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

Deliverable 4.2:
Final Standardised Triple-A Tools

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Preface

Triple-A has a very practical result-oriented approach, seeking to provide reliable information answering on three questions::

- How to *assess* the financing instruments and risks at 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 policies, 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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Glossary

API:	Application Programming Interface
ASHRAE:	American Society of Heating, Refrigerating and Air-Conditioning Engineers
BRW:	Borrower Specific
CPI:	Consumer Price Index
CSR:	Country Specific Risk
CV:	Coefficient of Variation
DEEP:	Derisking Energy Efficiency Platform
EE:	Energy Efficiency
EEM:	Energy Efficiency Measures
EEEF:	European EE Fund
ELECTRE:	ELimination Et Choix Traduisant la REalité
ESCO:	Energy Service COmpany
EU:	European Union
EU-SILC:	EU Statistics on Income and Living Conditions
EVO:	Efficiency Evaluation Organisation
EU-GBS:	European Union Green Bonds Standard
GHG:	Greenhouse Gases
HVAC & R:	Heating, ventilation, air conditioning & Refrigeration
IPMVP:	International Performance Measurement and Verification Protocol
IRR:	Internal Rate of Return
ISO:	International Organization for Standardization
KPI:	Key Performance Indicators
MCDA:	Multi Criteria Decision Analysis
NA:	Not Applicable
NPV:	Net Present Value
PI:	Profitability Index
PSR:	Project Specific Risk
PSRS:	Project and Sector Specific Risk
RES:	Renewable Energy Sources
SDG:	Sustainable Development Goals

Executive Summary

The Triple-A Standardised Tools are the key element to pave the way for identifying and financing Triple-A investments, as they materialise the Triple-A approach. The Triple-A Tools establish a one-stop-shop approach orientated towards all types of stakeholders in energy efficiency financing, facilitating project developers to benchmark their projects in a standardised way (Assess & Agree Tool), while also providing a hub to financers, bankers, and investors (Assign Tool) to finance bankable green projects. The Triple-A Tools are accessible through the Triple-A Standardised Toolbox platform[1], which can be reached directly or through the Triple-A webpage[2].

In particular, the Triple-A Assess Tool evaluates the risks and maturity of the inserted investment ideas together with the EU Taxonomy compliance, the Triple-A Agree Tool classifies the projects that passed the previous step and identifies the Triple-A ones, while the Triple-A Assign Platform matches the investments with state-of-the-art green financing schemes.

The report describes the philosophy, methodology, and process flow for each one of the Tools and incorporates design and implementation documents, administrator manuals, and training material. The Triple-A Tools are analysed individually, providing the necessary scientific background, calculations, and raw data utilisation. All the operation and support procedures are reported, along with the appropriate modifications, upgrades, and calibrations of the Draft version of the Standardised Triple-A Tools as presented in the deliverable D4.1 Draft Standardised Triple-A Tools, which was submitted in M10-June 2020.

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[1] Standardised Triple-A Toolbox: http://toolbox.aaa-h2020.eu/

[2] Triple-A Webpage: https://aaa-h2020.eu/tools/

1   Introduction

Increasing energy demand and climate change are two interconnected phenomena. Energy production and consumption are responsible to a large extend, for greenhouse gas (GHGs) emissions and environmental pollution. The European Union (EU) has been at the forefront of international efforts to fight climate change [1], setting Energy Efficiency (EE) targets and measures in order to mitigate the increasing energy demand in the EU area. EU legislation for implementing this target was adopted by the end of 2018 with the new amending Directive on Energy Efficiency (2018/2002). The EU Member States have set up indicative national targets that, collectively, should help the EU to reach its 32.5% EE target by 2030 [2].

The United Nations Member States adopted in 2015 the 2030 Agenda for Sustainable Development, which consists of 17 Sustainable Development Goals (SDGs) [1]. The SDGs cover a wide range of modern world issues on a social and environmental spectrum, including energy poverty, consumption, and efficiency. The EU is committed to support the implementation of the 2030 Agenda and to strive towards a sustainable future for all Member States [3]. However, the continuously increasing energy demand indicates that the current trends will not be adequate to reach the 2030 targets, and additional and enhanced efforts are necessary in the coming decade [4].

EE is one of the most cost-effective ways to reduce energy consumption while maintaining an equivalent level of economic activity [5], thus it is essential to boost EE investments in an attempt to mainstream EE financing. To this end, private investments are considered necessary in increasing EE by updating building stock and industry processes [6]. The European Commission's (EC) action plan is a significant step in developing an international regulatory system, in which banks can play a substantial role in financing the global energy transition, decarbonisation of the economy, and achieving the objectives of the Paris Agreement and the SDGs of the United Nations [6].

However, current investments are below half of this requirement and five times lower than required to deliver 2030 decarbonisation targets [7]. Despite the existence of many worthwhile EE investments in the development phase, very few get financed at the end. This underlying phenomenon is called the "efficiency paradox", or "EE gap" [8]. It represents a case in which business firms, which are often presumed (or taken axiomatically) to be economically efficient, make decisions that do not maximise profits [8].

The "gap" that the Triple-A scheme tries to cover, lays in the development phase of energy efficiency investments, where plenty of EE project ideas exist, and there is available capital to realise EE projects. However, these projects tend never to get financed for various reasons.

Besides, project developers do not have the expertise or resources to make a convincing financing case for investors. They consume a significant amount of working time auditing one EE project's potential energy savings, but in most cases, they 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 often suffer from a knowledge gap in how 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 creditworthiness 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, reduced local air pollution, a rise in property values, etc.

Furthermore, 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 realisation 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 standardisation 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.

In order to address the challenges mentioned above, the Triple-A scheme tries to identify which investments can be considered as Triple-A investments, fostering sustainable growth, while also having an extremely strong capacity to meet their commitments [9, 10], already from the first stages of investments generation and pre-selection/ pre-evaluation.

The Triple-A Tools materialise the Triple-A scheme, organised according to three central pillars: **Asses**, **Agree** and **Assign**, making EE investments more transparent, predictable, and attractive for investors / financiers and project developers.

Triple-A Tools offer:

- **Identification** of **attractive 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 organisations.

- Proposal of **funding strategies** (Green Bonds, Green Loans and Mortages) better match the examined investments and respective beneficiaries.

In particular, within the "**Assess**" Tool, project ideas are checked for EU Taxonomy Guidelines compliance [11], and then they are evaluated according to their perceived risk profile and factors. Risk assessment is performed following the Triple-A methodology, as described in the Triple-A "Final Report on Risks of Energy Efficiency Financing and Mitigation Strategies Typology" [12]. The risk assessment is performed not only from the creditability point of view but also by considering all the investment characteristics. These are the country in which the project will be implemented (e.g., broader economic environment, prices volatility), the sector and project category of the investment (e.g., rebound effect, technical complexity, etc.). In addition, other specific characteristics of the possible EE investment are considered, such as how the energy savings have been calculated, quality of equipment, the experience of the teams responsible for the implementation, etc. Considering all the above, the Triple-A Assess Tool calculates the total risk of an EE investment failing to achieve its predicted money and energy savings. The tool developed at this step leads to a pre-screening of investment ideas at the EU level. It is foreseen that a pipeline of at least 100 EE financially attractive projects will emerge through this step.

The **Triple-A Agree Tool** benchmarks the predicted performance of the EE project ideas that successfully pass the Assess Tool. The benchmarking takes advantage of the various existing or new key performance indicators (KPIs), including financial indicators such as the Net Present Value, the Internal Rate of Return, the Avoidance Cost, and the Discounted Payback Period. Besides, Risk assessment results, as well as Sustainable Development Goals (SDG) criteria to identify the potential "Triple-A investments" from the pipeline of the previous step. The benchmarking method is based on a Multicriteria Decision Making Analysis (MCDA) method that classifies alternatives into one of the following standardised categories: "Triple-A", "Reserved", or "Rejected". It is anticipated that 40-80 Triple-A investments will be derived from this step.

The **Triple-A Assign Tool** is a multidimensional platform that aims to match benchmarked projects with financing institutions (e.g., funds, investors, banks) looking to invest in green EE projects and create a green portfolio. The Tool provides a pool of Triple-A projects and a parameterised investing portfolio to financing bodies. At the same time, project developers, ESCOs, and EE companies could be notified in case their project has been selected for financing through a specific financing scheme. Triple-A Assign Tool supports all innovative green financing schemes, such as Green Loans and Mortgages, and the issuance of green bonds, while acts as a facilitator to project aggregation, to reduce risks and foster the financing of small-scale projects. This step will result in the elaboration of **50 project fiches**.

The first version of the Triple-A Tools was published in June 2020, along with the Deliverable D4.1: Triple-A Standardised Tools and the D4.3: User manuals (first version). This document is subsequent to the Deliverable "D4.1 Draft Standardised Tools", and it presents the methodology behind the final version of the Triple-A Tools. The latter includes upgrades and calibrations of the draft version, published in June 2020. The upgrades are a result of internal testing by partners and from feedback that has been received from collaboration with other relevant H2020 projects and stakeholders. Also, the final version of the Triple-A includes the developed Assign Tool that links financers with project developers by matchmaking profitable projects with state-of-the-art financing schemes.

(a)   (b)
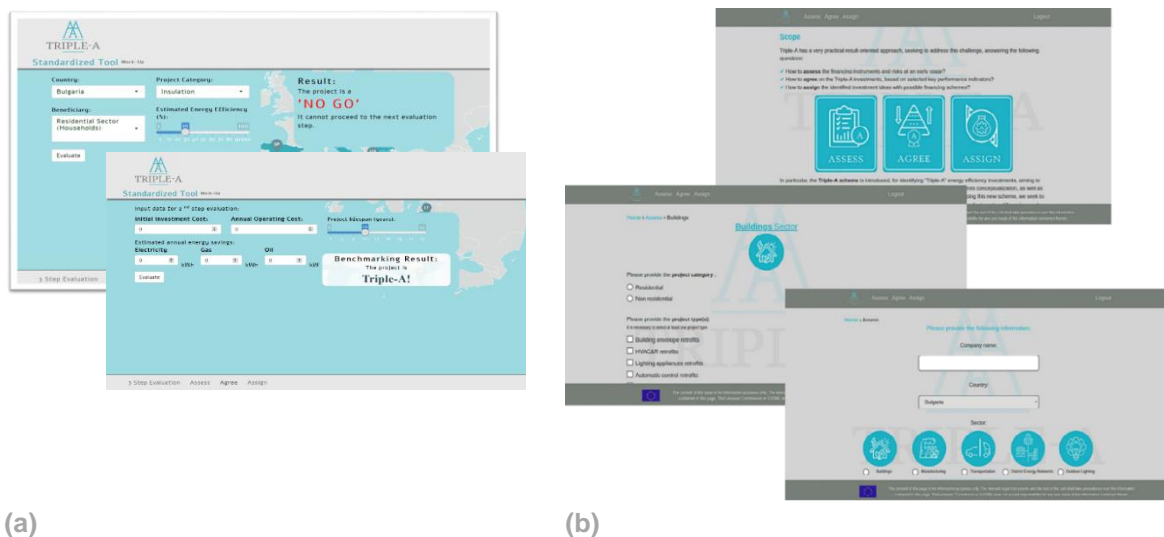
Figure 1: (a) Initial Standardised Triple-A Tools Interface (b) Final Standardised Triple-A Tools Interface

The Standardised Triple-A Tools have been implemented using Python 3.0 programming language. The web-based application is designed in Django, which is an open-source python web framework. The Triple-A Tools are accessible through the Triple-A Standardised Toolbox Platform (Standardised Triple-A Toolbox: http://toolbox.aaa-h2020.eu/), which can be reached through the direct link, or the Triple-A webpage (https://aaa-h2020.eu/tools/). More concise details on the steps to be followed by the user can be found in the Triple-A Tools' User Manuals[3] and in the Triple-A Tools Instructions Video which is available online in Triple-A YouTube channel[4], Triple-A website Home, Tools[5] and Media[6] pages. The Triple-A Tools Instructions Video shows and describes all the available functionalities and services that the Triple-A Tools provide in under 10 minutes, acting as an efficient, quick start guide for stakeholders that opt to use the Tools with the least effort needed.

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[3] https://aaa-h2020.eu/sites/default/files/reports/D4.4-User%20manuals%20(final%20version).pdf
[4] https://www.youtube.com/watch?v=wd1XG4k6uyk
[5] https://aaa-h2020.eu/tools
[6] https://aaa-h2020.eu/index.php/media
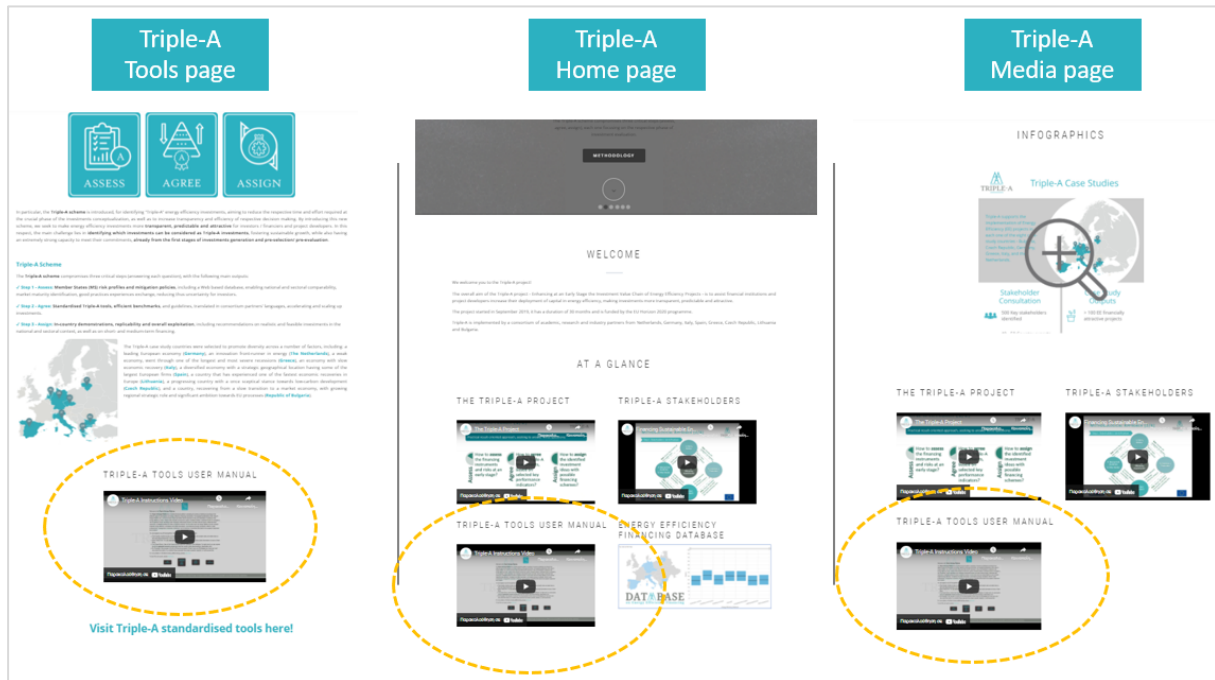
Figure 2: Triple-A Tools Instructions Video in Triple-A website

Apart from the Introduction section, the deliverable is structured as follows:

In Chapter 2, the implementation procedure, the methodological background, and the flowchart of the Triple-A Assess Tool are presented. In chapter 3, the Triple-A Agree Tool evaluation method, benchmarking criteria, and methodology are explained. Chapter 4 presents the methodology and design of the Triple-A Assign Tool, while in Chapter 5, the testing procedure of the Triple-A Tools is presented. Chapter 6 holds a wrap up of the present document, along with conclusions.

2   Tool 1: Assess

2.1   Overview

The Triple-A Assess Tool is the first step of the standardised Triple-A scheme for assessing and benchmarking EE project ideas. The Assess Tool estimates the risks and maturity of the proposed EE investment, along with their EU Taxonomy compliance. The risks are related to the specific country that the project is implemented, the proposed technologies, and the project management, while the maturity of the investments is related to its readiness for implementation. In this respect, key parameters on the EE financing have been identified (e.g., risk level, size of the investment, type of EE projects, EEM(s) eligible, etc.). These can be considered eligibility criteria to increase security and trust, necessary to proceed to further investigations.

The first part of the Assess Tool is based on technical screening criteria as defined in the EU Taxonomy [11] and the PREMIUM LIGHT PRO project (only for the Outdoor Lighting sector) [13]. Please note that **only the Technical Screening Criteria** of the EU Taxonomy are taken into account. As long as the investment is located in the EU Member States, it is assumed that the Do No Significant Harm criteria are met, including the appropriate management of the associated Social risks.

The user should insert the initial data of the candidate EE project, i.e., the project's country and sector, while in some cases, the sub-sector and the project category is needed. For each sector, the Assess Tool provides the corresponding requirements with which the project should be compliant according to the EU Taxonomy. At the end of the first part of the Assess Tool, the project would be characterised as EU Taxonomy compliant or not. The EU Taxonomy compliance indication of the project is visible in all three Triple-A Tools (Asses, Agree and Assign) to inform financing instruments and other energy efficiency stakeholders interested in investing in the respective project.

Following, a comprehensive risk assessment is realised in the second part of the Assess Tool. The user should provide additional project data by answering questions regarding the specific characteristics of the investment. Finally, the aggregated risk value of the project is calculated. Figure 3 displays the Assess tool's methodological steps along with the expected results.
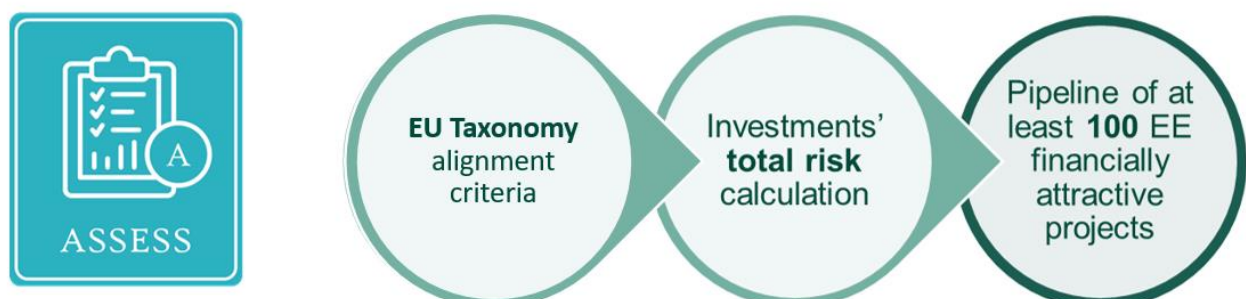
Figure 3: Triple-A Assess Tool Concept

2.2   Methodology

By entering on the Triple-A Assess Tool, the user (e.g., project developer) should provide some basic information regarding the investment proposed for financing.

Firstly, the user enters information about the applicant for the loan or financing, i.e., the company's or physical person's name. Then, they must select the country in which the EE Investment will take place (Table 1).

Next, the user selects the sector of the EE investment (Table 2) along with respective sub-sectors. Sectors and sub-sectors are related to the Energy Efficiency Measures (EEMs) implemented rather than the investment's beneficiary. The EU Taxonomy follows the same approach for defining EE sectors and sub-sectors. In this regard, for example, in case the EEMs implemented are connected to the parts of a building or building's appliances, or construction of a new building takes place, then the "Buildings" sector should be selected, irrespectively of the type of building. For the purchases of new vehicles, the "Transportation" sector is be chosen, while for retrofits that are connected to the manufacturing process (e.g., manufacturing machinery's retrofits), the user should select the "Manufacturing" sector. For retrofits or expansion of district energy networks, the "District energy networks" sector is selected. Finally, the "Outdoor lighting" sector is chosen for retrofits applied to outdoor lighting.

The next step is selecting the specific EEM(s) categories that will be implemented within the context of this project. The project categories that each sector includes are presented in Table 3. Next, a checklist corresponding with either the taxonomy criteria (for all the sectors except for the "Outdoor lighting" sector) or the criteria set (for the "Outdoor lighting" sector) that the investment should meet appears, where the user can quickly answer the fields using "Yes" or "No". Finally, the user proceeds to the risk calculation.

Regarding the Taxonomy aspect, the nature of EEM(s) secures the conformity of all measures with the first environmental objective, "Climate Change mitigation", while the "Do no significant harm" to any of the other five environmental objectives criteria is presumed that always met. Thus, the Triple-A Assess Tool examines only the proposed EEM(s) compliance with the minimum safeguards defined in the respective Regulation.

In the following tables, the Triple-A case study countries, sectors, and project categories are listed.

Table 1: Triple-A Case Study Countries

A/A	Case Study Countries
C_1	Italy
C_2	Spain
C_3	Netherlands
C_4	Germany
C_5	Greece
C_6	Republic of Bulgaria
C_7	Czech Republic
C_8	Lithuania

Table 2: Triple-A Tool Sectors and Sub-sectors

A/A	Sectors	Sub-sectors
S_1	Buildings	Residential
		Non-Residential
S_2	Manufacturing	Hydrogen
		Iron and Steel
		Aluminium
		Cement
		Low carbon technologies
		Fertilisers and Nitrogen
		Other organic basic chemicals
		Other inorganic basic chemicals
S_3	Transportation	Public Transport
		Passenger cars and light commercial vehicles
S_4	District Energy Networks	District Heating / Cooling Distribution
		Installation and operation of electric heat pumps
		Cogeneration of Heating / Cooling and Power
		Production of Heating / Cooling
S_5	Outdoor Lighting	-

Table 3: Triple-A Tool Project Categories

Sectors	A/A	Project categories
Buildings	P_1	Building envelope retrofits
	P_2	HVAC&R retrofits
	P_3	Lighting appliances' retrofits
	P_4	Automatic control retrofits
	P_5	RES installations
	P_6	Construction of new buildings
Manufacturing	P_7	Manufacturing-specific retrofits
Transportation	P_8	Purchase of new vehicles
District Energy Networks	P_9	District Energy Networks retrofits/ expansion
Outdoor Lighting	P_{10}	Outdoor lighting retrofits

The flowchart of the whole process of the Triple-A Assess Tool is presented in Figure 4.
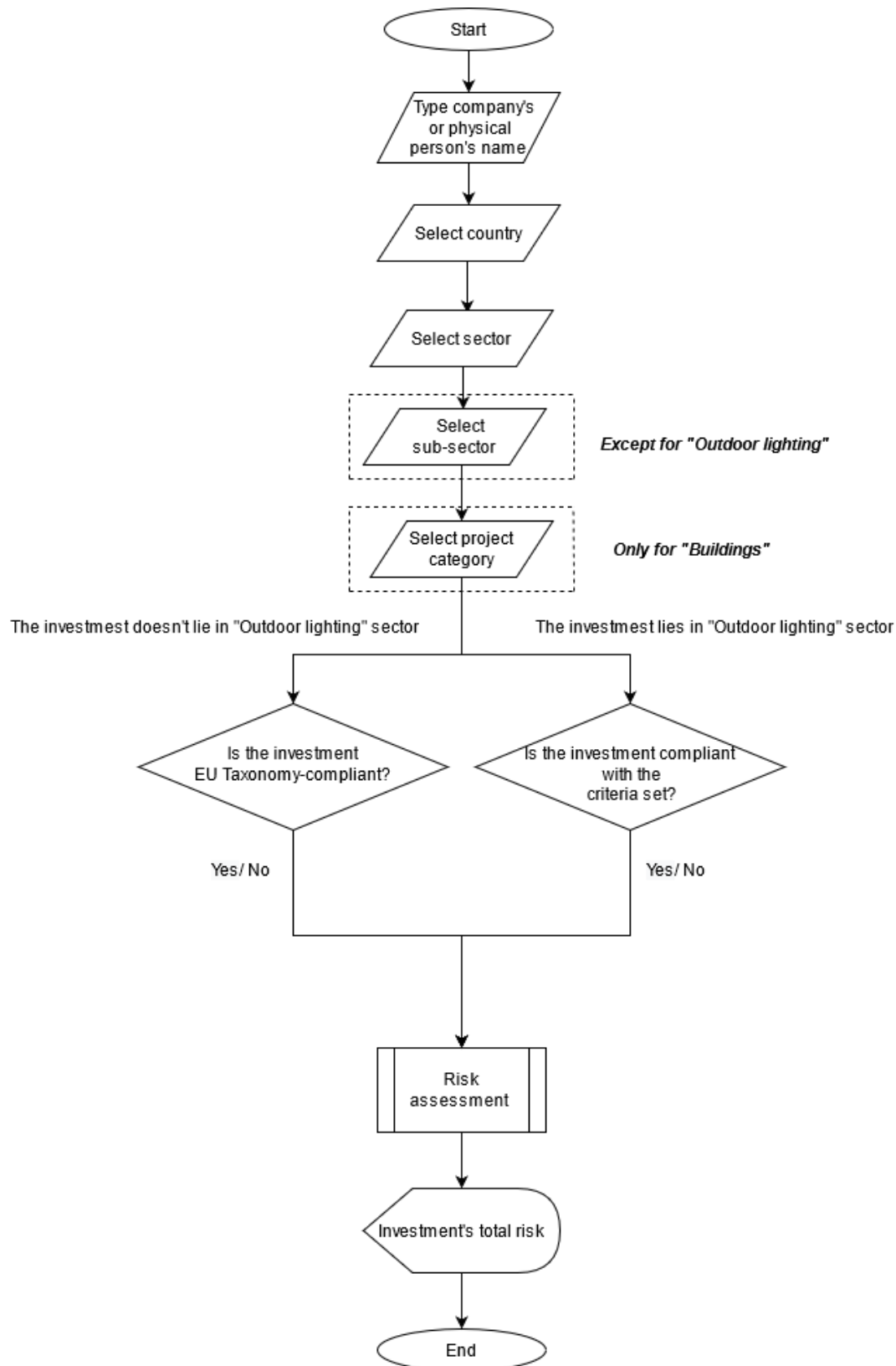
Figure 4: Triple-A Assess Tool Flowchart

2.3 EU Taxonomy Compliance

The Triple-A Assess Tool allows energy efficiency stakeholders to check the EU Taxonomy compliance of the assessed project. The Tools provides the EU Taxonomy Technical screening criteria based on the project's sector. These criteria include thresholds regarding the technical characteristics of EE projects varying from one sector to another. For all the sectors of the identified ones (Table 2) except for "Outdoor lighting", the criteria are set by using EU Taxonomy [11]. For "Outdoor lighting", the respective outcome of the PREMIUM LIGHT PRO project [13] is used for setting the requirements for the investments that lie in this sector.

The **EU Taxonomy** compliance process includes three steps (Figure 5). As also described in the previous section, the user selects the sector and sub-sector of interest (Table 2) and then the project categories that will be implemented in the context of the under-examination project. According to the user choices (sector, sub-sector, and project category), a corresponding checklist is displayed with the taxonomy criteria or the criteria set (for the "Outdoor lighting" sector) that the investment should meet. The final step of the **EU Taxonomy** compliance process is completed by fulfilling the project checklist. To do so, the user is replying simply by using "Yes" or "No", according to whether the investment is compliant with the criteria set in each case or not.
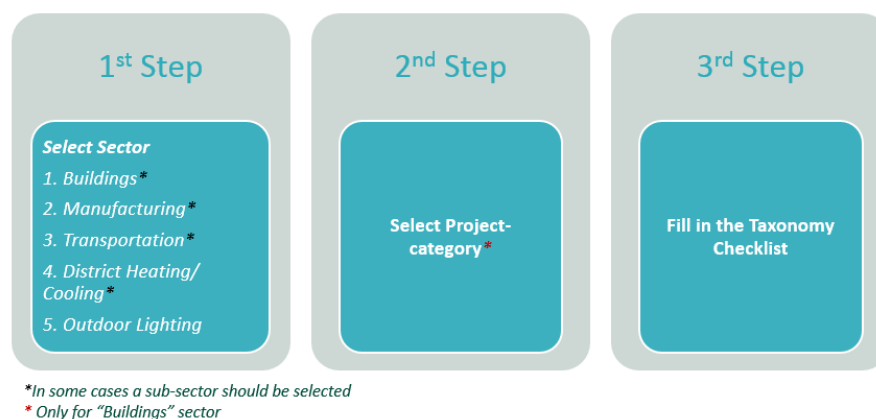
Figure 5: EU Taxonomy Compliance Process Flowchart

The specific requirements and threshold with which the project should comply in each case are presented in Appendix A.

2.4 Risk Assessment

The risk assessment follows the **EU Taxonomy compliance** step and is applicable for all projects, i.e., for projects that are EU Taxonomy compliant or not. This step aims to calculate the investment's total risk, and for this purpose, a qualitative and a quantitative approach are utilised.

Table 4 presents the risk categories of the Triple-A Tool, along with the related risk factors. Risk factors can be classified into the following categories: (a) Borrower-specific *(BRW)*, (b) Sector and Project-category specific *(PSRS)* (c) Country-specific risk *(CSR)* and (d) project-specific risk *(PSR)*.

The credit worthiness of the borrower, which is the only *BRW* risk factor, depends on the creditability of the applicant for the loan/ financing, being either a physical person or a company/ legal person. *PSRS* risk factors depend on the project's sector, and the EEMs implemented. *CSR* factors depend only on the country that the investment takes place. Finally, the *PSR* factors depend on the ad-hoc characteristics of each project irrespectively of all the ones mentioned above.

Table 4: Triple-A Tool Risk Categories and Risk Factors

Risk Factors	Risk Categories				
	Financial	**Behavioural**	**Energy Market & Regulatory**	**Economic**	**Technological, Planning & Operational**
Credit worthiness of the borrower *(BRW)*	✔				
Rebound effect *(PSRS)*		✔			
Energy prices and energy taxes volatility *(CSR)*			✔		
Request for issuing project permits *(PSR)*			✔		
Weak economic environment *(CSR)*				✔	
Technical Complexity *(PSRS)*					✔
Low quality of initial savings assessment *(PSR)*					✔
Implementation of low-quality equipment or poor project design *(PSR)*					✔
Inadequate Operation & Maintenance *(PSR)*					✔

BRW: Borrower-specific, PSRS: Project and Sector specific risk, CSR: Country-specific risk, PSR: project-specific risk

PSR risk factors are evaluated using a set of questions that capture the specific characteristics of each investment. Users are asked to reply to these questions after passing the **EU Taxonomy compliance** step. The questions are presented in Appendix B, and in most cases, a "Yes" or "No" answer is required. For selecting them, similar projects that try to evaluate the EE projects' technical risk were inspected[7]

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[7] This questionnaire was inspired also by work done in related projects, e.g., the Risk Assessment Framework/Tool developed under the UNIDO lead Industrial Energy Accelerator Initiative in 2019.

(e.g. [14]), as well as EE studies (e.g. [15]) that provide information regarding the risk of each sector or project category were reviewed.

Following, the user evaluates the applicant's creditworthiness for the loan/ financing (*BRW*)*,* when applicable, while a bypass option for this step is available. If the bypass option is selected, the borrower's creditworthiness will be skipped from the risk assessment. The *PSRS* risk factors are evaluated by relative studies and qualitative methods for calculating the risks in each sector and project category. The *CSR* *risk* factors are reviewed by selecting representative indices and using quantitative or qualitative methods for converting the indices' values to risk ones that lie in the range [0-1]. Figure 6 presents the Risk Assessment approach.
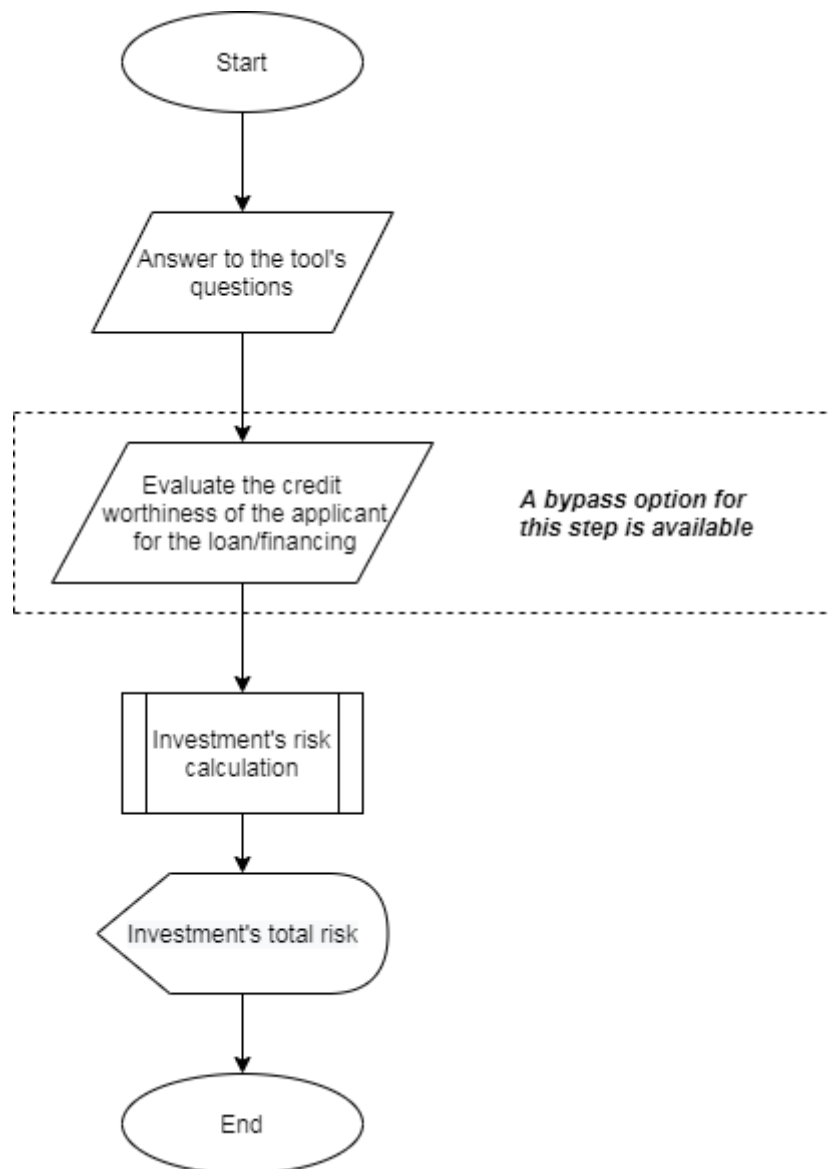
Figure 6: Risk Assessment Approach

Credit Worthiness

Credit worthiness indicates the financial capacity of the borrower to pay off his debt and is a critical factor from the perspective of a financial institution or bank when considering a loan [16], [17].

Bankers evaluate the physical person's creditworthiness or company by collecting indicative data regarding their financial position. They consider aspects like the person's income, debt to income ratio, company's revenue, debt to equity, etc. There are many difficulties for approximating the approach followed by financial institutions since much of this information is sensitive and, therefore, difficult to be obtained from project developers.

In this regard, credit worthiness is evaluated by assigning linguistic values[8], in particular: "**Low**", "**Medium**", "**High**", "**Unknown**", and "**Bypass/ NA**". At each scale of credit worthiness, a risk value is assigned, i.e., 0 for the choice that indicates the lower risk, 0.5 for the choice that indicates moderate risk, and 1 for the choice that demonstrates the highest risk. The "Unknown" option is considered equivalent to "Low" credit worthiness, as it entails high uncertainty. Table 5 presents the risk values that correspond to each choice after applying the approach above.

Table 5: Evaluating the Credit Worthiness

Credit worthiness evaluation values	Risk value
Low	1
Medium	0.5
High	0
Unknown	1
Bypass/ Not Applicable (NA)	-

Rebound Effect

The rebound effect describes a specific behavioural bias. It affects the end-user and mainly emerges when the implementation of an EE investment leads to lower costs for energy services, which invokes an increase in the demand for such services, thus resulting in higher final energy consumption than anticipated. This may lead to energy savings being significantly lower than planned.

A literature review of the sources that quantify the rebound effect across the identified project categories and beneficiaries in EE projects was conducted. Literature provides percentage ranges of the projected rebound effects per project category rather than single percentage values [18], [19]. According to these projections, the rebound effect mostly ranges from 0% to 50% in EE projects ([18], [19]). However, in extreme cases, the rebound effect can backfire, reaching more than 100%, leading to no energy savings and an increase in energy consumption.

For identifying the benchmarks for each of the used scales, the interval of the possible rebound effect values is disaggregated into a 5-level scale, where a higher rebound effect value corresponds to a higher risk. The benchmark of each scale is formulated as depicted in Table 6.

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[8] Evaluate the credit worthiness of the applicant for the loan/financing: i) "Low", ii) "Medium", iii) "High", iv) "Unknown", v) "Bypass/ NA".

Table 6: Rebound Effect Classification

Rebound effect scale	Risk	Risk value
Lower than 12,5%	Insignificant	0
Lower than 25%	Low	0.25
Lower than 37,5%	Medium	0.5
Lower than 50%	High	0.75
More than 50%	Very high	1

The risks assigned to each of the Triple-A's project categories according to the class that their projected rebound effect lies in, are presented in Appendix C.

Energy Prices and Taxes Volatility

Energy prices volatility is related to the uncertainty of energy prices and influences the decision to undertake an EE investment, leading to uncertainty about monetary savings and returns [20]. Likewise, energy taxes volatility is considered important since it affects end use prices and, thus, the monetary savings of EE investments. These two risk factors are associated with the price risk in EE investments.

In order to evaluate energy prices and taxes volatility, the **consumer price index (CPI) of the energy sector** [21] is used. This index involves energy prices and taxes enabling the valuation of both risk factors simultaneously. In order to measure the volatility of CPI at the energy sector for each of the examined countries, the coefficient of variation (CV) of monthly values [20, 21] for the last fifteen years (01/2005-12/2019), as reported by OECD [21] is calculated. CV is defined as the ratio of the standard deviation σ to the mean μ, and it can be expressed as follows:

$$CV = \frac{\sigma}{\mu} \qquad (1)$$

The *CV* values are converted to risk values [0-1] as follows:

$$\frac{CV\_CPI(country) - CV\_CPI(country\_min)}{CV\_CPI(country\_max) - CV\_CPI(country\_min)} \qquad (2)$$

where $CV\_CPI(country\_max)$ and $CV\_CPI(country\_min)$ are set nearly (0.01 deviation) to the coefficients of variation of the countries that present the highest and lowest volatility (Greece and Netherlands), respectively. Thus, the lowest and highest risk values tend to be, but are not equal to 0 and 1, respectively, which is more realistic from a risk analysis point of view.

Table 7: Energy Prices and Taxes Volatility Risk Values per Case Study Country

Country	Energy prices & taxes risk value
Netherlands	0.06
Germany	0.12
Italy	0.23
Czech Republic	0.27
Republic of Bulgaria	0.29
Spain	0.43
Lithuania	0.64
Greece	0.94

Request for Issuing Project Permits

The request for issuing project permits signifies the legislative complexity for completing a project (e.g., construction permits/licenses, protocols, or other approvals under the provisions of law), leading to administrative risk in a specific country. The administrative risk could be a decisive factor for selecting a country to implement a project, and it is modelled after the request for issuing necessary project permits/licenses for the implementation of the retrofit [15]. Request for issuing project permits/licenses for renovations of existing buildings, the installation of geothermal heat pumps, the change of the electromechanical equipment are some instances where administrative risk could emerge.

The benchmark of this component is based on the amount and type of project permits needed for the implementation of the project. It is going to be evaluated by the answer of the Tool's user to the third question of Appendix B, where the risks assigned to each answer to this question are presented in Table 8.

Table 8: Request for Issuing Project Permits' Evaluation

Possible answers	Risk	Risk value
No request for project permits	Insignificant	0
Request for small-scale project permits	Medium	0.5
Request for large-scale project permits	Very high	1

Weak economic environment

The weak economic environment is related to poor economic conditions in the country that the EE investment takes place. It is connected to, among other indicators, interest rates, inflation, availability of finance, etc. [24]. A weak economic environment can negatively influence the investment in many ways, affecting the investment's profitability through inflation or KPIs through interest rates.

This risk factor is evaluated through the countries' credit ratings provided by Standard & Poor's (S&Ps). A country's credit rating is an evaluation of its credit risk or probability of default [25], [26]. This index

was selected for assigning the credit ratings, S&Ps considers all the aspects of the economy. Therefore, credit ratings provide a holistic evaluation of the country's economy.

The possible credit rating values that can be assigned to a country by S&Ps are the following: AAA, AA+, AA, AA-, A+, A, A-, BBB+, BBB, BBB-, BB+, BB, BB-, B+, B, B-, CCC, CC, C, D. To each one of these values a number by starting with 1 to the best possible evaluation (AAA) and ending to 20 for the worst one (D) is assigned. By dividing these numbers by the number of possible values (20), the risk value that corresponds to each credit rating arises. If an investor (Tool's user) wills to bypass the "Weak Economic Environment" factor, they can set a meagre weight (e.g., 0%) in the parameters of the risk assessment of the Tool.

Table 9 presents the risk values for each of the case study countries produced by the approach mentioned above.

Table 9: Weak Economic Environment Risk Values per Case Study Country

Country	Credit rating	Risk value
Netherlands	AAA	0.05
Germany	AAA	0.05
Italy	BBB	0.47
Czech Republic	AA-	0.21
Republic of Bulgaria	BBB	0.47
Spain	A	0.32
Lithuania	A+	0.26
Greece	BB-	0.68

Technical Complexity

The technical complexity is related to the complexity of the EEMs implemented from a technological point of view. It affects chances for successful project implementation by increasing the possibility that expected energy savings are not achieved. A list of technical complexity scores per EEM and sector was used for assigning risk values to each project category after reviewing the respective literature [15]. Various EEMs have the same technical complexity values scale [0-1] (Table 10). Therefore, they could be aggregated and modelled after a single value.

Table 10: Technical Complexity Classification

Technical complexity scale	Risk	Risk Value
Low complexity	Insignificant	0
Medium complexity	Medium	0.5
High complexity	Very high	1

According to their technical complexity, the risks assigned to each one of the Triple-A's projects categories are presented in Appendix D.

Low Quality of Initial Savings Assessment

The low quality of initial savings assessment is associated with the capacity to accurately predict the expected energy savings and define the baseline energy consumption properly. Different practices used to estimate energy savings are using computational tools and simulation models from certified experts, empirical approaches and processes and results from other similar projects [15].

Defining the baseline of energy consumption is crucial for the better prediction of the project's energy savings, as well as for the measurement and verification of the energy savings during the project's lifetime. Reliable data of past energy consumption and simulation models should be used for this task. If there are no available data or the methodology is not accurate enough, there is the risk of defining the baseline poorly. Furthermore, if critical variables such as the intensity or the frequency of usage are going to change, the initially defined baseline will not be a comparable measurement for calculating energy savings [14]. Therefore, expected changes in usage should be incorporated into the baseline definition by adjusting them appropriately. For an accurate definition of the baseline ISO and EN standards, as well as ASHRAE guidelines and IPMVP EVO protocols are considered as suitable means [15].

This risk factor is going to be evaluated by the answer of the Tool's user to the first and second questions of Appendix B. The risk values assigned based on each answer are presented in Table 11, where the total risk factor's value is calculated by averaging the respective risk values derived from the answers.

Table 11: Low Quality of Initial Savings Assessment's Evaluation

Possible answers	Risk	Risk Value
Energy savings assessment through tools and simulation models from certified experts	Insignificant	0
Energy savings assessment through empirical approaches and processes	Medium	0.5
Energy savings assessment through similar projects' estimations	High	1
Baseline definition through standardised procedures	Insignificant	0
Baseline definition through non-standardised procedures	High	1

Implementation of Low-quality Equipment or Poor Project Design

The implementation of low-quality equipment or poor project design refers to the equipment and design characteristics of the examined project. According to the quality of the equipment and the design, a level of technical risk can be defined. A leading source of technical risk is that the equipment could fail to perform at an initially specified level. Reason for this could be its quality, which depends on the producer. Especially in large projects, where equipment costs play a significant role in the total project budget, finding a reliable producer is crucial for minimising technical risk.

Equipment is expected to be aligned with eco-design standards, technical prerequisites, and EU labelling standards [15], and its quality is assessed based on a proof about the installed equipment, for instance, certain standards or specific quality labels [27]. Equipment risk is assessed based on the availability of such credentials.

Design risk is another component of the technical risk and could even lead to the underperformance of high-quality equipment. Such failures could result from a lack of competence and expertise of the party responsible for the implementation of the project or even from the unclear assignment of tasks in case several parties are involved. Due diligence from independent parties is recommended, as this process minimises design risk ensuring expected energy savings levels [14].

This risk factor is going to be evaluated by the answer of the Tool's user to the fourth, fifth, and sixth question of Appendix B. The risk values assigned to each answer to these questions are presented in Table 12, where the total risk factor's value is calculated by averaging the respective risk values derived from the answers.

Table 12: Implementation of Low-quality Equipment or Poor Project Design's Evaluation

Possible answers	Risk	Risk Value
Proof about the quality of the equipment to be installed available	Insignificant	0
Proof about the quality of the equipment to be installed unavailable	Medium	0.5
Experienced team for planning and implementing the project	Insignificant	0
Inexperienced team for planning and implementing the project	Medium	0.5
ESCO conducts the technical implementation of the project	Insignificant	0
Borrower / supplier / another third party conducts the technical implementation of the project	Medium	0.5
Several stakeholders conduct the technical implementation of the project	High	1

Inadequate operation & maintenance

Inadequate Operation & Maintenance (O&M) represents the uncertainty regarding the proper operation and maintenance of equipment. O&M is considered a crucial factor in the achievement of expected energy savings. Monitoring the operation of the equipment is very important and can be conducted through on-site audits and measurements during the preliminary and regular operation of the equipment [15].

Equipment operation is expected to be based on operation standards and protocols followed by experts. However, usage adjustments and faulty operation could lead to underperformance of the project. User capacity regulates the resulting energy savings. Therefore, inexperience or lack of guidance and training regarding the use of technology could bear the operational risk for the project's success [14]. Operational risk is based on the capacity of the end-user in using and operating the proposed equipment.

Additional costs could be the outcome of improper maintenance. Maintenance can be conducted by providing instruction in manuals and spare parts catalogues. A regular maintenance plan should be in place for repairs and adaptations of the equipment according to the rules and procedures of constructors

[15]. Otherwise, the operation of the equipment could be affected, and energy savings could be reduced over time. Especially for long-term projects and demanding technologies, maintenance risk should be considered thoroughly.

Monitoring & Verification (M&V) is an efficient way of defining the achieved level of savings and could serve as a baseline for debt repayment. Regarding M&V, financial institutions should opt for the usage of M&V protocols and standards [14]. Specific ISO standards, such as ISO 5015 or the International Performance Measurement and Verification Protocol (IPMVP) EVO protocols could be crucial to transparency and quality of M&V since they refer to standardised procedures and ensure efficient results [15]. Regular M&V reports should be available for financial institutions so that the performance of the project is continuously evaluated, and debt repayment is secured.

This risk factor is going to be evaluated by the answers of the Tool's user to the seventh, eightieth, ninetieth, and tenth question of Appendix B. The risk values assigned to each answer to these questions are presented in Table 13, where the total risk factor's value is calculated by averaging the respective risk values derived from the answers.

Table 13: Inadequate O&M Evaluation

Possible answers	Risk	Risk Value
Experienced end user in using and operating the proposed equipment	Insignificant	0
Inexperienced end user in using and operating the proposed equipment	Medium	0.5
Maintenance plan available	Insignificant	0
Maintenance plan unavailable	Medium	0.5
Product warranties available	Insignificant	0
Product warranties unavailable	Medium	0.5
M&V protocols and standards available	Insignificant	0
M&V protocols and standards unavailable	High	1

Total Risk Calculation

After calculating the risk factors' values, the risk categories' values are calculated by averaging the values of the risk factors of which each category is composed. The total project's risk value is the weighted arithmetic mean of the risk categories' values and is calculated as follows:

$$Project's\ risk\ value = \sum_{i=1}^{n} w_i \times R_i \quad (3)$$

$w_i : i = 1, …, 5$ are each risk category's weight

$R_i : i = 1, …, 5$ are each risk category's value

It should be noted that in case the financial category (Credit worthiness) is skipped, the risk categories over which the total risk value is calculated are four. Moreover, through the stakeholder consultation process, weights are assigned to the risk categories according to their estimated impact on EE projects. These weights are used as the default weights of the tool, while bankers and investors could modify these weights according to their preferences and inspect how the total investment's risk is adjusted.

In this regard, for example, if an investor examines to invest in a specific risky country, as calculated by the country-specific risk analysis of the Tool, the user could eliminate the country-specific risks from the total risk calculation. To do so, he assigns zero or very small weights to the corresponding country-specific risk categories' weights, i.e., the "Energy Market & Regulatory" and "Economic" risk categories.

Revision of the Risk Factors

A revision of the risk factors is being performed periodically (twice a year) to harmonise Triple-A Tool's results with the up-to-date EE financing trends and characteristics for each country and project sector included in the Triple-A methodology. The Triple-A Assess Tool's results page informs the user of the output of the risk assessment and the date of the latest revision of the risk factors.
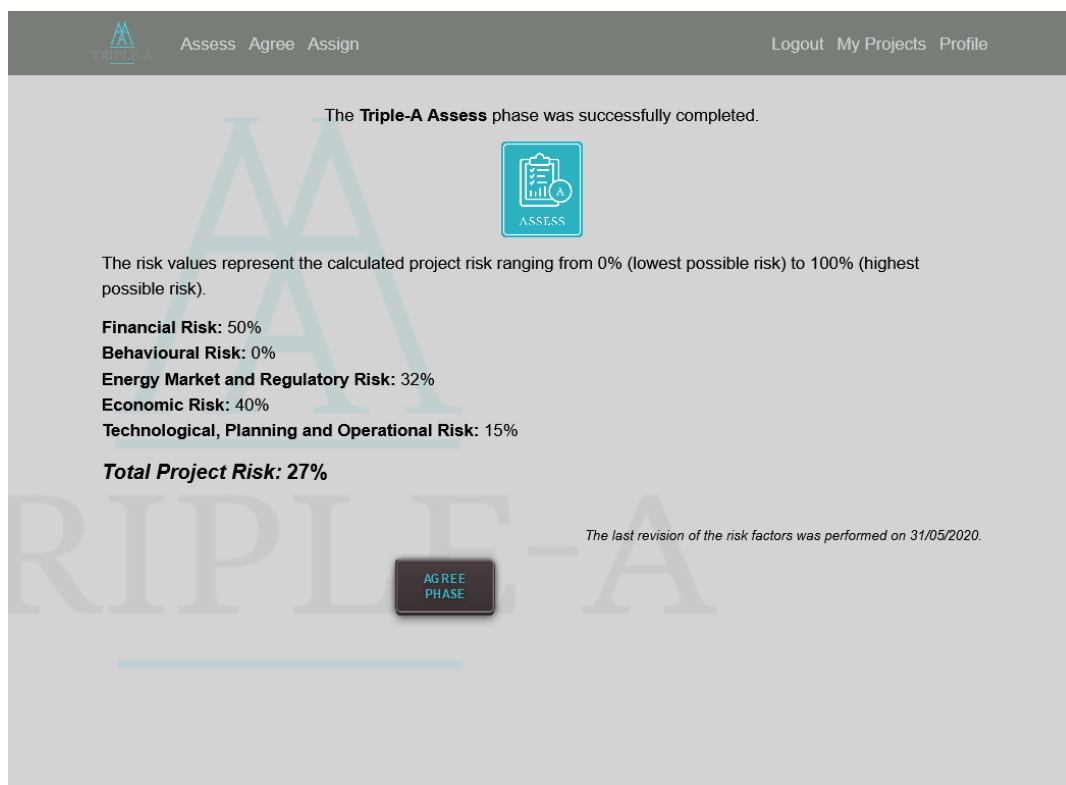
Figure 7 Triple-A Assess Tool - Result Page

3   Tool 2: Agree

3.1   Overview

The **Triple-A Agree Tool** is the implementation of the second step of the standardised Triple-A scheme for assessing and benchmarking EE project ideas.

The Triple-A Agree Tool benchmarks the predicted performance of the EE project ideas that have completed the Assess Tool. This tool supports the identification of Triple-A investments. Triple-A EE investments are defined as investments with an extremely strong capacity to meet their energy saving targets, already from their conceptual phase (where they are still considered project fiches). The Triple-A Agree Tool takes into account major **Financial**, **Risk** (as calculated in the Assess Tool) and **Sustainable Development Goals** (SDG) criteria and uses a multicriteria classification method to benchmark the project ideas that have successfully passed the previous step. The candidate projects are classified into one of the following categories: "**Triple-A**", "**Reserved**", or "**Rejected**", according to their performance on the evaluation criteria.
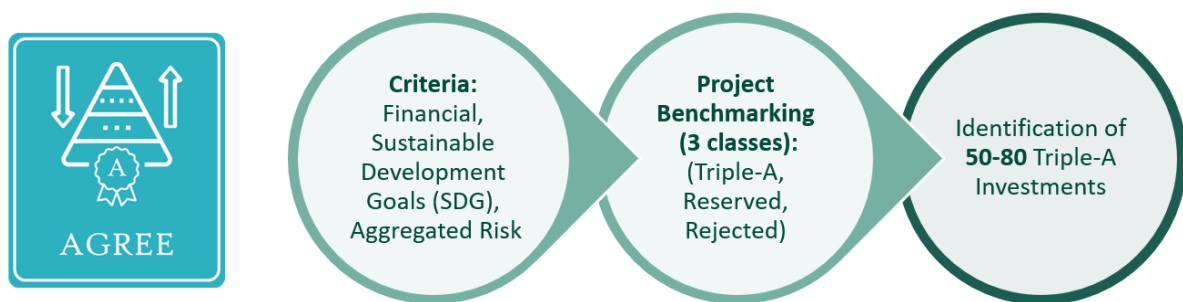
Figure 8: Triple-A Agree Tool - Overview

3.2   Methodology

The methodology is based on a benchmarking procedure, realised through an MCDA method (Figure 9). The benchmarking criteria consist of several performance indicators (financial, SDG, and risk related). The first step is to acquire the input needed to calculate the criteria. The input is categorised into three major types: user input, internal input from the Assess Tool, and external input from Eurostat & European Commission's reports. The user input interface of the Tool is depicted in Appendix E. Then, the financial and SDG criteria are being calculated and, along with the aggregated risk from the previous step, are inserted as input into the MDCA to be benchmarked for the candidate project. The project benchmarking is displayed on the user's screen and saved to the Tool's database.
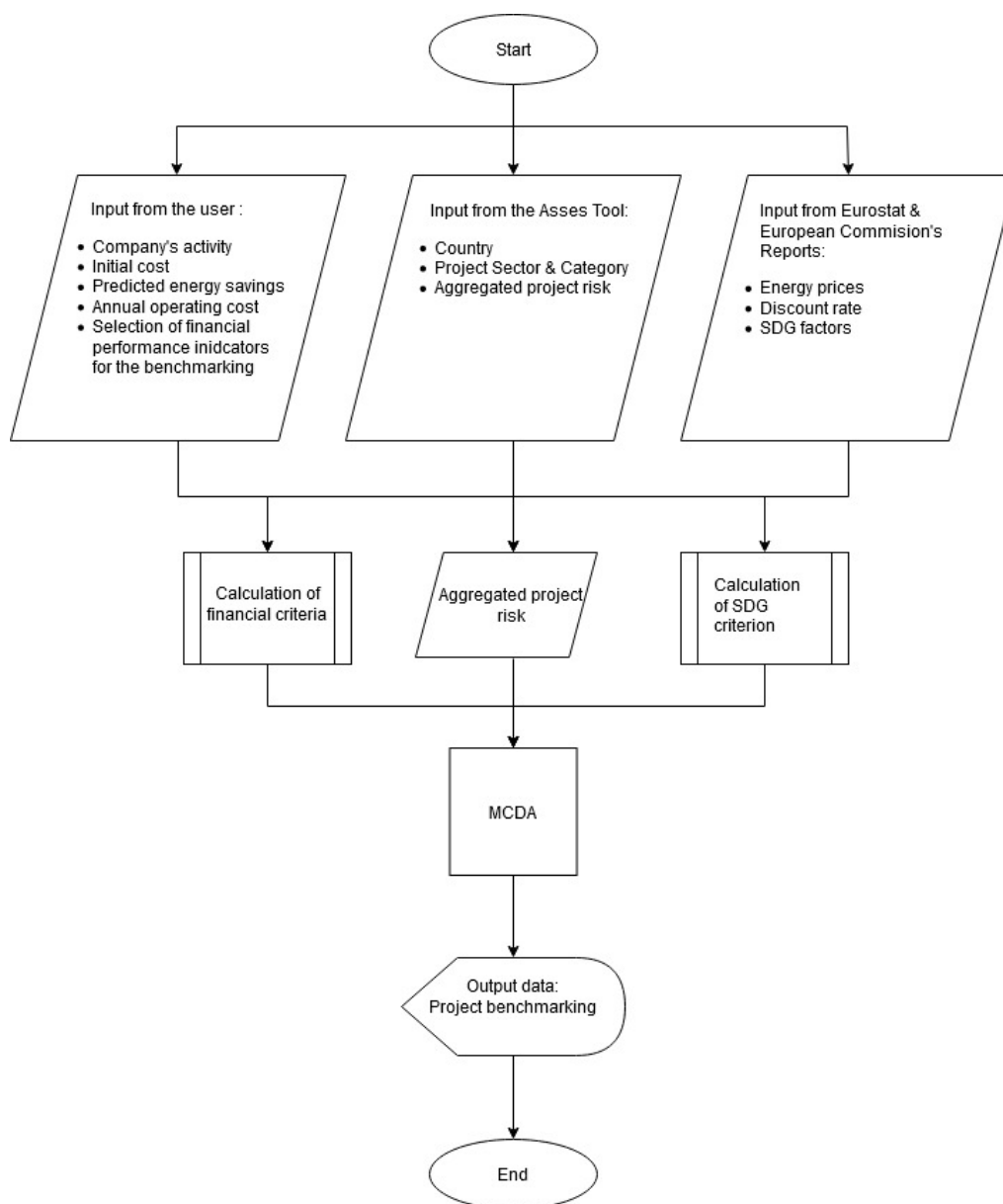
Figure 9: Triple-A Agree Tool - Flowchart

3.3   The Evaluation Criteria

In order to identify Triple-A project ideas, a standardised procedure that implements the ELECTRE Tri MCDA method is conducted. The KPIs used as criteria are either calculated based on EU Directives and Regulations on Cost-Benefit Analysis of Investment Projects or reflected directly from EU official statistics to provide a standardised, unbiased result. This builds confidence among investors and facilitates financing bodies and EE funds to rapidly detect and aggregate projects that meet the necessary criteria to be financed.

Financial Criteria Analysis

In Table 14, the KPIs that are most used in the financing sector to evaluate EE projects are presented (See also Appendix F).

Table 14: Financial Criteria

	Name	Description
A_1	Net Present Value (NPV)	NPV reflects the risk and cashflows discount by quantising it through the discount rate the profitability of the investment, by involving in the calculations the yearly income. It also reflects the operational costs and the initial investment.
A_2	Discounted Payback Period	The discounted payback period is the number of years necessary to recover the project cost of an investment while accounting for the time value of money. It is recommended since it allows for a quick assessment of the duration during which an investor's capital is at risk.
A_3	Internal Rate of Return (IRR)	IRR is a rate of return used in capital budgeting to measure and compare the profitability of investments. IRR provides a straightforward mean to compare different projects associated with benefits and risks.
A_4	Cost Effectiveness (or Avoidance Cost)	Cost effectiveness in its simplest form is a measure of whether an investment's benefits exceed its costs. In the proposed methodology, the Cost Effectiveness is calculated based on the project cost per kWh saved during the average lifetime of measures.

SDG Criteria Analysis

EE investments contribute to environmental and social factors while reducing energy consumption, leading to lower GHG emissions, improving comfort in living spaces, and industry productivity. Thus, SDG criteria are essential in the benchmarking procedure.

The SDG criterion is based on quantitative analysis, analysing factors that consist of Eurostat's statistical indicators. These indicators reflect the current situation of EE, energy poverty, and environmental pollution. The identified indicators are directly linked with the United Nations Sustainable Development Goals Agenda [28], mainly related to the energy sector and environmental protection. The criteria consist of statistical data per country or per country and sector, depending on the dataset's nature.

Table 15: Sustainable Development Goals Criteria

	Name	Description
C_1	*Arrears on utility bills*	It reflects the share of (sub)population (%) having arrears on utility bills, based on the question "In the last twelve months, has the household been in arrears, i.e., has been unable to pay on time due to financial difficulties for utility bills (heating, electricity, gas, water, etc.) for the main dwelling?"
C_2	*Total population living in a dwelling with a leaking roof, damp walls, floors or foundation, or rot in window frames or floor*	It indicates the share (%) of the population experiencing at least one of the following basic deficits in their housing condition: a leaking roof, damp walls, floors or foundation, or rot in window frames or floor.
C_3	*Population unable to keep home adequately warm by poverty status*	It indicates the share (%) of the population who are unable to keep home adequately warm. Data for this indicator are being collected as part of the EU Statistics on Income and Living Conditions (EU-SILC) to monitor poverty and social inclusion in the EU.
C_4	*Primary energy consumption*	It quantifies the Gross Inland Consumption in toe, excluding all non-energy use of energy carriers (e.g., natural gas used not for combustion but for producing chemicals).
C_5	*Energy import dependency*	The criterion shows the share (%) of the total energy needs of a country met by imports from other countries. It is calculated as net imports divided by the gross available energy
C_6	*Final energy consumption in the industry sector*	It includes all the energy supplied to the industry sector in toe; excluding deliveries to the energy transformation sector and the energy industries themselves).
C_7	*Final energy consumption in the transportation sector*	It measures the energy consumption of the transportation sector in toe, excluding deliveries to the energy transformation sector and the energy industries themselves.
C_8	*Final energy consumption in other sectors or commercial and public services*	It indicates the energy supplied to non-categorised sectors, commercial and public services in toe.
C_9	*Final energy consumption in households per capita*	The indicator measures how much electricity and heat every citizen consumes at home (kgoe/capita), excluding energy used for transportation. Since the indicator refers to final energy consumption, only energy used by end consumers is considered.
C_{10}	*GHG emissions from energy consumption*	The data are based on the European Environmental Energy Agency measures and represent the GHG emissions caused by the energy sector in ktn CO_{2-eq}.
C_{11}	*GHG emissions from the industrial sector*	Similar to C_{10}, the C_{11} criterion contains the GHG emissions (in ktn CO_{2-eq}) caused by the industrial sector, as reported by the European Environmental Energy Agency.

3.4   The Selected MCDA Method

In order to benchmark candidate EE project ideas effectively, while considering all the diverse and distinct factors that EE projects consist of, maintaining versatility, and providing a tool tailored to the investors' needs, the integration of an MCDA was foregone. The majority of the MCDA methods are oriented on ranking and choosing, whereas a benchmarking (sorting) problem is needed to implement the Triple-A Agree Tool. Namely, credible methods that perform benchmarking and are used frequently among the scientific community are certain variations of PROMETHEE UTADIS [29], descendants of the ELECTRE-Tri method, such as ELECTRE-Tri-B, ELECTRE-Tri-C [30], ELECTRE-Tri-nC [31] and ELECTRE-Tri-nB [32].

ELECTRE Tri is an MCDA method used for classification problems and, more specifically, in discrete classification problems, where the alternatives of the problem should be classified into predefined categories. The classification is made using pair-wise comparisons between the alternatives and the reference profiles based on concordance and discordance checks [33], [34].

The ELECTRE-Tri-B (referred to simply as ELECTRE-Tri from now on) was chosen to be used in the benchmarking procedure as it aggregates some key advantages. To begin with, it handles both qualitative and quantitative data, meaning that it can deal with the imperfect nature of knowledge [35]. In other words, imprecision, ill-determination, and uncertainty of the data provided are serious drawbacks that can be eliminated by using discrimination thresholds. In ELECTRE-Tri, each outranking relation is constructed after comparing each alternative to a predefined category limit. No direct comparisons between alternatives are performed. As a result, if a new alternative should be later added to the classification process, there is no need to reclassify the alternatives since the new alternative compares with the existing profile limits [36].

Besides, ELECTRE-Tri, in contrast to UTADIS methods, represents a non-compensatory model. A good performance on one criterion cannot offset a lousy performance on another one. Preference and indifference thresholds allow the compensation of minor differences, but the veto thresholds preserve the non-compensation character of the method. As a result, the sorting of a relatively poor alternative (one that performs good on one criterion but bad on another one) on a high category is avoided [37]. Besides, in ELECTRE-Tri, the incomparability relation is valid. Cases where the decision-maker cannot, do not want, or does not know how to compare two alternatives, can be modelled.

The steps of the ELECTRE Tri method, according to Yu, 1992 [38] and Mousseau et al., 1999 [39], are presented in Appendix G.

3.5   Application of the ELECTRE Tri Method

The application of the proposed methodology through the standardised Agree Tool follows the steps as depicted in 9 and described below.

Step1: Selection of the country

In the first step, the user selects the case study country from a dropdown list.

Step 2: Selection of the project type

In step 2, the user selects the project category according to the eligible sectors and measures listed in Table 2.

Step 3: Set the evaluation criteria

In step 3, the user is asked to select the criteria with which the project will be evaluated and insert the required input to calculate the criteria.

The ELECTRE Tri method is applied using four (4) criteria. The first two are financial criteria (K_1 & K_2), followed by one aggregated risk criterion (K_3) and one SDG criterion (K_4). In more detail:

K_1, K_2 (Financial criteria): In order to form a consistent family of criteria, a group of two Financial KPIs are applied to the ELECTRE Tri method. The user is able to select a group of preference. The criteria values are inserted directly as calculated in equivalent units, according to each KPI's nature.

K_3 (Aggregated risk criterion): The value of the Total Risk of the Investment is inserted into the MCDA, according to the methodology deployed in Section 2.4.

K_4 (Aggregated SDG criterion): The SDG Criterion consists of an aggregation of the SDG criteria applicable to each project category, as identified in Section 3.3. The benchmarking tool is oriented to evaluate EE investments based on the data, characteristics, and KPI's performance of each project. This approach adheres to the Financial Criteria, but with respect to the SDG methodology, a slightly different philosophy is applied. The multi benefits of EE measures cannot be easily quantified for every project because of their broad range of potential positive impacts, their synergist nature, and their non-technical parameters. In order to calculate the SDG contribution of a single EE investment, a robust analysis of the company, personnel, and production's/building's overall technical characteristics is needed. This is due to the fact that EE multi-benefits include, among others, a raise of the asset values, reduction of local air pollution, upgrade in health and well-being, and upgrade of industrial productivity [40]. At a country level, EE investments contribute to the alleviation of energy poverty, benefit macro-economic factors, increase energy security, and also reduce GHG emissions.

In the context of the preliminary evaluation of a project idea, it is not considered wise to ask the user to provide the comprehensive additional data needed for the SDG methodology. In such a manner, the methodology presented is based on the concept of intentionally biasing the results of the MCDA using the SDG criterion. By this token, EE investments will be boosted in countries or sectors that are more in need of such investments, according to European statistics. It should be highlighted that the SDG factor does not distort the financial performance of the candidate investment.

The calculation is being done in three processes:

Process 1: In order to proceed to the succeeding steps, each SDG factor has to be converted to comparable units among the case study countries. The C_4 and C_6-C_8 have been converted from toe to toe/capita, while the C_{10}, C_{11} have been converted from ktn $CO_{2\text{-eq}}$ to ktn $CO_{2\text{-eq}}$ /capita. The population data required for the conversion have been acquired from the related Eurostat Index [41].

Process 2: The indices are normalised to a [0-1] scale according to the following equation:

$$C'_{i,j} = \frac{C_{i,j} - \min(C_i)}{\max(C_i) - \min(C_i)} \qquad (4)$$

$i \in \{1, 2, \ldots, 11\}$, for each one of the SDG indices applicable to the candidate project, and

$j \in \{1, 2, \ldots, 8\}$, for each one of the case study countries

Process 3: The total SDG criterion is the average of the applicable to the candidate project scaled (SDG') values of the SDG indices.

$$K_4 = \frac{C'_1 + \ldots + C'_n}{n} \qquad (5)$$

where:

n the number of the applicable C'_i for the specific project.

Step 4: Set the criteria weights

The user is enabled to adjust the weights of the ELECTRE Tri criteria according to the importance of each factor and the user's preferences. Weights are percentages that reflect the effect of each criterion on the final benchmarking. Extreme weight values (0% or 100%) are rarely assigned to a criterion. At the same time, the sum of all criterion weights should be 100%. In the Agree Tool, weights are given as default values that the user can easily change from the Tool's interface.

Step 5: Set the benchmarking profiles and thresholds

The candidate EE project ideas are classified into one of the following standardised classes:

Triple-A	Projects that merit attention by the funding organizations are classified in this category. The Triple-A projects investments that have an extremely strong capacity to meet their energy saving targets, already from their conceptual phase (where they are still considered as project fiches from the funding institutes). This is in accordance with the definition of the respective Triple-A investment grade or rating, which refers to investments that have an extremely strong capacity to meet their financial commitments by achieving the expected performance targets.
Reserved	In this category the profitable, but not great projects are grouped. These projects have a good, but not outstanding performance in the MCDA criteria. They are projects that are capable to repay the initial capital invested and contribute significantly to the energy savings. They may have a higher overall risk than the Triple-A ones or poor performance in the SDG factor.
Rejected	The rejected projects are the ones that have an unsatisfactory total performance in the examined criteria. They may have risk higher than the maximum threshold, or they do not seem capable of recovering the total investment. Projects that did not manage to pass the Go/no-Go test are also characterized as Rejected.

The criteria thresholds of the benchmarking classes emerge from the Interoperability of the Triple-A Tools with the DEEP platform and input provided from experts via the stakeholder consultation process. The final thresholds are depicted in Appendix I.

The results of the Triple-A Agree Tool are presented to the user after finishing the procedure. An indicative screenshot of the Agree Tool's result page is displayed in the figure below.
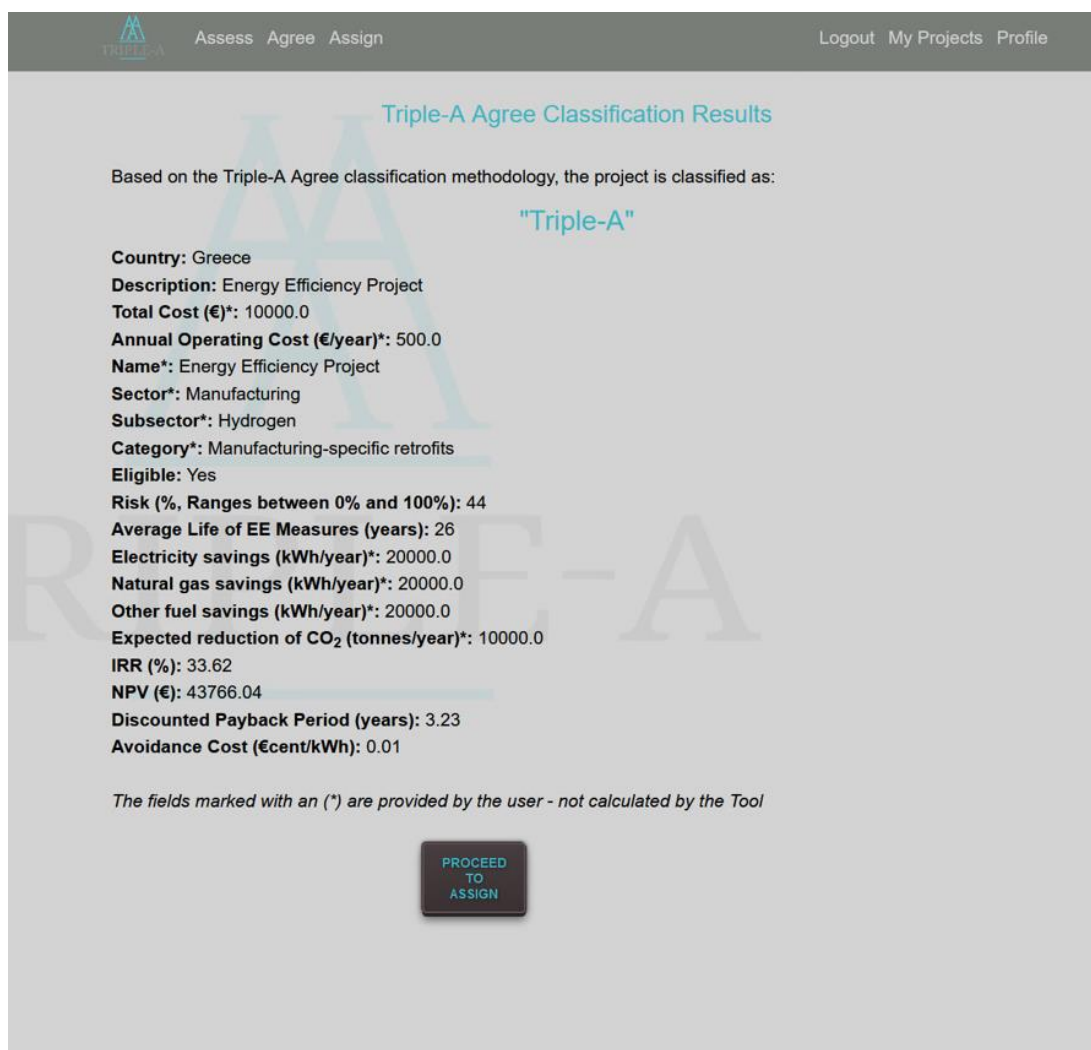
Figure 10 Triple-A Agree Tool – Result Page

3.6 Interoperability with the DEEP platform and the Triple-A Database on Energy Efficiency Financing

A parameterised statistical analysis of the DEEP Database has been concluded in order to identify initial KPIs thresholds that reflect the actual performance of EE projects and standardise the benchmarking procedure.

The interoperability with the DEEP platform has been established in two phases. First, the KPIs between the DEEP platform and Triple-A have been harmonised. The parameterisation consists of matching DEEP project categories to Triple-A project sectors and categories and calculating Triple-A KPIs that are not calculated by default in the DEEP database. The procedure was completed in close consultation, bilateral communication with DEEP platform developers, in which the parameters used by DEEP for the KPIs calculation have been identified and compared to the Triple-A ones. The matching between Triple-A project sectors and DEEP measures is shown in Appendix H.

After examining all the differences and similarities, Python code was composed by the Triple-A developers that perform calculations to the DEEP database, following the Triple-A standards. The code script has been sent to DEEP developers, so as to be incorporated in a specialised Triple-A section of the DEEP backend. Deploying the code provided by Triple-A, the DEEP developers have created a specialised API that provides the customised statistical data directly to the Triple-A Tool.

For the Triple-A project sectors that are not covered from the DEEP statistics, input from the consortium's financing institutions was given. The input consists of KPI thresholds and an evaluation of the API data. Partners input data are applied instead of the API data, where necessary, to harmonise Agree benchmarking to the up-to-date financing trends and needs. The KPIs thresholds can be found in Appendix H.

The personalised API, which emerged from the provided Triple-A code and incorporated by DEEP developers, is shown in the picture below. The API is linked to the "pmexis" DEEP platform user, which is a Triple-A collaborator. (For GDPR issues and confidentiality, the API address has been blurred.)
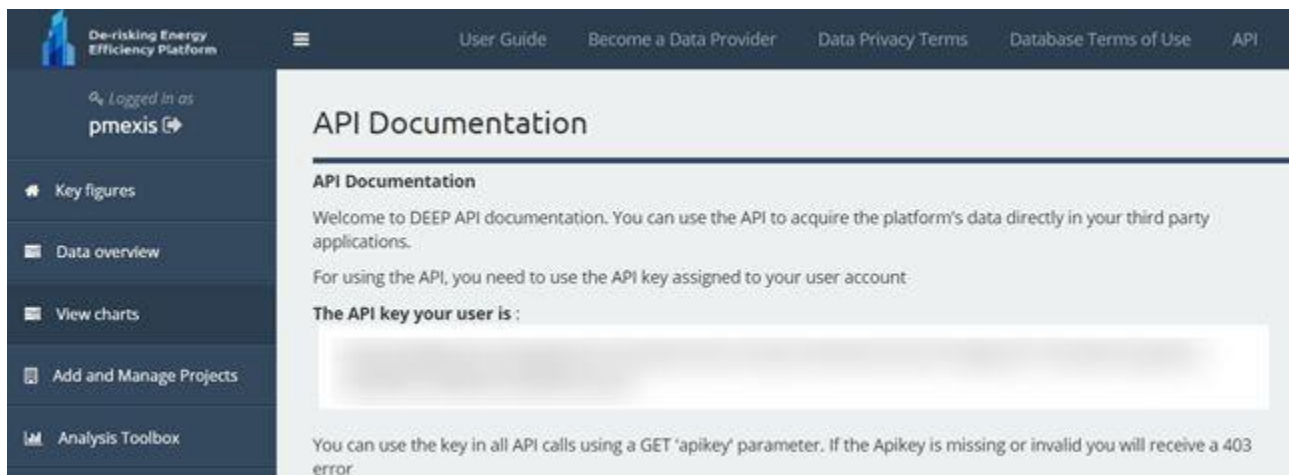
Figure 11: DEEP Database API

An indicative screenshot of the Triple-A script that is deployed in the DEEP database is shown in the figure below:
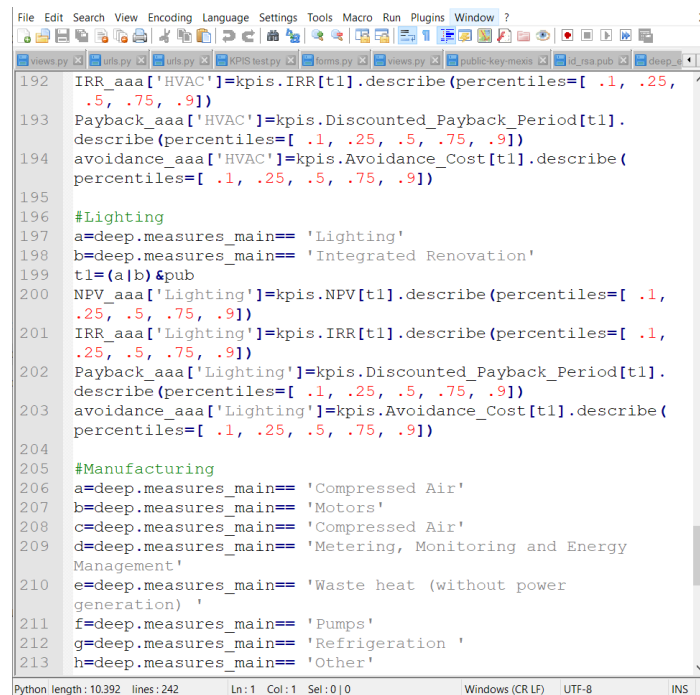
Figure 12: Triple-A Script for the DEEP Database

Additionally, the Triple-A Tools are interconnected with the Triple-A Database on Energy Efficiency Financing[9]. The Triple-A Database provides values to the Triple-A Tools regarding the country-specific risk factors, such as the *Energy Prices and Taxes Volatility* and the *Weak Economic Environment*. These country-specific Risk Factors are calculated on a regular basis, in accordance with the Triple-A Methodology, as described in Paragraph 2.4: Risk Assessment. The outcome of the calculations is saved in and reported by the Triple-A Database of Energy Efficiency Financing. The Triple-A Tools communicate with the Triple-A Database on Energy Efficiency Financing by deploying an automated dedicated API that interconnects these two interfaces and updates the values in the Triple-A Tools to perform the Risk Assessment for each specific project.

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[9] Triple-A Database on Energy Efficiency Financing: https://aaa-h2020.eu/database

4 Tool 3: Assign

4.1 Overview

The **Triple-A Assign Tool** is responsible for the match making of the Triple-A investment ideas, which successfully passed the Tool 1 and Tool 2, with the possible financing schemes; thus, formulates the pathway to be followed by involved parties to achieve project delivery (contracts, underwriting procedures, etc.).

The **Triple-A Assign Tool** is a multidimensional platform consisting of numerous interfaces according to the different types of beneficiaries and EE financing instruments. The targeted beneficiaries of the Triple-A Assign Platform are, on the one hand, financing bodies that are interested in investing in the EE sector. These bodies include commercial or green investment banks, investment funds (or managers), Unit Investment Trusts, developers and managers of financial products, and other relevant types of financers that search for a profitable portfolio of Triple-A projects to finance. On the other hand, the Assign Tool is oriented towards EE companies and project developers, including energy companies, ESCOs, credit professionals, management investment companies, and construction companies that need to find capital to implement their projects.

Financing bodies benefit from the Assign Tool as it provides access to a pool of profitable, pre-evaluated EE projects, e.g., projects that have successfully passed the Agree Tool as Triple-A projects. Stakeholders are able to filter and select projects according to criteria that better fit their investment strategy. Numerous project characteristics are presented in a user-friendly interface, such as the project benchmarking rating, country, sector, enabling the user to examine potential investments.

As concerns project developers, they could be notified of financing requests that investors have proposed for their projects, along with details regarding the proposed financing schemes and investor's contact data. In addition, the potential fundraising through the issuance of Green Bonds could be included in the Tool. EE companies interested in issue Green Bonds could search for profitable projects in the pool of Triple-A projects to aggregate them and issue bonds that attract investors.

The standardised benchmarking of the Triple-A Agree Tool and the selective filtering process facilitates financing bodies and EE funds to rapidly detect and aggregate projects that meet the necessary criteria to be financed. In this way, small-scale projects could be aggregated and financed by financing bodies, fostering EE, and mitigating risk related to investment size, rebound effect, and poor project planning.
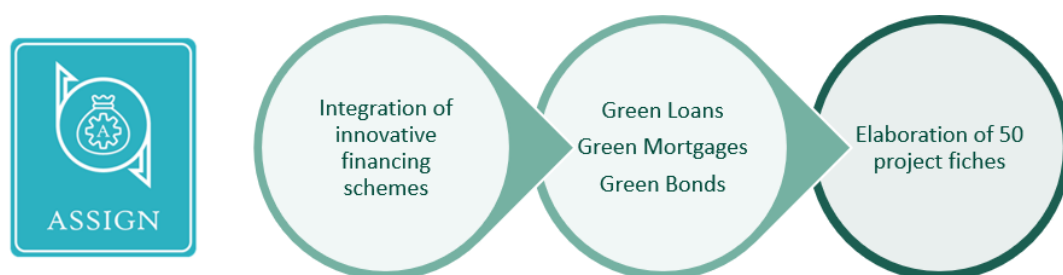
Figure 13: Triple-A Assign Tool - Overview

4.2   Methodology

The main functionality of the Assign Platform is to achieve matchmaking between EE projects and financing schemes. This is achieved by implementing numerous interfaces and functionalities for different types of EE stakeholders while creating effective communication links and incorporating the database of projects from the Asses and the Agree Tool.

The Tool addresses two main user types:

- *User Type I* – Financing Bodies: Green Investment Banks, Investment Funds (or managers), Unit Investment Trusts, Developers and Managers of Financial Products

- *User Type II* – Project Developers & Companies: Energy Companies, ESCOs, Credit Professionals, Management Investment Companies, and Construction Companies.

The Assign Tool could be assessed directly from the Triple-A Tools webpage, under the **"Assign"** tab. When entering the Assign Tool, each user type is redirected to a dedicated "Homepage", where they could find relevant links to the Tool's functionalities.

In detail, financers may:

- Explore the pool of projects from the Assess and the Agree Tool. The user is provided with a table including all the projects that have successfully passed the previous phases of the Triple-A Tools. The interface includes an analytic breakdown of projects with all necessary information regarding the projects.

- Select projects and send financing proposals to the company or the project developer that has submitted the project. The financing proposal includes preliminary information regarding the proposed financing scheme.

- View and manage all the proposals that have been sent from their account. The Tool provides information regarding the status of the proposals, e.g., if the proposal has been viewed by the project developer and contact information of the company of the project.

- Aggregate projects in order to prepare a portfolio for a Green Bond: The Assign Tool provides the functionality to companies interested in issuing a Green Bond to search profitable projects from the database and aggregate them. By doing so, a company can accumulate projects with similar ratings by the Agree Tool and similar financial or technical characteristics and accumulate them to proceed to the legal actions required to issue a Green Bond. It should be highlighted that the **bond is not issued within the platform**. The Assign Tool provides the required input needed for investors to get prepared and proceed to a Green Bond Issuance. Then, the Assign Tool supports the functionality to upload the green bonds issued to the Assign Platform Green Bonds database. The upload procedure is as simple as completing a form, while the database can be viewed by investors to buy these green bonds and finance the aggregated projects.

- Explore a database of Green Bonds that have been uploaded to the platform. Financers can view the companies and the projects included in the bond, check the Green Bond's characteristics, and proceed to further communication with the Green Bond's issuer.

At the same time, project developers may:

- View the projects they have submitted in the previous Tools (Assess and Agree), see benchmarking results, and update data.

- View the financing proposals for their projects and reply accordingly. Each project can have more than one proposal, so project developers are provided with a list of options to finance their projects. To facilitate the decision-making process, the user can view information regarding the proposed financing schemes and investor's contact details for each proposal.

Below, the overall flow chart of the Assign Tool is presented:
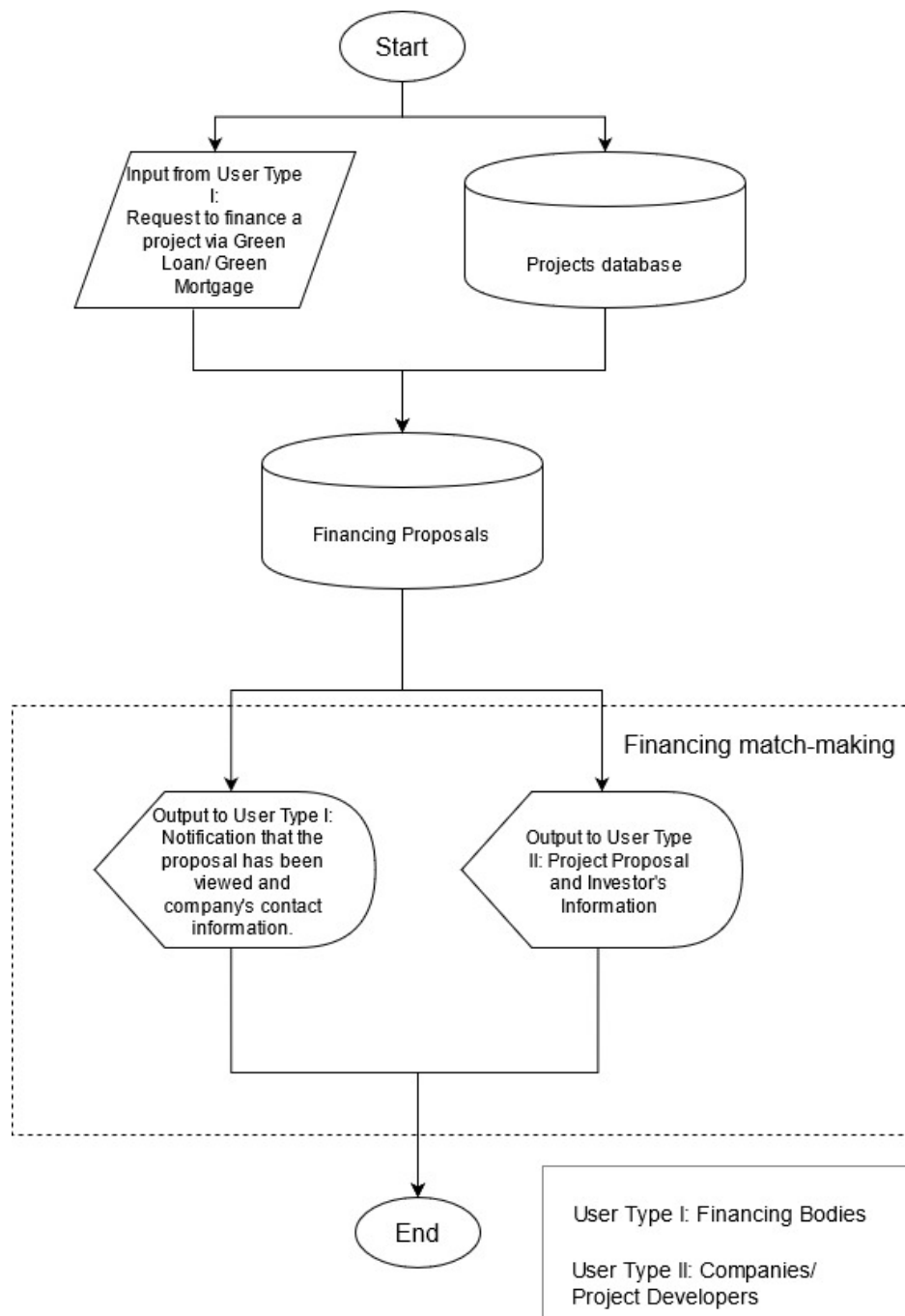
Figure 14: Triple-A Assign Tool - Flowchart

Detailed user profiles

The Assign Tool introduces a user community approach to the Triple-A Tools, enhancing the Triple-A ecosystem. At first, as mentioned at the beginning of this paragraph, users are grouped into two main types: Financing bodies and companies/ project developers. Users are prompt to choose their user type category in the sign-up procedure. Once the sign-up is completed, users may edit their profiles and add technical and financial data regarding their company/ organisation. This functionality could be found under a dedicated "Profile" section of the Triple-A Tools site, and it is performed by completing predefined surveys. The surveys are customised to each user type, and the procedure is optional.

The incorporation of survey questions for users' organisations' technical and financial profiles aims to build trust between financing bodies and companies/ project developers. The user profiles are visible to other Triple-A users. For example, an investor has access to the profile of a project developer, acquiring supporting information for the underwiring procedure. Vice versa, a project developer that receives a financing proposal from an investor could view the investor's profile. As a result, the Triple-A Tools supports decision-makers to build trust and proceed confidently to the decision-making process.

The user profile surveys are listed below:

Project Developers / Company

- Name
- Sector
- Years in activity
- Number of employees in total
- Number of employees with technical accreditations/certifications related to energy efficiency and climate change
- Any company certifications related to energy efficiency and climate change
- Total number of projects over the last year
- Number of projects related to energy efficiency and climate change over the last year
- Total revenue over the last year
- Company EBITDA over the last year
- Net profit over the last year
- Net debt over the last year
- Financial reports reviewed by a third party available

Financing Bodies

- Financing Body details and credentials
- Are you a public or private entity? If applicable, are you a physical person or a legal person?
- Sector
- Years in activity
- Total number of employees
- Total number of financed projects over the last year
- Number of financed projects related to energy efficiency and climate change over the last year

4.3 Green Loans and Mortgages

Loans are a classic form of financing that could be configured to match a wide variety of financing scenarios. Loan characteristics could vary drastically for each financing case. Many banks, including multilateral and national development banks, green (investment) banks, and general commercial banks, are developing broad environmental objectives and priorities. By this token, they provide green loans or credit lines for clients and projects, contributing to the banks' overall green goals [42].

As Green Loan products are part of the broader financial market, they come in a variety of configurations. Parameters such as the interest rate, payback period, payment method, required collaterals, and others are set by the financing body that designs and sells the product. Though, the Tool groups green loan products into two main categories:

(i) Green Loans

(ii) Green Mortgages

The above classification has emerged based on the popularity of these financial products, even though mortgages are a form of a loan. Since 2017, the Energy Efficient Mortgages Initiative has been working to ensure Europe's mortgage markets account for the energy efficiency of properties. Over 50 banks and financial institutions representing a quarter of Europe's GDP have joined the initiative [43].

When an investor makes a financing proposal for a project, the Tool gives them the flexibility to set the preferred loan parameters. The Tool accepts any type of financing proposal, e.g., the investor is not obliged to cover the project's total cost. They could partially finance the project and choose the preferred percentage of leverage. Project developers could assess the proposal and accept or reject it by using their personalised interface of the Tool.

Financing Proposal Form Data

The financing proposal submitted by Financing Bodies for a specific project includes the following data:

(i) Type of financial product (Green Loan/ Mortgage)

(ii) Interest rate (%)

(iii) Amount (€)

(iv) Term (years)

Procedure

The incorporation of Green Loans in the Tool is being performed in 3 sequential steps:

(i) The Tool provides the necessary introductory information (see Appendix J) regarding EE projects to possible investors.

(ii) Investors can select projects, view a detailed breakdown of data and KPIs regarding a project, and submit a financing proposal (proposal). See also Appendix J.

(iii) Project developers could assess the proposal for their project from the personalised interface. The interface provides data regarding the financing proposal and the investor, along with contact data. Project developers could either accept or reject the proposal or communicate with the investor.

Below, the Green Loans and Mortgages functionality of the Assign Tool is analysed in the following flowchart.
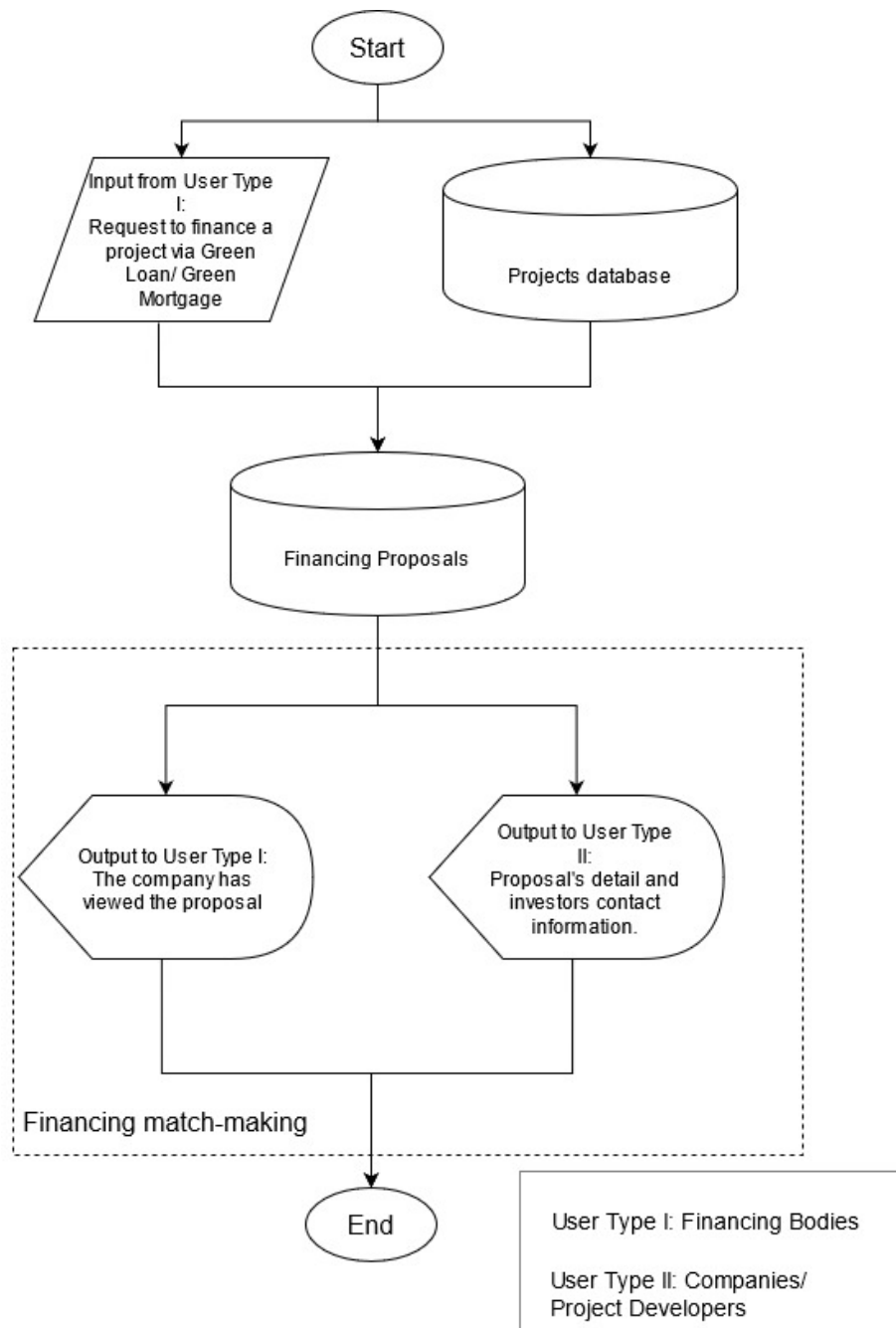
Figure 15: Triple-A Assign Tool - Green Loan and Mortgages flowchart

4.4   Green Bonds

A bond is a type of investment that represents a loan between a borrower and a lender. Bonds are considered debt investments. The main differences between bonds and a bank loan include the cost of capital, contract flexibility, collateral, and quick access to funding [44]. The issuers of stock or equity are typically companies; issuers of debt can be either companies or governments [45]. Green Bonds are

any type of bond instrument where the proceeds will be exclusively applied to finance or re-finance, in part or in full, new, and/or existing eligible Green Projects [46].

The Triple-A methodology introduces the approach in which an investor could come across companies and project developers to aggregate their projects. EE projects are often small and fragmented in nature compared with the large energy infrastructure projects such as power plants which must become a thing of the past [47]. Project aggregation expedites EE financing, as bundling small and medium-size projects into a larger build-up reduces the overall risk and is more appealing to investors. Small-scale EE projects are bundled to become attractive enough to be sold then to large investors or to be financed through bonds [48].

The Assign Tool is the ideal environment to create links between primary entities involved in the procedure of bond issuance. Focusing on the standardisation at an EU level, the Tool is harmonised and ready to support the forthcoming EU Green Bond Standard (EU-GBS). Based on the "Proposal for an EU Green Bond Standard" [49] published in June 2020 by the EU Technical Expert Group on Sustainable Finance, the Assign Tool supports Green Bond issuers to be compatible with the EU Green Bonds Standard by providing functionalities and necessary information.

In detail:

- Based on existing market practice, two types of reporting are required under the EU-GBS: Allocation Reporting and Impact Reporting. The Green Bond Issuance functionality of the Assign Tool, along with the pool of benchmarked projects and the project aggregation procedure, facilitates Green Bonds issuers to collect the necessary data for these reports effortlessly. This data includes the breakdown of the allocated amounts to Green Projects (selected from the Assign project database), a description of the Green Projects, the Environmental Objective pursued with the Green Projects, metrics about the projects' environmental impacts, information on the methodology and assumptions used to evaluate the Green Projects impacts.

- The Assign Tool promotes projects that are EU Taxonomy compliant, ensuring compatibility with the EU-GBS framework template.

- The Green Bond issuance form of the Assign Tool includes information regarding external reviews of the Bond (Rating, Rating Agency, etc.), a common practice among European issuers and is considered a key aspect in the EU-GBS report.

Methodology

The methodology that is followed in the Triple-A Assign Tool to encompass the Green Bonds functionality consists of several interactivity stages between users. Given that the main issue that the Tool aims to address is that not all companies/ project developers have a sufficient number of projects to issue a Green Bond, the first stage is project aggregation. Then follows the publication of the Green Bond bond by the company and the interest of the published bond by an investor. The Green Bond functionality of the Triple-A Assign Tool enables financers to invest their capital directly to credible and green projects without the involvement of banks and loans. When buying Green Bonds that have been emerged and issued with the Tool's assistance, their investment portfolio is being enriched with guaranteed green projects, promoting sustainable finance and growth.

The procedure in steps:

(i) The Assign Tool provides a dedicated interface to investors that opt to issue a Green Bond. In the interface, they could search for bankable, low-risk projects or projects with similar ratings and similar financial or technical characteristics that have successfully passed the Assess and the Agree Tool and are included in the Assign Tool. The user can click and view a breakdown of these projects along with contact details.

(ii) Within the next step, two actions need to be taken: the project developer selects these projects and then proceeds to the publication of the Green Bond's proposal. To complete the submission, the company/ project developer needs to provide the parameters of the Green Bonds that they want to issue. The Green Bond publication form is shown further below, in the corresponding paragraph of this section.

(iii) By the time a project developer/ EE company has included projects in a Green Bond proposal, the projects' owners (other projects developers/ companies) can view the proposal in the "My proposals" personalized interface. That interface provides an overview of the proposal and the issuer's contact data.

(iv) In the parameterised Green Bonds investors' interface, financers have access to the database of Green Bonds that are included in the Triple-A Assign Tool. They can explore all Green Bonds issued, get the detailed information regarding the bond, and contact the publisher.

Financing Proposal Form Data

(i) Face Value (€)

(ii) Type of interest (floating-rate, fixed)

(iii) Fixed → Percentage (%)

(iv) Floating rate → range (%)

(v) Interest period (month, quarter, 6 months, annual)

(vi) Maturity (year)

(vii) Issuer

(viii) Rating

(ix) Rating agency

Below, the Assign Tool's Green Bonds functionality is analysed in the form of a flowchart.
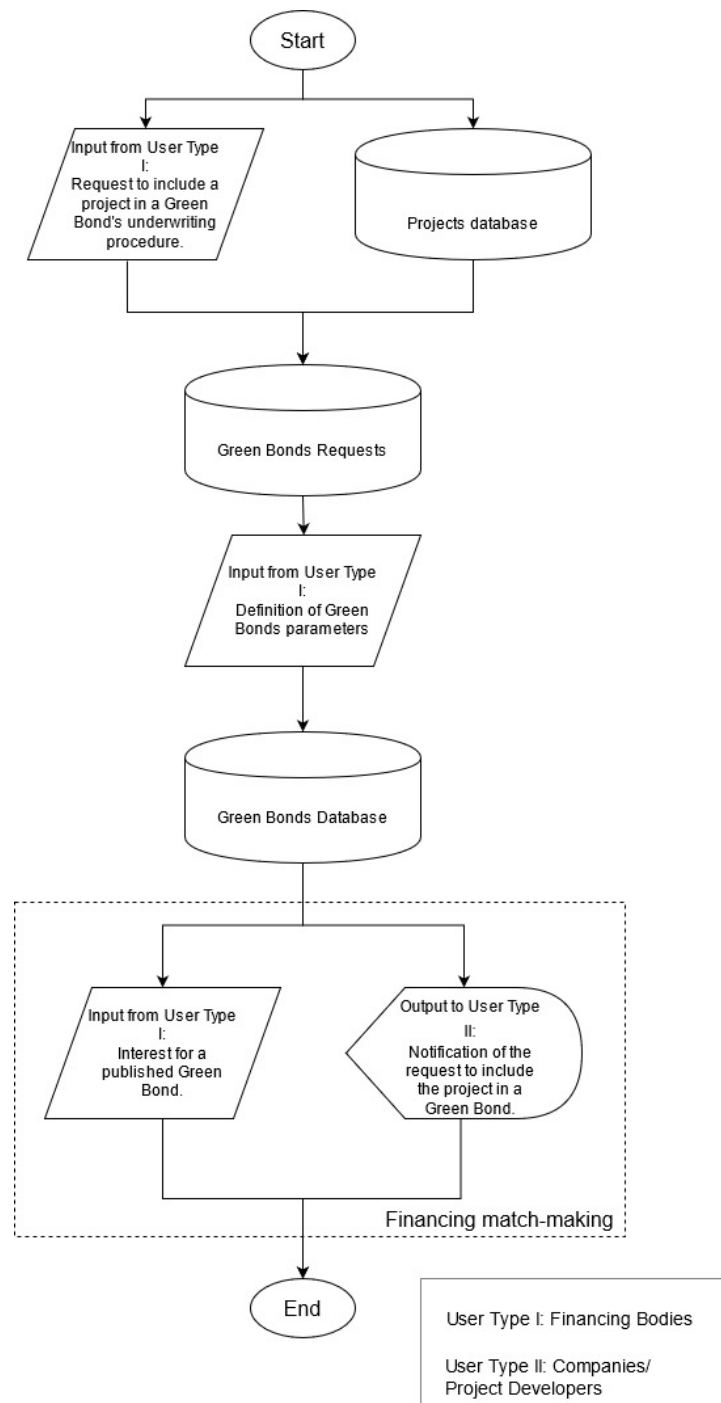
Figure 16: Triple-A Assign Tool - Green Bonds flowchart

4.5   Interfaces and interconnections

Under this section, the various interfaces provided by the Triple-A Assign Tool are listed, accompanied by a short description of their functionalities. More technical details can be found in Appendix J.
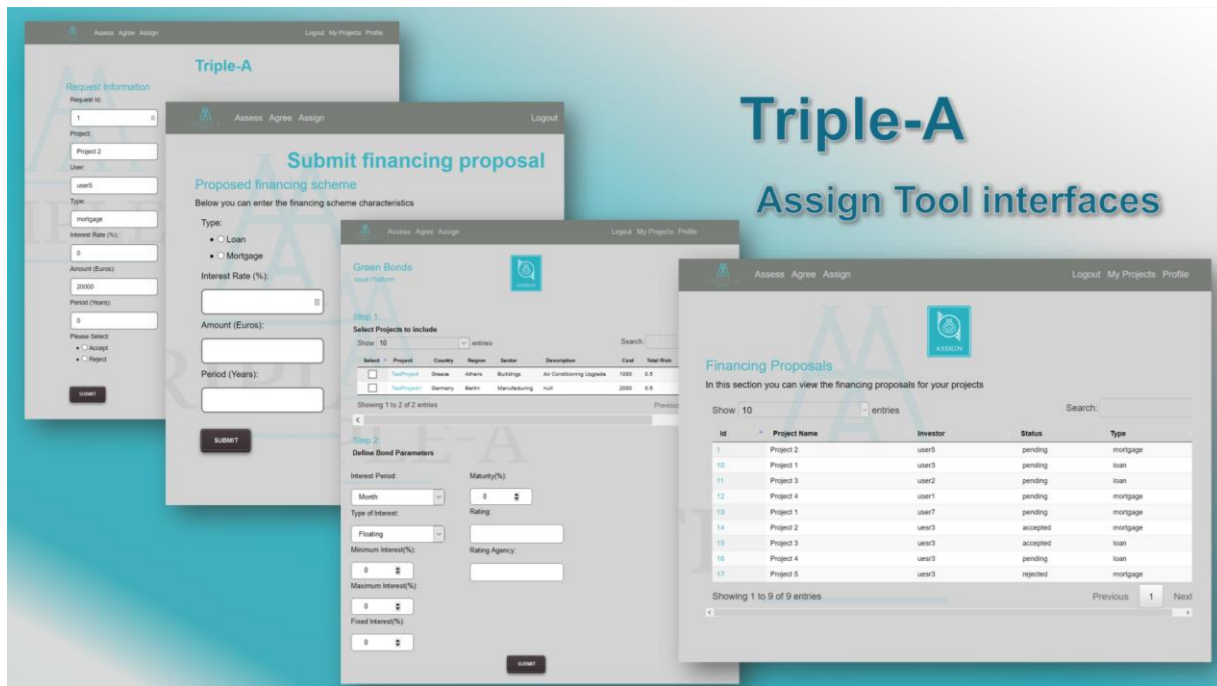
Figure 17: Triple-A Assign Tool - Interfaces

Financing Bodies

(i)   Find projects

In this interface, financing bodies can search the pool of projects available in the Assign Tool, view analytic data, and select them to send financing proposals for Green Loans and Mortgages.

(ii)   Find Green Bonds

In this section, financing bodies can view all the Green Bonds issued and available in the database. For each bond, they can access the list of aggregated projects included and view their analytic data (benchmarking, classification, etc). The scope of the interface is to attract investors to view the Green Bond and contact their publishers.

(iii) My proposals

In this section, financing bodies can access details regarding the financing proposals (Green Loans and Mortgages) they have sent, and check their status, e.g., whether these proposals have been viewed by the respective stakeholders.

(iv)   Aggregate Projects

This is a dedicated interface for investors that opt to aggregate project and create a portfolio for a Green Bond. The user could click and view a breakdown of these projects along with contact details.

The project developer selects these projects and then proceeds to the submission of the Green Bond proposal. To complete the submission, the company/ project developer needs to provide the parameters of the Green Bonds that would like to issue.

Companies & Project Developers

(i)   Financing proposals

In this section, Companies & Project Developers could access the list of their projects that have been selected by investors. The interface provides a table with the financing proposals along with information regarding each proposal. The proposals include:

(ii)   Loan proposal for a specific project.

(iii)   Mortgage proposal for a specific project.

(iv)   Proposal for a project to be aggregated in a Green Bond.

In the (c) case: proposal for a Green Bond, the project developer could view the bond's details and the other projects included in the Green Bond.

5   Triple-A Tools Testing

The Triple-A Tools' core development - container platform, benchmarking method, main functionalities - has been completed in December 2020, ensuring that the Tools are operational and accessible to all type of users and stakeholder groups (financiers, project developers, etc.).

As a first step, the Tools have been tested primarily by project partners, while demonstrations and testing by stakeholders have been conducted in bilateral meetings organised by project partners in local languages, in order to gather feedback in real time when each step of the Tools were live presented to them. More particularly, a number of almost **100 users** (project partners, Advisory Board Members, external stakeholders – e.g. INZEB, ABEC Group, Carbon Trust) have been signed up and tested the Tools, providing valuable feedback on the Tools functionalities, methodology and environment. Feedback received from testing and demonstration of the Tools has been send from partners to Triple-A Tools' lead partner (NTUA).

In particular, key input concerned the improvement of Tools functionalities, such as the incorporation of Green Bonds and Green Mortgages (main target, how to address these kind of financing instrument and provide interactivity with users, how to address the estimation of the creditworthiness of the borrower), the user-friendliness of the Tools (overall appearance, units in the results, links, more explanations on the result page, etc), the benchmarking methodology (thresholds and sensitivity), GDPR and privacy issues, perception of the EU Taxonomy questions to the stakeholders (regarding the Assess Tool). In addition, feedback on the Tools was also received from **130 stakeholders** through the stakeholders' consultation process since a dedicated section on the Tools functionalities and usefulness has been included in three Triple-A questionnaires. Finally, By the March 2021 Triple-A Tools were visited **by 346 unique users**.

As a reaction of the testing and feedback received, Triple-A has, among others:

- changed the terminology of the front-end of the Tools, and also added a disclaimer to clarify that the Tools are consultive with regards to the underwriting procedure and support the decision making, in order investors to identify the bankable projects effortlessly and get in contact with project developers.

- boosted the debugging procedure to detect any functionality issues, so as to ensure that all users are able to use the Tools.

- enriched the benchmarking results page with rigorous details on the KPIs and risk calculated for each project, included a dedicated page with the overall results of each project that the user can refer to at any time, and included the link to the user manual and deliverables that contain helpful information of the benchmarking procedure and methodology.

- included interactivity between users in the Assign Tool, aiming to promote personalised financing proposals to investors and encourage bilateral communication with project developers.

- requested input by project partners on the Zero Energy Buildings' national requirements and the implementation of the Energy Performance of Buildings Directive (EPBD) in the Triple-A case study countries, so as to be incorporated in the Database and exploited in the Tools.

- tested the Tools with mock-up projects and projects from the energy efficiency project pipeline gathered.

It has to be highlighted that since further stakeholder consultation is anticipated during project implementation, it is of the consortium intention to continue the testing and enhancement of the Triple-A Tools in both back-end and front-end, the forthcoming period. In that respect, the Triple-A benchmarks will emerge from the in-country demonstration of the Triple-A scheme and from the results and insights of the Capacity Building Webinars and the Regional Trainings Workshops, where live demonstration of Tools will take place and the participants will have the opportunity to test the Tools in real time and express their opinion though interactive activities (live surveys, polls, etc.).

6 Conclusions

The Standardised Triple-A Tools are available since June 2020 (draft version), facilitating EE professionals in assessing and benchmarking EE. Since then, a number of discussions among partners and stakeholder consultation activities have taken place in order to gather valuable feedback on Tools' environments, parameters, KPIs, methodology and functionalities, while several tests have been realised by both project partners and external stakeholders. Bilateral meetings, discussions, structured interviews, webinars, workshops, are some of the consultation means that were used by project partners in order to attract comments and input on the Tools, while live demonstrations and testing took in order to gather feedback in real-time in each step of the Tools.

After several modifications, an updated version of the Triple-A Tools was delivered in December 2020 including the final format and functionalities. The particular version has brought enhancements to the Assess and Agree Tool and has completed the series of Tools by launching the Triple-A Assign Tool that performs the matchmaking of EE projects with financing schemes while supporting the underwriting procedure.

Based on the stakeholder consultation, key input has been received concerning the improvement of Tools functionalities, such as the incorporation of Green Bonds and Green Mortgages, the Tools' environment, the benchmarking methodology, GDPR and privacy issues, perception of the EU Taxonomy questions to the stakeholders.

It is the intention of the Triple-A team to maintain and constantly update the Standardised Triple-A Tools in order to meet the challenges that may emerge, facilitate the user and assure that the Tools' functionalities address the users' requirements and ease. By that token, further stakeholder consultation is anticipated, resulting in additional testing and enhancement of the Triple-A Tools in both back-end and front-end.

Finally, in case any support is needed, or in case any question has been raised on the navigation and use of the Standardised Triple-A Tools, the user is more than welcome to contact Triple-A Team through the following contact email: contact@aaa-h2020.eu.

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Appendix A - Checklists with the Technical Screening Criteria

Checklist for "Buildings"

EU taxonomy defines:

- Individual building renovation measures:
  The individual building renovation measures are eligible if compliant with the energy performance standards set for individual components and systems in the applicable building regulations transposing the Energy Performance Building Directive (EPBD).
- Major Renovations:
  A renovation is compliant with energy performance standards set in the applicable building regulations for major renovations transposing the Energy Performance of Buildings Directive (EPBD), or the renovation achieves energy savings of at least 30% in comparison to the baseline performance of the building before the renovation.
- Construction of new buildings:
  A new building is eligible when it meets national requirements for the nearly zero-energy buildings (NZEB), and its level of energy performance equivalent to the EPC rating of B (or above).

Is your investment Taxonomy compliant?   Yes   No

Checklist for "Manufacturing of hydrogen"

EU taxonomy defines:
The following thresholds need to be met:

- Direct CO_2 emissions from manufacturing of hydrogen: 0.95 tCO_2e/t Hydrogen

- Electricity use for hydrogen produced by electrolysis is at or lower than 50 MWh/t Hydrogen

- Average carbon intensity of the electricity produced that is used for hydrogen manufacturing is at or below 100 gCO_2e/kWh

Metrics:

- GHG emissions per unit of production: tCO_2e/t Hydrogen

- Performance for electricity use: MWh/t Hydrogen
- Emissions factor, GHG emissions per unit of production for the electricity used: gCO_2e/kWh

Is your investment taxonomy compliant?   Yes   No

Checklist for "Manufacturing of iron and steel"

EU taxonomy defines:

- Manufacture of iron and steel is eligible if the GHG emissions associated to the production processes are lower than the values of the related EU-ETS benchmarks:
    1. Hot metal = 1.328 tCO_2e/t product

    2. Sintered ore = 0.171 tCO_2e/t product

    3. Iron casting = 0.325 tCO_2e/t product

    4. Electric Arc Furnace (EAF) high alloy steel = 0.352 tCO_2e/t product

    5. Electric Arc Furnace (EAF) carbon steel = 0.283 tCO_2e/t product

- All production of steel in Electric Arc Furnace (EAF) using at least 90% of scrap steel is considered eligible.

Metrics:

- *GHG emissions: (tCO$_2$e) / t product*
- *GHG emissions must be calculated according to the methodology used for EU-ETS benchmarks*

Is your investment taxonomy compliant?   Yes   No

Checklist for "Manufacturing of aluminium"

EU taxonomy defines:

- Manufacture of primary aluminium is eligible if:
    1. Direct emission for primary aluminium production is at or below 1.514 tCO$_2$e/t.
    2. Electricity consumption for electrolysis is at or below 15.29 MWh/t.
    3. Average carbon intensity of the electricity that is used for primary aluminium production (electrolysis) is at or below 100 g CO$_2$e/kWh.
- No thresholds apply on manufacture of secondary aluminium (i.e. production of aluminium from recycled aluminium).

Metrics:

- *GHG emissions per unit of production: tCO$_2$e/t aluminium (Direct emissions)*
- *Energy Efficiency for the electrolysis: MWh/t primary aluminium production*
- *Average GHG emissions associated to the electricity production per unit of electricity used: gCO$_2$e/kWh (Indirect emissions)*

Is your investment taxonomy compliant?   Yes   No

Checklist for "Manufacturing of cement"

EU taxonomy defines:

Thresholds for cement Clinker (A) are only applicable to cement clinker plants that are not producing finished cement (no cement mills). All other plants need to meet the thresholds for cement (B). For production of alternative binders only threshold (B) needs to be met.

- Cement clinker (A): Specific emissions associated to the clinker production processes are lower than 0.766 tCO$_2$e/t of clinker.
- Cement (B): Specific emissions associated to the clinker and cement production processes are lower than 0.498 tCO$_2$e/t of cement.
- GHG emissions must be calculated according to the methodology used for EU ETS benchmarks.

Metrics:

- *(A) Specific emissions (tCO$_2$e/t of clinker)*
- *(B) Specific emissions (tCO$_2$e/t of cement or alternative binder)*
- *GHG emissions must be calculated according to the methodology used for EU ETS benchmarks.*

Is your investment taxonomy compliant?   Yes   No

Checklist for "Manufacturing of low carbon technologies"

EU taxonomy defines:

Manufacture of vehicles, fleets and vessels must meet the following criteria:
- Passenger cars, light commercial and Category L vehicles: zero tailpipe emission vehicles (e.g., electric, hydrogen) or vehicles with tailpipe emission intensity of max 50 g CO_2/km (WLTP) (Until 2025).
- Heavy Duty Vehicles (N2 and N3 vehicles as defined by REGULATION (EU) 2018/858): Zero direct emission heavy-duty vehicles that emits less than 1g CO_2/kWh (or 1g CO_2/km for certain N2 vehicles)
- Low-emission heavy-duty vehicles with specific direct CO_2 emissions of less than 50% of the reference CO_2 emissions of all vehicles in the same sub-group.
- Rail Fleets: Zero direct emissions trains.
- Urban, suburban and interurban passenger land transport fleets: Zero direct emissions land transport fleets (e.g., light rail transit, metro, tram, trolleybus, bus and rail).
- Water transport: Zero direct emissions waterborne vessels.

Manufacture of energy efficient equipment for buildings and their key components must meet the following criteria:
- High efficiency windows (U-value better than 0.7 W/m^{2}K)
- High efficiency doors (U-value better than 1.2 W/m^{2}K)
- Insulation products with low thermal conductivity (lambda <= 0.045 W/mK, external cladding with U-value < 0.5 W/m2K and roofing systems with U-value < 0.3 W/m2K).
- Hot water fittings, household appliances, high efficiency lighting appliances, highly efficient space heating and domestic hot water systems, highly efficient cooling and ventilation systems rated in the top available class as defined by the respective European regulation.

Metrics:
- WLTP: Worldwide Harmonized Light Vehicle Test Procedure
- CO_2 emissions per vehicle kilometre: gCO_2/km
- CO_2 emissions per kilowatt-hour: gCO_2/kWh
- Watts conducted per meter, per degree of temperature difference (Kelvin) between one side and the other: W/mK
- Watts conducted per meter squared, per degree of temperature difference (Kelvin) between one side and the other: W/m^{2}K)

Is your investment taxonomy compliant?   Yes   No

Checklist for "Manufacturing of fertilizers and nitrogen compounds"

EU taxonomy defines:

- Manufacture of nitric acid is eligible if the GHG emissions associated to the production processes are lower than 0.302 tCO_2e/t.
- Manufacture of ammonia is eligible if the two following thresholds are met:
    1. Scope 1 emissions lower than 1 tCO_2/t Ammonia and
    2. Combined CO_2 emissions (scope 1 emissions and scope 2 emissions, from electricity consumed) lower than 1.3 tCO2/t Ammonia

Metrics:

- *Emission factor Nitric acid: tCO_2e/t Nitric acid*
- *Ammonia:*
    a. *Scope 1 emissions: tCO_2/t Ammonia*
    b. *Combined CO_2 emissions (scope 1 emissions and scope 2 emissions, from electricity consumed): tCO_2/t Ammonia.*
- *Scope 1 emissions: All Direct Emissions from the activities of an organisation or under their control.*
- *Scope 2 emissions: Indirect Emissions from electricity purchased and used by the organisation.*
- *GHG emissions must be calculated according to the methodology used for EU-ETS benchmarks.*

Is your investment taxonomy compliant?　　Yes　　　　　　　　No

Checklist for "Manufacturing of other inorganic basic chemicals"

EU taxonomy defines:

- Manufacture of carbon black and soda ash are eligible if the GHG emissions associated to the production processes are lower than the values of the related EU-ETS benchmarks:
    1. For carbon black: 1.954 tCO_2e/t
    2. For soda ash: 0.843 tCO_2e/t
- Manufacture of chlorine is eligible if the two following thresholds are met:
    1. Electricity use for chlorine manufacturing is at or lower than 2.75 MWh/t Chlorine.
    2. Average carbon intensity of the electricity that is used for chlorine manufacturing is at or below 100 gCO_2e/kWh.

Metrics:

- *Carbon black and soda ash:*
    - *GHG emissions $(tCO_2e)/t$ product*
    - *GHG emissions must be calculated according to the methodology used for EU-ETS benchmarks*
- *Chlorine:*
    - *Electricity use: MWh/t Chlorine*
    - *Carbon intensity of the electricity that is used for chlorine manufacturing: gCO_2e/kWh*

Is your investment taxonomy compliant?　　Yes　　　　　　　　No

Checklist for "Manufacturing of other organic basic chemicals"

EU taxonomy defines:

- ETS product benchmarks for the manufacturing of the chemicals covered in this activity (except for the organic metals) are:
    1. for HVC: 0.702 tCO_2e/t
    2. for aromatics: 0.0295 tCO_2e/t
    3. for vinyl chloride: 0.204 tCO_2e/t
    4. for styrene: 0.527 tCO_2e/t
    5. for ethylene oxide/ethylene glycols: 0.512 tCO_2e/t
    6. for adipic acid 2.79 (allowances/t).

- For organic metals the following criterion shall apply:
    a. the manufacturing of the organic chemicals shall be wholly or partially based on renewable feedstock and,
    b. the carbon footprint shall be substantially lower compared to the carbon footprint of the same chemical manufactured from fossil fuel feedstock, calculated in accordance with ISO 14067:2018 and validated by a third party.

Metrics:
- *Emission factor: GHG emissions (tCO_2e) / t product*
- *GHG emissions must be calculated according to the methodology used for EU-ETS benchmarks.*

Is your investment taxonomy compliant?   Yes   No

Checklist for "Public Transport"

EU taxonomy defines:

Public transport:
- Zero direct emissions land transport activities (e.g. light rail transit, metro, tram, trolleybus, bus and rail) are eligible.
- Other fleets are eligible if direct emissions are below 50 gCO_2e/pkm until 2025 (non-eligible thereafter).

Metrics:
- *CO_2 emissions per passenger - kilometre: gCO_2e/pkm*

Is your investment taxonomy compliant?   Yes   No

Checklist for "Passenger cars and light commercial vehicles"

EU taxonomy defines:

Passenger cars and light commercial vehicles:
- Zero tailpipe emission vehicles (incl. hydrogen, fuel cell, electric) are automatically eligible.
- Vehicles with tailpipe emission intensity of max 50 g CO_2/km (WLTP) are eligible until 2025.
- From 2026 onwards only vehicles with emission intensity of $0gCO_2$/km (WLTP) are eligible.

Category L vehicles (2- and 3-wheel vehicles and quadricycles):
- Only zero tailpipe emission vehicles (incl. hydrogen, fuel cell, electric) are eligible.

Metrics:
- *CO_2 emissions per vehicle kilometre: gCO_2/km*
- *WLTP: Worldwide Harmonized Light Vehicle Test Procedure*

Is your investment taxonomy compliant?   Yes   No

Checklist for "District heating/cooling distribution"

EU taxonomy defines:

Construction and operation of pipelines and associated infrastructure for distributing heating and cooling is eligible if the system meets the definition of efficient district heat/cool systems in the EU Energy Efficiency Directive.

The EU Energy Efficiency Directive defines "efficient district heating and cooling" as a district heating or cooling system using at least 50% renewable energy, 50% waste heat, 75% cogenerated heat or 50% of a combination of such energy and heat.

Is your investment taxonomy compliant?   Yes   No

Checklist for "Installation and operation of electric heat pumps"

EU taxonomy defines:

The following thresholds need to be met:

- Refrigerant: GWP <10
- SCOP > 3.33

Metrics:

- *GWP: Global Warming Potential*
- *SCOP: Seasonal Coefficient of Performance: the overall coefficient of performance of the unit, representative for the whole designated heating season, calculated as the reference annual heating demand divided by the annual electricity consumption for heating.*

Is your investment taxonomy compliant?   Yes   No

Checklist for "Cogeneration of Heating/Cooling and Power"

EU taxonomy defines:

Any combined heat and power generation technology is eligible if the facility is operating at less than the weighted cogeneration threshold and it can also be demonstrated, using an ISO 14044-compliant Life Cycle of Emissions (LCE) assessment.

- The Weighted Cogeneration Threshold is calculated from the relative production of heat and power, and based on the declining power generation threshold of 100 gCO_2e/kWh_e, and a notional heat threshold of 30 gCO_2e/kWh_{th}
- Weighted CHP threshold: $(30 * P_{th} + 100 * P_e) / (Pth + P_e)$ gCO_2e/kWh_{th+e}

*Concentrated solar power is always eligible.

Metrics:

a. *Thermal energy (P_{th}): thermal Kilo-watthours (kWh_{th})*
b. *Electricity (P_e): electric Kilo-watthours (kWh_e)*
c. *CO_2 emissions per 1 kWh of thermal energy: g CO_2e/kWh_{th}*
d. *CO_2 emissions per 1 kWh of electricity: g CO_2e/kWh_e*
e. *CO_2 emissions per 1 kWh of thermal energy and electricity: g CO_2e/kWh_{th+e}*

Is your investment taxonomy compliant?   Yes   No

Checklist for "Production of Heating/Cooling"

EU taxonomy defines:

Any heating or cooling generation technology is eligible* if life cycle impacts for producing 1 kWh of thermal energy are below 30g CO_2e/kWh, declining to 0 g CO_2e/kWh by 2050 and it can also be demonstrated, using an ISO 14044-compliant Life Cycle of Emissions (LCE) assessment.

Concentrated solar power is always eligible.

Recovery of waste heat is always eligible.

Metrics:

CO_2 emissions per 1 kWh of thermal energy: g CO_2e/kWh

Is your investment taxonomy compliant?   Yes   No

Checklist for "Outdoor Lighting"

The following thresholds need to be met:

- The Power Density Indicator (PDI) of the renovated system should be at least 40% lower than the one of the existing system.
- The Annual Energy Consumption Indicator (AECI) of the renovated system should be at least 500% lower than the one of the existing system.
- Luminaire energy efficiency:
  - ➢ If colour temperature ≥ 4000K: Luminaire energy efficiency ≥ 120 lm/W
  - ➢ If colour temperature ranges between 2700K – 3000K: Luminaire energy efficiency ≥ 105 lm/W
  - ➢ If colour temperature ≤ 2000K: Luminaire energy efficiency ≥ 80 lm/W
- LED module energy efficiency ≥ 160 lm/W
- Power factor:
  - ➢ For full load: cos phi ≥ 0.9
  - ➢ For 50% of load: cos phi ≥ 0.8
- Colour temperature:
  - ➢ For domestic areas and mainly pedestrian areas: Colour temperature ≤ 3000 K
  - ➢ For main roads, motorways and areas with mixed traffic: Colour temperature ≤ 4000 K
- Colour rendering (R_a):
  - ➢ For roads with mixed traffic including cyclists and pedestrians: R_a ≥ 80
  - ➢ For main roads and motorways: R_a ≥ 70
- Colour consistency: within 5 MacAdams-Ellipses at the time of putting into operation.
- Luminance and illuminance, light distribution: according to EN13201
- Average rated life, rated life and time to abrupt failure: better than L80 ≥ 60,000h, L80B10 ≥ 60,000h
- LED Luminaire lifetime: ≥ 60.000 hrs (min L80B10 & F10)

Metrics:

- Luminaire/LED energy efficiency: Lumens per Watt (lm/W)
- Colour temperature: Kelvin (K)

Sources:

1. Road lighting - Part 5: Energy performance indicators, CSN EN 13201-5, 2015
2. LED Street Lighting Procurement & Design Guidelines– Austrian Energy Agency, 09/2017 developed for "Premium Light Pro" Project, received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 695931

Is your investment compliant?   Yes   No

Appendix B - Front-end Questions of Assess Tool

1) Has the baseline for the calculation of energy savings been defined through standardised procedures (e.g., usage of standardised methodology, availability of past energy consumption data, weather data etc.)?
   - ➢ No
   - ➢ Yes

2) How has the energy savings assessment been conducted?
   - ➢ Through similar projects' estimations
   - ➢ Through empirical approaches and processes
   - ➢ Through tools & simulation models from certified experts

3) Has there been any request for project permits and of what scale?
   - ➢ There has been request for issuing large-scale project permits
   - ➢ There has been request for issuing small-scale project permits
   - ➢ There has been no request for issuing project permits

4) Does the team which plans and implements the project has sufficient competence and experience (e.g., proven through some sort of documentation?
   - ➢ No
   - ➢ Yes

5) Who conducts the technical implementation of the project (design, construction, installation, commissioning)?
   - ➢ Several stakeholders
   - ➢ The borrower
   - ➢ The technology supplier or another third party
   - ➢ An ESCO

6) Has there been proof about the quality of the equipment to be installed available (i.e. reference to a certain standard or specific quality label)?
   - ➢ No
   - ➢ Yes

7) Does the end user have experience in using and operating the proposed equipment?
   - ➢ No
   - ➢ Yes

8) Has a maintenance plan been considered (e.g., responsibilities regarding maintenance)?
   - ➢ No
   - ➢ Yes

9) Have M&V protocols and standards been considered (e.g., ISO 50015, IPMVP)?
   - ➢ No
   - ➢ Yes

10) Are there available product warranties?
   - ➢ No
   - ➢ Yes

Appendix C - Rebound Effect's Risk Evaluation per Project Category and Sub-sector

Project categories	Sub-sector	Risk
P_1	Residential	Insignificant
	Non-residential	Insignificant
P_2	Residential	Low
	Non-residential	Low
P_3	Residential	Insignificant
	Non-residential	Insignificant
P_4	Residential	Insignificant
	Non-residential	Insignificant
P_5	Residential	Insignificant
	Non-residential	Insignificant
P_6	Residential	Low
	Non-residential	Low
P_7	Hydrogen	Insignificant
	Iron and Steel	Insignificant
	Aluminium	Insignificant
	Cement	Insignificant
	Low carbon technologies	Insignificant
	Fertilizers and Nitrogen	Insignificant
	Other organic basic chemicals	Insignificant
	Other inorganic basic chemicals	Insignificant
P_8	Passenger cars	Low
	Public transport	Medium
P_9	District Heating/ Cooling Distribution	Low
	Installation and operation of electric heat pumps	Low
	Cogeneration of Heat/Cool and Power	Low
	Production of Heat/Cool	Low
P_{10}	-	Very high

Source: Energy efficiency and consumption – the rebound effect – a survey [18], Factors influencing energy efficiency investments in existing Swedish residential buildings [19]

Appendix D - Technical Complexity's Risk Evaluation per Project Category and Sub-sector

Project categories	Subsector	Risk
P_1	Residential	Medium
	Non-residential	Medium
P_2	Residential	Insignificant
	Non-residential	Medium
P_3	Residential	Insignificant
	Non-residential	Insignificant
P_4	Residential	Insignificant
	Non-residential	Insignificant
P_5	Residential	Medium
	Non-residential	Medium
P_6	Residential	Very high
	Non-residential	Very high
P_7	Hydrogen	Very high
	Iron and Steel	Very high
	Aluminium	Very high
	Cement	Very high
	Low carbon technologies	Very high
	Fertilizers and Nitrogen	Very high
	Other organic basic chemicals	Very high
	Other inorganic basic chemicals	Very high
P_8	Passenger cars	Insignificant
	Public transport	Insignificant
P_9	District Heating/ Cooling Distribution	Very high
	Installation and operation of electric heat pumps	Very high
	Cogeneration of Heat/Cool and Power	Very high
	Production of Heat/Cool	Very high
P_{10}	-	Insignificant

Source: Proposed standardized process for energy efficiency projects' assessment" [15]

Appendix E- Input interface for the Agree Tool

The user starts the Triple-A Agree Tool phase by clicking on the "**Get Started**" button or by hitting the button "**Agree Phase**" on the Assess Tool's results page. Then, the user is navigated to a screen, where all the necessary project-specific data should be filled in. At first, the user should enter the Project Name. If the user has landed directly from the Assess Tool while assessing a specific project, the project name is automatically loaded so they could proceed with the same project to Agree Tool.

The necessary information could be divided into two main categories:
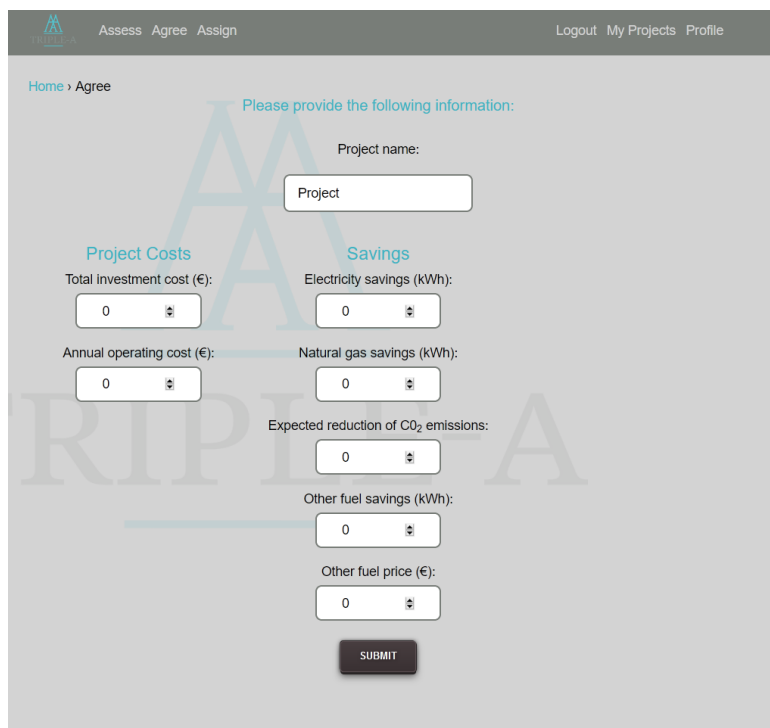
- ⌃ Project Costs
- ⌃ Savings

In terms of cost, the user should provide the **total investment cost** of the project, as well as the **annual operating cost**.

In the savings category, there are three fields:

- ⌃ electricity,
- ⌃ natural gas, and
- ⌃ other fuels.

Additionally, users can also enter the expected reduction of CO_2 emissions (tones/ year) triggered by the project.

If the investment results in savings in more than one category, the user should fill in all the corresponding fields. In case that the "**other fuels**" option is selected, the user should also fill in the fuel price.

Triple-A Agree Tool - Input page

Appendix F - KPIs equations and calculations

A₁-Net Present Value

NPV is one of the most important KPIs in investment evaluation. Numerous studies, articles, reports and technical guides make use of the NPV calculation to refer to the financial performance of EE measures. Briefly, it reflects:

- the risk and cashflows discount by quantizing it through the discount rate;

- the profitability of the investment, by involving in the calculations the yearly income, the operational costs and the initial investment.

NPV is calculated based on the following equation:

$$\text{Net Present Value} = -C + \sum_{y=1}^{Y} \frac{CF_y}{(1+i)^n} \qquad (6)$$

Where:

C = Initial Investment Cost

CF = Cash Flow for the year *y*

The cash flow for each year are being calculated based on the energy savings of the candidate project:

$$\sum_{y=1}^{Y} CF_y(\text{€}) = (S_{el} \cdot p_{el})_y + (S_{gas} \cdot p_{gas})_y + (S_{oil} \cdot p_{oil})_y + \Delta Cost_y \qquad (7)$$

Where,

S_{el} = energy savings: electricity (kWh)

S_{gas} = energy savings: gas (kWh)

S_{oil} = energy savings: other fuel (kWh)

$p_{el}, p_{gas}, p_{other}$ = fuel prices, and

$$\Delta Cost_y = \text{Annual Maintance Cost before EE measures-}$$
$$\text{Annual Maintance Cost after EE measures} \qquad (8)$$

A₂-Discounted Payback Period

The discounted payback period is the amount of years necessary to recover the investment's budget, while accounting for the time value of money. This criterion is recommended when risk is an issue (i.e., significant uncertainties are present), due to the fact that it allows for a quick assessment of the duration during which an investor's capital is at risk.

The calculation is shown below:

$$\text{Payback Period} = A + \frac{B}{C} \qquad (9)$$

Where,

A = the last period number with a negative cumulative discounted cash flow;

B = absolute value of cumulative discounted net cash flow at the end of the period A;

C= the total discounted cash inflow during the period following period A;

Discounted Cash Inflow of each period is being calculated according to:

$$\text{Discounted Cash Inflow} = \frac{\text{Actual Cash Inflow}}{(1+i)^n} \quad (10)$$

Where,

i is the discount rate, and

n is the period to which the cash inflow relates.

A₃-Internal Rate of Return (IRR)

The internal rate of return (IRR) is a rate of return used in capital budgeting to measure and compare the profitability of investments [50]. Theoretically all projects whose IRR is higher than an organization's cost of available capital should move forward. IRR provides a very easy mean to compare different projects associated benefits and risks.

$$0 = \text{NPV} = \sum_{t=1}^{T} \frac{C_t}{(1+\text{IRR})^t} - C_0 \quad (11)$$

Where:

C_t = Net cash infow during period t

C_0 = Total initial investment costs

IRR = the Internal Rate of Return

t = number of time periods

A₄-Profitability Index (PI)

The profitability index (PI) refers to the ratio of dis-counted benefits over the discounted costs. It is an evaluation of the profitability of an investment and can be compared with the profitability of other similar investments.

PI is calculated:

$$\text{PI} = \frac{\text{Present Value of Future Cash Flows}}{\text{Initial Investment}} \quad (12)$$

A₅-Cost Effectiveness

Cost effectiveness in its simplest form is a measure of whether an investment's benefits exceed its costs [51]. In the proposed methodology, Cost Effectiveness is calculated based on the project cost per kWh saved, according to the following equation:

$$\text{Cost Effectiveness} = \frac{\text{Life Cycle Cost (€)}}{\text{Savings (kWh)}} \quad (6)$$

Appendix G - ELECTRE Tri Methodology

The steps of ELECTRE Tri method, according to Yu, 1992 and Mousseau et al., 1999, are:

Step 1: Determine the alternatives (*m*) of the problem, the evaluation criteria (*n*), the offsets of the criteria (*w*) and the evaluation matrix (*m×n*), which contains the value of each alternative I for each criterion j.

Step 2: Determine the profiles on the basis of which the classification is made, as well as the preference (*p*), indifference (*q*) and veto (*v*) thresholds for each criterion.

Step 3: Define the partial concordance indexes $c_j(a,b)$ and $c_j(b,a)$, which are based on the pair-wise comparisons between the alternatives of the problem and the predefined profiles. The partial concordance indexes are calculated as follows:

If *j* is a maximization criterion:

$$c_j(a,b)=\begin{cases} 0 & \text{if } p \leq b-a \\ \frac{a-b+p}{p-q} & \text{if } q \leq b-a < p \\ 1 & \text{if } b-a < q \end{cases} \qquad (13)$$

$$c_j(b,a)=\begin{cases} 0 & \text{if } p \leq a-b \\ \frac{b-a+p}{p-q} & \text{if } q \leq a-b < p \\ 1 & \text{if } a-b < q \end{cases} \qquad (14)$$

If *j* is a minimization criterion:

$$c_j(a,b)=\begin{cases} 0 & \text{if } p \leq a-b \\ \frac{b-a+p}{p-q} & \text{if } q \leq a-b < p \\ 1 & \text{if } a-b < q \end{cases} \qquad (15)$$

$$c_j(b,a)=\begin{cases} 0 & \text{if } p \leq b-a \\ \frac{a-b+p}{p-q} & \text{if } q \leq b-a < p \\ 1 & \text{if } b-a < q \end{cases} \qquad (16)$$

Step 4: Calculate the concordance indices *C(a,b)* and *C(b,a)*. The index *C(a,b)* describes the following claim: "Alternative *a* is at least as good as profile *b* in all criteria". The concordance indices can be calculated as follows:

$$C(a,b)=\frac{\sum_{j=1}^{n} w_j c_j(a,b)}{\sum_{j=1}^{n} w_j} \qquad (17)$$

$$C(b,a)=\frac{\sum_{j=1}^{n} w_j c_j(b,a)}{\sum_{j=1}^{n} w_j} \qquad (18)$$

Step 5: Compute the discordance indices $d_j(a,b)$ and $d_j(b,a)$ for each criterion *j*:

If j is a maximization criterion:

$$d_j(a,b)=\begin{cases} 0 & \text{if } b-a \leq p \\ \frac{b-a-p}{v-p} & \text{if } p \leq b-a < v \\ 1 & \text{if } v \leq b-a \end{cases} \qquad (19)$$

$$d_j(b,a)=\begin{cases} 0 & \text{if } a\text{-}b\leq p \\ \frac{a\text{-}b\text{-}p}{v\text{-}p} & \text{if } p\leq a\text{-}b<v \\ 1 & \text{if } v\leq a\text{-}b \end{cases} \qquad (20)$$

If j is a minimization criterion:

$$d_j(a,b)=\begin{cases} 0 & \text{if } a\text{-}b\leq p \\ \frac{a\text{-}b\text{-}p}{v\text{-}p} & \text{if } p\leq a\text{-}b<v \\ 1 & \text{if } v\leq a\text{-}b \end{cases} \qquad (21)$$

$$d_j(b,a)=\begin{cases} 0 & \text{if } b\text{-}a\leq p \\ \frac{b\text{-}a\text{-}p}{v\text{-}p} & \text{if } p\leq b\text{-}a<v \\ 1 & \text{if } v\leq b\text{-}a \end{cases} \qquad (22)$$

Step 6: Calculate the credibility indices $\sigma(a,b)$ and $\sigma(b,a)$. The calculation of the credibility indices is based on the following assumptions: If for all criteria the relation $d_j(a,b)=0$ applies, then the credibility index is equal to the concordance index. Otherwise, if the relation $C(a,b)<d_j(a,b)<1$ applies, then the credibility index is proportionally decreased. Finally, if for at least one criterion the relation $d_j(a,b)=1$ applies, then the credibility index is set to zero, as a veto is imposed to this alternative by this criterion.

$$\sigma(a,b)=\begin{cases} C(a,b) & \text{if } \bar{F}(a,b)=\emptyset \\ C(a,b)\times \prod_{j\in\bar{F}}\frac{1-d_j(a,b)}{1-C(a,b)} & \text{if } \bar{F}(a,b)\neq\emptyset \end{cases} \qquad (23)$$

$$\sigma(a,b)=\begin{cases} C(b,a) & \text{if } \bar{F}(b,a)=\emptyset \\ C(b,a)\times \prod_{j\in\bar{F}}\frac{1-d_j(b,a)}{1-C(b,a)} & \text{if } \bar{F}(b,a)\neq\emptyset \end{cases} \qquad (24)$$

where,

$$\bar{F}(a,b)=\{j\in F | d_j(a,b)>C(a,b)\} \qquad (25)$$

and

$$\bar{F}(b,a)=\{j\in F | d_j(b,a)>C(b,a)\} \qquad (26)$$

where *F* is the set of evaluation criteria.

Step 7: Determine the cut-off threshold λ and compute the outranking relations between the alternatives and the profiles, based on which the final classification of the alternatives is made. There are three types of relations: *aIb* shows *preference, aPb* show *indifference* and *aRb* show *inability of comparison* between the alternatives. The relations are computed as follows:

$$aIb \Leftrightarrow aSb \wedge bSa \qquad (27)$$
$$aPb \Leftrightarrow aSb \wedge \neg bSa \qquad (28)$$
$$bPa \Leftrightarrow \neg aSb \wedge bSa \qquad (29)$$
$$aRb \Leftrightarrow \neg aSb \wedge \neg bSa \qquad (30)$$

Step 8: Conclude the classification procedure based on either the *optimistic* or the *pessimistic* approach [52]. Based on the optimistic approach every alternative is compared to the profiles in a decreasing order (beginning from the optimal profile) until there is a profile b_i, where aSb_i applies. Therefore, the alternative is classified in class C_{i+1}. Based on the pessimistic approach every alternative is compared to the profiles in an increasing order (beginning from the lowest profile) until there is a profile b_i, where $b_i Ra$ applies. Therefore, the alternative is classified in class C_i.

Appendix H - Triple-A Sectors and DEEP Measures Matching

Triple-A Sectors	DEEP Measures
Building Envelope	Building Fabric Measures
	Integrated Renovation
HVAC	HVAC Plant
	Integrated Renovation
Lighting	Lightning
	Integrated Renovation
Manufacturing	Compressed Air
	Motors
	Metering, Monitoring & Energy Management
	Waste heat without power generation
	Pumps
	Refrigeration
	Other
	Power Systems
	Cooling
	Heating
Outdoor Lightning	Street Lightning

Appendix I - KPI's Thresholds for the MCDA

Discounted Payback Period

Project Category	Triple-A	Reserved	Rejected
Building envelope retrofits	≤10,56	10,56 - 25	≥25
HVAC&R retrofits	≤2,13	2,13 - 15	≥15
Lighting appliances' retrofits	≤2,49	2,49 - 12	≥12
Automatic control retrofits	≤2	2 - 12	≥12
RES installations	≤6	6 - 20	≥20
Construction of new buildings	≤15	15 - 60	≥60
Manufacturing-specific retrofits	≤1,92	1,92 - 6	≥6
Purchase of new vehicles	≤4	4 - 6	≥6
District Energy Networks retrofits / expansion	≤12	12 - 20	≥20
Outdoor lightning	≤6	6 - 12	≥12

Cost Effectiveness

Project Category	Triple-A	Reserved	Rejected
Building envelope retrofits	≤4,67	4,67-8,06	≥8,06
HVAC&R retrofits	≤1,05	1,05-2,00	≥2,00
Lighting appliances' retrofits	≤1,66	1,66-2,83	≥2,83
Automatic control retrofits	≤0,3	0,3-0,6	≥0,6
RES installations	≤5	5-7	≥7
Construction of new buildings	≤3,5	3,5-9	≥9
Manufacturing-specific retrofits	≤0,46	0,46-1,31	≥1,31
Purchase of new vehicles	≤0,6	0,6-0,9	≥0,9
District Energy Networks retrofits/expansion	≤1,2	1,2 - 2	≥2
Outdoor lightning	≤0,6	0,6-1,0	≥1,0

Project Category	Triple-A	Reserved	Rejected
Building envelope retrofits	≥ 8%	4% -8%	≤4%
HVAC&R retrofits	≥ 41%	16% - 41%	≤16%
Lighting appliances' retrofits	≥ 38%	20% -38%	≤20%
Automatic control retrofits	≥12 %	8% -12%	≤8%
RES installations	≥12 %	8% -12%	≤8%
Construction of new buildings	≥8 %	4% -8%	≤4%
Manufacturing-specific retrofits	≥ 54%	54% -29%	≤29%
Purchase of new vehicles	≥ 12%	9% -12%	≤12%
District Energy Networks retrofits/expansion	≥ 10%	8% -10%	≤8
Outdoor lightning	≥ 12%	8% -12%	≤8

Appendix J - Assign Tool Inputs & Interfaces

Financing Bodies Interface

Find Projects

The page provides a table listing all available projects in the Assign Tool. The tables provide the following detailed information regarding the projects shown:

- Project Name
- Country
- Sector
- Region
- Sector
- Subsector
- Description
- Project Owner
- E-mail
- Phone Number
- Total Investment Cost

- Annual Operating Cost
- Electricity Savings
- Natural Gas Savings
- Other Fuel Savings
- Net Present Value
- Discounted Payback Period
- Internal Rate of Return
- Total Risk
- Expected Reduction of CO_2 emissions
- Avoidance Cost
- Project Rating

Green Bonds Database

Under this section, financing bodies could view a table that includes all the Green Bonds issued and available in the database. The table provides detailed information regarding the bond:

- Bond ID
- Face Value (€)
- Type of interest (floating rate, fixed)
- Fixed$\rightarrow$ Percentage (%)
- Floating rate$\rightarrow$ range (%)

- Interest period (month, quarter, 6 months, annual)
- Maturity (year)
- Issuer
- Rating
- Rating Agency

My Proposals

In this section, financing bodies could access details regarding the financing proposals (Green Loans and Mortgages) they have sent, while also check their status, e.g., whether these proposals have been accepted, rejected, or continue pending.

Companies & Project Developers Interface

Financing Proposals

In this section, companies & project developers could access the list of their projects that have been selected by investors and received a financing proposal. The interface provides a table with the financing proposals along with information regarding each proposal. The proposals include:

(v) Loan proposals

(vi) Mortgage Proposals

The table provides data to the user regarding the type and status (Accepted/ Rejected) of the financing proposal.

Issue Green Bond

This is a dedicated interface for project developers and companies that opt to issue a Green Bond. They could search for bankable, low-risk projects or projects with similar ratings and similar financial or technical characteristics that have successfully passed the Assess and the Agree Tool and are included in the Assign Tool.

Green Bonds Requests

This interface provides a table with requests to include projects in Green Bonds. The Company/ Project Developer could view all the Green Bonds issuance requests that pertain to their projects that have been submitted by other Companies/ Project Developers. The table provides the Green Bond's details, while the Green Bond's ID acts as a hyperlink that redirects to the complete table of projects that are included in the Green Bond, as depicted below. The table displays all the available data for the projects included.