover, even though the banks are financing several activities for the improvement and upgrade of equipment and appliances (e.g. in the industry sector), the EE proportion of the activities ('green part') is low compared to the other components of the activities.

4 Identification of EE Investments' Risks

4.1 Methodology

The first step of the identification of the main sources of risk in EE investments was to extract the individual risk factors from the initial database that emerged from the literature review. The next step was to classify the already found risk factors into risk categories by merging them according to their conceptual characteristics. Therefore, in this step the risk factors were both aggregated and filtered. After the aggregation of the identified risk factors with similar description from different literature sources, a list of three hundred twenty-eight (328) risk factors was created.

This initial list was filtered, according to three suitable criteria, in order to extract the most significant risk factors in EE investments. The first criterion is the frequency of occurrence, namely how many times the risk factors are observed in the database, a criterion that has also been used in [15] to identify the benefits resulting from EE investments. The second criterion is the minimization of the overlaps among risk factors and the last criterion is the capacity to quantify the risk factors, either with the usage of open-source data or through stakeholder consultation process. These criteria were applied in two steps.

In the first step of the filtering process, the frequency criterion was applied. Frequency indicates the importance of a risk factor, as it shows how it is evaluated by the literature. After the application of a threshold of two occurrences per risk factor, the list was reduced to ninety-one (91) risk factors. The cut-off percentage amounted to about seventy percent (70%) of the total risk factors. As the result can be considered sufficient, there is no need to increase the filtering threshold.

In the second step, the criterion of minimizing the overlaps was implemented. The elimination of the overlaps between the risk factors is paramount for the evasion of bias in the analysis. Additionally, risk factors were aggregated in all cases of strong interrelationships or significant overlaps. Simultaneously, risk factors that were either difficult to be quantified or not quantifiable were ruled out. After this final elimination step, the process resulted in nine (9) risk factors belonging to five (5) risk categories (see **Table 2**). Each risk factor was assigned to the contextually most relevant risk category so as to simplify further analysis.

Risk categories' formation was based on the most cited risk categories as they were presented in the literature review (see **Figure 2**), while considering the best way to assign the identified risk factors. Market and regulatory risk categories have both emerged with very high frequency in the literature review (eighteen (18) and sixteen (16) times respectively). The combination of these two risk categories was made with respect to their input factors which represent risks that are highly country specific but are not elements that affect the total economy of the country, since factors with this characteristic were assigned to the economic risk category. Technology, an also highly cited risk category, was combined with planning and operational categories, as the risk factors of these categories refer to technical characteristics of EE investments.

4.2 Results

The results are presented in **Table 2**, which incorporates the risk category and risk factor dimensions of the risk matrix. As it is shown, the selected risk categories are the following: a) Financial, b) Behavioural, c) Energy Market and Regulatory, d) Economic and e) Technological, Planning and Operational.

Table 2: Risk factors and risk categories

	Risk Categories				
Risk Factors	**Financial**	**Behavioural**	**Energy Market & Regulatory**	**Economic**	**Technological, Planning and Operational**
Credit worthiness of the borrower	✓				
Rebound effect		✓			
Energy prices volatility			✓		
Weak/unstable legislation or enforcement			✓		
Energy taxes volatility			✓		
Interest rates volatility				✓	
Maturity of the technology					✓
Construction, operation and maintenance					✓
Capacity to predict accurately the energy savings					✓

As regards the financial risk category, the factor 'credit worthiness of the borrower' indicates the financial capacity of the borrower to pay off his debt, a critical factor from the perspective of a financial institution or bank when considering giving a loan [23], [24].

The second risk category comprises the rebound effect, which describes a specific behavioural bias. It affects the end user and mostly emerges when the implementation of an EE investment leads to lower costs for energy services and that comes with an increase in the demand for such services, therefore resulting in higher final consumption than the one anticipated. This may lead to energy savings being significantly lower than the ones that were initially anticipated [25].

The third main risk category, which has been addressed in the literature as the riskiest one [24], is the energy market and regulatory, which includes the factors 'energy prices volatility' (mainly electricity and natural gas prices), 'weak/unstable legislation or enforcement' and energy taxes volatility. The uncertainty about energy prices influences the decision to undertake an EE investment as it may lead to unexpected monetary savings and therefore the return of the EE investment may differ from the initial estimation [26]. Energy taxes are considered important as they affect the end use price and thus

the monetary savings of the EE investments. These two risk factors are associated with the price risk in EE investments.

Weak/unstable legislation relates to the procurement and legal framework and arises when enforcement is slow [27]. It signifies the legislative complexity for the completion of a project (e.g. permits/licences, protocols or other approvals under the provisions of a law) in a specific country. This factor also includes the high bureaucracy that may exist in several countries and operates as a barrier for EE investments [27], as well as the lack of appropriate policies and government incentives that could enhance their implementation.

The fourth identified risk category is the economic one with main factor; the interest rates volatility. Interest rates can be either short-term or long-term. Long-term interest rates refer to the ten-year government bond yields and determine business investments. Fluctuation in interest rates may lead to an unexpected cost of capital deriving from changes in cost of debt for the borrower [25] and as a result, it prevents the accurate estimation of monetary savings [28].

The final risk category is the technological, planning and operational. It is composed of 'maturity of the technology', 'construction, operation and maintenance' and the 'capacity to predict accurately the energy savings'. Regarding the identified project categories, the maturity of the EEMs depends on the technology adoption of them in the EE market and their technical complexity. For example, lighting appliances (e.g. LEDs) are considered a mature technology since their operational characteristics (e.g. lifetime) are widely known and their technical complexity is low. The 'construction, operation and maintenance' risk shows the uncertainty about the probability of improper subcontractor's construction plan, operation [29] and whether the measure will be properly maintained [23]. The risk of not being able to predict accurately the energy savings is due to a lack of proper measurements, simulations or audits at an early stage of the project.

The following figure (**Figure 4**) presents the results of the identification process, i.e., the nine (9) risk factors that have been mentioned along with their frequency. The different colours in the columns indicate the five (5) different risk categories.

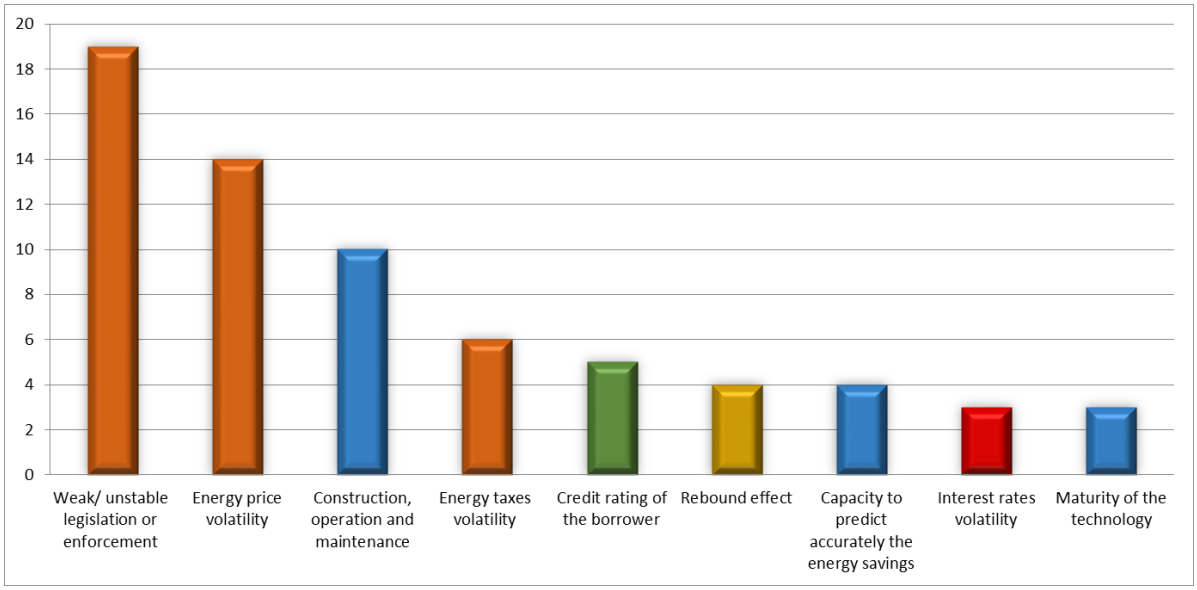

Figure 4: Results from the identification of risk factors in EE Investments

4.3 Project-specific and Country-specific Risks Identification

The risk factors presented in the previous section can be assessed in terms of impact on reaching the project's performance expectation and their probability of occurrence. Risk mitigation strategies, which help to avoid projects' underachievement, will be evaluated. The evaluation of these strategies will be related to the project characteristics and the country where the project will be implemented.

To facilitate further assessment, these risk factors can be classified into two categories: risk factors directly related to the countries' contextual and policy framework and risk factors related to the projects' characteristics (project category, beneficiary etc.). This categorization (**Table 3**) will be helpful afterwards as part of Task 3.2: Assessment of Member States Risk Profiles, where the member states' country risk profiles will be assessed.

The risk factors that have been identified as country-specific are energy prices volatility, energy taxes volatility, interest rates volatility and weak/unstable legislation or enforcement. These factors depend only in the country's specific contextual framework and they do not vary among different types of EE measures. The risk factors that have been identified as project-specific are credit worthiness of the borrower, rebound effect, maturity of the technology, construction, operation and maintenance and the capacity to predict accurately the energy savings.

Table 3: Categorization of risk-factors to project-specific and country-specific

Risk Factors	Project-specific	Country-specific
Credit worthiness of the borrower	✓	
Rebound effect	✓	
Energy prices volatility		✓
Energy taxes volatility		✓
Weak/unstable legislation or enforcement		✓
Interest rates volatility		✓
Maturity of the technology	✓	
Construction, operation and maintenance	✓	
Capacity to predict accurately the energy savings	✓	

4.4 Assessment of the Identified Risk Factors

The risk factors that have been identified in **Section 4.2** will we assessed through either qualitative or quantitative methods taking into account the nature of the factor. Where there is potential for quantitative evaluation, it will be preferred as in most cases it provides a more objective perspective. When qualitative assessment is unavoidable, it will be applied in an efficient way in order to minimize subjectivity and provide accurate results. It should be mentioned that all risk factors that have been

identified are considered quantifiable and the tools that will be used for qualitative evaluation can provide a quantified result.

A first consideration of the way that each risk factor will be evaluated (qualitative/quantitative) has been conducted considering the available data and literature. The risk of energy prices and energy taxes volatility will be assessed quantitatively by analysing and evaluating the available historical data, while interest rates will be also assessed in a similar way.

A qualitative evaluation will be employed for the credit worthiness of the borrower, which will be evaluated according to official credit rating available for big companies and organizations and available data for SMEs. The rebound effect will also be assessed qualitatively, taking into account the literature and considering the output of the stakeholder consultation process of Triple-A. “Maturity of the technology” and “weak and unstable legislation or enforcement” will both be assessed qualitatively considering the complexity of the legislation of the county for EE investment and the complexity of the technology that will be used respectively. “Construction, operation and maintenance” and “Capacity to predict accurately the energy savings” are risk factors that will receive a qualitative evaluation according to feedback from stakeholders in the consultation process.

Table 4: Assessment methods of risk factors

Risk Factors	Quantitative Assessment	Qualitative Assessment
Credit rating of the borrower		✓
Rebound effect		✓
Energy prices volatility	✓	
Energy taxes volatility	✓	
Weak/unstable legislation or enforcement		✓
Interest rates volatility	✓	
Maturity of the technology		✓
Construction, operation and maintenance		✓
Accuracy of the predicted energy savings		✓

4.5 Criteria for the Triple-A Assessment

The selection of criteria that influence the implementation of an EE activity and its Taxonomy eligibility is critical for the Triple-A methodology. The criteria selected are characterized as Go/No-Go criteria or criteria with veto, since a specific activity either fulfils the Taxonomy environmental and social criteria and technical screening thresholds or not. Furthermore, the activity has to fulfil the identified risk factors’ criteria.

Taxonomy environmental and social criteria

Due diligence (see environmental, social & governance (ESG) risk management) is necessary for assessing a company's environmental and social standards. For this risk management, basic criteria considered, are the following:

- DNSH criteria, which reflect the environmental objectives.
- Minimum social standards, regulated for all Taxonomy-eligible activities.

Whether DNSH criteria and minimum social safeguards are not fulfilled, the activity is not considered as Taxonomy-eligible.

Moreover, investors should also identify the percentage of the portfolio activities that satisfy the technical screening criteria. Carbon intensity is one of the most common metrics used as criteria. For EE investments, EE thresholds (see **Section 2**) are also determined in several sectors.

Finally, for the assessment of the EE investment projects, some identified risk factors will be used as input criteria. Whether these criteria are not satisfied, the investigated project is considered too risky to implement and thus, it is rejected. The selected criteria belong to the project-specific risk factors (e.g. credit rating of the borrower), since country-specific ones were not considered appropriate for this evaluation. The reason for this choice is that country-specific risk factors correspond to a country's risk profile and in case a country-specific criterion is not satisfied, then the respective country is considered unsuitable for investing in EE projects.

5 Risk Mitigation Strategies Typology

Ranking the risks according to severity is a common strategy that is used in risk management as it is almost impossible to deal with all possible risks that may occur in a project [30]. In this report, the most important risks that may appear in EE investments have been addressed in **Section 4**, where a typology of distinct risk factors was determined. In this section, mitigation strategies for the identified risk factors will be presented according to the literature.

There are four main strategies to deal with risk (**Table 5**). A risk can be reduced or eliminated, transferred, absorbed or accepted and avoided [29], [30]. Risk reduction or elimination suggests that remediation activities are planned in order to reduce the level of the risks' impact or probability of occurrence in the project [29]. Risk transfer means transferring the risk to another party (e.g. due to insurance contracts). Acceptance or absorption of the risk signifies that no actions are taken to reduce the risk because the possible impact is accepted in the context of the project [29]. Risk avoidance can take place by using quality control practices and procedures [30] to ensure that when the probability of risk occurrence exceeds a preset threshold, the project is aborted. Furthermore, this strategy can be taken into account when risks occur and their impact on the project is disastrous. In such cases, the project may be withdrawn or the project's objectives may change [29].

Table 5: Main risk mitigation strategies

Risk Mitigation Strategies
Risk reduction/elimination
Risk transfer
Risk acceptance/absorption
Risk avoidance

In the process of evaluating project proposals, it is important to audit the proposed risk plan to ensure that it is founded on reasonable assumptions and covers all pertinent risks. This evaluation should take under consideration the selection of suitable strategies for the mitigation and transferring of risks, along with the possible impact of the accepted risks, while taking into account the regulatory conditions. Although each project is different from another and risk mitigation strategies are formed specifically for each project, a literature review was conducted to identify major techniques and measures for risk reduction and transfer that, according to literature, can be implemented in EE investments to control the identified risks factors.

A highly cited technique used for risk reduction is hedging [28], [31]. Hedging can be characterized as a strategy that somebody employs in order to minimize or avoid losses, in case prices of an asset range unpredictably. In this way, it is possible to achieve a neutral overall result. Hedging can be achieved mostly with the use of derivatives like future or forward contracts, swaps or options contracts [32]. Hedging can be used as a risk mitigation strategy for a plethora of risk factors. Regarding the risk factors that have been identified (see **Section 4)**, hedging can be used to mitigate energy prices volatility [28], [31], [32] and interest rates volatility [25], [28]. Another similar way mentioned in the literature is the use of fixed-price contracts [32], while for interest rates volatility, it is suggested choosing a long-term fixed interest rate rather than a floating one [33].

With reference to the mitigation of price risk, since a high proportion of the end use energy price consists of taxes, a clear long-term government tax policy on energy could probably be considered as a risk mitigation strategy for the energy price volatility risk factor, while investing at the same time in green electricity generation (e.g. photovoltaics) could also mitigate this risk as the price for the energy produced this way will be constant for several years.

A specific risk transfer technique in EE investments is to sign energy service contracts and performance contracts. In this way, the risk can be transferred from the building owner to the energy service company (ESCO) [34], [35]. With regards to the same technique of transferring the risk from the building owner to another party [23], [34], it is also suggested to use an energy savings insurance (ESI) [23], [28].

Additionally, savings guarantees and performance bonds have been proposed as a means of managing the risk that comes from the system's and equipment's performance [23], [28], [32], while diagnostics can be used in order to detect potential causes of underperformance and take measures early on. In the context of Triple-A, the performance risk can be associated with the construction, operation and maintenance and the capacity to predict accurately the EEM's energy savings risk factors that have been identified in **Section 4**.Therefore, the aforementioned techniques can be considered as risk mitigation measures for these factors.

Considering the behavioral risk category, rebound effect is considered a major challenge in EE investments and the literature mentions a variety of mitigation measures for this risk factor. A comprehensive study about how to manage the rebound effect in EE investments suggests three general strategies based on the consumption context: consuming more efficiently, consuming differently and consuming less [36]. Other references to the mitigation of the rebound effect propose the examination of the required energy taxes needed to offset the rebound effect [37], as well as policy instruments to reduce rebound effect like information provision, price regulation, subsidies and tradable permits [38]. Furthermore, other strategies aim to introduce efficiency standards, eco-taxes, absolute caps and sustainability communication [39] and discuss policy measures considering design, evaluation and performance of policy and economic instruments along with new business models, sustainable life styles and consumer behavior, as well as raising awareness and promoting education in business, technology and innovation [40].

Reducing the risk of default of the borrower requires a careful study of the credibility of the borrower in the negotiation stage [29]. The literature review did not reveal specific measures that can be employed for the reduction of tax volatility and weak/unstable legislation or enforcement risk factors, though it must be considered that mitigation on a per project basis is virtually impossible for these two factors. However, it is common sense that the rules and regulations of the market should be helpful to mitigate possible risks in order to promote the implementation of EE investments in the market. The adoption of codes and standards in buildings, appliances, and equipment, can also employed as a strategy to enhance their implementation [18].

Finally, the certification of EE projects (e.g. the "Investor Ready Energy Efficiency – IREE" certification provided by the Investor Confidence Project) is considered crucial for creating an accurate energy baseline for the examined fields of EE action, reducing due diligence costs, increasing investors' confidence and promoting a standardized framework for creating attractive portfolios of highly profitable projects.

Table 6 gives a quick overview of the proposed risk mitigation measures for each identified risk factor and category.

Table 6: Risk mitigation measures with respect to the identified risk factors

Risk Category	Risk Factor	Risk Mitigation Measure
Financial Risk	Credit rating of the borrower	Careful study of the credit worthiness of the borrower in the negotiation stage
Behavioral Risk	Rebound effect	Energy taxes information provision, price regulation, subsidies and tradable permits, EE standards, eco-taxes, absolute caps, sustainability communication, design, evaluation and performance of policy, economic instruments, new business models, sustainable life styles and consumer behavior, raising awareness and promoting education in business, technology and innovation
Energy Market & Regulatory Risk	Energy prices volatility	Hedging (forward contracts, future contracts, swaps, option contracts), fixed-price contracts
Economic Risk	Interest rates volatility	Hedging (forward contracts, future contracts, swaps, option contracts), long term fixed interest rates
Technology, Planning & Operational Risk	Construction, operation and maintenance	Performance bonds, diagnostics
	Capacity to predict accurately the energy savings	Energy savings insurance (ESI), savings guarantees, diagnostics

6 Stakeholder Consultation Process

Following the identification of the risk factors with their corresponding categories, the project categories and the beneficiaries in EE investments, as well as the proposed division into project-specific and country-specific risks, their evaluation and the criteria for the Triple-A assessment, it is necessary to have these results and decisions validated by experts and professionals in the field of EE finance. In this context, a questionnaire will be distributed to the appropriately selected persons, according to their background and relevance to EE finance. The results of the stakeholders' consultation process are going to be presented at the final version of this report.

The questionnaire (see **Appendix C**) comprises a set of ten (10) questions revolving around the aforementioned validation points. For each question, the respondents are asked to select a yes or no answer), and provide a short explanation, if needed. The set of utilized questions focuses on the validation of the identified risk factors, risk categories, project categories and beneficiaries, respectively. Except for these questions, there are a few more questions which aim to enlighten decisions that have been taken, regarding the formulation of the risk matrix.

7 Conclusions

In the context of the current report, an extended literature review was conducted in order to collect and categorize risk and uncertainty factors that might reduce profitability of investments and in particular endanger debt repayment. This report presents the main risks and their respective mitigation strategies of EE financing in five (5) distinct categories: i) financial, ii) behavioral, iii) energy market and regulatory, iv) economic and v) technology, planning and operational regarding the most researched project categories: building envelope retrofits, HVAC&R retrofits, lighting appliances' retrofits and industrial-specific retrofits and beneficiaries: industrial, tertiary, residential sectors. Risks are classified into project-specific or country-specific, according to their conceptual characteristics. Some of them are selected as criteria with veto for the Triple-A assessment tool. Also, this report identifies the appropriate risk mitigation strategies according to the identified risks.

The results of this report could initiate a dialogue among stakeholders, possibly providing useful feedback to the analysis. For that purpose, a questionnaire was developed to be distributed to appropriately selected stakeholders. By means of these tools and through the stakeholder consultation process, the results will be finalized and presented in the final version of the current report. Those results will be the final risk matrix and the categorization of financing instruments with respect to risk, which will be direct inputs for Task 4.1: Standardized Triple-A Tools. Furthermore, results will be used as input for Task 3.2 and for this reason; they will be stored in the database developed in Task 3.3: Interactive Web-Based Database on Triple-A Investment.

With regards to the final version of the report, the systematic review will be continued so that more sources will be added. Additionally, a review of the risk analysis techniques will be conducted in order to decide on the risk evaluation methods that will be employed for the risk assessment. Ultimately, the aim of Task 3.1 is to provide information for analyzing all risks resulting in one risk value per project, thus it is thoughtful that the methodology for the assessment of risks will be a combination of both qualitative and quantitative methods. The risk value of each project will then be used for the techno-economic assessment of the project.

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Appendix A

Review of Horizon 2020 EE Financing Projects

EU Horizon 2020 Projects	Project Description	Perspective	Risks/Barriers	Beneficiaries	Risk Mitigation Strategies
SPEEDIER	Address the barriers that keep low the uptake of energy audits and the implementation of energy conservation measures (ECM) among SMEs by providing a self-financing outsourced energy management service to SMEs	SMEs, energy experts, technology installers, landlords, finance providers	**Barriers**: lack of finance, difficulty in choosing which ECMs to implement, Lack of knowledge regarding procurement of ECMs, lack of time, no control of building.	Manufacturing, services, education, energy, commercial, hospitality, other	
I3CP	Unlocking access to financing for the building, industry, district energy and street lighting markets by standardizing how EE projects are developed, documented and measured	Investor (facility owner, energy service company, finance firm, insurance provider, and utility programme)	Contractual risks, budget risks, programme risks/time delays, risks associated with third parties (e.g. equipment suppliers, installers), selection of poor-quality equipment, loss of income generation (e.g. renewable energy generation incentives)	Buildings, industrial sector, district energy sector	
NOVICE	Development and demonstration of a new business model in building renovation for	Energy Service Companies (ESCOs)	**Risks**: **general/debt risk**: credit risk, market risk, cultural norms, currency risk, management risk, pipeline risk, regulatory risk,	Buildings	

EU Horizon 2020 Projects	Project Description	Perspective	Risks/Barriers	Beneficiaries	Risk Mitigation Strategies
	the better monetization of EE by consolidating services and subsequent revenue streams from both energy savings and demand response		**performance risk**: repayment risk, technology risk, operation & maintenance risk, interface risk, energy price risk.		
PRODESA	Showcase EE and renewable energy projects, utilizing innovative financial tools and attracting private investments	Municipalities	**Risks**: risk of delayed payments, non-compliance with the agreed terms in the EPC, delays in scheduled programs, lack of trained staff for EPC in the public, complex procedure/bureaucracy, standard procedure for validation in the savings, credit risk of the public sector. **Market, legislative and regulatory, information & awareness, financial, technical barriers main barriers**: lack of standardized procurement procedures for EPCs in the public sector, lack of financing, lack of best practices examples/implemented projects, no historic data on energy consumption, difficulty on setting the energy baseline.	Public buildings, street lighting	Guarantees in the payment mechanism, low interest rate, insurance of the project or/and of the energy savings
PROSPECT	Enablement of peer to peer learning in regional and local authorities in order to finance and implement sustainable energy plans	Cities/municipalities	**Financial, legal and capacity barriers**: higher upfront cost investments, principal agent issues, lack of information among investors, energy-efficient products are still unfamiliar. **Risks**: risk exposure, Discount rate problems, external benefits are	Public and private sector (public and private buildings, transport, cross-sectoral)	

EU Horizon 2020 Projects	Project Description	Perspective	Risks/Barriers	Beneficiaries	Risk Mitigation Strategies
			hard to quantify, lack of technical capacity to implement projects, lack of experience on EE technologies		
QualitEE	Quality certification frameworks for EE services to scale up responsible investment in the building sector	Public and private clients of EE services, facilitators of EE services, ESCOs, financial institutions, government bodies etc.	**Regulatory and administrative barriers**, **structural barriers**, **financial barriers:** complexity of concept/lack of information, mistrust of the ESCO industry, raising affordable financing, standardization of M&V, lack of support from the government	Public and private sector	
BUILDINTEREST	Enhancement of the attractiveness of investments in EE and sustainability in buildings	Consumers	**Financial/economic barriers**: a)access to capital: initial cost, b) risk exposure, c) discount rate, d) payback time, e) flawed financial models/evaluation issues, f) short term thinking, g) reluctance to finance on-balance sheet, h) asset-based culture in financing, i) low collateral asset value. **Institutional & administrative barriers**: a) high transaction costs, b) large number of decision makers/ market fragmentation / multistakeholder issues, c) burdensome procedures, d) small project size, e) energy prices, f) split incentives, g) conservative construction sector, h) disincentives or vested interests in the status quo.	Buildings Sector	
		Financiers	**Societal barriers**: a) behavioural economics (personal priorities), b) information failure, c) uncertainty associated with energy savings, d)		

EU Horizon 2020 Projects	Project Description	Perspective	Risks/Barriers	Beneficiaries	Risk Mitigation Strategies
			limited insight in current energy performance of buildings. **Policy barriers**: a) lack of enforcement of building energy codes, b) unstable policy, c) lack of administrative capacity to develop EE legislation, d) internal procedures and rules of public budgeting. **Technological barriers**: a) solutions not available yet, b) uncertainty with regard to performance.		
CITYnvest	Increase of the cities' capacities for Innovative Financing in EE	Local authorities	**Technical know-how barrier**: too little awareness and understanding of the financial support that the EU can provide. **Regulatory/ governance barriers**: high investment volumes for smaller municipalities, pre-studies needed to prepare technical assistance applications are expensive and often local authorities lack the right skills and expertise to prepare the applications on their own. Applications can be only submitted in a limited number of EU languages. **Financial/ regulatory barrier**: structures for connecting different local authorities at national level require financial resources. **Regulatory barriers**: the social benefits provided by Renewable Energy Cooperatives (REScoops) often not recognised and are not taken into account in tendering processes. This lack of a regulatory framework to encourage local authorities to team up with	Local authorities	

EU Horizon 2020 Projects	Project Description	Perspective	Risks/Barriers	Beneficiaries	Risk Mitigation Strategies
			REScoops does not support the wide replication of this model. **Political barrier.**		
EeMAP	Creation of a standardised "energy efficient mortgage", according to which building owners are incentivised to improve the EE of their buildings or to acquire an already EE property	Mortgage receivers	**Market Barriers**: *Customer Experience & Bank Processes*: lack of awareness among consumers/borrowers and lending institutions about EE and the potential value and risk implication of energy performance, potential complexity of journey and additional process costs, lack of coordination of and between all relevant partners, *Asset Eligibility / Impact Reporting*: lack of harmonised framework for impact reporting, fragmentation of energy performance criteria and targets, current lack of robust quantitative evidence linking EE to value and risk, regulatory inconsistencies, *Data & IT*: lack of publicly available and accessible EPC data in a digital format, lack of quality and representative data (limited data history), lack of data tagging, harmonisation (definitions & methodologies) and comparability between financial, valuation & building performance data, dynamic data monitoring and analysis of non-bank data (energy savings and real-time energy consumption), IT system updates and implementation costs	Residential sector	

EU Horizon 2020 Projects	Project Description	Perspective	Risks/Barriers	Beneficiaries	Risk Mitigation Strategies
		Banks	**Risks:** credit risk, market risk, liquidity risk, interest rate, foreign exchange risk, solvency risk, operational risk, hidden risk		
ET RISK	Provision of research and tools for the assessment of the financial risks and opportunities associated with the transition to a low-carbon economy	Company	**Macroeconomic factors**: price of commodities, GDP per capita growth, exchange rates and interest rates, **external factors**: taxation, regulation and geopolitical changes (such as tax policy changes, strikes or war), investors' confidence and market sentiment, expectations that might change rapidly and without notice, depending on developments specific to individual industries, political uncertainty, changes in general economic conditions that adversely affect the level of demand for the company's products or services, changes in foreign exchange markets, changes in international and domestic financial markets and in the competitive environment, and other factors relating to the foregoing	Automotive sector, Steel sector, Electric Utilities	
		Industry	a) Production & technology, b) Market prices, c) Policy mandates, c) incentives & taxes, d) Unconventional risks		
SEAF	Development of a holistic IT Platform to bridge the gap between contractors and investors in	Asset's owner	**Regulatory barriers:** Accounting Rules for EE Finance in the Public Sector, Energy Performance of Buildings Directive**, Electricity**	Buildings sector (Sustainable energy assets)	Building automation and control (crucial component of demand response), Smart

EU Horizon 2020 Projects	Project Description	Perspective	Risks/Barriers	Beneficiaries	Risk Mitigation Strategies
	Sustainable Energy Assets (SEA)		**Market Design:** Capacity Mechanisms, EUROSTAT accounting rules to the finance of public projects		Financing, reduction of transaction costs and risks, enhancement of bankability, enhancement of investors' confidence through innovative and relevant asset valuation methodologies
CRREM	Development of a tool that will allow investors in the commercial real estate sector to analyse the risks of stranded assets due to low energy performance and to reallocate investment into more energy efficient buildings	Investor	**Transition risks:** Policy and legal, technology, market, reputation, **Physical risks:** Acute, chronic	Commercial real estate sector	Implementation of a retrofit project to reduce energy consumption (real estate investment perspective), insurance contracts, diversification of the assets that are at risk of becoming stranded due to regulatory changes, not investing in inefficient properties that need retrofitting, or even disposing of inefficient assets

Appendix B

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Appendix C

Questionnaire

1) *Is there any important risk factor in EE investments that we have not taken into consideration (see **Section 4.2** for the identified risk factors)? Do you believe that the risk factor "exchange rates volatility" should be appended to the identified risk factors in EE investments?*

Please provide an answer.

If your answer was yes, please explain:

2) *Is there any important risk category in EE investments that we have not taken into consideration (see **Section 7 or 4.2** for the identified risk categories)? Do you agree with the classification of risk factors into the identified risk categories that have been done?*

Please provide an answer.

If your answer was no, what changes would you propose?

Please explain:

3) *Is there any risk category of the identified ones that could be combined or aggregated with another identified risk category? Is there any risk category of the identified ones that could be extended into a more generic category?*

Please provide an answer.

If your answer was yes, please explain:

4) *Is there any important project category in EE investments that we have not taken into consideration (see **Section 7 or Section 3.2** for the main project categories)?*

Please provide an answer.

If your answer was yes, please explain:

5) *Is there any key beneficiary in EE investments that we have not taken into consideration (see **Section 7 or Section 3.2** for the main beneficiaries)? Do you believe that the public, agriculture and/or transport sectors should also be focal points of the Triple-A assessment?*

Please provide an answer.

If your answer was yes, please explain:

6) *Do you agree with the division of risks to project-specific and country-specific (see **Section 4.3**)?*

Please provide an answer.

Please explain:

7) *Do you agree with the proposed assessment of the identified risk factors (see **Section 4.4**)?*

Please provide an answer.

Please explain:

8) *Do you agree with the criteria for the Triple-A assessment (see **Section 4.5**)?*

Please provide an answer.

Please explain:

9) *Do you agree with the proposed risk mitigation strategies (see **Section 5**)?*

Please provide an answer.

Please explain:

10) *Do you believe that the total risk of the economic risk category can be quantified from the government bond yield for each one of the examined countries*?

Please provide an answer.

If your answer was yes, please explain. If your answer was no, what alternatives would you propose for the category's risk calculation?