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

Deliverable 4.1:
Draft Standardised Triple-A Tools

June 2020

The Triple-A project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement no. 846569.

TRIPLE-A

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

GA#: 846569

Topic: LC-SC3-EE-10-2018-2019-2020

Funding Scheme: CSA

Start Date: September 2019

Duration: 30 Months

Project Coordinator: NTUA

Deliverable Number (relative in WP)	**4.1**
Deliverable Title	**Draft Standardised Triple-A Tools**
Work Package Number	**4**
Task Number	**4.1**
Date of Delivery	**June 2020**
Dissemination Level	**Public**
Work Package Leader	**NTUA**
Task Leader	**NTUA**
Lead Beneficiary	**NTUA**
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Keywords	**Benchmarking Tool Standardization Process, Investment Evaluation, Multiple Criteria Decision Analysis**

Preface

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

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

ESG: Environmental, Social & Governance

EU: European Union

EU-SILC: EU Statistics on Income and Living Conditions

EVO: Efficiency Evaluation Organization

GHG: Green House Gases

HVAC & R: Heating, ventilation, air conditioning & Refrigeration

IPMVP: International Performance Measurement and Verification Protocol

IRR: Internal Rate of Return

ISO: International Organization for Standarization

KPI: Key Performance Indicators

MCDA: Multi Criteria Decision Analysis

NA: Not Applicable

NPV: Net Present Value

PI: Profitability Index

PSR: Project Specific

PSRS: Sector & Project category

RES: Renewable Energy Sources

SDG: Sustainable Development Goals

WHEEL: Warehouse for EE Loans

Executive Summary

The Triple-A Standardized Tools are the key element to pave the way for identifying and financing Triple-A investments, as they materialize the Triple-A approach. 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 and the Triple-A Assign Tool matches the investments with state-of-the-art green financing schemes. The Triple-A Tools will facilitate project developers to benchmark their own project in a standardized way (Assess & Agree Tool), while providing a link to financers, bankers and investor (Assign Tool) in order to finance the benchmarked projects. The Triple-A Tools are accessible though the Triple-A Standardized Toolbox platform[1] which can be reached directly, or through the Triple-A webpage[2].

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 utilization. All the operation and support procedures are reported, along with the next steps and further implementation procedures towards the finalization of the Triple-A Standardized Tools by December 2020.

[1] Standardized 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 national indicative 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 reducing energy consumption, while maintaining an equivalent level of economic activity [5], thus it is important to boost EE investments in an attempt to mainstreaming EE financing. To this end, private investments are considered important 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 concrete 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 on 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 maximize profits [8].

The "gap" that Triple-A scheme tries to cover can be identified in the concept development phase of energy efficiency investments. On the one hand, project developers don't have the expertise or resources to make a convincing case for investors. They spent a huge amount of hours auditing one plant's potential energy savings, but in most cases, never actually carrying out the project, because they cannot convince investors to give the capital needed to do the work.

On the other hand, private investors often lack the knowledge to understand how project developers do business, especially at an early state of project identification. At the same time, the majority of banks have not energy efficiency - based criteria for selecting the most attractive project to finance, since the sole criterion remains the creditworthiness of the borrower, despite the fact that energy efficiency measures come along with a multi-benefit advantage.

In order to address the above-mentioned challenges, 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, which is organized according to 3 major 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.
- **Categorisation** of the projects and **selection** Triple-A EE investments, which **merit attention** by the funding organizations.
- **Proposal** of funding state-of-the-art strategies (Warehouse lending, Green Bonds, EE Auctions) & **portfolio of EE projects** that better match with the needs of respective beneficiaries.

In particular, the **Triple-A Assess Tool** checks if the project idea is compliant to EU Taxonomy Guidelines [11] and if so, it evaluates the risk of an investment not only from the creditability point of view, but also by considering all the characteristics of the investment. 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.), as well as other specific characteristics of the possible EE investment (how the energy-savings have been calculated, quality of equipment, experience of the teams that is in charge for the implementation etc.). Considering all the above, the Triple-A Assess Tool calculates the total risk of an EE investment of failing to achieve its predicted money and energy savings.

The **Triple-A Agree Tool** benchmarks the predicted performance of the EE project ideas that successfully pass the Assess Tool. The benchmarking is based on predicted financial and energy savings data, such as the initial project cost, estimated annual energy savings and annual operating costs. The benchmarking method is based on a Multicriteria Decision Making Analysis (MCDA) method that classifies alternatives, taking into account major financial Key Performance Indicators (KPIs), among which the Net Present Value, Internal Rate of Return, Avoidance Cost and Discounted Payback Period, as well as Environmental, Social & Governance (ESG) criteria linked to SDG Goals. The KPIs are calculated automatically in a standardized method, while the projects are being classified into one of the following standardized categories: “Triple-A”, “Reserved”, or “Rejected”.

The **Triple-A Assign Tool** is a multidimensional platform that aims to match benchmarked projects with financing institutions (e.g. funds, investor, banks) that are looking to invest in green EE projects. The platform provides a pool of Triple-A projects and a parameterized investing portfolio to financing bodies. At the same time project developers and ESCOs could be notified in case their project has been selected for financing through a specific financing scheme. Triple-A Assign Tool supports all the modern trends of green financing, such as warehouse credit lending, energy auctions, green bonds and acts as a facilitator to project aggregation, in order to reduce risks and foster the financing of small-scale projects. The concept of the Assign Tool, including the unique interfaces for bankers, investors, fund and project developers, as well as the next steps are illustrated, since the Assign Tool is under development.

This document presents the draft version of the Triple-A Tools, which will be further developed, refined and calibrated in next versions. Feedback for fine tuning of the Triple-A Tools will be gained from collaboration with other relevant H2020 projects and the stakeholders consultation process to be conducted during Triple-A’s implementation. The consultation process will be carried out through bilateral meetings, webinars and training workshops in the Triple-A’s case study countries.

The Triple-A Tools are accessible through the Triple-A Standardized Toolbox platform[3] which can be reached directly through the direct link, or through the Triple-A webpage[4].

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 to the methodology and design of the Triple-A Assign Tool, while in Chapter 5 the development phases of the Triple-A Tools are presented. In Chapter 6, the next steps for the Triple-A Tools' implementation procedure are listed.

[3] Standardized Triple-A Toolbox: http://toolbox.aaa-h2020.eu/

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

2 Tool 1: Assess

2.1 Overview

The Triple-A Assess Tool is the first step of the standardized Triple-A scheme for assessing and benchmarking EE project ideas. The Assess Tool has a Go / No-Go character, which assesses mainly the risks and maturity of the proposed EE investment. 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 implementing. In this respect, key parameters on the EE financing have been identified (e.g. risk level, size of investment, type of EE projects, EEM(s) eligible, etc.). These can be considered as eligibility criteria, to increase security and trust, necessary to proceed to further investigations.

The first part of the Assess Tool is based on screening criteria as defined in the EU Taxonomy [11] and the PREMIUM LIGHT PRO project (only for the Outdoor Lighting sector) [12]. 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. At the end of the first part of the Assess Tool, the project would be characterized as Go (the project passes to the next step) or No-Go (the project does not pass to the next step).

For the Go projects a comprehensive risk assessment is followed in the second part of the Assess Tool. The user should provide additional project data by answering to a bunch of questions with which the specific characteristics of the investment are captured. Finally, the aggregated risk value of the project is calculated. Figure 1 displays the Assess tool's methodological steps along with the expected results.

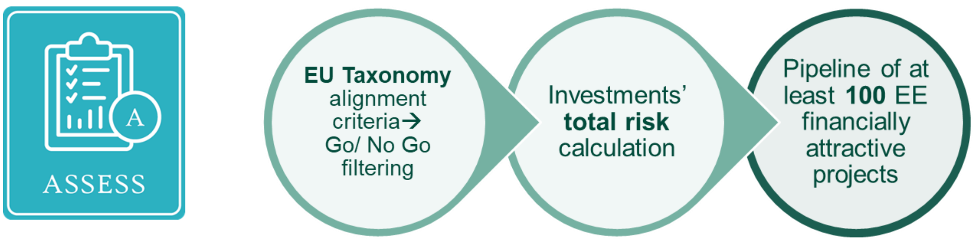


Figure 1: Triple-A Assess Tool Concept

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 that is 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 a 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 selected, while for retrofits that are connected to the manufacturing process (e.g. manufacturing machinery's retrofits), the user should select "Manufacturing" sector. For retrofits or expansion of district energy networks, the "District energy networks" sector is to be selected. Finally, the "Outdoor lighting" sector is selected for retrofits applied on outdoor lighting.

The next step is the selection of 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 easily answer the fields using "Yes" or "No". Finally, the user proceeds to the risk calculation (Go investment) or is informed that the investment is rejected (No-Go investment).

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
		Fertilizers 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 2.

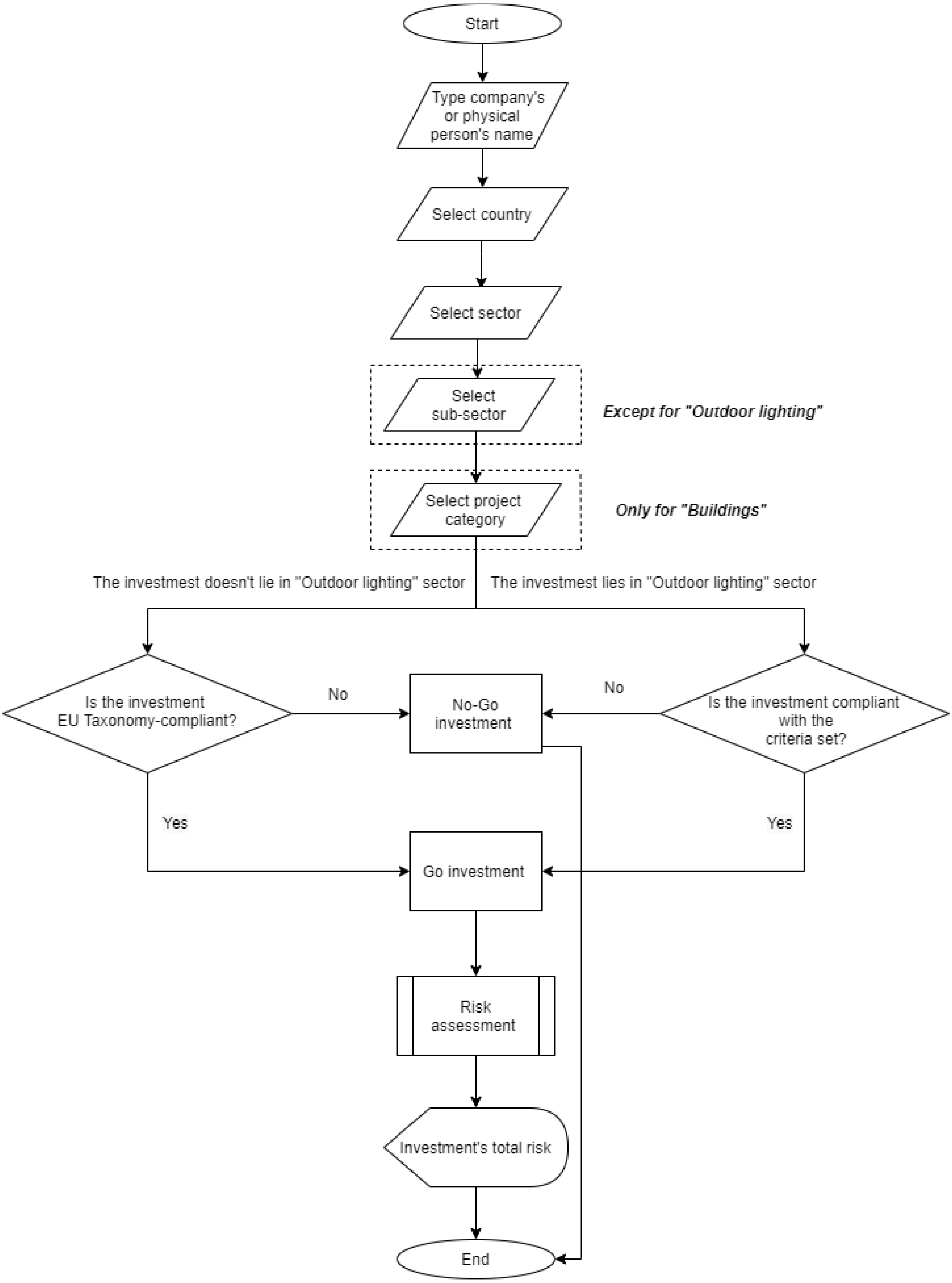


Figure 2: Triple-A Assess Tool Flowchart

2.3 Go / No-Go Approach

The **Go / No-Go** decision about the EE investments is made after meeting preselected technical screening criteria. 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 PREMIUM LIGHT PRO project [12] is used for setting the requirements for the investments that lie in this sector. If an examined project does not comply with the proposed characteristics, then it is considered as a **No-Go** project. Otherwise, the project is considered as a **Go** one and move to the risk assessment phase for calculating its total risk.

The **Go / No-Go** filtering process includes three steps (Figure 3). 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 are going to be implemented in the context of the under-examination project. According to the user choices (sector, sub-sector, and project category), a corresponding checklist with the taxonomy criteria or the criteria set (for the “Outdoor lighting” sector) that the investment should meet is appeared. The final step of the **Go / No-Go** filtering process is completed by fulfilling the project checklist. To do so, 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.

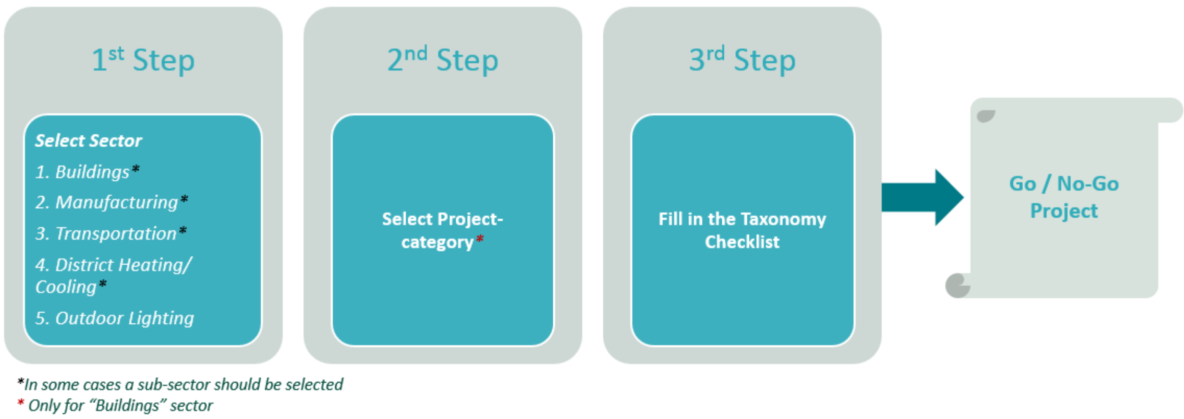


Figure 3: Go/ No-Go Process Flowchart

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

2.4 Risk Assessment

The risk assessment follows the **Go / No-Go** step and is applicable only for **Go** investments, i.e. investments that meet the criteria set in each case. This step aims to calculate the investment’s total risk and for this purpose, a **qualitative** approach along with a **quantitative** one is utilized.

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 ***(CSR)*** and (d) project-specific ***(PSR).***

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*** risk factors depend only on the country that the investment takes place. Finally, the ***PSR*** risk factors depend on the ad-hoc characteristics of each project irrespectively of all the aforementioned ones.

Table 4: Triple-A Tool risk categories and risk factors

	Risk Categories				
Risk Factors	**Financial**	**Behavioural**	**Energy Market & Regulatory**	**Economic**	**Technological, Planning and 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:*** *Sector and Project-category specific,* ***CSR:*** *Country-specific,* ***PSR:*** *project-specific*

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 **Go/No-Go** 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[5] (e.g. [13]), as well as,

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

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

Following, the user evaluates the credit worthiness of the applicant for the loan/ financing (***BRW***), when applicable, while a bypass option for this step is available. In accordance to this evaluation, the credit worthiness of the borrower is considered for calculating the investment's total risk. If the bypass option is selected, it will be totally skipped for the risk assessment. The ***PSRS*** risk factors are evaluated by relative studies and using qualitative methods for calculating the risks at each sector and project category. The ***CSR*** *risk* factors are evaluated 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 4 presents the Risk Assessment approach.

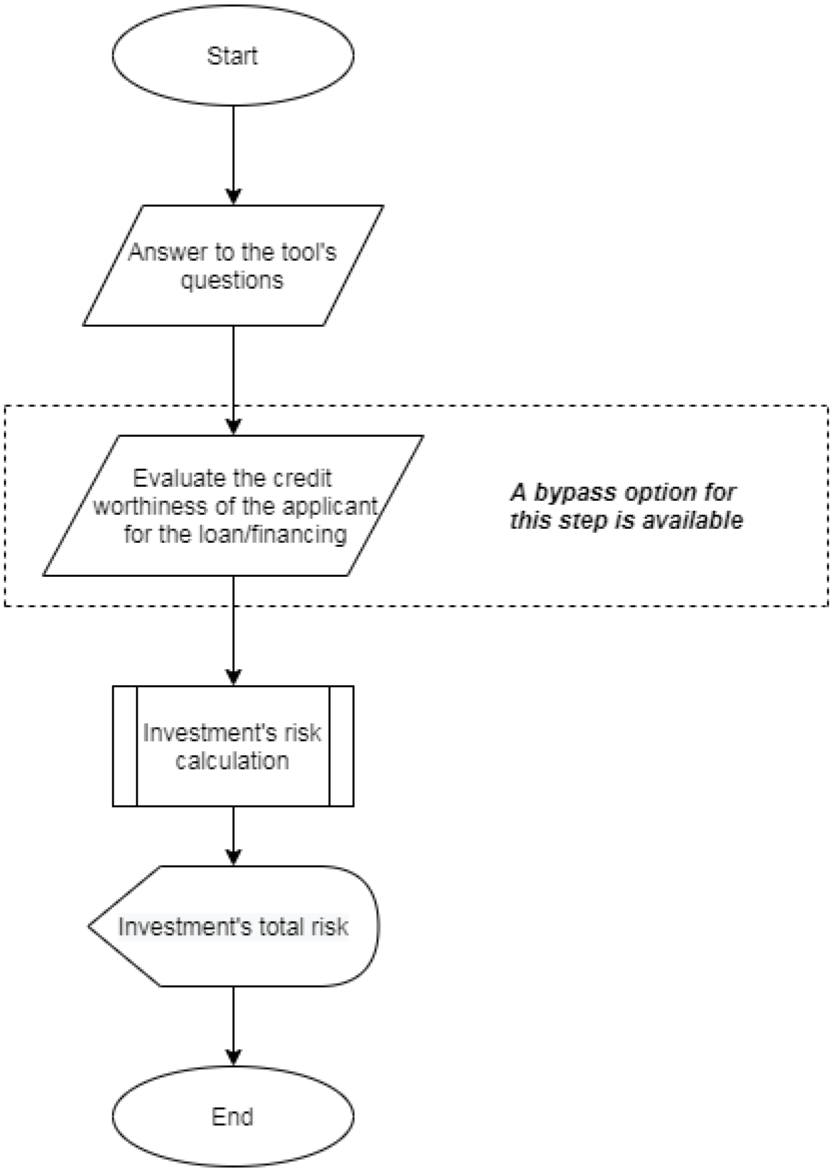


Figure 4: Risk Assessment Approach

Credit worthiness

The 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 [15], [16].

Bankers evaluate the credit worthiness of the physical person 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 many of this information is sensitive and, therefore, difficult to be obtain from project developers.

In this regard, credit worthiness is evaluated by assigning linguistic values [6], 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 a moderate risk, and 1 for the choice that indicates 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 aforementioned approach.

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)	-

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, as it may lead to uncertainty about monetary savings and returns [17]. 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** [18] 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 [19], [20] for the last fifteen years (01/2005-12/2019), as reported by OECD [18] 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:

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

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

where $CV\_CPI(\text{country\_max})$ and $CV\_CPI(\text{country\_min})$ 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 aren't equal to 0 and 1 respectively, which is more realistic from a risk analysis point of view.

Table 6: 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

Weak economic environment

The weak economic environment is related to poor economic conditions that may exist in the country that the EE investment takes place. It is connected to, among other indicators, interest rates, inflation, availability of finance etc. [21]. Weak economic environment can negatively influence the investment by many ways, such as affecting the investment's profitability through inflation or KPIs through interest rates.

This risk factor is evaluated through the countries' credit ratings as provided by Standard & Poor's (S&Ps). A country's credit rating is an evaluation of its credit risk or probability of default [22], [23]. This index was selected as 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 ratings 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 with the number of possible values (20), the risk value that corresponds to each credit rating is arisen. If an investor (Tool's user) wills to bypass the "Weak Economic Environment" factor, they can set a very low weight (e.g. 0%) in the parameters of the risk assessment of the Tool.

Table 7 presents the risk values for each of the case study countries produced by the aforementioned approach.

Table 7: 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

Request for issuing project permits

The request for issuing project permits signifies the legislative complexity for the completion of a project (e.g. construction permits/licences, protocols or other approvals under the provisions of a law), which could lead to administrative risk, in a specific country. Administrative risk could be a decisive factor for the selection of 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 [14]. 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 of this question are presented at 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

Rebound effect

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

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 [24], [25]. According to these projections, the rebound effect mostly ranges from 0% to 50% in EE projects ([24], [25]). However, in extreme cases the rebound effect can backfire, reaching more than 100% and 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 9.

Table 9: 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.

Technical complexity

The technical complexity is related to the complexity of the EEMs implemented form a technological point of view. It affects chances for a 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 [14]. 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

The risks assigned to each of the Triple-A's project-categories according to their technical complexity, is presented in Appendix D.

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 main source of the 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 major role in the total project budget, finding a reliable producer is crucial for minimizing technical risk.

Equipment is expected to be aligned with ecological design standards, technical prerequisites and EU labelling standards [14] and its quality is assessed based on proof about the installed equipment, for instance certain standards or specific quality labels [26]. 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 underperformance of high-quality equipment. Such failures could result from lack of competence and expertise of the party responsible for the implementation of the project or even from unclear assignment of tasks in case several parties are involved. Due diligence from independent parties is recommended, as this process minimizes design risk ensuring expected energy savings levels [13].

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 of these questions 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: 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 for 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 [14]. Different approaches, such as the development of monitoring indices, the definition of monitoring parameters etc. are used.

Equipment operation is expected to be based on operation standards and protocols followed from 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 operational risk for the project's success [13]. 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 [14]. Otherwise, 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 [13]. Specific ISO standards, such as ISO 5015 or the International Performance Measurement and Verification Protocol (IPMVP) EVO protocols could be key to transparency and quality of M&V, since they refer to standardized procedures and ensure efficient results [14]. 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 of 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: Inadequate Operation & Maintenance's 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

Low quality of initial savings assessment

The low quality of initial savings assessment is associated with the capacity to predict accurately the expected energy savings, as well as to define properly the baseline energy consumption. Different practices used for the estimation of energy savings are the usage of computational tools and simulation models from certified experts, empirical approaches and processes and results from other similar projects [14].

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 key 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 the calculation of energy savings [13]. Therefore, expected changes in usage should be incorporated in the baseline definition by adjusting them properly. 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 [14].

This risk factor is going to be evaluated by the answer of the tool's user to the first and second question of Appendix B. The risk values assigned based on each answer are presented at Table 13, where the total risk factor's value is calculated by averaging the respective risk values derived from the answers.

Table 13: 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 standardized procedures	Insignificant	0
Baseline definition through non-standardized procedures	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:

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

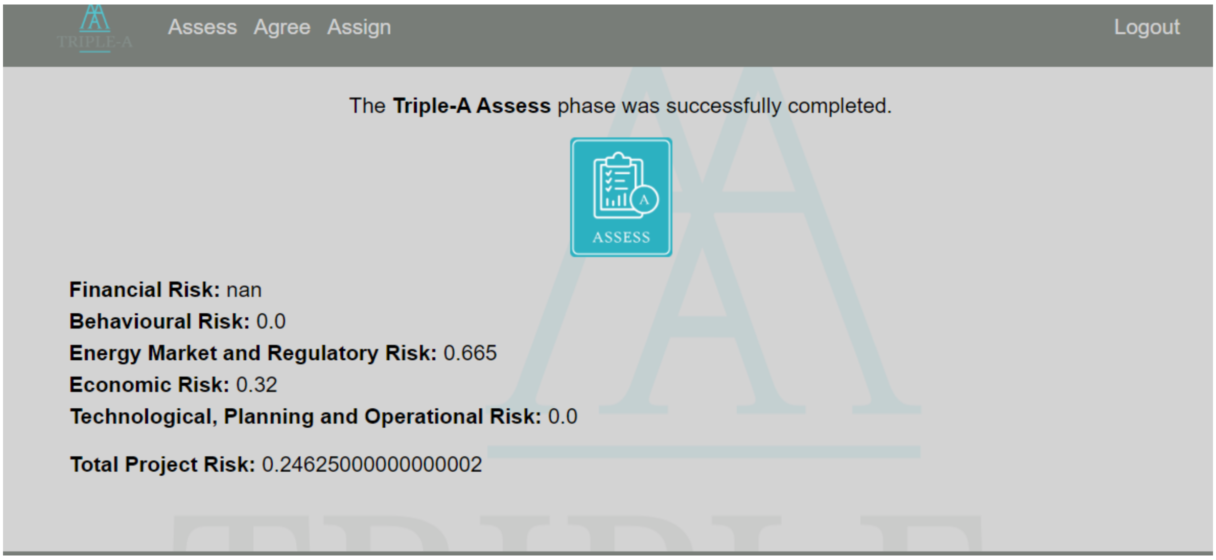
$w_i : i = 1, \ldots, 5$ are each risk category's weight

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

It should be noted that in case that 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 will be assigned to the risk categories according to their estimated impact on EE projects. These weights will be used as the default weights of the tool, while bankers and investors will be able to 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 wants to invest in a specific country or doesn't have an alternative option than to invest in a risky country as calculated by the country-specific risk analysis of the tool, he will be able to eliminate the country component from the total risk calculation. To do so, he will assign zero weights or very small numbers to the corresponding country-specific risk categories' weights, i.e. the "Energy Market & Regulatory" and "Economic" risk categories.

Revision of the risk factors



3 Tool 2: Agree

3.1 Overview

The **Triple-A Agree Tool** is the implementation of the second step of the standardized 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 successfully pass the Assess **Go/ No-Go** test. This tool supports the identification of Triple-A investments. Triple-A EE investments are defined as the 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). The Triple-A Agree Tool takes into account major **Financial**, **Risk** (as calculated in the Assess Tool) and **Environmental**, **Social** and **Governance** (ESG) criteria and uses a multicriteria classification method in order 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.

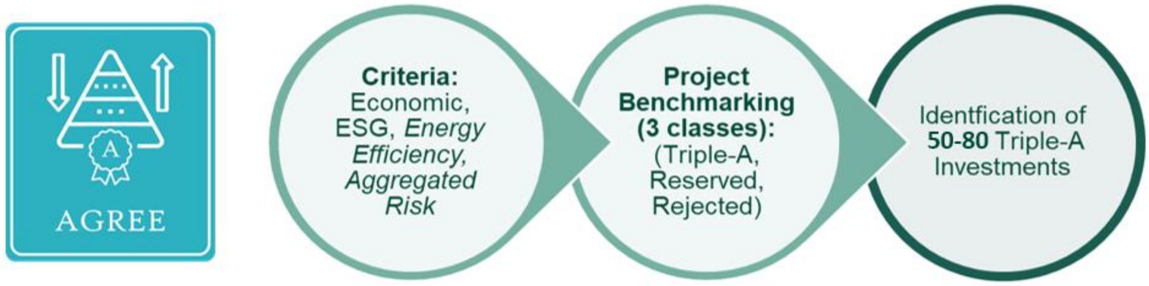


Figure 5: Triple-A Agree Tool Overview

3.2 Methodology

The methodology is based on a benchmarking procedure, which is realized through a MCDA method (Figure 6). The benchmarking criteria consist of several performance indicators (financial, ESG and risk related). The first step is to acquire the input needed to calculate the criteria. The input is categorized into three major types: user input, internal input from the Asses Tool and external input from Eurostat & European Commission’s reports. Then, the financial & ESG criteria are being calculated and, along with the aggregated risk from the previous step, are inserted as input into the MDCA, so as for the candidate project to be benchmarked. The project’s benchmarking is displayed to the user’s screen and saved to the Tool’s database.

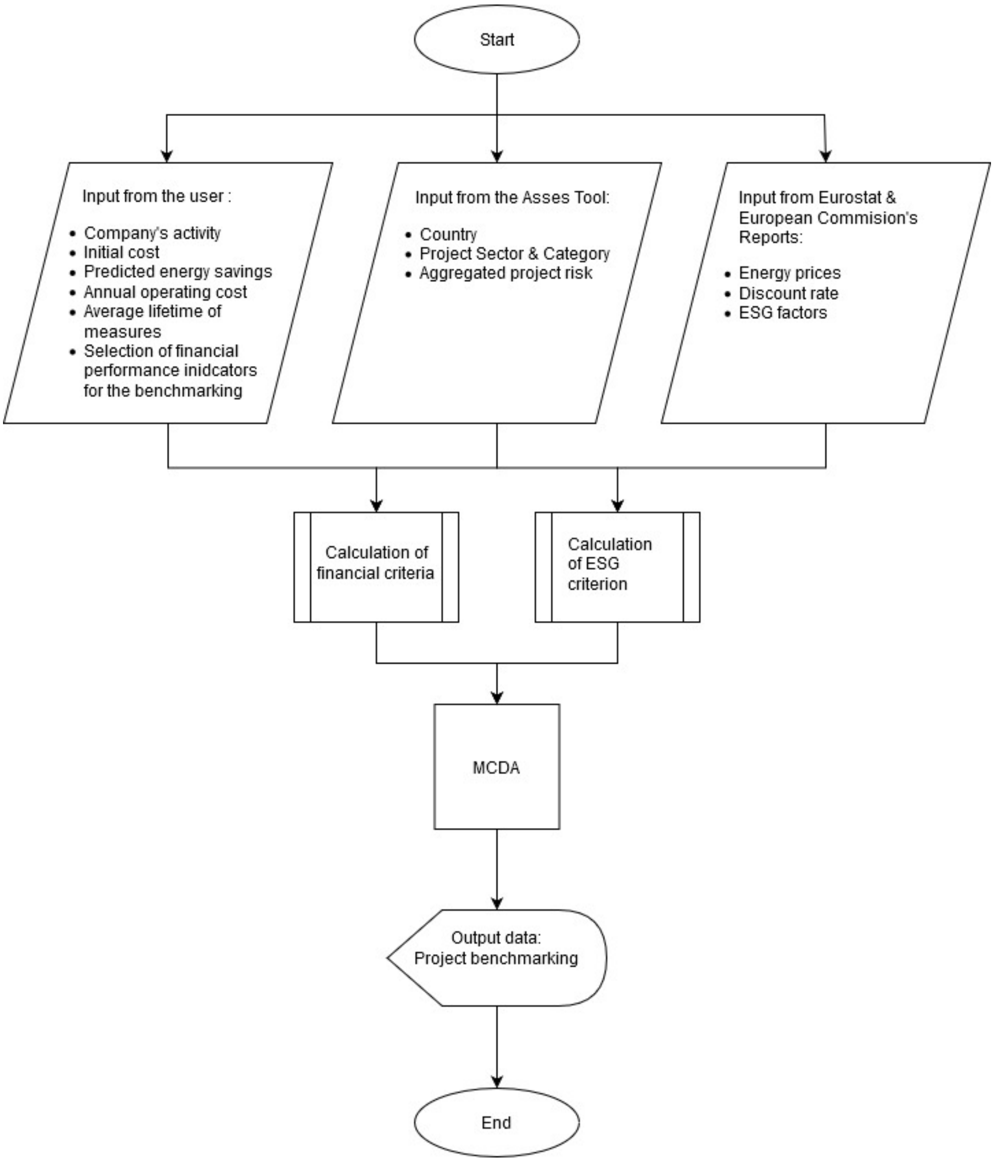


Figure 6: Triple-A Agree Tool Flowchart

3.3 The Evaluation Criteria

In order to identify Triple-A project ideas a standardized 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 form EU official statistics, in order to provide a standardized, 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 commonly used in the financing sector to evaluate EE projects are presented (See also Appendix E).

Table 14: Financial Criteria

	Name	Description
A_1	*Net Present Value (NPV)*	NPV 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. It also reflects the operational costs and the initial investment.
A_2	*Discounted Payback Period*	The discounted payback period is the amount 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 very easy means to compare different projects associated benefits and risks.
A_4	*Profitability Index (PI)*	PI refers to the ratio of discounted 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.
A_5	*Cost Effectiveness*	Cost effectiveness in its simplest form is a measure of whether an investment's benefits exceed its costs. In the proposed methodology, Cost Effectiveness is calculated based on the project cost per kWh saved.

ESG Criteria Analysis

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

The ESG criterion is based on a 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 [27], mostly to those related with the energy sector and the environmental protection. The criteria consist of statistical data per country or per country and sector, depending on the dataset's nature.

Table 15: Environmental, Social & Governance Criteria

	Name	Description
C_1	*Arrears on utility bills*	It reflects the share of (sub)population (%) having arrears on utility bills, based on 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 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 the development of 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 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-categorized 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 measures of the European Environmental Energy Agency and represent the GHG emissions caused by the energy sector in ktn $CO_{2\text{-eq}}$.
C_{11}	*GHG emissions from the industrial sector*	Similar to C_{10}, the C_{11} criterion contains the GHG emissions (in ktn $CO_{2\text{-eq}}$) 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 taking into consideration 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 a MCDA was foregone. The majority of the MCDA methods are oriented on ranking and choosing, whereas a benchmarking (sorting) problematic is needed for the implementation of the Triple-A Agree Tool. Namely, credible methods that perform benchmarking and used frequently among the scientific community are certain variations of PROMETHEE UTADIS [28], descendants of the ELECTRE-Tri method such as ELECTRE-Tri-B, ELECTRE-Tri-C [29], ELECTRE-Tri-nC [30] and ELECTRE-Tri-nB [31].

ELECTRE Tri is a 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 [32], [33].

The ELECTRE-Tri-B (referred simply as ELECTRE-Tri from now-on) was chosen to be used in the benchmarking procedure as 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 [34]. In other word, 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 [35].

Besides, ELECTRE-Tri, in contrast to UTADIS methods, represents a non-compensatory model. A good performance on one criterion cannot offset a bad performance on another one. Preference and indifference thresholds allow the compensation of small 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 to another one) on a high category is avoided [36]. In addition, in ELECTRE-Tri incomparability relation is valid. Cases where the decision maker cannot, does not want or does not know how to compare two alternatives, can be modelled.

The steps of ELECTRE Tri method, according to Yu, 1992 and Mousseau et al., 1999, are presented in Appendix F.

3.5 Application of the ELECTRE Tri Method

The application of the proposed methodology through the standardized Agree Tool follows the steps as depicted in Figure 6 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 for the calculation of the criteria.

The ELECTRE Tri method will be applied using 4 criteria. The first two are financial criteria (K_1 & K_2) followed by one aggregated risk criterion (K_3) and one ESG 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 the 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 will be inserted to the MCDA, according to the methodology deployed in Section 2.4.

K_4 (Aggregated ESG ccriterion): The ESG Criterion consist of an aggregation of the ESG 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 individual project. This approach is adhered to the Financial Criteria, but in respect to the ESG methodology a slightly different philosophy is applied. The multi benefits of EE measures cannot be easily quantified for each single project, because of their broad range of potential positive impacts, their synergist nature and their non-technical parameters. In order to calculate the ESG contribution of a single EE investment, a robust analysis of the company, personnel, and production's/building's overall technical characteristics are needed. This is due to the fact that EE multi benefits include, among others, raise of the asset values, reduction of local air pollution, upgrade in health and well-being, and upgrade of industrial productivity [39]. At 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 doesn't make sense to ask the user to provide the comprehensive additional data needed for the ESG methodology. In such manner, the approach of the methodology presented is based on the concept of intentionally biasing the results of the MCDA using the ESG criterion. By this token, EE investments will be boosted in countries or sectors that are more in need of such investments, in accordance with European statistics. It has to be highlighted that the ESG factor will 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 ESG 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 [40].

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

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

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

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

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

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

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 in case that the user does not wish to set some specific values. More specifically, equal weights have been assigned to all the criteria except the ESG criterion, which is given a lower weighting factor in order not to affect the financial performance to a large extent.

Step 5: Set the benchmarking profiles and thresholds

The candidate EE project ideas are classified into one of the following standardized 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
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
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 not seem capable of recovering the total investment. Projects that didn't manage to pass the Go/no-Go test are also characterized as Rejected.

The criteria thresholds of the benchmarking classes will emerge from the Interoperability of the Triple-A Tools with the DEEP platform.

3.6 Interoperability with the DEEP platform

A parameterized statistical analysis of the DEEP Database has been concluded in order to identify initial KPIs thresholds that will reflect the actual performance of EE projects and standardize the benchmarking procedure. The parameterization 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 matching between Triple-A Project Sectors and DEEP measures is shown in Appendix G. The procedure was completed in close consultation with DEEP platform developers and an Application Programming Interface (API) was created in order to automatically refresh the DEEP Statistics in the Triple-A Tools, when needed.

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

4 Tool 3: Assign

4.1 Overview

The Triple-A Assign Tool will be a multidimensional platform consisting of numerous interfaces according to the different types of beneficiaries. The targeted beneficiaries of the Triple-A Assign Tool are, on the one hand, project developers, ESCOs, etc. that seek proposed financing schemes/ instruments to support their project ideas, and, on the other hand, financing bodies, such as banks, investment funds, etc. that search for a profitable portfolio of Triple-A projects to finance.

As concerns project developers, they will be notified on the most appropriate financing schemes that fit their projects, in accordance to the Triple-A methodology. For the case of financing institutions, the Assign Tool will provide a pool of Triple-A projects. Banks could filter and select projects according to several characteristics such as benchmarking rating, country, sector or other criteria, in order to examine potential proposed investments or already financed projects. Also, consultants could create a list of sound investment opportunities for financing to be communicated to relative investment funds through warehouse credit lending. In addition, warehouse lending is a way for banks to provide loans without using their own capital. In this case, banks could serve as "entry point" (Intermediate Financial Institution) for project ideas and provide warehouse lines of credit to mortgage lenders, who, in our case, could be investment funds, such as the Warehouse for EE Loans (WHEEL), the European EE Fund (EEEF) etc.

The standardized benchmarking of the Triple-A Agree Tool and the selective filtering process could facilitate 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 can be aggregated and financed by larger financing bodies, fostering EE and mitigating risk related to investment size, rebound effect and poor project planning.

Regarding debt financing the potential fund raising through the issuance of Green Bonds will be included in the tool. Green Bonds are fixed income securities for raising capital for financing low carbon or, generally, environmentally friendly investments. The International Capital Market Association highlights that, apart from the renewable energy sector, EE constitutes a critical Green Bonds' category [41].

Furthermore, Triple-A will support EE investors that are willing to participate in EE auctions schemes. The tool will facilitate the bidding strategy of the investors taking into account financial, risk and auction specific characteristics, as well as supporting the access to finance of the investor regarding the "own financing contribution" part.

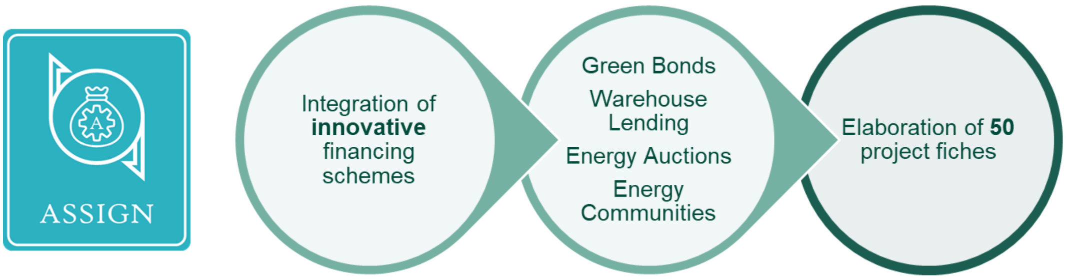


Figure 7: Triple-A Assign Tool Overview

4.2 Methodology

The basic elements of the Triple-A Assign Tool have already been designed, but there are several elements that still need to be resolved before the Tool's implementation. In this respect, the upcoming stakeholder consultation is considered crucial, while it will facilitate the Assign Tool finalization and the fine tune and testing of the Triple-A Tools using real project ideas.

The Tool will address different User Types:

- User Type I: financers, funds, banks and investors
- User Type II: project developers or ESCOs

The first step of the methodology is to update the Assign project database with the Triple-A & Reserved projects that emerge from the Agree Tool. At the same time, the User Type I input will be acquired, which consists of the filtering criteria for the personalized proposed investment portfolio. The filtering input will provide to User Type I the corresponding candidate projects along with the state-of-the financing methods. In the final step the project matching occurs. The User Type I selects and aggregates the proposed projects in order to finance them while the User Type II gets notified of the proposed financing scheme (Figure 8).

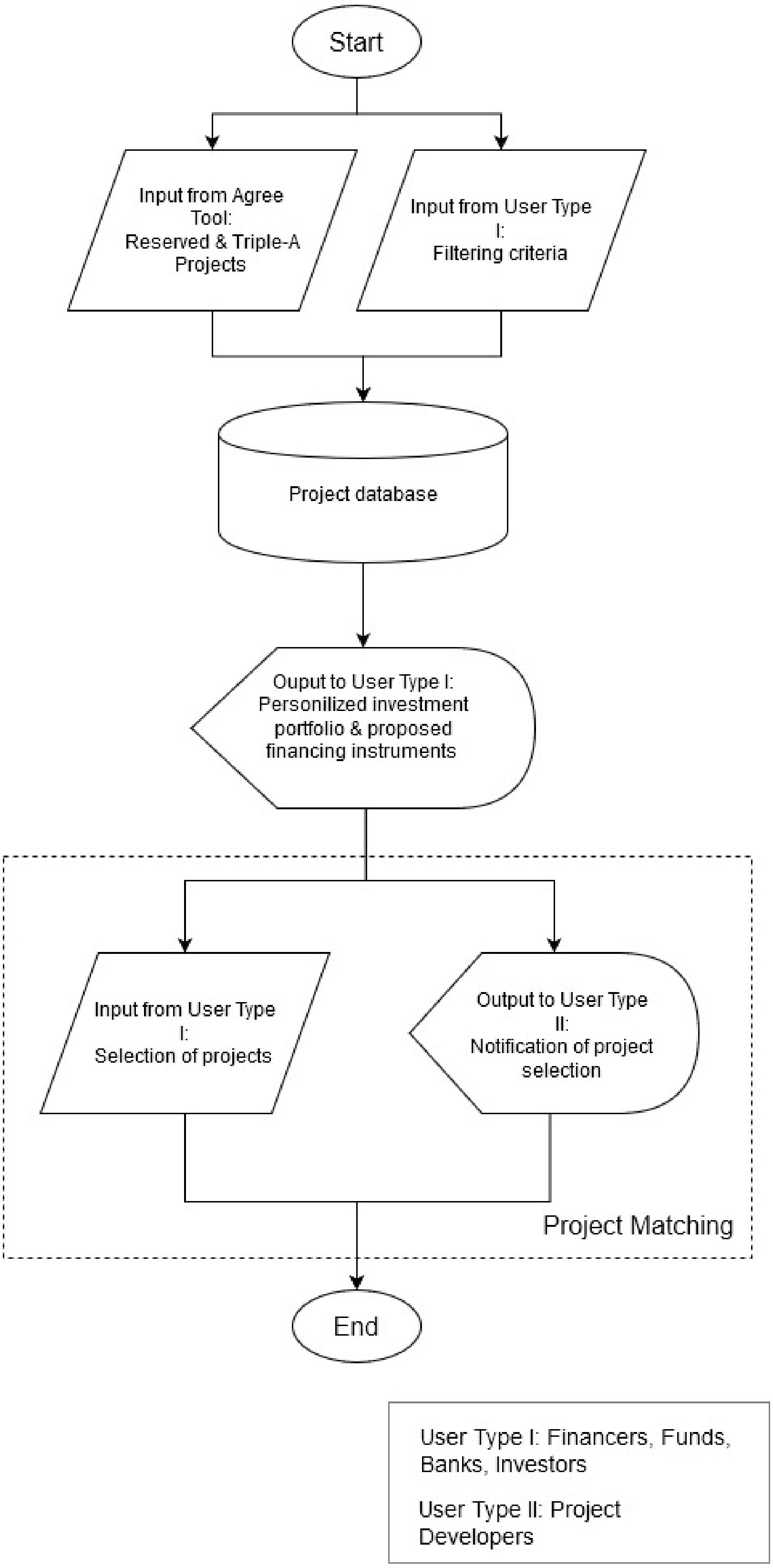


Figure 8: Triple-A Assign Tool Flowchart

5 Triple-A Standardized Tools

Initially, a prototype of the Triple-A Tool was created in order to provide an overview of the KPIs calculation, the required project data and an approach on how the Tool's user input components could be arranged in the final interface.

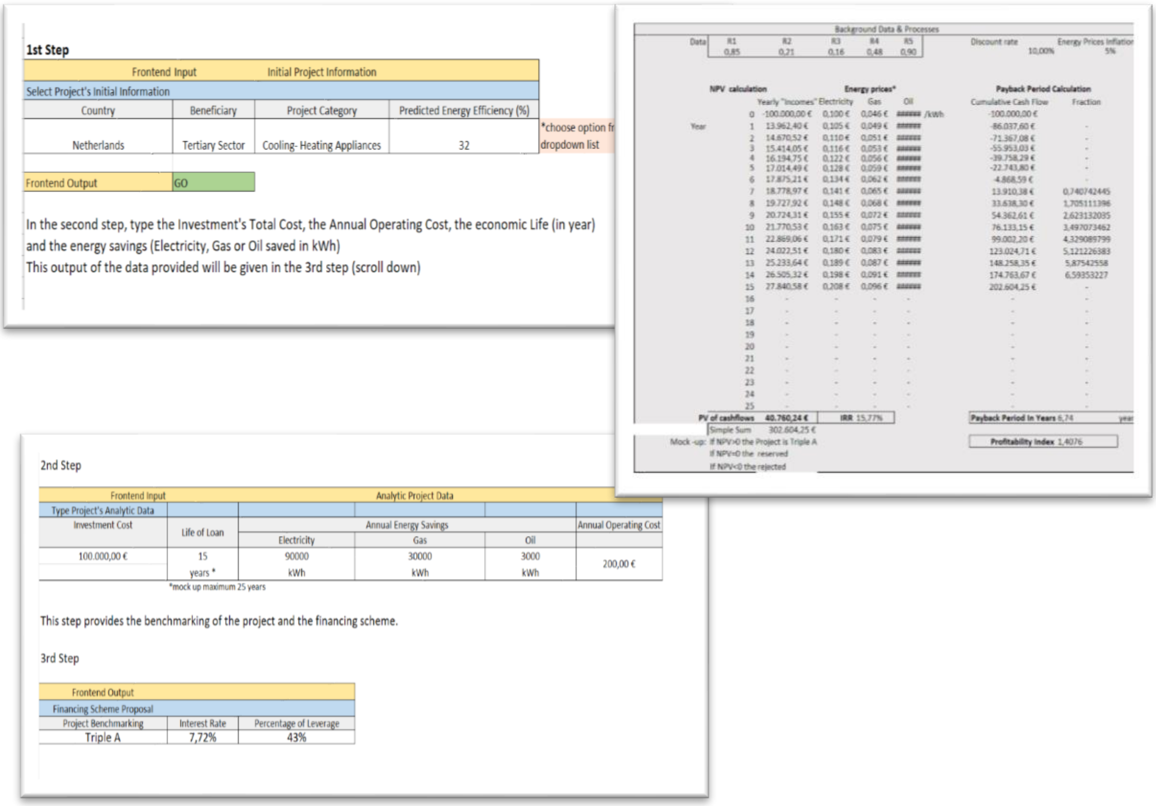


Figure 9: Initial Triple-A Tools Prototype

As a next step, online versions of the Triple-A Tools were created, displaying the user input and output interface of the three Triple-A Tools. The aim was to familiarize selected partners with the Triple-A Tools methodology and to get the necessary feedback as to proceed to the first Triple-A Tools version.

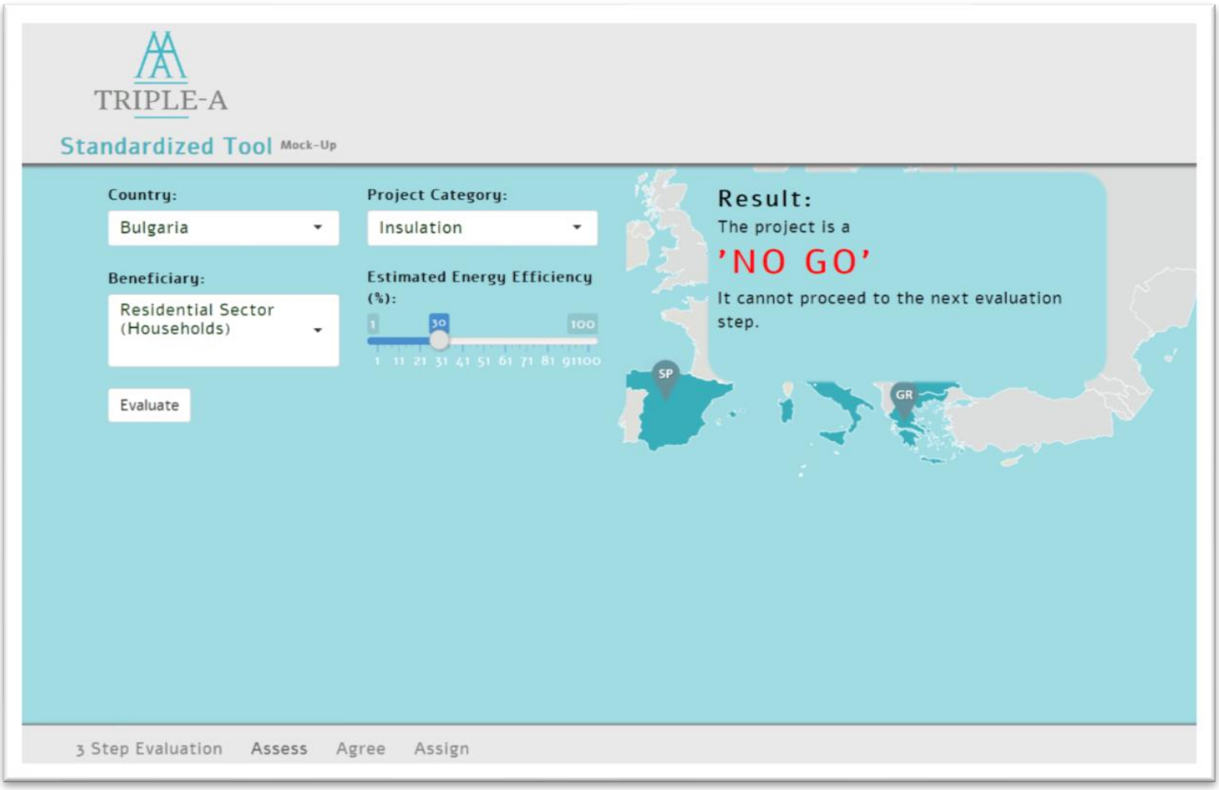


Figure 10: Preliminary online Triple-A Assess Tool

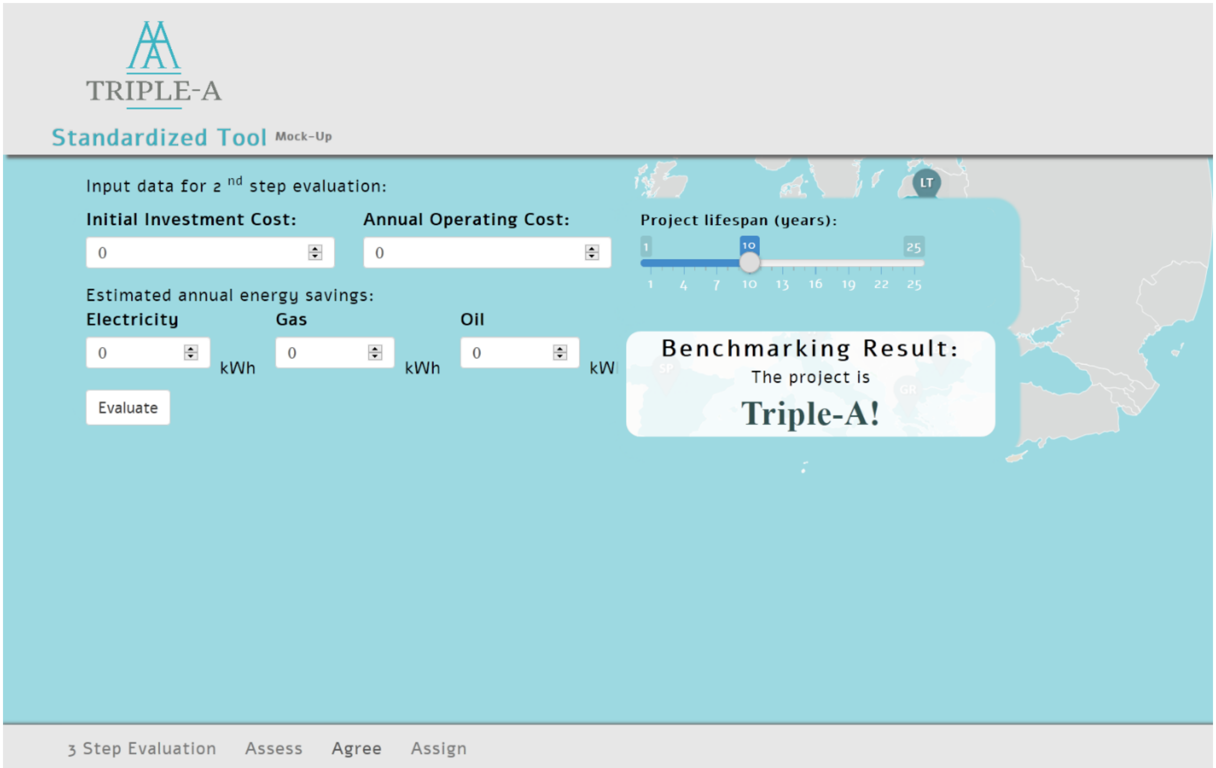


Figure 11: Preliminary online Triple-A Agree Tool

The first version of the Triple-A Tools (Figure 12) that incorporate all developments to date in the Triple-A methodology is implemented using Python 3.0 programming language. The web-based application is designed in Django, which is an open-source python web framework. Moreover, the user can interfere in the process as the system is fully configurable. The Triple-A Tools are accessible through the Triple-A Standardized Toolbox platform[7] which could be reached through the dedicated Triple-A webpage[8].

Along with the D4.1: Triple-A Standardised Tools, the D4.3: User manuals (first version) is published. The user manuals provide all necessary information regarding the Triple-A Tools functionality, while explaining the steps that an user should follow when using the Tools. The Triple-A Tools are analysed individually in the user manual, reporting all the operations that are required during the navigation to the information system.

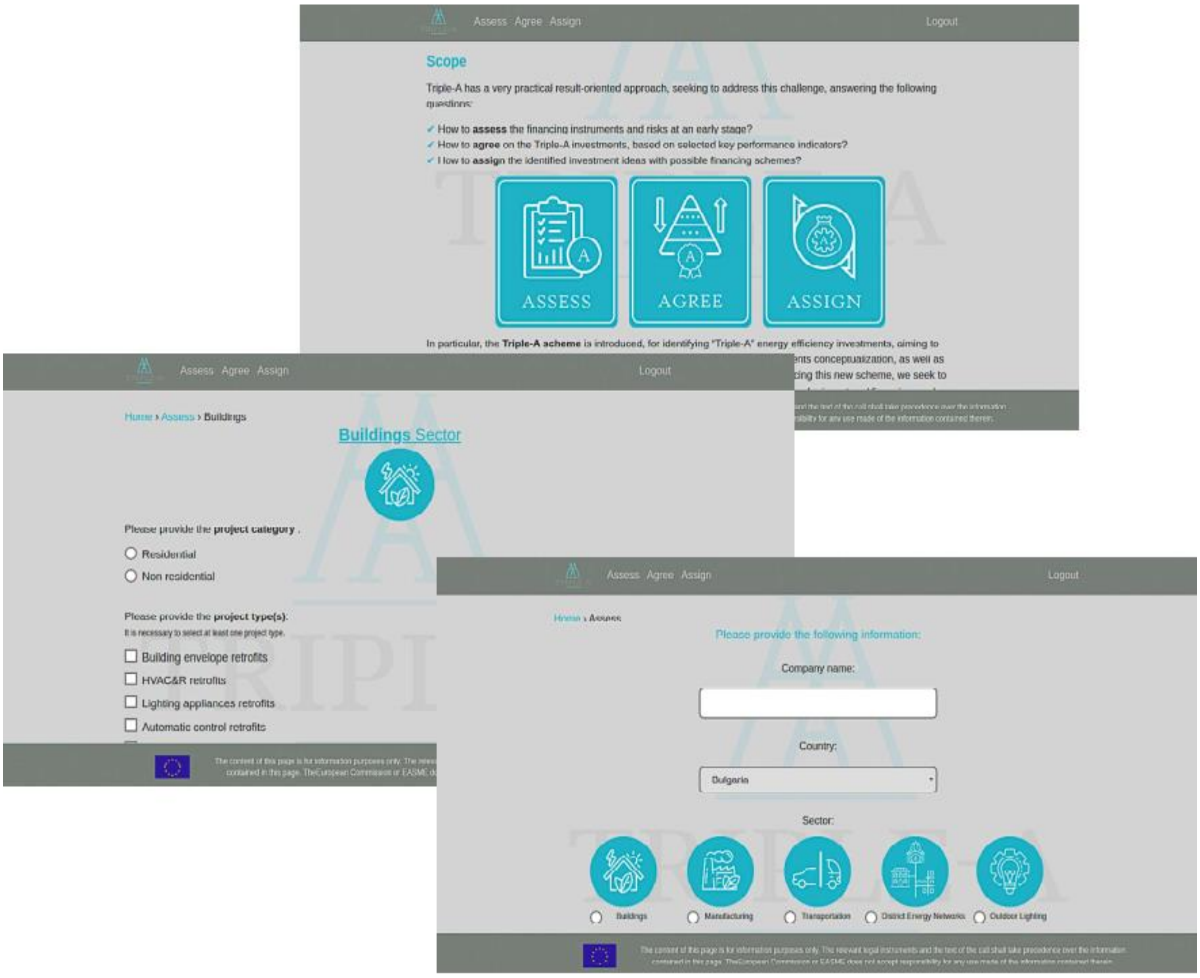


Figure 12: Draft Standardised Triple-A Tools Interface

[7] Standardized Triple-A Toolbox: http://toolbox.aaa-h2020.eu/

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

6 Next Steps

The Triple-A Tools delivered in June 2020 are draft versions of the Final Triple-A Tools that will be finished by December 2020. During the next period a stakeholders consultation process is conducted to provide valuable feedback and input data crucial to finetune the three Triple-A Tools.

Based on feedback received and in line with user needs and suggestions that will emerge, several upgrades and developments are planned for the User Interface and the backend methodology. The Final Triple-A Tools are prescribed to be user friendly, to incorporate all elements of the Triple-A Scheme and to facilitate the screening of EE projects. This draft version of the Tools is a starting point for further beautification, customization and upgrades.

The Final Triple-A Standardised Tools will be analytically presented in the related Deliverable 4.2: Final Standardised Triple-A Tools, due in M16 (December 2020).

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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_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 "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_2e/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_2e/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_2e/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_2e/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_2e/t of clinker.
- Cement (B): Specific emissions associated to the clinker and cement production processes are lower than 0.498 tCO_2e/t of cement.
- GHG emissions must be calculated according to the methodology used for EU ETS benchmarks.

Metrics:

- *(A) Specific emissions (tCO_2e/t of clinker)*
- *(B) Specific emissions (tCO_2e/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^2K)
- High efficiency doors (U-value better than 1.2 W/m^2K)
- 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 kilometer: 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^2K)

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 emmission 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-watt-hours (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 standardized procedures (e.g. usage of standardized 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

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

Appendix E - KPIs equations and calculations

A_1-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:

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

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:

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

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

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

A_2-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.

A_3-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 [42]. 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

A_4-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:

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

A_5-Cost Effectiveness

Cost effectiveness in its simplest form is a measure of whether an investment's benefits exceed its costs [43]. 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 F- 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:

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

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

If j is a minimization criterion:

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

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

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 [44]. 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 $b_i R a$ applies. Therefore, the alternative is classified in class C_i.

Appendix G - Triple-A Sectors & 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 H -KPI's thresholds

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

Internal Rate of Return

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